COMPAQ

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intraNetWare Performance Management

Compaq TechNote

Includes information on:

- Optimizing hardware configuration

- Recommended Guidelines for tuning SET parameters

- Planning and implementation of intraNetWare SFT III

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NOTICE

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Chapter 1
About This TechNote

This TechNote provides configuration and performance guidelines for intraNetWare based on Compaq integration and performance testing. It is intended for system integrators and network administrators with a knowledge of Compaq server products and intraNetWare. It is a supplement to the *Compaq Hardware Reference* documentation and the *intraNetWare* documentation.

This TechNote will help you:

■ Optimize hardware configuration

■ Tune SET parameters using recommended guidelines

■ Plan and install intraNetWare SFT III

This TechNote provides you with an understanding of the performance characteristics of intraNetWare, helps you understand how different configuration options can affect the performance of your Compaq server, and provides you with a foundation for network performance analysis and management. This TechNote focuses on file and print service environments, which typically support applications such as word processing, spreadsheets, PC-based databases, and graphic development. It also addresses the operating system and hardware components, such as applications and network protocols, that may also contribute to overall network performance.

NOTE: While this describes a majority of intraNetWare server implementations, the actual performance characteristics of your server can differ significantly due to the architecture of your network and the applications running on your server.

Although the typical resource-sharing environment does not always include internetwork communications, this TechNote provides some suggestions for performance enhancement in a WAN environment, because intraNetWare fully supports this environment.

Chapter Organization

The chapters in this Compaq TechNote contain the following information:

- *Chapter 1* – Introduces the TechNote with a brief summary of each chapter and general information about notational conventions used.

- *Chapter 2* – Discusses hardware planning, including system memory, hard drive subsystem, network interface controllers, and the system processor.

- *Chapter 3* – Discusses design and installation issues for intraNetWare, such as NDS, intraNetWare Time Service, file compression, block suballocation, and bindery services.

- *Chapter 4* – Focuses on monitoring your existing network server and using intraNetWare SET parameters to tune your server.

- *Chapter 5* – Discusses managing desktop performance in a distributed enterprise environment.

- *Chapter 6* – Discusses intraNetWare SFT III installation issues.

- *Appendix A* – Provides names of some manufacturers and suppliers of hardware and software for maintaining client and intraNetWare server time.

- *Appendix B* – Provides additional resources you can use to find more information on intraNetWare performance.

- *Glossary* – Defines server management and related networking terms.

Notational Conventions

Table 1-1 lists the conventions that this TechNote uses to distinguish elements of text found within this document.

Table 1-1
Notational Conventions

Convention	Use
CAUTION	Indicates that failure to follow directions could result in damage to equipment or loss of information.
COMMANDS, DIRECTORY NAMES, DRIVE NAMES, PROGRAMS, and UTILITIES	These items always appear in uppercase.
Enter	When instructed to enter information, type the information and press **Enter**.
FILENAMES	Names of files appear in uppercase italics.
IMPORTANT	Presents clarifying or specific points of information.
items of importance	Presents important or specific points of information. These items appear in italics.
Keys	Keys, such as **Enter**, **A**, **B**, **C**, appear in boldface.
Key+**Key**	When you see a plus sign (+) between two keys, hold down the first key while you simultaneously press the second key.
	For example, "Press the **Ctrl**+**Z** keys" means press and hold down the **Ctrl** key while you press and release the **Z** key.
"new terms" and "prompts"	The first occurrence of a technical term, prompt, or reference to a word other than a command appears in quotes.
NOTE	Presents commentary, sidelights, or interesting points of information.
screen selections and *variables*	These items appear in italics.
Select *item* → *item*	Items separated by arrows indicate items you select in a sequence.

Table 1-1
Notational Conventions

Convention	Use
User input and screen displays	Type Information exactly as it appears on the screen.
WARNING	Indicates that failure to follow directions could result in bodily harm or serious damage to equipment.

Chapter 2
Hardware Planning

Compaq offers a wide variety of hardware choices that are supported in an intraNetWare environment. This chapter discusses the Compaq hardware platform selection based on each of the following key subsystems:

■   System memory

■   Hard drive subsystem

■   Network interface controllers

■   System processor

It also discusses the relationships among these subsystems and provides guidelines on achieving a workload balance.

System Memory

Configuring your server with an adequate amount of system memory is critical to ensure optimum performance. This section helps you determine how much system memory is right for your Compaq server.

intraNetWare system memory architecture differs from earlier versions of NetWare, and uses more cache than earlier versions to enhance intraNetWare performance and to accommodate new memory protection schemes. In intraNetWare, system memory is allocated to a single global memory pool of 4-KB pages that intraNetWare can allocate to different processes.

Each NetWare Loadable Module (NLM) is allocated memory pages that are returned to the global pool when they are not used. When an NLM initially requests memory allocation, it receives a specific set of memory pages (called a node) and uses that node for all subsequent calls. Because the NLM uses the same node repeatedly during the time that the NLM is loaded, allocation becomes more efficient and fragmentation is reduced.

The following worksheet and example demonstrate how to calculate the recommended system memory requirements for your Compaq server to run intraNetWare. The minimum memory required to install intraNetWare is 20MB. However, this worksheet allows you to calculate a more efficient value for either a new server or double-check the memory requirements for an existing server. This worksheet replaces memory calculation formulas found in previous NetWare 3 and 4 documentation.

intraNetWare Server Memory Calculation Worksheet
(from *Novell AppNotes*, March 1997 – Photocopy as needed)

STEP 1: Calculate the following variables.

V1. Enter the *total* number of megabytes of disk connected to the server.   _____MB
   (For example: enter 1 for each MB, enter 1024 for each GB.)

V2. Calculate the number of megabytes of *useable* disk space connected to the server.   _____MB
   (If you are mirroring or duplexing multiply V1 * 0.5, otherwise copy V1.)

V3. Enter the server's volume block size (4, 8, 16, 32, or 64).   _____KB

V4. Calculate the number of disk blocks per MB (divide 1024 / V3).   _____Blocks/MB

V5. Calculate the total number of disk blocks (multiply V2 * V4).   _____Blocks

V6. Enter the maximum number of clients (end-users) attached to the server.   _____Clients
   (For example: enter 24 for 24 end-users)

V7. Enter the maximum number of files that will reside on the server.   _____Files

STEP 2: Calculate your individual memory requirements.

Line 1. Enter the base memory requirement for the core OS and NDS.   _____KB
   (Enter 6144 for intraNetWare; 11,264 for SFT; or 12,288 for SMP.)

Line 2. Calculate the memory requirement for the Media Manager (multiply V1 * 0.1).   _____KB

Line 3. Calculate the memory requirement for directory tables   _____KB
   (multiply V7 * .006, or if suballocation is enabled multiply V7 * .011).

Line 4. Calculate the memory requirement for additional Name Spaces   _____KB
   (multiply V7 * .006 * number of additional Name Spaces loaded on the server).

Line 5. Calculate the memory required to cache the FAT (multiply Line V5 * .008).   _____KB

Line 6. Calculate the memory requirement for file cache using the following table: _____KB
This calculation uses a 0.4-MB file cache per client memory requirement. The decrease as
the user community size increases is based on assumptions regarding increased repetitive
use of shared data (temporal and spatial locality) within cache.

Less than 100 clients	V6 * 400
Between 100 and 250 clients	40,000 + ((V6 - 100) * 200)
Between 250 and 500 clients	70,000 + ((V6 - 250) * 100)
Between 500 and 1000 clients	95,000 + ((V6 - 500) * 50)

Line 7. Enter the total memory (KB) required for support NLMs.   _____KB
   2,000KB is recommended for BTRIEVE(700), CLIB(500), INSTALL(600), and
   PSERVER(200)

Line 8. Enter the total memory (KB) required for other services.   _____KB
   Other services include GroupWise, ManageWise, NetWare for Macintosh, NetWare for
   SAA, and so on.

STEP 3: Calculate the server's total memory requirement.

Line 9: Total Lines 1–8 for your total memory requirement (in KB).   _____KB

Line 10: Divide Line 9 by 1024 for a result in MB.   _____MB
Using this result, round up to the server's nearest memory configuration. intraNetWare will
enhance server performance by using all leftover memory for additional file cache.

Example for Calculating intraNetWare System Memory

For this example on calculating system memory for intraNetWare, the following server configuration was used: Compaq ProLiant 1500 with five 2.1 gigabyte hot pluggable SCSI-2 drives in a RAID 0 configuration, Compaq NetFlex-2 ENET/TR Ethernet controller, and 250 clients. Add one additional Name Space for LONG.NAM for Windows 95.

To calculate the system memory requirement for intraNetWare, first determine the value of each of the server variables:

1. Add the total amount of disk space connected to the server. $V1 = 10752$ megabytes.

2. Calculate V2 by the number of megabytes of useable disk space connected to the server. $V2 = 10752$ megabytes.

3. Add the server's volume block size for V3. $V3 = 64$ Kbytes.

4. Calculate V4 by dividing 1024 by V3 (64). $V4 = 16$ blocks per megabyte.

5. Calculate V5 by multiplying the value of V2 (10752 megabytes) by V4, (16 blocks per megabyte). $V5 = 172{,}032$ blocks.

6. Add the maximum number of clients attached to the server. $V6 = 250$ clients.

7. Add the total number of files that will reside on the server. $V7 = 10{,}000$ files.

Now plug the server variables into the memory requirements worksheet to calculate the server memory for your Compaq server:

1. Enter 6144 for intraNetWare. Line 1 = 6144.

2. Calculate Line 2 by multiplying V1 (10240) by 0.1. Line 2 = 1075.2.

3. Calculate Line 3 by multiplying V7 (10,000) by 0.011 since suballocation is enabled. Line 3 = 110.

4. Calculate Line 4 by multiplying V7 by 0.006, then multiplying that answer by the number of Additional Name Spaces loaded on the server. Line 4 = 60.

5. Calculate Line 5 by multiplying V5 (172,032 blocks) by 0.008. Line 5 = 1376.256.

6. Calculate Line 6 by subtracting 100 from V6 (250) and multiplying by 200. Then add 40,000. Line 6 = 70,000.

7. Add the total memory required to load NLMs on the server for Line 7.

   For this example, the server will run the following NLMs and LAN driver: *CPQETHER.LAN*, *CPQHTHSA.NLM*, *DS.NLM*, *ETHERTSM.NLM*, *MONITOR.NLM*, *MSM.NLM*, *NWSNUT.NLM*, and *TIMESYNC.NLM*. See Table 2-4 for more information on approximate driver memory requirements.

   The total amount of memory needed for all NLMs is approximately 1105.6 Kbytes. Line 7 = 1105.6

8. Enter 0 since no additional services are running. Line 8 = 0.

Plugging these values into the server worksheet yields an optimal system memory requirement for this server of 78.0 megabytes. The complete formula is:

$$\text{Optimal Memory} \quad \frac{6144 + 1075.2 + 60 + 110 + 1376.256 + 70{,}000 + 1105.6 + 0}{1024}$$

Optimal Memory = approximately 78.0 megabytes.

The standard memory configuration for a Compaq ProLiant 1500 is 16 megabytes. Therefore, you would need to increase the system memory by adding four 16-megabyte SIMM modules. This would increase the system memory to 80 megabytes for this server configuration example.

NLM Memory Requirements

Table 2-1 lists some of the NLMs used in a resource-sharing intraNetWare environment and the *approximate* memory requirements for each. Use this list as a guideline for your server configuration.

Table 2-1
Approximate Driver Memory Requirements

Driver	Memory Requirement (KB)
Storage Drivers	
CPQARRAY.HAM	52.3
CPQDA386.DSK	37.1

Table 2-1
Approximate Driver Memory Requirements

Driver	Memory Requirement (KB)
CPQS710.DSK	95.0
CPQSCSI.HAM	116
CPQSDISK.DSK	46.2
CPQSHD.CDM	57.1
CPQSXPT.DSK	6.2
IDEATA.HAM	16.0
IDECD.CDM	9.6
IDEHD.CDM	9.7
NWASPI.CDM	12.5
SCSI2TP.CDM	38.0
SCSICD.CDM	24.6
SCSICHGR.CDM	26.6
SCSIHD.CDM	24.4
SCSIMO.CDM	24.4
LANs	
CPQ2ETH.LAN	73.4
CPQ2TOK.LAN	79.9
CPQETHER.LAN	73.0
CPQNF3.LAN	60.7
CPQTOKEN.LAN	79.9
PCNTNW.LAN	20.5
NLMs	
CDROM.NLM	131.3

Table 2-1
Approximate Driver Memory Requirements

Driver	Memory Requirement (KB)
CPQBSSA.NLM	114.9
CPQDSKSA.NLM[1]	72.8
CPQHLTH.NLM	107.7
CPQHTHSA.NLM	80.8
CPQMULIB.NLM	23.1
CPQSASPI.NLM	16.6
CPQSCD.NLM	14.4
CPQSTAPE.NLM	41.5
CPQTHRSA.NLM	12.8
DIAG411.NLM	23.0
DS.NLM	661.3
DSLOADER.NLM	8.9
ETHERTSM.NLM	9.0
FPSM.NLM	38.5
IPXS.NLM	6.3
LOADER	103.6
MONITOR.NLM	144.4
MSM.NLM	41.2
NB1.NLM	25.3
NBI.NLM	20.0
NBI31X.NLM	37.0
NLMLIB.NLM	154.5
NPAPATCH.NLM	3.0

Table 2-1
Approximate Driver Memory Requirements

Driver	Memory Requirement (KB)
NWPA.NLM	89.0
NWPAIO.NLM	32.0
NWPALOAD.NLM	4.0
NWPAMS.NLM	69.0
NWSNUT.NLM	72.6
PM312.NLM	15.0
REQUESTER.NLM	74.1
SERVER.NLM	1796.0
SNMP.NLM	74.0
STREAMS.NLM	49.4
SURVEY.NLM	324.0
THREADS.NLM	173.4
TIMESYNC.NLM	23.3
TLI.NLM	11.2
TOKENTSM.NLM	11.9

[1]Memory allocation for CPQDSKSA varies depending on the number of hard drives and hard drive controllers used. Most configurations use between 20 KB and 60 KB of memory.

NOTE: The memory requirements shown above are what the operating system initially reserves for these NLMs. Some NLMs might use additional memory after they are loaded.

Hard Drive Subsystem

In an intraNetWare environment, your hard drive subsystem is the second most important component to consider when configuring your Compaq server. In many environments, a large amount of system memory can compensate for an overworked drive subsystem, but ultimately the speed and reliability of your hard drive is a key element in the overall performance of your server.

Current hard drive technology provides a wide variety of offerings in the server industry. These offerings include high-performance drive arrays that provide hardware-based fault tolerance and support a large number of users, high-performance Fast-SCSI-2 drives that can easily meet the needs of most medium-sized networks, and drives with integrated intelligent controllers.

When selecting a hard drive subsystem for your network server, the following should be considered in your selection:

■ Fast-SCSI-2 drives

■ Fast-Wide SCSI-2 drives

■ Wide-Ultra SCSI-3 drives

■ Fast-SCSI-2, Fast-Wide SCSI-2, and Wide-Ultra SCSI-3 device drivers

■ Compaq drive array device drivers

■ Fault tolerance options

Compaq has integrated Fast-SCSI-2, Fast-Wide SCSI-2, and Wide-Ultra SCSI-3 technology into its servers and hard drive options to ensure maximum server performance.

Fast-SCSI-2 Drives

Compaq Fast-SCSI-2 drives use Error Correcting Code (ECC) logic to provide protection from data loss. During a write operation, ECC bytes are calculated and are written to the drive with the data. During a read operation, the data and the ECC bytes are read back. The ECC bytes are then recalculated on the data and are compared. If the ECC bytes match, the read is successful. If the ECC bytes do not match, the data can be reconstructed using the original ECC bytes. Faulty sectors, identified by mismatched ECC bytes, are remapped using Automatic Read/Write Reallocation. This ensures that the data is not written to the defective area. Figure 2-1 shows how Compaq drives use ECC to verify data.
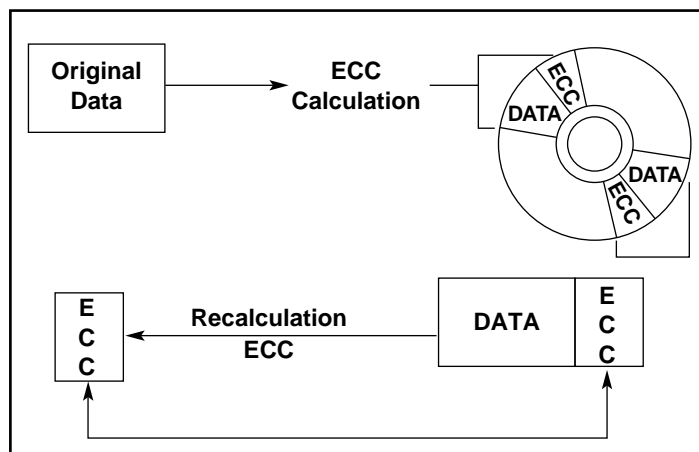
Figure 2-1.   Error Correcting Code (ECC) used by Compaq Fast-SCSI-2 drives

Fast-Wide SCSI-2 Drives

Fast-Wide SCSI-2 drives were developed to further enhance Fast-SCSI-2. This is accomplished by "widening" the Fast-SCSI-2 8 bit data bus to 16 bits and using the same bus speed as Fast-SCSI-2. The result is that Fast-Wide SCSI-2 doubles the transfer rate of Fast-SCSI-2 up to a maximum transfer rate of 20 megabytes per second. Although the maximum data transfer rate is doubled with Fast-Wide SCSI-2, the actual throughput enhancement you will experience is highly dependent on your server workload.

Server environments with a large number of small, random disk reads and writes will see little benefit. However, large, sequential read and write requests will perform significantly better than they would in a Fast-SCSI-2 subsystem.

Compaq Fast-Wide SCSI-2 drives can use the Fast-Wide SCSI-2 controllers. Since Fast-Wide SCSI-2 is a 16 bit bus, there are 16 legal device IDs available (0-15). However, Compaq supports only eight IDs per bus, one for the controller plus a maximum of seven for the drives. Limiting configurations to eight IDs per SCSI bus provides backward compatibility for continued use of Fast-SCSI-2 and maximum system configuration flexibility.

These drives provide an efficient interface between the hard drive and the operating system and include the following features:

■   Scatter/gather

■   Tagged command queuing

Table 2-2
Storage Drivers

DDFS driver	Equivalent NWPA driver	Description
CPQSTAPE.DSK	SCSI2TP.CDM	This module provides the tape device driver support for Compaq tape devices connected to Compaq SCSI-2 Controllers.
CPQSCD.DSK	SCSICD.CDM	Compaq SCSI CD-ROM driver. This module provides the driver support for CD-ROM devices connected to Compaq SCSI-2 Controllers.
CPQSASPI.NLM	NWASPI.CDM	Compaq ASPI support is provided by CPQSASPI.NLM. When CPQSASPI is loaded from the NetWare console, it reports the ASPI host adapter numbers associated with each slot where it finds a SCSI bus. ASPI host adapter numbers are assigned starting at zero and are based on the order in which the SCSI Interface Modules initialize the SCSI buses associated with particular slots. The order that the SCSI Interface Modules are loaded in the STARTUP.NCF file affects the order in which the SCSI Interface Modules initialize the SCSI buses.
CPQDA386.DSK	CPQARRAY.HAM	Drive Array device driver for NetWare v3.12, NetWare 4.11 SFT III, and intraNetWare/ NetWare 4.11.
CPQS94.DSK	no NWPA support	This module is the low-level SCSI bus device driver for Compaq Integrated SCSI-2 Controllers.
CPQSXPT.DSK	no NWPA equivalent necessary	The Compaq SCSI Transport module provides the transport of commands from the Compaq device drivers (such as CPQSDISK, CPQSTAPE, CPQSCD, and CPQSASPI) to the low-level SCSI bus interface modules such as CPQS710.DSK and CPQS94.DSK.

For most installations, DDFS drivers will perform adequately. However, there are several reasons why you may consider upgrading to the NWPA architecture. The primary reason for upgrading is that the next major release of intraNetWare/NetWare will only support NWPA drivers. Second, NWPA separates the host adapters—(called Host Adapter Modules, or HAMs) from the attached devices, such as hard disk drives, tape backups, and CD-ROM drives, —(called Custom Device Modules, or CDMs). This allows you to unload specific instances of the driver when multiple instances of the same driver are loaded. Furthermore, if your hardware supports PCI Hot Plug technology, NWPA drivers are required. Future storage options may only be supported by NWPA drivers. This includes Fibre Channel technology.

NOTE: intraNetWare server support for the Compaq 6260 SCSI-2 adapter used in Compaq desktop products is not provided.

NWPA Drivers
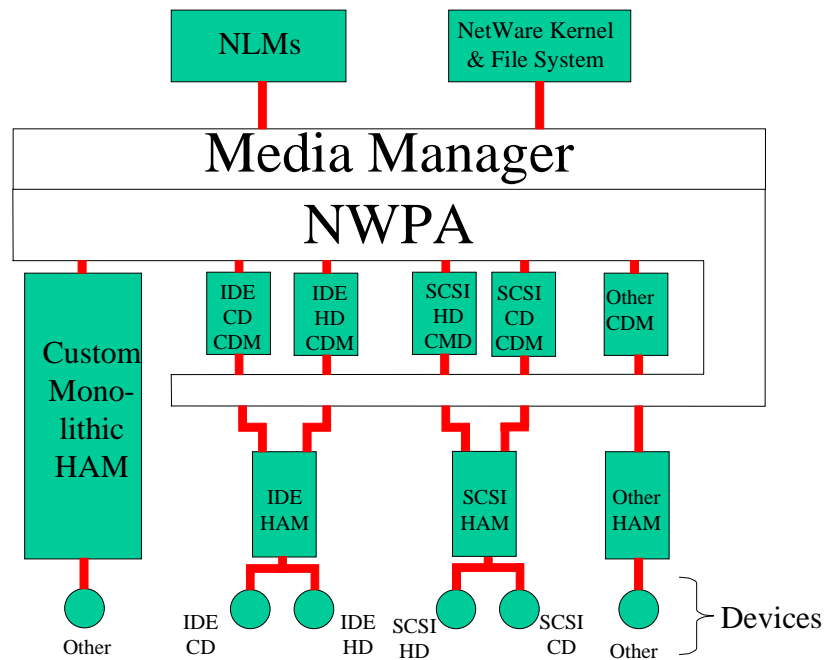
Figure 2-2. NWPA Architecture

There are some HAMs that include CDM functionality and do not require a separate CDM. These are referred to as monolithic or custom HAMs.

The HAM is the low-level driver for the host bus adapter hardware (controller). The CDM drives the devices connected to the host adapter bus. When you need to connect a new hardware device, you must load the appropriate CDM for that device, in addition to any HAMs and CDMs already loaded. It is no longer necessary to have a disk driver capable of running all devices attached to the adapter, making NWPA a better design for scalability.

NWPA.NLM is auto-loaded when the first HAM is loaded. It interfaces between the NWPA and the Media Manager. The Media Manager, in turn, interfaces between applications and storage device drivers to provide storage management. The applicable CDMs are loaded next.

The NWPA support files are located in the NWPA directory of the Novell Software Support Diskettes (NSSD) Disk 4.

CPQSCSI.HAM

CPQSCSI.HAM is the NWPA Host Adapter Module for Compaq Fast/Wide 32-Bit SCSI-2 Controllers and Wide-Ultra SCSI-3 Controllers.

The following are Compaq controllers supported by *CPQSCSI.HAM*:

■ Compaq 32-Bit Fast SCSI-2 Controller

■ Compaq Integrated 32-Bit Fast-Wide SCSI-2 Controller (PCI on ProLiant 850R, 1500, and 5000; EISA on ProLiant 4500)

■ Compaq 32-Bit Fast-Wide SCSI-2/E and /P Controllers

■ Compaq Integrated 32-Bit Fast SCSI-2 Controller in the following servers:

   ❑ Compaq ProLiant 1000, 2000, and 4000

   ❑ Compaq ProSignia

   ❑ Compaq ProSignia VS

■ Compaq Integrated 32-Bit Fast SCSI-2/P Controller in the following servers:

   ❑ Compaq ProSignia 300

   ❑ Compaq ProSignia 500

■ Compaq Integrated Wide-Ultra SCSI-3 Controller in the following servers:

❏ Compaq ProLiant 1200   ❏ Compaq ProLiant 1600

❏ Compaq ProLiant 2500   ❏ Compaq ProLiant 5000

❏ Compaq ProLiant 6000   ❏ Compaq ProLiant 6500

❏ Compaq ProLiant 7000

■ Compaq Wide-Ultra SCSI-3

■ Compaq Dual Channel Wide-Ultra SCSI-3

❏ Compaq ProLiant 3000

CPQSCSI.HAM Command Line Syntax

The *CPQSCSI.HAM* driver supports two optional command line parameters:

SLOT=X

port=x

Example:

LOAD [path]CPQSCSI SLOT=5 PORT=1

If the SLOT parameter is used, the driver must be loaded one time for each slot containing a Compaq 32-Bit SCSI Controller. If no SLOT parameter is specified, the CPQSCSI driver will locate all occurrences of supported controllers and initialize each, beginning with the lowest slot number. It may be necessary for the SLOT parameter to initialize controllers in an order required for tape drive support.

Using the optional PORT parameter, PORT=1 identifies the SCSI controller routed to the first drive cage, while PORT=2 specifies the controller routed to optional SCSI upgrade kits.

CPQSCSI.HAM automatically determines if supported devices are *Fast-Wide, Wide-Ultra,* or *narrow*, and therefore requires no command line switches to enable or disable Fast-Wide or Wide-Ultra devices.

If the SCSI Hard Drive Custom Device Module is not already loaded, *CPQSCSI.HAM* will autoload *CPQSHD.CDM*.

CPQSHD.CDM - Compaq SCSI Hard Drive Custom Device Module

CPQSHD.CDM is the NWPA SCSI Hard Drive Custom Device Module for Compaq hard disks. It contains the necessary code to handle the device-specific requirements of SCSI hard drives.

CPQSHD.CDM provides the disk driver interface from the intraNetWare operating system to disk devices connected to Compaq SCSI Controllers. It translates intraNetWare device driver commands (read, write, I/O) into SCSI commands.

When the CPQSHD module is loaded, it searches for all supported disk devices and registers them with intraNetWare. It also takes advantage of the performance features of the Compaq SCSI-2 subsystems.

CPQSHD.CDM supports the following command line switches:

- -DPR — Disable Prioritized Reads (default)

- -EPR — Enable Prioritized Reads

- -Q — Enable Tagged Queuing on third-party drives (default if Compaq)

- -V — Enable hardware level read-after-write verify (default if third-party)

Example:

LOAD [path]CPQSHD [-V][-Q][-EPR/-DPR]

DDFS Drivers

Like all Compaq hard disk device drivers, the Fast-SCSI-2, Fast-Wide SCSI-2, and Wide-Ultra SCSI-3 DDFS device drivers also include performance enhancement features that take advantage of the supported hard drive subsystem. The Fast-SCSI-2, Fast-Wide SCSI-2, and Wide-Ultra SCSI-3 DDFS device drivers are modular designs that include the following files:

- *CPQSDISK.DSK* - Provides support for devices connected to the Fast-SCSI-2, Fast-Wide SCSI-2, and Wide-Ultra SCSI-3 controller board or the Integrated Fast-SCSI-2, Fast-Wide SCSI-2, and Wide-Ultra SCSI-3 controller.

- *CPQS710.DSK* - Supports the Fast-SCSI-2, Fast-Wide SCSI-2, and Wide-Ultra SCSI-3 controller board and the Integrated Fast-SCSI-2, Fast-Wide SCSI-2, and Wide-Ultra SCSI-3 controller on all Compaq ProLiant and ProSignia servers.

■ *CPQSXPT.DSK* - Provides command transport from CPQSDISK.DSK
to *CPQS710.DSK*.

Compaq Drive Array Device Drivers

Compaq provides the DDFS device driver *CPQDA386.DSK* and the NWPA
driver *CPQARRAY.HAM*, for all Compaq drive array controllers.
CPQDA386.DSK and *CPQARRAY.HAM* include features that take advantage of
Compaq drive array subsystems such as the ability to send multiple concurrent
requests and chain sequential requests to enhance performance. The
CPQDA386.DSK and *CPQARRAY.HAM* device drivers also use the EISA bus
mastering capabilities to transfer data, which can significantly enhance
throughput.

CPQARRAY.HAM

The NWPA device driver, *CPQARRAY.HAM*, is a custom or monolithic .HAM
and has the following features:

■ Provides the functionality of both a HAM and a CDM, so a separate
CDM is not necessary.

■ Supports the following controllers:

❏ Compaq SCSI Managed Array Technology (SMART) Controller

❏ Compaq SCSI SMART-2 Array Controller

❏ Compaq SCSI SMART-2SL Array Controller

❏ Compaq SCSI SMART-2DH Array Controller

❏ Compaq 32-Bit Intelligent Drive Array (IDA) Controller

❏ Compaq 32-Bit IDA-2 Controller

❏ Compaq 32-Bit IDA Expansion Controller

■ Does not support the integrated SCSI controller on the SystemPro XL or
the DeskPro XL.

The *CPQARRAY.HAM* driver will automatically discover all supported
controllers when loaded without any command line parameters. If the SLOT
parameter is used to force a specific controller activation order, the driver must
be loaded for each slot containing a Compaq SCSI Controller. If no SLOT
parameter is specified, the driver will locate all occurrences of supported
controllers and initialize each.

The load command is:

> LOAD [path]CPQARRAY.HAM [SLOT=<slot #>]

△ **CAUTION:**   Do **NOT** attempt to load *ISADISK.DSK*. If the hard drives for a single drive array subsystem are configured and volumes are created using *CPQDA386.DSK or CPQARRAY.HAM*, and if *ISADISK.DSK* is loaded subsequently, all data will be lost.

NOTE: If you do not use SmartStart to install intraNetWare, you can find *CPQDA386.DSK* or *CPQARRAY.HAM* on Novell Software Support Diskettes (NSSD) 3.40 or later. See Appendix B for more information on NSSD. Always use the most current driver available.

Read-After-Write Verify

Compaq array drivers do not require or support intraNetWare software level read-after-write verify. This is due to increased reliability in disk subsystems and improved error detection and correction intelligence.

Fault Tolerance Options

While intraNetWare includes fault tolerance features for data integrity, such as NetWare Hot Fix, Read-After-Write Verification (RAWV), and Transaction Tracking System (TTS), these features alone do not provide comprehensive fault tolerance.

Fault tolerance can be provided by either the hardware or the operating system. Hardware fault tolerance methods, such as those provided in Compaq Array Controllers are independent of intraNetWare, relieving it of the task of managing the hard drive subsystem fault tolerance. The most common implementation of hardware fault tolerance is referred to as Redundant Arrays of Inexpensive Disks (RAID).

Compaq drive array controllers support four levels of RAID:

■   RAID 0 - Data striping with no fault tolerance

■   RAID 1 - Drive mirroring

■   RAID 4 - Data guarding

■   RAID 5 - Distributed data guarding

The method of fault tolerance you select for your server will affect the server performance. Drive mirroring (RAID 1) uses the "split seeks" feature to enhance performance by alternating read operations between the primary and secondary drive array. intraNetWare controller duplexing is an enhanced version of drive mirroring where the mirrored disk pairs are placed on separate disk controllers.

NOTE: Controller duplexing requires two controllers or one Compaq Dual Channel Wide-Ultra SCSI-3 controller. These controllers can include two SMART Controllers, two SMART-2 controllers, two Fast-SCSI-2 controllers (both integrated and board versions), two Fast-Wide-SCSI-2 controllers (both integrated and board versions), or two Wide-Ultra SCSI-3 controllers. For controller duplexing, the intraNetWare partitions must be the same size.

Compaq data guarding and distributed data guarding use less disk space to duplicate the data by using a single parity drive or parity "area" on each disk that stores encoded data. For data guarding, encoding the data for the parity drive requires overhead that can impede the performance. However, using distributed data guarding, intraNetWare writes data to multiple disks, rather than a single disk, eliminating much of the data guarding overhead.

The Compaq SMART or SMART-2 SCSI Array Controller can be configured for drive mirroring (RAID 1), data guarding (RAID 4), or distributed data guarding (RAID 5), providing protection against data loss. When the SMART or SMART-2 Controller is configured for one of these methods of fault tolerance, a hardware implementation of RAWV, called Dynamic Sector Repairing, is automatically enabled. This is a hardware task that reads and verifies all the sectors on the logical drive. Defective sectors are flagged as unusable and the data is remapped to reserved sectors.

In all cases, some implementation of fault tolerance is recommended. Select the appropriate method of fault tolerance based on site-specific criteria, such as cost, performance, and criticality of the network data. Use Table 2-3 to compare fault tolerance features.

Table 2-3
Comparison of Fault Tolerance Features

Fault Tolerance Method	No Fault Tolerance (RAID 0)	Mirroring (RAID 1)	Controller Duplexing	Data Guarding (RAID 4)	Distributed Data Guarding (RAID 5)
Usable Disk	100%	50%	50%	66% - 93%	66% - 93%
Parity and Redundancy	None	Duplicate data	Duplicate data	Dedicated parity drive.	Dedicated parity area on each drive.
Minimum # of Drives in Array	1	2	2	3	3
Advantage	Highest performance. Maximum available storage.	Data redundancy. Multiple reads and writes. Split reads.	Data and controller redundancy. Multiple reads and writes. Split reads.	Data integrity through parity. Can have good performance in sequential read application.	Multiple simultaneous reads and writes. Data integrity via parity.
Disadvantage	High risk. No data redundancy.	Requires twice the disk space of no fault tolerance.	Requires two controllers and twice the disk space of no fault tolerance.	Performance degradation with write operations. Recommend RAID 5 whenever possible.	Minimal performance degradation with write operations (less than with RAID 4). Degradation decreases with additional drives or drive array pairs.
Typical Environment	Non-critical data.	High performance database; real-time critical data.		Provides fault tolerance for critical data where disk space is more important than performance.	

Compaq Online Configuration Utility for intraNetWare

CPQONLIN.NLM is supported on both NetWare 3.12 and intraNetWare. It is not supported on earlier versions of NetWare.

NOTE: Before loading *CPQONLIN.NLM*, you must load the array device driver, either *CPQARRAY.HAM* or *CPQDA386.DSK* 3.01 or later.

You can configure the SMART-2 Controller without taking down your intraNetWare server or any existing intraNetWare volumes by running *CPQONLIN.NLM*.

The following functions can be performed by *CPQONLIN.NLM*:

■   Create or delete arrays

■   Reconfigure arrays

■   Expand arrays

■   Assign spare drives

The following basic information about the status of the logical drives attached to the SMART-2 Array Controller is available:

■   Failed logical drive

■   Expanding array

■   Rebuilding array

■   Queued expansion or rebuild (of an array)

The following basic information about the physical drives attached to the SMART-2 Array Controller is available:

■   Location

■   Size

■   Firmware version

■   Model

Installing the Online Configuration Utility for intraNetWare

The following are steps required to install *CPQONLIN.NLM*:

1.   Copy the *CPQONLIN.NLM* into a directory on an intraNetWare volume such as SYS:SYSTEM. *CPQONLIN.NLM* cannot be loaded from a DOS partition on NetWare 3.12 servers. Attempting to load this NLM from DOS may cause the server to hang.

   On intraNetWare servers, you may install the Compaq Online Configuration Utility from the Installation Options menu of the intraNetWare Install utility. From the *Product options* selection, choose *Install a product not listed.* Follow the prompt screens, inserting the NSSD diskettes as requested. All necessary files will be installed.

2. You must have the Novell Media Manager installed. The two required files are *PARTAPI.NLM* and *VOLLIB.NLM*. These files must exist in an intraNetWare directory that is in the SEARCH path.

3. Load *CPQARRAY.HAM,* or *CPQDA386.DSK* 3.01 or later, even if the Compaq Array Controllers in the system have not been configured.

4. Load the Compaq Online Configuration Utility for intraNetWare by entering the following command at the intraNetWare console prompt:

   LOAD CPQONLIN

Initial Available Options Menu Screen from CPQONLIN.NLM
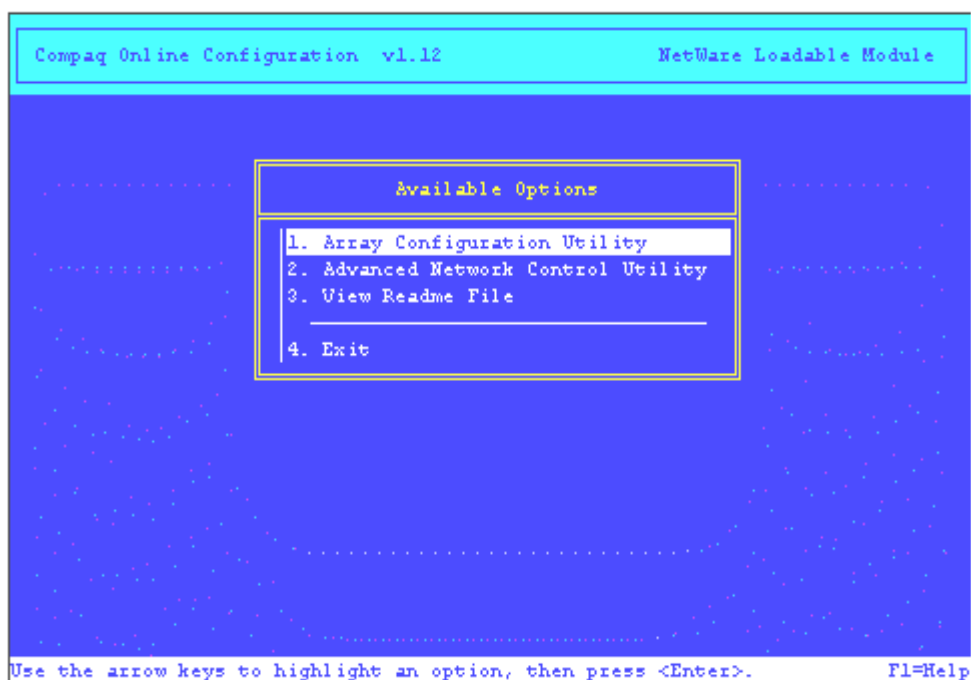
Figure 2-3. Compaq Online Configuration Available Options Screen

The initial Available Options menu screen gives the following selections:

■ **Array Configuration Utility** — Allows you to select which array controller you would like to configure.

■ **Advanced Network Control Utility**— Used to monitor the status of the active and standby network controllers. This feature pertains to network interface controllers and is not, therefore, discussed in this module.

■ **View Readme File** — Allows you to view a portion of the Storage Readme file that is also found on the NSSD Disk 2. This gives you the option of viewing necessary information at the server console without having to search additional materials.

■ **Exit** — Unloads *CPQONLIN.NLM*.

IDE Technology

IDE Basics

IDE/ATA (Integrated Drive Electronics/AT Attachment)

IDE and ATA are the same thing; a disk drive configuration that integrates the controller onto the drive instead of a card. Thus, interface costs are reduced, and firmware implementations are simplified.

EIDE (Enhanced IDE)

Contrary to popular belief, EIDE is not a standard. It is a marketing program consisting of a software part – an Enhanced BIOS specification which breaks the 504 MB barrier, and a hardware part that has been derived from the ATA-2 (hard drives and ATA-PI (tapes, CD-ROMs) standards. EIDE consists of four basic features (although some companies do not incorporate all of them in their EIDE configurations):

■ High Capacity Addressing of ATA Hard Drives – This feature is based on the AT Attachment (ATA) industry standard specification that defines how drives greater than 528 MB are addressed by the system BIOS. Proper implementation requires that the drive, BIOS, and operating system all support the ATA specification.

■ Fast Data Transfer Rates for ATA Hard Drives – This feature is based on the ATA industry standard specification for programmed input/output (PIO) mode 3, and multiword direct memory access (DMA) mode 1. These transfer modes support burst transfer rates of up to 11.1 MB/s, and 13.3 MS/s, respectively. The fast transfer capabilities take advantage of the higher bandwidth of ATA local-bus attachments, and are wasted if the drive is attached to a low bandwidth connection such as the ISA bus.

■ Dual ATA Host Adapters – This feature uses a secondary host adapter address along with a secondary system interrupt (IRQ15) to address a second ATA host adapter, thus support up to four devices.

■ Non-Hard Disk ATA Peripherals – This feature is targeted at CD-ROM drives, tape drives, and other peripherals that use the ATAPI (AT Attachment Packet Interface) specification command set. Previously, only hard drives could be connected to an IDE Controller.

ATAPI (AT Attachment Packet Interface)

The Western Digital-authorized ATAPI specification is an enhanced IDE-ATA specification that enables connectivity of non-disk peripherals to an IDE controller. In other words, ATAPI is designed to allow devices such as CD-ROMs and tape drives to plug into an ordinary ATA (IDE) port. ATAPI is a packet-based interface whose command set is actually derived from SCSI. The principal advantage of ATAPI hardware is that it is inexpensive and works with existing host computer hardware and cabling.

IDE Operation Modes and Speeds

PIO (Programmed I/0)

PIO uses an interrupt-driven method to transfer data. The chain of events is as follows: a data request is made by the CPU; the device (disk drive) retrieves the data, and then generates an interrupt to the processor. The CPU responds to the interrupt and the data transfer begins. This method is slow, but is simple and efficient in terms of hardware cost.

PIO modes are rated according to maximum data transfer speed. The modes ranges from 0-4, with a subsequent speed increase on each level. The modes and speeds are:

■ Mode 0 (3.3 MB/s)

■ Mode 1 (5.2 MB/s)

■ Mode 2 (8.3 MB/s)

■ Mode 3 (11.1 MB/s)

■ Mode 4 (16.6 MB/s)

DMA Modes

DMA, or Direct Memory Access, means that the data is transferred directly between drive and memory without using the CPU as an intemediary, in contrast to PIO. In true multitasking operating systems, DMA leaves the CPU free to do something useful during disk transfers. In a DOS/Windows environment, the CPU will have to wait for the transfer to finish anyway, so in these cases DMA is not particularly useful.

There are two distinct types of direct memory access: DMA and bus-mastering DMA. Ordinary DMA relies on the DMA controller on the unit's system board to perform the complex task of arbitration, grabbing the system bus and transferring the data. In the case of bus-mastering DMA, all this is done by logic on the interface controller itself. Of course, this adds considerably to the complexity and the price of a bus-mastering interface.

Bus-mastering is a protocol by which the CPU actually gives control of the bus to an I/O device, such as a disk controller. This allows the controller to transfer data directly between itself and memory. The CPU does not have to act as a mediator on the bus; therefore, there is minimal CPU utilization during transfers, and the data transfers can be very fast.

EDMA (Enhanced Direct Memory Access)

Enhanced DMA is the term for the method used to achieve the DMA bus mastering transfers on the IDE controller. While the EDMA speeds appear to be similar to those of PIO Mode 4, the real advantages to EDMA are the support of burst transfers on the bus, and the decrease in processor utilization due to DMA. The EDMA modes and speeds are:

■ multi-word DMA Mode 0 (4.17 MB/s)

■ multi-word DMA Mode 1 (13.3 MB/s)

■ multi-word DMA Mode 2 (16.6 MB/s)

Ultra ATA/UDMA (Ultra Direct Memory Access)

UDMA, Ultra ATA, or Ultra ATA-33 hard drives and system interfaces are fully backward compatible with all EIDE and IDE modes. Transfer speeds will simply adjust to the slowest link in the chain. The interface supports both Master/Slave and Cable Select configuration. Compared to EDMA, the UDMA standard adds the additional feature of CRC (Cyclic Redundancy Check) to the IDE bus along with the increased transfer rates. UDMA is included in the new ATA-4 specification.

UDMA is supported in BIOS, and by the IDE controller. There are no special drivers, as UDMA is just a different interface between the drive and the controller. The software aspect is the same. The standard Microsoft DMA driver will work. Unlike some earlier units, the system BIOS determines the drive speed and sets up everything. This was previously handled by some drivers. BIOS will sense integrity issues with the given device configuration and adjust the IDE bus speed accordingly. If necessary, you can force the interface into a slower mode using Computer **F10** Setup. UDMA modes and speeds are:

■　Mode 0 (16.6 MB/s)

■　Mode 1 (25 MB/s)

■　Mode 2 (33.3 MB/s)

UDMA Service Issues

For UDMA modes, close attention should be paid to cable length when using a standard IDE/EIDE 40-conductor cable. Adding cables longer than 14" in a single drive configuration will cause data integrity problems. Units will ship with a standard 40-conductor cable that is less than 14" in length. In a single hard drive configuration, UDMA mode 2 (33.3 MB/s) is supported.

If a second drive is added and the standard 40-conductor cable is used, BIOS will set UDMA to Mode 1 (25 MB/s). if a second drive is used and the 80-conductor cable is used (recommended), BIOS will sense this and set UDMA to Mode 2 (33.3 MB/s).

For optimal performance, keep the hard drives on the primary controller; CDs, tape drives, LS-120s, etc. should reside on the secondary controller.

IDE Configuration

IDE Translations

Standard CHS (Cylinders-Heads-Sectors) and the 528 MB Barrier

The standard CHS scheme used on older PCs was limited to 1024 cylinders, 16 heads, and 64 sectors (denoted 1024/16/63) due to the compatibility issues between the ATA/IDE interface, which links the hard drive to the BIOS, and the Int13h interface, which links the BIOS and DOS (or the O/S). Thus, the maximum formatted drive capacity that could be used by the system was 528 MB, even if the actual drive capacity was greater.

The size limitation was due to the difference between the interfaces, not the actual limitations of each interface. The differences are as follows:

Parameters	IDE/ATA	BIOS (Int 13h)	Lowest Common Denominator
Sectors per track (SPT)	225	63	63
Heads	16	255	16
Cylinders	65536	1024	1024
Max. Size	137 GB	8.4 GB	528 MB

Clearly, each interface is individually capable of much more than 528 MB, but the lowest common denominator must be used in communication between the interfaces. Thus, 528 MB is the effective maximum capacity available to the system under the Standard CHS scheme.

Extended CHS

Extended CHS (also referred to as Large Disk Mode) attempted to break the 528 MB barrier by translating the CHS parameters at the BIOS/Int 13H interface to the CHS parameters at the ATA/IDE interface. For example, if your drive has 1500 cylinders and 16 heads, a translating BIOS will make programs think that the drive has 750 cylinders and 32 heads.

LBA (Logical Block Addressing)

With this method, the standard addressing convention described above is completely replaced. The same registers are used to pass cylinder, head, and sector information, but the information itself is completely redefined as a logical block address, such as an address found in SCSI.

LBA is a means of linearly addressing sector addresses, beginning at sector 1 of head 0, cylinder 0 as LBA 0, and proceeding on to the last physical sector on the drive, which, for instance, on a standard 540 MB drive would be LBA 1,065,456. This has always been the adressing mode used in SCSI.

LBA reduces CPU overhead because the O/S makes requests in LBA calls, which the BIOS normally has to convert to CHS (cylinder head sector) addressing (the common method) before calling the drive. With LBA, this conversion process is removed.

Master/Slave Relationships

A master/slave relationship exists when there are two hard drives connected to a single port. In this situation, one drive must be designated as the master, or primary drive, and the other as the slave, or secondary drive. This designation is necessary because both drives cannot work simultaneously.

Cable Select

Some computers use cable-select (CS) technology for identifying IDE hard drive device 0 (master) and device 1 (slave), depending on where they are connected on the cable-select cable. The configuration jumpers on both hard drives are set the same, usually on the "CS" setting. The jumpers on new Compaq IDE hard drives are preset for cable-select installation.

Cable-select hard drives and IDE cables are backward-compatible with computers that do not support cable-select. When a cable-select hard drive is used in a non-cable select computer, the drive jumpers must be reconfigured for drive select.

Drive Select

Drive select designates IDE hard drives as master or slave based on jumper settings on the hard drive, not on position on the cable. When installing a slave drive with an existing single drive, the jumpers on the existing drive may have to be changed from "single" to "master", depending on the drive. For some drives, the single and master jumper settings are identical.

Note: If a third party drive or a drive option does not support cable-select, cable-select is invalidated, and the master/slave jumpers will have to be configured on the drives to identify which drive is C and which drive is D.

IDE Support

IDE device support is provided by NWPA drivers, which are located in the \IDE directory of the NSSD. NWPA drivers require support files located in the \NWPA directory of the NSSD. These files are shown in Table 2-4.

Table 2-4
IDE Support

Driver	Description
IDEATA.HAM	This Novell provided Host Adapter Module provides the driver support for IDE controllers.
IDECD.CDM	This Novell provided NWPA Custom Adapter Module provides the driver support for IDE CD-ROM devices. This device driver, along with IDEATA.HAM, may be used with any NetWare application that uses the NWPA Media Manager Interface to communicate with devices such as CDROM.NLM.
IDEHD.CDM	This Novell provided NWPA Custom Device Module provides the driver support for IDE disk drives.

CD-ROM Support Overview

Compaq SCSI CD-ROM devices may be attached to any of the Compaq 32-Bit SCSI Controllers. It may be possible for third party CD-ROM NLM applications to use the Compaq Advanced SCSI programming Interface (ASPI) support to access CD-ROM devices attached to these Compaq Controllers. Refer to the section "ASPI Support from Compaq" on the NSSD for more information about installing the CPQSASPI NLM.

If an IDE CD-ROM drive and a hard drive are on the same controller, the performance of the hard drive may be degraded. Therefore, IDE CD-ROM drives should be attached to the secondary controller if one is present. Refer to the IDE Support section for information on the necessary device drivers and support modules.

For information on installing NetWare from CD-ROM, see *INSTALL.RDM* on the NSSD.

The *CPQSCD.DSK* DDFS device driver and *SCSICD.CDM* NWPA device driver provide support for the NetWare 3.12, NetWare 4.x, and intraNetWare CDROM NLM to obtain data from a Compaq CD-ROM device attached to a Compaq 32-Bit SCSI Controller. The *CPQSCD.DSK* and *SCSICD.CDM* files are located on the NSSD. *SCSI2TP.CDM* supports Compaq SCSI tape drives.

SCSICD.CDM

SCSICD.CDM provides driver support for Compaq CD-ROM devices connected to Compaq SCSI Controllers, which are supported by *CPQSCSI.HAM*.

SCSICD.CDM performs the following functions:

- Supports intraNetWare applications that use the Disk Application Interface (DAI) or Media Manager Interface to communicate with devices

- Supports Compaq CD-ROM drives with *CDROM.NLM* from Novell

- Does not support applications that use the ASPI interface

Some applications use the ASPI interface, supplied by *NWASPI.NLM*, to communicate with CD-ROM devices. If the application uses the *SCSICD.CDM* driver, SCSICD provides all device specific handling. Refer to your application documentation to determine which driver interface to use.

Using the CD-ROM Under NetWare 3.12, 4.X, and intraNetWare

Novell's *CDROM NLM* ships with NetWare 3.12, NetWare 4.x, and intraNetWare. This NLM can be used with the Compaq *CPQSCD.DSK* or *SCSICD.CDM* driver to access information located on a CD installed in a Compaq CD-ROM drive. Refer to the Novell documentation for further information about installing and using the *CDROM NLM*.

1. To load the *CPQSCD.DSK* or *SCSICD.CDM* file, use the following command:

   LOAD *CPQSCD.DSK* or
   LOAD *SCSICD.CDM*

   If you want to load the CPQSCD driver each time NetWare is restarted, add the LOAD command to your server's *STARTUP.NCF* or *AUTOEXEC.NCF* file.

2. Once CPQSCD is loaded, Novell's *CDROM.NLM* will recognize CD-ROM devices. To load the *CDROM NLM*, use the following command.

    LOAD CDROM.NLM

    This LOAD directive may also be included in the *AUTOEXEC.NCF* file. You should add it after the LOAD *CPQSCD.DSK* or *SCSICD.CDM* command.

3. To mount a CD volume, follow these steps:

    a. Insert a Compact Disc (CD) into the CD-ROM drive.

    b. Display the list of available CD volumes using the *CDROM NLM* command from the NetWare server console CD VOLUME LIST**.**

    c. Mount the CD volume by a name of your choice using the following CDROM NLM command from NetWare server console. The volume name used in this example is VolumeName.

    CD MOUNT VolumeName

4. To mount a CD-ROM as an IntranetWare volume with SCSICD.CDM:

    a. Verify that the NWPA Custom Device Module is loaded for the Compaq SCSI Controller on which the Compaq CD-ROM is attached.

    b. LOAD *SCSICD.CDM*.

    c. LOAD *NWPA.NLM* (NetWare Peripheral Architecture NLM).

    d. LOAD *CDROM.NLM*.

    e. Enter *CD DEVICE LIST* to identify the CDROM device number or volume name.

    f. Enter *CD MOUNT* [device number] or [volume name].

    g. You may now map the volume as you would with a hard drive volume.

5. For more information about CD commands supported by the CDROM NLM, refer to Novell documentation. Online help for *CDROM.NLM* is available at your NetWare server console by issuing the following command.

    CD HELP

Installing Compaq NWPA Storage Support

First, install the latest Support Pack from Novell. Then, to install the NWPA drivers:

1. Load *INSTALL.NLM* at the server console.

2. Select *Product Options* from the Main Menu.

3. Choose *Install a product not listed*.

4. Insert the NSSD Disk 1 and press **Enter**.

5. Choose *NWPA Storage Support from Compaq*.

6. Press **F10** to begin the installation process and specify the server boot path.

7. Insert the requested NSSD disk when prompted.

8. When the installation is complete, restart the server.

Tape Drive Support Overview

NOTE: SCSI devices cannot be configured both internally and externally on the same SCSI Bus.

CPQSTAPE.DSK - Compaq DDFS SCSI Tape Driver

CPQSTAPE.DSK provides the tape device driver support for Compaq tape devices connected to Compaq SCSI controllers, which are supported by *CPQS710.DSK* and *CPQS94.DSK*. *CPQSTAPE.DSK* only supports Compaq ACA and DAT tape drives and performs the following functions:

■ Supports IntranetWare applications that use the DAI or Media Manager Interface to communicate with devices

■ Supports Compaq tape drives

■ Does not support applications that use the ASPI interface

When using NetWare SBackup 3.1x, also use the *CPQSDIBI.NLM* to provide the Device Independent Backup Interface (DIBI) from SBackup 3.1x to the CPQSTAPE driver. NetWare 4.x SBackup does not require the CPQSDIBI NLM. Some tape applications use the ASPI interface, supplied by *CPQSASPI.NLM*, to communicate with tape devices. For example, Cheyenne ARCserve uses the Compaq ASPI interface. If the application uses the *CPQSTAPE.DSK* driver, CPQSTAPE provides all device specific handling. Refer to your application documentation to determine which driver interface it will use.

SCSI2TP.CDM – NWPA SCSI Tape Driver

The Novell provided *SCSI2TP.CDM* Custom Device Module provides support for many (but not all) Compaq tape devices connected to SCSI Controllers which are supported by *CPQSCSI.HAM*, for *SBACKUP* support.

If you have another type of tape drive:

1. Include the following statements in your STARTUP.NCF file.

    LOAD *CPQS710.DSK* or *CPQSCSI.HAM*

    LOAD *CPQSDISK.DSK* or *CPQSHD.CDM*

2. Make sure the AUTOEXEC.NCF file has the following lines:

    LOAD *CPQSASPI.NLM* or *NWASPI.NLM*

    LOAD *TAPEDAI.NLM*

Cheyenne ARCserve 6.1 has been found to have problems when it is run with the default *SCSI2TP.CDM* still loaded. The problem is caused by both the default CDM and the ARCserve driver attempting to control the tape at the same time. The tape drive receives commands from both paths and corrupts backup tapes being produced by rewinding or repositioning. This problem should be common to all ASPI tape drives.

The solution is a two step fix.

1. Rename *SCSI2TP.CDM* to a *SCSI2TP.SAV*. This file is located in the SYS:SYSTEM directory or C: partition where *SERVER.EXE* is located.

2. Ensure the *ASPIBD.NLM* is at least build number of 78. The build numbers of *ASPIBD.NLM* installed from the ARCserve 6.1 Service Pack for NetWare from 3/97 is 78, and from 6/97 is 88. Either of these versions will properly support the Compaq *CPQSCSI.HAM* driver.

Installing ARCserve

ARCserve from Compaq backup software solution combines the capabilities of Cheyenne ARCserve with streamlined installation and ease use on Compaq systems. Refer to the Compaq SmartStart documentation for complete installation and troubleshooting information.

Installing Cheyenne ARCserve 6

ARCserve uses the ASPI programming interface to send commands to SCSI devices, such as tape drives, and uses the ASPI host number to specify to which SCSI bus the command should be sent. Configurations with a single SCSI bus will use ASPI host number zero. See the section on "ASPI Host Numbers for Configurations with Multiple SCSI Buses" on the NSSD for more detail.

Compaq TurboDAT Autoloader and Installation of ARCserve Autoloader Tape Driver

In many NetWare environments, the use of a tape autoloader can greatly reduce the manual effort and time required by most backup systems. The Compaq TurboDAT Autoloader incorporates a single Digital Data Storage-2 (DDS-2) DAT drive and an autoloader mechanism to manipulate a removable cassette magazine which holds the DAT cassettes.

The Compaq TurboDAT Autoloader requires autoloading software such as ARCserve Autoloader from Compaq. This software comprehends which tapes are in which slots in the autoloader so that the tapes can be loaded at the appropriate times.

NOTE: SBackup does not support the TurboDAT Autoloader.

Novell's Storage Management Services (SMS)

Novell's Storage Management Services (SMS) are NLMs that provide support for server based backup software. For NetWare 4.x, Novell evolved the SMS design from SMS under NetWare 3.11. More specifically, backup applications that use SMS 1.2 under NetWare 3.11 will not be compatible with SMS 1.3 under NetWare 4.x. Furthermore, applications that use SMS 1.2 and SMS 1.3 do not read or write the same logical tape format and therefore do not interchange data. Care should be taken when labeling tapes created by SBackup to indicate the version used.

Network Interface Controllers

The third subsystem to consider when optimizing your Compaq server configuration is the Network Interface Controllers. Compaq Network Interface Controllers (NICs) provide diverse functionality that can meet the needs of intraNetWare environments. The latest Compaq NIC offerings provide Adaptive Performance Optimization, full duplex operation, and 100 Mb/s LAN throughput. New features and enhancements for existing Compaq NICs in both hardware and device drivers provide substantial performance gains.

Compaq NetFlex-3 and Netelligent Controllers include the TI ThunderLAN chip. The ThunderLAN architecture employs a PCI chip-level interface to speed data throughput and a patent-pending feature, Adaptive Performance Optimization (APO), to guarantee optimal performance for unique server configurations. APO automatically senses the bandwidth demands on the system I/O bus and adjusts the dynamic data buffer accordingly to deliver the maximum data throughput.

NetFlex-3 Controllers

The Compaq NetFlex-3 Controller supports a standard 10Base-T/10Base-2 Physical Layer and allows upgrades to either 100Base-TX or 100VG-AnyLAN with the addition of optional modules. The NetFlex-3 Controller comes with a choice of either EISA or PCI versions.

Netelligent Controllers

The Netelligent product line consists of more than 100 individual networking products designed for industry-leading price/performance and ease-of-use in heterogeneous networking environments. Heterogeneous environments contain client, server and networking products from multiple vendors.

The Netelligent products include three network interface controllers (NICs) for 10Base-T, 10/100Base-TX and Token Ring.

Netelligent 10Base-T and 10/100Base-TX
NICs

Compaq Netelligent 10 T PCI and 10/100TX PCI network interface controllers (NICs) are low-cost, high-performance products designed and tested to perform equally well in a variety of PCI-based clients and servers. These are the first PCI-based controllers offered by Compaq to be sold for and supported in third-party platforms.

Compaq Netelligent 10 T PCI and 10/100 TX PCI NICs share the following features:

■   design supports a common driver set

■   32-bit bus mastering technology to maximize system performance

■   single RJ-45 connector

■   Plug and Play features of the controller enable automatic configuration of memory and interrupt settings for enhanced ease-of-use and installation

■   Simple Network Management Protocol (SNMP) manageability through software such as Compaq's Insight Manager, providing users easy set-up, use, and management on existing networks

■   broad support for network and client operating systems

The Netelligent 10 T PCI NIC offers full-duplex capability, allowing two-way data transmission at an aggregate rate of 20Mbps. The Netelligent 10/100 TX Ethernet PCI controller also supports full-duplex capability, allowing two-way transmission between nodes and providing increased bandwidth of up to 200Mbps

The design of the Netelligent 10/100 TX Ethernet PCI controller, which supports a common driver set, reduces the cost of owning and maintaining a high-performance adapter and offers an easy migration from 10Mbps to 100Mbps transfer rates. These dynamic auto-negotiating drivers allow the card to detect and automatically configure itself to 10 or 100Mbps network connections.

Netelligent 100 FDDI Controllers

The Compaq Netelligent 100 Fiber Distributed Data Interface (FDDI) PCI Controllers are designed to meet the demands of high-performance servers and workstations. These low-cost FDDI controllers are the preferred solution for corporate servers and enterprise backbones where reliability and performance are a must. High-end workstations and workgroups will also benefit from FDDI's ability to move the huge data files required in Computer Aided Design (CAD), digital image processing, and multimedia applications quickly and efficiently. There are PCI and EISA versions of the controller.

Features of the Compaq Netelligent 100 FDDI Controllers are shown below:

■ High Performance - 32-bit bus-mastering technology

■ The use of a custom ASIC DMA engine, along with EISA Burst Mode (Type C) DMA at 33MB/s, maximizes throughput and ensures host compatibility on the EISA controller

■ Plug and Play - Automatically configures memory and interrupt settings

■ Single Attach Station (SAS) Capability – SAS controllers are attached to a concentrator for a point to point connection. The concentrator, which itself may be stand-alone or be attached to a dual ring, acts as a central hub for the single attached devices connected to it.

■ Dual Attach Station (DAS) Capability - DAS controllers allow for the use of redundant FDDI rings

■ Drivers for Mirrored Server Link (MSL) - Supports NetWare SFT III with MSL drivers. This allows for fault tolerant servers using NetWare SFT III

■ Manageability - Management support is available through an SNMP DOS agent that ships with the controller or through most SNMP compatible agents.

Netelligent Token Ring PCI NIC

The Compaq Netelligent 4/16 TR PCI IBM UTP/STP network interface controller is an ideal, high-performance server controller where 100% IBM compatibility is required. This product can also be used as a 100% IBM-compatible client controller in environments where performance is the most important criteria.

The Netelligent 4/16 Token Ring PCI NIC offers these features:

■ Plug and Play for automatic configuration of memory and interrupt settings on system start-up

■ supports auto-speed sensing, enabling the card to automatically detect whether it should operate at 4 or 16Mbps

■ full-duplex two-way transmission for up to 32Mbps aggregate bandwidth through its single RJ-45 connector

■ supports 32-bit bus-mastering technology for significantly improved
throughput and low CPU utilization

■ includes a built-in Remote Program Load (RPL) capability acting as a
boot ROM that lets a diskless workstation attach to a network using files
the computer receives from the server

Compaq Advanced Network Fault Detection and Correction
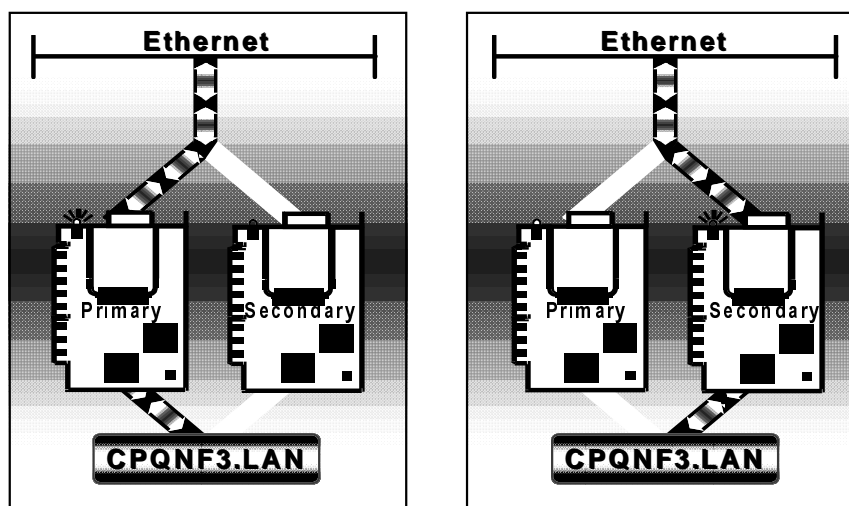
Figure 2-4. Advanced Network Fault Detection and Correction

The Advanced Network Fault Detection and Correction Feature of
CPQNF3.LAN allows a secondary controller to take over network
responsibilities should the primary controller fail. This secondary controller
does not handle any network activity unless a failure occurs with the primary
controller. These two controllers are referred to as the *controller pair*. When
using a controller pair, *CPQNF3.LAN* can detect failure events and recover
from these errors, usually without noticeably disturbing normal operation.

Advanced Network Fault Detection and Correction includes recovery from the following error types:

■ Hardware Failure Events

❑ Adapter Checks — These errors indicate that the hardware experienced a problem. A console error message that details the problem will be generated and an immediate switchover to the secondary controller will take place.

❑ Transmit Timeouts — This counter is incremented when a packet does not transfer within the expected amount of time. The controller from which it was transmitted is presumed failed and is reset. If this was the primary controller, the *CPQNF3.LAN* driver switches over to the secondary controller.

At the next scheduled maintenance you should check:

a. Cabling

b. Hub operation

c. NIC operation

■ Network Status Changes

❑ Transmit Integrity Check Timeouts — When a secondary controller is installed in your server and idle time exists for either controller, the Transmitter Integrity Check feature will transmit packets to itself. The secondary controller, since it is not active, will use this feature regularly. If the primary controller fails the Transmitter Integrity Check, the secondary controller will assume control of network activity. A console alert will be generated and the event will be logged in the console log. If at any time the secondary controller does not pass the Transmitter Integrity Check, an alert will be generated, and the event will be recorded in the console log.

❑ Link Status Changes — This may occur when a cable is unplugged or a hub problem occurs. If a link status change occurs on the primary controller, the secondary controller will assume control of network activity. If the secondary controller is attached to the same hub as the primary controller, the problem will be resolved if the cause was a cabling problem. However, if the hub is related to the problem, both controllers will be marked failed. An alert will occur, and the event will be logged in the console log.

Secondary Controller Recovery Process

When the driver detects failures on the primary controller and the secondary
controller has a valid link, redundant recovery will occur automatically. At the
time of switchover (when the primary controller fails the Transmit Integrity
Check), the MAC address of the primary controller is copied to the secondary
controller by the driver. The secondary controller will then begin operation.

If the secondary controller has been installed on a different hub from the
primary controller, the controller pair can continue operation through a single
hub power loss or hub failure on one of the controllers.

If the secondary controller takes over operation for any reason, an alert
notification of the primary controller failure is sent to the intraNetWare console.
At the next scheduled maintenance, run Compaq Diagnostics on the failed
controller to diagnose the failure.

Hardware Installation for Advanced
Network Fault Detection and Correction
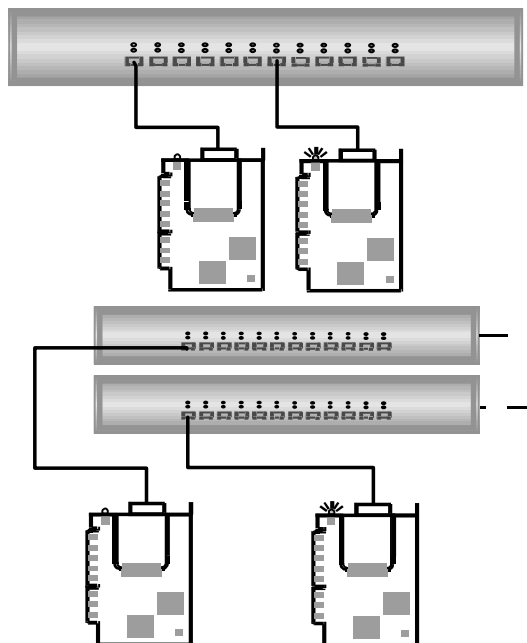
Figure 2-5.   Hardware Installation for Advanced Network Fault Detection and Correction

The following guidelines are used to install the network controllers for Advanced Network Fault Detection and Correction:

■ The supported hardware is:

❑ All NetFlex-3 Controllers.

❑ Netelligent 10 T PCI UTP Controller.

❑ Netelligent 10/100 TX PCI UTP Controller.

❑ Netelligent 10 T/2 PCI UTP/Coax Controller.

❑ Netelligent Dual 10/100 TX PCI UTP Controller.

❑ Netelligent Integrated 10/100 TX UTP Controller.

❑ Netelligent 10/100 TX Embedded UTP Controller.

■ The secondary controller must be installed on the same segment as the primary controller.

❑ Attaching to the same hub will protect against a cable or adapter failure.

❑ Attaching to a different hub will protect against a hub failure in addition to the above failure conditions.

■ The primary and secondary controllers may be different controller types, but must be on the same topology.

Example

The Netelligent 10/100 TX PCI UTP controller can be paired with a NetFlex-3/E as long as both controllers are attached to a 10Base-T hub.

Advanced Network Control Utility for
intraNetWare
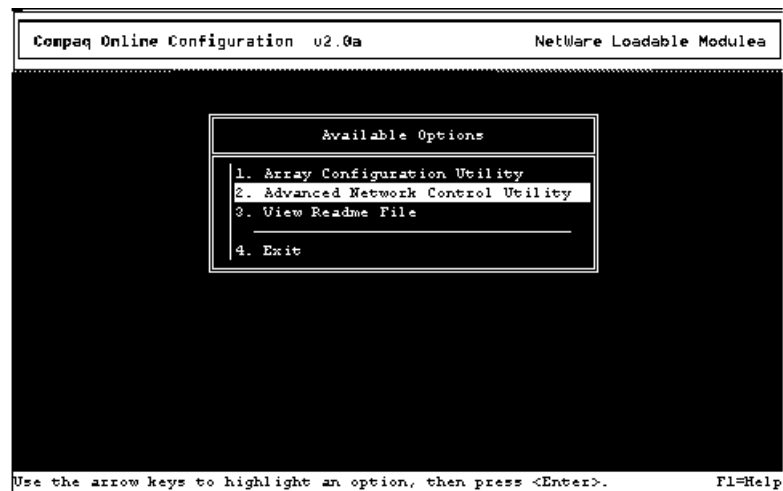
Figure 2-6.   Advanced Network Control Utility for intraNetWare

The Advanced Network Control Utility is located within the Compaq Online
Configuration Utility, *CPQONLIN.NLM*. This utility allows you to:

■   Control and monitor the status of controller pairs configured for the
    Advanced Network Fault Detection and Correction.

■   Change the mode of operation of the controller pairs.

■   Switch control to the secondary controller at any time.

■   View a subset of the *NETWORK.RDM* from NSSD Disk 2 while on-line.

Selecting the Controller Pair
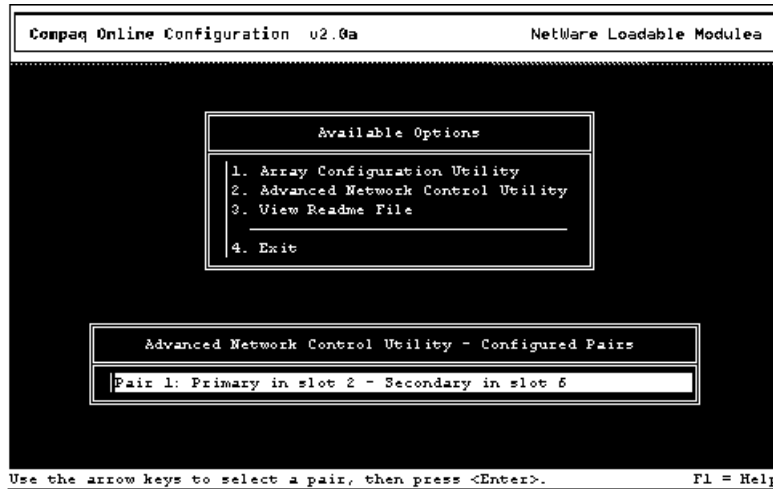
Figure 2-7.   Advanced Network Control Utility – Configured Pairs

After selecting the Advanced Network Control Utility from the Available Options screen, you will see a menu listing the configured controller pairs. From this menu, select the controller pairs that you want to monitor or control.

Status and Control
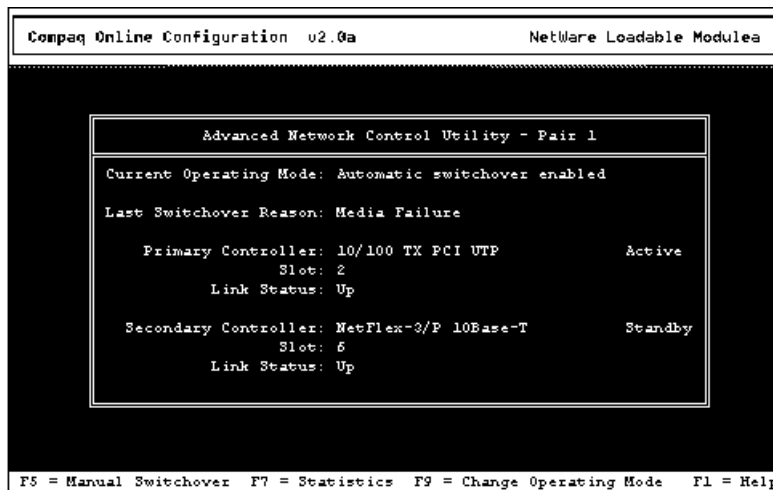
Figure 2-8.   Configured Pair Selection Screen

The *Configured Pair* selection screen allows you to view the following status:

■ Current Operating Mode — The **F9** key toggles the Operating mode.

- ❑ Automatic — If the active controller experiences a failure for any reason, activity will be automatically switched to the standby controller in the system. Switchover can be done manually by using the **F5** key.

- ❑ Manual —When in manual mode, you must manually switch operation of the active controller to the standby controller. If a failure occurs, activity will not automatically switch to the standby controller. Manual mode is used for test purposes.

■ Last Switchover Reason — Indicates the cause of the last switchover

- ❑ Media Failure

- ❑ Adapter Check

- ❑ Transmit Timeout

- ❑ Initialization Failure

- ❑ Manual Switchover

■ Controller Information —

- ❑ Primary/Secondary — Indicates which controller was initially loaded as active (Primary) and which was loaded as standby (Secondary)

- ❑ Type of controllers in the pair and the slot where each is installed

- ❑ Current status — Indicates if the controller is active or standby

■ Link Status — Indicates if the link is up or down

■ Statistics — Press **F7** to view advanced statistics for the controller pair.

Advanced Network Fault Detection and Correction Command Line Switches

The NetFlex-3 driver must be configured properly for the network fault detection feature. This feature cannot be configured using the INETCFG.NLM. Three new command line options are available for configuring a controller pair for fault tolerant operation—PAIR, SECONDARY, and TXTESTTIME.

- PAIR — This parameter identifies the controller pair associated with the controller, and must be used when loading both controllers. This parameter is valid only when using the Advanced Network Fault Detection and Correction feature and is required to load the primary and secondary controllers. If the SECONDARY keyword is not present, this controller will be recognized as the <u>primary</u> controller of the controller pair.

NOTE: The secondary controller must be loaded before loading the primary controller of a controller pair.

- SECONDARY — This keyword is required on the command line for the driver to load the secondary controller when using the Advanced Network Fault Detection and Correction feature. If this keyword is present on the command line, the controller will be placed in an inactive (standby) state awaiting activation when the primary (active) controller (of the controller pair) is loaded. This keyword may only be used with the PAIR parameter.

Example

LOAD CPQNF3 SLOT=6 PAIR=1 SECONDARY

LOAD CPQNF3 SLOT=7 PAIR=1 NAME=E_2FD FRAME=ETHERNET_802.2

- TXTESTTIME — The TXTESTTIME parameter controls the frequency that test frames are transmitted by the controller in order to verify that a valid network link exists. Using a setting of zero will disable this feature. The default setting is zero (disabled) unless the Advanced Network Fault Detection and Correction Feature is used. In this case, the default is one second. The test frames will only be transmitted during periods of inactivity. The minimum setting is 0 (disabled); the maximum setting is 10. Exercise caution when changing this parameter. If the TXTESTTIME value is too large, *CPQNF3* may not be able to switch over after a failure without workstations losing their connection to the server.

Example

LOAD CPQNF3 SLOT=6 PAIR=1 SECONDARY

LOAD CPQNF3 SLOT=7 PAIR=1 TXTESTTIME=2 NAME=E_2FD
FRAME=ETHERNET_802.2

Configuring the Redundant Pair Using *INSTALL.NLM*

To configure the redundant pair for intraNetWare, perform the following steps:

1. Install the second NIC in the server. Note the slot number.

2. Connect the second NIC to a hub on the same network segment.

3. Start the server. At the console command prompt, enter:

    LOAD install

4. You should then see the Available Options Screen. Select *NCF Files Options*.

5. Select *Edit AUTOEXEC.NCF*.

> **❗ IMPORTANT:** You cannot use INETCFG.NLM to configure redundant NICs for multiple protocols.

The screen below shows a configuration for redundant NICs over both IP and IPX protocols.

```
NetWare 386 Text Editor   V1.0                    NetWare 386 Loadable Module


                        File SYS:SYSTEM\AUTOEXEC.NCF

LOAD SNMP   CONTROLCOMMUNITY=public MONITORCOMMUNITY=public

LOAD CPQNF3.LAN SLOT=6 NAME=BOARD2 FRAME=ETHERNET_II SECONDARY PAIR=1 10HD
LOAD CPQNF3.LAN SLOT=2 NAME=BOARD1 FRAME=ETHERNET_II PAIR=1 10HD
LOAD TCPIP
BIND IP TO BOARD1 ADDRESS=131.168.162.40 MASK=255.255.0.0

LOAD CPQNF3.LAN SLOT=6 NAME=Board4 FRAME=Ethernet_802.2 SECONDARY PAIR=1 10HD
LOAD CPQNF3.LAN SLOT=2 NAME=Board3 FRAME=Ethernet_802.2 PAIR=1 10HD
BIND IPX TO Board3 NET=1700F3




LOAD CPQHLTH.NLM
LOAD CPQRI.NLM
LOAD CPQMAINT.NLM
```

Figure 2-9. *AUTOEXEC.NCF* Edit Screen

6. Find the LOAD statement for *CPQNF3*. Use **F5** to mark the entire line. Press the **Delete** key→**Insert** key→**Enter** and then press the **Insert** key again to copy the line. Edit so that the lines look like this example:

   load cpqnf3 slot=6 name=board2 secondary pair=1 10HD

   load cpqnf3 slot=2 name=board1 pair=1 10HD

   Bind ipx to board1 net=17003f

7. Verify that the slot numbers correspond to the locations of your NICs. Enter **down** and **exit** at the server console. Power cycle the server.

Network Interface Controller Drivers

CPQNF3.LAN
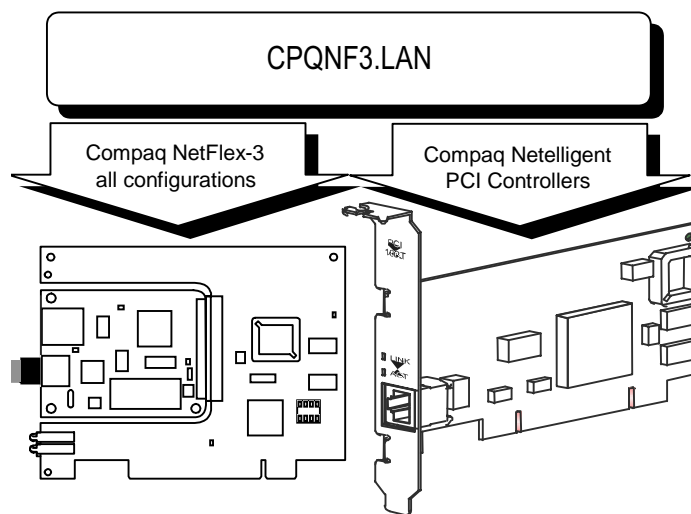
Figure 2-10.   CPQNF3.LAN HSM

CPQNF3.LAN is the Hardware Specific Module (HSM) for Compaq network interface controllers based on the Compaq/TI ThunderLAN chip set. This includes the NetFlex-3 Controller and the Compaq Netelligent family of Ethernet controllers.

CPQNF3.LAN supports full duplex 10Base-T and 100Base-TX modules. It also supports full duplex mode.

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Using full duplex, one pair transmits data, and one pair receives data. Because transmission and reception occur over separate wires, there are no packet collisions, allowing you to increase the number of users on a segment and transfer data at up to 20 Mb/s for 10BaseT networks and 200 Mb/s for 100Base-TX networks.

Full duplex requires a Full Duplex Switched Ethernet (FDSE) 10BaseT or 100Base-TX hub. The hub buffers the transmit and receive data.

CPQNF3.LAN supports the following Compaq controllers in any of the following configurations:

■　NetFlex-3/E — EISA 10Base-T/10Base-2

■　NetFlex-3/P — PCI 10Base-T/10Base-2

■　NetFlex-3 10/100TX/E — NetFlex-3/E with 100Base-TX UTP module

■　NetFlex-3 10/100TX/P — NetFlex-3/P with 100Base-TX UTP module

■　NetFlex-3 100VG/E — NetFlex-3/E with 100VG-AnyLAN UTP module

■　NetFlex-3 100VG/P — NetFlex-3/P with 100VG-AnyLAN UTP module

■　Integrated NetFlex-3/P (also supports a 10/100 TX UTP module)

■　Netelligent 10 T PCI UTP

■　Netelligent 10/100 TX PCI UTP

■　Netelligent 10 T/2 PCI UTP/Coax

■　Netelligent Dual 10/100 TX PCI UTP

■　Netelligent Integrated 10/100 TX UTP (e.g. ProLiant 2500)

■　Netelligent 10/100 TX Embedded UTP

CPQNF3.LAN has the following features:

■　Supports full duplex Ethernet operation when configured for 10BASE-T or 100BASE-TX.

■　Supports Compaq Advanced Network Fault Detection and Correction.

■　Version 2.24 and later supports Auto-Negotiation of duplex mode or link speed only when used with these adapters:

❏　NetFlex-3/E or /P with 10/100Base-TX UTP Module

❏　Integrated NetFlex-3 with 10/100Base-TX UTP Module

intraNetWare Performance Management

❑ Netelligent 10 T/2 PCI UTP/Coax

❑ Netelligent 10/100 TX PCI UTP

❑ Netelligent Integrated 10/100 TX UTP

❑ Netelligent 10/100 TX Embedded UTP

❑ Netelligent Dual 10/100 TX PCI UTP

■ Version 2.30 and later supports Hot Plug PCI operation and is compliant with the Novell ODI Assembly HSM Specification version 3.31.

SKFPNW.LAN

The *SKFPNW.LAN* driver is installed with the Compaq Netelligent 100 FDDI PCI controller in NetWare 3.1x and intraNetWare servers. It is a high-performance, intraNetWare-compliant server driver that meets the Open Data Link Interface (ODI) version 3.3 specification. It can be used in the following environments:

■ NetWare 3.11 servers (requires *PATCHMAN.NLM, LSLENH.NLM, A3112.NLM, NBI1X.NLM, MSM31X.NLM* to be loaded)

■ NetWare 3.12 servers (requires *NBI31X.NLM* and *MSM31X.NLM* to be loaded)

■ intraNetWare servers (requires *NBI.NLM* and *MSM.NLM* to be loaded)

■ Servers running SFT III in intraNetWare (as an Internetwork Packet Exchange (IPX) link, not as an MSL link)

SKFPMSL.MSL

The *SKFPMSL.MSL* is installed with the Compaq Netelligent 100 FDDI PCI Controllers as a Mirrored Server Link (MSL) in NetWare SFT III. It complies with Novell's MSL Driver Specification Version 3.0 and can be loaded multiple times.

Compaq has tested this MSL on a standard FDDI LAN, as well as on a dedicated point to point connection. It is possible to mirror more than one server pair on one FDDI ring, or to put a third standby server in the LAN (which is only powered on when one of the two mirrored servers is down). Configuration with the *SKFPMSL.MSL* is very flexible.

Starting with version 4.11, the MSL supports Synchronous FDDI. In this mode, each station can reserve part of the total bandwidth. This is especially useful if you use one FDDI ring for several MSL connections.

High Availability

Increased server availability has become an important requirement of network and system administrators. Recent advances in server availability include hot swapping of components and online capacity expansion of system components. These include power supplies, storage devices, and, in some cases, hot swappable controllers through expensive proprietary buses and boards.

These advances have moved unplanned downtime into the realm of planned downtime. Yet, administrators must still power down a system at some point to replace a failed component. Compaq, along with its operating system partners, is bringing hot pluggable board technology to industry-standard PCI boards. This allows network administrators to perform online maintenance and online capacity expansion necessary in today's business-critical environments.

PCI Hot Plug Benefits

The first stage of PCI Hot Plug development allows Hot Replace, or replacing like for like PCI cards while the system is live. This first stage is complete and hardware will soon be available. The second stage is the ability to perform Hot Upgrade, or replacing an existing card with a new version of the card and driver. The third stage of PCI Hot Plug will include Hot Expansion, or adding a new previously uninstalled card and associated driver software.

PCI Hot Plug Requirements

A totally hot plug-capable system includes all the system hardware, operating system, and device driver (NWPA) support required for PCI Hot Plug. An existing adapter board should be hot-pluggable if it is in compliance with the established PCI specification and has hot plug device driver support.

To ensure hardware support and compatibility, each of the following hardware components must be provided for each PCI Hot Plug expansion slot:

■ **PCI Expansion Boards** – Most existing PCI expansion boards are fully functional in any system that has hot plug capabilities. However, for an existing PCI board to be hot plug capable, the board must meet all PCI Hot Plug specification guidelines. In addition, in order for hot plug to be functional, the device also needs software support, including hot plug-aware (NWPA) device drivers.

■ **Slot Release Lever** – The slot release lever holds the boards in the I/O expansion slots. When the lever is closed, the hot plug driver can apply power to the slot through the operating system software. If the lever is opened, power is removed form the slot. Keep in mind that you should always turn off power to the slot through the operating system software before opening the lever.

■ **Expansion Slot LEDs** – Each PCI Hot Plug slot has two LED indicators above the slot release lever. When the green LED (top) is on, it indicates power has been applied to the slot. When it is off, there is no power applied to the slot. The amber LED (bottom) indicates that a condition has been detected that requires corrective action for normal operation to continue, such as when there is a problem with the slot, the board, or the device driver.

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PCI Hot Plug/intraNetWare Integration
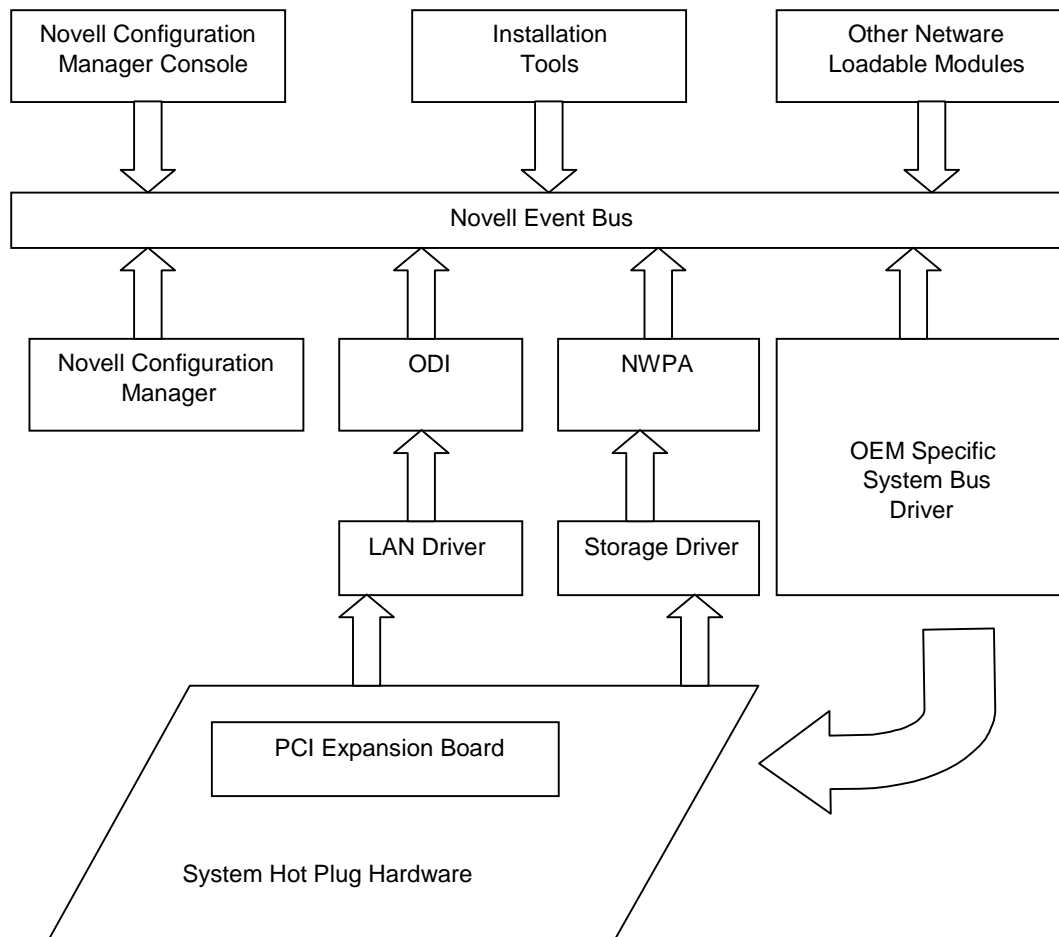
Figure 2-11. Novell intraNetWare Hot Plug Architecture

The PCI Hot Plug architecture leverages the inherent modularity of
intraNetWare to minimize changes required of third-party adapter board
software. The system relies on a new central component, the Novell Event Bus,
which facilitates communications between different software modules. The
Event Bus is implemented as a NetWare Loadable Module (NLM), allowing
implementation of PCI Hot Plug on existing versions of intraNetWare.

Listed below are the components of the PCI Hot Plug architecture for
intraNetWare:

■ Novell Event Bus (NEB)

■ Novell Configuration Manager (NCM)

■ OEM Specific System Bus Driver (SBD)

■ Novell Configuration Manager Console (NCMCON)

■ Device Drivers

❏ ODI-Compliant network boards

❏ NWPA-Compliant storage boards

❏ Other Boards

■ Installation Tools

Novell Event Bus (*NEB.NLM*)

The central component of the PCI Hot Plug software architecture is the Novell
Event Bus. This module facilitates communication between the administrator,
the software modules, management agents, and device drivers, providing the
foundation for the software architecture. The Event Bus is implemented first as
an NLM, allowing implementation of PCI Hot Plug on existing versions of
intraNetWare. Future versions will integrate the Event Bus into the operating
system.

Novell Configuration Manager
(*NCM.NLM*)

For PCI Hot Plug servers, the Novell Configuration Manager manages the hot
plug system and ensures proper system behavior. Its primary function is to
sequence hot plug operations to ensure stability of the system. To achieve this
function, the Configuration Manager properly shuts down the board's device
driver before removing power from the slot. The Configuration Manager also
maps hardware resources to device driver software. Future releases of
intraNetWare will have an enhanced Configuration Manager to encompass
other technologies in addition to PCI Hot Plug.

System Bus Driver (*CPQSBD.NLM*)

Compaq is providing a system bus driver specific to the PCI Hot Plug hardware implementation.

The system bus driver abstracts the platform-specific implementation of PCI Hot Plug in the ProLiant family of servers. This driver controls the system hardware necessary to perform hot plug functions and is responsible for the following:

■ Enabling or removing power from a hot plug slot upon request.

■ Configuring hardware and assigning resources like memory, I/O ports, and interrupts for PCI boards in hot plug slots.

Novell Configuration Manager Console (*NCMCON.NLM*)

The Novell Configuration Manager Console is necessary to perform hot plug functions in intraNetWare systems. This NLM provides the interface for controlling all hot plug operations. In addition, it displays slot configuration details, including board driver information and status.

The Configuration Manager Console consists of two screens: the Main Menu and Slot Detail Information screen. The Main Menu displays a list of all PCI slots in the system. For each slot, the Main Menu displays the following information:

■ Slot number

■ Slot hot plug status

■ Product name or description of the board

■ Status of the slot/board

The Slot Detail screen displays information about a specific slot and the board in that slot. This information includes the following:

■ Slot number

■ Board name or description

■ Bus number associated with that slot

■ Slot/board hot plug status

■ Device driver information associated with the board

Pressing **F2** activates the Slot Options menu, which allows the administrator to take actions such as removing or replacing the board in that particular slot.

32-Bit ODI LAN Device Driver Requirements

The Novell ODI interface specification documents the driver architecture for network devices. The ODI specification has recently been modified to encompass PCI Hot Plug technology. Because of the inherent modularity of intraNetWare, the changes required in third-party board device drivers are minimal.

The ODI architecture standardizes the support for network PCI Hot Plug drivers by providing a translation layer between the specific device drivers and the operating system. This translation layer, called ODINEB, abstracts the ODI device drivers (hardware-specific modules) from the PCI Hot Plug system. Device drivers compliant with the modified ODI specification are PCI Hot Plug compatible and continue to work in non-hot plug environments.

To obtain PCI Hot Plug functionality, LAN drivers need to be updated to be compliant with either the Assembly HSM 3.31 specification or the CHSM 1.11 specification.

Performing Hot-Plug Actions with intraNetWare

Compaq PCI Hot Plug and the intraNetWare operating system work together to allow the following hot plug actions:

■ **Hot removal of boards** – You can manually shut down and permanently remove a board.

■ **Hot replacement of boards** – This allows you to replace a failed board with an identical board. This command applies power to and configures the slot.

■ **View slot detail information** – This allows you to see detailed information about each PCI slot.

System Processor

In an intraNetWare resource-sharing environment, consider the NICs, hard drive subsystem, and the amount of system memory as more significant performance factors than the speed or type of system processor running in the server.

Compaq recommends at least a 486-based system processor to efficiently run the increased number of background tasks supported in intraNetWare. A high-performance system processor, such as Pentium or Pentium Pro, however, offers more speed and efficiency in managing CPU-intensive NLM applications and network services, such as printing, remote bridging, file compression, databases, and tape backup, as well as in managing a large number of users on the same network.

Chapter 3
intraNetWare Design and Implementation

Before implementing a new network or changing an existing network, planning your network server environment is an important step. intraNetWare includes new features that allow ease of installation, require less administration, and improve overall network server efficiency. These features have the most impact on network performance and performance management. They include:

■ Novell Directory Services (NDS) design

■ Novell Directory Services (NDS) partitioning and replication

■ intraNetWare Time Service

■ File compression

■ Disk allocation and block suballocation

■ Bindery services

Your server environment may require you to use all of these features or only some of them. This chapter provides intraNetWare planning guidelines for using these features.

Novell Directory Services

Novell Directory Services (NDS) represents a database of network resources and user information that is distributed globally over the entire network. The Directory is the common name for the NDS database. NDS in intraNetWare environments replaces the bindery services found in NetWare 3.x environments. Because the Directory is on multiple servers, user and network resource information becomes easier to maintain and provides greater access for the user. Although intraNetWare provides significant functional enhancements, there are several points you must consider to ensure a smooth transition.

Consider the following as you plan your migration to NDS:

■   Some NetWare 3.x applications might not be compatible with NDS and therefore require bindery emulation. Verify the requirements of your application before implementing NDS.

■   Verify the ability of your backup software to backup and restore NDS.

■   Increased bandwidth is necessary for intraNetWare logins.

■   NDS and time synchronization create overhead.

NDS is based on a hierarchical tree structure that is composed of three kinds of objects: physical objects (such as users and printers), logical objects (such as groups and print queues), and organizational objects (such as organizational units). The Directory tree is the "framework" for your entire intraNetWare environment. Since the Directory tree structure can affect your network security, availability, and ease of management, consider the following as you plan your NDS:

■   Standardize on a naming convention for all objects and enforce the convention. This ensures consistency for the Directory tree and makes management easier.

■   Keep the NDS design as simple as possible. Flat, simple trees are more stable and easier to troubleshoot than large, complex trees. Novell recommends that you use no more than five levels in your Directory tree.

NOTE: Novell has developed an extensive set of Application Notes for intraNetWare. Many of these focus on planning and implementing Novell Directory Services. Before you begin your intraNetWare implementation, you may want to review these Application Notes. See Appendix B for more information on Application Notes.

NDS Partitioning and Replication

While a single database, like a large bindery, would ultimately be the most efficient way of managing and maintaining all network information, it is not the most practical solution in many network environments. Large networks involving many users or WAN connections would not benefit from a single large database of network information. Allowing the Directory to remain a single database on a single server causes all network traffic to be routed to a single server during peak login times, thereby loading the server. For WANs, it would also require access from remote sites over wide area links, which would cause delays in the login process for remote-site users.

intraNetWare gives you two tools to manage the Directory database:

■ Partitioning

■ Replication

Partitions are portions of the overall database and replicas are copies of the Directory partitions. In general, you should partition the database to make it easier to manage and replicate the database to provide fault tolerance.

Partitions

intraNetWare allows you to make logical "partitions" within your Directory tree. This allows you to more easily manage the Directory tree in a large network and can allow remote-site users to log into the network without using a wide area link.

You can create new Directory partitions after installing a server by using the NDS Manager or PARTMGR utilities.

When planning a large network or a WAN, create Directory partitions for remote sites to minimize the traffic over wide area links. See WAN NDS Design in this chapter for more information on creating partitions. See Appendix B for additional resources for more detailed information about intraNetWare.

You can place a replica of a directory partition on multiple servers to ensure that users can still access the network in case of a server or connection failure. Distributing part of the naming service to a server closest to the users who would be using it most often can reduce NDS server load.

Distribution of Replicas

Replicating the Directory or Directory partitions onto multiple servers reduces the risk of login failure due to the unavailability of the information on a failed server. If a server hard drive fails and loses a partition that is not replicated, users have no access to that partition on the tree, and you must rebuild the partition manually or restore it from tape backup. Replication also provides a way to balance the load between several servers. There are three types of replicas:

■   *Master* - intraNetWare automatically creates and stores the Master replica on the first server. You can use the Master replica to change the Directory partition's relationship to the rest of the database.

■   *Read/Write* - intraNetWare automatically stores Read/Write replicas on two other servers within the same container object.

■   *Read Only* - intraNetWare does not automatically create Read Only replicas. You must create them manually. Read Only replicas are available for compliance with the X.500 standard if you require that standard. You can not authenticate logins from a Read Only partition.

> **!** **IMPORTANT:**   Directory replication only duplicates the NDS information, not the file system. You must use Novell Replication Services to duplicate the file system between servers.

WAN NDS Design

In a WAN environment, it is important to design the Directory tree so that it is easy to place services such as NDS replicas close to the workstations that use them frequently. Because NDS replicas also exist to provide fault tolerance, three replicas of each partition should usually be created. These replicas must send synchronization updates to each other to maintain replica consistency. When replicas synchronize to update the database, network traffic is generated. The amount of data transmitted is equal to the number of replicas multiplied by the number of objects changed. A good NDS design provides NDS fault tolerance while reducing NDS synchronization traffic, especially across a WAN.

Reduce synchronization traffic by using the following strategies:

■ Create containers representing locations near the top of the tree based on the WAN infrastructure.

NOTE: In general, do not include "dial-up" sites in a corporate tree. Create a separate NDS tree for each such site.

■ Create site partitions based on the WAN infrastructure.

■ Plan server object placement carefully. Do not create more than 15 server objects in a single container. This will ensure that there is never a need for more than 15 replicas of a single partition.

■ Plan replica placement carefully. Use high-end servers for replicas. Replicas placed on low-end servers will slow down the synchronization process.

■ Place replicas locally if possible. When this is not an option, use these suggestions for WANs with the following conditions:

❏ If there is a remote site with no servers:

• Create a container for the site, but not a separate partition.

• Include the site container as part of the hub site partition.

❏ If the remote site has one server:

• Because the site is small, create a partition for the site.

• Place one replica locally and one at the closest site. For a small partition, the fault tolerance value of a second replica outweighs the cost of its resulting slight increase in WAN traffic.

❏ If the remote site has two servers:

• Create a partition for the site.

• Place replicas on the local servers. Do not create a third replica unless a T-1 or better connection exists to another site.

■ Do not over-replicate partitions. Three replicas are generally sufficient for any partition. Sometimes, the need for bindery services will force partition replication when there is no other reason to do so. Reduce this need whenever possible. Upgrade to NDS-aware applications, printer NIC firmware, and print server hardware.

- Too many Subordinate Reference replicas increase both synchronization traffic and the likelihood that a replica will be unavailable during a partition operation.

- To reduce the number of Subordinate References:

  - Keep the [Root] partition small and replicate it at the hub site. If the [Root] partition contains no user objects, it may be replicated to other sites to improve name resolution performance without causing significant increases in synchronization traffic across the WAN.

  - Do not exceed 15 child partitions per parent partition. Creating regional containers and partitions just below the Organization container will make this possible even in a WAN environment with more than 15 sites.

  - Limit replication of parent partitions. Remember that for every parent partition replica placed on a server, there are Subordinate References created for all of its child partitions unless there is already a replica of the child on that server.

- Ensure that the intraNetWare Transaction Tracking System (TTS) is enabled when using NDS. TTS is enabled by default in intraNetWare.

intraNetWare Time Service

The intraNetWare Time Service feature maintains the time synchronization among all resources on the network and time stamps the Novell Directory Service exchanges. This feature ensures that when changes to the NDS are synchronized between replicas, they will be applied in the order in which they occurred. It also provides time stamp information to distributed applications that use the time stamp to record or synchronize data.

Time synchronization can greatly affect your network performance if time servers are not configured optimally. Although time synchronization traffic is insignificant compared to NDS network traffic, if the time servers are not synchronized, the amount of network traffic increases as the servers on the network attempt to negotiate the correct time.

Time Servers

Each intraNetWare server must have a time server designation, and each designation performs a specific function in Time Services. These designations are as follows:

■ *Reference* -- the main source of time on a network. Reference time servers can be synchronized with an external time source. They also poll Primary servers for the time.

■ *Primary* -- the main source of "official" time for all servers and a local source of time for Secondary servers. Primary time servers poll other Reference and Primary servers and then "vote" to identify the correct time. Primary servers adjust their own clocks to synchronize with Reference servers, allowing the time to shift during the synchronization process. They provide a redundant source of time so that if one time source server fails, the network still functions.

■ *Secondary* -- the time receivers on a network. Secondary time servers cannot negotiate the correct time. They obtain their time from time source servers. If one time source server is unavailable, a Secondary time server can obtain the time from another time source server.

> **!** **IMPORTANT:** Because Reference servers do not adjust their clocks, the only way to synchronize two Reference servers on the same network is to use an external time source. (See Appendix A for information about software that can synchronize Reference servers to external time sources.)

■ *Single Reference* -- the single source of time for a network. When a Single Reference time server is used, all other servers on the network are Secondary servers. Single Reference servers do not adjust their clocks and represent a single point of failure for time synchronization.

Single Reference, Reference, and Primary time servers are called time source servers. They can provide the time to other servers on the network and to network clients. Secondary time servers receive the time from these time source servers and forward the time to network clients only.

Time Server Communication

Time servers can communicate among themselves by either of two methods:

■   Service Advertising Protocol (SAP)

■   Custom configuration

Service Advertising Protocol

Using the SAP, time source servers announce their presence on the network and poll other time source servers to determine the correct time. Secondary servers also use the SAP to locate a time server and obtain the network time.

Because the SAP method of advertising is the default method for all intraNetWare server communications, the network layout is not a factor in the time services implementation. Using the SAP method allows you to install intraNetWare servers and add them to the network easily, so that modifications to the network (such as new workstations, new servers, or changes in the layout) do not affect time services.

Although the SAP method of advertising allows for ease of administration, the constant communication that occurs among servers using the SAP method generates additional traffic on the network. The more servers advertising on the network, the more traffic on the network.

Custom Configuration

The custom configuration method allows you to define which time source servers provide time information for each server. It also allows you to control the use of the SAP for time services by turning off SAP broadcasts normally generated by time source servers.

Custom configuration, however, requires some planning and maintenance. Adding servers, removing servers, or changing the time status of a server requires manually changing the time source server list on each server on the network.

Time Service Planning

Since you must identify each time server during intraNetWare installation, you must plan your time services before beginning the network upgrade or network implementation. Planning your time services includes identifying the following information about your network:

■   Size of the network

■   Geographical or physical location of each server

■   Criticality of the data on the network

While the intraNetWare default settings are adequate for some LAN environments, they might not be adequate for WANs, enterprise networks, mission-critical environments, and large LANs.

> **!**   **IMPORTANT:**   Reference and Primary time servers must exchange time information with at least one other Primary or Reference time server to continue to provide time services to Secondary servers and clients. If this condition is not met, the Reference or Primary server will go to sleep and will not provide time services.

Time Service Design Guidelines

Use Figure 3-1 to determine the most effective time services configuration for your network. As the default, intraNetWare and Compaq SmartStart configure the first intraNetWare server as a Single Reference server and subsequent servers as Secondary servers. SAP is used for communication.

The default time configuration does not provide inherent fault tolerance and is only useful for networks located at a single site with 30 or fewer servers. Custom time configuration is required for other networks. To change the default configuration, use the intraNetWare SET commands related to time synchronization or the SERVMAN utility.
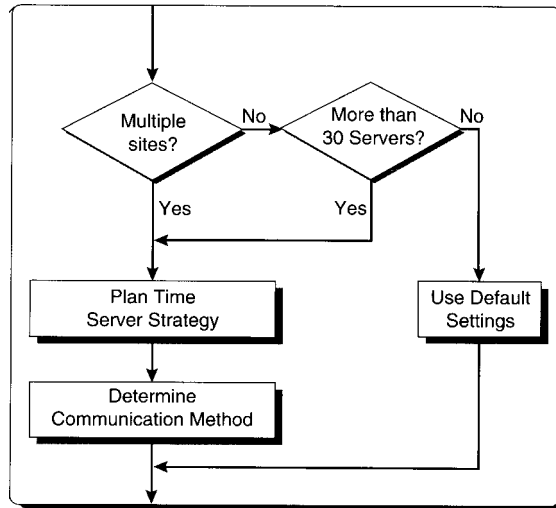
Figure 3-1. Planning a Time Synchronization Strategy

For example, a mission-critical network that spans both the United States and
Canada with 7 servers and 150 workstations can be configured with one
Reference server at the central site and two Primary servers at each remote site,
with all other servers configured as Secondary. If network performance is more
important than ease of time service administration, use the custom
configuration method of distributing time service, so that the servers are not
constantly polling each other over the wide area link. To eliminate any time
synchronization traffic across the WAN link, each site may have a Reference
server with two or three Primary servers, with the Reference servers using an
external time source to stay synchronized. All servers' time source lists are
configured to poll for or receive time from local servers.

In another example, a mission-critical LAN with 20 servers and 450
workstations may be configured with one Reference server and two Primary
servers, with all other servers configured as Secondary. The SAP method of
advertising can still be used. However, using a Reference server with Primary
servers provides fault tolerance. Should the Reference server fail, the Primary
servers maintain time for the LAN, so that the network remains operational.

Time Service Configuration

When planning time synchronization, consider the following:

■   Ensure that Secondary time servers contact the Primary or Reference time servers that are physically closest to them with the fewest possible hops (routers and LAN segments) between the servers. This reduces the amount of traffic on the network.

■   Ensure that Reference servers are synchronized by a *reliable* external time source. A power surge or outage may cause time synchronization problems when the Reference server polls the external source.

■   In a network environment with heavy traffic, increase the default ten-minute polling period among servers. This reduces network traffic. However, if server clocks drift by more than two seconds, they will become unsynchronized. Ensure that the polling interval is short enough to allow the servers to synchronize.

File Compression

The intraNetWare file compression feature allows you to store more data on the hard drive by compressing files. The files are automatically decompressed when accessed.

File Decompression—Comparison
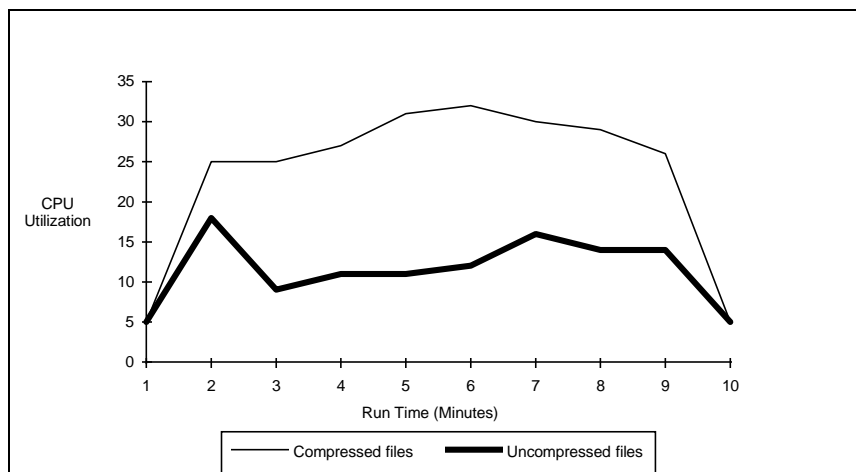
Figure 3-2. CPU Utilization for Server Providing Compressed and Uncompressed Files

The figure above compares the amount of CPU utilization generated on a server when a workstation requests compressed files and when it requests uncompressed files. The increase in CPU utilization is caused by the decompression process. Note that the response time was the same for both tasks. Users do not experience any difference in response time performance when requesting compressed and uncompressed files if there are sufficient CPU cycles available to service the task. The data accessed from the had disk is compressed, so there are fewer bytes being transferred into cache, thereby increasing the speed of the transfer. However, the decompression algorithm generates overhead and requires CPU cycles, which reduces the speed of the transfer. Therefore, the response time is the same for workstation requests for compressed files and requests for uncompressed files.

Compression Ratio

Although the file compression algorithms in intraNetWare can increase usable disk space up to 63 percent, the compression ratio depends on the type of data and its redundancy. The more redundancy in the data, the more compressible the data.

Typical office environments generate a mixture of data:

■   Binary data, such as executable files and system files.

■   Text data, such as ASCII text files and word processing document files.

■   Database data, which are mostly composed of text and numeric data.

■   Spreadsheet data, such as Microsoft Excel and Lotus 1-2-3 worksheet files.

Binary data is already in its most basic format and does not compress well. In fact, binary text compresses at an average ratio of 1.5 to 1. Text, database, and spreadsheet data compress well, with compression ratios averaging about 2.6 to 1, due to the amount of redundancy in the data.

File Compression Planning

File compression in intraNetWare is highly configurable. Though this feature can greatly increase usable disk space, it can also adversely affect server performance if not properly configured.

You can change the priority of the compression task to the point that compression competes with other applications or network functions (such as backups). Compaq integration testing shows that file compression works well, but is a CPU-intensive process. Therefore, Compaq cautions against changing any default values for file compression except as outlined in this chapter.

Figure 3-3 illustrates the CPU utilization of a server while compressing a single volume of mixed data (binary, spreadsheet, text, database, and graphics). The CPU used for this test was a 486 processor running at 33 MHz. Notice that the CPU utilization remained well above 50 percent during the compression task.
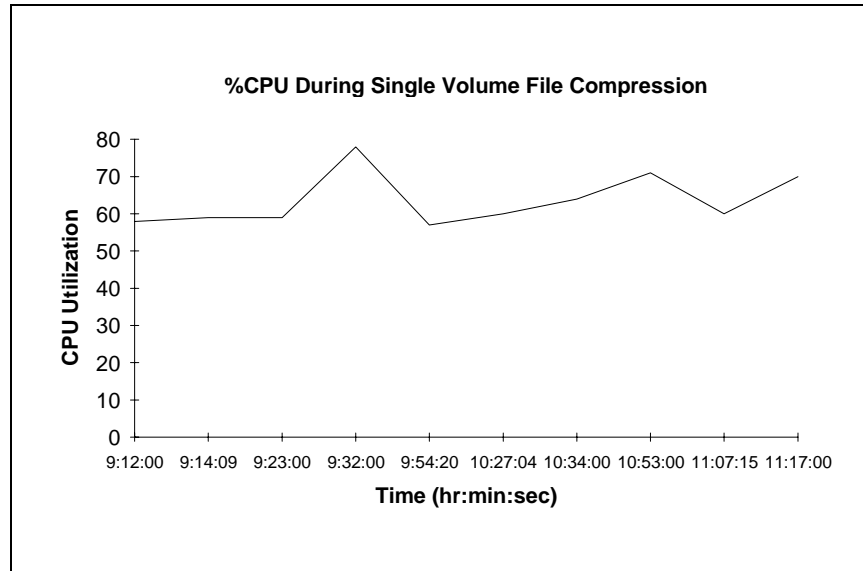
Figure 3-3. Percent of CPU utilization during single-volume file compression

The SET MINIMUM COMPRESSION PERCENTAGE GAIN parameter helps you control the types of files that intraNetWare compresses. The 20 percent default setting allows intraNetWare to compress all files that can be compressed by at least 20 per cent. Leaving this parameter at its default setting means that intraNetWare will compress many files in the volume. The 50 percent maximum value allows intraNetWare to compress all files that can be compressed by at least 50 percent. This may exclude most binary files, but most other data will be compressed (2.6 to 1 compression ratio).

If you flag your executable files for immediate compression and the SET MINIMUM COMPRESSION PERCENTAGE GAIN to 50, intraNetWare generates overhead attempting to compress data that cannot be compressed to 50 percent of its original size.

> **!** **IMPORTANT:** The SET MINIMUM COMPRESSION PERCENTAGE GAIN parameter indirectly affects the amount of available disk space, but does **not** affect the amount of time required for the compression process. intraNetWare requires the same amount of time to analyze each file regardless of whether you increase the compression gain.

Compressed Volume Low on Disk Space

If a compression-enabled volume is low on disk space, files cannot be decompressed on the volume after being decompressed in server RAM when requested by a user. This is indicated by a server console alert message, "Compressed files are not being committed." To temporarily solve this problem, use the SET DECOMPRESS PERCENT DISK SPACE FREE TO ALLOW COMMIT parameter to reduce the percentage of disk space needed to commit. Left unresolved, this situation can cause excessive compression or decompression activity. Use the SET COMPRESS SCREEN = ON parameter and toggle to the server compression screen to see the activity.

Deleted Files Compression Option Parameter

The default setting for the SET DELETED FILES COMPRESSION OPTION parameter is 1, which compresses deleted files the next day. Setting this parameter to 2 will cause deleted files to be compressed immediately after deletion. This will negatively affect server utilization and performance.

Days Untouched Before Compression Parameter

The SET DAYS UNTOUCHED BEFORE COMPRESSION parameter defines how long the files must be inactive before intraNetWare compresses them. Lowering the 14-day default value to achieve more usable disk space increases CPU utilization. If you lower this value, ensure that the compression is scheduled for off-peak hours to avoid user performance impact. The intraNetWare default start time for compression is midnight, and the stop time is 6:00 a.m.

intraNetWare allows users to designate files or directories of files for immediate compression by flagging the file or directory with the IMMEDIATE COMPRESS (IC) attribute.

Consider the following before you use IMMEDIATE COMPRESS:

■ Although this feature may save disk space, compression due to the IC flag is performed as a normal priority thread each time the file is closed. intraNetWare generates overhead during the compression and decompression process, taking resources away from more important tasks.

■ Unless the traffic on your network is very light or unless your server lacks adequate disk space, do not allow users to flag for immediate compression.

■ Use MONITOR.NLM to observe CPU utilization if this feature is used.

■ Data compression is the first level of your data archival process. It is not a method of reducing the amount of disk space needed for day-to-day work.

intraNetWare Compression Recommendations

When planning intraNetWare servers, consider the following recommendations:

■ Enable a volume for compression only if you are sure you want to compress that volume.

■ Once you enable a volume for compression, you cannot change it unless you back up the files in the volume, delete the volume, recreate the volume, disable compression before initially mounting it, and restore the files.

■ Due to the high CPU utilization that occurs during file compression and the length of time needed for the process, always schedule file compression during off-peak hours, which is the default setting.

■ Ensure that your server is configured with enough system memory to perform file compression.

■ If your server does not have enough memory, the message *Insufficient RAM to compress (server #)* displays. Add enough system memory to cache the largest file on each volume flagged for compression. Check the Novell memory calculation worksheet to be sure you have enough memory for compression.

■ Use the memory calculation worksheet in this TechNote to verify that you have estimated enough system memory for your server.

■ When compressing files and performing tape backup, ensure that you schedule enough time to allow both tasks to complete. These tasks cannot be scheduled concurrently. Be sure to schedule file compression and tape backup to run sequentially within the designated off-peak hours. Ensure that your backup software is compression-aware and will not decompress files in order to backup. If compression runs first, then backup will take less media space.

Use the SET MAXIMUM CONCURRENT COMPRESSIONS parameter to compress up to eight volumes. intraNetWare performs these compressions only one volume at a time. Compaq integration testing indicates that volumes are compressed sequentially, not concurrently.

Table 3-1
Concurrent Compression

VOL1 (KB)	Time	VOL2 (KB)	Time
236,228	14:56:48	264,512	14:56:48
232,320	15:01:05	264,512	15:01:05
216,384	15:15:44	264,512	15:15:44
200,000	15:22:48	264,512	15:22:48
175,872	15:29:48	264,512	15:29:48
145,344	15:43:48	264,512	15:43:48
125,504	15:59:50	264,512	15:59:50
104,064	16:29:53	264,512	16:29:53
98,496	16:35:48	264,512	16:35:48
93,888	**16:39:33**	**264,512**	**16:39:33**
		264,064	16:40:32
		258,560	16:45:32
		226,496	16:49:48

This table shows data from the same compression test as the file compression progressed. As indicated in the VOL1 and VOL2 columns, intraNetWare did not begin VOL2 compression until VOL1 compression was complete.

These volumes included binary, text, database, spreadsheet, and graphics data. With the SET MAXIMUM CONCURRENT COMPRESSIONS parameter set to 2 and the SET MINIMUM COMPRESSION PERCENTAGE GAIN set to 50, intraNetWare required approximately 103 minutes to compress a 236.3MB volume to 93.8MB.

File Compression Scheduling Guidelines

When scheduling file compression, consider the following recommendations:

■   Repeated compression and decompression might generate enough overhead on the server to cause performance degradation.

■   Use caution when restoring intraNetWare compressed data. Most tape drives, such as Compaq DAT Drives, perform file compression during backup. Compressing files using intraNetWare and then the tape drive does not yield any more tape space. If you must restore from these tapes, you must restore the files to a compression-enabled volume using the same version of intraNetWare. Otherwise, you may not be able to access the data.

!   IMPORTANT: The file compression operation runs at a lower-priority thread than tape backup operations. Do not schedule your tape backup and file compression to run at the same time.

Disk Allocation and Block Suballocation

A disk allocation block (or volume block) is a unit of storage for data on an intraNetWare volume. During installation, intraNetWare recommends an allocation block size based on the size of the intraNetWare volume. The intraNetWare default size is 64 Kbytes.

Compaq integration testing, however, noted only a small difference in performance when changing the disk allocation block size. Furthermore, the smaller block sizes you use, the more system memory is consumed to manage the blocks. Because of this, always set disk allocation block size to 64 Kbytes. When block suballocation is enabled, any partially used disk allocation block is divided into 512-byte suballocation blocks. Suballocation provides a way to efficiently use large disk allocation blocks. These blocks store leftover fragments from other files.

Disk Suballocation Guidelines

When planning disk allocation and block suballocation, consider the following:

■ Always set disk allocation block size to 64 Kbytes and enable block suballocation.

■ Once you enable block suballocation and set the disk allocation block size, you cannot change it, unless you back up the volume, delete it, recreate it, and restore the data.

■ The cache buffer size in intraNetWare is always 4 Kbytes. While the cache buffer size in NetWare 3.1*x* is configurable using the SET CACHE BUFFER SIZE parameter, it is not configurable in intraNetWare.

Bindery Services

Many intraNetWare environments have migrated or will migrate from earlier versions of NetWare. Any network that is experiencing this migratory process must run in "bindery emulation" until the entire network is converted to intraNetWare. Bindery services provide backward compatibility for users and servers that are still running another version of NetWare. Bindery services provide a structure so that these users and servers can access information on an intraNetWare server as if the server were in a bindery.

NOTE: Bindery services are automatically enabled when you install intraNetWare. If your network includes Macintosh network nodes, you must either leave bindery services enabled or install the MAC OS Client for intraNetWare, which is NDS-aware.

Many software products that provide backward compatibility also provide only part of the feature set and limited performance of the previous software version. This is also true in an intraNetWare environment. To maintain compatibility with an earlier operating system version, running your network in bindery services can degrade your overall intraNetWare performance, as well as limit the use of intraNetWare features. If your network server migration requires bindery services, consider the following for optimum performance:

■ Plan your migration well to ensure that the network runs in bindery services only for a short time.

■ Create users in the container where each user's primary server is located. This should place users in the same container with resources they access.

■ Because the processor creates one thread for all bindery connections, utilization will increase on a server with a lot of bindery emulation. This includes connections related to printing.

■ To avoid bindery services, Netports or other hardware must be set to be NDS-aware.

You can disable bindery services temporarily by using the SET parameter as follows:

SET BINDERY CONTEXT = .

To disable bindery services permanently, you must delete the SET BINDERY CONTEXT = statement from your *AUTOEXEC.NCF* file.

Chapter 4
Monitoring and Tuning

This chapter focuses on monitoring your existing network server and using intraNetWare SET parameters to tune it and make full use of the available resources.

The primary tools for monitoring server performance are Compaq Insight Manager and *MONITOR.NLM*. Compaq Insight Manager is included with SmartStart and with Compaq ProLiant servers. *MONITOR.NLM* is part of the intraNetWare operating system.

intraNetWare Auto-Tuning Parameters

intraNetWare provides several parameters whose values can be tuned according to the demands made on the server. For these parameters, intraNetWare allows you to set thresholds and then operates within the designated thresholds.

Once you set the thresholds and implement the server, you can "fine-tune" the server by adjusting these thresholds, based on your network server analysis. However, intraNetWare eventually performs this tuning process by allocating services or buffers as they are needed.

Compaq SmartStart

Compaq SmartStart is the intelligent way to quickly install and configure a tested and proven server platform. If you use SmartStart to install intraNetWare, the configuration is optimized by including the performance recommendations discussed in this TechNote.

Some advantages for using SmartStart are:

■ SmartStart restarts your server, runs the System Configuration Utility, creates a system partition, and sets hardware parameters specific to the selected software.

■ SmartStart has three installation paths: Assisted Integration, Replicated Installation, and Manual Configuration.

   ❏ Assisted Integration provides for accepting the SmartStart default installation options without going through the entire SmartStart interview process. Assisted Integration gives you a fast option for basic, default-based installation on a single-server LAN.

   ❏ Replicated Installation allows you to automatically create a server with the same configuration as one previously SmartStarted, using a Replication diskette created during a previous installation.

   ❏ Manual Configuration allows you to customize the install for your particular network.

■ The installation of the appropriate Compaq Insight Management Agents and the creation of the Compaq Insight Manager diskettes for installation on the management PC are integral parts of the SmartStart installation program. When you install the operating system, the appropriate Compaq Insight Management Agents will install automatically.

> **!** **IMPORTANT:**   Compaq SmartStart is tested and supported only on Compaq servers.

Software Licensing

To obtain a license for system software provided on the Software Product CDs provided by Compaq, you need to purchase Activation Key(s). One Activation Key typically validates one software license. If you purchase multiple copies of a specific software product using the same SmartStart serial number, the SmartStart Activation Key Fax Form indicates the quantity of valid licenses that you may install.

> **!** **IMPORTANT:**   Activation Keys are not required for Compaq Insight Manager and Compaq Insight Management Agents. However, the Compaq Insight Asynchronous Management software does require the purchase of an Activation Key.

Keys can be purchased through any Compaq Authorized Reseller or Dealer. You may specify that you wish to order keys for any number of system software products from Compaq when you order your server. To order an Activation Key after you have received your server, complete the SmartStart Activation Key Order Form and process your order through your Compaq Authorized Reseller or Dealer. SmartStart Activation Key Order Forms are included with the SmartStart Software Product pack.

The Compaq SmartStart Ordering System is a Windows Wizard style application which automates the process of filling out the SmartStart Activation Key Order Forms. The application is intended for use by end users and resellers. The completed order forms printed by the SmartStart Ordering System can be faxed to a local Compaq supplier for processing. The application is very easy to use and takes just a few minutes to install. Additional information on the SmartStart Ordering System, and instructions for downloading and using the application can be found at the following web site:

http://www.compaq.com/products/servers/smartstart/ss-os.html

You may be required to send a purchase order with your completed SmartStart Activation Key Order Form. After processing your order, Activation Keys will be faxed to you. The SmartStart Activation Key Order Forms can also be used to order printed documentation kits for software and the SmartStart Subscription Service. Documentation kits will be shipped to you in the usual way.

Off-the-Shelf Software

SmartStart now works with Novell off-the-shelf software media purchased from somewhere other than Compaq, as well as with the Compaq Software Product CDs. Novell diskette licenses and MLA/CLA licenses are also supported.

Product and Driver Diskettes

Compaq SmartStart and Support Software CD contains a great deal of information, including detailed documentation on SmartStart, various utilities, NetWare drivers for Compaq hardware, and product documentation as well as copies of several Compaq Integration TechNotes. You can access all of this information through a utility called Diskette Builder, included on the CD.

Diskette Builder is a Windows application that allows you to generate product and driver diskettes as well as view online documentation. You can access Diskette Builder in one of two ways. Either boot the server from the SmartStart CD and select *Create Support Software* to launch the Diskette Builder utility, or run Diskette Builder from an existing Windows workstation. Once you have done this, you can build diskettes, view online documentation, or install the Diskette Builder application on the hard disk in your server.

For more information on installing support software directly from the SmartStart and Support Software CD, refer to the [drive]: /CPQSUPSW/README.TXT file on the SmartStart and Support Software CD, where [drive] is the drive letter of your CD-ROM.

To run Diskette Builder from the Compaq SmartStart and Support Software CD using Windows 95 or Windows NT, with a CD-ROM drive, follow the steps outlined below:

1. Insert the SmartStart and Support Software CD. In most cases, it will autorun a popup application that contains a button to launch Diskette Builder automatically.

2. If Diskette Builder does not autorun, click *Start→Run* and enter [drive]: /DSKBLDR/DSKBLDR.EXE - where [drive] is the drive letter of your CD-ROM.

3. Once the program launches, follow the instructions on the screen.

To install Diskette Builder on the hard drive of your PC or network server, follow the steps outlined below:

1. Insert the SmartStart and Support Software CD.

2. Click *Start→Run*.

3. Enter [drive]: /DSKBLDR/SETUP.EXE - where [drive] is the drive letter of your hard drive.

4. Once the setup program launches, follow the instructions on the screen.

The system will then build and copy the files to the designated drive. After installation is complete you will have a Diskette Builder icon that you can open from within Windows 95 or Windows NT.

Once you are in Diskette Builder, follow the steps outlined below to create diskettes from a CD-ROM:

From the Software Selection screen, select the products for which you wish to create support software diskettes. The following table lists the diskette images available and the CD location where they can be found:

Table 4-1
Diskette Builder Software

Diskette Image	Location
Compaq drivers and support software	SmartStart and Support Software CD or appropriate operating system CD
Compaq server utilities	SmartStart and Support Software CD
Compaq Insight Management Software	Compaq Management CD
Workstation components specific	Appropriate operating system CD to software products

NOTE: When prompted, insert the appropriate CD for the selected software diskettes being created. This process is repeated for each software product. Select OK to verify that you have inserted the appropriate software CD.

1.   If the software being created is locked, you are prompted to enter the activation key at this time.

2.   The File Information dialog box is displayed. This screen provides you with feedback on the progress of the diskette creation. It shows details of the creation process in the form of product name, source file, current file status, and product status progress bars. To abort the diskette creation process, select Cancel.

3.   The Diskette Message dialog box is displayed to inform you of any action you may be required to take for the images being created. Follow the instructions on the screen. Each action may vary depending on the software or items selected for diskette creation.

The system will then build and copy the files to the diskette(s).

Compaq Systems Reference Library CD

The Compaq Systems Reference Library provides customers with a wide variety of user, reference, and integration information on one medium, delivered with every Compaq server. The Systems Reference Library is also included with the SmartStart Subscription Service.

To access the documentation from the Compaq Systems Reference Library CD, you need a system with Microsoft Windows 3.1 or higher or Microsoft Windows NT, and a CD-ROM drive.

Set Parameters

Configuring Set Parameters with SmartStart

SmartStart normally configures Set Parameters during installation. If you want to manually change the Set Parameters, you can do so during the *Pre-Installation Interview* phase of the SmartStart installation procedure. After the *NetWare Configuration* screen is displayed, and you have configured your Network Interface Controller (NIC) with the *frame type* and *network number*, the *NetWare Set Parameters* screen will display. You can change any set parameters from the default settings. After you are done, click O*K→Continue* to display the *Customer Hardware Registration* screen.

Only a limited number of SET parameters have a significant performance impact on your Compaq server. Table 4-1 shows the recommended values for SET parameters that Compaq engineers found to have a positive impact on server performance.

Table 4-2
Compaq Recommended Settings

SET Parameter	Setting
SET MAXIMUM SERVICE PROCESSES	60 for 1 to 499 users 100 for 500 plus users
SET MINIMUM PACKET RECEIVE BUFFERS	40 x Number of NICs plus user count

Table 4-2
Compaq Recommended Settings

SET Parameter	Setting
SET MAXIMUM PACKET RECEIVE BUFFERS	Minimum Packet Receive Buffers parameter plus 150
SET MAXIMUM PHYSICAL RECEIVE PACKET SIZE	6000 for FDDI NIC 4202 for Token Ring 1545 for Ethernet
SET MINIMUM DIRECTORY CACHE BUFFERS	300 for 1 to 499 users 1,000 for 500 plus users
SET MAXIMUM DIRECTORY CACHE BUFFERS	600 for 1 to 499 users 2,000 for 500 plus users
SET MAXIMUM CONCURRENT DIRECTORY CACHE WRITES	10
SET DIRTY DIRECTORY CACHE DELAY TIME	0.5 seconds
SET MAXIMUM CONCURRENT DISK CACHE WRITES	100

The following sections explain in more detail the recommended settings for the parameters.

Service Processes

"Service processes" are the execution threads used to receive incoming service requests from workstations. When a workstation sends a request, the request cannot be processed until a service process becomes available to handle it. If there are not enough service processes available, a temporary I/O bottleneck can emerge, until intraNetWare creates more service processes for handling requests.

You can use the SET MAXIMUM SERVICE PROCESSES parameter to allow intraNetWare to create enough service processes to manage the workload. This ensures that the bottleneck generated due to a sudden increase in workload is only temporary. You can adjust the maximum service processes number by changing the following parameter:

SET MAXIMUM SERVICE PROCESSES   = *number*

Specify the maximum number of service processes that the operating system can create.

Supported values:	5 to 1,000
intraNetWare default:	40
Compaq recommends:	60 for 1 to 499 users
	100 for 500+ users

These recommendations do not always cover every situation. For example, if the server is low on memory, decrease this parameter temporarily. On the other hand if the number of service processes is at the maximum, increase this parameter. Increasing this parameter helps only if more than 20 requests are being delayed simultaneously. You can view the number of service processes using the *MONITOR.NLM*.

If intraNetWare must create additional service processes, it waits a designated amount of time before it creates the next process. You can designate the wait time using the SET NEW SERVICE PROCESS WAIT TIME parameter. The default value of 2.2 seconds is adequate for most intraNetWare environments.

Packet Receive Buffers

"Packet receive buffers" hold communication packets that are waiting to be processed or transmitted. You can adjust the minimum and maximum number of buffers that intraNetWare generates by changing the following parameters:

SET MINIMUM PACKET RECEIVE BUFFERS   = *number*

Specify the minimum number of packet receive buffers the operating system can allocate. The operating system allocates this number of buffers as soon as the server restarts. You must add this parameter to the *STARTUP.NCF* file. You cannot change the setting at the console prompt.

Supported values:	10 to 2,000 (at startup)
intraNetWare default:	50
Compaq recommends:	40 x Number of NICs plus user count

Before increasing this parameter, use *MONITOR.NLM* to view the use of packet receive buffers on the server. If you have EISA bus master NICs in the server and are receiving "No ECB available count" errors right after the server starts, increase this parameter so that each board can have at least 5 packet receive buffers. You can use *MONITOR.NLM* to determine if the board is producing errors. If the allocated number is higher than 10 and the server does not respond immediately after starting, increase this parameter.

The value of this parameter must be less than the value of the MAXIMUM PACKET RECEIVE BUFFERS parameter. If it is greater, the system increases the value to match that of the MINIMUM PACKET RECEIVE BUFFERS parameter.

> **!** **IMPORTANT:**   Increasing the minimum packet receive buffers takes system memory from the intraNetWare memory pool. Adjust the maximum packet receive buffer size to match the network media frame size. This reduces the overall packet buffer memory requirement. Ensure that increasing this value does not leave the server with too little memory for file caching. Once the memory is allocated as packet receive buffers, it is not deallocated until you bring down the server.

SET MAXIMUM PACKET RECEIVE BUFFERS = *number*

Specify the maximum number of packet receive buffers that the operating system can allocate.

Supported values:	50 to 4,000
intraNetWare default:	100
Compaq recommends:	Minimum Packet Receive Buffers parameter plus 150

One way to determine if your maximum packet receive buffers value is too low is to use the *MONITOR.NLM* LAN Information option. intraNetWare creates new communication buffers as they are needed, until the number of buffers reaches the maximum buffers value defined in the SET parameter. In the LAN Information Custom Statistics, the No ECB Available Count statistic increments each time a communication buffer is unavailable when the server receives a packet. Any number in the No ECB Available Count statistic shows that you might need to increase the maximum packet receive buffers value to accommodate the number of requests to your server.

Before increasing this parameter, use *MONITOR.NLM* to view the use of packet receive buffers and service processes on the server. If the number of packet receive buffers is at maximum, increase this parameter in increments of 10 until you can have one packet receive buffer per workstation. If you have EISA bus master NICs in the server, increase this parameter to provide at least 5 buffers per NIC.

intraNetWare also allows you to adjust the amount of time between creation of packet receive buffers. The default value for the SET NEW PACKET RECEIVE BUFFER WAIT TIME parameter is from 0.1 to 20 seconds. intraNetWare waits the 0.1 second interval, allocates system memory for packet receive buffers, and then creates a new buffer. This dynamic allocation provides enough buffers for most environments.

Packet Size

You can adjust the MAXIMUM PHYSICAL RECEIVE PACKET SIZE number by changing the following parameter:

SET MAXIMUM PHYSICAL RECEIVE PACKET SIZE   = *number*

Specify the maximum size of packets that can be transmitted on the network. You must add this command to the *STARTUP.NCF* file. You cannot change the setting at the console prompt.

Supported values:	618 to 24,682
intraNetWare default:	4202
Compaq recommends:	6000 for FDDI NIC
	4202 for Token Ring
	1514 for Ethernet

The default value allows 4 Kbytes, which includes data with the packet header. If you use Token Ring or Ethernet boards, the default value is acceptable. If some of your network boards transmit more than 512 bytes of data per packet, set this parameter for the largest packet size.

File Directory Caching

To improve data access time, intraNetWare uses system memory to cache the FAT and directory entry table. intraNetWare obtains file location information from the directory cache and then accesses the file from either data cache or disk. Using the least recently used (LRU) algorithm, intraNetWare then discards unused directory blocks.

intraNetWare allocates 20 directory cache buffers from a fixed cache buffer pool to perform directory caching. Each cache buffer is 4 Kbytes, which can hold up to 32 directory entries.

The intraNetWare auto-tuning process will automatically allocate more directory cache blocks based on several algorithms and two intraNetWare SET parameters.

SET MINIMUM DIRECTORY CACHE BUFFERS   *= number*

Specify the minimum number of cache buffers that the system can allocate for directory caching.

Supported values:	10 – 2000
intraNetWare default:	20
Compaq recommends:	250 for Low Use Environment. 2000 for High Use Environment
New Server:	300 for 1 – 499 users 1000 for 500 plus users

.

SET MAXIMUM DIRECTORY CACHE BUFFERS   *= number*

Specify the maximum number of cache buffers that the system can allocate for directory caching.

Supported values:	20 –4000
intraNetWare default:	500
Compaq recommends:	500 for Low Use Environment 4000 for High Use Environment
New Server:	600 for 1 – 499 users 2000 for 500 plus users

Recommended Strategies to Use

You need to determine which of these two scenarios describes your circumstances:

■   Low-use – User activity is limited to a small region of the directory, such as a home directory. A small number of directories are shared.

■   High-use – User activity spans a very large number of directories and files. An example might be a document-based system in which searches would frequently encompass large portions of a large directory.

If your environment is Low-use, leave the default settings in place. intraNetWare will allocate directory cache buffers as needed up to the maximum of 512 buffers (2 MB), which is sufficient for this environment.

If your environment is High-use, adjust the SET parameters for the Minimum and Maximum Directory Cache Buffers in the AUTOEXEC.NCF as shown above. These settings will allocate 8 MB of RAM for directory cache immediately upon request and allow up to 16 MB to be allocated at maximum.

If neither of the scenarios apply to the environment, check the number of allocated Directory Cache Buffers in MONITOR.NLM. Use this number as the Directory Cache Buffer Watermark for the server. Set the minimum directory cache buffers at this number. Adjust the maximum directory cache buffers setting to 100 over the new minimum. If you wish to add an additional Name Space, multiply the Directory Cache Buffer Watermark by two for one additional Name Space, three for two additional, and so forth. Then follow the same procedure as above with the new Directory Cache Buffer Watermark. If you are tuning a new server, use the values suggested according to the user count until you can tune according to use.

NOTE: When a directory cache buffer is allocated, the allocation is permanent until the server restarts. The buffers do not return to file caching when the need for directory cache buffers decreases.

Maximum Concurrent Directory Cache Writes

For most other intraNetWare SET parameters, the default values provide sufficient performance without taking buffers away from other processes. However, if your intraNetWare environment is write intensive, you might want to increase the default value for the SET MAXIMUM CONCURRENT DIRECTORY CACHE WRITES parameter. You can adjust the maximum number of concurrent directory cache writes value by changing the following parameter:

SET MAXIMUM CONCURRENT DIRECTORY CACHE WRITES   = *number*

Specify how many write requests from directory cache buffers are put in the elevator before the disk head begins a sweep across the disk.

Supported values:	5 to 50
intraNetWare default:	10
Compaq recommends:	10

A high number creates more efficient write requests and a low number creates more efficient read requests.

Dirty Directory Cache Delay Time

If your server includes a large number of small, frequently-accessed files, increase the value of the SET DIRTY DIRECTORY CACHE DELAY TIME parameter, so that these files are not written to disk too quickly. You can adjust the value of the dirty directory cache delay time, by changing the value of the following parameter:

SET DIRTY DIRECTORY CACHE DELAY TIME   = *number*

Specify how long the system keeps a directory table write request in memory before writing it to disk.

Supported values:	0 to 10 seconds
intraNetWare default:	0.5 seconds
Compaq recommends:	0.5 seconds

Increasing this parameter gives slightly quicker performance, but it will increase the probability of the directory tables becoming corrupted. A zero setting reduces performance dramatically.

Once your server is operational, always monitor your server performance over a period of several hours to several days. This ensures that any adjustments made to the network server are based on careful monitoring and analysis.

> ❗ **IMPORTANT:** As you change the values of these and all cache-related SET parameters, the operating system takes memory from the cache buffers pool. Once these buffers are allocated, intraNetWare does not release these buffers to the cache buffers pool until you bring down the server.
>
> Ensure that the server has enough system memory to service requests by using the recommended system memory formula provided in Chapter 2, "Hardware Planning."

Concurrent Disk Requests

The Concurrent Disk Requests value in the *MONITOR.NLM* Information menu displays the number of enqueued disk requests for the server to process. This value can peak near or above 100 for brief periods of time; however, if the value is consistently near or above 100, performance may be degraded.

Begin by checking the value of the SET MAXIMUM CONCURRENT DISK CACHE WRITES parameter. It controls how many write requests are placed in the elevator before the disk head begins a sweep across the disk platter.

To create more efficient read and write requests for your system, you can adjust the maximum number of concurrent disk cache writes by changing the following parameter:

SET MAXIMUM CONCURRENT DISK CACHE WRITES   = *number*

Specify the number of write requests for changed file data that can be put in the elevator before the disk head begins a sweep across the disk.

Supported values:	10 to 4,000
intraNetWare default:	50
Compaq recommends:	100

Always monitor the network server performance to analyze your network environment and obtain baseline statistics before making any changes to the server.

If your server uses a Compaq drive array controller or a SCSI subsystem, increasing the value of the SET MAXIMUM CONCURRENT DISK CACHE WRITES parameter may relieve the subsystem bottleneck by taking advantage of the capabilities of Compaq hard drive subsystems. Compaq hard drive subsystems can service multiple requests at a time.

When you change this parameter, however, you must be aware of your network read-write ratio. Most resource-sharing environments perform more read operations than write operations. Current estimates identify three read operations to one write operation as a typical resource-sharing environment. To increase performance for implementations that perform more read operations than write operations, use a smaller value, such as 20 to 35. To increase performance for implementations that perform more write operations, use a larger value, such as 100 or greater. For example, if 80 percent of server requests are for read operations and only 20 percent of server requests are for write operations, then lower the value of the SET MAXIMUM CONCURRENT DISK CACHE WRITES parameter.

Network Interface

There are a variety of tools to monitor your network subsystem. To monitor the physical network, you can use either a protocol analyzer or network monitoring software. To monitor your server NICs, you can use Compaq Insight Manager or you can use the custom statistics provided by the NIC driver and *MONITOR.NLM*.

Physical Network

A protocol analyzer or network monitoring software provides information about the percentage of available bandwidth (network utilization) your network uses at a given time.

In Ethernet environments, the network utilization should generally remain below 40 percent. During peak network hours (for example, at the beginning of the work shift or work day), the utilization may peak above 40 percent, but only temporarily. As the network utilization increases in an Ethernet environment, the chance for packet collisions also increases. As the number of packet collisions increases, so does the number of retries, which generates even more traffic on the network. If the network utilization is consistently above 40 percent, segment your network using routers or relocate servers.

Because of the deterministic nature of Token Ring environments, high network utilization does not degrade network performance. The ring is not as sensitive as Ethernet to the number of workstations or to the amount of data being transmitted; therefore, in most Token Ring environments, the network utilization is not a factor.

In a multiprotocol, routed environment, routers can become a congestion point or bottleneck. Typically, routers supporting high-traffic demands cannot forward simultaneous multiple protocols at wire speed. Minimizing the number of routers (hops) between the user's logon, file, and print services can reduce network delay and therefore improve performance. If these services cannot be provided within the same network, creating a server-only subnet may be of benefit. Server-only subnets are dedicated networks directly attached to a router (or server acting as a router) containing only servers. These special types of network configurations can be helpful in reducing cross-network traffic.

Server Network Subsystem

To monitor network subsystem performance and identify bottlenecks, you can use either or both of the following:

■   Compaq Insight Manager

■   *MONITOR.NLM*

Both products provide statistics that show the existence of or the potential for a network interface bottleneck, but Compaq Insight Manager allows you to set thresholds for some of its statistics. When the statistic exceeds the threshold, the Management PC generates a warning to you either over the network or via pager. Use both of these monitoring tools to check your network subsystem performance.

The following sections describe the most commonly used statistics that allow you to monitor server performance and avoid NIC bottlenecks.

Compaq Insight Manager

Compaq Insight Manager is the Compaq application for easily managing servers. Insight Manager delivers monitoring and alerting, remote maintenance, and visual control of your servers. In the unlikely event of server failures, Insight Manager provides remote maintenance and control facilities, which include:

■ Diagnostics to analyze the condition of your server

■ System configuration and restart

■ System firmware updating

Compaq Insight Manager shows statistics, but also allows you to set thresholds so that the management PC informs you when these thresholds are exceeded. For the network subsystem, Insight Manager provides both generic statistics and environment-specific statistics.

MONITOR.NLM

MONITOR.NLM shows generic statistics as well as custom statistics provided by the NIC device driver. These statistics can help you monitor the network subsystem. The following paragraphs discuss the most informative generic and custom statistics for performance monitoring and analysis.

Generic LAN Statistics (Token Ring and Ethernet)

Use *MONITOR.NLM* to review the following generic statistics for both the Compaq NetFlex-2 ENET/TR Token Ring and the Compaq NetFlex-3 Ethernet controllers:

■ Checksum Errors

■ No ECB Available Count

■ Send Packet Too Big Count

■ Receive Packet Overflow Count

The **Checksum Errors** statistic indicates data errors that occur when the checksum byte at the end of a packet does not equal the sum of bytes in the packet. This verification is performed at the data link layer. SET CHECKSUM ERROR= 0 disables the feature, setting it to 1 enables the checksum feature if the feature is also enabled on the client, and setting it to 2 enables the checksum feature. The checksum feature is not supported under Ethernet 802.3 and is not recommended unless you suspect packet errors.

The **No ECB Available Count** statistic is a key indicator of a lack of available packet receive buffers. This statistic increments when the SET MAXIMUM PACKET RECEIVE BUFFERS parameter is set too low and the number of buffers has reached the maximum, or when the server does not have enough system memory to provide the adequate number of packet receive buffers. In either case, the network subsystem performance has degraded and requires attention.

The **Send Packet Too Big Count** statistic is a counter that increments when the server tries to transmit a packet that is too large for the hardware to handle.

The **Receive Packet Overflow Count** statistic is a counter that increments when the server receives a packet that is too big to store in a cache buffer. This happens rarely, unless you are running a software program that does not negotiate packet size.

Custom LAN Statistics (Token Ring)

Use *MONITOR.NLM* to review the following custom statistics for the Compaq NetFlex-2 ENET/TR Token Ring controller performance analysis:

■ Send Abort Bad TCB from TSM

■ Send Abort Ring Beaconing

The **Send Abort Bad TCB from TSM** statistic is a counter that increments when invalid packets are detected before transmission.

The **Send Abort Ring Beaconing** statistic reports transmit resources returned to the operating system during a beaconing condition. If this statistic is increasing, your server is experiencing a beaconing condition that should be resolved. To reset this statistic to zero, unload and then reload the driver.

Custom LAN Statistics (Ethernet)

Use *MONITOR.NLM* to review the following custom statistics for the Compaq NetFlex-3 Ethernet controller performance analysis:

- Adapter Check Count

- Transmit Timeout Errors

- Transmit Packets Copied

- Oversized Receive Errors

- Driver Operating Time (minutes)

- Link Speed (bps)

- Promiscuous Mode (0 = Off, 1 = On)

- Network Link Status (0 = Up, 1 = Down)

- VG Transitions Into Training

- VG Training Failures

- Send Abort Failures

- Duplex Mode

- TLAN Device Revision (X.X)

The **Adapter Check Count** statistic counts the number of adapter checks that occur and indicates a possible hardware problem. This statistic generates a console error message that details the problem. The adapter resets and operation should continue. The **Adapter Reset** statistic also increments.

At the next scheduled maintenance, bring down the server and run Compaq Diagnostics to determine if the board should be replaced.

The **Transmit Timeout Errors** statistic is incremented when a frame does not transfer within the expected amount of time. The adapter resets and operation should continue. The **Adapter Reset** statistic also increments.

If this statistic increments rapidly in a short period of time, check to ensure that the cables are properly connected. The Link Status LED should be lit if the driver is loaded and the adapter is connected to a hub. If this statistic still increments, you should power off the system and check the following:

■ Check the module on the NetFlex-3 controller to ensure that it is correctly installed.

■ Check the seating of the NetFlex-3 controller into its slot.

If all of these elements appear to be in working order, you should check the following:

■ Swap out the adapter and adapter cable one at a time. If you find a faulty component, replace it.

■ Check your hub. This component might be at fault. Use the diagnostics from the hub manufacturer to help you determine if a problem exists.

The **Transmit Packets Copied** statistic indicates how many packets have been copied by the driver before transmission. This statistic enables you to monitor inefficient NLMs running on the server. NLMs that use up to 16 fragments transmitted per packet might cause this statistic to be incremented.

A typical file server will never see this statistic increment.

The **Oversized Receive Errors** statistic increments if a packet is received that is larger than the maximum allowed on the NetFlex-3 Ethernet controller. A high number of these errors indicates that a node has malfunctioned and is transmitting oversized frames. You can use a network analyzer to determine which node on the network is causing the problem.

The **Driver Operating Time (minutes)** statistic indicates the approximate time that the driver has been operating in minutes.

The **Link Speed (bps)** statistic indicates the speed at which the adapter is running.

The **Promiscuous Mode (0 = Off, 1 = On)** statistic indicates whether Promiscuous Mode is currently turned on or off and can be used to verify the operation of network analyzer products such as Novell's LANalyzer NLM. (When the LANalyzer is capturing network data, Promiscuous Mode is on). To use the Promiscuous Mode:

■   0 - indicates on

■   1 - indicates off

The **Network Link Status (0 = Up, 1 = Down)** statistic reports the current status of the link. To use **Network Link Status**:

■   0 - indicates the link is working

■   1 - indicates that there is no communication with the hub

If this statistic is 1, check your cables and connections. If none of these solutions alleviate the problem, try resetting the hub.

The **VG Transitions Into Training** statistic is a training session that occurs before a controller is given access to the network. Twenty four packets are sent to the hub and echoed back. When this occurs successfully, data can be transferred on to the network from a controller. If a hub or controller detects interference or invalid data control sequences, training occurs.

This statistic tracks the number of times the controller enters the training state. If this statistic goes up rapidly, the controller is disconnecting/reconnecting to the hub numerous times. Excessive transitions into training might mean a bad cable, in which case you should check the following:

■   Swap out the controller and controller cable one at a time. If you find a faulty component, replace it.

■   Check your hub. This component might be at fault. Use the diagnostics from the hub manufacturer to help you determine if a problem exists.

■   Run Compaq Diagnostics. If none of these suggestions clear the problem, contact your service provider. You might need a driver upgrade.

The **VG Training Failures** statistic counts the number of times a training session has failed. For example, this statistic increases if your controller is disconnected from the hub because periodically the controller attempts to connect to the hub. If this statistic increments rapidly, you should check the following:

■ Make sure your adapter is connected to the hub using proper cabling.

■ Check your hub. This component might be at fault. Use the diagnostics from the hub manufacturer to help you determine if a problem exists.

■ Run Compaq Diagnostics. If none of these suggestions clear the problem, contact your service provider. You might need a driver upgrade.

The **Send Abort Link Failures** statistic indicates how many transmitted packets have failed to transmit due to link failures.

The **Duplex Mode** (0=Half, 1=Full) statistic indicates the duplex mode in which the adapter is operating. Use this information to ensure that the adapter is operating in the same mode as the device to which it is connected.

TLAN Device Revision (X.X) is a two-digit number that represents the version of ThunderLAN that is used on your controller. For instance, if this value is 23, then that means that the TLAN version in use is 2.3.

Hard Drive Subsystem

The following sections describe how to identify hard drive subsystem bottlenecks and the measures to take to correct them.

You can use the *MONITOR.NLM* Information menu to inspect the cache buffers. If intraNetWare has too few cache buffers to satisfy I/O requests, the cache flush occurs often, and the hard drive, rather than the cache, must service remaining read requests. Since most intraNetWare environments are read intensive, the cache can satisfy most read requests if you have allocated the cache buffers correctly.

Using *MONITOR.NLM*, you can monitor the following statistics to ensure that the server has enough cache to satisfy the majority of the read requests:

Table 4-3
Statistics to Monitor

Statistic or Parameter	Description	Recommendation
Dirty Cache Buffers	Current write requests in cache; indicates system memory or hard drive subsystem bottleneck if consistently > 70% of Total Cache Buffers	Add system memory **unless** Short-Term Cache Hits below 90% and Current Disk Requests near or > 100
Dirty Cache Buffers above 70% of Total Cache Buffers **and** Short-Term Cache Hits below 90% and Current Disk Requests near or > 100	Indicates a hard drive subsystem bottleneck	Balance the hard drive subsystem over multiple controllers; balance application load across hard disks/controllers
SET DIRTY DISK CACHE DELAY TIME	How long the OS retains a write request in cache before it is written to the hard disk	Increase from default of 3.3 sec. if there are many small writes
Original Cache Buffers	Memory available at server startup	Multiply by cache buffer size for actual amount
Total Cache Buffers	Memory available to the users for caching	Multiply by cache buffer size for actual amount
Original Cache Buffers - Total Cache Buffers	Memory used to load NLMs and SET parameters	Multiply by cache buffer size for actual amount
Cache Buffers in Server Memory Statistics	Percentage of memory allocated to cache buffers	Add system memory until at least 70%

Dirty Cache Buffers

The number of dirty cache buffers can provide information about how many write requests reside in cache while awaiting a cache flush. You can see this value in the *MONITOR.NLM* Information menu. Monitor the network for several hours before making any changes. This ensures that the value displayed is not a peak activity value. If dirty cache buffers value is consistently *above 70 percent* of the total cache buffers, then there is a bottleneck either in system memory or in the hard drive subsystem.

Adding system memory is usually the first answer, but check the percentage of short-term cache hits and the Current Disk Requests statistic. If the percentage of short-term cache hits remains below 90 percent and the number of Current Disk Requests remains near or above 100, the performance degradation is probably due to a hard drive subsystem bottleneck.

The SET DIRTY DISK CACHE DELAY TIME parameter defines how long the operating system retains a write request in system memory before writing the request to the hard drive. The request may not be enough to fill a cache buffer, so the system memory retains the request until the cache buffer fills or until this period of time expires.

SET DIRTY DISK CACHE DELAY TIME   = *number*

Defines how long the operating system retains a write request in system memory before writing the request to the hard drive.

Supported values:	0.1 to 10 seconds
intraNetWare default:	3.3
Compaq recommends:	3.3

If the majority of system activity consists of small write requests, increasing the delay time can make the write operation more efficient. Decreasing the delay time between write operations in this same environment can drastically degrade performance.

Original Cache Buffers

The Original Cache Buffers statistic provides information about how many cache buffers are allocated at network server startup. You can view this value in the *MONITOR.NLM* Information menu. Use this statistic to help you calculate the amount of system memory used for loading NLMs and SET parameters and the amount of system memory available for file caching.

By multiplying the value of Original Cache Buffers by the cache buffer size (4 Kbytes), you can determine the amount of system memory available for the file cache at network server startup, as shown in the following example. For example, if the Original Cache Buffers displays 3,500 buffers, more than 14 megabytes of system memory are available at network server startup.

Original Cache Buffers * Cache Buffer Size	= System Memory available at startup
3,500 * 4,096	= 14,336,000 (approximately 14 MB)

Total Cache Buffers

The *MONITOR.NLM* Information menu also provides the total cache buffers, the number of cache buffers that are currently available for file caching. As you load NLMs on the server, the total cache buffers value decreases.

To determine the amount of system memory that is available to the users for file caching, multiply the total cache buffers value by the cache buffer size (4 Kbytes). This formula provides an estimate of how much system memory can be used for caching disk I/O requests and how much system memory is needed by other resources like NLMs.

For example, if the Total Cache Buffers menu displays 2,975 total cache buffers, this means that approximately 12 megabytes of system memory are available to cache disk I/O requests.

Total Cache Buffers * Cache Buffer Size	= Current available System Memory
2,975 * 4,096	= 12,185,600 (approximately 12 MB)

If you subtract the value of total cache buffers from the value of the Original
Cache Buffers statistic, you can determine the number of buffers allocated for
loading NLMs and SET parameters (3,500 - 2,975 = 525). If you multiply this
value by the cache buffer size, you can determine approximately how much
system memory is currently used to load NLMs and SET parameters.

Cache Buffer Size (Original Cache Buffers - Total Cache Buffers)	= System Memory used for NLMs and SET parameters
4,096 * (3,500 - 2,975)	= 2,150,400 (approximately 2 MB)

Cache Buffers in Server Memory Statistics

MONITOR.NLM also provides the Server Memory Statistics screen under the
Resource Utilization option that displays a percentage of system memory that is
allocated to Cache Buffers. Compaq integration and performance testing has
determined that keeping this percentage above 70 percent allows the system
extra resources for even the most saturated environment. If this value is *below
70 percent*, add system memory until the value exceeds 70 percent.

System Processor

The Utilization statistic in the *MONITOR.NLM* Information menu and the
Server Utilization parameter in Compaq Insight Manager provide an indirect
indication of how the system processor is performing. However, these values
reflect the utilization of the whole server, not just the system processor. A value
consistently greater than 80 percent may indicate that the system processor is
spending most of its time on tasks that require system processor intervention.

A high utilization value does not necessarily mean that the server lacks enough
system processor power. The most common reason for high utilization is
because another resource such as system memory, NICs (especially if they are
not bus master NICs), or disk I/O is not properly configured or tuned.
Upgrading the system processor may cause a drop in the utilization statistic, but
this might not help user workstation response time.

Other network server subsystems can cause the utilization value to be high. For
example, if the server uses two ISA NICs, the utilization value may be
45 percent. By changing these ISA NICs to EISA bus master NICs, the
utilization value may drop by as much as 30 percent.

Chapter 5
Workstation Configuration and Enterprise Network Performance

intraNetWare provides the infrastructure necessary to provide enterprise-wide services to the user community. However, the complexity of managing individual workstation (or desktop) performance in this new environment increases depending on the size and scope of the network and services provided.

This chapter discusses the issues of managing desktop performance in an enterprise environment.

Workstation Performance

In this discussion, workstation performance is broken into three components:

■ Hardware performance

■ Software performance

■ Workstation performance over WAN connections

Overall workstation performance depends on the appropriate configuration of components to meet the individual user's requirements.

Hardware Performance

LAN workstations usually consist of four major subsystems:

■ System processor

■ Network interface

■ System memory

■ Hard drive

Overall hardware performance is dependent on a complex interaction of these components as shown in Figure 5-1.
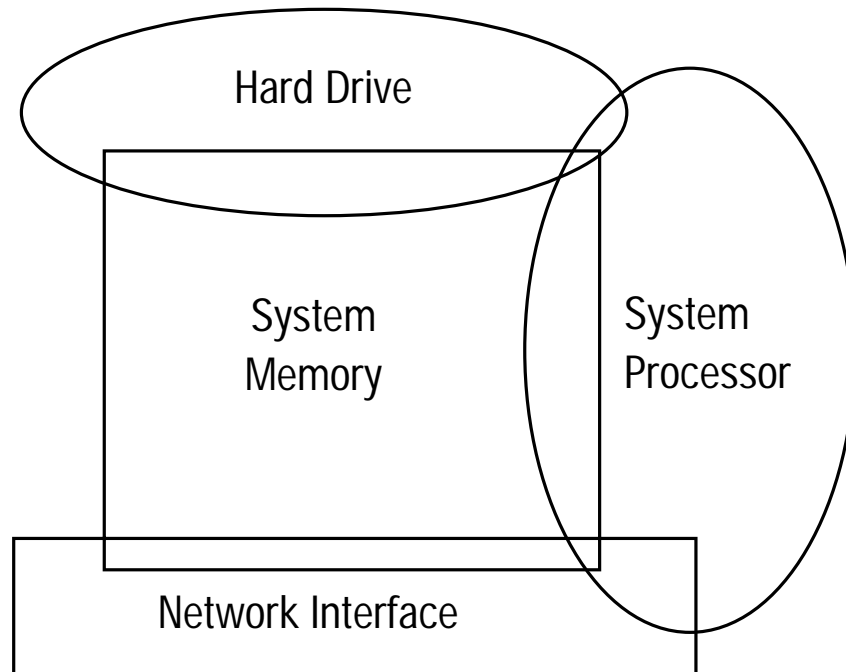
Figure 5-1.   Subsystem relationships

System Processor Performance

In a network environment, resource sharing usually entails functions such as file transfers and printing. Most applications that run in a network environment use the file transfer capabilities and print services of the network, but use the computing functions of the workstation to process data. For this reason, an important factor in workstation performance is the system processor.

Workstation users develop a perception of adequate performance, which varies with the individual. If system processor-intensive applications run at the workstation, the user can experience as much as a 100 percent performance difference between a 486- and a 586-based workstation. Upgrading the system processor increases the performance of system processor-intensive applications more noticeably than that of network-intensive applications.

Network Subsystem Performance

The workstation NIC selection can also affect the overall network performance. Consider the following factors:

■ Type of workstation NIC (8-, 16-, and 32-bit NICs)

■ Workstation device driver

Type of Workstation NIC

NICs that use bus mastering or that support larger packet sizes provide higher performance for the workstation. In some cases, a high-performance NIC can enhance the performance of a slow workstation until it is similar to a workstation with a faster system processor and a slower NIC.

The amount of data that the network transfers should determine the NIC requirement. When little network traffic occurs, an 8-bit or 16-bit NIC may suffice. However, when the network frequently transfers large files and programs, a 16-bit or 32-bit NIC enhances performance. Enterprise networking, by its very nature, increases the need for a faster networking interface as more services are distributed and accessed across the enterprise. In addition, the performance of intraNetWare logins, time synchronization activity, and file transfers can be severely bottlenecked without sufficient network throughput.

Workstation Device Driver

Optimized device drivers can enhance NIC performance. Features such as early token release and large packet sizes can significantly increase the amount of data throughput.

Software Performance

Various device drivers and software parameter settings can affect overall network performance. The components having the largest impact on workstation software performance are:

■ Workstation device drivers

■ intraNetWare Client 32 software

■ Packet Burst and Large Internet Packets (LIP)

Workstation Device Driver

Compaq device drivers provide features that can further enhance NIC performance, such as full duplex, larger packet size, and packet burst capabilities. The latest workstation device drivers from Novell use the Open Datalink Interface (ODI) for enhanced performance. Be sure to use ODI compliant device drivers in intraNetWare clients for higher performance.

intraNetWare Client 32 Software

Client 32 for intraNetWare

There are three 32-bit versions of Novell's Client 32 software: DOS/Windows 3.X, Windows 95, and Windows NT. The client-side caching in Client 32 reduces network and server congestion. Memory allocation depends on the OS being used and the amount of free memory available after the OS loads. The Windows 95 Client 32 allocates 25% of free memory. The DOS/Windows Client 32 allocates memory roughly according to the chart below:

Table 5-1
Client 32 for DOS/Windows Cache Size

Free memory at load time	Resulting Client 32 cache size
0 KB to 384 KB	0 KB
384 KB to 6 MB	384 KB
6 MB to 8 MB	512 KB
8 MB to 12 MB	1.5 MB
12 MB to 16 MB	2 MB
16 MB to 20 MB	3 MB
20 MB to 24 MB	8 MB
24 MB +	50%

Usually, larger client cache size translates to greater network file I/O performance. The default cache value for the Windows 95 Client may be user-configured. Use the Start menu, Settings→Control Panel→Network to highlight the Client 32 entry. Click on Properties and set the MAXIMUM CACHE SIZE keyword to the desired value in KB. You may also turn off the cache by setting the FILE CACHE LEVEL property to zero.

Keep in mind that there is a finite amount of RAM in the workstation. More memory allocated to the cache makes a faster client but makes that memory unavailable to other Windows applications.

Other suggestions to increase the client speed include:

■ Bind protocols only to boards that use them.

■ Allow delayed writes. This permits an application to continue working without waiting for data to be written to the server. This involves changing the CLOSE BEHIND TICKS setting, which risks data integrity.

■ Change the FILE CACHE LEVEL to control whether everything is cached, nothing is cached, or other levels in between the extremes, remembering that RAM used for cache is no longer available to applications.

Many of the options that increase client speed also reduce the level of data integrity. For example, enabling delayed writes means that data reported as written to the server is actually in workstation RAM for a period of time until actually written to disk. During this time, if power to the workstation is interrupted, the data is lost.

If the user closes the files or exits the application, the data is written immediately. If the user is willing to do this before turning off the workstation, the CLOSE BEHIND TICKS may be set to 36 (2 seconds) and DELAYED WRITES set to on. Users working with mission-critical data may wish to set TRUE COMMIT to ON to ensure that a write will not be reported completed until the data is safely written to disk.

Data Integrity

Many of the options that increase client speed also reduce the level of data integrity. For example, enabling delayed writes means that data reported as written to the server is actually in workstation RAM for a period of time until actually written to disk. During this time, if power to the workstation is interrupted, the data is lost.

If the user closes the files or exits the application, the data is written immediately. If the user is willing to do this before turning off the workstation, the CLOSE BEHIND TICKS may be set to 36 (2 seconds) and DELAYED WRITES set to on. Users working with mission-critical data may wish to set TRUE COMMIT to ON to ensure that a write will not be reported completed until the data is safely written to disk.

If data integrity is a stronger concern than workstation speed, the AUTO RECONNECT LEVEL may be set to 4, which auto-reconnects all with guaranteed write data integrity across reconnection, but slows file write operations significantly.

Table 5-2
Data Integrity Settings

Auto-reconnect Level	Definition
0	No auto-reconnect support
1	Only auto-reconnect connections, drives, and printers
2	Auto-reconnect all except files that have been written to
3 (Default)	Auto-reconnect all with best-guess rewrite of data after reconnection (Fastest option)
4	Auto-reconnect all with guaranteed write data integrity across reconnection (very slow option for file write operations)

A new default-enabled Client 32 feature called *Opportunistic Locking* is used only when a file is opened that the server reports is only being accessed by that user. Performance is greatly enhanced in this case because the client can then cache files that are not normally cached. Caching for the file is turned off if another workstation attempts to open the same file.

Advanced Settings

To configure for optimal performance with Client 32, the advanced settings listed in the following table may be modified as previously discussed:

Table 5-3
Client 32 Advanced Settings

Parameter	Definition	Default
Cache writes	When this option is ON, the client will cache writes until a certain size block is written, as opposed to writing each write request as it is made.	ON
Allow writes to delay beyond application close	If this option is ON, the cache buffer is forced to flush immediately when an application closes. Otherwise, the buffer's data will remain in memory until it would normally have been flushed.	OFF
Detect exclusive access files for caching	If a file is being used exclusively by a single user, the client has more flexibility in caching. By detecting whether a file is being accessed by only one user, the client will deliver faster network access. When turned ON, this bidirectional protocol allows a client to cache data even though others are granted access to that data. As long as actual access has not occurred, the client will continue caching the file. As soon as the server notifies the client that actual access has been made to the file, the client flushes any dirty buffers or invalidates read buffers before continuing.	ON
Override cache writes Override cache reads	If you know that you are the only person using the files you are currently accessing, you may turn these options on to improve performance. This is most helpful when using a phone line or low-speed connection.	OFF OFF
Ticks to delay close of file	For environments where files are opened and closed frequently, Client 32 supports an optimization technique where close requests are delayed for a short period. If the file is opened again during that period, it is reused without hitting the network. The delay period is specified in ticks and is configurable. Range is 0-65,535	9 (1/2 sec.)

When adding RAM, increase the MAX CACHE SIZE appropriately.

For DOS/Windows, change the settings in the NET.CFG.

For Windows 95 or Windows NT, change them using Start menu→Settings→Control Panel→Network→Client 32 properties.

Client 32 versus VLMs

Client 32 benefits performance even if the workstation NIC is 16-bit. Also, if there is no 32-bit driver for the workstation's 32-bit NIC, Client 32 is still recommended. Testing shows that even in a 16-bit environment, Client 32 users experience a 20-25% performance gain over previous client software (VLMs). Server resource utilization is also reduced when compared to VLMs.

However, the greatest improvement is seen with matched client systems rather than a hybrid system.

Uninstalling Client 32 from Windows 95

A special Uninstall Client 32 Utility is provided with the latest version of Client 32 and is available from the Novell Web site (http://www.novell.com). It is the safest way to remove the Client 32 software without losing network connectivity.

Client 32 Software Settings that Affect Workstation Performance

Table 5-4
Client 32 Parameter Settings

Parameter	Description
CHECKSUM = 0	Provides packet verification for transmitted packets. Since most NICs have error-checking capabilities built into the hardware or firmware, you can disable the parameter: CHECKSUM = 0. Not supported on the Ethernet 802.3 protocol.
LARGE INTERNET PACKET = ON	Allows network packets to pass through bridges and routers that support packets larger than 576 bytes.
PB BUFFERS = 3	Allows the workstation to transmit and receive a series or *burst* of packets without requiring acknowledgment for each packet.
CACHE WRITES = ON	Allows the workstation to cache files and data locally before sending them over the network.
TRUE COMMIT = OFF	Allows the workstation to ensure data integrity by causing the server to commit the data to disk immediately.
SIGNATURE LEVEL = 0	Provides a security feature that embeds signature information in each packet to prevent network compromise from forged packets.

CHECKSUM = 0

When enabled, the CHECKSUM parameter provides packet verification for transmitted packets. This additional verification can cause degradation in overall performance, especially in workstation response time. Since most NICs have error-checking capabilities built into the hardware or firmware, you can disable the parameter: CHECKSUM = 0.

NOTE: This parameter is not supported on the Ethernet 802.3 protocol.

LARGE INTERNET PACKET = ON

This parameter allows network packets to pass through bridges and routers that support packets larger than 576 bytes. LIP must also be loaded on all servers acting as routers that are located between the workstation and server connection. Leaving this parameter enabled (ON) in a local area network environment that has no bridges or routers does not impede performance. However, enabling it in a wide area network environment that supports large packets can substantially increase performance.

PB BUFFERS = 3

The intraNetWare Packet Burst feature allows the workstation to transmit and receive a series or *burst* of packets without requiring acknowledgment for each packet. The PB BUFFERS parameter is actually either enabled (any value other than 0) or disabled (value of 0). If your server has packet burst enabled, ensure that this parameter is enabled at all workstations to improve response time

CACHE WRITES = ON

This parameter allows the workstation to cache files and data locally before sending them over the network. However, if the server fails, the data in the local cache is usually lost. If data integrity is a higher priority than performance, turn off cache writes. If performance is a higher priority than data integrity, turn on cache writes.

TRUE COMMIT = OFF

This parameter, when enabled, allows the workstation to ensure data integrity by causing the server to commit the data to disk immediately. When this happens, the data in intraNetWare cache is written to disk with the data that was transmitted from the workstation. The workstation then waits for acknowledgment that the data was written to disk and that the File Allocation Table (FAT) was updated.

While this parameter enhances data integrity, transmitting data across the wire and writing it to disk is much slower than letting intraNetWare perform the task in the background.

SIGNATURE LEVEL = 0

This parameter is a security feature that embeds signature information in each packet to prevent network compromise from forged packets. Setting the signature level to 0 disables it, and setting it to 1 uses packet signature only for devices that request them. Because adding the packet signature to each packet generates overhead both at the server and at the workstation, enabling the signature level can degrade performance significantly.

Unless security is the highest priority for the network, disable this parameter or leave it at the default value of 1.

Packet Burst and Large Internet Packets (LIP)

Packet Burst

LAN traffic patterns in an enterprise, resource sharing (not database) environment tend to be randomly distributed and have intermittent bursts of activity. In large, highly segmented router based networks, perhaps 10-20 percent of the users logged in may be actively trying to use the network at the same time. Performance using NCP read/write requests was severely degraded when these users accessed services only reachable across WAN facilities. NICs utilizing packet burst were less impacted because of the packet burst ability to better utilize bandwidth over WAN connections.

The problem with using the NCP/IPX NCP requests to handle network file oriented requests was its noticeable degraded performance over multihop LAN or WAN connections. PBURST/IPX was developed to improve workstation performance over these types of connections.
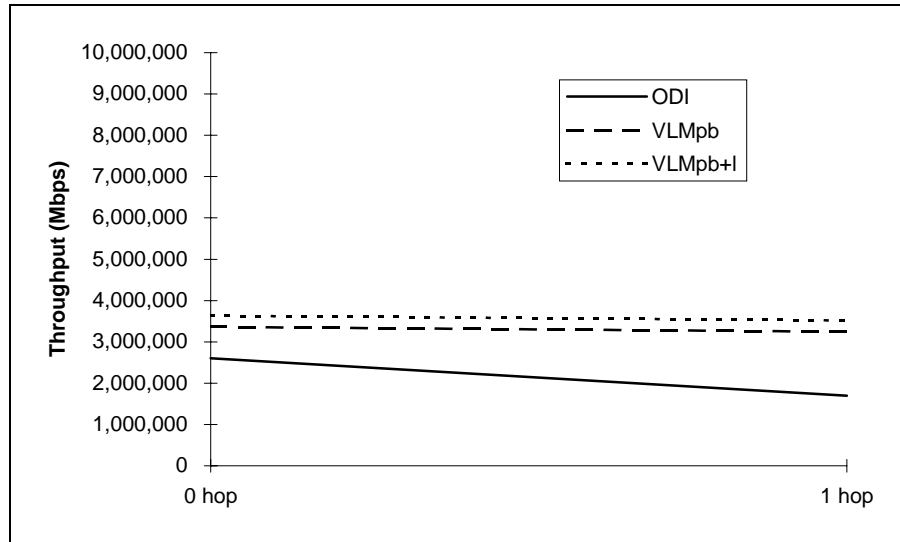
Figure 5-2. How network delay can affect LAN performance

Figure 5-2 indicates the performance gain that you can achieve by using Packet Burst. However, actual performance will vary greatly depending upon several factors: speed of the workstation NIC, NIC driver, whether or not the data being requested is located in cache, number of router hops, number of workstations contending for network bandwidth, and amount of available bandwidth.

Large Internet Packet (LIP)

Some network topologies, such as Ethernet and Token Ring, allow large packets to be sent over the network. The LIP capability enhances throughput over bridges or routers by increasing the packet size. LIP allows the packet size to increase from the default of 576 bytes when crossing bridges or routers. The throughput over the bridges and routers is enhanced by LIP when they are not limited to small packet sizes. The intraNetWare client software negotiates with the intraNetWare server to agree on the largest packet size available.

LIP is not required for every installation, but disabling LIP causes speed degradation. LIP is automatically enabled in Client 32, but you can configure it for your needs.

Workstation Performance over WAN Connections

Network delays in WAN environments prevent some types of protocols from operating effectively. Packet burst and Large Internet Packet (LIP) were developed to overcome this deficiency.

Because of the inherent speed and network delay differences between LANs and WANs, we highly recommend minimizing traffic across WAN facilities and using Novell VLM client drivers. You can configure your network to minimize traffic between remote sites in the following ways:

■   Keep network services, such as NDS and login, authentication, time, file, and print services local to the remote users.

■   Compress files (through software or hardware) before they are transmitted over the WAN.

As shown in Figure 5-3, Client 32 with Packet Burst and LIP enabled can take advantage of high speed WAN facilities. The network delays on the x-axis are typical round-trip delays found in most WAN connections. Leftmost (0 msec) simulates most connections within a city, 60 msec delay simulates most connections within North America, 125 msec delay simulates most North America to U.K. connections, 250 msec simulates most North America to Europe connections, and 500 msec simulates "best case" satellite connections.

These curves show the performance of transferring large files between one intraNetWare workstation and server. Multiple intraNetWare workstations could take advantage of one T-1 connection.
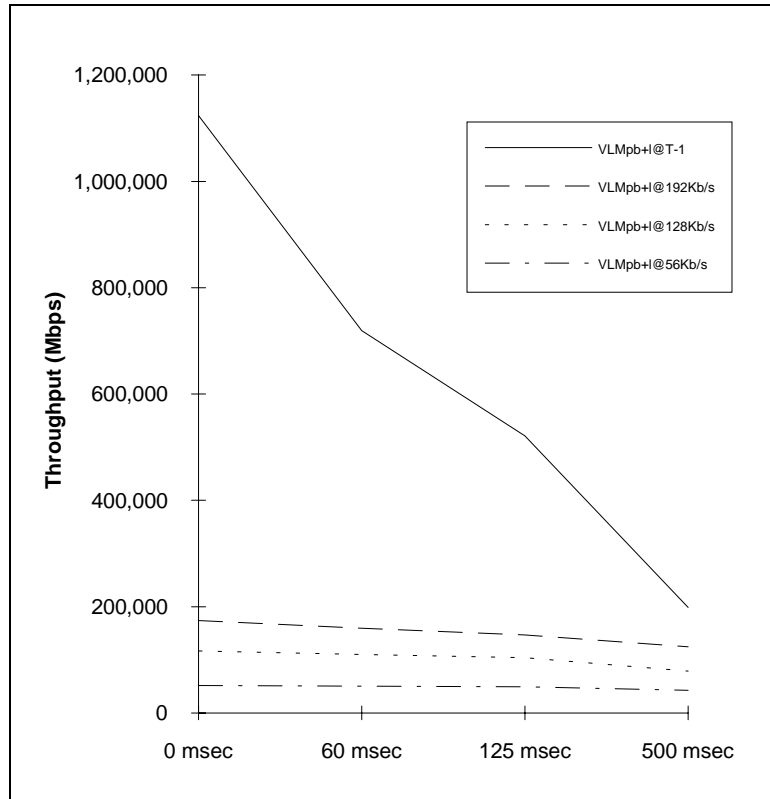
Figure 5-3.   How network delay can affect performance to remote sites

Figure 5-3 illustrates that Novell Client 32 with Packet Burst and LIP enabled significantly improved intraNetWare client-server performance between remote locations. Minimizing the amount of data traversing the WAN can also significantly improve overall performance between remote sites. This not only involves file I/O related traffic but NDS lookups, intraNetWare logins, server attachments, and time synchronization traffic. See Chapter 3, "intraNetWare Design and Implementation" for NDS and Time Service recommendations.

Data Compression

Another method for improving throughput and reducing the amount of traffic across WANs is to consider using data compression equipment. Figures 5-4 and 5-5 show how data throughput can vary by the amount of available bandwidth, the round-trip network delay, and the type of data being transmitted. In both figures, the solid line represents files that were compressed using a software program (pkzip) and then sent through a hardware data compression (dc) box.
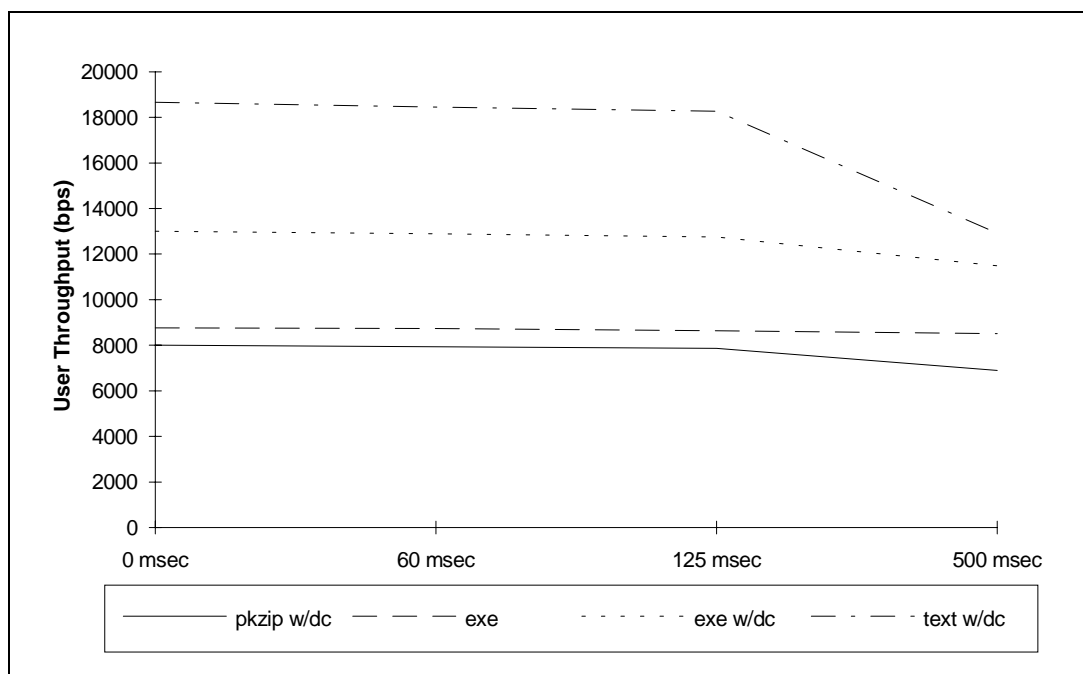
Figure 5-4.   How network delay can affect throughput (9.6 Kbps)

As Figure 5-4 indicates, you can obtain greater efficiencies by using data compression over slower WAN connections.

NOTE: The exception is transferring files that are already compressed where the latency of the compression algorithm exceeds the compression gain of the data being transmitted. If you usually transmit compressed files, then you probably will not benefit from using file compression.

Though compression gains are greater when using slower speed circuits, improvements can still be achieved when using higher transmission rates, as shown in Figure 5-5.
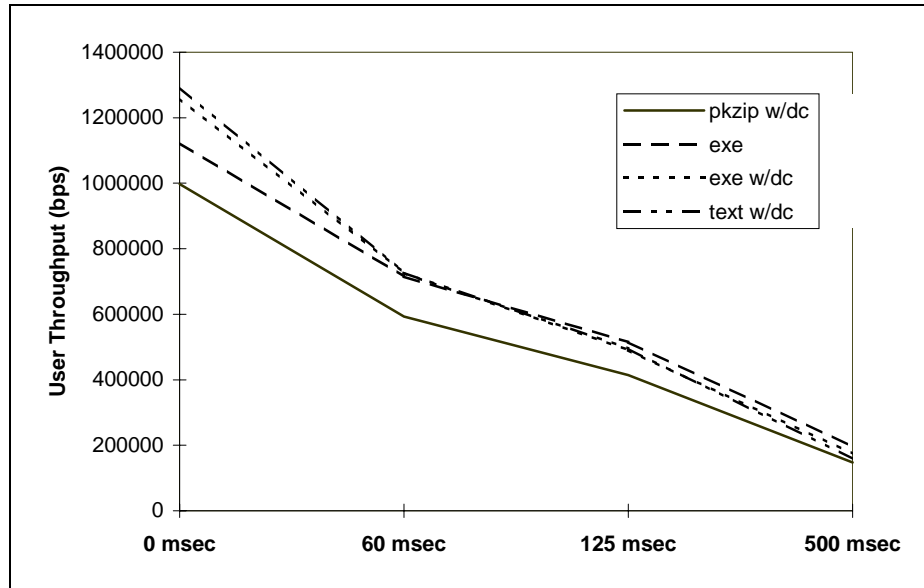
Figure 5-5.   How network delay can affect throughput (T-1 circuit)

Chapter 6
intraNetWare SFT III Planning and Implementation

intraNetWare System Fault Tolerance (SFT) III is a fault-tolerant, mirrored server solution. intraNetWare SFT III offers a high level of fault tolerance and full server mirroring in the intraNetWare environment. It is ideal for customers who demand the highest degree of network availability while running business-critical applications.

intraNetWare SFT III uses high-speed Mirrored Server Link (MSL) boards to provide server synchronization between two network servers. If one server fails, the second server ensures continuous transaction processing without loss of data or services to network users.

This chapter focuses on the considerations of planning and implementing an SFT III fault tolerant, mirrored server solution.

Planning for intraNetWare SFT III

Planning your intraNetWare SFT III system is essential to your system's reliability. Redundant hardware and multiple communication paths are vital to ensuring that loss of data and user productivity is minimal in the event of a hardware component or server failure. This section includes:

■   Planning alternate routing paths

■   Using redundant MSL boards

■   Using a print server with intraNetWare SFT III

Planning Alternate Routing Paths

Alternate routing paths are essential for successful implementation of intraNetWare SFT III. When the primary and secondary servers are located across a large internet, the many bridges and routers between the two servers represent possible points of failure.

Figure 6-1 illustrates an example of alternate routing paths. The IOEngines communicate over the internet. If there is only one path for this communication, one hardware failure in the cabling can compromise the fault tolerance of the intraNetWare SFT III system. Providing additional paths ensures that the two IOEngines continue to communicate even if the primary communication path fails. In the example shown in Figure 6-1, if Bridge/router B1 fails or is removed from the network, the primary and secondary servers can communicate through Bridge/router B2.
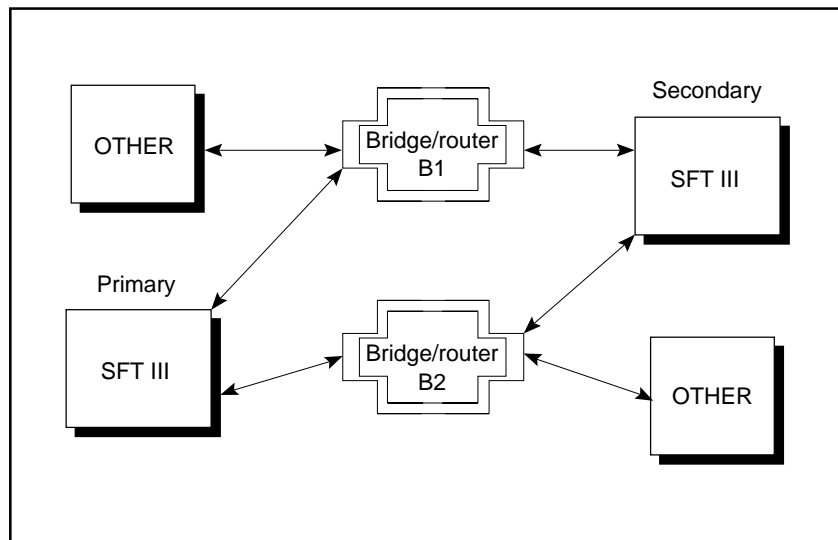

Figure 6-1. Alternate routing paths

Using Redundant MSL Boards

intraNetWare SFT III has one unrecoverable point of failure. If the MSL board fails in the primary server, then this server must be brought down for repair. This action compromises the fault tolerance of intraNetWare SFT III.

To eliminate this problem, install redundant MSL boards. If the MSL board fails in the primary server, the driver for the redundant MSL board is loaded in the IOEngine of each server, and the intraNetWare SFT III system can return to a mirrored state. intraNetWare SFT III is very timing sensitive. Compaq recommends you use the appropriate MSL board for your Compaq server. Table 6-1 lists certified third party MSL boards certified with Compaq servers.

Table 6-1
Third Party MSL Boards

Product	MSL Board	Date	Bulletin Number
ProLiant			
ProLiant 1500 5/133	DEC FDDI Controller/PCI-SAS UTP	11/14/96	F-6453
ProLiant 1500 5/166	DEC FDDI Controller/PCI-SAS UTP	11/21/96	F-6457
ProLiant 1500 6/200 with FlexSMP Dual Processor Board	DEC FDDI Controller/EISA-SAS UTP	11/01/96	F-6407
ProLiant 1500R 5/133	DEC FDDI Controller/PCI-SAS UTP	11/14/96	F-6454
ProLiant 1500R 6/200 with FlexSMP Dual Processor Board	DEC FDDI Controller/EISA-SAS UTP	11/01/96	F-6406
ProLiant 1500R 5/166	DEC FDDI Controller/PCI-SAS UTP	11/21/96	F-6458
ProLiant 2500N 6/200	DEC FDDI Controller/PCI-SAS UTP	10/21/96	F-6352
ProLiant 4500 5/100	Microdyne NMSLplus EISA Fiber	11/18/96	F-6458
ProLiant 4500R 5/100	Microdyne NMSLplus EISA Fiber	11/18/96	F-6459
ProLiant 4500 5/133	DEC FDDI Controller/EISA SAS UTP	11/01/96	F-6404
ProLiant 4500 5/166	DEC FDDI Controller/EISA SAS UTP	11/01/96	F-6402
ProLiant 4500R 5/133	DEC FDDI Controller/EISA SAS UTP	11/01/96	F-6405
ProLiant 4500R 5/166	DEC FDDI Controller/EISA SAS UTP	11/01/96	F-6403

Table 6-1
Third Party MSL Boards

Product	MSL Board	Date	Bulletin Number
ProLiant			
ProLiant 5000 6/166	DEC FDDI Controller/PCI-SAS UTP	10/08/96	F-6230
ProLiant 5000R 6/166	DEC FDDI Controller/PCI-SAS UTP	10/04/96	F-6262
ProLiant 5000 6/200	Netelligent 100 FDDI/PCI FSD	02/21/97	M-86
ProLiant 5000 6/200	TCNS TC3047 EISA BNC	10/04/96	M-72
ProLiant 5000 6/200	DEC FDDI Controller/PCI-SAS UTP	10/08/96	F-6231
ProLiant 5000R 6/200	DEC FDDI Controller/PCI-SAS UTP	10/07/96	F-6170
ProSignia			
ProSignia 300 5/120	DEC FDDI Controller/PCI-SAS UTP	10/21/96	F-6355
ProSignia 300 5/150	DEC FDDI Controller/PCI-SAS UTP	10/21/96	F-6356
ProSignia 500 5/120	Microdyne NMSLplus EISA Fiber	11/18/96	F-6457
ProSignia 500 5/150	DEC FDDI Controller/PCI-SAS UTP	10/07/96	F-6171

Using a Print Server with intraNetWare SFT III

Using an intraNetWare server as a print server is a common solution for many printing needs; however, installing a print server on an intraNetWare SFT III mirrored server is more complex. When a server fails, the print server halts, and the other print server does not assume control.

> **!**   **IMPORTANT:**   The optimal solution is to *avoid* loading any print server on your intraNetWare SFT III system.

Although it is not the optimal solution, you can implement print services on an intraNetWare SFT III system. The print server is loaded in the IOEngine of each intraNetWare SFT III server, creating two independent print servers. When you implement a print server on the intraNetWare SFT III system, printing fault tolerance is not available.

The optimal solution in an intraNetWare SFT III environment is to implement a print server using a separate server or workstation with third-party products and system utilities, or using a network printer that functions as a print server.

Preinstallation Requirements

The requirements for converting intraNetWare to SFT III are as follows:

■   intraNetWare SFT III license diskette

■   Three (3) blank, formatted, high density diskettes

■   Server with intraNetWare installed and a DOS partition with a minimum of 15 megabytes

■   Second server with DOS and a DOS partition with a minimum of 15 megabytes (same DOS partition as the first server)

■   Identical Mirrored Server Link (MSL) board connecting both servers

■   Equal memory, disk capacities, and CPU speed on both servers

Installation Procedure

To install SFT III, follow these steps:

1. Verify that all hardware is installed for both the primary and secondary servers. Since the primary and secondary servers must be identical, it does not make any difference which server is selected as primary for installation.

2. Ensure that the MSL adapters have the correct cable installed between them.

3. Locate the MSL drivers for the MSL adapters you have selected.

4. Install intraNetWare from SmartStart on the primary server.

5. Install the same size DOS partition on the secondary server as is on the primary server.

6. Verify that the correct drivers are loaded by rebooting the server as follows:

    a. Down and exit the server.

    b. Remove the CD from the CD-ROM drive.

    c. Cycle the power switch on the server.

7. Insert the intraNetWare Software from Compaq CD-ROM No.1 or the intraNetWare Operating System CD into the CD-ROM drive.

8. Verify that the intraNetWare installation was successful.

9. Down and exit the server.

10. Make the CD-ROM drive (F:) the active drive.

11. Change directories to F:\410 and enter:

    INSTALL.BAT

    During this process, you might be prompted to choose the path of the software to be installed. If so, enter F:\410.

12. Select the language in which you want to install the software.

13. Select "NetWare 4.11 Server Installation".

14. Select "NetWare SFT III.

    A menu displaying intraNetWare SFT III installation options appears.

15. Select "Convert NetWare 4.11 to SFT III".

16. Follow the steps on the screen to complete the installation.

Additional information about intraNetWare SFT III installation can be found in the intraNetWare online documentation in Chapter 5, "Installing intraNetWare SFT III" or refer to the SmartStart online documentation. See Appendix B for more information on online documentation.

Implementing Dual Processing

To implement dual processing with intraNetWare SFT III on Compaq servers, you must have a server with two CPUs installed and the Compaq dual processing driver, *CPQMP.NLM* version 2.00 or greater.

CPQMP.NLM is available on NetWare Programs from Compaq v2.56B or greater, or the new Novell Software Support Diskettes (NSSD). *CPQMP.NLM* v2.00 or greater only operates with intraNetWare SFT III and does not support NetWare SFT III 3.11.

To install *CPQMP.NLM*, follow these steps:

1. Copy the *CPQMP.NLM* driver from the NSSD Disk 1 \SFT3 directory to the primary MS-DOS partition of your hard drive, for each intraNetWare server that contains dual processors. For example:

    COPY A:\SFT3\CPQMP.NLM C:\ CPQMP.NLM

2. Edit the *IOSTART.NCF* file associated with each SFT III server and add the following statement:

    LOAD CPQMP

Loading *CPQMP.NLM* on a Compaq server with dual processors enables the use of the second processor by intraNetWare SFT III

Compaq Insight Manager Support

Compaq Insight Manager does not provide the ability to monitor SFT III servers. If you are running Compaq Insight Management Agents on an intraNetWare server and convert to SFT III, you will not be able to monitor that server using Compaq Insight Manager.

Additionally, SmartStart will disable the automatic installation of Compaq Insight Management Agents and the Compaq Asynchronous Insight Management Agents during an install of intraNetWare and SFT III.

ARCserve Support

Backup and restore for an intraNetWare server in an SFT III configuration is supported with ARCserve 5.01g or greater. Refer to the Release Notes for ARCserve for a description of the necessary modifications required for ARCserve to support intraNetWare SFT III.

SET Parameters for NCF Files

intraNetWare SFT III provides additional SET parameters to help you test and customize your mirrored server environment. Some SET parameters affect only one engine; the MSEngine or IOEngine. A few parameters can be set in both engines. See intraNetWare online documentation for more information. See Appendix B for detail information on online documentation.

NOTE: Changing one SFT III SET parameter might affect other parameters. Compaq recommends changing only one parameter at a time.

MSEngine SET Parameters at Startup (*MSSTART.NCF*)

Minimum Packet Receive Buffers
Cache Buffer Size
Maximum Subdirectory Tree Depth
Auto TTS Backup Flag
Concurrent Remirror Requests

NOTE: If you change the Minimum Packet Receive Buffers parameter in the *MSSTART.NCF* file, you must also put the same SET parameter in the *IOSTART.NCF* file.

IOEngine SET Parameters at Startup (*IOSTART.NCF*)

Maximum Physical Receive Packet Size
Minimum Packet Receive Buffers
Auto Register Memory Above 16 Megabytes

SET Parameters in Both Engines

Maximum Packet Receive Buffers
Minimum Packet Receive Buffers

NOTE: The parameters setting in both IOEngine and MSEngine should match for most cases.

Examples of NCF Files

The following examples of NCF files are for IOSTART.NCF, *MSAUTO.NCF*, and *IOAUTO.NCF*.

IOSTART.NCF

The following is an example of an *IOSTART.NCF* file on the DOS partition:

```
ioengine name NWSFT3 IO1
ioengine ipx internal net 2F827202
set new start address for unclaimed memory block = 10485760
set new end address for unclaimed memory block = 81100800
load CPQSDISK.DSK
load CPQS710.DSK
load DECMSL4X.MSL
```

MSAUTO.NCF

The following is an example of a *MSAUTO.NCF* file on the SYS volume:

```
set Time Zone = CST6CDT
set Daylight Savings Time Offset = 1:00:00
set Start of Daylight Savings Time = (APRIL SUNDAY FIRST 2:00:00 AM)
set End of Daylight Savings Time = (OCTOBER SUNDAY LAST 2:00:00 AM)
set Default Time server = Primary
set Bindery Context = 0=Compaq
msengine name NWSFT3
msengine ipx internal net 2F818A4A
Mount All
Load Monitor
```

IOAUTO.NCF

The following is an example of an *IOAUTO.NCF* file on the DOS partition or the SYS volume:

```
load CPQNF3.LAN slot=6 Frame=Ethernet 802.2 Name=CPQ1
Bind IPX to CPQ1 Net=E802
```

Changes from SFT III 3.11 to intraNetWare SFT III

intraNetWare SFT III incorporates several new features and changes from SFT III 3.11. Table 6-2 shows some of the new features and changes for intraNetWare SFT III.

Table 6-2
Changes from SFT III 3.11 to intraNetWare SFT III

Change/New Feature	SFT III 3.11	intraNetWare SFT III
Default memory amount assigned to IOEngine	2 MB	5 MB
NCF: Placement of LAN driver load statements	IOSTART.NCF	IOAUTO.NCF
NCF: Placement of LAN device drivers	DOS partition	SYS:SYSTEM
SET Parameter Name Changes	See Table 6-3	See Table 6-3
Group/user Notification upon Server/disk Failure	Broadcasts to every attached user when a failure occurs	Broadcasts only to specific groups and/or users via a SET parameter
Alternate/backup MSL Feature	Allows only one MSL per server	Allows the use of more than one MSL per server

SET Parameter Names

The SET parameters are named differently in intraNetWare SFT III than in SFT III 3.11. Table 6-3 shows the differences between the two versions.

Table 6-3
SET Parameter Names

SFT III 3.11	intraNetWare SFT III
Mirrored Server Comm ACK Wait Time Out	MSL Error Wait Time
Secondary Take Over Delay Amount	Secondary Take Over Wait Time
Comm Deadlock Detect Wait Time	MSL Deadlock Wait Time
Check Server to Server Comm	Extra MSL Checking
Primary Server Comm Deadlock Recovery Option	Primary Server MSL Deadlock Recovery Option
Secondary Server Comm Deadlock Recovery Option	Secondary Server MSL Deadlock Recovery Option
MSEngine Outputs Different	MSEngine Outputs Different Recovery Option
Primary Server Comm Consistency Recovery Option	Primary Server MSL Consistency Error Recovery Option
Secondary Server Comm Consistency Recovery Option	Secondary Server MSL Consistency Error Recovery Option
Primary Server Comm Driver Stuck Recovery Option	Primary Server MSL Send Blocked Recovery Option
Secondary Server Comm Driver Stuck Recovery Option	Secondary Server MSL Send Blocked Recovery Option
Primary Server Comm Hardware Failure Recovery Option	Primary Server MSL Hardware Failure Recovery Option
Secondary Server Comm Hardware Failure Recovery Option	Secondary Server MSL Hardware Failure Recovery Option
Notify Users of Mirrored Server Synchronization	Notify All Users of Mirrored Server Synchronization
Notify Users of Mirrored Server Failures	Server Failure Notification Name

Table 6-4 lists the new set parameters found with intraNetWare SFT III.

Table 6-4
New SET Parameter Names

SFT3 Error Wait Time

Turbo Memory Synch

The "SFT3 Error Wait Time" automatically adjusts the time of the following SFT III wait time parameters:

❑   MSL Error Wait Time

❑   Secondary Take Over Wait Time

❑   IPX Internet Down Wait Time

❑   MSL Deadlock Wait Time

❑   Check LAN Extra Wait Time

The "SFT3 Error Wait Time" parameter should be adjusted only for systems experiencing multiple timeouts. The set parameter supports values between 0.5 and 10 seconds, and defaults to a value of 3 seconds.

The "Turbo Memory Synch" set parameter enables you to speed up memory synchronization between a pair of SFT III servers. The set parameter supports the following values: 0=Disable, 1=Enable and clear the memory, and 2=Enable but don't clear memory. The default value is 2.

Adding System Memory

intraNetWare SFT III allows you to add additional memory to your SFT III server without loss of service to the clients. To add memory to both servers, follow these steps:

1. Halt the secondary server and turn it off.

2. Add memory to the secondary server and turn it on again.

3. Reconfigure the secondary server by running the System Configuration Utility.

4. Type the following from the DOS prompt C:\ SERVER.4X on the secondary server, when using the Compaq SmartStart package:

   MSERVER

   Type the following from the DOS prompt C:\NWSERVER on the secondary server, when using the intraNetWare package:

   MSERVER

   Wait for resynchronization to complete. During resynchronization, the primary server does not recognize the additional memory in the secondary server.

5. After the disks are remirrored, halt the primary server and turn it off. At this time, the secondary server becomes the primary server.

6. Add memory to the new secondary server and turn it on.

7. Reconfigure the server by running the System Configuration Utility.

8. Type the following from the DOS prompt C:\ SERVER.4X on the secondary server, when using the Compaq SmartStart package:

   MSERVER

   Type the following from the DOS prompt C:\NWSERVER on the secondary server, when using the intraNetWare package:

   MSERVER

   Wait for resynchronization to complete. During resynchronization, the primary server now recognizes the additional memory in the secondary server.

Appendix A
Time Resources

The following tables list third-party manufacturers and suppliers of hardware and software for maintaining client and intraNetWare server time. The latest edition of this information is available in the Time Synchronization Solution Guide by Marcus Williamson at http://www.connecttotel.com/ .

NOTE: The inclusion in these tables does not constitute certification or recommendation of any of these products.

DOS Time Resources

Table A-1 provides information on DOS time resources.

<div align="center">

Table A-1
DOS Time Resources

</div>

Software:	Atomic Network Time (DOS)
Hardware	COM1:/COM2: serial port
Sources	NIST
Supplier	PMC Systems
E-MAIL	100141.2110@compuserve.com
Comments	Workstation utility to synchronize multiple servers to the NIST time source via modem.
Software	**DOS Device Driver (DOS)**
Hardware	External Receiver
Source	DCF77
Supplier	Conrod Electronics PO Box 12 7500 AA Enschede, Netherlands

**Table A-1
DOS Time Resources**

Telephone	+31 53 282000
FAX	+31 53 283075
Comments	Provides software and hardware in kit or ready-built form for DOS PCs to allow synchronization to the DCF77 radio clock.
Software	**DOS Device Driver (DOS)**
Hardware	Rugby Clock Receiver Kit
Source	MSF Rugby (UK)
Supplier	Maplin Electronics P. O. Box 3 Rayleigh, Essex SS6 8LR, UK
Telephone	+44 1702 552911 (International) 01702 552911 (UK)
Comments	Provides software and hardware in kit form for DOS PCs to allow synchronization to the MSF Rugby clock. This can be used with *NSETTIME.EXE* to allow setting of the server time.
Software:	**MK-Cron (NLM/DOS)**
Supplier	Mueller-Knoche GmbH Schleswiger Str. 1-5 D-90425 Nuernberg Germany
Telephone	+49 (0)911 93488-0
Fax	+49 (0)911 93488-35
E-Mail	MK@MUEKNO
WWW	http://ww.muekno.de

Table A-1
DOS Time Resources

Comments	Schedules execution of server console commands at specified times/days. Includes tool to coldboot remote DOS workstations.
Software:	**MK-DOSSync (DOS)**
Sources	Server MK-NetClock or MK-NetClock-II
Supplier	Mueller-Knoche GmbH Schleswiger Str. 1-5 D-90425 Nuernberg Germany
Telephone	+49 911 93488-0
Fax	+49 911 93488-35
E-Mail	MK@MUEKNO (via CSERVE)
Comments	DOS device driver which keeps DOS and Windows workstations in sync to servers with MK-NetClock or MK-NetClock-II. Announcement: (OS/2 workstation in beta, Windows NT in development)
Software:	**NetTime (Windows)**
Hardware	COM1:/COM2: serial port
Sources	NIST, NBS
Supplier	HiFive Software 12427 W. Jefferson #112 LA, CA 90066
E-MAIL	75612.2532@compuserve.com
Comments	Windows program to dial atomic clock then log-on to and set the time on all NetWare file servers.

Table A-1
DOS Time Resources

Software:	NetTime (Windows) CompuServe NOVUSER forum library (*NETTIM.ZIP)*
Hardware	COM1:/COM2: serial port
Sources	NIST, NBS
Supplier	HiFive Software 12427 W. Jefferson #112 LA, CA 90066 USA
E-MAIL	Khass@gt11p.com
Comments	Windows program to dial atomic clock then log-on to and set the time on all NetWare file servers.
Software:	NetTime Station (Windows)
Hardware	N/A
Sources	NetWare File Server
Supplier	HiFive Software 12427 W. Jefferson #112 LA, CA 90066 USA
E-MAIL	Khass@gt11p.com
Comments	Windows program that runs in background and synchronizes workstation time to a NetWare file server.
Software:	NetTime GPS (Windows)
Hardware	GPS Decoder
Sources	GPS

Table A-1
DOS Time Resources

Supplier	HiFive Software 12427 W. Jefferson #112 LA, CA 90066 USA
E-MAIL	Khass@gt11p.com
Comments	Windows program to get the time from a satellite, then update all NetWare file servers.
Software:	**NetTime Internet (Windows)**
Sources	UNIX Time Server
Supplier	HiFive Software 12427 W. Jefferson #112 LA, CA 90066 USA
E-MAIL	Khass@gt11p.com
Comments	Windows program to get the time from a UNIX Time Server using the UNIX rdate protocol, then update all NetWare file servers.
Software:	**NET-TIME (DOS)**
Sources	File Server
Supplier	CompuServe NOVUSER forum library (*NETTIME.ZIP*)
E-MAIL	72300.502@compuserve.com
Comments	DOS TSR programs to maintain time synchronization at all workstations in a NetWare LAN.
Software:	**NovSync (DOS)**
Sources	File Server

Table A-1
DOS Time Resources

Supplier	CompuServe NOVUSER forum library (*NVSYNC.ZIP*)
E-MAIL	71333.427@compuserve.com
Comments	DOS device driver that keeps the workstation clock in sync with the server.
Software:	**Office-Logic Clerk (DOS/NLM)**
Hardware	COM1:/COM2: serial port
Sources	NIST
Supplier	LAN-ACES Inc. TX USA
Telephone	+1 713 890 9787 From US: 1 800 LANACES
BBS	+1 713 890 9790
Comments	Provides time synchronization via dial up modem to NIST Time Server. Can synchronize current server time to all other local servers. Designed to run with Novell MHS/GMHS Email networks. Also, includes NSETTIME.EXE. Can be used together with other time synchronization packages to set the time on one or more file servers.
Software:	**Phantom of the Console v5.10 (NLM/MS-WIN/DOS)**
Supplier	Circuit Masters Software, Inc. 22503 Katy Freeway Suite #7 Katy, TX 77450 USA
Telephone	+1 713 392 7400 In US: 1 800 764 5444

Table A-1
DOS Time Resources

Fax	+1 713 392 7405
E-Mail	cmsi@hic.net
Comments	NLM based scheduling and scripting solution for NetWare 3.x and 4.x servers. Allows the scheduled loading and unload of NLM's, as well as file level action such as copy, move, del, etc. DOS and WINDOWS scheduling interface.
Software:	**Server to Station (DOS)**
Sources	Workstation
Supplier	CompuServe NOVUSER forum library (*S2S100.ZIP*)
E-MAIL	76516.1113@compuserve.com
Comments	Utility that allows the user to synchronize any NetWare 2.x or 3.x file server to the date/time of the workstation.
Software:	**Servset (DOS)**
Sources	Workstation
Supplier	CompuServe NOVUSER forum library (*SERVST.ZIP*)
E-MAIL	100117.213@compuserve.com
Comments	Utility to set a NetWare file server's software clock to that of a PC workstation.
Software:	**SERVTIME (DOS)**
Sources	Workstation
Supplier	CompuServe NOVUSER forum library (*SERVET.ZIP*)
E-MAIL	72007.1055@compuserve.com

Table A-1
DOS Time Resources

Comments	Utility to set a NetWare file server's software clock to that of a PC workstation.
Software:	**SYNCTIME (DOS)**
Hardware	COM1:/COM2: serial port
Sources	NIST
Type	Modem
Supplier	CompuServe NOVUSER forum Library (*WSTIME.ZIP*)
E-MAIL	76636.2764@compuserve.com
Comments	Synchronizes the PC clock on a Novell NetWare File Server to the time and date regulated by the (NIST) in Denver, CO. (USA). Executes from any workstation equipped with a Hayes compatible modem.
Software:	**SYNCTIME (DOS)**
Sources	Current default server
Supplier	CompuServe NOVUSER forum Library (*SYNCTI.LZH*)
E-MAIL	72302.3171@compuserve.com
Comments	Workstation utility to synchronize all servers to the time of the current default server.
Software:	**TIMEBASE/PC (DOS, Windows)**
Sources	NetWare file server
Supplier	NetConnect Limited Cambridge UK

Table A-1
DOS Time Resources

Telephone	+44 1223 423523 (International) 01223 423523 (UK)
E-Mail	TIMEBASE@NETCON (via NHUB) timebase@netconnect.co.uk http://www.netconnect.co.uk/
Comments	A workstation TSR for NetWare clients running DOS or Windows which synchronizes periodically to a server on the network.
Software:	**TIMEBASE/TSR (DOS, Windows)**
Hardware	TimeBase Rugby Decoder
Sources	MSF Rugby (UK)
Supplier	NetConnect Limited Cambridge UK
Telephone	+44 1223 423523 (International) 01223 423523 (UK)
E-Mail	TIMEBASE@NETCON (via NHUB) timebase@netconnect.co.uk http://www.netconnect.co.uk/
Comments	A PC TSR which allows standalone PCs to keep accurate time by communicating with a TimeBase hardware unit which is attached to a serial port.
Software	**TimeBase (DOS/Windows)**
Hardware	TimeBase Decoder
Source	MSF Rugby (UK)
Supplier	NetConnect Limited Cambridge, UK

Table A-1
DOS Time Resources

Telephone	+44 1223 423523 (International) 01223 423523 (UK)
Comments	A hardware radio decoder, which detects the time signal being broadcast over the UK from Rugby, using data from The National Physical Laboratory. Its serial interface connects to an available COM port on the file server, delivering accurate date and time.
Software:	**TCRsync (NLM), Novelset (DOS/WIN)**
Hardware	TCR-200 Time Code (TC) Reader Card GPS-100 GPS Atomic Clock Referenced SMPTE TC Generator
Sources	SMPTE-30 & 25 fps, IRIG-B(1) Time Codes
Supplier	Clark & Associates, Ltd 4 Rye Court Macomb, IL 61455-9703 USA
Telephone	+1 800 940 2248 309 837 2244
Fax	+1 309 833 5175
Comments	GPS-100 generates SMPTE TC accurate to within 100 micro sec of UTC. TCR-200 reads SMPTE (30 &25 FPS) or IRIG-B(1) TC and synchronizes PC Clock. NLM sets Server time to external TC, TSR furnished for DOS/WIN systems. Software tested and running on NetWare 3.11 and 4.XX.
Software:	**Time Master and Time Master Plus (DOS,NLM,OS/2)**
Hardware	Contact MDI
Sources	WWVB, DCF77, NIST, NRC, US Naval Observatory

Table A-1
DOS Time Resources

Supplier	MDI, 311 B Avenue, Suite A Lake Oswego Oregon 97034, USA
Telephone	+1 503 635 6370
FAX	+1 503 636 9501
Comments	Provides a Time Master (*TM.NLM*) and Time Slave (*TS.NLM*) which may be used to synchronize time on 2.*x*, 3.*x* and 4.*x* servers as well as device drivers for DOS and OS/2 workstations.
Software:	**Time:LAN! (DOS/NLM)**
Hardware	External receiver
Sources	DCF77
Supplier	Tobit Software Gmbh D-48664 Ahaus, Germany
Telephone	+49 2561 913190 From U.S.: 1 800 GOTOBIT
Fax	+49 2561 913191 From U.S.: 1 800 FAXWARE
Comments	Provides hardware and software to allow synchronization of client and/or server to DCF77 time source.
Software	**WANTimes (DOS)**
Hardware	COM1/COM2 Serial Port
Source	NIST
Supplier	Tom Ruby USA
E-MAIL	71224.161@compuserve.com

Table A-1
DOS Time Resources

Comments	NetWare client software which dials NIST then sets the clocks of all File Servers to the time received. This software can be downloaded from the CompuServe NOVUSER forum as the file *WANTIM.ZIP*.
Software:	**Win SETTIME**
Hardware	COM1:/COM2: serial port
Sources	NIST, US Naval Observatory
Supplier	CompuServe NOVUSER forum library (WSTIME.ZIP)
E-MAIL	72274.3252@compuserve.com
Comments	Win SetTime dials any atomic clock in the world and updates your computer clock and calendar. Can determine the time via atomic clocks at the U.S. Naval Observatory, National Institute for Standards & Technology (NIST), and others.
Software:	**Worldwide Time Server (DOS)**
Hardware	COM1:/COM2/COM3/COM4: serial port
Sources	NRC (Canada)
Supplier	Jiri Severa 819 Archibald Str. Ottawa ON K1ZH62 Canada
E-MAIL	ah158@freenet.carleton.ca
Comments	Workstation-based software connects with the Ottawa, Canada NRC atomic clock via modem – then synchronizes time on NetWare servers (up to 8 per installation). Logs results.

NLM Time Resources

Table A-2 provides information on NLM time resources.

Table A-2
NLM Time Resources

Software	Cadence (NLM)
Hardware	COM1/COM2 and others
Source	NIST, NBS
Supplier	C-Note Software, Inc / Polygon Software St Louis, MO, USA
Telephone	+1 314 432 4142
FAX	+1 314 997 9696
Internet	INFO@POLYGON.COM
Comments	Provides NLM which can synchronize NetWare 3.x and 4.x servers to NIST and NBS time sources via dial-up modem.
Software:	**Console Manager for NetWare**
Supplier	Podell Systems 2001 Union Street Suite #450 San Franscisco, CA 94123 USA
Telephone	+1 415 292 7700 In US: 1 800 350 0001
FAX	+1 415 292 6948
E-Mail	74777.3134@compuserve.com

Table A-2
NLM Time Resources

Comments	Product is an NLM that runs and displays on the NetWare 3.1x or NetWare 4.x file server console. Schedules the loading and unloading of NLM's, adds COPY, DELETE, PRINT, etc. commands to the console command line. Novell Labs certified "Tested and Approved" product.
Software:	**MK-Cron (NLM/DOS)**
Supplier	Mueller-Knoche GmbH Schleswiger Str. 1-5 D-90425 Nuernberg Germany
Telephone	+49 (0)911 93488-0
Fax	+49 (0)911 93488-35
E-Mail	MK@MUEKNO
WWW	http://ww.muekno.de
Comments	Schedules execution of server console commands at specified times/days. Includes tool to coldboot remote DOS workstations.
Software:	**MK-Netclock (NLM/VAP)**
Hardware	External devices via COM1/COM2 and internal boards ISA/EISA/MCA
Sources	DCF77
Supplier	Mueller-Knoche GmbH Schleswiger Str. 1-5 D-90425 Nuernberg, Germany
Telephone	+49 911 93488-0
FAX	+49 911 934988-35

Table A-2
NLM Time Resources

E-Mail	MK@MUEKNO (via CSERVE)
Comments	Provides NLM which can synchronize NetWare 3.x, and 4.x servers to DCF77 time source.
Software:	**MK-TimeSync(NLM/VAP)**
Sources	Server with MK-NETCLOCK or NK-NetClock II
Supplier	Mueller-Knoche GmbH Schleswiger Stra. 1-5 D-90425 Nuernberg, Germany
Telephone	+49 911 93488-0
FAX	+49 911 934988-35
E-Mail	MK@MUEKNO (via CSERVE)
Comments	Provides NLM to synchronize NetWare 2.15 (VAP), 2.2, 3.x, and 4.x servers to time reference server running MK-NETCLOCK. Provides time synchronization mechanism to 3.x and 2.15 servers.
Software:	**MK-Netclock-II (NLM)**
Hardware	Internal ISA board, external antenna
Sources	Global Positioning System GPS (Worldwide)
Supplier	Mueller-Knoche GmbH Schleswiger Stra 1-5 D-90425 Nuernberg, Germany
Telephone	+49 911 93488-0
FAX	+49 911 934988-35
E-Mail	MK@MUEKNO (via CSERVE)

Table A-2
NLM Time Resources

Comments	Provides NLM which can synchronize NetWare 3.x, and 4.x servers to the GPS system as time source.
Software:	**NetCONSOLE (NLM)**
Supplier	Citadel Systems, Inc. 9800 Northwest Frwy, Suite 610 Houston, TX 77092 USA
Telephone	+1 713 686 6400 From US: 1 800 962 0701
FAX	+1 713 686 6495
E-Mail	70760.151@compuserve.com
Comments	Schedules execution of server console commands at specified times/days.
Software:	**NetWare Console Plus (NLM)**
Supplier	NSE
E-MAIL	100064.2230@compuserve.com
Comments	Provides 34 new server console commands, including scheduling of up to 64 background processes.
Software:	**NetWare Auto Broadcast (NLM)**
Sources	CompuServe NOVUSER forum library (*ABC100.ZIP*)
Supplier	Horst Jelonneck
E-MAIL	100413.3035@compuserve.com
Comments	Schedules broadcast messages and other server console commands at specified times.

Table A-2
NLM Time Resources

Software:	**NLMAuto (NLM)**
Supplier	Knozall Systems 375 E. Elliot Road Suite 10 Chandler, AZ 85225-1130 USA
Telephone	+1 602 545 0006 From US: 1 800 333 8698
FAX	+1 602 545 0008
WWW	http://www.knozall.com
Comments	Provides scheduling and additional commands at the server console.
Software:	**NOVCRON (NLM)**
Sources	CompuServe NOVUSER forum library (*NOVCRO.ZIP*)
Supplier	Classic Software 4746 Spottswood Ave Ste 107 Memphis, TN 38117 USA
E-MAIL	sales@classic.com
Comments	Schedule execution of any NLM, NCF, or console command. Uses data file similar to a UNIX CRONTAB file.
Software:	**Office-Logic Clerk (DOS/NLM)**
Hardware	COM1:/COM2: serial port
Sources	NIST

**Table A-2
NLM Time Resources**

Supplier	LAN-ACES Inc. TX USA
Telephone	+1 713 890 9787 From US: 1 800 LANACES
BBS	+1 713 890 9790
Comments	Provides time synchronization via dial up modem to NIST Time Server. Can synchronize current server time to all other local servers. Designed to run with Novell MHS/GMHS Email networks. Also, includes NSETTIME.EXE. Can be used together with other time synchronization packages to set the time on one or more file servers.
Software:	**Phantom of the Console v5.10 (NLM/MS-WIN/DOS)**
Supplier	Circuit Masters Software, Inc. 22503 Katy Freeway Suite #7 Katy, TX 77450 USA
Telephone	+1 713 392 7400 In US: 1 800 764 5444
Fax	+1 713 392 7405
E-Mail	cmsi@hic.net
Comments	NLM based scheduling and scripting solution for NetWare 3.x and 4.x servers. Allows the scheduled loading and unload of NLM's, as well as file level action such as copy, move, del, etc. DOS and WINDOWS scheduling interface.
Software:	**ProTime (NLM)**
Hardware	Contact Protocom

Table A-2
NLM Time Resources

Sources	Telecom Australia
Supplier	Protocom Development Systems Pty Ltd
Telephone	+61 15 335190
FAX	+61 35 780144
Comments	Provides NLM for NetWare 3.*x* and 4.*x* servers to synchronize to Telecom Australia digital time source.
Software:	**RDATE2 (NLM)**
Sources	UNIX Time Server
Supplier	Richard Letts University of Salford Salford UK
FTP	ftp.salford.ac.uk:network/noms/rdate.zip
WWW	http://www.suns.salford.ac.uk/
Comments	Provides NLM to synchronize with UNIX Time Server using the UNIX rdate protocol. Includes source code.
Software:	***RDATE.NLM* (NLM)**
Sources	UNIX Time Server
Supplier	MurkWorks PO Box 610 Potsdam, NY, 13676 USA
Telephone	+1 315 268 1000
FAX	+1 315 268 9812

Table A-2
NLM Time Resources

E-Mail	Info@MurkWorks.com
Comments	Provides an NLM which synchronizes with a UNIX time source using UNIX rdate protocol over TCP/IP.
Software:	***RECVTIME.NLM*** **(NLM)**
Hardware	External receiver
Sources	DCF77
Supplier	Waldbrenner Systemtechnik GmbH via B.W. Computer Vertriebs GmbH Am Kandel D-74912 Kirchhardt
Telephone	+49 7266 9490
FAX	+49 7266 94920
Comments	NLM allowing synchronization of server clock to DCF77 time source.
Software:	**RexxWare (NLM)**
Supplier	SimWare
Telephone	+1 613 727 1779
FAX	+1 613 727 3533
WWW	http://www.simware.com
Comments	Provides implementation of Rexx batch language for the NetWare server console, including scheduling capabilities.
Software:	***RTCTOOLS.NLM*** **(NLM)**
Hardware	CTS-10 Card

Table A-2
NLM Time Resources

Sources	WWV (10MHz)
Supplier	Odetics, Inc via Personal Computer Tools 90 Industrial Park RD Hingham, MA 02043, USA
Telephone	+1 800 767 6728
FAX	+1 617 740 2728
Comments	Provides hardware card, antenna and *RTCTOOLS.NLM* software for receiving WWV broadcast.
Software:	**SYNC (NLM)**
Sources	File Server
Supplier	CompuServe NOVUSER forum library (*SYNC.ZIP*)
E-MAIL	75730.1051@compuserve.com
Comments	*SYNC.NLM* will check a remote time source server (NW 2.x, 3.x, or 4.x) in time intervals as specified and update the time of the local server (NW 3.x or NW 4.x). Time zones will be taken into account. SYNC runs on NetWare 3.x and NetWare 4.x.
Software:	**TaskMaster (NLM)**
Supplier	Avanti Technology, Inc. 13492 Research Blvd #120-271 Austin, TX 78750
Telephone	+1 512 335 1168 From US: 1 800 638 1168
Fax	+1 512 335 7838

Table A-2
NLM Time Resources

E-Mail	Prodinfo@avanti-tech.com
	www.avanti-tech.com
Comments	TaskMaster couples Automated Server task Scheduling with an enhanced scripting language and support for DOS file commands from the Server Console.
Software:	**TCRsync (NLM), Novelset (DOS/WIN)**
Hardware	TCR-200 Time Code (TC) Reader Card
	GPS-100 GPS Atomic Clock Referenced SMPTE TC Generator
Sources	SMPTE-30 & 25 fps, IRIG-B(1) Time Codes
Supplier	Clark & Associates, Ltd
	512A S Fifth St.
	St. Charles, MO 63301-2635
	USA
Telephone	+1 800 940 2248
	+1 314 724 3666
Fax	+1 314 724 3776
Comments	GPS-100 generates SMPTE TC accurate to within 100 micro sec of UTC. TCR-200 reads SMPTE (30 &25 FPS) or IRIG-B(1) TC and synchronizes PC Clock. NLM sets Server time to external TC, TSR furnished for DOS/WIN systems. Software tested and running on NetWare 3.11 and 4.XX.
Software	**TimeBase/NLM (NW3.1x, 4.1)**
Hardware	TimeBase Decoder
Source	MSF Rugby (UK)
Supplier	NetConnect Limited
	Cambridge, UK

Table A-2
NLM Time Resources

Telephone	+44 1223 423523 (International) 01223 423523 (UK)
E-Mail	TIMEBASE@NETCON (via NHUB) timebase@netconnect.co.uk http://www.netconnect.co.uk/
Comments	An NLM which keeps a file server's time accurate. It interrogates the TimeBase decoder to determine the correct time.
Software	**TimeBase/4 (NW 4.X)**
Hardware	TimeBase Decoder
Source	MSF Rugby (UK)
Supplier	NetConnect Limited Cambridge, UK
Telephone	+44 1223 423523 (International) 01223 423523 (UK)
E-Mail	TIMEBASE@NETCON (via NHUB) timebase@netconnect.co.uk http://www.netconnect.co.uk/
Comments	An enhanced version of TimeBase/NLM which specifically supports NW 4.1. As well as being able to make immediate adjustments to the server's time, large changes can be scheduled. Alerts are generated if the external time source fails.
Software	**TimeBase (DOS/Windows)**
Hardware	TimeBase Decoder
Source	MSF Rugby (UK)
Supplier	NetConnect Limited Cambridge, UK

Table A-2
NLM Time Resources

Telephone	+44 1223 423523 (International) 01223 423523 (UK)
E-Mail	TIMEBASE@NETCON (via NHUB) timebase@netconnect.co.uk http://www.netconnect.co.uk/
Comments	A hardware radio decoder, which detects the time signal being broadcast over the UK from Rugby, using data from The National Physical Laboratory. Its serial interface connects to an available COM port on the file server, delivering accurate date and time.
Software	**TIMEBASE /UNIX (NetWare 3.1x, 4.x)**
Hardware	TimeBase Decoder
Source	MSF Rugby (UK)
Supplier	NetConnect Limited Cambridge, UK
Telephone	+44 1223 423523 (International) 01223 423523 (UK)
E-Mail	TIMEBASE@NETCON (via NHUB) timebase@netconnect.co.uk http://www.netconnect.co.uk/
Comments	An NLM (called TIMED) which runs under NW3.x and NW4.x alongside TimeBase/NLM or GPS/NLM. This allows UNIX devices on the network to synchronize their clocks to the NetWare file server. The *TIMED.NLM* can provide the time and day services equivalent to those found under UNIX.
Software	**TIMEBASE/GPS (NetWare 3.1x, 4.x)**
Hardware	NAVSYMM/GPS

Table A-2
NLM Time Resources

Source	GPS Satellite Network
Supplier	NetConnect Limited Cambridge, UK
Telephone	+44 1223 423523 (International) 01223 423523 (UK)
E-Mail	TIMEBASE@NETCON (via NHUB) timebase@netconnect.co.uk http://www.netconnect.co.uk/
Comments	An NLM for NW 4.X which works in conjunction with the Navstar GPS Satellite Decoder. As well as keeping highly accurate file server time, when the NLM loads, it also gives the location of the file server and its height above seal level. The satellite decoder consists of a small antenna and a Navstar GPS Timing and Frequency decoder. A serial cable connects the decoder to the file server's serial port and delivers time and location information direct from the GPS satellite clocks.
Software:	**Time:LAN! (NLM/DOS)**
Hardware	External receiver
Sources	DCF77
Supplier	Tobit Software Gmbh D-48664 Ahaus, Germany
Telephone	+49 2561 913190 From US: 1 800 GOTOBIT
Fax	+49 2561 913191 From US: 1 800 FAXWARE

Table A-2
NLM Time Resources

E-Mail	HELLO@TOBIT (via CSERVE)
	HELLO@TOBIT.mhs.compuserve.com
	http://www.tobit.de
Comments	Provides hardware and software to allow synchronization of client and/or server to DCF77 time source.
Software	**TIMEVIEW/NLM (NetWare 3.1x, 4.x)**
Hardware	TimeBase Decoder
Source	MSF Rugby (UK)
Supplier	NetConnect Limited
	Cambridge, UK
Telephone	+44 1223 423523 (International)
	01223 423523 (UK)
E-Mail	TIMEBASE@NETCON (via NHUB)
	timebase@netconnect.co.uk
	http://www.netconnect.co.uk/
Comments	An NLM which displays the current time information for a NetWare 4.x file server on a single screen. As well as showing local time and UTC time, it indicates if any time adjustments have been scheduled and displays an alert if the server loses synchronization.
Software:	**Time Master and Time Master Plus (NLM,DOS,OS/2)**
Hardware	Contact MDI
Sources	WWVB, DCF77, NIST, NRC, US Naval Observatory
Supplier	MDI, 311 B Avenue, Suite A
	Lake Oswego
	Oregon 97034, USA

Table A-2
NLM Time Resources

Telephone	+1 503 635 6370
FAX	+1 503 636 9501
Comments	Provides a Time Master (*TM.NLM*) and Time Slave (*TS.NLM*) which may be used to synchronize time on 2.*x*, 3.*x* and 4.*x* servers as well as device drivers for DOS and OS/2 workstations.
Software:	***WMODEM.NLM* (NLM)**
Hardware	COM1:/COM2: or External receiver
Sources	Westerstrands time base, DCF77, MSF Rugby (UK)
Supplier	Westerstrand Urfabrik AB Box 133 S-545 23 Toereboda, Sweden
Telephone	+46 506 71600
FAX	+46 506 16169
E-MAIL	76711.772@compuserve.com (Mats Sunesson)
Comments	Provides time synchronization via dial up modem to Westerstrands time base or from master clock connected to serial port on server.

Appendix B
Additional Resources to Use

Use the following list of resources, which are used throughout this TechNote, for more information on intraNetWare:

■ *DynaText*

   DynaText allows you to read intraNetWare online documentation from your workstation. You can install DynaText files on an intraNetWare server, a local hard disk, or access the files directly from the CD. You must set up a Windows workstation to view DynaText.

■ NetWire Information Service

   NetWire gives you 24-hour access to technical and product information from Novell. It puts you in touch with others who use Novell products. The service is updated daily and provides you with timely technical support from experienced system operators. Questions posted on NetWire are answered within 24 hours.

   To access NetWire:

   ❏ On CompuServe: type **go netwire**

   ❏ On Internet - World Wide Web: http://support.novell.com/

   ❏ On Internet - File Transfer Protocol: ftp.novell.com

   NOTE: In Europe, replace the *.com* with *.de* for Internet access.

■ *Novell Application Notes (AppNotes)*

   These notes cover technical aspects of Novell-based system design, server tuning, optimization, network troubleshooting, intraNetWare and Windows integration, and software development. The material is based on technical research performed by Novell personnel. To subscribe to AppNotes, call one of the following numbers:

   ❏ In the United States or Canada: 1-800-377-4136

   ❏ In locations other than the United States or Canada, call 1-303-297-2725

See the following AppNotes for detailed information on intraNetWare performance and NetWare Directory Services:

❑   Special issue for intraNetWare Client for Windows NT May 1997,
    Novell Application Notes,
    P/N 464-000052-005

❑   "Optimizing intraNetWare 1 and 2 Server Memory" March 1997,
    Novell Application Notes,
    P/N 464-000052-003

❑   "Using the Directory Services Trace (DSTRACE) Screen" February
    1997, *Novell Application Notes,*
    P/N 464-000052-002

❑   "Disconnecting NetWare Clients that Have Automatic
    Reconnection Enabled" February 1997, *Novell Application Notes,*
    P/N 464-000052-002

❑   "Design Rules for NDS Replica Placement" January 1997, *Novell
    Application Notes,*
    P/N 464-000052-001

❑   "Capacity Planning for the intraNetWare IPX/IP Gateway"
    December 1996, *Novell Application Notes,*
    P/N 164-000050-012

❑   Issue for NetWare Client 32 for Windows 95 November 1996,
    Novell Application Notes,
    P/N 164-000050-011

❑   Issue for NetWare 4.11 October 1996, *Novell Application Notes,*
    P/N 164-000050-010

❑   "An Introduction to Novell's intraNetWare IPX/IP Gateway"
    September 1996, *Novell Application Notes,*
    P/N 164-000050-009

■   *Novell's QuickPath to NetWare 4.1 Networks*

The document provides easy-to-understand design and installation
guidelines for NetWare 4.1 operating system. It provides an 8-step
process for designing a NetWare 4.1 network.

■ Compaq TechNote: NetWare Migration from 3.12 to 4, P/N 181152-001

   This TechNote provides guidelines for migrating data and user
   information using the Across-the-Wire migration utility, as well as
   guidelines on installing NetWare Client software and Novell DynaText.

■ Compaq Insight Manager User Guide, P/N 133394-008

   This document explains how to install, configure, and use Compaq
   Insight Manager. There is also a discussion on Compaq Insight
   Asynchronous Management guidelines, server discovery process,
   and alarms.

■ *Compaq Hardware Reference* documentation

   This documentation can help isolate a problem to a certain computer
   component or cable segment. Some network problems occur because of
   malfunctioning hardware; check the documentation that came with the
   hardware involved.

■ CompuServe

   This service is available to interact with other users and support
   engineers or to get product information:

   ❏ To access Compaq on CompuServe: at any ! prompt,
      type **go compaq**.

   ❏ To access Novell on CompuServe: at any ! prompt,
      type **go novell**.

   To open a CompuServe account, call one of the following numbers:

   ❏ In the United States or Canada: 1-800-524-3388.

   ❏ In locations other than the United States or Canada, call
      (614) 529-1349. Ask for "Representative 200," which identifies you
      as a Novell customer.

■ Internet

   This service allows you to submit technical questions, download SoftPaq
   software, and access support information, documentation, and Compaq
   press releases.

❏ To access the Compaq home page on the Internet:

   http://www.compaq.com for information

   http://support@compaq.com for technical questions

   ftp.Compaq.com for files

❏ To access the Novell home page on the Internet:

   http://www.novell.com

■ Novell Software Support Diskettes (NSSD)

The drivers, utilities, and patches found on the NSSD are designed to enhance the performance of Compaq servers. NSSD are available from the following locations:

❏ SmartStart & Software Support CD	❏ Quickfind
❏ DownLoad Facility 281-518-1418 U.S.	❏ TechPaq
❏ Compaq Internet FTP Host Server: FTP://FTP.COMPAQ.COM	❏ Prodigy
❏ Compaq Internet WEB Home Page: HTTP://WWW.COMPAQ.COM	❏ CompuServe
	❏ America OnLine

For more information, contact your Authorized Compaq Reseller, Compaq Service Provider, or call the Compaq Service Support Center.

Glossary

Authentication	A process of verifying that you are authorized to use both Novell Directory Services and file system resources.
Collision	An event that happens when two devices transmit data at the same time, resulting in a loss of data.
Compaq Insight Manager	An application from Compaq for easy management of servers. Insight Manager delivers intelligent monitoring and alerting, remote maintenance, and visual control of servers.
DynaText	Online viewer that allows you to read intraNetWare online documentation from your Windows workstation.
ECC	*See* Error Correcting Code.
Error Correcting Code (ECC)	A fault tolerance feature that detects and corrects all single-bit memory parity errors, as well as detecting 2-bit and 3-bit memory errors. This feature ensures that common memory errors including the failure of an entire DRAM can be corrected without interrupting system operation.
FAT	*See* File Allocation Table.
File Allocation Table (FAT)	A table that keeps track of file locations in a particular volume. The intraNetWare network operating system (NOS) divides each volume into blocks and stores files on the volume in these blocks. If the file consists of one or more blocks, the file might be stored in blocks that are not adjacent. The FAT keeps track of the block numbers where different parts of the file are located. To retrieve a file, the intraNetWare NOS searches through the FAT until it finds the FAT entries and corresponding block numbers for the requested file.

Hot Fix	intraNetWare feature that protects data from failures in the network hardware. When this feature is activated, a small portion of a hard disk's storage space is set aside as a Hot Fix redirection area. When read-after-write verification determines that there is a bad data block on the disk, Hot Fix redirects data that was to be stored in the bad block to the Hot Fix redirection area. Hot Fix marks the defective block as bad, and the server will not attempt to store data there again.
Identity	The user name of any person that has access to use resources on the server.
Input/Output Engine	The part of the SFT III operating system that handles physical processes, such as network and disk I/O, hardware interrupts, device drivers, timing, and routing.
IOEngine	*See* Input/Output Engine.
intraNetWare network operating system (NOS)	The operating system, which was developed by Novell, Inc., is loaded on the server when the server is started. It controls all system resources and the way information is processed on the entire network or internetwork.
KB	*See* kilobyte.
Kilobyte (KB)	A unit of measure for memory or disk storage capacity. The measurement is two to the 10th power (1,024) bytes.
LAN	*See* Local Area Network.
Local Area Network (LAN)	A system that links computers together to form a network, usually with a wiring-based cabling scheme. LANs connect personal computers and electronic office equipment, enabling users to communicate, share resources such as data storage and printers, and access remote hosts or other networks.
MB	*See* megabyte.

Megabyte (MB)	A unit of measure for memory or disk storage capacity. The measurement is two to the 20th power (1,048,576) bytes.
Mirrored Server Engine	The part of the SFT III operating system that handles nonphysical processes, such as the NetWare file system and the Directory.
Mirrored Server Link	A dedicated, high-speed connection between SFT III primary and secondary servers. The MSL manages server synchronization.
	The MSL is essentially a bus extension from the primary IOEngine to the secondary IOEngine. It requires similar boards in each server, directly connected by fiber-optic or other cables.
MONITOR	An NLM that allows you to see how efficiently your network is operating. Also allows you to lock the file server console.
MSEngine	*See* Mirrored Server Engine.
MSL	*See* Mirrored Server Link.
NDS	*See* Novell Directory Services.
NETADMIN utility	A DOS-based system administrative utility used in intraNetWare that provides many system maintenance functions, including setting up accounts for new users, modifying settings of existing users, creating and managing groups of users and their access rights, and managing the system accounting.
Novell Directory Services (NDS)	A database that maintains information about resources on the network. In intraNetWare, replaces the NetWare 3 bindery.
NetWare Loadable Module (NLM)	A program you can load and unload from file server memory while the server is running. NLMs link disk drives, LAN drivers, name space, and other file server management and enhancement utilities to the operating system.

NetWire	Public bulletin board system (BBS) from Novell, which provides access to Novell product information, Novell service information, and time-sensitive technical information for intraNetWare users. NetWire is accessed through the CompuServe Information Service and the Internet.
Network Interface Controller (NIC)	A controller installed in each workstation to allow stations to communicate with each other and with the file server.
NIC	*See* Network Interface Controller.
NLM	*See* NetWare Loadable Module.
NOS	*See* intraNetWare network operating system.
Novell Software Support Diskettes (NSSD)	Novell software with Compaq drivers provided by Compaq.
NSSD	*See* Novell Software Support Diskettes (NSSD)
NWADMIN utility	A Windows-based system administrative utility used in intraNetWare that provides many system maintenance functions, including setting up accounts for new users, modifying settings of existing users, creating and managing groups of users and their access rights, and managing the system accounting.
ODI	*See* Open Data-Link Interface.
Open Data-Link Interface (ODI)	An architecture that allows multiple LAN drivers and protocols to coexist on network systems. ODI supports media- and protocol-independent communications by providing a standard interface that allows transport protocols to share a single network without conflict.

Packet size	The size of a unit of information by which the network communicates. Each packet contains the identities of the sending and receiving stations, error-control information, a request for services, information on how to handle the request, and any necessary data that must be transferred.
RAID	*See* Redundant Arrays of Inexpensive Disks.
RAID 0	*See* Redundant Array of Inexpensive Disks - No Fault Tolerance.
RAID 1	*See* Redundant Arrays of Inexpensive Disks - Drive Mirroring.
RAID 4	*See* Redundant Arrays of Inexpensive Disks - Data Guarding.
RAID 5	*See* Redundant Arrays of Inexpensive Disks - Distributed Data Guarding.
RAWV	*See* Read After Write Verification.
Read After Write Verification (RAWV)	When data is written to disk, the data is immediately read back from the disk and compared to the original data still in memory.
Redundant Arrays of Inexpensive Disks - No Fault Tolerance (RAID 0)	RAID 0 indicates that there is no fault tolerance method used.
Redundant Arrays of Inexpensive Disks - Drive Mirroring (RAID 1)	RAID 1 is a fault tolerance method that uses 50 percent of drive storage capacity to provide greater data reliability by storing a duplicate of all user data. Half the drives in the array are duplicated or "mirrored" by the other half.
Redundant Arrays of Inexpensive Disks - Data Guarding (RAID 4)	RAID 4 is a fault tolerance method that uses a small percentage of a drive array storage capacity to store data guard code that is used to recover data if a drive fails.

Redundant Arrays of Inexpensive Disks - Distributed Data Guarding (RAID 5)	RAID 5 is a fault tolerance method that "stripes" data and parity across all the drives in the configuration to ensure the uninterrupted availability of uncorrupted data. It allocates a small percentage of the drive array storage to protect users from data loss.
SAP	*See* Service Advertising Protocol.
Service Advertising Protocol (SAP)	A protocol that provides a way for servers to advertise their services on a intraNetWare internetwork.
SFT	*See* System Fault Tolerance.
STREAMS	NLMs that provide a common interface between intraNetWare and transport protocols that need to deliver data and requests to intraNetWare for processing. By making the transport protocol transparent to the network operating system, STREAMS allow services to be provided across the network, regardless of the transport protocols used.
System Fault Tolerance (SFT)	Duplicating data on multiple storage devices so that if one storage device fails, the data is available from another device. There are several levels of hardware and software system fault tolerance. Each level of redundancy (duplication) decreases the possibility of data loss.
Transaction Tracking System (TTS)	A system that protects database applications from corruption by "backing out" incomplete transactions that result from a failure in a network component.
Trustee	A user or group that has been assigned rights to work in a directory or file.
TTS	*See* Transaction Tracking System.
Virtual Loadable Module (VLM)	A portion of the NetWare DOS Requester that is loaded through the *VLM.EXE*.
VLM	*See* Virtual Loadable Module.

Volume block	This is the block size used during the installation of your NetWare volumes. The accuracy of this variable is important because volumes with 4 KB blocks require 16 times the amount of memory required by volumes with 64 KB blocks
WAN	*See* Wide Area Network.
Wide Area Network (WAN)	Network of LANs connected by routers or bridges, usually covering a large geographic area.

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intraNetWare Memory Worksheet

STEP 1: Calculate the following variables.

V1. Enter the *total* number of megabytes of disk connected to the server. _____MB
   (For example: enter 1 for each MB, enter 1024 for each GB.)

V2. Calculate the number of megabytes of *useable* disk space connected to the server. _____MB
   (If you are mirroring or duplexing multiply V1 * 0.5, otherwise copy V1.)

V3. Enter the server's volume block size (4, 8, 16, 32, or 64). _____KB

V4. Calculate the number of disk blocks per MB (divide 1024 / V3). _____Blocks/MB

V5. Calculate the total number of disk blocks (multiply V2 * V4). _____Blocks

V6. Enter the maximum number of clients (end-users) attached to the server. _____Clients
   (For example: enter 24 for 24 end-users)

V7. Enter the maximum number of files that will reside on the server. _____Files

STEP 2: Calculate your individual memory requirements.

Line 1. Enter the base memory requirement for the core OS and NDS. _____KB
   (Enter 6144 for intraNetWare; 11,264 for SFT; or 12,288 for SMP.)

Line 2. Calculate the memory requirement for the Media Manager (multiply V1 * 0.1). _____KB

Line 3. Calculate the memory requirement for directory tables _____KB
   (multiply V7 * .006, or if suballocation is enabled multiply V7 * .011).

Line 4. Calculate the memory requirement for additional Name Spaces _____KB
   (multiply V7 * .006 * number of additional Name Spaces loaded on the server).

Line 5. Calculate the memory required to cache the FAT (multiply Line V5 * .008). _____KB

Line 6. Calculate the memory requirement for file cache using the following table: _____KB
This calculation uses a 0.4-MB file cache per client memory requirement. The decrease as
the user community size increases is based on assumptions regarding increased repetitive
use of shared data (temporal and spatial locality) within cache.

Less than 100 clients	V6 * 400
Between 100 and 250 clients	40,000 + ((V6 - 100) * 200)
Between 250 and 500 clients	70,000 + ((V6 - 250) * 100)
Between 500 and 1000 clients	95,000 + ((V6 - 500) * 50)

Line 7. Enter the total memory (KB) required for support NLMs. _____KB
   2,000KB is recommended for BTRIEVE(700), CLIB(500), INSTALL(600), and
   PSERVER(200)

Line 8. Enter the total memory (KB) required for other services. _____KB

   Other services include GroupWise, ManageWise, NetWare for Macintosh, NetWare for
   SAA, and so on.

STEP 3: Calculate the server's total memory requirement.

Line 9: Total Lines 1–8 for your total memory requirement (in KB). _____KB

Line 10: Divide Line 9 by 1024 for a result in MB. _____MB
Using this result, round up to the server's nearest memory configuration. intraNetWare will
enhance server performance by using all leftover memory for additional file cache.