

COMPAQ

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# Performance Management In a NetWare v3.1x Environment

Compaq TechNote

Includes information on:

- Optimizing performance of Compaq PC Servers
- Analysis and troubleshooting of network performance problems
- Quick Reference Charts

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### ***COMPAQ TECHNOTE FOR NETWARE***

#### ***PERFORMANCE MANAGEMENT IN A NETWARE v3.1x ENVIRONMENT***

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## *Chapter 1*

# INTRODUCTION

This COMPAQ TechNote is for system integrators with experience in configuring a NetWare-based LAN using NetWare v3.1x and a COMPAQ EISA-based product as a network server. Understanding the information presented in this COMPAQ TechNote requires a thorough knowledge of NetWare v3.1x and COMPAQ EISA-based products.

**NOTE:** Some of this information was originally published as part of the *Compaq and Novell Integration ToolKit* in July 1991. It has been revised and updated twice for distribution as a COMPAQ TechNote.

Because the network is a dynamic workgroup productivity tool, network requirements and workload often change. LAN product technology also changes rapidly. To ensure that network performance satisfies user requirements and that the network incorporates new technology when necessary, the integration process must include periodic network monitoring and performance management.

Network performance depends on the number of users on the system, the application environment (resource sharing, client-server), the speed and efficiency of the server and workstations, and the bandwidth and speed that are available to the physical network. The type of server, NICs, and cabling systems play important roles in network operation under heavy traffic conditions. Evaluate these items carefully.

Network performance is often associated with network user expectations, and can be interpreted as the response time that network users realize at their workstations when attempting to access resources on the network. User perception of a "slow" network usually results in an arduous attempt by network support personnel to find and resolve the network problem to satisfy the user.



A bottleneck is an area of congestion on the network that slows down network performance. As you add applications to the network and as the number of users or workstations on the network changes, network bottlenecks may emerge.

Any component of the network can emerge as a bottleneck. For example, the type of NIC used in the network server or the workstation can become a bottleneck. You must tailor the network to meet the needs of the users and to accommodate additional applications.

"Tuning" the network components to maximize performance and to address user productivity issues, application software design, and data structure is called performance management. However, tuning is not the elimination of all bottlenecks. Tuning is the adjustment of subsystems to minimize the effects of bottlenecks and to maximize the overall network performance.

Solving network performance problems requires a working knowledge of the network environment, a set of tools for monitoring the network, and the proper training. Without these, it might be difficult to analyze a given network environment, to find the required information, and to draw a logical conclusion to solve a network performance problem.

For example, a network may suffer poor workstation response time even though the network bandwidth utilization indicates low network activity. Which part of the network platform is causing the poor response time? With the appropriate monitoring tools and the proper information, you can isolate and relieve the bottleneck.

Managing network performance may require that you devote additional time and attention to the network as it grows and changes. Once you implement the network, you must monitor all subsystems regularly to ensure adequate performance.



## **ABOUT THIS COMPAQ TECHNOTE**

This COMPAQ TechNote provides guidelines, based on Compaq integration and performance testing, for using a variety of network monitoring tools to analyze network server and network communication subsystems and to manage network performance.

This COMPAQ TechNote provides information on theory of operations to help you understand how your network environment performs. It also provides examples to help you decide how to manage the performance of your network and provide the most benefit to network users.

Network performance differs with each application environment, so the symptoms of network problems are different with each application environment. This COMPAQ TechNote focuses on the resource-sharing environment, the sharing of file and print services, as represented by typical office automation functions such as word processing, spreadsheet generation, and PC-based databases. The resource-sharing environment does not encompass additional network services, such as internetwork communications or network-based database services. It also does not include client-server applications.

Although many performance characteristics may be common across application environments, focusing on the resource-sharing environment provides a foundation for network performance analysis and management in other application environments.

This COMPAQ TechNote primarily addresses the operating system and hardware components. Other factors, such as applications, network protocols, and other hardware, may also contribute to overall network performance. This COMPAQ TechNote provides general information on these issues and provides some ways to isolate problems related to these factors, but providing corrections for site-specific problems is beyond the scope of this document.

This COMPAQ TechNote is divided into the following chapters:

- **Chapter 1** - Provides an overview of performance management, this COMPAQ TechNote, and tested configurations.
- **Chapter 2** - Describes network monitoring tools and protocol analyzers.
- **Chapter 3** - Discusses workstation performance analysis and management.
- **Chapter 4** - Discusses the network server communication subsystem performance analysis and management.
- **Chapter 5** - Discusses the network server hard drive subsystem performance analysis and management.
- **Chapter 6** - Discusses the system memory subsystem performance analysis and management.
- **Chapter 7** - Discusses the system processor subsystem performance analysis and management.
- **Chapter 8** - Outlines other factors that affect network performance.
- **Chapter 9** - Illustrates network performance management.
- **Chapter 10** - Summarizes performance management, and provides performance analysis and management flow diagrams and checklists. Use the flow diagrams to perform a complete analysis of your network configuration. Use the accompanying checklists to track your progress during analysis.





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## TESTED CONFIGURATIONS

Several test configurations were used for development of this COMPAQ TechNote. They include the following COMPAQ ProSignia, COMPAQ SYSTEMPRO, and COMPAQ SYSTEMPRO/LT products.

### COMPAQ ProSignia Configurations

COMPAQ ProSignia Model 486/33-1050 with the following:

- 16 megabytes of system memory
- 1.05-Gigabyte Fast-SCSI-2 Hard Drive, with an additional three 1.05-gigabyte drives (for a total of 4.2 gigabytes)
- Integrated 32-Bit Fast-SCSI-2 Controller
- COMPAQ 32-Bit NetFlex Controller

**NOTE:** Add a COMPAQ Fast-SCSI-2 Controller board for controller duplexing. The amount of system memory for the server and the Fast-SCSI-2 hard drive subsystem was based on a 8-Kbyte volume block size. See Chapter 5 for more information on volume block size.

COMPAQ ProSignia Model 486/33-1020 with the following:

- 16 megabytes of system memory
- 1020-Megabyte Drive Array Pair, with an additional 1020-Megabyte Drive Array Pair (for a total of 2.04 gigabytes)
- COMPAQ Intelligent Drive Array Controller-2 (IDA-2)
- COMPAQ 32-Bit NetFlex Controller

**NOTE:** The amount of system memory for the server and IDA-2 subsystem was based on an 8-Kbyte volume block size.

### **COMPAQ SYSTEMPRO Configuration**

COMPAQ SYSTEMPRO Model 386-840 with the following:

- 16 megabytes of system memory
- 840-Megabyte Intelligent Drive Array (two 420-Megabyte Drive Array Pairs)
- 32-Bit Intelligent Drive Array Controller
- Novell NE3200 File Server Board
- COMPAQ Enhanced 32-Bit DualSpeed Token Ring Controller

**NOTE:** Use additional drive array pairs and IDA Controller for controller duplexing.

### **COMPAQ SYSTEMPRO Configuration With the Intelligent Array Expansion System**

COMPAQ SYSTEMPRO Model 486-840 with the following:

- 32 megabytes of system memory
- 840-Megabyte Intelligent Drive Array (two 420-Megabyte Drive Array Pairs)
- 32-Bit Intelligent Drive Array Controller
- Intelligent Drive Array Expansion System with 9.1 gigabytes of hard drive space
- Novell NE3200 File Server Board
- COMPAQ Enhanced 32-Bit DualSpeed Token Ring Controller

**NOTE:** Use an additional drive array and IDA Controller for controller duplexing.



## **COMPAQ SYSTEMPRO IDA-2 Configuration**

COMPAQ SYSTEMPRO Model 486/33-1020e with:

- 16 megabytes of system memory
- 1020-Megabyte Drive Array Pair
- COMPAQ Intelligent Drive Array-2 Controller with 4-Megabyte Array Accelerator Write Cache
- Novell NE3200 File Server Board
- COMPAQ Enhanced 32-Bit DualSpeed Token Ring Controller

**NOTE:** Use an additional drive array and 32-Bit IDA-2 Controller for controller duplexing.

## **COMPAQ SYSTEMPRO/LT Configurations**

COMPAQ SYSTEMPRO/LT Models 386/25, 486SX/25, and 486/33 with the following:

- 8 megabytes of system memory
- 510-Megabyte Hard Drive
- Novell NE3200 File Server Board
- COMPAQ Enhanced 32-Bit DualSpeed Token Ring Controller

**NOTE:** Add the same number of hard drives to the hard drive subsystem for drive mirroring.



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## *Chapter 2*

# NETWORK MONITORING TOOLS AND PROTOCOL ANALYZERS

When you monitor the network and plan for network expansion, a variety of network monitoring tools provide statistical information to help you isolate performance problems.

This chapter describes the following monitoring tools that you can use to analyze your network for performance bottlenecks. This list is only a partial list of available tools.

- *MONITOR.NLM*
- COMPAQ INSIGHT Manager
- COMPAQ Server Manager/R
- Protocol analyzers
- Network monitoring software

Using the monitoring tools and interpreting the data they provide are skills that you should master for successful network management. If you cannot interpret the data, you cannot manage the network effectively.

This COMPAQ TechNote does not provide installation guidelines or configuration information for these monitoring tools. Each tool or analyzer that you use provides adequate installation instructions.



**IMPORTANT:** Chapters 3 through 8 discuss using monitoring tools for identifying specific performance problems. Where applicable, these discussions mention the tools that can give you the appropriate information.

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## MONITOR.NLM

*MONITOR.NLM*, a NetWare utility, allows you to inspect information on specific components of the server, as well as general server performance. Several menus provide statistical information on the server system memory, hard drive subsystem, and network communication subsystem. You can use these screens to track a suspected performance problem or to assist in isolating a hardware problem.



**IMPORTANT:** Ensure that you load *MONITOR.NLM* as the last NLM in the *AUTOEXEC.NCF* file. If you load other NLMs after *MONITOR.NLM*, it cannot accurately read the network server information. You may not receive the correct representation of the values in the Resource Utilization menu.

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When loaded, *MONITOR.NLM* immediately displays the following in the Information menu:

- File Server Up Time
- Utilization
- Original Cache Buffers
- Total Cache Buffers
- Dirty Cache Buffers
- Current Disk Requests
- Packet Receive Buffers
- Directory Cache Buffers
- Service Processes
- Connections In Use
- Open Files



Using *MONITOR.NLM*, you can view information for the following menu options:

- Connection Information
- Disk Information
- LAN Information
- System Module Information
- Resource Utilization

The following paragraphs discuss these menu options in detail.

### **Connection Information**

The Connection Information menu provides the status of current connections logged into the server. The following lists some of the options in the Connection Information menu. Use this menu to identify the number of workstation connections and requests.

- Connection Time
- Network Address
- Requests
- Kilobytes Read and Written
- Status

### **Disk Information**

The Disk Information menu allows you to monitor the status of the hard drive subsystem and to view device driver information. Use this option and COMPAQ INSIGHT Manager to view most hard drive subsystem information.

## **LAN Information**

The LAN Information menu provides information on network traffic. The following lists some of the information available from the LAN Information menu in *MONITOR.NLM*. This information varies with the NIC device driver.

- Version of the LAN Device Driver
- Node and Network Address
- Total Packets Sent and Received
- No ECB Counts Available
- Send Packet Too Big Count and Send Packet Too Small Count
- Receive Packet Overflow Count
- Receive Packet Too Big Count and Receive Packet Too Small Count
- Send Packet Miscellaneous Errors and Receive Packet Miscellaneous Errors
- Send Packet Retry Count

Use the LAN Information menu to identify the number of No ECB Counts Available and the number of sent or received miscellaneous packet errors. You can also use the LAN Information menu to view the custom statistics for the Novell NE3200 File Server Board, the COMPAQ 32-Bit DualSpeed Token Ring Controller, and the COMPAQ 32-Bit NetFlex Controller, as well as other NICs.

## **System Module Information**

The System Module Information menu provides information on every NLM on the server, including the amount of memory each requires and the number of resource tags it has allocated.



## Resource Utilization

The Resource Utilization menu can provide information on NetWare's use of server system memory. This information can help you decide when your server needs more system memory. Use this menu to monitor the following:

- Bytes of memory reserved for a particular memory pool or buffer
- Percentage of available system memory being used by a pool or buffer
- In-Use indicating amount of available system memory that is being used

Six different system memory statistics provide information on server system memory allocation:

- Permanent Memory Pool
- Alloc Memory Pool
- Cache Buffers Pool
- Cache Movable Memory
- Cache Non-Movable Memory
- Total Server Work Memory

Under the Resource Utilization menu, the Server Memory Statistics option allows you to track the amount of system memory that NetWare dynamically allocates for caching disk I/O requests. NetWare typically allocates some of that system memory for NLMs and allocates the remaining system memory to the Cache Buffers pool for distribution to other memory pools. Four different types of memory pools are used to manage this system memory:

- Movable, returnable to cache, expandable
- Non-movable, returnable to cache, nonexpandable
- Non-movable, not returnable to cache (fragmented), nonexpandable
- Fast short-term memory allocation, not returnable to cache



## **COMPAQ INSIGHT MANAGER**

COMPAQ INSIGHT Manager is a Microsoft Windows-based application that monitors any COMPAQ server, providing management information. The managed server can alert you at the management console of potentially critical problems. COMPAQ INSIGHT Manager collects both real-time and historical information about servers, allowing you to better manage your network.

The Windows-based module of COMPAQ INSIGHT Manager resides on the management PC. COMPAQ Management Agents reside on the "managed" network server. A server loaded with these management agents is said to be "instrumented."

COMPAQ INSIGHT Manager provides the following information for an instrumented server:

- Configuration
- Disk storage
- Expansion boards
- Security configuration
- System board

When configured with COMPAQ Server Manager/R, it provides the following additional information:

- Environment
- I/O Ports



The COMPAQ Management Agents include one Simple Network Management Protocol (SNMP) agent and four COMPAQ instrumentation agents to provide specific server information. COMPAQ INSIGHT Manager uses SNMP over an IPX network to collect data from the Management Agents, transferring the collected information "on the network" (that is, the data from the managed server is transferred over the physical network cabling). These agents are:

- *SNMP.NLM*, which provides the SNMP connection between the managed server and the management PC.
- *CPQBSSA.NLM*, the Base System SNMP instrumentation agent, which provides the management PC with configuration information about the managed server.
- *CPQDSKSA.NLM*, the COMPAQ Drive Array instrumentation agent, which provides information about COMPAQ drive array products installed in the managed server.
- *CPQSMBSA.NLM*, the COMPAQ Server Manager/R Board SNMP instrumentation agent, which provides information about a Server Manager/R board installed in the managed server.
- *CPQHTHSA.NLM*, the COMPAQ Server Health SNMP instrumentation agent, which provides information from COMPAQ PC Servers with Server Health features.

Using COMPAQ INSIGHT Manager, you can analyze critical network server subsystems and troubleshoot network server problems. Using both COMPAQ Server Manager/R and COMPAQ INSIGHT Manager provides comprehensive network server analysis and management.



**IMPORTANT:** For information about COMPAQ Server Manager/R and COMPAQ INSIGHT Manager, see the COMPAQ TechNote for Netware titled *NetWare Server Management*.

For more information, contact your Authorized COMPAQ Reseller or Service Provider or call the Compaq Customer Support Center at 1-800-345-1518 in North America. In Canada, call 1-800-263-5868. Outside the United States and Canada, contact your local Compaq office.

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COMPAQ INSIGHT Manager is a snap-in application for the NetWare Management System (NMS) for Microsoft Windows. COMPAQ INSIGHT Manager can be launched from and provide alerts to the NetWare Management Map (NMM), a Windows-based console application that provides a logical map of all devices on an IPX network and a physical map of all devices on the network.

## COMPAQ SERVER MANAGER/R

COMPAQ Server Manager/R is a system management tool that monitors and provides information about any COMPAQ EISA-based PC, PC System, or PC Server. Server Manager/R includes a 32-bit bus master board and associated NetWare software and device drivers for the monitored system. For remote management, the Server Manager/R board includes an enhanced modem that supports up to 2400 baud. This modem allows you to dial into the monitored server, and allows Server Manager/R to contact a list of designated administrators in the event of a network problem. The serial port supports connections up to 19.2K baud. The Server Manager/R board also includes battery backup in the event of a server power failure. The battery retains data about the status of the server before the power failure for up to 30 days.

Server Manager/R software includes Server Manager Facility/R (SMF) and Server Manager Collector/R (SMC). Each of these Microsoft Windows-based software applications provides an important function in the network performance management process.



Server Manager Facility/R resides on the management PC. It communicates with the monitored server via direct connection through the serial port or dial-up connection through the modem. SMF provides "real-time" information on network server status (much like NetWare *MONITOR.NLM*); however, its primary function is to alert network administrators when server problems occur. You can define thresholds for a variety of components (for example, temperature, I/O bus, and hard drive). You can also direct Server Manager/R to monitor the server and to alert a designated administrator via voice, pager, or management PC message when the server conditions exceed the designated thresholds.

SMF also includes the Remote Console feature that allows you to access *MONITOR.NLM*. From Remote Console, you can view *MONITOR.NLM* statistics and access the system prompt. From the system prompt, you can load *INSTALL*, load and unload NLMs, and change SET parameters.

Server Manager Collector/R resides on the management PC. It also communicates with the monitored system via direct connection through the serial port or dial-up connection through the modem. SMC, however, provides historical data or a series of "snapshots" for trend analysis. You can establish baseline performance data and use this data to analyze network performance trends.



**IMPORTANT:** For information about COMPAQ Server Manager/R, see the COMPAQ TechNote for Netware titled *NetWare Server Management*.

For more information, contact your Authorized COMPAQ Reseller or Service Provider or call the Compaq Customer Support Center at 1-800-345-1518 in North America. In Canada, call 1-800-263-5868. Outside the United States and Canada, contact your local Compaq office.

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## **PROTOCOL ANALYZERS**

A network protocol analyzer provides network monitoring, troubleshooting, and application software debugging functions. It allows you to analyze the network performance for a variety of application environments based on configured hardware, software, and protocols. A protocol analyzer provides a "snapshot" of current network activity or provides a historical record of network activity.

A protocol analyzer kit usually includes hardware and software for Ethernet or Token Ring networks. The software usually includes application test suites and protocol decodes.

Using most protocol analyzers, you can perform the following:

- Find network traffic bottlenecks
- Plan for network expansion
- Detect intruders
- Identify baseline performance
- Identify defective hardware and ineffective software
- Redistribute traffic between network servers (that is, rebalance the network load between servers)

Several of these options direct you to specific network performance problems, allowing you to identify and isolate network problems more quickly than when using software monitoring tools. For example, when analyzing a segment of a Token Ring, you can set up filters on individual network addresses and establish thresholds on these addresses to track network error conditions. After capturing the packets and analyzing them, you can determine whether a single workstation address is generating corrupted data.

A protocol analyzer provides a comprehensive analysis of the network and its performance. Using a protocol analyzer, you can analyze all network activity, troubleshoot problems, identify and isolate network-related bottlenecks, and manage network performance based on the amount of network traffic, number of users, and types of applications on the network.



## **NETWORK MONITORING SOFTWARE**

Network monitoring software provides information on the current network activity and provides a historical record of the same network activity over a period of time. It usually includes hardware and software for either Ethernet or Token Ring environments. Both versions provide the same functionality.

Network monitoring software usually resides on a workstation that is attached to a network segment, providing information for a single station or the network. It also allows you to perform limited cable and station testing.

Although most monitoring software only supports one network segment at a time, some software can provide limited information on internetwork status. Most software provides the following information about a selected segment:

- Current Usage
- Average Usage
- Total Frames
- Total Errors
- Total Bytes
- Average Frame Size

Network monitoring software can provide performance statistics to help you isolate network performance problems; however, most software does not provide all the functionality of a protocol analyzer. Use network monitoring software as a "starting point" for isolating network performance problems.



## **SUMMARY**

The monitoring tools and protocol analyzers used during Compaq integration testing are only a few of those available for NetWare v3.1x. You usually need a combination of these to gather all of the data that you need to analyze and manage network performance. Each network implementation requires a unique combination of tools for data gathering. Analyze the requirements for managing the performance of your network before selecting the appropriate set of monitoring tools.



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## *Chapter 3*

# **WORKSTATION PERFORMANCE ANALYSIS AND MANAGEMENT**

Since the workstation provides the interface to the network and its performance, users may believe that the "network" is not functioning properly when the actual cause of the perceived performance degradation is the workstation.

In many workgroup environments, 30 to 50 workstations access the network server. Usually, the amount of network traffic and the number of service requests at the server are relatively low, with heavier network traffic and a peak number of service requests at certain times of the business day. Throughout the day, workstations run a variety of PC-based applications, such as word processors, spreadsheets, and database applications, and perform a variety of tasks, such as file transfers and printing.

When managing network performance, changing or modifying the server configuration (depending on the network implementation) may yield only a 10 percent difference in workstation response time. Upgrading the workstation configuration may yield as much as 100 percent improvement in workstation response time.

In a file transfer/storage resource-sharing environment, most PC-based applications on the network load the executable files to the workstation and then transfer entire data and document files to the workstation for processing. The network server provides the files, and the workstation manipulates them. However, when printing to a network printer, the network server manages the printing tasks or the designated print server.



Considering the type of resource sharing being performed and the user's perception of performance, you must determine an acceptable response time under light network loads and an acceptable amount of degradation under heavier network loads. Identifying the applications used and determining how well they perform on the network can set an acceptable response time. If the network response time is not within this range of acceptable performance, then you can systematically analyze the network to identify the problem and perform corrective action. Establishing baseline network performance statistics for workstations can also help set user expectations in evaluating network performance.

For example, you can collect workstation response time statistics in a standalone environment and compare these statistics to the same configuration in a network environment under both light and heavy network loads.

As a rule, if the network application performance is less than 50 percent slower than the standalone application performance, then consider the network performance acceptable, and begin analysis of the application and the workstation. For example, if the standalone application test completed in 1 minute and the network application test completed within 1.5 minutes, then the network is within the acceptable range of performance.

Configurations and applications vary from one workstation to another. The workstation discussion in this chapter provides general information on the effects of workstation configuration on network performance, but does not cover the workstation configuration in great depth. When monitoring the performance of the network, consider the workstation configuration, including the type of system processor, the type of workstation shell program, the type of NIC, and the applications that run on the workstation.



## WORKSTATION PERFORMANCE PROBLEMS

When analyzing the network performance, determine whether the network problem affects an isolated workstation, a group of workstations, or the entire segment or ring. This can help indicate the cause of the problem. If the problem affects only one workstation, you can begin analysis at that workstation. If the problem affects many workstations, but not all of them, then you must identify the similarity among these users (that is, the same application software, same workstation configuration, same network segment, and so on). If the problem affects all workstations, then analyze the network cabling or the network server first.



**IMPORTANT:** Chapter 10 provides a collection of performance analysis/management checklists and flow diagrams. Use these tools to analyze your workstations.

For additional information on COMPAQ workstations, contact your Authorized COMPAQ Reseller or Service Provider or call the Compaq Customer Support Center at 1-800-345-1518 in North America. In Canada, call 1-800-263-5868. Outside the United States and Canada, contact your local Compaq office.

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When analyzing the workstation as part of the network, consider the following:

- Workstation system processor
- Workstation network communication subsystem
- Workstation system memory
- Other factors affecting workstation performance

The following paragraphs discuss these workstation performance factors.

## **Workstation System Processor**

In a LAN environment, resource sharing usually entails functions such as file transfers and printing. Most applications that run in a LAN environment use the file transfer capabilities and print services of the LAN, 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 286- and a 386-based workstation. Upgrading the system processor will increase the performance of system processor-intensive applications more noticeably than that of file-intensive applications.

Workstations with high-performance system processors, such as a 386 or 486, process data much faster than 286-based workstations. Users who require more processing power should use high-end workstations based on high-performance system processors. If the load on the workstation system processor is minimal, such as in a word processing environment, a lower performance 386-based workstation may be adequate for network use.

## **Workstation Network Communication Subsystem**

Your 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**

An important factor in workstation performance is the type of NIC used. NICs that use bus mastering or that support larger packet sizes help 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 often transfers large files and programs, a 16-bit or 32-bit NIC will enhance performance. For example, in a CAD environment, the network constantly transfers many large files and even program overlays, and it is advantageous to use a 32-bit NIC on all workstations that perform this function.

When selecting NICs, consider the processing capabilities of the workstation. Different types of NICs (8-bit, 16-bit, 32-bit) operate at different transfer rates. The type of NIC used and the efficiency of the device driver can affect even the highest-performance workstation.

Table 3-1 demonstrates the difference that the NIC can make on a variety of workstations. As shown in Table 3-1, when configured in a 386/33-based PC, a 32-bit EISA bus master NIC can yield as much as a 128 percent performance improvement over an 8-bit NIC.

**Table 3-1**  
**Effects of NIC on Workstation Performance**

PC or PC System	Type of NIC	Throughput (Kbytes per Second)
DESKPRO 386/16	8-Bit	329
DESKPRO 386/33	8-Bit	335
DESKPRO 286/12	16-Bit	340
DESKPRO 386/16	16-Bit	358
DESKPRO 386/33	16-Bit	413
DESKPRO 386/33L	32-Bit	430

### WORKSTATION DEVICE DRIVER

Optimized device drivers can further enhance NIC performance. Several NIC manufacturers provide device drivers that use special features. For example, some Token Ring NIC device drivers support larger packet sizes that can significantly increase the amount of data throughput when compared to earlier versions that use smaller packet sizes.

Usually, the latest version of a device driver provides enhanced performance. As new device driver versions are released, these new versions include modifications to enhance overall reliability and efficiency and to support higher-performance PCs and PC systems.

### Workstation System Memory

The amount of system memory required for network device drivers and applications also contributes to workstation performance. The workstation device driver (*IPX.COM*) and network shell program (*NETX.COM*) can require from 50 Kbytes to 60 Kbytes of contiguous system memory.



When large applications run on a workstation, there may not be enough conventional memory available to run both the network drivers and the application. Novell provides two shell programs that can use system memory beyond the 640-Kbyte conventional limit. Use the *EMSNETX.EXE* file for workstations using expanded memory, and the *XMSNETX.EXE* file for workstations using extended memory.

**NOTE:** Workstations running MS-DOS v5.0 as published by Compaq or MS-DOS v6.0 come with memory managers that allow you to run *NETX.COM* in upper memory. Third-party memory managers are also available for MS-DOS versions 3.x and later.

To enable workstations to use expanded (or "paged") memory, the *EMSNETX.EXE* shell requires an expanded memory driver such as COMPAQ *CEMM.EXE*. When using *CEMM.EXE* and *EMSNETX.EXE*, the workstation makes more conventional memory available for applications. The *EMSNETX.EXE* shell requires approximately 9 Kbytes of conventional memory, rather than the 43 Kbytes of conventional memory required for *NETX.COM*.

To enable workstations to use extended memory, the *XMSNETX.EXE* shell requires that a driver such as *HIMEM.EXE* or *HIMEM.SYS* be loaded. *XMSNETX.EXE* requires approximately 8 Kbytes of conventional memory, rather than the 43 Kbytes of conventional memory required for *NETX.COM*.

When running *EMSNETX.EXE* or *XMSNETX.EXE*, applications have more conventional memory available. These shells allow the workstations to run larger applications.

## **Other Factors Affecting Workstation Performance**

Several other factors affect workstation performance. One factor is the use of caching utilities, such as the COMPAQ DOS CACHE and VDISK Utilities, available on the COMPAQ User Programs diskette for MS-DOS v5.0 (and earlier) as published by Compaq. The use of math coprocessors, printing directly to the network queue, and storing files on the workstation hard drive, are also performance factors. These factors, as they relate to performance management, are discussed in the following paragraphs.

### **CACHING UTILITIES**

Caching utilities, such as COMPAQ DOS CACHE Utility and COMPAQ VDISK Utility, available on the COMPAQ User Programs diskette, allow your workstation to use a portion of system memory to store data. However, to take full advantage of these caching utilities, the workstation must have an adequate amount of system memory. Use either or both of these utilities if the workstation has more than enough system memory to run applications.

The DOS CACHE Utility writes a copy of the most recently written data to a designated portion of system memory. The VDISK Utility uses a portion of system memory as if it were a hard drive.

### **VDISK Utility**

Using the VDISK Utility from Compaq improves workstation performance in a disk I/O intensive application environment. VDISK reserves a portion of the workstation system memory to function as a hard drive. This allocated portion of system memory is called a "virtual disk" or a "RAM drive."

VDISK options include the designation of virtual disk size, use of expanded memory or extended memory, use of conventional memory only, use of VDISK in extended memory only, designation of sector size, and number of directory entries. If the workstation uses expanded memory with the VDISK Utility, you must also load *CEMM.EXE* or another expanded memory manager.



The VDISK Utility is available on the COMPAQ User Programs diskette.



**CAUTION:** The virtual disk resides in volatile system memory. Copy all data from the virtual disk to a hard drive or diskette before turning off or rebooting the workstation. Otherwise, all data in the virtual disk is lost.

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### **DOS CACHE Utility**

Using the DOS CACHE Utility from Compaq can improve workstation performance in read-intensive application environments by decreasing the time required to access data on either the workstation or the network server hard drive. Copies of the most recently accessed data are stored in a portion of system memory that is allocated by the DOS CACHE Utility. Depending on the type of workstation, this system memory can be conventional, expanded, or extended memory.

Each time the application requests data, the workstation searches the cache. If the data is in the cache, the workstation transfers it to system memory. If the data is not in the cache, then the workstation must transfer the data from the hard drive to system memory. Read-intensive applications, such as databases, and applications that use overlay files (some word processors) can take advantage of the DOS CACHE Utility. The DOS CACHE Utility is on the COMPAQ User Programs diskette. Refer to the COMPAQ User Programs documentation for installation instructions.

### **Windows SMARTDRV Utility**

The Microsoft Windows SMARTDRV utility is a disk cache program that saves data read from the hard drive to workstation system memory. When the application requests the data again, the SMARTDRV utility provides it from system memory, rather than from the hard drive. Unlike most disk cache utilities that inflexibly partition the system memory, the SMARTDRV utility closely operates with Windows to share system memory resources dynamically.



Add the following command line to the workstation *CONFIG.SYS* file to allocate SMARTDRV with a maximum cache of 1,024 Kbytes and a minimum cache of 256 Kbytes:

```
DEVICE=C:\WINDOWS\SMARTDRV.SYS 1024 256
```



**IMPORTANT:** Do not use the COMPAQ DOS CACHE Utility and SMARTDRV together.

---

## **MATH COPROCESSORS**

The math coprocessor manages computational tasks for the system processor. Many applications, including business, engineering, accounting, statistical, and graphics applications, take advantage of the math coprocessor.

If your workstation application environment is "compute-intensive" and your application supports a math coprocessor, you can improve workstation performance by adding one, or upgrading to a 486DX processor, which includes a math coprocessor.

## **DIRECTLY PRINTING TO NETWORK QUEUE**

Most MS-DOS applications, both DOS-based and Windows-based, use the NetWare CAPTURE command to print over the network. NetWare uses the CAPTURE command to manage the print process. Some network-aware applications, such as WordPerfect, can print directly to the network queue rather than relying on the NetWare CAPTURE command for server/queue/print redirection. This offloads the print management responsibility from the system processor, allowing it to perform other tasks.

If your application supports printing directly to the network queue, you can use this function to improve network printing performance.



## FILE STORAGE ON WORKSTATION HARD DRIVE

As PC applications grow more complex, the application files grow larger and often do not fit in workstation conventional memory. Some applications use overlay files to hold portions of application software code for various routines. The application installation program does not load these files into workstation system memory with the application files, but stores them at the network server and loads them "on demand." The network server then passes them to the workstation.



**IMPORTANT:** To avoid this overhead, store overlay files at the workstation, instead of at the server, to reduce network traffic.

If applications create overlay files or temporary files, ensure that the correct path is specified in the *AUTOEXEC.BAT* file, so that these files are not transferred to the default network drive. This also helps minimize the amount of network traffic.

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For example, in a WordPerfect application environment, if a 286-based workstation with expanded memory is initialized, the overlay file (*WP.FIL*) can be loaded to workstation expanded memory or to the hard drive. In this example, WordPerfect uses the workstation copy of the file, rather than the server copy of the file. Redirect all temporary files to the workstation hard drive directory to reduce network traffic.

## WORKSTATION SUMMARY

When analyzing the network, consider the configuration of the workstation as a major factor in user perception of performance, including the system processor type, NIC type, and device drivers. Upgrading the workstation may yield as much as a 100 percent improvement in workstation response time. Since the workstation provides the interface between the network server and the user, users may perceive that the network performance is inadequate, when the workstation configuration is actually the cause of the poor response time.



Applications and application environments also affect network performance. Many times the application causes the perceived degradation in performance. Consider the type of resource sharing, and determine an acceptable response time during light network traffic and an acceptable amount of degradation under heavier network loads. If the response time is not within the acceptable limits, then you can begin workstation and network analysis.

When monitoring the network performance, you must determine whether the problem affects an isolated workstation or a group of workstations. If the problem affects a single workstation, you can remove the workstation from the network and perform analysis without affecting the performance of other workstations on the network. If the problem affects a group of workstations, you can use the Performance Analysis/Management Checklist and the Performance Analysis/Management Flow Diagram in Chapter 10 of this TechNote to help you identify the problem.



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## *Chapter 4*

# **NETWORK COMMUNICATION SUBSYSTEM PERFORMANCE**

Testing the performance of a network server is complicated, because a server is not a single device, but is rather a collection of components that make up a network server system. Server subsystems include the following components:

- Network communication subsystem
- Hard drive subsystem
- System memory
- System processor

The performance of each of these network server components affects the performance of the others. For example, a lack of system memory affects the hard drive subsystem, network communication subsystem, and system processor.

The following chapters discuss network server subsystems as they relate to performance. They describe how to adjust these subsystems to minimize the effects of bottlenecks and to maximize overall network server performance. This chapter deals with the network communication subsystem.

Poor network server or workstation performance is often associated with "physical network" problems. If the network is over-congested or poorly designed, then the highest performance network server and workstations do very little to improve overall network performance.

The topology on which the network operates is a key factor in network performance. This section shows you how to identify network performance problems using the physical operating characteristics of two environments: Token Ring and Ethernet. This chapter is presented in three parts:

- Definition of performance characteristics inherent to both network environments.
- Identification of Token Ring-specific performance problems and corrective action.
- Identification of Ethernet-specific performance problems and corrective action.

This information helps you determine if there is a performance problem with the network communication subsystem, and provides suggestions for resolving it.

## **NETWORK PERFORMANCE CHARACTERISTICS**

Four important performance factors in any network environment are:

- Packet size and number of communication buffers
- Device driver efficiency at the server and workstation
- Type of NIC used at the server and workstation
- Error Handling

These factors are discussed in the following paragraphs.

### **Packet Size and Number of Communication Buffers**

Packet size has a noticeable effect on network performance. Different topologies support different packet sizes. The number of buffers allocated to server NICs also affects the network performance. If there are not enough communication buffers, a bottleneck can emerge.



NetWare provides the following SET parameters to manage and optimize network communications subsystem performance. Check these parameter values by using the NetWare SET command from the NetWare prompt.

- SET MAXIMUM PHYSICAL RECEIVE PACKET SIZE = [VALUE]
- SET MINIMUM PACKET RECEIVE BUFFERS =  
10\*(NUMBER OF EISA NICs) + 1\*(NUMBER OF USERS)
- SET MAXIMUM PACKET RECEIVE BUFFERS = [VALUE]

When installing a NIC on the server, follow the manufacturer's specifications, and configure the SET MAXIMUM PHYSICAL RECEIVE PACKET SIZE parameter to the largest supported packet size as stated by the manufacturer. Setting the value of the SET MAXIMUM PHYSICAL RECEIVE PACKET SIZE parameter to the maximum supported value allows the operating system to transmit and receive larger packets on the network, which can substantially improve network performance.

The SET MAXIMUM PHYSICAL RECEIVE PACKET SIZE parameter is especially important to Token Ring performance. The COMPAQ 32-Bit NetFlex Controller (with a plug-in COMPAQ DualSpeed Token Ring adapter module) can support a 4-Kbyte (4202) packet size. However, if this SET parameter is set to the NetWare default value of 1130, when the NIC device driver is loaded, the Transmit Buffer Size is displayed as 1130. The operating system does not allow a 4-Kbyte packet size to be sent until the SET parameter value is changed.



Use the values in Table 4-1 as a guideline to set the SET MAXIMUM PHYSICAL RECEIVE PACKET SIZE parameter accordingly.

**Table 4-1  
Standard Packet Sizes**

Topology	Packet Size
Token Ring (16-Mbps)	4202
Token Ring (4-Mbps)	2154
Ethernet	1130
ARCnet	618

**SET MINIMUM PACKET  
RECEIVE BUFFERS =  
10\*(NUMBER OF EISA NICS) +  
1\*(NUMBER OF USERS)**

The SET MINIMUM PACKET RECEIVE BUFFERS parameter allows you to adjust the minimum number of communication buffers that the server can allocate at start-up, rather than waiting for the server to reallocate communication buffers automatically. NetWare dynamically increases this value if it is set too low, but you can expect delays when processing packets until NetWare increases this value to allow for enough buffers. An indication that this number is set *too low* is if "No ECB Counts Available" errors are generated.

Several considerations can influence the use of these buffers, such as the type of NICs used and the number of users on the network. If EISA NICs are used, increase this value to allow an additional 10 buffers for each EISA NIC. Ensure that one packet receive buffer is allocated for each network user.

For example, if a COMPAQ ProSignia network server is configured with 2 COMPAQ 32-Bit NetFlex Controllers and 40 users, set the minimum packet receive buffers value to 60. This allows for 10 buffers per NIC and an additional 40 buffers to match the number of users. Table 4-2 provides values for the minimum packet receive buffers.

**Table 4-2**  
**Minimum Packet Receive Buffers**

EISA NICs		ISA NICs	
EISA NIC	10	ISA NIC	5
EISA NIC	10	ISA NIC	5
40 Users	+ 40	40 Users	+ 40
Total	60	Total	50

Since the SET MINIMUM PACKET RECEIVE BUFFERS parameter value is dynamic, monitor this value to ensure that it is always less than the value of the SET MAXIMUM PACKET RECEIVE BUFFERS parameter.

Once you have implemented the network server, monitor it for several days to establish baseline server performance and values. Write down the value of the Packet Receive Buffers option from *MONITOR.NLM*. Bring down the server, and change the SET MINIMUM PACKET RECEIVE BUFFERS parameter in the *STARTUP.NCF* file to the recorded value. Whenever you must restart the server, the minimum packet receive buffers are allocated automatically, so the server does not spend time going through the dynamic allocation process.



**IMPORTANT:** You must bring down the server to effect the change you have made to the SET MINIMUM PACKET RECEIVE BUFFERS parameter.



### **SET MAXIMUM PACKET RECEIVE BUFFERS = [VALUE]**

The SET MAXIMUM PACKET RECEIVE BUFFERS parameter establishes the maximum number of communication buffers that the server can allocate.

Modify the value of this parameter according to the value of the SET MINIMUM PACKET RECEIVE BUFFERS parameter. When modifying the value of the SET MAXIMUM PACKET RECEIVE BUFFERS parameter, ensure that it is always at least 100 greater than the value in the SET MINIMUM PACKET RECEIVE BUFFERS parameter. If the value of the Packet Receive Buffers statistic in *MONITOR.NLM* reaches the value of the SET MAXIMUM PACKET RECEIVE BUFFERS parameter, increase the SET MAXIMUM PACKET RECEIVE BUFFERS parameter value in increments of 100 buffers until this situation no longer occurs.

Increasing the value of the SET MAXIMUM PACKET RECEIVE BUFFERS parameter takes buffers from the Cache Buffers pool. If you increase this value, check the Resource Utilization value in the *MONITOR.NLM* Available Options menu to ensure that there are enough buffers for other processes.



**IMPORTANT:** Changing the value of the SET MAXIMUM PACKET RECEIVE BUFFERS parameter does not require bringing down the server.

---

### **Device Driver Efficiency**

Device driver efficiency is another factor in NetWare network performance. Earlier versions of NetWare device drivers are not as efficient, or fast, as the most recent versions. Third-party manufacturers are constantly writing more efficient NIC drivers to optimize workstation and server performance.

The device driver is responsible for facilitating communications between the operating system software and the NIC hardware by assembling and disassembling the NetWare IPX packets for the network. The more efficient the device driver, the better the overall performance of the device.



Ensure that you are using the newest device drivers, especially on pre-existing network implementations where the NetWare operating system has been upgraded from an older version or where a combination of 286-based NetWare and 386-based NetWare are implemented.

When upgrading drivers, ensure that the new device drivers are backward- and forward-compatible before upgrading all workstations.

## **Type of NIC**

The type of NIC is also a major factor in server and network performance. Bus master 32-bit EISA NICs greatly enhance the performance of a network server. These NICs are capable of handling large amounts of network I/O from workstations. EISA NICs complement the NetWare 32-bit network operating system architecture.

EISA bus master expansion boards provide their own on-board processor and memory. They read and write data directly between system memory and NIC memory at speeds of up to 33 megabytes per second (using DMA Burst Mode), without requiring the services of the system processor.

Furthermore, because EISA NICs are 32-bit, data transfers occur across a 32-bit data path (rather than 8- or 16-bit), thereby reducing bus time and increasing operating system work time. Both the system processor and bus master NICs operate simultaneously without the restrictions of traditional DMA transfers.

## **Error Handling**

Error detection and correction are an important part of the Data Link Layer; however, they apply to the detection and correction of errors that may occur within the Physical Layer. The error detection function detects transmission, format, and operational errors occurring either on the physical connection or as a result of a malfunction of the corresponding data link entity.

Examples of these types of errors in an Ethernet environment are:

- CRC Alignment error
- Ethernet jabbering
- Data packet collision

Examples of Token Ring transmit errors are:

- Transmit beaconing
- Counter overflow
- Signal loss

When errors occur, the error recovery function, via a recovery operation that is specific to Ethernet or Token Ring, notifies the network entities of errors that are unrecoverable. An example of an Ethernet recovery method is the "backoff" algorithm that Ethernet uses when detecting a data collision. An example of a Token Ring recovery method is beaconing signals when an error is detected. When these errors occur, they cause the stations to retry data transmission, creating additional traffic on the network and degradation of network performance. This degradation problem can surface at a single workstation or the entire network.

## **TOKEN RING ENVIRONMENT**

Although there are similarities between the different network environments, each presents a different set of variables for network analysis. The following paragraphs discuss identifying performance problems in a Token Ring environment and taking corrective action to resolve the problem. A collection of example configurations summarizes this Token Ring discussion.



## **Identification of Token Ring Network Performance Problems**

NetWare reports most errors by examining Token Ring MAC frames. MAC frames are the key to isolating problems on a Token Ring network, since multiple errors on the Token Ring can cause the network to degrade in performance.

With a Token Ring monitoring tool or protocol analyzer, you can isolate MAC frame errors and the workstation (or location) where the error originates, and decode the information provided by the tool or analyzer. If you cannot decode the MAC frame information, you can, at a minimum, locate the workstation that is causing the errors using the hardware address provided by the tool or analyzer. Once you identify the source of the problem, you can remove the faulty device or cable from the ring and replace it.

Three factors that can affect Token Ring performance are:

- Workstation Processing Speed
- MAC Frame Errors
- Transfer Buffer Size

### **WORKSTATION PROCESSING SPEED**

The processing speed of the workstations and the applications that run on them are usually the cause of network performance degradation. In most cases, the ring will not be saturated by the number of workstations on the ring or by the amount of information being transferred among them, even when the ring is operating at 4 megabits per second.

### MAC FRAME ERRORS

Congestion errors being reported by a Token Ring MAC frame usually indicate that a single workstation cannot buffer enough packets to process the data. The destination workstation cannot accept incoming packets until the buffer is emptied. This forces the sending workstation to continue to transmit the packet until the "frame copied" bit is registered. Recurring transmission errors cause the sending workstation to retransmit until the frame reaches its destination and is copied, or until the sending workstation "times out." This may also cause the higher layer protocol, such as NetWare IPX, to time out and generate an error.

### TRANSFER BUFFER SIZE

The size of the transfer buffer also affects network performance. Before two workstations communicate, a session is established between two Token Ring Logical Link Control (LLC) layers (session establishment and release are part of the LLC operation), as well as between higher layer protocols such as Novell IPX/SPX protocols.

When two workstations establish a session, they negotiate a packet size that both can buffer and process. The device driver (*IPX.COM*) on the workstation and the transfer buffer size of the network server (SET MAXIMUM PHYSICAL RECEIVE PACKET SIZE) determine the size of the packet.



**IMPORTANT:** The larger the packet size, the more efficient the transmission. Since there is as much overhead associated with sending a 50-byte frame as there is in sending a 2,000-byte frame, using larger packets can significantly boost total network performance in many environments.

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### Corrective Actions for Token Ring Performance Problems

Use *MONITOR.NLM* as a starting tool for identifying potential network communication subsystem bottlenecks on the server. *MONITOR.NLM* displays general NIC statistics from NetWare.



*MONITOR.NLM* also displays custom statistics for the COMPAQ 32-Bit NetFlex Controller (with a plug-in COMPAQ DualSpeed Token Ring adapter module) and the COMPAQ 32-Bit DualSpeed Token Ring Controller (device driver *CPQTKNW.LAN*). These custom statistics can help you identify problems with the server Token Ring Controller. The custom statistics provide the following information:

- Transmit Requests Queued
- Broadcast Packets Received
- Multicast Packets Received
- Invalid Packets Received
- Packets Discarded
- Line Errors, Burst Errors, ARI/FCI Errors, Lost Frame Errors, Frame Copied Errors, Token Errors
- Receive Congestion Errors
- DMA Bus Errors and DMA Parity Errors

Most Token Ring NICs have device drivers that provide *MONITOR.NLM* with similar custom statistics. If you install a Token Ring NIC that does not provide custom statistics, you may not be able to gather this information.

The **Transmit Requests Queued** statistic is one of the most useful provided for the NetFlex Controller and the DualSpeed Token Ring Controller. It indicates the number of times that the protocol stack attempts to transmit a packet that the device driver cannot transmit. This occurs when the system processor processes packets faster than the NIC can send them. The Transmit Requests Queued statistic can provide information as to the location of system bottlenecks. If a large percentage of packets is queued and not transmitted, this may indicate a bottleneck at the server NIC or on the physical network.

The **Broadcast Packets Received** statistic represents the number of broadcast packets received since the device driver was loaded. A broadcast packet is a packet that every station on the physical network receives. This statistic is useful in identifying when the server receives a large number of broadcast packets from a workstation, which can indicate a defective workstation NIC or an incompatible NIC/software setup.

The **Multicast Packets Received** statistic is a diagnostic tool that allows you to ensure that the NIC is configured to receive multicast frames. A multicast packet is a packet that a group of stations on the network receives. This counter represents the number of packets received that have a functional destination address. Although Token Ring does not really support "multicast" packets, the custom statistics use the term "multicast packets," because Novell uses this terminology in the device driver specification.

The **Invalid Packets Received** statistic shows the number of packets that the device driver receives, but does not understand. Most invalid packets are broadcast packets that are intended for other devices. For example, if a device driver is configured to receive a Token Ring frame type, then all Token Ring\_SNAP frames are considered invalid.

The **Packets Discarded** statistic represents the number of packets that are discarded at the device driver level, including invalid packets and broadcast packets that the device driver has transmitted. In a NetWare environment, transmitting stations discard their own broadcast packets, because the device driver must not pass its own broadcasts up the protocol stacks.

Soft Errors include **Line Errors, Burst Errors, ARI/FCI Errors, Lost Frame Errors, Frame Copied Errors,** and **Token Errors.** Soft errors do not usually affect the operation of the ring, but a large number of soft errors can affect network performance. If any of these statistics equals more than 2 percent of the total frames received or transmitted, this usually indicates a problem with the NIC or the physical network.

The **Receive Congestion Errors** statistic represents a condition that occurs when the NIC receives a packet, but cannot buffer it. The packet is then dropped. This condition can occur if more packets are received than the system processor can handle.



**Direct Memory Access (DMA) Bus Errors** and **DMA Parity Errors** are diagnostic counters that indicate the number of errors that occur when the NIC attempts to bus master data to the system processor. Under normal conditions, these counters should never rise; therefore, an increase in these counters can indicate a defective NIC. If this happens, replace the NIC.

### **Examples of Token Ring Performance Problems in a NetWare Environment**

By looking at the condition of the network, analyzing the information, and determining whether the condition is global or localized at a single workstation, you can reduce the magnitude of the problem-solving task.

If you determine that the network server is the bottleneck and you make the appropriate server modifications to correct the problem, verify that you have alleviated the problem after you have modified the server configuration.

#### **EXAMPLE OF EARLY DEVICE DRIVER USE**

In this example, network response time seems adequate for some users, but not for others. One workstation seems to be lagging in performance while another workstation demonstrates excellent response times. Both workstations are COMPAQ DESKPRO 386/33i PCs with 16-bit Token Ring adapters that run similar applications.

Use a protocol analyzer to check the condition of the network. If the two workstations are in close proximity to each other (both on the same Token Ring and MAU unit) and the error counts are at acceptable operating levels, use a protocol analyzer to set up a filter so that you can monitor only the two workstations and the network server traffic statistics. You may notice that the "slow" workstation is generating more errors than other workstations or the network server, but not enough errors to raise concern.

Use the protocol analyzer to verify the packet size. You may notice that the slow workstation is sending more packets than the other workstation, and that these packets are smaller.



Check the shell information for the "slow" workstation. You may find that you have a number of different Token Ring device driver versions on various workstations and that these device drivers support different packet sizes. Since many NetWare installations are upgraded from earlier NetWare implementations, this is a common occurrence. Upgrade the device driver to the most current version. With upgraded device drivers, the workstation performance should be similar to the performance of other workstations on the network.

### **EXAMPLE OF A HEAVILY CONGESTED BACKBONE**

In this example, a non-NetWare external router handles the forwarding of the packets to the network backbone in a multivendor network environment. The external router routes the user packet to the backbone, where another router reads its address. This router forwards the packet to the proper network segment and then to the proper network server.

Local network traffic is minimal, but the backbone is heavily congested. Typically, routing devices cannot filter and forward packets at the full network speed. In this case, the workstation may be waiting for the router to forward the packet, even if the remote network server can respond to the request immediately.

On a heavily loaded, isolated Token Ring, you may find that the network server is responding poorly, since it cannot handle all the outstanding requests. In a NetWare environment, it would not be uncommon to have 100 or more workstations requesting information from a single network server at the same time.

The network server must be able to buffer all requests to process them. If a NIC on the Token Ring network cannot facilitate the number of incoming packets, it might generate a MAC frame error indicating that there is a congestion problem. This type of error is usually temporary and not fatal to network operations, but consistent generation of MAC frame errors can indicate a NIC failure or a physical network problem.



In this case, breaking the larger ring into multiple smaller rings with a more manageable number of users can alleviate the congestion problem and provide a more manageable environment for network administration.

**EXAMPLE OF TOO MANY  
APPLICATION SERVERS  
ON A SINGLE TOKEN RING**

On a Token Ring that includes a document imaging server, an SQL database server in a client-server environment, and an optical disk storage system, a workstation user can request data that requires multiple separate network transmissions to multiple servers to service the request. The multiple number of requests between workstation and server, in addition to the number of requests between servers, can rapidly exhaust available cable bandwidth. Using a protocol analyzer, you can identify the problem as a congested Token Ring.

In this example, workstation-to-server traffic competes with server-to-server activity. A viable solution is to balance the network load by segregating all application servers and all workstations on two separate rings, and installing two Token Ring adapters in the network server, so that it functions as a bridge between the two rings.

When changing the layout of the network, make sure that you follow Token Ring specifications.

Segregating the workstations from the application servers not only reduces the network traffic on the user ring, but also allows for future growth. You can add more users to the ring before you add another ring to the network. When the user ring reaches "zero available bandwidth," you can add another Token Ring adapter to the server/bridge and redistribute the large group of users across two separate user rings.

This example can also apply to the Ethernet topology, where user workstations and application servers are distributed over two segments or legs, instead of rings.

## **ETHERNET ENVIRONMENT**

Although there are similarities between the different network environments, the Ethernet network environment presents a different set of variables for network analysis from the Token Ring environment. The following paragraphs discuss identifying performance problems in an Ethernet environment and taking corrective action to resolve the performance problem. A collection of example configurations summarizes this Ethernet analysis and management discussion.

### **Identification of Ethernet Network Performance Problems**

A bottleneck can occur at any individual component in the network. The network communication subsystem (pieces composing the protocol) can become a bottleneck when there are more requests to process data than the network communication subsystem can handle. As you add more workstations to the network, more traffic is created. The greater the level of traffic, the slower the network may appear.

Several factors that affect performance in an Ethernet environment are:

- Collisions
- CRC Alignment errors
- "Jabbering"

A major performance factor in the Ethernet environment is when more than one station transmits data at the same time. A collision occurs, which causes these stations to stop sending and wait a random amount of time to retransmit. This wait causes performance degradation. As more collisions occur on the physical network, the degradation can become even more significant.

In the Ethernet topology, the workstation reports errors. Each workstation performs a Cyclic Redundancy Check (CRC) on each packet of data that it receives. Each workstation also checks transmitted data for errors. When these CRC Alignment errors occur, data must be retransmitted.



Inadequate or defective equipment can also degrade performance in the Ethernet environment. Faulty terminators, cabling, or NICs can all affect the performance of the network. For example, a faulty NIC in a workstation can cause jabbering. This means that the station monopolizes the physical network and transmits inaccurate data, while the other stations vie for use of the physical network. It also means that all workstations attempt to retransmit, causing more traffic on the physical network.

These performance issues can become even greater on a larger scale, such as in a WAN (Wide Area Network). The distance the packets must travel (over the length of the cable, including the number of "hops" between routers/bridges) can also directly affect performance. The packets may travel through many routers and bridges to reach the receiving station. Typically, components like routers and bridges have a large amount of traffic passing through them to receiving stations. This can increase the probability of errors throughout the WAN.



**IMPORTANT:** Always ensure that the Ethernet design adheres to IEEE specifications. IEEE 10Base-2 ThinNet specifications identify the maximum number of users per segment without a repeater (30) and the maximum length of cable that can be used for each segment (185 meters).

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Protocol analyzers like the Novell LANalyzer or Network General Advanced Sniffer also allow inspection of the number of errors that occur on the Ethernet network. If many packet collisions occur and the performance level is not acceptable (that is, if the utilization of the physical network is constantly greater than 40 percent), then you must make some type of modification to the network. This required modification could be as minor as changing the SET MAXIMUM PACKET RECEIVE BUFFERS parameter or as drastic as redistributing the workstations on the network to balance the network load.

During Compaq integration and performance testing, when more than 40 percent of the bandwidth of the physical network was used, collisions began to occur, and the network performance began to degrade. The number of workstations was not the cause of the performance problem. The saturation test that was run on the workstations caused the performance bottleneck. The number of retransmissions basically indicates how the performance is affected.

### **Corrective Actions for Ethernet Network Performance Problems**

Use *MONITOR.NLM* as a starting tool for identifying potential network communication subsystem bottlenecks on the server and to track the number of errors that have occurred over a predetermined period of time. *MONITOR.NLM* displays general NIC statistics from NetWare.

*MONITOR.NLM* displays custom statistics for the COMPAQ 32-Bit NetFlex Controller to identify problems. It displays the following NetFlex custom statistics to help you identify NIC or network problems. These statistics are explained in the paragraphs that follow. They can help you begin your evaluation of server NIC status.

- Collisions
- Excessive Collisions
- Late Collisions
- FCS Errors
- Alignment Errors
- Deferred Transmissions
- Carrier Sense Errors
- Invalid Packets Received

Most Ethernet NICs have device drivers that provide *MONITOR.NLM* with similar custom statistics. If you install an Ethernet NIC that does not provide custom statistics, you may not be able to gather this information.



The **Collisions** statistic records the number of packet collisions that have occurred. Collisions occur regularly under normal operation. This statistic is cumulative and will often be equal to or greater than the number of packets transmitted.

The **Excessive Collisions** statistic increases when the preset number of retries is exceeded. The NIC automatically retries a receive or transmit operation a predetermined number of times before it fails. This typically indicates a hardware failure at the server.

The **Late Collisions** statistic records the number of times a collision was detected later than 512 bit times into the transmission packet. When a packet is transmitted, the sending station "listens" for possible collisions for a specified period of time. A late collision is detected after the station stops "listening." If this number suddenly increases or becomes unusually high when compared to baseline performance statistics, a problem with the physical network (such as a faulty NIC or cable) may be indicated.

The **FCS Errors** statistic indicates the number of frame check sequence errors that have occurred. A frame check sequence error occurs when a transmitted packet does not pass the cyclic redundancy check (CRC) and must be retransmitted. If the number of FCS errors becomes unusually high when compared to baseline performance statistics, this may indicate a problem with the physical network. It may indicate a faulty NIC or network cable.

The **Alignment Errors** statistic indicates the number of packets received whose length is not an integral number of bytes. These packets fail the CRC check and must be retransmitted. You can expect some alignment errors to occur during normal operations. However, if the number of alignment errors becomes unusually high when compared to baseline performance statistics, this may indicate a problem with the physical network. It may indicate a faulty NIC or network cable.

The **Deferred Transmissions** statistic is instrumental in identifying NIC I/O errors by tracking the number of times that I/O operations are not accepted by the NIC. The Deferred Transmissions statistic provides only an estimate of how busy the NIC is and should not be used as a definitive gauge. This value can rise during brief periods of heavy network activity; however, if this value exceeds 10 for an extended period of time, then the server may need additional NICs. You can use Server Manager/R and Server Manager Collector/R (SMC) software to monitor the network and to help you identify peaks in network activity, how significant they are, and how often they occur.

The **Carrier Sense Errors** statistic indicates the loss of a cable connection or that a cable problem exists.

The **Invalid Packets Received** counter records the number of packets that the driver received but cannot pass to the protocol stacks. Most invalid packets are broadcast packets intended to be received by another service to the network. For example, if the NIC driver is configured to receive ETHERNET\_802.3 frames, all other frame types received would be considered invalid.

Before modifying the network communications subsystem, verify that the NetWare SET parameters are set correctly to allow enough buffers for communications. Verify the values for the following SET parameters:

SET MAXIMUM PHYSICAL RECEIVE PACKET SIZE = 1514  
SET MINIMUM PACKET RECEIVE BUFFERS =  
10\*(NUMBER OF EISA NICS) + 1\*(NUMBER OF USERS)  
SET MAXIMUM PHYSICAL RECEIVE BUFFERS = [VALUE]

### **Examples of Ethernet Performance Problems in a NetWare Environment**

With the right monitoring tools and an understanding of the factors that affect Ethernet performance, you can identify NIC- or physical network-related performance problems and take appropriate measures to solve them. The following paragraphs illustrate possible Ethernet network performance problems.



### **EXAMPLE OF A DEFECTIVE NETWORK SERVER NIC**

In this example, the network response time for the entire network seems slow. By first looking at the physical layout of the network, you see that there is only one network segment and that all the users on the segment are having the same problem.

First, determine where the problem resides. If a single workstation or a small group of workstations experiences performance problems, begin your analysis at the workstation or at a single segment.

If your analysis determines that the problem is not at the workstation, use a network monitoring tool or protocol analyzer to analyze the bandwidth use of the physical network. You may notice that the users are not using all of the bandwidth of the physical network, and the physical network bandwidth exceeds 40 percent only at peak times. This indicates that the problem does not include the physical network.

By using *MONITOR.NLM* to inspect the NIC statistics, you may note that the NetFlex Controller has been generating many Excessive Collisions. This indicates a faulty server NIC. Replace the NIC, and the performance should improve.

### **EXAMPLE OF A CONGESTED SEGMENT**

A congested segment can develop as the result of a congested physical network or as the result of a defective workstation NIC. The following examples illustrate the symptoms and provide suggested corrections for a congested segment.



**IMPORTANT:** These suggested corrections are not necessarily the only applicable corrections under the example circumstances.

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### **Congested Physical Network**

In this example, the performance is not acceptable for all the users, and the protocol analyzer shows that traffic on the physical network is very heavy (greater than 80 percent). The physical network is being utilized beyond safe packet transfer limits, and packet collisions are occurring. (This almost always occurs with 30 users on a single segment.) You can improve performance by adding one or more NICs to the network server and redistributing users over multiple segments (legs) of the network. This minimizes packet collisions by decreasing the number of workstations on the same physical network.

### **Defective Workstation NIC**

If some users on a network are having performance problems, but other users on the same segment are not, there may be a workstation problem in the NIC or the NIC device driver. Run the diagnostic program for the NIC on each of the workstations that have performance problems.

If the diagnostic program does not indicate a problem with the NIC or the NIC device driver, use a protocol analyzer to look for errors that may be coming from the problem workstation address. If you notice errors while filtering these addresses, this may also indicate a defective workstation NIC. Replace the defective NIC to alleviate the workstation problem.

## **NETWORK COMMUNICATION SUBSYSTEM SUMMARY**

In a resource-sharing environment, information is transferred between workstation and server. The network communication subsystem, due to its heavy use in this environment, provides one of the most likely places for network performance problems.



When addressing performance problems surrounding the network communications subsystem, it is important to remember that there are several variables that affect the network communication subsystem performance. In some cases, the cause of the problem has to do with a saturated segment or ring, and you can resolve the problem by adding more NICs to the server and then balancing the network load among these multiple NICs.

Redistribution of network load not only helps improve performance, it also provides a better network management strategy. For example, if an entire group resides on a single ring or segment and the server NIC fails, the users cannot access the server. If you divide the workstations between two NICs, with each NIC servicing half the workstations, you can enhance the network performance for the entire group. Furthermore, if a server NIC fails, half of the workstations can still maintain their connections to the network.

Several factors can affect the amount of time needed to identify/isolate the problem and to take the appropriate action to eliminate the bottleneck. Your knowledge of the network design and implementation is a major factor in how quickly you isolate the problem. If you are unfamiliar with the network layout, an accurate physical map of the network layout and a documented history of network problems and corrective actions can help lessen the amount of time required to research the network problem. When making modifications to any network, document all modifications to ensure that accurate records are available should a similar network problem occur later.



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## *Chapter 5*

# **HARD DRIVE SUBSYSTEM PERFORMANCE**

Resource sharing includes information retrieval and storage at the network server. In most resource-sharing environments, disk I/O comprises a major part of the daily network operations; therefore, the server hard drive subsystem is one of the most important performance factors in the network.

This chapter includes the following sections:

- Identification of Hard Drive Performance Problems
- Corrective Actions for Hard Drive
- Example of Hard Drive Subsystem Performance Problem
- Hard Drive Summary

## **IDENTIFICATION OF HARD DRIVE PERFORMANCE PROBLEMS**

To understand how the disk I/O channel affects network server performance, you must understand the process by which NetWare v3.1x handles disk I/O requests. This chapter provides information on how NetWare handles read and write requests, and how this affects overall network performance. It also provides information on how to manage this operation and how to alleviate hard drive subsystem bottlenecks, should they occur.

The following paragraphs explain the process as it relates to the performance of the network server. This discussion may not cover some areas of disk I/O, because these areas do not substantially affect the network performance or because these areas have not been studied within the scope of Compaq systems integration testing.

The following paragraphs discuss the effects of the hard drive subsystem on network server performance. This discussion includes the following:

- File Service Processes
- Disk Caching
- Hard Disk Device Drivers
- Method of Fault Tolerance

This discussion also defines the relationship between the hard drive subsystem and system memory. It includes suggestions for correcting hard drive subsystem bottlenecks and examples for applying these corrective measures.

### **File Service Processes**

When a workstation issues a request to the server for file access, the NetWare shell at the workstation builds a packet with the appropriate NetWare Core Protocol (NCP) request. This packet is sent to the server where the NCP request from the workstation is then changed to a File Service Process (FSP). A disk I/O bottleneck can emerge if there are not enough FSPs available to process the NCP requests from the workstations. Figure 5-1 illustrates the disk I/O process.

If a workstation sends another NCP request to the server for processing, it cannot be processed until an FSP becomes available to handle it. In the meantime, other workstations may send additional NCP requests to the server for processing. For basic information about the principles of FSPs and NCPs, refer to the Novell Application Notes 286-*Based NetWare 2.1x File Service Processes: The Final Word* released in June 1990, or *NetWare v2.x Server Memory and File Service Processes (v2.2 Update)*, released in September 1991.

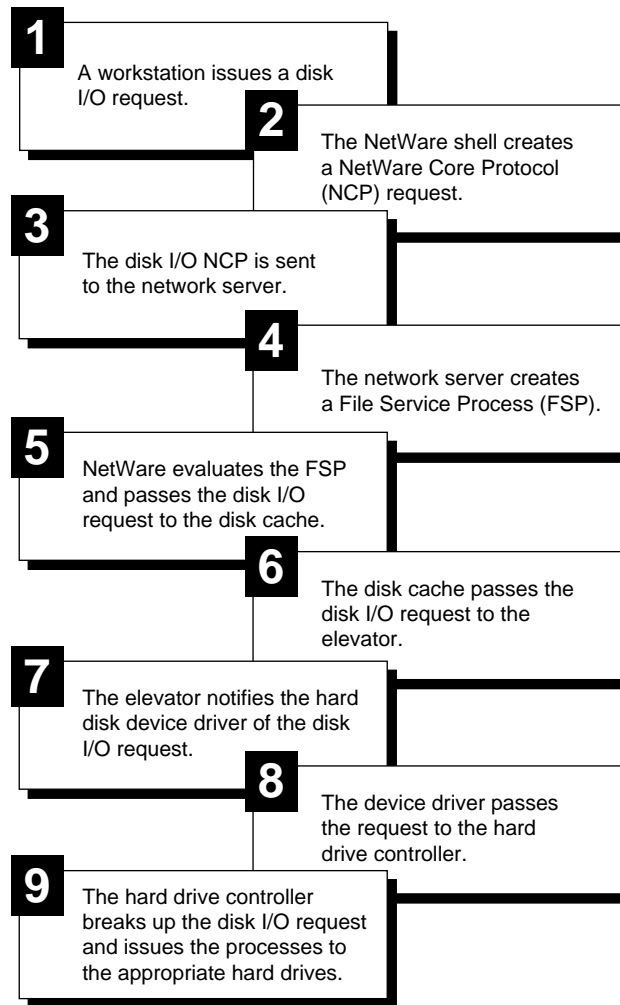


Figure 5-1. General Overview of Disk I/O Process

## **Disk Caching Schemes**

Caching data to system memory or to memory on a controller can provide enhanced performance in a resource-sharing environment. NetWare employs a disk caching scheme that allows applications to write data to and read data from system memory instead of disk. The COMPAQ Intelligent Drive Array Controller-2 (IDA-2) and the COMPAQ SMART SCSI Array Controller provide additional caching capabilities with the 4-Megabyte Array Accelerator Write Cache. This caching is independent of the NetWare cache. The NetWare caching scheme and the Array Accelerator caching scheme, and how they enhance server disk I/O performance, are discussed in the following paragraphs.

### **NETWARE CACHING SCHEME**

NetWare uses a disk caching scheme that enables the cache, under many circumstances, to satisfy most disk I/O requests. The system processes many read requests and posts write requests in the cache. When data is requested, it is obtained from the cache and not from the hard drive, providing faster access than in typical network environments. Most disk I/O requests in NetWare go through the cache, providing more efficient data access and storage.

Although it may be possible to avoid writing to the cache (by writing to the hard drive directly instead), this option is not discussed, since the disk cache feature enhances network server performance.

When a write request enters the cache, NetWare reports to the application that the write operation has completed successfully. The cache accumulates multiple write operations and then passes them to the elevator when the cache is full, when dirty disk cache delay time is reached, or when an application forces the cache to flush. NetWare sorts the requests in an order that makes the most efficient use of the hard drive. This NetWare feature is called "elevator seeking." This enables a more effective method of processing requests.



For example, if a request to write 512 bytes of data is sent to the server, the 512 bytes of data are equal to only one sector of data on the hard drive. The cache stores the data and combines it with another write request of approximately the same size. When the server must handle other tasks besides the disk I/O, posting similarly sized write requests in cache and "getting back to them later" is an efficient method of processing requests. Caching allows processing of multiple requests at one time, increasing performance.

NetWare's ability to cache files is based on two major factors:

- Size of the files and write requests.
- Amount of system memory available to create a cache area large enough to handle most requests.

You can control some of the aspects of the NetWare disk cache system using the NetWare SET parameters. For example, you can use the SET MAXIMUM CONCURRENT DISK CACHE WRITES parameter to accommodate more write requests. If many write requests are waiting for an available location within the cache, then increasing the value of this SET parameter may help by increasing the number of write operations that can go to cache.

You can also use the SET DIRTY CACHE DELAY TIME parameter to control the amount of time the cache holds a request when the cache is not full. If network users perform more small write requests than large ones during daily operations, this may require additional system processor bandwidth, causing the server to spend more time on disk I/O and less time on other tasks. Increasing the dirty cache delay time forces the cache to hold these requests longer, making more efficient use of the cache area.

Since the disk cache performs most of the disk process, the disk cache area can directly impact network performance. A network server with an inadequate amount of system memory may not have enough cache buffers to perform large file requests. If there are not enough cache buffers to perform these requests, then all file requests are written directly to the hard drive, requiring more system processor bandwidth and allowing the system processor less time to perform other tasks.

### **SMART CONTROLLER AND IDA-2 SUBSYSTEM CACHING SCHEME**

The COMPAQ SMART SCSI Array Controller and the COMPAQ Intelligent Drive Array Controller-2 (IDA-2) both offer the 4-Megabyte Array Accelerator Write Cache, which provides write cache capabilities transparent to the NetWare caching scheme. The NetWare caching scheme does not change.

When a request enters the NetWare cache, NetWare reports that the write operation has successfully completed. When NetWare flushes the cache, instead of flushing directly to the hard drive, the data flushes to the Array Accelerator. The Array Accelerator accumulates multiple write operations and then passes them to the elevator when the cache is full, during idle times, and before an orderly system power-down. The Array Accelerator caches up to 2 megabytes of data, using the remaining 2 megabytes to mirror the data.

If the server loses power, the on-board batteries of the Array Accelerator retain the data for five to eight days on IDA-2, and up to four days on the SMART Controller. The Array Accelerator verifies that the data in the cache is valid and flushes the saved data to disk when the server reboots.

The additional caching capabilities of the Array Accelerator provide enhanced performance and data integrity.

### **Hard Disk Device Drivers**

Since all requests pass through the hard disk device driver, it plays a very important role in network server performance. In other operating systems, such as DOS, the BIOS on the PC server handles the disk I/O. NetWare, however, does not use BIOS and requires a hard disk device driver to handle all disk I/O requests.

The hard disk device driver decodes the disk I/O requests and passes them to the appropriate parts of the hard drive subsystem. This enables NetWare to be independent of any particular type of hard drive, and allows NetWare to function with any hard drive that provides device drivers to the NetWare specification.





NetWare uses device drivers instead of the BIOS for several performance reasons:

- NetWare device drivers are multithreaded, whereas BIOS is single-threaded. The server must post a disk I/O request and wait until that request has been serviced before it can post the next request. Support for multithreaded drivers depends on the hard drive and controllers in the subsystem.
- BIOS operates in real mode, and NetWare operates in protected mode. Using the BIOS requires the server to operate in real mode to handle the BIOS interrupt and then "toggle" to protected mode. Toggling between real mode and protected mode creates a significant amount of overhead.
- Device drivers are more adaptable to change as the network configuration and requirements change. This can play an important role in system management.

The following paragraphs discuss COMPAQ hard drive subsystem device drivers.

### **DRIVE ARRAY SUBSYSTEMS**

NetWare provides a generic hard disk device driver, *ISADISK.DSK*, for many non-array hard drive subsystems. However, because it is generic, it provides only minimal disk I/O performance for drive array subsystems.

COMPAQ provides a multithreaded device driver, *CPQDA386.DSK*, for the following controller subsystems:

- COMPAQ SMART SCSI Array Controller
- COMPAQ Intelligent Drive Array Controller-2 (IDA-2)
- COMPAQ 32-Bit Intelligent Drive Array Controller (IDA)
- COMPAQ Intelligent Array Expansion System

*CPQDA386.DSK* is available on the NetWare Programs from Compaq (NPFC) v2.20 or later diskette. NPFC v2.20 is available on the Compaq CompuServe Forum as SoftPaq file *SP0475.EXE*. For more information, contact your Authorized COMPAQ Reseller or COMPAQ Service Provider or call the Compaq Customer Support Center at 1-800-345-1518 in North America. In Canada, call 1-800-263-5868. Outside the United States and Canada, contact your local Compaq office.

The multithreaded capabilities of the *CPQDA386.DSK* device driver allow it to service concurrent requests. To support the *CPQDA386.DSK* device driver, COMPAQ drive array controllers use a memory structure that allows the device driver to send requests to the hard drives and receive data from the hard drives simultaneously. The controller can also post multiple requests to system memory. Handling multiple requests provides additional performance in network environments with heavy I/O activity.



**IMPORTANT:** To ensure maximum I/O performance, always use *CPQDA386.DSK* when configuring your COMPAQ drive array controller subsystem. Do not use *ISADISK.DSK*.

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The *CPQDA386.DSK* device driver is similar to *ISADISK.DSK*, but it includes many performance-enhancing features that take advantage of COMPAQ drive array subsystems. The *CPQDA386.DSK* device driver uses the EISA bus master capabilities of the controllers listed earlier to transfer data. This means the device driver can transfer significantly more data with fewer resources than most ISA-based PCs and PC systems that use the *ISADISK.DSK* device driver. See Figure 5-2 for a functional comparison of *ISADISK.DSK* and *CPQDA386.DSK*.



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

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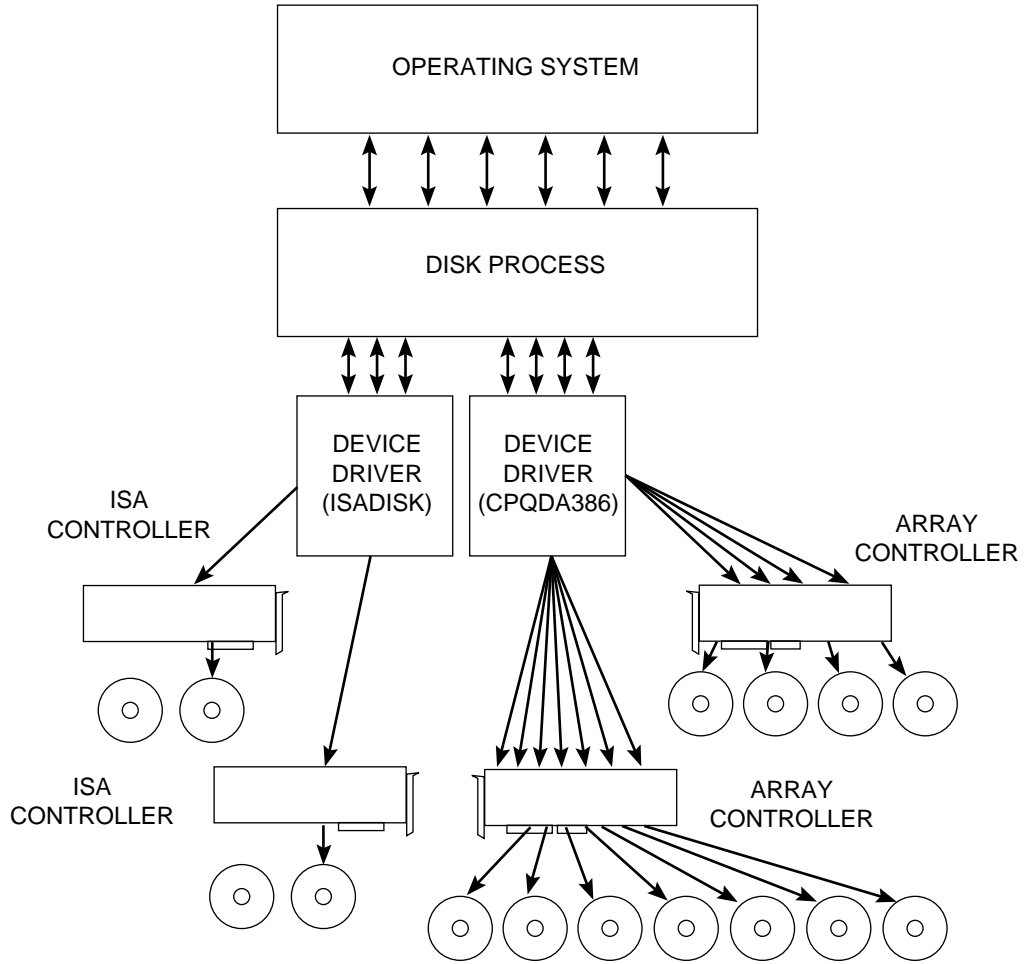


Figure 5-2. Functional Comparison Between *ISADISK.DSK* and *CPQDA386.DSK*



## **FAST-SCSI-2 SUBSYSTEM**

The COMPAQ 32-Bit Fast-SCSI-2 Controller device driver includes performance enhancement features that take advantage of the Fast-SCSI-2 subsystem, such as tagged command queuing and scatter/gather.

The Fast-SCSI-2 device driver, available on the NetWare Programs from Compaq diskette, is modular. This driver supports NetWare v3.1x, NetWare 4.0, and NetWare SFT III. See the *SCSI.RDM* file on the NetWare Programs from Compaq diskette for more information about the device driver architecture. Three files are necessary for the multilayered Fast-SCSI-2 device driver.

- *CPQSDISK.DSK* - Provides support for devices connected to the Fast-SCSI-2 Controller or the integrated Fast-SCSI-Controller.
- *CPQS710.DSK* - Supports the Fast-SCSI-2 Controller and the integrated Fast-SCSI-2 Controller on the COMPAQ ProSignia.
- *CPQSXPT.DSK* - Provides command transport from *CPQSDISK.DSK* to *CPQS710.DSK*.

The COMPAQ device driver for the Fast-SCSI-2 subsystem provides an efficient interface between hard drive and operating system, including scatter/gather. Scatter/gather combines multiple requests and reduces the overhead that results from negotiation between controller and SCSI device, so that they negotiate once for several requests, rather than once for each request. Scatter/gather can provide up to 20 percent performance improvement in disk I/O throughput.

Tagged command queuing allows the hard drive to queue and sort multiple commands, allowing the drive firmware to handle them in the most optimal manner. This ensures that at least one request is queued at all times, so when the hard drive completes one request, it immediately processes the next one.

## **Method of Fault Tolerance**

The method of fault tolerance you choose also affects network server performance. Hardware fault tolerance methods relieve the operating system of the task of managing the hard drive subsystem fault tolerance. These methods are independent of the NetWare operating system.

Drive mirroring (RAID 1) provides redundant hard drives and stores complete sets of data on primary drives and secondary drives.

Controller duplexing is similar to drive mirroring, but provides complete redundancy of the hard drive subsystem (hard drives, cables, and controller). If a component of one subsystem (the primary channel) fails, the duplexed subsystem (the secondary channel) can service requests until you repair the primary channel.

Data guarding (RAID 4) uses a dedicated parity drive. The controller writes data to each of three drives, while using the fourth drive to hold parity data.

Distributed data guarding (RAID 5) does not require a dedicated parity disk. Instead, a "parity area" is implemented at the sector level on each hard disk in the array, so parity data is spread over the entire array. Distributed data guarding enhances the performance of write operations by writing to multiple drives simultaneously. In addition, if a single drive fails, then the data is rebuilt from the encoded data that resides on the remaining drives.

NetWare v3.1x includes several system fault tolerance (SFT) features for data integrity, such as controller duplexing, drive mirroring, duplicate directories, NetWare Hot Fix, and NetWare Transaction Tracking System (TTS). Two NetWare features that can affect network performance are NetWare drive mirroring and controller duplexing.

The following table lists hardware and software fault tolerance options for COMPAQ hard drive subsystems.

**Table 5-1**  
**Supported Methods of Fault Tolerance**

Fault Tolerance	SMART SCSI Array Controller	IDA-2 Controller	IDA Controller	Fast- SCSI-2 Controller	Intelligent Array Expansion Controller
Drive Mirroring (RAID 1)	✓	✓	✓		✓
NetWare Drive Mirroring (RAID 1)	✓	✓	✓	✓	✓
NetWare Controller Duplexing	✓	✓	✓	✓	✓
Data Guarding (RAID 4)	✓	✓	✓		
Distributed Data Guarding (RAID 5) *	✓	✓			
Online Spare	✓				✓

\* With SMART Controller data guarding and distributed data guarding configurations, the N+1 fault tolerance feature allows you to use as few as three drives (2 + 1) or as many as 14 drives (13 + 1). The percentage of your total drive space allocated for data protection can vary from 33 percent to as little as 7 percent.

**NOTE:** Controller duplexing requires a minimum of two controllers. These controllers can include two SMART Controllers, two IDA-2 Controllers, two Fast-SCSI-2 Controllers (both integrated and board versions), or two COMPAQ 32-Bit IDA Expansion Controllers. For controller duplexing, the NetWare partitions must be the same size.

The following table compares fault tolerance features.

**Table 5-2  
Fault Tolerance Features Comparison**

<b>Fault Tolerance Method</b>	<b>No Fault Tolerance</b>	<b>Mirroring (RAID 1)</b>	<b>Controller Duplexing</b>	<b>Data Guarding (RAID 4)</b>	<b>Distributed Data Guarding (RAID 5)</b>
<b>Usable Disk</b>	100%	50%	50%	75% (or varies) *	75% (or varies) *
<b>Parity and Redundancy</b>	None	Duplicate data	Duplicate data, channel redundancy	Dedicated parity drive	Dedicated parity area on each drive
<b>Minimum # of Drives in Array</b>	N/A	2	2	4 or 3 *	4 or 3 *
<b>Advantage</b>	Highest performance. Maximum available storage.	Data redundancy. Multiple reads and writes. Split reads.	Data and controller redundancy. Multiple reads and writes. Split reads.	Multiple simultaneous reads and writes. Data integrity via parity.	Multiple simultaneous reads and writes. Data integrity via parity.
<b>Cautions</b>	High risk. No data redundancy. Not recommended.	50 percent of disk space used for fault tolerance.	Requires two controllers and twice the disk space of no fault tolerance.	Performance degradation with write operations.	Less performance degradation with write operations than with RAID 4. Degradation decreases with additional drives.
<b>Typical Environment</b>	Non-critical data.	High performance database; real-time critical data	High performance database; real-time critical data	Store and forward critical data where disk space is the primary consideration.	Store and forward critical data; database

\* In SMART Controller data guarding and distributed data guarding configurations, the N+1 fault tolerance feature allows you to use as few as three drives (2 + 1) or as many as 14 drives (13 + 1). The percentage of your total drive space allocated for data protection can vary from 33 percent to as little as 7 percent.





Depending on the method of fault tolerance chosen, network server performance can be affected positively or negatively. NetWare controller duplexing uses the "split seeks" feature to enhance performance by alternating read operations between the primary and secondary drive array. COMPAQ data guarding and distributed data guarding use less disk space to duplicate the data by using a single parity drive or parity "area" that stores encoded data. Using data guarding, encoding the data for the parity drive requires overhead which can impede the performance. However, using distributed data guarding, NetWare writes data to multiple disks, rather than a single disk, eliminating much of the overhead and enhancing performance.

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.

## **CORRECTIVE ACTIONS FOR HARD DRIVE**

In the typical resource-sharing environment, read requests dominate write requests by a large factor; however, the ratio of read operations to write operations depends upon the environment and applications. For example, a server that runs a custom database application may spend 90 percent of its daily operations performing database updates that involve more write operations than read operations. In this case, optimizing the server performance for write operations can improve the overall performance. The following paragraphs discuss how to determine the ratio of read to write requests, and steps you can take if you identify the hard drive subsystem as a bottleneck.

COMPAQ INSIGHT Manager, described in Chapter 2, provides read and write statistics for the following COMPAQ subsystems:

- COMPAQ SMART SCSI Array Controller
- COMPAQ Intelligent Drive Array Controller (IDA-2)
- COMPAQ 32-Bit Intelligent Drive Array Controller (IDA)
- COMPAQ 32-Bit Fast-SCSI-2 Controller
- COMPAQ 32-Bit Intelligent Array Expansion Controller

These statistics can help you optimize your server. See the COMPAQ TechNote for NetWare titled *NetWare Server Management* for more information.

For other drive subsystems, use *MONITOR.NLM* to determine whether your server performs more read operations or write operations. The *MONITOR.NLM* Connection Information menu shows the number of disk I/O requests in Kbytes read and Kbytes written. However, this menu shows only information on individual users, not the entire network. To determine the ratio of read requests to write requests, record the number of Kbytes read and Kbytes written for each user, and use the sum of all read requests and write requests for all users.

**NOTE:** *MONITOR.NLM* provides dynamic statistics. The statistics for each user change as each user accesses the server, then return to zero as each user logs out of the network. Collecting this information is not an exact measurement of network server usage; it is an estimate to help you determine the read/write ratio for your server.

Hard drive subsystem bottlenecks occur when there are frequently more requests than the hard drive controller can accommodate at one time. Since NetWare ties the hard drive subsystem so closely to the cache, you should examine both read/write operations and cache information together during your analysis.

Write requests are stored in the disk cache for a period of time before they are flushed to disk. They do not require the immediate attention of the system processor. When a read request is sent, if the information is not located in the cache, the disk must perform a read operation from the disk to satisfy this request. NetWare manages read requests and write requests differently in that NetWare finishes the write operation at its own discretion, but it must service the read request from disk when the user issues the request.

If you identify the hard drive subsystem as the bottleneck, use one or a combination of the following options, depending on the information gathered by the monitoring tools, to correct the problem:

1. Check the volume block size and ensure that it matches the cache buffer size.



2. Use the *MONITOR.NLM* Information menu to inspect cache buffers. You may need to add more system memory.
3. Check the Hot Fix Redirection Area for drive array subsystems.
4. Use the *MONITOR.NLM* Information menu to check the number of service processes.
5. Modify the disk-related SET parameters.
6. Add hard drives.
7. Use multiple controllers.
8. Redistribute the disk I/O requests among multiple hard drives.
9. Review your fault tolerance method.

These options are discussed in the following paragraphs.

### Check Volume Block Size

Setting the volume block size is one of the few exceptions to the rule that "default settings provide adequate performance." The default volume block size for NetWare is 4 Kbytes; however, when implementing a COMPAQ PC Server with a drive array subsystem, you can improve disk I/O performance by modifying the NetWare volume block size to match the drive array striping factor.

In the NetWare environment, the striping factor for the IDA and IDA-2 subsystems is 16 sectors. The striping factor for the SMART Controller and Array Expansion subsystems is 32 sectors. The optimal performance for each of these hard drive subsystems depends on this striping factor. Using the following formula, the appropriate value for the COMPAQ IDA and IDA-2 subsystems is 8 Kbytes. The appropriate value for the SMART Controller and Array Expansion subsystems is 16 Kbytes.

16 Sector Striping Factor \* 512 bytes per sector = 8192 (8 KB)

32 Sector Striping Factor \* 512 bytes per sector = 16384 (16 KB)

While these volume block sizes provide optimal server performance, using them may result in inefficient use of disk space by failing to fill an 8-Kbyte or 16-Kbyte block with data. In cases where the use of these values results in improved performance but the inefficient use of disk space, you must address the trade-off between improved performance and adequate disk space.

For example, if the network server uses a 16-Kbyte block size and most of the files stored on the hard drive are only 5 Kbytes, then 11 Kbytes of disk space are wasted for each file. This amount of wasted space may seem insignificant when observed on a "per file" basis, but it becomes very significant in a large network environment when 50 users are storing multiple files on the network server.



**CAUTION:** You set the volume block size when you create each volume. Once you set the volume block size, changing it will result in loss of all data in that volume. Always perform a complete backup before changing the volume block size. Then delete the volume, create a new volume with a new volume block size, and then restore the data to the new volume.

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When configuring a non-arrayed COMPAQ Fast-SCSI-2 Controller subsystem, increasing the volume block size from the default of 4 Kbytes to 8 Kbytes can substantially increase disk I/O performance.

When analyzing your server, note the size of the data files for the applications that your server runs. Typical office productivity software stores files that include formatting, graphics, and fonts, as well as text. These files generally exceed 8 Kbytes. If your server runs in a resource-sharing environment and you do not have access to file-size information, use an 8-Kbyte volume block size as a starting point. This gives you a higher level of performance without wasting disk space when running today's common applications.



The following illustrations show performance gains realized from increasing the volume block size for a COMPAQ Fast-SCSI-2 Controller configured with four 550-megabyte drives. Figure 5-3 shows results of a performance comparison between the different volume block sizes during *write* operations. Figure 5-4 shows performance results during *read* operations. Although the performance returns are significant when increasing the volume block size from 4 Kbytes to 8 Kbytes, the performance returns diminish as the volume block size exceeds 8 Kbytes.

**NOTE:** The actual performance gains for your server will depend on your particular environment.

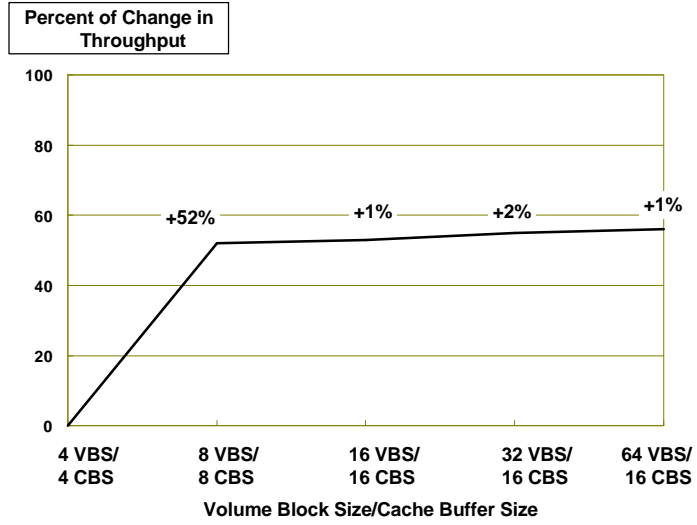


Figure 5-3. COMPAQ Fast-SCSI-2 Controller WRITE Test Results - Volume Block Size Comparison

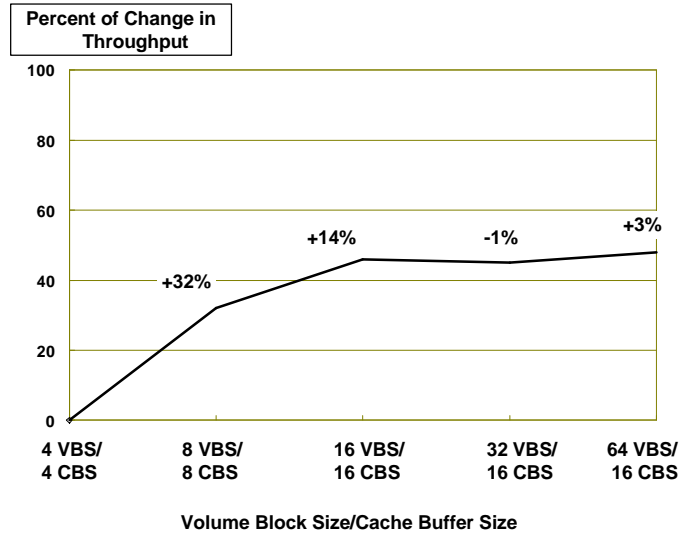


Figure 5-4. COMPAQ Fast-SCSI-2 Controller READ Test Results - Volume Block Size Comparison



## Inspect Cache Buffers

You can use the *MONITOR.NLM* Information menu to inspect the cache buffers. If NetWare has too few disk 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 NetWare environments are read intensive, the cache can satisfy most read requests if you have allocated the cache buffers correctly.

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

- Total Cache Buffers
- Original Cache Buffers
- Dirty Cache Buffers
- Current Disk Requests

### CACHE BUFFER SIZE

Once you define the volume block size, set the cache buffer size to be equal to or less than the volume block size. Matching the volume block size and the cache buffer size is optimal. For example, if you select an 8-Kbyte volume block size, set the cache buffer size to 8192 (8 Kbytes). When the cache buffer size matches the volume block size, the cache can service a single request with a single cache operation. If, however, you set the cache buffer size to 4 Kbytes and the volume block size is 8 Kbytes, the read request requires two cache operations to match the 8-Kbyte volume block size. This slows the cache memory system when performing many disk requests.



**IMPORTANT:** If you configure multiple volumes with different volume block sizes, set the cache buffer size *no larger than the smallest* volume block size. If the volume block size is smaller than the cache buffer size, NetWare cannot mount the volume.

---



Use the *INSTALL.NLM* Volume option to view the volume block size. Include the SET CACHE BUFFER SIZE parameter in the *STARTUP.NCF* file as follows, so it loads automatically when the server initializes:

SET CACHE BUFFER SIZE = 8192

If you configure multiple volumes with different block sizes, do not set the cache buffer size any larger than the smallest volume block allocation. By making this parameter value match the volume block size, NetWare can read more files into system memory with only one request. The supported values are 4096, 8192, and 16384, with a default of 4096.

Use the following table to set both the volume block size using *INSTALL.NLM* and the appropriate cache buffer size using the NetWare SET parameter SET CACHE BUFFER SIZE.

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**Table 5-3**  
**Volume Block and Cache Buffer Size Recommendations**

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<b>Volume Block Size (Kbytes)</b>	<b>Cache Buffer Size</b>
4	4096
8	8192
16	16384
32	16384
64	16384

---





## CACHE BUFFER ALLOCATION

*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 the cache buffers. Novell recommends adding more system memory to increase this value if it falls below 20 percent. 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.

## DIRTY CACHE BUFFERS

The number of dirty cache buffers can also provide information about how many write requests reside in cache while awaiting a cache flush. You can view this value in the *MONITOR.NLM* Information menu. If this value is constantly *above 70 percent* of the total cache buffers, then the hard drive subsystem may be saturated.

When analyzing the number of dirty cache buffers, monitor the network for several hours before making any changes. This ensures that the value displayed is not a peak activity value. If the number of dirty cache buffers is constantly high (above 70 percent of total cache buffers) during normal network operation, there may be a performance problem, and you may need to add system memory to the server.

The more outstanding dirty cache buffers, the greater the performance advantage of the drive array subsystem. The drive array subsystem can handle many requests simultaneously, whereas other hard drive subsystem technologies must process single requests. This advantage becomes more apparent in environments with heavy activity, where the number of dirty cache buffers is constantly above 50.

When the cache buffer is full, it causes a cache flush. The cache buffer passes write requests to the elevator, where NetWare sorts the requests in an order that makes the most efficient use of the hard drive. This NetWare feature is called "elevator seeking." NetWare can write more data to the hard drive with a single pass of the read/write heads over the platter.

The SET DIRTY 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.

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.

The supported values are 0.1 to 5 seconds, and the default value is 3.3. Use the default value of 3.3 seconds in most environments.

### **CURRENT DISK REQUESTS**

The Current Disk Requests value in the *MONITOR.NLM* Information menu displays the number of enqueued disk requests for the server to process. You can view this value in the *MONITOR.NLM* Information menu.

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. Increasing the value of the SET MAXIMUM CONCURRENT DISK CACHE WRITES parameter can relieve this performance problem.

The SET MAXIMUM CONCURRENT DISK CACHE WRITES parameter controls how many write requests are placed in the elevator before the disk head begins a sweep across the disk platter. The default for this parameter is 50, within the range of 10 to 100.

To increase performance for implementations that perform more read operations than write operations, use a smaller value, such as 35. To increase performance for implementations that perform more write operations, use a larger value, such as 80. If the number of dirty cache buffers (in the *MONITOR.NLM* Information menu) is greater than 70 percent of total cache buffers (also in the *MONITOR.NLM* Information menu), increase this value to improve write requests or decrease this value to improve read requests.



Change this parameter only after monitoring the network server to obtain baseline performance statistics. (COMPAQ INSIGHT Manager also provides this information.) If your network environment includes significantly more read operations than write operations, then a lower value is more suitable. 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. If more write operations occur, increasing this value is more suitable.



**IMPORTANT:** As you change these parameters, optimizing the server for read operations can degrade server performance during write operations. Consequently, optimizing the server for write operations can degrade server performance during read operations.

## 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 caching disk requests.

By multiplying the value of Original Cache Buffers by the cache buffer size, you can determine the amount of system memory available for the cache upon network server startup, as shown in the following example. For example, if the Original Cache Buffers displays 1,500 buffers with the cache buffer size set to 8 Kbytes, more than 12 megabytes of system memory are available at network server startup.

$$1,500 \times 8,192 = 12,288,000 \text{ (approximately 12 megabytes)}$$

## TOTAL CACHE BUFFERS

The *MONITOR.NLM* Information menu also provides the total cache buffers, the number of cache buffers that are currently available to cache disk I/O requests. As you load NLMs on the server, the total cache buffers value decreases.

If you multiply the total cache buffers value by the cache buffer size, you can determine the amount of system memory that is available to the users for caching disk I/O requests. 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 1,170 total cache buffers with the cache buffer size set for 8 Kbytes, this means that approximately 9.5 megabytes of system memory are available to cache disk I/O requests.

$$1,170 \times 8,192 = 9,584,640 \text{ (approximately 9.5 megabytes)}$$

If you subtract the value of total cache buffers from the value of the Original Cache Buffers option, you can determine the number of buffers allocated for loading NLMs and SET parameters ( $1,500 - 1,170 = 330$ ). If you multiply this value by the cache buffer size, you can determine how much system memory is available to load NLMs and SET parameters.

$$8,192(1,500 - 1,170) = 2,703,360 \text{ (approximately 2.5 megabytes)}$$

## Check Hot Fix Redirection Area for Drive Array Subsystems

Each NetWare partition includes an area of storage on the hard drive called the Hot Fix Redirection Area. NetWare allocates this area of storage to hold faulty data blocks that are "redirected" by NetWare from the main data storage area of the hard drive. The default size of Hot Fix Redirection Area is about 2 percent of the total disk space at the time of the NetWare partition installation.



Drive array systems, such as the COMPAQ SMART SCSI Array Controller, COMPAQ Intelligent Drive Array Controller-2 (IDA-2), COMPAQ 32-Bit Intelligent Drive Array Controller (IDA), and the COMPAQ Intelligent Array Expansion System, provide fault tolerance and reliability features that can detect and correct single-sector media failures, multiple-sector media failures, and hard drive failures. With large-volume hard drive subsystems (with more than 2 gigabytes of disk space), the Hot Fix Redirection Area can become larger than necessary. For example, 2 percent of 5 gigabytes of disk space equals approximately 100 megabytes of Hot Fix Redirection Area. For many implementations, 100 megabytes may be excessive. Combining different reliability and fault tolerance features can help reduce the need for a large Hot Fix Redirection Area. You can resize the Hot Fix Redirection Area to accommodate a more practical amount of disk space.

The size of the Hot Fix Redirection Area is limited to 30,720 blocks in NetWare v3.11. On partitions of 6 gigabytes or larger, when NetWare attempts to create the 2 percent Hot Fix Redirection Area, the default will be 30,720 blocks.



**CAUTION:** Before changing the size of the Hot Fix Redirection Area, always perform a complete backup. Changing the size may destroy any existing data on the volume.

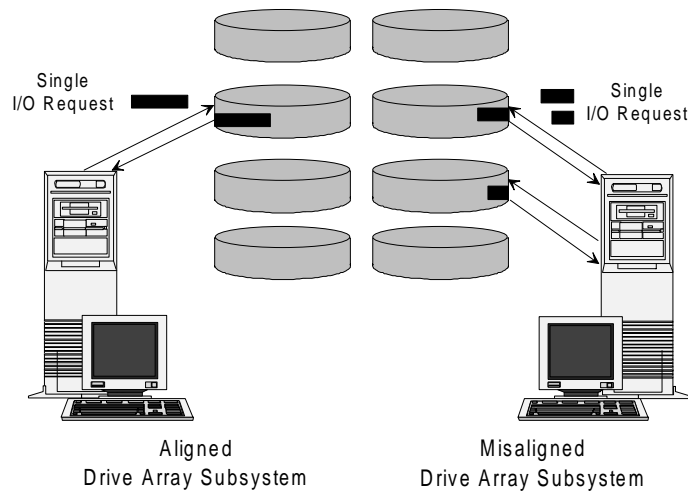
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Choosing an optimal Hot Fix Redirection Area size can improve performance of your COMPAQ drive array by ensuring that the NetWare volume blocks align with the drive array striping factor to optimize drive subsystem throughput.

**NOTE:** This does not affect non-array drive subsystems such as Fast-SCSI-2.

When configuring a drive array subsystem with NetWare, you can align the NetWare file system data area with the COMPAQ drive array striping factor by specifying the value for the number of Hot Fix Redirection Area blocks. If you do not provide this specific value and accept the system default, the NetWare volume blocks (which immediately follow the Hot Fix Redirection Area on the drive) may not begin on an aligned boundary. When a significant number of read and write requests cross the stripe boundaries, the result is decreased performance.

Figure 5-5 illustrates the effect of aligned volume blocks and array striping factor and the effect of volume blocks that cross the stripe boundaries.



**Figure 5-5.** Effect of Striping Alignment and Misalignment

Compaq provides *CPQDAOPT.NLM* to assist you in optimizing COMPAQ drive array subsystems. Although *CPQDAOPT.NLM* works for all COMPAQ drive arrays, you can also use Table 5-4 to determine the optimal number of Hot Fix Redirection Area blocks to specify for existing COMPAQ IDA, IDA-2, and Intelligent Array Expansion configurations. For SMART Controllers, use *CPQDAOPT.NLM*.



### ***CPQDAOPT.NLM***

*CPQDAOPT.NLM* assists you in optimizing the performance of a NetWare volume on a COMPAQ drive array by providing a formula (specific to your configuration) for determining the optimal number of NetWare Hot Fix Redirection Area blocks.

**NOTE:** *CPQDAOPT.NLM* is available on the NetWare Programs from Compaq (NPFC) v2.20 diskette, which ships with COMPAQ server products and with NetWare from Compaq. NPFC is also available on the Compaq CompuServe Forum. For more information, call your Authorized Compaq Service Provider or the Compaq Customer Support Center at 1-800-345-1518 in North America. In Canada, call 1-800-263-5868. Outside the United States and Canada, call your local Compaq office.

*CPQDAOPT.NLM* should be loaded during the installation of new systems to provide recommendations for optimization when creating your NetWare partitions. To optimize an existing system, use the following steps to install *CPQDAOPT.NLM*.

1. From a workstation logged into the server, copy *CPQDAOPT.NLM* from the NPFC diskette to the server SYS:SYSTEM volume.
2. If your server is running NetWare v3.11, and your *CLIB.NLM* is dated prior to 11/11/1992 (*CLIB.NLM* v3.11c), load *CPQCPAT.NLM* before loading *CPQDAOPT.NLM*. *CPQCPAT.NLM* is on the NPFC diskette. If you load *CPQCPAT.NLM* on a server where it is not needed, you receive the following error message:

```
Symbol already defined: ImportSymbol
Load file defines a public variable that has already been defined.
Module CPQCPAT.NLM NOT loaded
```

If your server requires this patch, from a workstation logged into the server, copy *CPQCPAT.NLM* from the NPFC diskette to the server SYS:SYSTEM volume.

3. To load the *CPQCPAT.NLM* from your NetWare server console prompt, type the following command:  
LOAD CPQCPAT
4. After you have started your NetWare server, and loaded the *CPQDA386.DSK* hard disk device driver, and the *CPQCPAT.NLM* if needed, load the *CPQDAOPT.NLM*. At the NetWare server console prompt, type the following command:  
LOAD CPQDAOPT
5. *CPQDAOPT.NLM* will display the registered disk devices it has located for you to choose from. Select the device that you wish to optimize. *CPQDAOPT.NLM* provides a formula for determining the size of the Hot Fix Redirection Area you should select when creating the NetWare partition.

For more information on *CPQDAOPT.NLM*, see the README file *ARRAY.RDM* on the NetWare Programs from Compaq (NPFC) v2.20 diskette.

### **CONFIGURING HOT FIX**

The following steps provide installation guidelines for configuring Hot Fix Redirection Area blocks for COMPAQ drive array subsystems.



**CAUTION:** Always perform a complete backup before changing the size of the Hot Fix Redirection Area. Changing the size of the Hot Fix Redirection Area will destroy data on the volume.

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1. If you have an IDA or IDA-2 Controller, begin optimization of the logical drive by ensuring that a DOS partition exists.

If you have a SMART Controller, go to step 2.

If you have an Array Expansion subsystem, ensure that it has been configured with EISA Configuration Utility v2.07 or later.



**CAUTION:** Since the Array Expansion System does not support a bootable DOS partition, all disk space is available for installing NetWare partitions. Reconfiguring a logical drive on the Array Expansion System with COMPAQ EISA Configuration Utility version 2.07 or greater causes the loss of all data on the logical drive. To reconfigure an existing logical drive in the Array Expansion System (configured with an EISA Configuration Utility version prior to 2.07), you must back up and then restore the data on the drive.

- 
2. Load the *CPQDA386.DSK* device driver.
  3. Determine the correct formula for the Hot Fix Redirection Area using *CPQDAOPT.NLM*. For IDA, IDA-2, and Array Expansion subsystems, you can also use Table 5-4.

**Table 5-4**  
**Hot Fix Configurations**

Controller	Drives	Number of Hot Fix Blocks
IDA	120, 210, 340, 510 MB	Even
	120-MB drives with 1 or 2 pairs of drives installed in a mirroring or no fault tolerance configuration	Even, if the number of cylinders in the DOS partition is even. Odd, if the number of cylinders in the DOS partition is odd.
IDA-2	120, 210, 340, 510 MB	Even
Array Expansion	1.3 GB	Multiple of 4
	4 or 5 drives configured for no fault tolerance	Multiple of 4, plus 1.

4. Load *INSTALL.NLM*.
5. Select the desired device from the Available Disk Drives menu, and press the **ENTER** key to display the current partition information.



6. Select *Create NetWare Partition* from the Partition Options menu to display the Partition Information screen.
7. Increase the number of Hot Fix Redirection Area blocks as needed.



**CAUTION:** Always perform a complete backup before changing the size of the Hot Fix Redirection Area. Changing the size of the Hot Fix Redirection Area will destroy data on the volume.

---

## Check File Service Processes

To ensure that the drive array subsystem has adequate File Service Processes (FSPs), view the Service Processes statistic in the *MONITOR.NLM* Information menu. This statistic displays the number of service processes that are being used.

The SET MAXIMUM SERVICE PROCESSES parameter controls the maximum number of service processes the operating system can create. The supported values are 5 to 40, and the default value is 20.

Using the *MONITOR.NLM* Information menu, you can view the Current Disk Request statistic to determine whether you need to increase the value of the SET MAXIMUM SERVICE PROCESSES parameter. When you set this value to its default of 20, and the server consistently has more than 20 FSP requests, DISK requests can be delayed due to a lack of available FSPs. If the server needs additional service processes, you can increase the value of the SET MAXIMUM SERVICE PROCESSES parameter to accommodate the number of requests.

After increasing the value of the SET MAXIMUM SERVICE PROCESSES parameter, check the server system memory statistics using the *MONITOR.NLM* Resource Utilization menu, and ensure that the value of the Total Cache Buffers statistic is not below 70 percent of the total server work memory.

---

**!** **IMPORTANT:** If you increase the value of the SET MAXIMUM SERVICE PROCESSES parameter, the operating system takes system memory from the Cache Buffers pool. Once NetWare creates more service processes, NetWare does not release this system memory to the Cache Buffers pool until the server is "brought down."

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### **Modify Disk-Related SET Parameters**

Before making any changes to the SET parameters, use COMPAQ INSIGHT Manager to analyze the number of read and write requests. (See Chapter 2 for more information on COMPAQ INSIGHT Manager.) This ratio affects most disk-related SET parameters.

Use the following example as a guideline for SET parameter values:

```
SET CACHE BUFFER SIZE = 8192
SET MAXIMUM CONCURRENT DISK CACHE WRITES = 100
SET DIRTY CACHE DELAY TIME = 3.3
SET IMMEDIATE PURGE OF DELETED FILES = OFF
SET ENABLE DISK READ AFTER WRITE VERIFY = OFF
```

#### **SET IMMEDIATE PURGE OF DELETED FILES**

This parameter can affect performance if many file deletions occur. When a user deletes a file, NetWare does not immediately delete the file, but marks it for deletion. If the file is needed and has not been "purged," it can be restored with the NetWare SALVAGE utility. Purging is the actual deletion of the file from the NetWare file system. Disk space does not become available until the purge has been performed.



If you enable SET IMMEDIATE PURGE OF DELETED FILES, each file deletion request requires the system to mark the file for deletion and then purge it immediately from the salvage area. Files are not salvageable because they are immediately purged. The network server must spend extra time on each file deletion request. This can drastically reduce network server performance in an environment that performs many delete operations.

When purging files from the network server, you must specify the volume that you want to purge. If you do not specify the volume, you purge only the SYS volume.

The default value for IMMEDIATE PURGE OF DELETED FILES is OFF. An alternative to immediately purging deleted files is to schedule the purge process. You can schedule a batch file to be executed during off-peak hours. If you use the default value, you must use the following SET commands:

- SET MINIMUM FILE DELETE WAIT TIME=[TIME]: This value can range from 0 seconds to 7 days. It determines the length of time a deleted file remains salvageable. The default value is 1 minute and 5.9 seconds. The deleted file is not purged from the system until the wait time has elapsed.
- SET FILE DELETE WAIT TIME=[TIME]: This value indicates to NetWare when a salvageable file can be purged to provide available space on the volume. The default value is 5 minutes and 29.6 seconds. The system attempts to maintain a minimum of 1/32 of the available space on the volume. When a marked, salvageable file exceeds this value, it can be purged. If the volume reaches the 1/32 minimum, the oldest purgeable files are deleted.

### **SET ENABLE DISK READ AFTER WRITE VERIFY**

The NetWare SET ENABLE DISK READ AFTER WRITE VERIFY parameter ensures the integrity of data written to a target device. In the NetWare environment, the device driver for the hard drive controller implements NetWare Read After Write Verify operations.

After the system memory writes data to a storage device, such as a hard drive, the data is read back from the hard drive and compared to the original data to ensure that it was correctly written. The NetWare READ AFTER WRITE VERIFY parameter checks data integrity only when the data is written. It does not provide protection against future media failures that could lead to data corruption.

Most available hard drive subsystems, including COMPAQ drive arrays and Fast-SCSI-2 subsystems, have "built-in" intelligence to determine if a write operation completes successfully. If the operation does not complete successfully, the device driver and NetWare flag the sector on the disk as faulty and remap it. Since these hard drive subsystems include this "built-in" intelligence, and since NetWare provides the Hot Fix Redirection feature, the read-after-write verification process becomes unnecessary.

Considering the detection and correction capabilities of each hard drive in the intelligent drive array, the levels of fault tolerance, the negative performance impact, and the increased system memory required, the software Read After Write Verify feature has not been implemented in *CPQDA386.DSK* for NetWare.

In the Fast-SCSI-2 subsystem, read-after-write verification is supported at the hardware level only. The COMPAQ Fast-SCSI-2 device driver disregards the NetWare SET ENABLE DISK READ AFTER WRITE VERIFY parameter in favor of performing this task at the hard drive subsystem level. The default setting for read-after-write verification is *disabled*. The performance impact of read-after-write verification is significant. Enabling read-after-write verification yields about a 50 percent decrease in throughput.

The *hardware* read-after-write verification capability is included in the Fast-SCSI-2 subsystem to support NetWare compatibility. You can enable read-after-write verification by using either of the following methods.

- Using the *-V* parameter when you load the *CPQSDISK.DSK*
- Using *MONITOR.NLM*



The text file *PRO\_SIG.RDM* on the NetWare Programs from Compaq (NPFC) diskette provides information for enabling hardware read-after-write verification.



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**IMPORTANT:** Both of these methods enable *hardware* read-after-write verification via the hard disk device driver. They do not enable the NetWare SET ENABLE DISK READ AFTER WRITE VERIFY parameter.

---

When you configure the drive array controller for a *hardware* method of fault tolerance (such as COMPAQ drive mirroring, distributed data guarding, or data guarding), the system automatically enables Dynamic Sector Repairing, a COMPAQ hardware feature, as a background task. While the controller waits for I/O requests, it performs read and write operations to disk sectors and remaps the faulty sectors. Dynamic Sector Repairing works much like the NetWare Hot Fix Redirection feature, but it is transparent to NetWare. Although the Hot Fix Redirection feature is still enabled under NetWare, it is used only when the hard drive runs out of spare sectors for Dynamic Sector Repairing.

When you configure the drive array controller for a *software* method of fault tolerance (such as NetWare drive mirroring or controller duplexing), the system *does not enable* Dynamic Sector Repairing. However, the hard drive subsystem and the Hot Fix Redirection feature provide sector remapping. The drive array subsystem includes "built-in" intelligence to determine if a write operation completes successfully. If the operation does not complete successfully, the device driver and NetWare flag the sector on the disk as faulty and remap the sector to an available sector in the Hot Fix Redirection Area. Since these hard drive subsystems include this "built-in" intelligence that works with the Hot Fix Redirection feature, the read-after-write verification process becomes unnecessary.



**IMPORTANT:** Read-after-write verification, whether it is hardware-based or software-based, is independent of the Hot Fix Redirection feature of NetWare. If read-after-write verification is disabled, the NetWare Hot Fix feature remains enabled.

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## **Add Hard Drives**

In some configurations, adding hard drives to your disk subsystem can improve performance. Additional drives can maximize your disk throughput and I/O performance.

When adding more hard drives to a drive array subsystem, performance gains can result from striping the data across a greater number of drives. Using drive array technology, the drives are accessed independently, allowing multiple simultaneous reads and writes. With more drives in the array, more simultaneous operations can be supported, thus increasing the performance of the subsystem. These performance increases will be substantially more noticeable in a disk-intensive environment than in environments where disk activity is light.

For example, if you configure an IDA-2 controller with a single 1020-megabyte drive array pair, the subsystem accesses data across only two hard drives. By adding another 1020-megabyte drive array pair, data can be accessed across four drives, allowing more simultaneous operations. By adding more drives to the array, you not only increase the storage capacity of the subsystem, you may also increase performance.

Compaq integration testing indicates that performance improves as you add drives to the server in Fast-SCSI-2 environments. The hard drives receive requests for data and disconnect from the SCSI bus while they retrieve it. As the drive processes one request, the device driver can issue other requests to other hard drives.





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**!** **IMPORTANT:** When you configure low-throughput devices, such as tape drives, on the same SCSI bus as high-throughput devices, such as Fast-SCSI-2 hard drives, the low-throughput devices do *not* affect the performance of the high-throughput devices. Each SCSI device negotiates its own throughput on the SCSI bus.

---

Compaq integration testing using a COMPAQ ProSignia with an 8-Kbyte volume block size, 8-Kbyte cache buffer size, and a single NetWare volume with multiple drives, indicated that adding hard drives to the server increased the throughput performance. The most dramatic increase occurred when the second hard drive was added to the server. With additional hard drives, the performance increase was less dramatic. When upgrading your server from a single-drive configuration, you can add a second hard drive to substantially increase throughput performance. For example, when upgrading a COMPAQ ProSignia Model 486DX2/66-330, you can add a second 330-megabyte hard drive for better throughput performance.

When adding hard drives to either drive array or Fast SCSI-2 drive subsystems, you can increase server performance by configuring multiple hard drives to obtain the same amount of disk space. Using smaller, multiple drives, however, limits the total amount of internal disk capacity. You must consider the trade-off between throughput performance and total internal disk capacity.

For example, if you are planning a server with approximately 1 gigabyte of hard disk space, for better performance, you can plan for two 550-megabyte SCSI drives or two 680-megabyte drive array pairs, depending on the type of storage subsystem you have selected. (See Table 5-5.) Using a greater number of smaller drives will limit the total internal storage capacity of the server. In configurations where a substantial increase in internal storage is anticipated, you may decide that using fewer larger capacity drives to enhance the total storage capability is more important than the performance gains of using a greater number of smaller drives.

Table 5-5 illustrates the trade-off between performance and capacity.

**Table 5-5**  
**Hard Drive Performance and Capacity Comparison**  
**for 1 Gigabyte of Disk Space**

<b>Hard Drive Configuration</b>	<b>Relative Performance</b>	<b>Total Internal Expansion (Maximum 7 Devices)</b>
One 1050-MB	Good	7.35 GB (Provides maximum potential expandability)
Two 550-MB	Better	3.85 GB (Provides better performance, but with limited potential expandability)

**NOTE:** When adding hard drives to your server, ensure that your server has enough system memory to support the total amount of disk space.

### **Use Multiple Controllers**

You can increase the amount of information processed by using multiple hard drive controllers. Use *MONITOR.NLM* to analyze the value of the Current Disk Requests statistic in the *MONITOR.NLM* Information menu. If this value is constantly greater than 100, there may not be enough hard drive controllers to process data requests due to full saturation of the controller. By adding another controller to the server, you can greatly enhance disk I/O performance.

### **Redistribute the Disk I/O Requests Among Hard Drives**

Adding controllers does not provide any benefit if all disk I/O requests are made to one controller while the other controllers remain inactive. For this reason, you must evenly distribute the disk requests among the controllers and drive subsystems, so that each controller services a comparable number of requests.



## Review the Method of Fault Tolerance

In a NetWare environment, the method of fault tolerance (that is, controller duplexing, drive mirroring, distributed data guarding, or data guarding) can affect network server performance. If network server performance is unacceptable and you have tried other corrective measures, review the method of fault tolerance while considering the following:

- In a read-intensive environment, data guarding and distributed data guarding are cost-effective choices, because they require less disk space to duplicate the data on the drive array.
- For the COMPAQ SMART SCSI Array Controller and the COMPAQ Intelligent Drive Array Controller 2 (IDA-2), distributed data guarding is not only cost-effective, but also provides impressive performance, especially during data guarding write operations. If your server configuration includes a drive array subsystem with a SMART Controller or IDA-2 Controller, consider using distributed data guarding.
- Although NetWare controller duplexing and COMPAQ drive mirroring use more disk space, they also provide enhanced performance by using split seek operations during read operations. Split seeks allow the SMART Controller and IDA-2 Controller to alternate read operations between the primary drive array and the secondary drive array. These controllers can service read requests using the drive array that is available to provide the service, rather than using a single drive array to service all requests.

## EXAMPLE OF HARD DRIVE SUBSYSTEM PERFORMANCE PROBLEM

On a 100-user network with a server that includes two COMPAQ SMART SCSI Array Controllers, you must balance the network traffic and allow each controller to perform an equal number of tasks. One way to balance the network traffic is to assign 50 users to one channel and 50 users to the other. You can do this when establishing workgroups and mapping the groups to different hard drives.

This situation is hypothetical, since the NetWare volume structure, type of user activity, and type of application have not been addressed, but the concept of each controller performing an equal number of tasks is represented in this example.

Another way to balance the load is to use COMPAQ INSIGHT Manager to monitor the network server by comparing the number of read requests to write requests. (For more information on COMPAQ INSIGHT Manager, see Chapter 2.) If the server includes two SMART Controllers with four 550-megabyte Fast-SCSI-2 drives attached to each, you can use COMPAQ INSIGHT Manager to analyze the number of read write requests to each controller. If one controller services 80 percent of the disk I/O requests, then the additional controller is only servicing 20 percent and is not providing relief for the other controller. To rebalance this load, consider one or both of the following suggestions:

- Set up a different NetWare volume structure.
- Identify which user groups are causing the most traffic and redistribute them between the two controllers.

## **HARD DRIVE SUMMARY**

The hard drive subsystem plays a major role in the resource-sharing environment. Since resource sharing includes information retrieval and storage to a storage medium at the server, disk I/O performance can greatly impact the network server performance.

An important part of the disk I/O process is NetWare's ability to cache data, so that the cache, rather than the hard drive, satisfies many read requests. Since the size of the Cache Buffers pool depends on the amount of available system memory, analyze the performance of the hard drive subsystem and system memory together. In many cases, a perceived hard drive subsystem bottleneck is actually a system memory bottleneck. See Chapter 6 for more information.



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## *Chapter 6*

# **SYSTEM MEMORY PERFORMANCE**

Another subsystem to consider in a performance evaluation is system memory. This chapter discusses the amount of system memory needed and how it is allocated among the NetWare resources.

## **NETWARE SYSTEM MEMORY ALLOCATION**

NetWare dynamically allocates system memory to areas that require more system memory for a specific task. Minimum and maximum thresholds are allocated to certain areas, and these thresholds can be modified either manually or by the operating system.

NetWare allocates system memory to a large memory pool, the Cache Buffers pool, that distributes system memory to other memory pools. How NetWare uses these memory pools can impact network server performance. You must understand NetWare's use of these buffers and memory pools to determine whether the network server needs more system memory or whether you must reallocate the existing system memory. NetWare divides the system memory into three main memory pools:

- Cache buffers
- Permanent memory
- Alloc memory

The Cache Buffers pool is the main memory pool from which other pools receive memory. The remaining system memory in the Cache Buffers pool performs disk caching. During operation, when other pools require more system memory, the Cache Buffers pool passes system memory to these pools, depleting the amount in the Cache Buffers pool. Table 6-1 lists the types of data stored in the memory pools. Figure 6-1 illustrates the dynamic allocation of system memory among the memory pools.

Depending on the type of request, NetWare allocates system memory to the appropriate pool. NetWare allocates the minimum amount of system memory to the Permanent and Alloc Memory pools, allowing these pools to grow upon demand. Before adding system memory to the server, monitor the server for at least 10 minutes while running a normal workload, allowing the server to adjust these memory pools.

The Permanent Memory pool provides system memory resources for long-term system memory needs, such as directory cache buffers and packet receive buffers.

The Alloc Memory pool stores information for the resources listed below. The Alloc Memory pool does not return this allocated system memory to the Cache Buffers pool until you bring down the server.

- Drive mappings
- Service request buffers
- Open and locked files
- Server advertising
- User connection information
- Messages waiting to be broadcast
- Loadable module tables
- Queue manager tables

Two additional memory pools use system memory from the Cache Buffers pool and return it upon completion of their tasks: Cache Movable Memory pool and Cache Non-Movable Memory pool.



The Cache Movable Memory pool lists blocks of system memory that are free and can be moved to different locations, and provides system memory to resources such as the HASH table.

The Cache Non-Movable Memory pool lists memory buffers that are temporarily allocated to other programs and returns them upon the completion of its tasks.

---

**Table 6-1**  
**NetWare Memory Pools**

<b>Memory Pool Name</b>	<b>Data Stored</b>
Cache Buffers Pool	Cache files, data, and applications
Cache Movable Memory Pool (Nonfragmented)	NetWare internal tables including HASH, Directory tables, and FAT
Cache Non-Movable Memory Pool (Fragmented)	CLIB and NLMs
Permanent Memory Pool	Directory cache buffers, Link State Layers (LSLs), TurboFAT
Alloc Memory Pool	Menu screen draw, connection tables, print queues, Service Advertising Packages (SAPs)
Semi-Permanent Memory Pool	LAN and hard device drivers

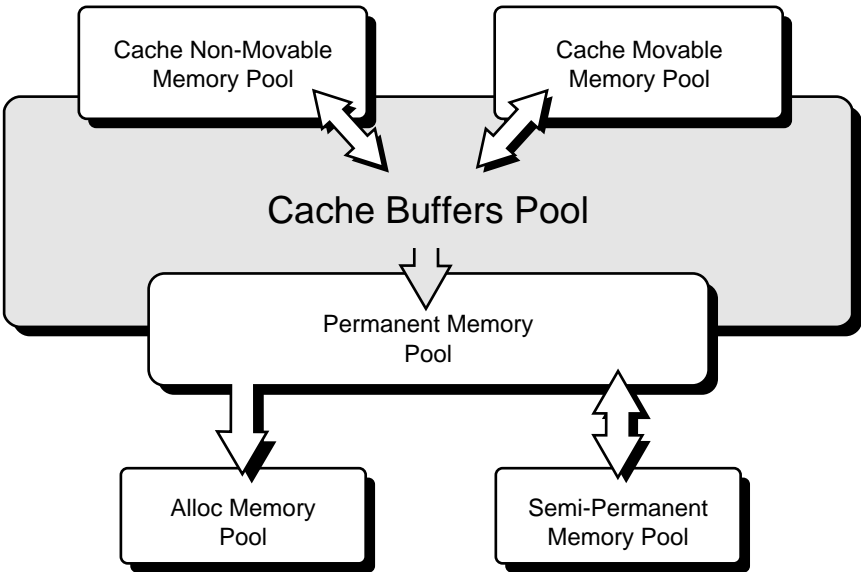


Figure 6-1. System Memory Allocation for Memory Pools



To explain the use of memory pools, the following example configuration is used:

COMPAQ SYSTEMPRO/LT 386/33 Model 840 with  
16 megabytes of system memory configured for an  
8-Kbyte volume block and 8-Kbyte cache buffer size

When you first initialize the server, the number of Original Cache Buffers in the *MONITOR.NLM* Information menu is 1878. If this value is multiplied by the cache buffer size of 8 Kbytes, approximately 15 megabytes of system memory are available in the Cache Buffers pool to allocate to different areas of the system. The value of Total Cache Buffers is 1581. This means that 297 buffers are allocated to other pools.

In the example, NetWare allocates the buffers in the following manner:

Permanent Memory Pool	=	457,680	3%	454,304	In Use
Alloc Memory Pool	=	49,152	0%	21,608	In Use
Cache Buffers	=	13,945,932	89%		
Cache Movable Memory	=	1,047,816	7%		
Cache Non-Movable	=	<u>232,848</u>	1%		
Total Server Work Memory		15,733,452			

## **CORRECTIVE ACTIONS FOR SYSTEM MEMORY PERFORMANCE PROBLEMS**

NetWare manages system memory without intervention. It uses all system memory beyond that required by the operating system and allocates this remaining system memory to the Cache Buffers pool. NetWare then requests system memory from the Cache Buffer pool and allocates it to other memory pools. This dynamic system memory allocation makes manual "tuning" of the system memory less efficient.

Since NetWare dynamically allocates system memory to the resources that need it, the operating system requires little interaction from the system administrator for system memory management. You can perform the following corrective actions:

- Ensure that the network server has enough system memory to handle the demands of the network. See "Calculate Server System Memory" below.
- Use NetWare SET parameters to set minimum and maximum thresholds to limit the amount of system memory allocated to memory pools.

Each subsystem in the network server uses system memory, and NetWare uses the remaining system memory as buffers for disk caching. Performance problems are likely to occur if the server does not have enough system memory.

### Calculate Server System Memory

Since each server configuration is site-specific and the amount of system memory depends on the server configuration and the workload environment, the amount of system memory required for each server is also site-specific. To estimate the minimum amount of system memory needed to initialize your server configuration, use the formula discussed below. As the capacity of your server hard drive subsystem increases (for example, when you add another drive or when you change the method of fault tolerance), you must recalculate the required system memory, and perhaps add memory.

The following paragraphs provide formulas for calculating the *minimum* amount of system memory on a network server. You will need to add additional memory in order to achieve maximum performance.

#### FOR EACH NETWARE VOLUME

The formulas provided in this chapter determine the *minimum* amount of system memory required to initialize the network server, based on the size of each NetWare volume on the server.

Use the following formulas to estimate the *minimum* amount of system memory required for each volume.



**Table 6-2**  
**Estimating System Memory for Each Volume**

NetWare Volume Type	System Memory Calculation
DOS files	$(0.023 \times \text{total MB of volume}) = \text{system memory for DOS}$ volume block size in KB
DOS files + Name Space support	$(0.032 \times \text{total MB of volume}) = \text{for DOS + name space}$ volume block size in KB

**NOTE:** Name Space is used for support of Macintosh, UNIX, and OS/2 file systems.

### FOR THE SERVER

Use the following formula to calculate the *minimum* total amount of required system memory for the network server:

$$\begin{array}{r}
 \text{system memory required for DOS volume} \\
 \text{system memory required for DOS volumes with name space} \\
 + \text{4 megabytes of system memory} \\
 \hline
 \text{Total amount of required system memory for network server}
 \end{array}$$

The following example shows how to use the formula with a single volume, multiple volumes with different block sizes, and Name Space.



Calculation of 1050-megabyte Fast-SCSI-2 drive with a 200-megabyte DOS volume and 4-Kbyte block size, a 600-megabyte DOS volume with 8-Kbyte block size, and a 250-megabyte Name Space volume with 8-Kbyte block size:

$$\frac{0.023 \times 200}{4 \text{ KB}} = 1.15$$

$$\frac{0.023 \times 600}{8 \text{ KB}} = 1.725$$

$$\frac{0.032 \times 250}{8 \text{ KB}} = 1.0$$

$$3.875 + 4 \text{ MB} = 8 \text{ MB Total}$$



**CAUTION:** This formula estimates the *minimum* amount of system memory required. Do *not* consider this formula a recommendation for the optimum amount of system memory. Depending on the server hardware configuration, the number of NLMs loaded, the number of users on the network, and so on, you may need to add system memory to achieve optimal performance.

### Allocate Server System Memory

The *MONITOR.NLM* Resource Utilization menu provides information on the amount of system memory installed in the server and how NetWare allocates it. This menu in *MONITOR.NLM* can also help pinpoint areas where more system memory might improve performance.

NetWare requires system memory to provide the following:

- FAT caching
- HASH Tables caching
- Loading NLMs
- Connection Information



- Server Advertising
- Communication Buffers

Select the *Resource Utilization* option from the *MONITOR.NLM* Available Options menu to view the following system memory information:

- Amount of system memory, in bytes, allocated to a system memory pool or buffer.
- Percentage amount of available system memory being used by a particular memory pool or buffer.
- Amount of system memory, in bytes, allocated from available system memory.

You can identify potential system memory problems by noting the Total Cache Buffers statistic at the *MONITOR.NLM* Information menu. This value represents the number of buffers that are allocated to cache disk requests or that are made available to other resources.

You can allocate more system memory for the operating system, so that it uses as much system memory as is available. If unnecessary NLMs are loaded, unloading them can return system memory to the Cache Buffers pool. If you suspect that the system memory is not being returned to the available memory pools, you can reboot the server to return it. You can also use the REMOVE DOS command to release the system memory that is used to store DOS information.



**IMPORTANT:** As you view the Resource Utilization option in *MONITOR.NLM*, note the value of the Total Cache Buffers. This value should *never* be less than 20. If this value is less than 20, add more system memory until this value rises above 70. This ensures that the server has adequate system memory to dynamically adjust to meet network needs.

---

After noting the Total Cache Buffers statistic, note the Dirty Cache Buffers statistic. If this value is more than 70 percent of the total cache buffers, then a hard drive bottleneck may have emerged.

Before making any changes to the server configuration, monitor the network server performance for a period of several hours to ensure that the values are not a result of a network traffic "spike."

## **Modifying Server System Memory SET Parameters**

System memory-related NetWare SET parameters that can affect network server performance are:

- SET MAXIMUM ALLOC SHORT TERM MEMORY = 2097152
- SET CACHE BUFFER SIZE = 8192
- SET AUTO REGISTER MEMORY ABOVE 16 MEGABYTES = on/off

You can control the Alloc Memory pool using the SET MAXIMUM ALLOCATED SHORT TERM MEMORY parameter. The default value (2 megabytes) is adequate for up to 250 users. If the Alloc Memory pool value in the *MONITOR.NLM* Resource Utilization menu is greater than 10 percent, you may need to bring down the server to return the system memory to the Cache Buffers pool. The Alloc Memory pool does not automatically return system memory to the Cache Buffers pool, but retains it for NLM and connection information. If the Alloc Memory pool uses this system memory, do not reboot the server to return the system memory to the Cache Buffers pool. However, if the Alloc Memory pool no longer needs this system memory, you can reboot the server to recover it.

When using the SET AUTO REGISTER MEMORY ABOVE 16 MEGABYTES parameter to configure system memory greater than 16 megabytes, this parameter defaults to ON, enabling the server to use more than 16 megabytes of system memory. Enable this parameter when the network server has more than 16 megabytes of system memory, especially when configuring the servers with large amount of disk storage.



## SYSTEM MEMORY SUMMARY

You can monitor the NetWare system memory allocation to determine whether the server needs more system memory. *MONITOR.NLM* provides you with statistical information, and the NetWare SET parameters provide a limited amount of control over how system memory is allocated within the operating system and server.

Because the hard drive subsystem is closely tied to how system memory is allocated, analyze both the system memory and the hard drive subsystem together. In some cases, adding system memory can reduce or eliminate a hard drive subsystem bottleneck.



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## *Chapter 7*

# **SYSTEM PROCESSOR PERFORMANCE**

A faster system processor does not guarantee a faster network server or network response time. In a NetWare 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. These subsystems are more likely to cause a performance bottleneck in the server than the processor.

## **IDENTIFICATION OF SYSTEM PROCESSOR PERFORMANCE PROBLEMS**

Upgrading the system processor in a resource-sharing environment typically does not improve user response time. Upgrading the system processor can minimize the performance impact when adding more users; however, applications and network bandwidth also contribute to response time and performance.

In a resource-sharing environment, other network components may be the bottleneck. The workstation configuration and its applications can cause a network bottleneck. If you determine that the bottleneck is at the server, then the hard drive subsystem, network communications subsystem, or system memory is most likely the bottleneck. The key to server performance management is maintaining the balance among these resources and to offload extra tasks from the system processor.

A high-performance system processor offers more speed and efficiency in managing CPU-intensive NLM applications and network services, such as printing and remote bridging, and in tracking a large network of users. Although upgrading the system processor can potentially improve the network server performance, this solution may not be best in all cases.



Other factors of the system processor that affect network server performance include the bus architecture and support of bus master expansion boards. The ability to use 8-, 16-, or 32-bit data paths and "bus master" devices to offload tasks or "cycles" from the system processor can greatly improve network server performance.

In an EISA system, a bus master device performs two bus cycle timing variations: standard and burst. The data transfer rate varies according to the timing and whether the EISA system must translate between devices with different bus widths (8-, 16-, or 32-bit).

EISA systems provide seven direct memory access (DMA) channels that provide enhanced performance, while maintaining ISA compatibility. EISA DMA incorporates the following:

- EISA logic performs data size translations necessary for transfers between system memory and DMA device sizes (8-, 16-, or 32-bit).
- Full 32-bit address and data buses are supported between the devices on the expansion bus and the system memory.
- DMA channels can be configured for 8-, 16-, or 32-bit DMA devices.
- Any DMA channel can be programmed to be ISA-compatible Type A, B, or C (Burst DMA). Burst transfers between two 32-bit DMA devices can reach 33 megabytes per second.
- In an ISA environment, DMA transfers are slow compared to EISA DMA transfers. In fact, in an ISA environment, the hard drive can perform programmed I/O (PIO) transfers through the system processor more efficiently than the DMA controller.



The following table provides a functional comparison of the various DMA cycle types. In the table, as the data path increases in width, the effective data transfer rate increases proportionately. In many ISA-based PCs, the internal bus can become a bottleneck in a network environment. A PC with an 8-bit path must access a device twice as many times as one with a 16-bit path. A PC with a 16-bit path must access a device twice as many times as one with a 32-bit path.

The system bus connects the subsystems, which allows these components to transfer data to the system processor or to another system component. The widening of the system I/O bus can accelerate system throughput.

**Table 7-1  
Comparison of DMA Cycle Types**

<b>DMA Cycle Type</b>	<b>Description</b>	<b>Transfer Width</b>	<b>Transfer Rate (MB/Sec)</b>	<b>Compatibility</b>
ISA Compatible	Original, industry-standard DMA device.	8-Bit	1.0	All ISA
		16-Bit	2.0	All ISA
Type A	With special programming, allows most ISA-compatible DMA devices to achieve higher performance.	8-Bit	1.3	Most ISA
		16-Bit	2.6	Most ISA
		32-Bit	5.3	EISA Only
Type B	With special programming, allows most ISA-compatible DMA devices to achieve even higher performance.	8-Bit	2.0	Some ISA
		16-Bit	4.0	Some ISA
		32-Bit	8.0	EISA Only
Type C Burst Mode	Highest performance DMA cycle. Available to EISA DMA devices that are designed for Burst Mode.	8-Bit	8.2	EISA Only
		16-Bit	16.5	EISA Only
		32-Bit	33.0	EISA Only



## **CORRECTIVE ACTIONS FOR SYSTEM PROCESSOR PERFORMANCE PROBLEMS**

When analyzing the network for system processor-related bottlenecks, the primary diagnostic tools are COMPAQ INSIGHT Manager and *MONITOR.NLM*. The Utilization statistic in the *MONITOR.NLM* Information menu provides an indirect indication of how the system processor is performing. However, this Utilization value reflects the utilization of the whole server, not just the system processor. A value greater than 80 percent may indicate that the system processor is spending most of its time on tasks that require system processor intervention. Using COMPAQ Server Manager Collector/R (SMC) software or *STAT.NLM* (available from Novell), you can record server utilization at designated intervals over a predefined period of time and chart this data for analysis.

**NOTE:** *STAT.NLM* is a Novell application that records NetWare v3.11 server resource utilization. For more information, see the March 1992 Novell Application Note titled *STAT.NLM: A Tool for Measuring NetWare v3.11 Server Resource Utilization*. *STAT.NLM* is available in the CompuServe NetWire Forum.

A high Utilization value does not necessarily mean that the server lacks enough system processor power. The primary 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 may not be reflected in the 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.

## **EXAMPLES OF PERFORMANCE MANAGEMENT AFFECTING THE SYSTEM PROCESSOR**

The following paragraphs illustrate the circumstances under which you can upgrade the system processor to improve network server performance.

### **Adding Users to an Existing Environment**

A network server with 75 workstations runs file and print services, and the performance is perceived as adequate. Users are satisfied with response times. Another department of 30 users must then be added to the same network server. Adding 30 users to the existing network server might affect the current server response time. Using the following procedure, you can define the need for upgrading the system processor.

Document all steps and procedures that you perform to ensure that you have an accurate record of the changes being made to the server and to validate the results of your tests.

1. Check the Utilization value with the *MONITOR.NLM* Information menu.
2. Ensure that the physical network (wire) is not congested (more than 40 percent utilization for Token Ring or Ethernet) by using a network monitoring tool or a protocol analyzer.
3. Run a test application (that is, one of the applications that users run on your network) to identify the network throughput.
4. Add the new users to the network server and survey the users to determine if they have noticed a change in response time.
5. Run the test application after adding the new users to verify that the workstations are obtaining the same throughput levels as they were before the new users were added.
6. Compare the results of the two tests. If the changed values reflect a performance degradation, using the Performance Management checklists and flow diagrams in Chapter 10, analyze the network and the server to ensure that all other subsystems are tuned correctly.



7. Document all information gathered from *MONITOR.NLM* and from the other monitoring tools and protocol analyzers before upgrading the server.
8. If all other subsystems are tuned correctly and are documented as such, upgrade the server system processor.
9. Check the Utilization value in the *MONITOR.NLM* Information menu. This value should decrease, and you should be able to observe an increase in performance.

In this example, the Utilization value may be displayed at 100 percent. With 100 users accessing the network server, upgrading the system processor may change the Utilization statistic to 75 percent. However, this may not be apparent in the user workstation response time.

### **Managing Performance by Using EISA Bus Master NICs**

A COMPAQ SYSTEMPRO is configured as a network server with non-bus master 8-bit or 16-bit NICs. In this environment, the system processor must handle tasks such as transferring data and generating bus addresses. The performance degradation becomes very apparent.

Non-bus master devices require system processor intervention to transfer, in some cases, a single byte of data. As the server becomes increasingly busy, the system processor spends most of the time servicing NIC requests rather than managing the operating system. When the system processor services the 8- or 16-bit NIC, it must execute the operation two or three times, rather than once for a 32-bit NIC. These factors can contribute to a degradation in server performance.

Perform the following procedure to determine the effects of replacing ISA NICs with EISA NICs.

1. Check the Utilization value in the *MONITOR.NLM* Information menu.
2. If *MONITOR.NLM* constantly reflects a high Utilization percentage (greater than 80 percent), reconfigure the network server with 32-bit EISA NICs.

3. Reboot the network server and load the appropriate device drivers for the new NICs, and monitor the *MONITOR.NLM* Utilization statistics.

In almost every case, the value of the Utilization statistic should be significantly lower, and as the network activity increases, more drastic drops in server utilization should be apparent. This becomes especially clear when the network server is configured with multiple NICs.

## **SYSTEM PROCESSOR SUMMARY**

A high-performance system processor offers more efficiency only in managing CPU-intensive applications and network services, such as printing and remote bridging. Although upgrading the system processor may potentially improve the network server performance, this solution may not be best in all cases.

Other factors, such as bus architecture, can offload cycles from the system processor and greatly improve network server performance. The EISA server bus architecture supports a wider data path of 32 bits than ISA bus architectures. As the width of the data path increases, the effective data transfer rate increases proportionately. In many ISA-based servers, the internal bus can become a bottleneck in the network environment.

Support of bus master devices provides additional performance enhancements. Non-bus master devices require system processor intervention to transfer data. As the server becomes increasingly busy, the system processor spends more time servicing NIC requests than managing the operating system.

In a NetWare 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.



---

## *Chapter 8*

# **OTHER FACTORS AFFECTING NETWORK PERFORMANCE**

Other factors can affect the perceived performance of the network. These include other network protocols, applications, and the Microsoft Windows environment.

## **OTHER PROTOCOLS**

NetWare provides workstation configuration files for both the network driver and the shell programs, *NET.CFG* and *SHELL.CFG*. You can modify parameters in these files to control how the driver and shell operate, allowing more flexibility during operation. Changing the values of these parameters, such as increasing the number of *SPX* connections or the number of cache buffers, can affect workstation performance in any network environment. The Novell *NetWare Application Note August 1990: A Comparison of NetWare IPX, SPX, and NetBIOS* provides detailed information on these protocols and their effect on network workstation performance.

Version 3.x (or later) of the shell program replaces the *SHELL.CFG* file with the *NET.CFG* file by incorporating the information from both files in previous versions.

## **APPLICATIONS**

Applications also affect the overall performance of the network. Applications that run inefficiently or that require much overhead to run can negatively affect the network performance.



Applications differ in their ability to recognize that they operate in a network environment, and in their cooperation with the network operating system. Some applications do not run on the network. Some applications run on the network but are not optimized for network use. Knowing and understanding these differences can help you determine and solve application problems in a network environment.

In analyzing network performance and the applications that run on the network, consider the following:

- Type of application
- How the application uses network resources

Three types of applications are:

- Network-Incompatible Applications
- Network-Compatible Applications
- Network-Aware Applications

### **Network-Incompatible Applications**

Network-incompatible applications run at the workstation and do not use network resources. They cannot print to a printer that is not physically attached to the workstation printer port. They cannot operate under an active network shell program.

### **Network-Compatible Applications**

Network-compatible applications can run as standalone applications or in a network environment. However, network-compatible applications, with modifications, use only some of the network resources and, because they run in both standalone and network environments, are not optimized for network use. Network-compatible applications usually require modifications to operate in a network environment, such as flagging program files and capturing the workstation printer port to a network queue, so that the workstation user can print to a network printer.



## Network-Aware Applications

Network-aware applications, written for network environments to support multiple users, take advantage of all network resources to optimize network use. Network-aware applications can print directly to network print queues, and can load program overlay files from a local hard disk rather than across the network.

Some kinds of network-aware applications (such as word processors and databases) may require modifications to the workstation configuration or to the network implementation. For example, some applications use large disk requests, but if the NIC device driver breaks these large requests into many smaller ones, then the workstation NIC subsystem becomes the bottleneck. Substituting another device driver to allow larger packet transfers can relieve this bottleneck.

## MICROSOFT WINDOWS ENVIRONMENT

The Microsoft Windows environment provides a unique set of considerations for networks. As a graphical user interface, Windows requires more system memory and system processor cycles to "paint" the workstation screen than text-based applications. However, Windows is a network-aware application environment that can provide a practical solution for department or corporate-wide computing.

Since this COMPAQ TechNote focuses on performance management, the following paragraphs provide Windows information that can help you maximize network performance in a NetWare/Windows environment. This includes the following:

- Location of Microsoft Windows Files and Temporary Files
- Use of Permanent or Temporary Virtual "Swap" Files
- Use of Disk Caching Utilities

## **Location of Files**

To take advantage of Windows "networkability," you must consider the network design, including the number of users, the configuration of each workstation, and the amount of network traffic. For example, if the amount of network traffic is historically high, installing Windows on the network server drives for all users to access can add traffic to the network, creating the potential for network performance problems.

### **WINDOWS PROGRAM FILES**

If network performance is a major concern to workstation users, consider the following suggestions when monitoring the network for performance management.

When the network load is historically heavy or when workstation configurations have less than 2 megabytes of system memory, you can install Windows on the workstation hard drive to provide better workstation response time. In these configurations, Windows memory manager discards inactive program segments when the workstation needs to use more system memory and then reloads these program segments as needed.

When the network load is historically light or when 386-based workstations have more than 4 megabytes of system memory, you can install Windows on the network server hard drive and run Windows in 386-Enhanced Mode. The 386-Enhanced mode allows you to use virtual memory to cache program segments, so that the performance overhead generated by the network is offset by the performance advantages of using a 386-based workstation in Windows 386-Enhanced mode.

### **WINDOWS TEMPORARY FILES**

Windows uses temporary files (*.TMP* files) for two purposes:

- To store scratch files for Windows applications.
- To swap DOS applications out of disk and into system memory.



Many Windows applications do not run correctly without access to these temporary files. To avoid additional network traffic, load these temporary files on the workstation hard drive by adding the following command to the workstation *AUTOEXEC.BAT* file:

```
SET TEMP=C:\WINDOWS\TEMP
```

### **Permanent Versus Temporary Virtual "Swap" Files**

Windows 386-Enhanced mode can use either temporary or permanent swap files as "virtual RAM." A permanent swap file allows workstations with limited amounts of system memory to use the workstation hard drive as "virtual RAM." Using permanent swap files improves workstation performance especially when the workstation system memory is limited; however, using permanent swap files also reduces the amount of available hard drive space, even when Windows is not running.

A temporary swap file also allows workstations to use hard drive space as "virtual RAM." When Windows executes, Windows creates a temporary swap file. When Windows terminates, Windows releases the hard drive space. Use temporary swap files when both workstation system memory and workstation hard drive space are limited. A temporary swap file does not provide as much performance enhancement as a permanent swap file, because Windows creates the temporary swap file each time Windows loads.

### **Disk Caching Utilities**

The COMPAQ DOS CACHE Utility and Windows SMARTDRV Utility allow you to use a portion of system memory to store data. However, to take full advantage of either of these caching utilities, your configuration must have an adequate amount of system memory.

### **DOS CACHE UTILITY**

Using the COMPAQ DOS CACHE Utility can improve performance in read-intensive application environments by decreasing the amount of time required for data access on the network server hard drive. The DOS CACHE Utility stores copies of the most recently accessed data in a portion of system memory. Depending on the type of workstation configuration, this system memory can be conventional, expanded, or extended memory.

Read-intensive applications, such as databases and applications that use overlay files (some word processors), can take advantage of the DOS CACHE Utility.

**NOTE:** The DOS CACHE Utility is on the COMPAQ User Programs diskette for MS-DOS v5.0 (and earlier) as published by Compaq. Use the COMPAQ User Programs diskette documentation to install the DOS CACHE Utility.

Use the following example command to enable the DOS CACHE Utility to use 1,024 Kbytes of system memory as cache:

```
DEVICE = C:\DOS\CACHE.EXE 1024 /EXT
```

### **WINDOWS SMARTDRV UTILITY**

The Windows SMARTDRV utility is a disk cache program that saves data read from the hard drive to workstation system memory. When the application requests the data again, the SMARTDRV utility provides it from system memory, rather than from the hard drive. Unlike most disk cache utilities that inflexibly partition the system memory, the SMARTDRV utility closely operates with Windows to share system memory resources dynamically.

Add the following command line to the workstation *CONFIG.SYS* file to allocate SMARTDRV with a maximum cache of 1,024 Kbytes and a minimum cache of 256 Kbytes:

```
DEVICE=C:\WINDOWS\SMARTDRV.SYS 1024 256
```



**IMPORTANT:** Do not use COMPAQ DOS CACHE Utility and SMARTDRV together.

---

## SUMMARY

Factors such as network protocols, applications, and the Windows environment also affect network performance. You can modify parameters in the workstation *NET.CFG* and *SHELL.CFG* files to control how these drivers operate. Use network-aware applications and caching utilities on both the server and the workstation to improve network performance. Plan the location of DOS applications and their temporary files.



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## *Chapter 9*

# **NETWORK PERFORMANCE MANAGEMENT EXAMPLE**

The following example illustrates a possible performance management problem for a Token Ring network. This example is not the only scenario, nor is it the only solution. A performance management strategy must be based on analysis of a specific network environment.



**IMPORTANT:** Use this example as a guideline for using the Performance Analysis/Management Checklists and flow diagrams in Chapter 10 of this TechNote.

---

## **SERVER CONFIGURATION**

COMPAQ ProSignia Model 486/33-1050 with  
8 megabytes of system memory  
One COMPAQ Integrated Fast-SCSI-2 Controller with  
1.05-Gigabyte Fast-SCSI-2 Hard Drive

Three COMPAQ 32-Bit NetFlex Controllers (with plug-in  
COMPAQ DualSpeed Token Ring adapter modules)  
that support a total of 65 workstations

Resource-sharing environment with a variety of office automation  
applications (electronic mail, database, spreadsheet, and  
word processing)

## SCENARIO

In this example, system integrators in the MIS department of a corporation provide support for a large NetWare v3.11 Token Ring LAN. Many of the COMPAQ ProSignia and COMPAQ SYSTEMPRO network servers support multiple rings.

In a single department, one server provides service to 65 workstations that are distributed over three rings. As the department grows, network administrators add 25 new users to these Token Rings. To accommodate the new users, integrators add a 1.05-gigabyte drive to the server to allow enough disk space for all users to store their files.

Before the new users and the new drive are added to the network, the Utilization value in *MONITOR.NLM* typically displays approximately 42 percent, and workstation response time is adequate for 65 users. Adding the new users and the new drive to the network results in scattered complaints of slow response times when accessing the network server and the inability of some users to log into the server.

The MIS support personnel perform the following procedure to identify and correct the network performance problem:

1. Check for workstation bottleneck.
2. Check for network communication subsystem bottleneck.
3. Check for hard drive subsystem bottleneck.
4. Check for system memory bottleneck.

### Check for Workstation Bottleneck

Since slow response times are not isolated to a single workstation or a single ring, system integrators deduce that the performance problem is not at the workstations.





### **Check for Network Communication Subsystem Bottleneck**

Using a protocol analyzer to check the network bandwidth, integrators notice a 50-percent Token Ring bandwidth utilization.

The SET MINIMUM PACKET RECEIVE BUFFERS parameter value equals 120 at server startup, but due to the amount of traffic on the network, the value rises to 200. The SET MAXIMUM PACKET RECEIVE BUFFERS parameter value is set to 200 and must be increased.

The SET MAXIMUM PACKET RECEIVE BUFFERS parameter value is increased in increments of 50 buffers until it reaches 500. The minimum packet receive buffers value eventually reaches 342. At this point, all users can log into the server, but the workstation response time is still inadequate for users.

### **Check for Hard Drive Subsystem Bottleneck**

The *MONITOR.NLM* Utilization statistic constantly displays a value greater than 85 percent, indicating an overburdened network server. System integrators verify that the cache buffer size equals the volume block size (8 Kbytes for the COMPAQ ProSignia Fast-SCSI-2 subsystem), and that the SET IMMEDIATE PURGE OF DELETED FILES parameter is disabled.

System integrators then check the *MONITOR.NLM* Dirty Cache Buffers statistic, noting that the value equals 75 percent of the Total Cache Buffers. They also note that the Current Disk Requests value equals 10. The low number of disk requests indicates that the hard drive subsystem is not the cause of the performance problem.

## **Check for System Memory Bottleneck**

Under the Resource Utilization option of *MONITOR.NLM*, the Cache Buffers value equals only 22 percent of the Total Server Memory value. This value should be greater than 70 percent.

## **CONCLUSION**

The addition of users and hard drives to the network server, in this example, creates three performance-related problems:

- Adding users to the network creates more network traffic and increases server access, requiring additional packet receive buffers for the server to process requests.
- Increasing the number of packet receive buffers depletes the number of buffers in the Cache Buffers pool, leaving fewer buffers to cache disk requests.
- Adding more hard drive storage to the server requires more system memory.

In this example, when system integrators added the additional 1.05-gigabyte drive to the network server, the additional drive space required additional system memory for the server. System integrators install an 8-megabyte memory module in the network server, providing a total of 16 megabytes of system memory, and the *MONITOR.NLM* Utilization statistic value is at 44 percent. Under the Resource Utilization option, the Cache Buffers value equals 79 percent of the Total Server Memory value.



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## *Chapter 10*

# **PERFORMANCE MANAGEMENT SUMMARY**

Managing network performance requires continuous network monitoring as the network implementation and workstation user requirements grow and change. Once the network is implemented, network performance analysis begins. Solving network performance problems requires a knowledge of the network environment, a set of monitoring tools, and performance management training. Without these, it becomes difficult to gather and analyze network performance data and to identify and resolve the network performance problem.

Although this COMPAQ TechNote focuses on hardware and operating system software, other factors, such as applications, network protocols, and other hardware also affect network performance. Address these factors in your analysis of the network environment to ensure that your diagnosis of the network performance problem is accurate and complete.

To help you with the network performance management process, this chapter includes a set of checklists and a set of accompanying flow diagrams for use during network analysis. This set of Performance Management worksheets and flow diagrams address performance analysis as follows:

- Workstation
- Ethernet Server
- Token Ring Server
- All Servers



Use these Performance Management flow diagrams and worksheets in the following manner:

1. Begin the network performance analysis using Table 10-1, Performance Analysis/Management Checklist for Workstations, and Figure 10-1, Workstation Analysis Flow Diagram.
2. Depending on your network environment, use either Table 10-2, Performance Analysis/Management Checklist for Token Ring, and Figure 10-2, Token Ring Analysis Flow Diagram, or Table 10-3, Performance Analysis/Management Checklist for Ethernet, and Figure 10-3, Ethernet Analysis Flow Diagram, to evaluate the network communication subsystem.
3. Use Table 10-4, Performance Analysis/Management Checklist for All Servers, and Figures 10-4 and 10-5, Network Server Analysis Flow Diagram, to evaluate the network server subsystems, including system memory and hard drive subsystems.

The circled numbers in the flow diagrams correspond to the steps listed in the checklists. Use the following checklists to track performance management and troubleshooting and to document the steps taken during this process.

**Table 10-1**  
**Performance Analysis/Management Checklist for Workstations**

YES	NO	
		<b>1. Is only one workstation experiencing slow response time?</b>
		Y) Does the response time fit within the acceptable range of performance?
		N) Is a group of workstations running the same application?
		<b>2. Did the workstation NIC diagnostics fail?</b>
		Y) Replace the NIC.
		N) Is the workstation NIC device driver the latest version? If YES, go to Question 3. If Token Ring, verify that the workstation packet size matches the server packet size. If NO, update the workstation NIC device driver to the latest version.
		<b>3. Is the application providing slow response time? (Isolate the workstation, and run the application as standalone.)</b>
		Y) Is the application network aware? If YES, check the application parameters and communicate expectations to the workstation user. If NO, try to localize the data, overlay files, and temporary files created by the application to the workstation hard drive. Communicate expectations to the user.
		N) Is the amount of workstation memory adequate for running the application? If YES, install COMPAQ DOS CACHE Utility, and go to Question 4. If NO, add memory to the workstation.
		<b>4. Does the application run better on a faster PC (286, 386, or 486)?</b>
		Y) Upgrade to a faster workstation, or communicate expectations to the workstation user.
		N) Check the physical network, then the server. Reset expectations.



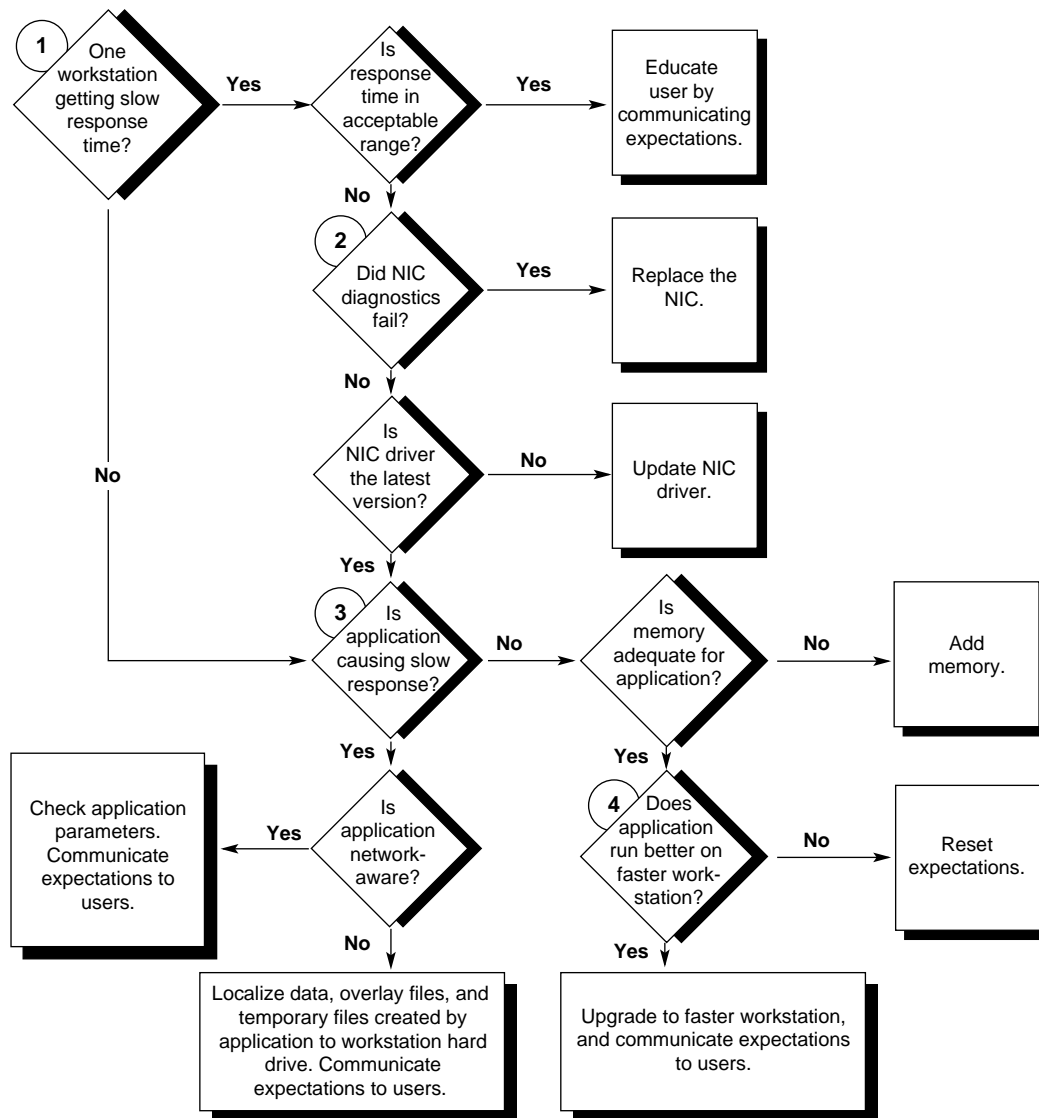


Figure 10-1. Workstation Analysis Flow Diagram





**Table 10-2**  
**Performance Analysis/Management Checklist for Token Ring**

YES	NO	
		<b>1. Does network bandwidth utilization exceed 60 percent? (Use monitoring software or protocol analyzer to check bandwidth.)</b>
		Y) Redistribute the load by adding a new ring and redistributing the workstations over two rings.
		N) Go to Question 2.
		<b>2. Is the server maximum packet size set to maximum value?</b>
		Y) Is the workstation packet size equal to the server packet size? (Use a protocol analyzer to view packet sizes of all connected workstations.) If YES, go to Question 3. If NO, change the packet size to the maximum value (for example, 4202 for 16-Mbps or 2154 for 4-Mbps)
		N) Change the packet size to the maximum value (for example, 4202 for 16-Mbps or 2154 for 4-Mbps)
		<b>3. Does the server display the "No ECB Counts Available" message?</b>
		Y) Check the SET MINIMUM PACKET RECEIVE BUFFERS parameters. Verify that the value equals 10 buffers per NIC + 1 buffer per user. Check the SET MAXIMUM PACKET RECEIVE BUFFERS parameter. Verify that the value is greater than the value of minimum packet receive buffers. Check cache buffers statistics in <i>MONITOR.NLM</i> to ensure that the server has enough memory.
		N) Verify that the cabling system meets Token Ring cabling specifications.



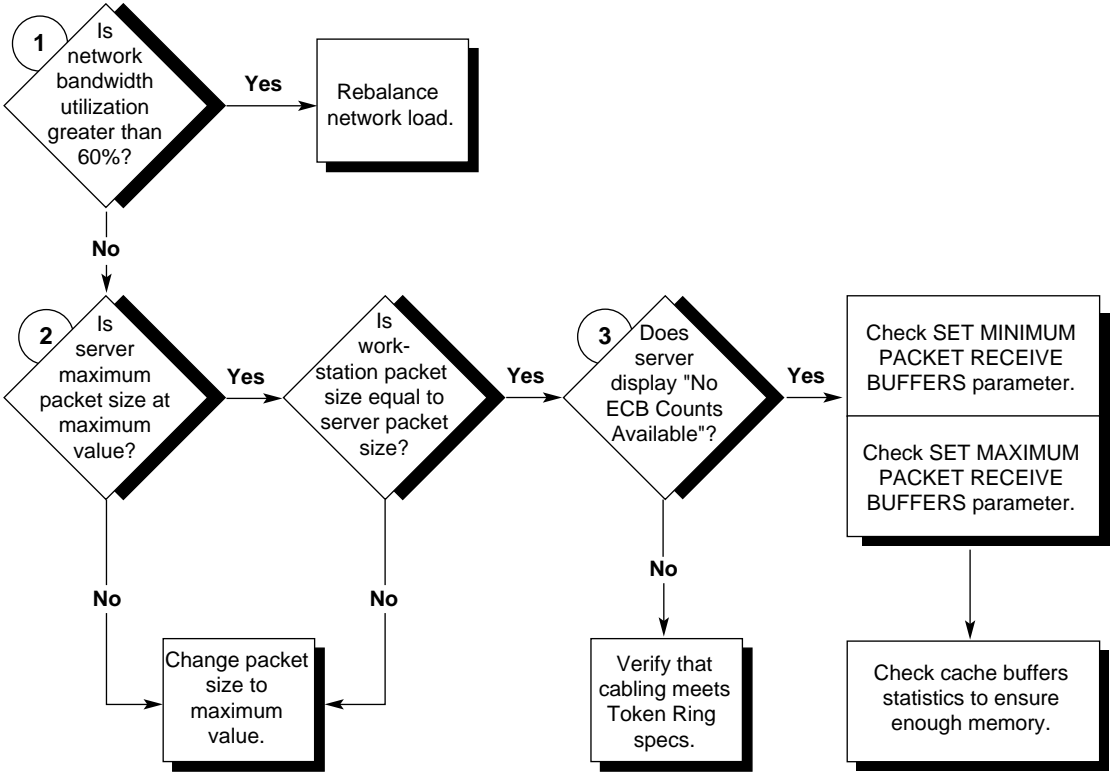


Figure 10-2. Token Ring Analysis Flow Diagram



**Table 10-3  
Performance Analysis/Management Checklist for Ethernet**

YES	NO	
		<b>1. Do packet collisions total more than 2 percent? (Use protocol analyzer to verify.)</b>
		Y) Did the server NIC diagnostics fail? If YES, replace the server NIC. If NO, go to Question 2.
		N) Go to Question 3.
		<b>2. Did the network pass the protocol analyzer's cable test?</b>
		Y) Rebalance the network load, by adding another NIC to the server and redistributing workstations between the NICs.
		N) Repair the network cabling.
		<b>3. Do Deferred Transmissions exceed 10? (Use <i>MONITOR.NLM</i> Custom Statistics.)</b>
		Y) Rebalance the network load, by adding another NIC to the server and redistributing workstations between the NICs.
		N) Go to Question 4.
		<b>4. Does the server display the "No ECB Counts Available" message? (Use <i>MONITOR.NLM</i>.)</b>
		Y) Check the SET MINIMUM PACKET RECEIVE BUFFERS parameters. Verify that the value equals 10 buffers for each NIC + 1 buffer for each user. Check the SET MAXIMUM PACKET RECEIVE BUFFERS parameter. Verify that the value is greater than the value of minimum packet receive buffers. Check cache buffers statistics in <i>MONITOR.NLM</i> to ensure that the server has enough memory.

		N) Verify that the cabling system meets Ethernet cabling specifications.
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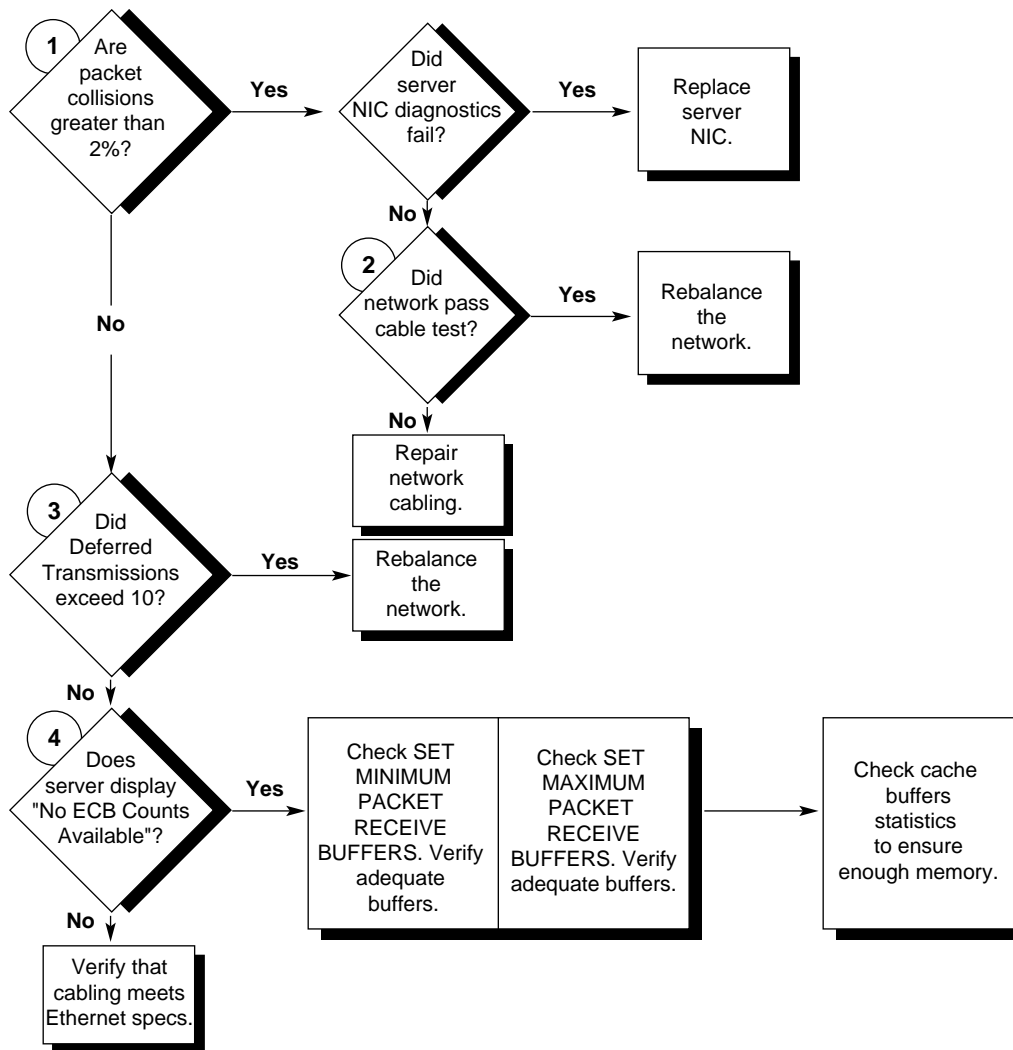


Figure 10-3. Ethernet Analysis Flow Diagram





**Table 10-4**  
**Performance Analysis/Management Checklist for All Servers**

YES	NO	
		<b>1. Is <i>MONITOR.NLM</i> Utilization value greater than 80 percent?</b>
		Y) Go to Question 2.
		N) Check workstation or physical network for performance problem. (Use checklists for workstation and Ethernet or Ethernet.)
		<b>2. Does Cache Buffer Size match the Volume Block Size? (Use <i>INSTALL.NLM</i> Volume option to verify Volume Block Size. Use SET command to view the Cache Buffer Size.)</b>
		Y) Go to Question 3.
		N) Change the cache buffer size to match the volume block size up to 16 Kbytes. (See Table 5-3 of this COMPAQ TechNote.)
		<b>3. Is SET IMMEDIATE PURGE OF DELETED FILES disabled? (Use SET command to view status.)</b>
		Y) Go to Question 4.
		N) Set the parameter value to OFF.
		<b>4. Is the <i>MONITOR.NLM</i> Cache Buffers value greater than 70 percent? (Use <i>MONITOR.NLM</i> Resource Utilization screen.)</b>
		Y) Go to Question 5.
		N) Add system memory until this value exceeds 70 percent.

*Continued*

Table 10-4 continued

YES	NO	
		<p><b>5. Is the value of the <i>MONITOR.NLM</i> Dirty Cache Buffers greater than 70 percent of the Total Cache Buffers value?</b></p>
		<p>Y) Is the Current Disk Requests value greater than 70?            If YES, go to Question 6.            If NO, then environment is <i>write-intensive</i>. Verify by using INSIGHT Manager. <i>Increase values</i> of SET CONCURRENT DISK CACHE WRITES and SET DIRTY CACHE DELAY TIME parameters.</p>
		<p>N) Is the Current Disk Requests value greater than 70?            If YES, then environment is <i>read-intensive</i>. Verify by using COMPAQ INSIGHT Manager.  <i>Decrease values</i> of SET CONCURRENT DISK CACHE WRITES and SET DIRTY CACHE DELAY TIME parameters.            If NO, upgrade to a faster processor in the network server, or add a new server and rebalance the network load.</p>
		<p><b>6. Is the network environment either read-intensive or write-intensive? (Use COMPAQ INSIGHT Manager to verify.)</b></p>
		<p>Y) Check SET Parameters, and go to Question 7.            If <i>write-intensive</i>, <i>decrease values</i> of SET CONCURRENT DISK CACHE WRITES and SET DIRTY CACHE DELAY TIME parameters.            If <i>read-intensive</i>, <i>increase values</i> of SET CONCURRENT DISK CACHE WRITES and SET DIRTY CACHE DELAY TIME parameters.</p>
		<p>N) Add hard drives or a hard drive controller and rebalance the load.</p>
		<p><b>7. Is Current Disk Request value still greater than 70?</b></p>
		<p>Y) Add hard drives or a hard drive controller, and rebalance the load.</p>
		<p>N) End.</p>

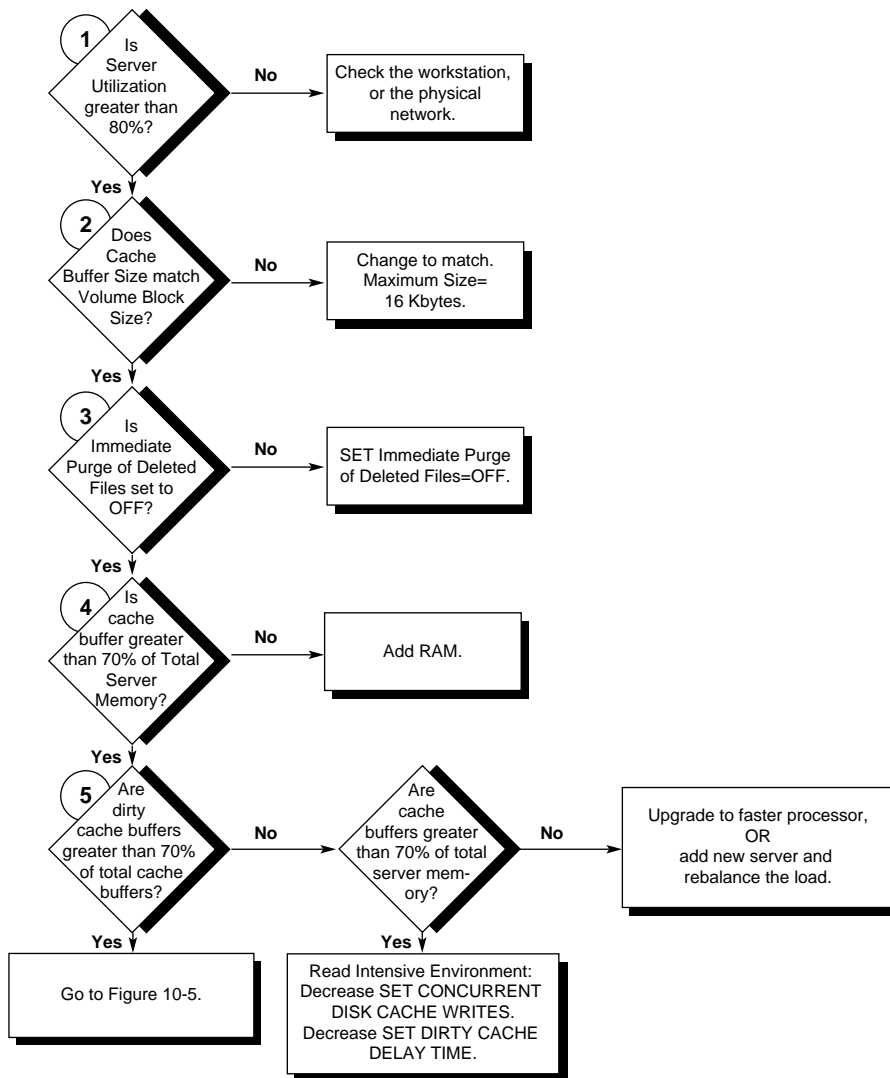


Figure 10-4. Network Server Analysis Flow Diagram (1 of 2)



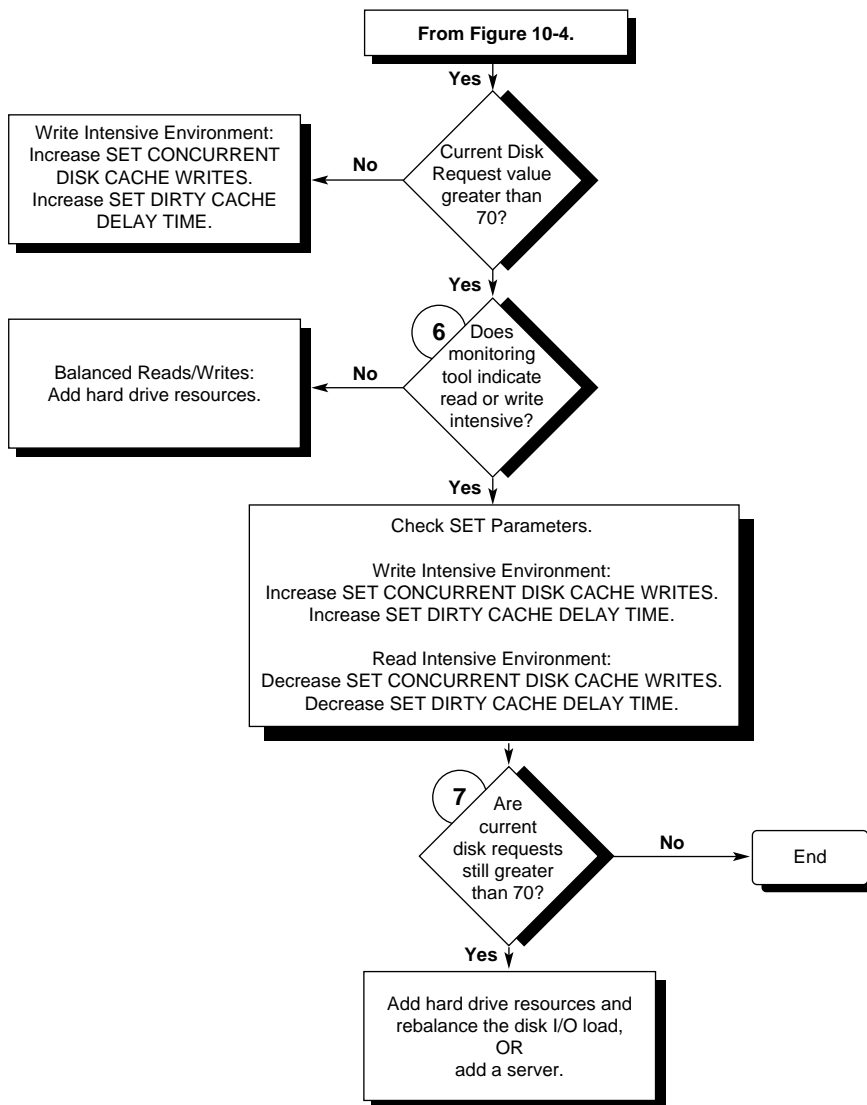


Figure 10-5. Network Server Analysis Flow Diagram (2 of 2)



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