

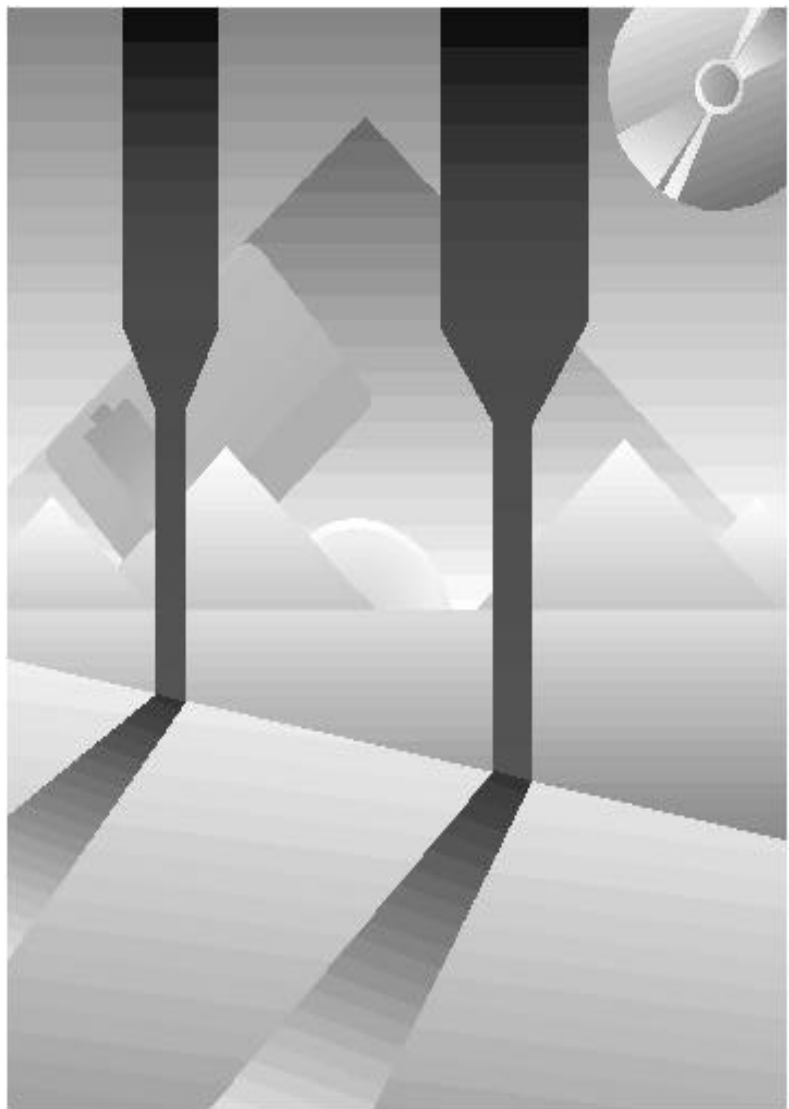
COMPAQ

Sybase SQL Server 4.2.2 for NetWare: Tuning & Performance

Compaq TechNote

Includes information on:

- Planning and configuration guidelines
- Tuning and performance recommendations



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Chapter 1

About This TechNote

The purpose of this TechNote is to provide you with general guidelines on configuration, performance tuning, and monitoring of Sybase SQL Server 4.2.2 running on NetWare 3.11 and 4.01. At this time, Sybase does not support SQL Server 4.2.2 running on NetWare 3.12 or SFT III. The information presented here is based on technical knowledge acquired by Compaq System Engineers while testing these products in a closely controlled and monitored environment. By sharing this information with you, Compaq hopes to provide a better understanding of the performance capabilities of the Compaq ProLiant, ProSignia, and Systempro families of servers.

This TechNote is for system integrators and network administrators with a knowledge of Compaq Server products, Sybase SQL Server, and NetWare. It is a supplement to the *Compaq Hardware Reference* documentation and the *Sybase SQL Server for Novell NetWare* documentation. This TechNote provides:

- General planning and configuration guidelines
- Performance tuning and monitoring for Sybase SQL Server for Novell NetWare

The chapters in this Compaq TechNote contain the following information:

- **Chapter 1** -- Introduces the TechNote with a brief summary of each chapter, general information about notational conventions used, and additional resources you can use to find more information about Sybase and NetWare.
- **Chapter 2** -- Provides system processor, memory, disk subsystem, and network guidelines.
- **Chapter 3** -- Provides Sybase SQL Server tuning parameters and monitoring using Compaq Insight Manager.
- **Chapter 4** -- Provides a tuning and performance checklist.

- **Appendix A** -- Provides information on how to get individual Compaq TechNotes, including location of Web site, pricing information, toll free telephone numbers, and a list of the latest TechNotes available.
- **Glossary** -- Defines server management and related networking terms.

Notational Conventions

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

Convention	Use
CAUTION	Indicates that failure to follow directions could result in damage to equipment or loss of information.
COMMANDS, DIRECTORY NAMES, DRIVE NAMES, PROGRAMS, and UTILITIES	These items always appear in uppercase in DOS and in other environments.
<i>FILENAMES</i>	Names of files appear in uppercase italics in DOS and in other environments.
Get, Set	Screen button labels appear in bold initial caps.
! IMPORTANT	Presents clarifying or specific points of information.
<i>items of importance</i>	Presents important or specific points of information. These items appear in italics in all chapters of this TechNote.
Keys	Keys on your keyboard appear in boldface.

continued

Notational Conventions *continued*

Convention	Use
Key+Key	When you see a plus sign (+) between two keys, hold down the first key while you simultaneously press the second key. For example, "Press the Ctrl+Z keys" means press and hold down the Ctrl key while you press and release the Z key.
"new terms" and "prompts"	The first occurrence of a technical term, prompts, or references to a word other than a command appears in quotes.
NOTE	Presents commentary, sidelights, or interesting points of information.
<i>screen selections and variables</i>	These items appear in italics in all chapters of this TechNote.
Select item → item → item	Items separated by arrows indicate menu items you select in a sequence.
type	When instructed to type information, do so without pressing the Enter key.
User input and screen displays	Information you type exactly as it appears on the screen.
WARNING	Indicates that failure to follow directions could result bodily harm or in damage to equipment.

Other Resources To Use

You may want to consult the following resources for additional information on obtaining the best possible performance and throughput with Sybase SQL Server for Novell NetWare:

- Compaq TechNote: *Configuring Compaq RAID Technology for Database Servers*, P/N 184206-001.

The Compaq TechNote, *Configuring Compaq RAID Technology for Database Servers*, provides general help to determine the best configuration of the Compaq SMART SCSI Array Controller for database server needs. It also contains information on Compaq drive subsystem terminology and RAID.

■ *Sybase SQL Server for Novell NetWare* documentation.

The *Sybase SQL Server for Novell NetWare* documentation set provides installation and troubleshooting guidelines, as well as a system administration guide.

- *Sybase SQL Server Release Bulletin and Installation Guide for Novell NetWare*, Document ID: 34401-01-0420-01.
- *Sybase SQL Server System Administration Guide for Novell NetWare*, Document ID: 32491-01-0420-01.
- *Sybase Troubleshooting Guide for Novell NetWare*, Document ID: 35901-01-0100-01.

■ Sybase Technical Support for Engineering Bug Fixes (EBFs).

Sybase Technical Support provides a toll-free hotline for technical support of Sybase SQL Server. Contact Sybase at 1-800-8-Sybase to get the latest updates for Sybase SQL Server.

■ NetWire on CompuServe.

NetWire is a fairly inexpensive way to get up-to-date advice and patches on the CompuServe bulletin board. To open a CompuServe account, call one of the following numbers:

- In the United States or Canada, call (800) 524-3388.
- In the United Kingdom, call 0800-289-378.
- In Germany, call 0130-37-32.
- In other European countries, call 44-272-255-111.
- In locations other than the United States, Canada, or Europe, call (614) 457-0802. Ask for "Representative 200," which identifies you as a Novell customer.

- Compaq Insight Server Management Technical Communiqué.
- *Compaq Insight Manager* documentation.

The *Compaq Insight Manager* documentation can deliver perceptible fault, performance, and configuration management capabilities for all key server subsystems in a variety of operating environments.

- *Compaq Hardware Reference* documentation.

The *Compaq Hardware Reference* documentation can help isolate a problem to a certain computer component or cable segment. Some network problems occur because of malfunctioning hardware; check the documentation that came with the hardware involved.

NOTE: These are not the only sources of information, this list is not intended to be all comprehensive of the materials available but access to these materials will be of benefit to the reader.

Chapter 2

General Planning and Configuration Guidelines

This chapter provides planning and configuration guidelines for the following:

- System Processor
- Memory
- Disk Subsystem
- Network

The results presented here are based upon various tests run on Compaq ProLiant, ProSignia, and Systempro families of servers. For most of the testing, NetWare 3.11 was utilized in conjunction with the latest patches and library updates available from the Novell Forum on CompuServe. These patches and updates are also available from your local NetWare software support office. See “Other Resources To Use” discussed previously in this TechNote for more information on CompuServe and Sybase Technical Support. The Sybase SQL Server 4.2.2 with Engineering Bug Fix (EBF) #2388 was used in our testing. See “Tips for Installing EBFs” of this TechNote for more information on EBFs.

Installation Tips for Upgrading or New Sybase SQL Servers

Most problems encountered with Sybase 4.2.2 and NetWare can be avoided by paying close attention to the revision levels of the device drivers and library routines installed on your system. Table 2-1 lists the Novell files that can have an impact on Sybase SQL Servers’ ability to load and execute without causing abends.

**Table 2-1
Novell Files**

CLIB.NLM	DIBI\DIBIDAI.NLM	DIBI\NOVADIBI.NLM
DIBI\WANGTEK.NLM	DIRECTFS.NLM	DR\SIDR.NLM
IPXS.NLM	MATHLIB.NLM	MATHLIBC.NLM
NFS113.RTP	NFS113.TXT	PATCH.EXE
PHYSADDR.DSK	SBACKUP.NLM	SPXS.NLM
STREAMS.NLM	TAPEDAI.DSK	TCPIP.NLM
TLI.NLM	TSA.NLM	TSA\TSA-311.NLM

Updated revisions of these files are on the Sybase SQL Server distribution diskettes. Before loading or upgrading Sybase SQL Server, follow these steps:

1. Check the revision levels of your currently installed Novell files using the *MODULES.NLM* or the *VERSION.EXE* program.
2. Check the revision levels of these files on the Sybase SQL Server distribution diskettes.
3. Install and use the most recent revisions of these files.

When you have the most recent revisions of these files, proceed to load or upgrade the Sybase SQL Server.

Tips for Installing EBFs

Engineering Bug Fixes (EBF) diskettes received from Sybase Technical Support may not include the necessary Novell file updates needed for the upgrade to function properly. Before installing the EBF, check the revision levels of your currently installed Novell files. Refer to the documentation that came with the EBF for details. You may have to obtain updated Novell files from NetWire on CompuServe or your local Novell reseller. See "Other Resources To Use" discussed previously in this TechNote for more information on NetWire.

For example, the documentation that accompanied EBF #2388 contained the following information:

NetWare 3.11

The following version (or newer) of device driver and library routine is required for EBF #2388 to function properly under NetWare 3.11:

CLIB.NLM3.12dJan 3, 1994

Additionally you will have to manually load *DIRECTFS.NLM* before starting the SQL Server.

NetWare 4.01

The following version (or newer) of device driver and library routine is required for EBF #2388 to function properly under NetWare 4.01:

CLIB.NLM4.01dJan 3, 1994

System Processor Planning

When planning for system processor upgrades, you should evaluate tests on CPU scaling. Figure 2-1 illustrates the performance gains that can be accomplished when moving up to a faster CPU. The Memory Test assumes an ideal transaction processing environment where all of the data requests are resident in the Sybase SQL Server memory area. The Disk Test is more typical of a normal user transaction processing environment where the data requests are larger than the Sybase SQL Server memory area thus forcing I/O to the disk subsystem.

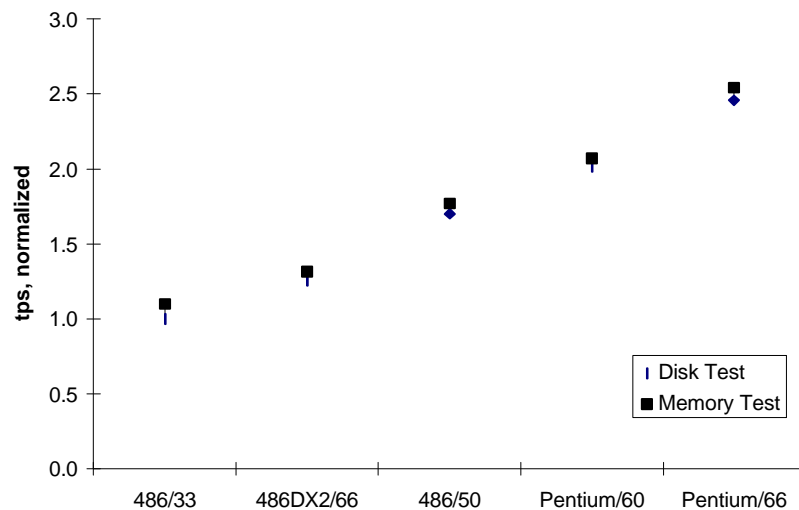


Figure 2-1. CPU Scalability for SYBASE.NLM 4.2.2

Using a normalized transactions per second (tps) scale, where a 486/33 is capable of 1 normal tps, a Pentium/66-based server is capable of 2.5 normal tps. This is roughly twice the throughput of the 486DX2/66-based server. Upgrading to a faster CPU will not improve your system if it's experiencing an I/O "bottleneck."

Novell NetWare 3.1x and 4.01 operating systems support only single CPU processor systems. Therefore the addition of the second, third, or fourth CPU processor board results in no increased performance or throughput.

On some Compaq servers the second level cache is an option. Compaq does not recommend running in a database environment without the second level cache installed and enabled.

Memory Planning

When planning memory requirements, you should evaluate the initial memory recommendations, other memory considerations, and common memory problems and solutions as described in the following sections.

Initial Memory Recommendations

Sybase recommends a minimum of 12 megabytes of memory to install and run Sybase SQL Server. These initial memory requirements may need to be increased based upon the number of users, complexity of queries, number of disk controllers and NICs, amount of total disk storage, and intensity of the workload in your environment.

For each user, the Sybase SQL Server allocates approximately 40 Kbytes for the users' stack area and an additional 5 to 10 Kbytes for the users' procedure cache. Therefore to estimate the minimum memory requirements for a 512 user system simply follow this formula:

$$(512 \times 50 \text{ KB}) + 12 \text{ MB} = 37 \text{ MB}$$

In our testing, we have found that a minimum of 24 megabytes for NetWare 3.11 and a minimum of 32 megabytes for NetWare 4.01 is the best starting configuration for most environments.

.....

2-6 General Planning and Configuration Guidelines

To determine the memory utilization of Sybase SQL Server while running, follow these steps:

1. Load Monitor.
2. Select *Resource Utilization*.
3. Look at the number of Cache Buffers. This is how much of the Total Server Work Memory is available on the server.

NOTE: The default size of a NetWare buffer is 4 Kbytes for both NetWare 3.1x and 4.01. Under NetWare 3.1x this size can be altered by using the SET CACHE BUFFER SIZE equal to a value between 4096 and 16384.

Increasing the SP_CONFIGURE value for MEMORY decreases the number of "Cache Buffers" and increases the number of "Non-Moveable Memory." For non-dedicated application servers the percentage of "Cache Buffers" should never drop below 50%. For dedicated application server the percentage of "Cache Buffers" can be reduced to the range of 20 to 30%. If the percentage of "Cache Buffers" falls below these values you will either have to reduce the value for SP_CONFIGURE MEMORY, unload unnecessary NLMs, or add more memory to the system.

Check the SET parameter for MINIMUM NUMBER OF CACHE BUFFERS. Its default value is 20. If this is set too high Sybase SQL Server will not be able to allocate the memory it needs. You may have to SET this parameter to a lower value if Sybase SQL Server starts generating memory allocation errors. Use the **CPERRLOG** utility to dump the contents of the Sybase errorlog file to a text file. On a regular basis, scan the errorlog file looking for error messages.

Other Memory Considerations

NetWare volume block size can be altered at volume creation time to be in the range of 4 to 64 Kbytes. Using a volume block size of 64 Kbytes allows NetWare to manage a smaller number of large I/O blocks, thus reducing the I/O overhead. In NetWare 3.11 if the volume block size has been altered, the corresponding SET CACHE BUFFER SIZE value can be increased to match the volume block size or the maximum value of 16384. Larger volume block sizes consume fewer buffers thus leaving more memory available for Sybase SQL Server.

Common Memory Problems and Solutions for NetWare 3.11

The following four examples are some common errors that can occur when attempting to perform standard NetWare commands:

- Unable to mount NetWare volume
- Memory error on load of NLM
- Memory error on unload of NLM
- Unexplainable server abends and memory fragmentation

This information is usually displayed on the NetWare Console Screen and logged into the *SYSTEM/SYS\$LOG.ERR* file.

Unable to Mount NetWare Volume

This error occurs when attempting to mount a NetWare volume on a server that has insufficient memory available to cache the directory and file structures of the volume.

```
:MOUNT VOLUME2
```

```
1.1.40 Number of cache buffers is getting too low.
```

```
Mounting VOLUME2
```

```
Insufficient memory available to mount volume.
```

Volume VOLUME2 NOT mounted.

1.1.38 Cache memory allocator exceeded minimum cache buffer left limit.

To remedy this problem try the following options, which are listed in order of easiest to hardest:

- For NetWare 3.11 only, if various NLMs have been loaded and unloaded, memory may have become fragmented. Stop and restart the server; this will insure that memory fragmentation is reduced.
- SET MINIMUM NUMBER OF CACHE BUFFERS to a lower value and restart the server.
- Change the order of **LOAD** and **MOUNT** commands in *AUTOEXEC.NCF* and *STARTUP.NCF* files to **MOUNT** volumes before loading additional NLMs. Restart the server.
- Do not load unnecessary NLMs.
- Add more memory to the system.
- Use larger NetWare volume block size, if possible. This will require you to back up the existing data, delete the existing volume, recreate the volume with new block size, and restore the data.

Memory Error on Load of NLM

This error occurs when you have insufficient memory resources available to properly load and execute a NLM.

:LOAD SQLSRVR

1.1.39 Cache memory allocator out of available memory.

In this case, the Sybase SQL Server can actually load and execute properly. NetWare is running dangerously low on available memory for it to perform its normal management tasks. Your server may abend for seemingly unknown reasons if NetWare is unable to allocate enough memory for its use in performing management tasks.

To remedy this problem try the following options, which are listed in order of easiest to hardest:

- SET MINIMUM NUMBER OF CACHE BUFFERS to a lower value and restart the server.
- Reconfigure Sybase SQL Server to use less memory (for example, SP_CONFIGURE "MEMORY").
- Add more memory to the system.

Memory Error on Unload of NLM

This error occurs when unloading a NLM that does not release all of the resources it has allocated.

```
:UNLOAD MYNLM
```

```
1.1.14 Module did not release 72 resources.
```

```
Module: NetWare 3.x MYNLM
```

```
Resource: Small memory allocations.
```

```
Description: Alloc Short Term Memory (Bytes)
```

```
or
```

```
1.1.16 Module did not release 72 resources.
```

```
Module: NetWare 3.x MYNLM
```

```
Resource: Large memory allocations.
```

```
Description: Alloc Short Term Memory (Bytes)
```

These errors are not fatal but are a result of the NLM not properly releasing memory back to the memory pool. This memory will be recovered when NetWare performs memory garbage collection. Until then, the memory will be unavailable for other processes to use. If these type of errors happen on a regular basis, increase the amount of system memory in the server.

Unexplainable Server Abends and Memory Fragmentation

Unexplainable NetWare and Sybase SQL Server abends occur on a server that is experiencing severe memory fragmentation. Memory fragmentation occurs when NLMs are repeatedly loaded and unloaded.

There are a couple of ways to minimize memory fragmentation. The simplest is to avoid doing NetWare and Sybase SQL Server administrative tasks at the server console. Repeated loading and unloading of NLMs can result in memory fragmentation; when the available memory runs too low the server will abend. Perform as many of these tasks as possible from a remote workstation via NetWare remote console feature and/or Sybase **ISQL** utility.

The other remedy is to periodically stop the Sybase SQL Server and NetWare, then restart them to “reset” the memory allocations and eliminate the memory fragmentation. This is usually not an option for most Sybase SQL Server installations.

Disk Subsystem Planning

When planning for disk subsystems, you should consider using drive fault tolerance systems, array accelerator, the Compaq SMART SCSI Array Controller, and database striping as described in the following sections.

Drive Fault Tolerance Systems

Use the hardware features of the Compaq SMART SCSI Array Controller to provide RAID1 and RAID5 for environments that require fault tolerance. Try to avoid using Novell controller duplexing, because it will use CPU cycles that otherwise would be available for the database engine; this can adversely affect overall Sybase SQL Server throughput. Sybase SQL Server also provides data fault tolerance via database mirroring; this also may reduce overall throughput.

See the Compaq TechNote, *Configuring Compaq RAID Technology for Database Servers*, for additional information on RAID and Compaq disk controllers.

Array Accelerator

Compaq Array Accelerator on the IDA-2 and SMART controllers provide substantial performance improvements for database activities under NetWare. Both controllers have an array accelerator consisting of a 4-megabyte mirrored posted write cache with battery backup. The fault tolerance of memory mirroring and the battery backup were implemented to ensure the integrity of the database system. Both controllers can provide data fault tolerance for the operating and database system. See the Compaq TechNote, *Configuring Compaq RAID Technology for Database Servers*, for more detailed information.

To determine the benefit the Array Accelerator cache has on performance, a 486DX50 system was configured with a single Compaq SMART SCSI Array Controller. On the SMART controller port #1, 4x1 gigabyte drives were configured as a single logical drive array volume using RAID1. This was then configured under NetWare as a single volume for the system and transaction log files. On controller port #2, 7x1 gigabyte drives were configured as a second logical drive array volume using RAID0. This second volume was configured under NetWare as a single volume for the user database files. A series of performance tests were performed by enabling and disabling the array accelerator cache on a logical drive array volume basis via the Compaq System Configuration utility, as shown in Figure 2-2.

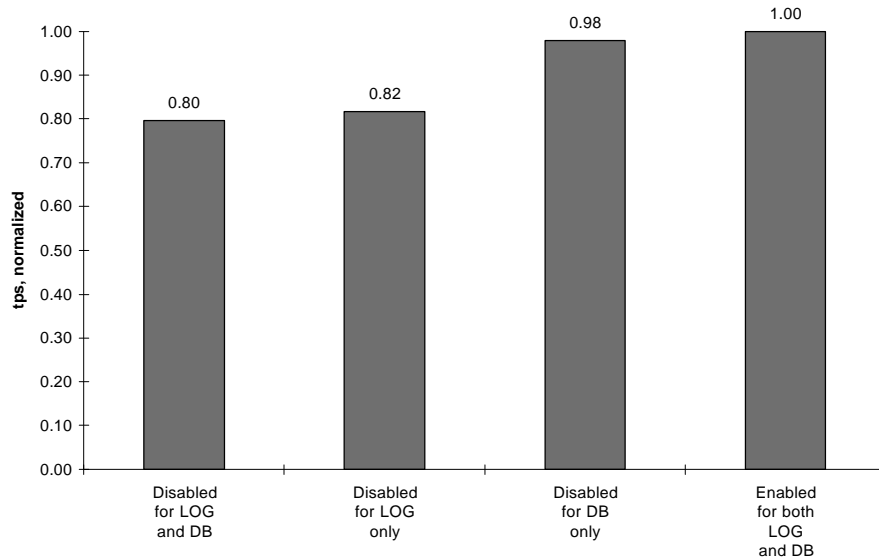


Figure 2-2. Effect of Disabling SMART Array Accelerator

The database files were being accessed randomly for both reads and writes. The log file was being accessed sequentially for writes only. Having the array accelerator enabled for both the database and log file access resulted in the best performance. Disabling the array accelerator for the database access resulted in a performance loss of 2%. Disabling the array accelerator for the log access resulted in a performance loss of 18%. Because the Compaq Array Accelerator is a 4-megabyte mirrored posted write cache, greater performance benefits occurred when performing writes as opposed to reads.

Compaq SMART SCSI Array Controller and Database Striping

The Compaq SMART SCSI Array Controller does perform excellent I/O load balancing with a single controller. However, you need to perform manual striping across multiple SMART controllers to receive the maximum possible performance benefits in your client server environment. Good basic database design techniques such as database striping, horizontal partitioning, multiple databases, and other techniques can have a big effect on performance. See the Compaq TechNote, *Configuring Compaq RAID Technology for Database Servers*, for additional information on database design for fault tolerance using Compaq disk controllers.

For example, a system where the customer account table consists of a large number of customers. At creation/load time the data was written sequentially into the table and is accessed in a random fashion for updates. The entire customer account table is stored on a single NetWare disk volume of one Compaq SMART SCSI Array Controller.

At first the client workstation response time was acceptable, but as the number of accounts and workstations increased the users started complaining about a slow down in response time. The System Administrator determined that an I/O bottleneck occurs on the account table. To alleviate the problem a second Compaq SMART SCSI Array Controller and additional hard drives were added to the system. The customer account table was expanded to use both volumes. Users still complained about poor response times.

Upon investigating the problem, it was discovered that the I/O “bottleneck” still existed on the customer account table. The problem is that the account data is not evenly distributed across both disk volumes. The disk workload is the first disk volume still is receiving most of the data requests.

The following example shows the code used to generate the disk load imbalance and a method that would help balance the disk workload across both volumes.

.....

2-14 *General Planning and Configuration Guidelines*

NetWare Volume1 on the first Compaq SMART SCSI Array Controller consists of seven 550 megabyte drives; Volume2 on the second Compaq SMART SCSI Array Controller also consists of seven 550 megabyte drives. During database initialization the segments Acct1 and Acct2 are created on Volume1 and Volume2 respectively. Data is loaded sequentially into the account table.

ISQL

....

```
1> disk init name = "acct1",
2>physname = "volume1:acct1.dat",
3>vdevno = 5,
4>size = 512000
5> go
```

```
1> disk init name = "acct2",
2>physname = "volume2:acct2.dat",
3>vdevno = 6,
4>size = 512000
5> go
```

...

```
1> create database mycustomers on
2>acct1 = 1024, acct2 = 1024,
```

....

```
1> exec sp_addsegment acct, acct1
2> go
```

...

```
1> exec sp_extendsegment acct, acct2
2>
```


The imbalance was generated in the “create database ...” statement when the striping of data was specified as “acct1=1024, acct2=1024.” This means that when the data is loaded sequentially into the account table, the data would have to completely fill the acct1 segment before utilizing any of the space of the acct2 segment.

A better disk load balance would be provided by forcing data striping of the account data across the 2 disk volumes. To do this, simply replace the “create database...” statement with the one in the following code fragment.

```
....  
1> create database mycustomers on  
2>acct1 = 128, acct2 = 128,  
3>acct1 = 128, acct2 = 128,  
4>acct1 = 128, acct2 = 128,  
5>acct1 = 128, acct2 = 128  
...
```

This segments the account table across both disk volumes. Note that the Sybase SQL Server 4.2.2 has a limitation of 32 segments per database. A solution to work around this limitation is to create multiple databases. The limitation on the number of databases is 256.

Now when the data is reloaded into the account table, the data is written sequentially in alternating blocks to both Acct1 and Acct2 disk volumes.

Network Planning

When planning a network, you should consider the network characteristics of Sybase SQL Server environments, network interface controllers, network protocols, and frame types as described in the following sections.

Network Characteristics of a Sybase SQL Server Environment

A client workstation assembles a group of Sybase SQL commands and submits them for execution by the database server. The server processes the commands and returns the resultant data. Rather than having the client workstation send a huge grouping of Sybase SQL commands, you should profile the queries. Determine if any of the queries are candidates for conversion to stored procedures. A stored procedure is a grouping of “standardized” Sybase SQL query commands that are pre-compiled and placed into the procedure area of the database by the System Administrator. The stored procedure can then be referenced by name for execution. Utilizing stored procedures for most of the standard DBMS activities reduces the amount of network traffic and uses less server CPU resources to process the query.

Network Interface Controllers: NetFlex and NetFlex-2

NetFlex-2 utilizes a burst mode packet accelerator that greatly improves the response time where you have a large number of relatively small packets to process. However, both the server and clients must have network cards that support burst mode packets. You should enable burst mode packet features of both client workstations and server network cards to take advantage of the improved throughput. Packet burst mode is enabled by default in NetWare versions 3.11 and 4.01. The Compaq Ethernet 16TP Controller, typically used in client workstations, also utilizes packet burst mode by default.

Network Protocols: TCP/IP and SPX/IPX

Sybase SQL Server supports both TCP/IP and SPX/IPX protocols. Using TCP/IP can provide up to a 10% performance improvement over SPX/IPX. Additionally, TCP/IP provides connectivity to a wide variety of dissimilar CPU platforms. Do not change your network from SPX/IPX to TCP/IP just for the increased performance. You will have to determine if the extra administrative task of managing IP addresses across the network will outweigh the performance advantage.

With TCP/IP services installed on the SQL Server, you can provide connectivity to other diverse environments, such as UNIX-based servers, UNIX-based workstations, non-PC platforms (RISC systems), and DOS-based PCs.

With SPX/IPX services installed on the SQL Server, you can provide access of Novell NetWare clients with access to the database system and connectivity to other Novell NetWare servers for database, file, and printer services.

Frame Types: 802.3, 802.2 and Ethernet_II

NetWare 3.11 and 4.01 provide support for Ethernet_802.3, Ethernet_802.2 and Ethernet_II frame types. Problems can arise when both NetWare 3.11 and NetWare 4.01 servers coexist on the same physical network because NetWare 3.11 defaults to frame type Ethernet_802.3 and NetWare 4.01 defaults to Ethernet_802.2. To alleviate this problem, you can load and bind both frame types to the same network on each server. As time permits you can then migrate your client workstations to the Ethernet_802.2 frame type and eventually eliminate the usage of the Ethernet_802.3 frame type.

Example from *AUTOEXEC.NCF*:

```
LOAD CPQETHER NAME=NW-IPX-3 SLOT=5 FRAME=ETHERNET_802.3
BIND IPX TO NW-IPX-3 NET=ABC8023

LOAD CPQETHER NAME=NW-IPX-2 SLOT=5 FRAME=ETHERNET_802.2
BIND IPX TO NW-IPX-2 NET=ABC8022
```

The frame type Ethernet_II may need to be utilized instead of Ethernet 802.3 or Ethernet 802.2 if the network you are attached to also provides connectivity to networks other than Novell NetWare. This usually occurs in large, complex networks that connect dissimilar CPU platforms with TCP/IP. The following example shows both SPX/IPX and TCP/IP connectivity being provided by the server to a single network on the same NIC.

Example from *AUTOEXEC.NCF*:

```
LOAD CPQETHER NAME=NW-IP SLOT=5 FRAME=ETHERNET_II
LOAD CPQETHER NAME=NW-IPX SLOT=5
BIND IPX to NW-IPX NET=ABC2
LOAD TCPIP
BIND IP TO NW-IP ADDR=123.123.123.1 MASK=FF.FF.FF.0
```

The problem that can arise from having multiple frame types loaded is that NetWare, from time to time, will automatically search for other servers on the network. By having multiple frame types loaded NetWare sends out search packets for each frame type. This has the potential of utilizing scarce server CPU cycles and generating additional network traffic. If you need to have multiple frame types loaded and have extra CPU cycles and network bandwidth to spare, you should not have a problem. If memory is limited, attempt to migrate all users to one frame type and eliminate the loading of the unused frame type(s) in the servers *AUTOEXEC.NCF*.

When loaded, each network protocol utilizes a memory area to store its procedures, protocol stack(s) and other related information. This memory is unavailable to other processes, whether or not the protocol is used in your network environment. To conserve memory do not load unnecessary network protocols.

Chapter 3

Performance Tuning and Monitoring

This chapter provides guidelines for Novell NetWare SET parameters and Sybase SQL Server tuning parameters. Also monitoring guidelines are included using Compaq Insight Manager.

Novell NetWare SET Parameters

Typically in a file server environment you would adjust the following SET parameters to improve performance and reduce I/O response times:

- MAXIMUM CONCURRENT DISK CACHE WRITES
- DIRTY DISK CACHE DELAY TIME
- MAXIMUM CONCURRENT DIRECTORY CACHE WRITES
- MAXIMUM DIRECTORY CACHE BUFFERS
- MINIMUM DIRECTORY CACHE BUFFERS

In the Sybase client/server environment adjusting these values from their default settings will not improve performance or reduce I/O response times. This is because Sybase SQL Server communicates to the database files using the Novell Direct File System (DIRECTFS) for improved performance.

You should change the following SET parameters to these values to help improve the system throughput.

- READ AFTER WRITE VERIFY = OFF
- IMMEDIATE PURGE OF DELETED FILES = ON
- MAXIMUM PHYSICAL RECEIVE PACKET SIZE = 1130 if 10Mbps Ethernet, 4202 if 16Mbps Token-Ring, 2154 if 4Mbps Token-Ring
- CACHE BUFFER SIZE = 16384 or less if block size is less than 16 Kbytes (NetWare 3.11 only)

.....

3-2 Performance Tuning and Monitoring

- FILE DELETE WAIT TIME = 4 (NetWare 3.11 only)
- MINIMUM FILE DELETE WAIT TIME = 1 (NetWare 3.11 only)
- FILE DELETE WAIT TIME = 1 MIN (NetWare 4.01 only)
- MINIMUM FILE DELETE WAIT TIME = 30 SEC (NetWare 4.01 only)
- GARBAGE COLLECTION INTERVAL = 1 MIN (NetWare 4.01 only)

Additionally, you should pay close attention to the values displayed by the *MONITOR.NLM* and any errors that appear in the error log file and make adjustments as needed.

Some of the SET parameters that may need some adjustment are as follows:

- MINIMUM PACKET RECEIVE BUFFERS
- MAXIMUM PACKET RECEIVE BUFFERS
- MINIMUM NUMBER OF CACHE BUFFERS

Sybase SQL Server Tuning Parameters

Sybase recommends that the SQL Server NLM be run on a system dedicated to SQL Server functions; printer and file services should run on another server on the network. If the Sybase SQL Server NLM is being run on a dedicated system, you should load the Sybase SQL Server NLM with the -P command line switch. This reduces the number of process threads reserved for other NetWare services and makes them available for Sybase SQL Server to use.

SP_CONFIGURE Items

Usually the default settings for the SP_CONFIGURE parameters are sufficient for running Sybase SQL Server. If you do need to alter these parameters do so with caution. Some of the SP_CONFIGURE values take effect dynamically as you change them and yet others will require you to stop and restart Sybase SQL Server to take effect. If SQL Server determines that you are setting a value outside of its pre-determined normal guidelines, you may have to issue a RECONFIGURE WITH OVERRIDE followed by a CHECKPOINT parameter for the new value to be valid. In all cases, check via the **ISQL** routine to ensure that the SP_CONFIGURE run_value and config_value match before letting additional users onto the system.

It is possible to configure these parameters in such a way that you are unable to start Sybase SQL Server. If this happens you can reset ALL of the SP_CONFIGURE parameters to their default values via the **BLDMASTR** routine.

```
LOAD BLDMASTR -dSYS:\SYBASE\MASTER.DAT -r
```

If the number of devices your database requires exceeds the default number of 10 devices, you will not be able to start your database. To increase the number of database devices, use the command line switch -ycnvdisks=nn, where nn is the number of database devices you need. For example, if your database utilizes 25 devices, issue the following reset command:

```
LOAD BLDMASTR -dSYS:\SYBASE\MASTER.DAT -ycnvdisks=25
```

After doing a reset, start the Sybase SQL Server and login using the **ISQL** routine to check the parameter settings for SP_CONFIGURE items. You will notice that run_value and config_value settings may not agree. This is normal after a reset command has been issued. Verify that the config values are set properly, make any necessary changes, RECONFIGURE, CHECKPOINT, stop and restart the Sybase SQL Server for the config_value parameter settings to take effect. Then start the **ISQL** routine and verify that the SP_CONFIGURE parameter settings for run_value and config_value are in agreement.

SP_CONFIGURE RECOVERY INTERVAL setting should be left at the default value unless you are willing to take the risk of setting it to a higher value. If the recovery interval is set too long, the user response times will deteriorate and become intolerable when a CHECKPOINT does occur. Setting the recovery interval too short will waste valuable CPU cycles and generate excessive disk I/O. During a CHECKPOINT, the Sybase SQL Servers' data cache area is forcibly written to disk, during which time all other database activity is suspended. Immediately after a CHECKPOINT, user response times will be slightly faster than normal until the data cache area becomes filled. Once this area is filled, user response times will slow down to normal levels due to necessary disk access and memory management.

The following three SP_CONFIGURE items are intertwined:

- USER CONNECTIONS
- MEMORY
- PROCEDURE CACHE

A change in value to one of these items can affect the others. If you increase the value for number of USER CONNECTIONS you may also have to increase the value for MEMORY. If you increase the value for PROCEDURE CACHE you may also have to increase the value for MEMORY. If you increase the value for MEMORY but leave the value for number of USER CONNECTIONS unchanged, you may want to decrease the value for PROCEDURE CACHE.

SP_CONFIGURE USER CONNECTIONS setting should be set at the minimum allowable you can run with. Setting this parameter too high increases the size of the table that Sybase needs to scan when looking for new user logins or existing users logging out. You can determine the minimum value for setting this parameter by using the following procedure.

NOTE: For each user connection the Sybase SQL Server allocates approximately 40 Kbytes for the users' stack area and an additional 5 to 10 Kbytes for the users' procedure cache. You may have to readjust the SP_CONFIGURE MEMORY value depending upon the number of user connections your environment requires.

1. Assume at least 1 connection per actual client workstation, more if client workstations are capable of multiple database connections via software or multi-tasking operating systems.
2. Execute the following **ISQL** commands to determine number of devices requiring user connections:

```
1> select count(*) from master..sysdevices
2>   where cntrtype = 0
3> go
-----
          9
(1 row affected)
1> select count(*) from sysdevices
2>   where mirrorname is not NULL
3> go
-----
          0
(1 row affected)
1> select count(*) from sys.servers
2>   where srvname != @@servername
3> go
-----
          3
(1 row affected)
```
3. On quiescent systems, check for the number of background processes. Background processes will have a login name of NULL. See Table 3-1 for more details.

```
1> sp_who
2> go
```

**Table 3-1
Quiescent Systems**

spid	status	login	host	blk	database	cmd
1	running	sa	GUMP	0	master	SELECT
2	sleeping	NULL		0	master	NETWORK HANDLER
3	sleeping	NULL		0	master	MIRROR HANDLER
4	sleeping	NULL		0	master	CHECKPOINT SLEEP

(4 rows affected, return status = 0)

4. Check the current USER CONNECTION value.

```
1> sp_configure "user conn"
2> go
```

name	min	max	config_value	run_value
user connections	5	512	240	240

(return status = 0)

5. Add the total number of workstation connections; the values received from steps 2 and 3 plus 1 for server console **ISQL**. Use this total as the minimum value for SP_CONFIGURE USER CONNECTIONS. In this case, we have 20 physical workstations each running 10 client connections to the database for a total of 200 clients, 9 database devices, no mirrored database devices, 3 remote Sybase SQL Servers, 3 background processes (NULL users) and 1 user reserved for **ISQL**.

200 clients
9 db devices
0 mirrored db devices
+ 3 remote servers
3 background processors
1 for server console ISQL = 216 user connections

6. Compare step 4 and 5. The run_value of 240 user connections, as shown in step 4, should be sufficient for our server. This value could be reduced to 216, thus freeing up additional memory.
7. If the calculation for the total number of user connections needed had exceeded the value for maximum number of connections or if problems exist with devices not loading or users unable to get connections, contact Sybase Customer Support for further assistance. The maximum number of user connections tested at Compaq has been 512. See "Other Resources To Use" discussed previously in this TechNote for more information.

```
1> sp_configure "user conn", 512
```

```
2> go
```

SP_CONFIGURE MEMORY setting can be initially left at its default value of 4096. If you have a large number of active user connections or users are unable to connect to the database you will need to increase this value. The value expressed by SP_CONFIGURE is 2 Kbytes pages. This memory area is used to store the data and procedure caches. See "Initial Memory Recommendations" and "SP_CONFIGURE USER CONNECTIONS" discussed previously in this TechNote for more details on determining the proper value for this parameter. Further tuning can be done by adjusting this value up or down for best user response times.

One method to improve performance would be to set MEMORY large enough for heavily used tables and indexes to fit into the data cache area. Be careful in doing this, because setting this value higher than necessary may cause a loss of performance, not a gain. Sybase SQL Server may end up spending more time attempting to manage the data cache memory area instead of utilizing it. If you set the value for MEMORY higher than the amount of memory available to the server, you will be unable to start the Sybase SQL Server. If this occurs, use the **BLDMASTR** routine to reset the value and restart the Sybase SQL Server.

SP_CONFIGURE PROCEDURE CACHE setting is a percentage of the MEMORY that is reserved for caching of stored procedures. The initial default setting of 20 percent (4096 MEMORY pages * 20% = 820 pages) should be sufficient for most database environments.

If you are experiencing errors 701 and/or 703, you have exceeded the amount of procedure cache required to execute your queries. When this happens, your options are to increase the PROCEDURE CACHE value or increase the value for the MEMORY parameter.

Memory Utilization

If you want to view how the memory is currently being utilized, issue the **CPERRLOG** utility. This utility takes a snapshot of the Sybase SQL Server errorlog file into a text file. You can scan the text file looking for the following information.

NOTE: To get the most recent values, start at the end of the file and scan towards the beginning.

server: Number of buffers in buffer cache: 1224.

server: Number of proc buffers allocated: 306.

server: Number of blocks left for proc headers: 240.

In this example:

- 1224 pages (2.39 Mb) are allocated for the data cache.
- 240 pages (0.47 Mb) are allocated for the procedure cache.
- 306 proc buffers are allocated for compiled objects (triggers, views, stored procedures).
21 procedure buffers fit on one page.
306 proc buffers / 21 proc buffers per page = 15 pages (0.03 Mb)

Therefore, 1224 pages are used for the data cache and 255 pages are used for the procedure cache, for a total of 1479 pages (2.89 megabyte). The SP_CONFIGURE values on this system, for MEMORY and PROCEDURE CACHE are 4100 and 4. So of the 4100 pages configured for memory, only 1479 pages are accounted for in the information from the errorlog file. To see how these unaccounted pages are being used, execute the **DBCC MEMUSAGE** command.

NOTE: DBCC TRACEON(3604) redirects the output from the DBCC commands to the users console instead of the Sybase SQL Servers console.

```
1> dbcc traceon(3604)
2> go
1> dbcc memusage
2> go
1> dbcc traceoff(3604)
2> go
```

Table 3-2 shows the portion of the results on page utilization.

Table 3-2 Page Utilization			
	Meg.	2K Blks	Bytes
Configured Memory:	8.0078	4100	8396800
Code Size:	0.8083	414	847580
Kernel Structures:	1.5170	777	1590647
Server Structures:	0.8259	423	866020
Page Cache:	4.5288	2319	474896
Proc Buffers:	0.0115	6	12032
Proc Headers:	0.3164	162	331725

Table 3-2 shows how the remaining unaccounted pages are being utilized. The total of code size, kernel structures and server structures defines how much of the memory is utilized by the Sybase SQL Server itself. The remainder, the sum of page cache, proc buffers and proc headers, is available for data and procedure cache. The values shown here for page cache, proc buffers and proc headers will differ from the values obtained from the errorlog file. This is not an error; the overhead for initializing and maintaining these memory areas is not included in the **DBCC MEMUSAGE** listing. Use the values from the errorlog file for actual determination of MEMORY and PROCEDURE CACHE sizes.

The **DBCC MEMUSAGE** command also reports the memory requirements for the most often utilized stored procedures. You can sum the total memory requirements listed for those stored procedures and adjust the values for MEMORY and PROCEDURE CACHE as needed to provide the best system throughput.

If you want to view the memory requirements of all currently executing procedures, issue the **SQL** command:

```
1> select spid, program_name, cmd, trans_name, memusage from sysprocesses
2> go
```

Table 3-3 shows the results of memory usage.

Table 3-3
Memory Usage Results

spid	program_name	cmd	trans_name	memusage
1	isql	SELECT	NULL	2
2		NETWORK HANDLER	NULL	0
3		MIRROR HANDLER	NULL	0
4		CHECKPOINT SLEEP	NULL	0

The sum of the values reported for memusage represents the current amount of procedure cache in use. Compare this value to the actual values used for MEMORY and PROCEDURE CACHE and adjust your system accordingly to minimize overallocation of memory to the Sybase SQL Server.

Compaq Insight Manager v2.1

Compaq Insight Manager is a SNMP-based management tool that can monitor Compaq server hardware configuration, provide the system administrator with pre-failure warnings, remote recovery, and diagnostics. Compaq Insight Manager has two parts, the server-based agents and the client workstation MS-Windows management program. See the documentation that accompanies the Compaq Insight Manager and the *Compaq Tech Communiqué COMPAQ INSIGHT Server Management* for more detailed information.

Overhead Incurred by Compaq Insight Manager Agents on Server Performance

In this testing a Pentium/66 unit was run under the same workload as utilized for the disk I/O test from the "CPU Scaling" section discussed previously in this TechNote. The Compaq Insight Management Agents for NetWare were installed using the Compaq SmartStart CD and loaded. The additional workload of the Compaq Insight Management Agents running resulted in less than a 2% reduction in system throughput.

Monitoring CPU and EISA Bus Workload

Compaq Insight Manager provides the ability to monitor the workload of the server from any location on the network that has the capabilities to access and run the Compaq Insight Manager. During the testing, the EISA bus utilization never exceeded 12% but at times the CPU was at 100%.

Chapter 4

Recommendations

This chapter provides a checklist of recommendations for tuning and performance of the Sybase SQL Server 4.2.2 for Novell NetWare.

Tuning and Performance Check List

Initial recommendations for the Sybase SQL Server 4.2.2 system running on Novell NetWare:

- Design your database with performance in mind from the start.
- Start with minimum of 32 megabytes of RAM.
- Use NetWare 4.01 for better memory management.
- To avoid memory fragmentation using NetWare 3.11, do not load and unload unnecessary NLMs and utilities at the server.
- Perform administrative tasks at a client workstation whenever possible.
- Check revision levels of Novell files; update to newer revisions as needed.
- Dedicate the server to SQL Server and use other servers for file and print services.
- Use the Compaq SMART SCSI Array controller with array accelerator enabled for increased performance.
- Use the Compaq SMART SCSI Array controller hardware fault tolerance features, if there is a need for fault tolerance.
- Use 64 Kbytes block factor when setting up NetWare partitions.
- Use Novell controller duplexing with caution because CPU overhead can impact performance.
- Use Sybase database mirroring with caution because CPU overhead can impact performance.
- Use database striping methods to balance workload across multiple controllers.

Sybase SQL Server 4.2.2 for NetWare: Tuning and Performance

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4-2 Recommendations

- Standardize by using only one network protocol and frame type.
- Do not load multiple frame types, if not required.
- Use installation default SET parameters, except where noted in this TechNote.
- Use Compaq Insight Manager to monitor system hardware, CPU, and EISA bus utilization.
- Load SQLSRVR with the -P option on dedicated systems.
- Do not overallocate MEMORY to Sybase SQL Server.
- Do not set SYBASE USER CONNECTIONS higher than necessary.
- Monitor database utilization and access methods to determine system “bottlenecks.”
- Use stored procedures to reduce network traffic and server CPU load.

Appendix A

Multivendor Integration from Compaq

To help you successfully integrate and optimize your network or multivendor system, Compaq has developed a library of systems integration TechNotes for the NetWare, Microsoft Windows NT, SCO UNIX, and OS/2 operating system environments. TechNotes provide you with important information on topics such as network performance management, server management, and operating system interconnectivity.

To get a copy of a particular TechNote in electronic format, you can access:

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[http:// www.compaq.com](http://www.compaq.com)

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Current TechNotes

The current TechNotes available are listed in Table C-1.

**Table A-1
Compaq TechNotes**

TechNote Name	Available on SmartStart	Part Number
<i>Compaq Insight Management</i>		
Integrating Compaq Insight Manager with Enterprise Management Platforms (8/95)	√	145806-003
Integrating Compaq Insight Manager with Microsoft Systems Management Server (8/95)	√	184720-001
Integrating Compaq Insight Manager with ManageWise (8/95)	√	182074-001
<i>NetWare</i>		
Performance Management in a NetWare v3.1x Environment (4/93)		133399-002
NetWare Tape Backup Management Using ARCserve from Compaq (4/93)	√	137535-001
NetWare 4 Performance Management (9/95)	√	137989-002
ORACLE Server Planning in a NetWare v3.11 Environment (5/93)		145143-001
NetWare Server Management (9/92)		145231-001
Compaq IDA-2 Configuration for NetWare (12/92)		145536-001
Compaq ProSignia Configuration Guidelines for NetWare v3.x (12/92)		145537-001
Compaq Answers to Technical Support Questions for NetWare Environments (2/95)		145710-002
NetWare SFT III v3.11 Installation (9/93)		145905-001
NetWare Migration from 2.x to 3.12 (6/94)	√	181069-001

continued

Sybase SQL Server 4.2.2 for NetWare: Tuning and Performance

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A-4 *Multivendor Integration from Compaq*

Compaq TechNotes *continued*

TechNote Name	Available on SmartStart	Part Number
<i>NetWare (continued)</i>		
NetWare Migration from 3.12 to 4 (11/94)	√	181152-001
Sybase SQL Server 4.2.2 for NetWare: Tuning and Performance (10/95)	√	184429-002
Performance of Lotus Notes 3.1 on Compaq ProLiant Servers with NetWare 3.1x (2/95)		184430-001
Configuration and Tuning of Oracle7 for NetWare on Compaq Servers (11/94)	√	Not available in bound format
<i>Microsoft</i>		
Implementing Lotus Notes on Compaq Servers with Microsoft LAN Manager (9/92)		145201-001
Microsoft SQL Server and Novell NetWare Requester for OS/2 (9/92)		145376-001
Drive Subsystem Performance with Microsoft LAN Manager 2.1 (11/92)		145517-001
Configuration and Tuning of Microsoft SQL Server for Windows NT on Compaq Servers (7/94)		184207-001
Migrating from Microsoft Windows NT Advanced Server 3.1 to Microsoft Windows NT Server 3.5 (2/95)		184669-001
Compaq Backup and Recovery for Microsoft SQL Server (3/95)		184489-001
Configuration and Tuning of Oracle7 for Windows NT on Compaq Servers (7/95)		184853-001
Implementing Microsoft Windows NT Server RAS, DHCP, and WINS on Compaq Servers (9/95)		184488-001
Migrating to Microsoft Windows NT Server 3.51 on Compaq Servers (8/95)		185026-001

continued

Compaq TechNotes *continued*

TechNote Name	Available on SmartStart	Part Number
UNIX		
SCO UNIX in an SNA Environment Using CLEO DataTalker U/X (5/92)		145081-001
SCO UNIX in an SNA Environment Using Computone LYNX (7/92)		145116-001
SCO UNIX Database Servers in Novell Networks (10/92)		145402-001
Printing in SCO UNIX and NetWare Integrated Environments (3/93)		145538-001
SCO UNIX Connectivity to SNA Environments Over X.25 Networks (1/93)		145583-001
Disk Mirroring with VERITAS VxMirror (12/93)		145656-001
SCO UNIX IP Routing Over X.25 Networks (4/93)		145711-001
Performance Tuning for SCO UNIX on Compaq Systems (5/93)		145730-001
Performance Tuning for ORACLE7 on Compaq Systems Running SCO UNIX (7/93)		145942-001
Configuration and Tuning of Oracle7 for SCO UNIX on Compaq Servers (11/94)	√	184329-001
Configuration and Tuning of Sybase System 10 for Novell UnixWare 2.0 on Compaq Servers (7/95)		184943-001
The Compaq, SCO UNIX, and ORACLE7 Database Server (9/93)		195818-001
Configuration and Tuning of Sybase System 10 for SCO UNIX Open Server 3.0 on Compaq Servers (9/95)		185111-001

*continued**Sybase SQL Server 4.2.2 for NetWare: Tuning and Performance*

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A-6 *Multivendor Integration from Compaq*

Compaq TechNotes *continued*

TechNote Name	Available on SmartStart	Part Number
<i>IBM</i>		
Compaq Answers to Technical Support Questions for OS/2 Environments (11/94)	√	Not available in bound format
Performance of Lotus Notes 3.1.5 on Compaq ProLiant Servers with OS/2 2.11 (3/95)		184655-001
<i>Technology Overview</i>		
Configuring Compaq RAID Technology for Database Servers (7/94)	√	184206-001

Glossary

Abend (Abnormal end)	A message issued by the operating system when it detects a serious problem, such as a hardware or software failure. The abend stops the server.
Bottleneck	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.
Compaq Insight Manager	Server management software delivering intuitive fault, performance, and configuration management capabilities for all key server subsystems in a variety of operating environments.
Compaq SMART SCSI Array Controller	A 32-bit EISA bus master with two SCSI channels that support up to 14 SCSI drives per controller, delivering maximum fault management, performance, and configuration capabilities.
EISA	See Extended Industry Standard Architecture.
Ethernet	Network cabling and signaling scheme with the 10 megabits per second rate that works over a wide variety of cabling.
Extended Industry Standard Architecture (EISA)	Open extension to the industry- standard expansion bus architecture, allowing the use of 8-/16-bit peripherals as well as 32-bit devices.

Fault Tolerance	The capability of a system to perform its function in accordance with design specifications, even in the presence of hardware or software failures. If, in the event of faults, the system functions can be performed but do not meet the design specifications with respect to the time required to complete the job or the storage capacity required for the job, the system is said to be partially or quasi fault tolerant. Fault tolerance is provided by the application of protective reliability. These resources can consist of more hardware, software, or time, or a combination of all three.
IDA	See Intelligent Drive Array.
Intelligent Drive Array (IDA)	Compaq Drive Array Controllers, including the Compaq 32-Bit Intelligent Drive Array Controller-2, the Compaq 32-Bit Intelligent Drive Array Controller, and the Compaq 32-Bit Intelligent Drive Array Expansion Controller.
Internet Packet Exchange (IPX)	NetWare LAN communication protocol; moves data between server and/or workstation running on different network nodes.
Internet Protocol (IP)	The part of the TCP/IP protocol set that provides the routing mechanism. TCP controls the transfer of data.
IP	See Internet Protocol.
IPX	See Internet Packet Exchange.

NetWare Loadable Modules (NLM)	A program you can load and unload from file server memory while the server is running. NLMs link disk drives, LAN drivers, name space, and other server management and enhancement utilities to the operating system.
Network board	See Network Interface Controller.
Network Interface Controller (NIC)	A circuit board installed in each workstation to allow stations to communicate with each other and with the file server. Also called Network board.
NIC	See Network Interface Controller.
NLM	See NetWare Loadable Modules.
Performance management	“Tuning” the network components to maximize performance and address user productivity issues, application software design, and data structure.
RAID	See Redundant Arrays of Inexpensive Disks.
Redundant Arrays of Inexpensive Disks (RAID) Technology	A system with more consistent performance, higher levels of fault-tolerance, and easier fault-recovery than traditional non-RAID systems.
TCP/IP	Protocol that manages the transmission of packets on a network and checks for errors. This protocol includes the Internet connection-based (TCP) and connectionless (IP) protocol.

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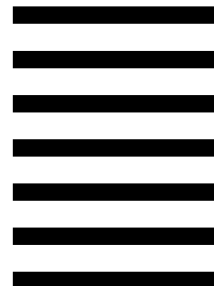
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