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### *Performance of Lotus Notes 3.1 on Compaq ProLiant Servers with NetWare 3.1x*

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*Chapter 1*
# About This TechNote

This Compaq TechNote provides the results of a performance analysis
conducted by Compaq Engineers on the Lotus Notes Server for NetWare. The
information presented here is based on technical knowledge acquired by
Compaq Engineers while testing these products in a closely controlled and
monitored environment.

This TechNote is for system integrators and network administrators with a
knowledge of Compaq Server products, Lotus Notes, and NetWare. It is a
supplement to the *Compaq Hardware Reference* documentation and the *Lotus
Notes 3.1* documentation. The results and conclusions of this TechNote will
give you:

■ An understanding of how individual Lotus Notes user and server tasks
impact overall system performance.

■ Suggestions for improving your Lotus Notes Server for
NetWare performance.

■ Recommendations for selecting the appropriate server hardware for your
Lotus Notes Server for NetWare.

The chapters in this TechNote contain the following information:

■ *Chapter 1 - About This TechNote* provides an introduction to the
TechNote with a brief summary of each chapter, general information
about the conventions used, and a list of other resources to get more
details on particular information.

■ *Chapter 2 - Overview* discusses the research methods used, which
include the following:

❏ Atomic Task Definition

❏ Lab Setup

❏ Profiling and Load Modeling Tool

❏ Data Collection and Recording

■ *Chapter 3 - Atomic Task Profiling* provides an understanding of the impact of individual tasks or server resources.

- ❏ Profiling Methodology

- ❏ Profile Graphs

- ❏ Atomic Task Profiling conclusions

■ *Chapter 4 - Performance Analysis* incorporates the results of the Atomic Task profiling into recommendations for the selection of appropriate hardware.

- ❏ Hardware performance comparison

- ❏ Comparing NetWare 3.11 with 3.12

- ❏ Tuning considerations

- ❏ Performance conclusions

■ *Appendix A - Multivendor Integration From Compaq* provides information on how to order individual Compaq TechNotes, including pricing information, 1(800) 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.

**Table 1-1**
**Notational Conventions**

| Convention | Use |
|---|---|
| Keys | Keys on your keyboard appear in boldface. |
| Keys+Keys | When you see a plus sign (+) between two keys, hold down the first key while you 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. |
| *screen selections*, *variables*, and *new terms* | These items always appear in italics. |
| *FILENAMES* | Names of files appear in uppercase italics in DOS and in other environments. |
| COMMANDS, DIRECTORY NAMES, DRIVE NAMES, and PROGRAMS | These items appear in uppercase in DOS and in other environments. |
| USER INPUT | Information you type exactly as it appears is shown in uppercase. |
| **! IMPORTANT** | Presents clarifying or specific points of information. |
| **NOTE:** | Presents commentary, sidelights, or interesting points of information. |
| type | When instructed to type information, do so without pressing the **Enter** key. |
| Select item → item → item | Items separated by arrows indicate items you select in a sequence. |

## Other Resources to Use

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

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

This TechNote provides general to help 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.

■ Compaq TechNote: *Performance Management in a NetWare v3.1x Environment*, P/N 133399-002

This 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.

■ Lotus Notes 3.1 documentation.

The Lotus Notes 3.1 documentation set provides a comprehensive set of documents covering installation, reference, and an administrator's guide with detailed information on Lotus Notes 3.1.

■ 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.

■ NetWare Application Notes and Research Reports.

NetWare Application Notes and Research Reports cover technical
aspects of NetWare-based system design, implementation,
and management.

❑ June 1993 "NetWare Migration Utilities Part 1: The In-Place
Upgrade NLM"

❑ September 1993 "NetWare Migration Utilities Part 2: The Across-
the-Wire Migration Utility"

■ *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:** 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*
# Overview

This chapter consists of an overview of the research methodology used, which includes the following:

■ Atomic Task Definition

❑ Database Server Program

❑ Replicator Program

❑ Indexer Program

❑ Router Program

❑ Chronos Program

■ Lab Setup

❑ Lotus Notes Server

❑ Lotus Notes Clients

■ Profiling and Load Modeling Tool

■ Data Collection and Recording

■ Executive Summary

A Lotus Notes Atomic Task can be defined as a fundamental operation initiated either from the Lotus Notes Server (Server Atomic Task), or from the Lotus Notes client (User Atomic Task), which is executed by one of the Lotus Notes Server Programs. For example, one of the User Atomic Tasks is Sending a Mail Message. This causes the Router Program to execute its routine to route mail. In turn, this server activity impacts overall system performance.

The performance investigation of a Lotus Notes Server for NetWare involves two phases:

■ Atomic Task profiling - To understand the impact of individual tasks or server resources.

■ Performance analysis - To incorporate the results of the Atomic Task Profiling into recommendations for the selection of the appropriate hardware.

For the Atomic Task profiling phase, User Atomic Task tests were conducted with a single workstation. Server Atomic Tasks are shown in the results, but they are workstation independent.

For the performance analysis phase, User Atomic Task tests were conducted with up to 20 workstations in order to increase the stress on a specific server subsystem.

## Atomic Task Definition

The following is a description of the Atomic Tasks identified for study by Compaq Engineers. Although the list of Atomic Tasks is not exhaustive, it covers the commonly used tasks that you or your systems administrator performs during hours of peak activity. The Atomic Tasks have been identified based upon the interviews with Lotus Notes customers and internal groups who have participated in the world-wide deployment of Lotus Notes at Compaq.

The Lotus Notes Atomic Tasks are organized according to the Lotus Notes Server program that executes the task. The most frequently used Lotus Notes Server programs during peak hours of server activity are the following:

■ Database Server

■ Replicator

■ Router

■ Indexer

■ Chronos

For a detailed description of Lotus Notes Server Programs, refer to the *Lotus Notes Administrator's Guide,* "Server Commands and Programs."

**NOTE:**   There are other Lotus Notes Server Programs that are less frequently used or used at off-peak hours. Since these tasks are not normally active during hours of peak activity, their impact has not been considered for this performance study. Keep in mind, however, that some off-peak tasks can be quite stressful on the system. If they are active during normal hours, you can experience performance degradation.

## Database Server Program

The Database Server program covers the following Atomic Tasks:

■ Scrolling in a View

■ Reading a Document

■ Editing a Document

■ Expanding or Collapsing a Category

■ Detaching a File

■ Replicating Workstation to Server

■ Replicating Server to Workstation

■ Rebuilding a View Index

■ Executing a Non-Indexed Text Search

■ Executing an Indexed Full Text Search

Table 2-1 shows how to use the Atomic Tasks for the Database Server Program from the user interface.

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**Table 2-1**
**Use of Atomic Tasks for the Database Server Program**

| Atomic Task | From the User Interface |
| --- | --- |
| Scrolling in a View | Press the **Pg Dn** key to scroll down. Press the **Pg Up** key to scroll up. |
| Reading a Document | Highlight and press the **Enter** key or highlight and double click the mouse. |
| Editing a Document | Press the **Ctrl**+**E** keys to go into edit mode. Press the **Ctrl**+**S** keys to save the document. |
| Expanding or Collapsing a Category | Press the Plus (**+**) key to expand a category. Press the Minus (**-**) key to collapse a category. |
| Detaching a File | Double click the mouse on the attached file icon. |
| Replicating Workstation to Server | Highlight the Database icon and select *Tools*. |
| Replicating Server to Workstation | Highlight the Workstation icon and select *Tools*. |
| Rebuilding a View Index | Press the **Ctrl**+**F9** keys. |
| Executing a Non-Indexed Text Search | Select *Edit*. |
| Executing an Indexed Full Text Search | Select *Edit*. |

### Scrolling in a View

Scrolling consists of navigating forward or backward through the documents in the database. This task causes the Database Server to continually position the document cursor in the active view to the desired location. Scrolling assumes that you have opened a view in a Lotus Notes Database.

To scroll from the user interface, press either the **Pg Dn** key or the **Pg Up** key while in the active view to scroll forward or backward by twenty-one documents.

### Reading a Document

Reading consists of opening a document to view its contents. This task causes the Database Server to read the document from the disk or from the cache if the document data is already cached in memory. Reading assumes that you have opened a view in a Lotus Notes Database and that the document cursor is positioned at the document you wish to read.

To read a document from the user interface, highlight a document in the active view and press the **Enter** key or double click the mouse.

### Editing a Document

Editing a document consists of reading, modifying, and saving the document contents. This task causes the Database Server to save the document to the disk or disk cache. Editing assumes that you have opened a view in a Lotus Notes Database and that the document cursor is positioned at the document that you wish to edit.

To edit and save a document from the user interface, first open the document. Then use the **Ctrl**+**E** key combination to put the document in edit mode. Finally, use the **Ctrl**+**S** key combination to save the document after making your edits.

### Expanding or Collapsing a Category

Expanding a category shows additional categories or Lotus Notes documents grouped within that category. Collapsing is the inverse operation. This causes the Database Server to continually retrieve the indices of the documents or document categories. Expanding and collapsing categories assumes that you have opened a categorized view in a Lotus Notes Database.

To expand and collapse a category from the user interface, use the Plus (+) key to expand a category and the Minus (-) key to collapse a category.

### Detaching a File

Detaching extracts a file attachment from a Lotus Notes Database to a local file on the Lotus Notes client. This task causes the Database Server to retrieve the file attachment from the document to which it is attached and to send the contents over the network to the Lotus Notes client. Detaching a file assumes that you have opened a document with attached files in a Lotus Notes Database.

To detach a file from the user interface, double click on the attached file icon within an opened document to bring up a dialog box for detaching the file. Then follow the directions in the dialog box.

### Replicating Workstation to Server

Replication allows you to store copies of a database on multiple Lotus Notes servers and clients and guarantee that they are synchronized. During replication, any new documents from the Lotus Notes client are copied to the Lotus Notes Server's replica copy, and vice-versa. For the first replication and the context of this Atomic Task, the documents will only be copied one way from the client to the server. This Atomic Task assumes that you have a database on the client you wish to replicate to the Lotus Notes Server. It also assumes that you have created a replica stub on the server to receive the new documents.

To replicate from the user interface, highlight the local database icon, then select *Tools*. The *Replicate* dialog box is displayed for selecting the desired server.

### Replicating Server to Workstation

This Atomic Task is the same as the previous one, except the direction is reversed: the documents are copied from the Lotus Notes server to a stub on the workstation.

### Rebuilding a View Index

All views must have an updated view index. When you open a view with no view index, or when you force a rebuild, it causes the Database Server to build an index of all the documents in the view. Rebuilding a view assumes you have opened a view in a Lotus Notes database.

To rebuild a view from the user interface, simply select a view without a previously built view index. Or, press **Ctrl**+**F9** to force a rebuild of an existing index of the currently displayed view.

**NOTE:**   The view index should not be confused with the full text index discussed later in this section.

### Executing a Non-Indexed Text Search

Executing a Non-Indexed Text Search initiates a search in a non-indexed database for documents matching your criteria. This causes the Database Server to look through the documents in the database and collect the ones that match. A non-indexed text search assumes that you have opened a view in a database that has not been full text indexed.

To execute a non-indexed text search from the user interface, select *Edit*. The *Find* dialog box is displayed for specifying your search criteria.

### Executing an Indexed Full Text Search

Executing an Indexed Full Text Search initiates a search in an indexed database for documents matching your criteria. This Atomic Task is similar to the previous one, except that the database has been previously full text indexed. An indexed text search assumes that you have opened a view in a database that has been full text indexed.

## Replicator Program

The Replicator program covers the following Atomic Tasks:

■   Replicating Server to Server (Write)

■   Replicating Server to Server (Read)

### Replicating Server to Server (Write)

The Replicator program is used to replicate server to server. Replication has been described earlier in the context of the Database Server (Workstation to Server, and vice-versa). Server to server replication has the same purpose: to synchronize databases between two servers. However, this Atomic Task involves the Replicator, rather than the Database Server. The Replicator is invoked when the Lotus Notes Server pulls documents from another server. For the write replication, the Notes Server under test receives the updates.

This Atomic Task is not invoked via the user interface.

### Replicating Server to Server (Read)

This Atomic Task is similar to the previous one, except that during read replication, the Notes Server under test sends the updates. Strictly speaking, this Atomic Task is associated with the Database Server program, rather than the Replicator program. The Replicator is only invoked when the Notes Server pulls documents, not when it sends documents.

This Atomic Task is not invoked via the user interface.

## Indexer Program

The Indexer program covers the Creating a Full Text Index Atomic Task.

The Indexer program is used to create a full text index. This Atomic Task causes the Indexer to build the full text index for the database. A full text index can be created on any database.

To create a full text index from the user interface, select the desired database, then select *Full Text Search.* The *Create Index* dialog box is displayed for creating the index.

**NOTE:**  The Full Text index should not be confused with the view index discussed earlier.

## Router Program

The Router program covers the Sending a Mail Message Atomic Task.

The Router program is used to send mail. Sending mail consists of composing a mail message and sending it to the desired recipients. This causes the Router to route the messages to the proper mailboxes. This Atomic Task assumes that you have properly configured your clients and the server to handle mail.

To send mail from the user interface, select *Mail,* then select *Compose* to compose a new message.

## Chronos Program

The Chronos program covers the Executing a Background Macro Atomic Task.

Background macro execution uses the Chronos program. Background macro execution consists of executing a background macro on the server on a periodic basis (hourly, in this case). Each hour, Chronos runs through the databases checking to see if it has any macros to execute. Background macro execution assumes you have a database that contains an active hourly background macro.

This Atomic Task is not invoked via the user interface.

# Lab Setup

In order to analyze Lotus Notes performance, the following configuration was setup:

■ Lotus Notes Server

■ Lotus Notes Clients

## Lotus Notes Server

The following hardware and software were used for the Lotus Notes Server:

■ *Hardware*: Compaq ProLiant 2000 (Pentium/66, 32 megabytes RAM, Compaq SMART Array Controller, Compaq NetFlex/2 controller)

■ *Operating System*: NetWare 3.11, 3.12

■ *Lotus Notes Server Software*: Version 3.1

## Lotus Notes Clients

The following hardware and software were used for the Lotus Notes Clients:

■ *Hardware*: Compaq ProLinea Net1/25s Model 200/E (486SX/25, 8 megabytes RAM, Compaq Ethernet 16E network controller)

■ *Operating System*: Windows 3.1 with MS-DOS 6.2

■ *Lotus Notes Client Software*: Version 3.1

To sufficiently load the server during tests, 20 identical clients were configured. Figure 2-1 illustrates the network setup.

**Notes Workstations**          **Notes Server under Test**
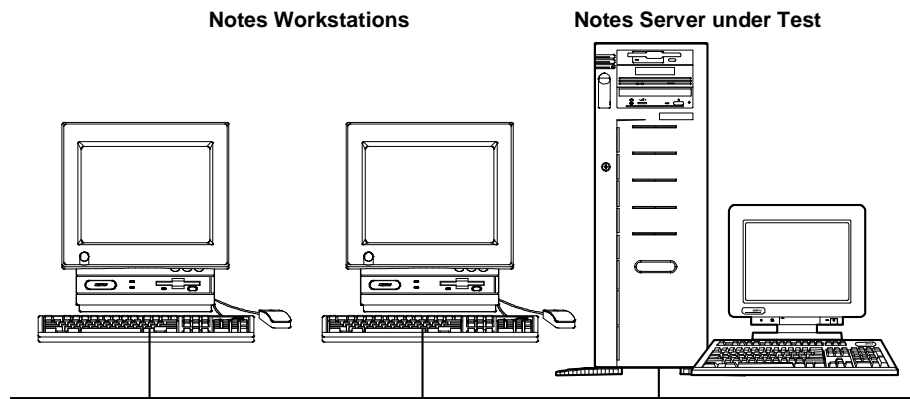


**Figure 2-1.**    Network Setup for Lotus Notes Performance Analysis

# Profiling and Load Modeling Tool

At the time of this research, there were no readily available performance monitoring and load generation test tools for Lotus Notes. Therefore, the Compaq Groupware Engineering Team developed a custom tool called the Profiling And Load Modeling (PALM) Tool.

The PALM Tool consists of an editor, a script execution program, and a set of Lotus Notes Atomic Task scripts. The editor was written with Visual Basic 3.0 and the scripts were written using Microsoft Test 2.0.

Visual Basic provides a fast and flexible development environment for Microsoft Windows programs. The resulting editor is a Windows program which is easy for an engineer to use in configuring the script parameters.

Microsoft Test offers several advantages for scripting and script execution. It uses the native Lotus Notes client software to send user commands to the server that generate a real world interaction with the Lotus Notes Server. Also, the language used in Microsoft Test is very similar to Visual Basic which makes it easier to develop an integrated test tool.

The PALM Tool has the following features:

■ Executes a variety of test scripts in the Lotus Notes environment.

■ Records response times from each workstation in a centralized log file. The completion time for a particular test script is referred to as the response time.

■ Synchronizes participating workstations at the start of each test.

■ Halts all participating workstations when a test is canceled.

■ Distributes PALM Tool updates to each workstation automatically.

The PALM Tool consists of two executable parts:

■ PALM Tool Editor - A Visual Basic front end program to create a *MASTER.INI* file that specifies the test script and the test parameters to be used in a given test. Some parameters are as follows:

   ❏ Notes server name

   ❏ Database name

   ❏ View specifier (in the database)

   ❏ Test script name

   ❏ Number of workstations

   ❏ Number of documents in the test (if applicable)

   ❏ Length of the test, measured in one of two ways: number of passes through the data or number of minutes

■ PALM Tool Script Executor - A Microsoft Test program to read the test specifications from *MASTER.INI*, execute the appropriate script, measure the completion time, and save the results into a common log file. This log file records the completion time for each participating workstation as well as the test parameters and the date and time that the script was run.

## Data Collection and Recording

At the NetWare server, a Novell-developed utility called *STAT.NLM* was used for collecting CPU, disk, and LAN utilization. *STAT.NLM* has been used in many other test situations involving NetWare server performance, and Compaq Engineers are very comfortable with its accuracy. Information about the *STAT.NLM* utility is available in the following locations:

■ NetWare Application Notes: March 1992 "STAT.NLM: A Tool for Measuring NetWare v3.11 Server Resource Utilization."

■ CompuServe bulletin board. To download the *STAT.NLM* utility, follow these steps:

   a. At the CompuServe prompt, enter GO NOVLIB.

   b. Go to the forum titled: "Novell Library" and select the section titled: "TechInfo/IMSP's."

   c. Select the utility titled: *STAT.NLM* - Server Resource Utilization Tool.

   d. Follow the instructions on how to download the utility.

At each Lotus Notes client, the PALM Tool logged the time to complete each task in seconds.

Compaq Engineers considered using the available Lotus Notes Server Statistics, but did not do so for the following reasons:

■ The Statistic Log program must run on the server in order to capture statistics. The interaction of this program with the other Lotus Notes Server programs being measured would have skewed our results.

■ The predefined data collection interval is 15 minutes. This interval did not provide the required granularity for our tests, especially since many of them were less than 15 minutes.

## Summary of Results

The following points summarize the results of the research:

■ Lotus Notes Server for NetWare is a CPU intensive application.

The most important insight gained from the performance analysis of the Lotus Notes Server for NetWare is that it is primarily a CPU intensive application. This means that the CPU was the most significantly stressed subsystem during execution of the test scripts. Both the disk and the network subsystems were impacted very little by comparison.

■ Perform CPU intensive tasks during off-peak hours.

Indexing and replication were the most CPU intensive tasks. By rebuilding view indexes, creating full text indexes, and performing server to server replications during off-peak hours, the performance of the Lotus Notes Server for NetWare will be improved.

■ Lotus Notes Server for NetWare requires large amounts of RAM.

During ten simultaneous workstation to server replication tests, the server began dropping connections and did not complete some of the tests. By doubling server memory from 32 megabytes to 64 megabytes, these problems were solved. Since NetWare 3.1x can not swap to disk as memory usage increases, it is critical that the server have sufficient memory for all tasks.

■ The recommended Compaq hardware configuration for Lotus Notes Server for NetWare is:

Compaq ProLiant 2000 with 64 megabytes of RAM and 1 system processor

This server offers either a Pentium/90 (standard) or a Pentium/100 (optional) CPU as well as the Compaq SMART Controller (standard), which provides the recommended Distributed Data Guarding fault tolerance (RAID5).

**NOTE:** For details on the research that supports these executive conclusions, see the Performance Analysis chapter later in this TechNote.

## *Chapter 3*
# Atomic Task Profiling

The goal of Atomic Task profiling is to identify and measure the impact of User and Server Atomic Tasks on a Lotus Notes Server for NetWare. This information can be used as follows:

■ Identification of the stressful Atomic Tasks highlights certain basic administrator options to improve overall system performance.

■ These stressful tasks can be used to create a system workload so that hardware can be varied to determine the optimum hardware configuration of a Lotus Notes Server for NetWare.

■ In future research, these identified tasks can be used in combination to stress the server to determine boundary conditions. The boundary condition information can then be used for performance tuning and capacity planning.

## Profiling Methodology

The profiling methodology consists of data collection, analysis and display.

### Data Collection

Data from each test script was collected in two ways. The response time measured by Microsoft Test was recorded in the centralized log file mentioned earlier. *STAT.NLM* provided the CPU, disk, and LAN utilization on the Novell server.

The utilization numbers were then imported into a spreadsheet and were graphed as raw data to revealed the greatest subsystem stress. The raw data graphs of the disk and LAN subsystems were excluded from further analysis because they did not reveal sufficient stress on the server to be of interest. The CPU utility data are discussed in the following sections.

## Data Display

The data for each subsystem is summarized in the following figures. The entire set of bar charts is sorted in descending order based on CPU utilization. This is because the CPU is the most stressed subsystem in the server.

In the subsystem graphs, the bars appear in pairs. The first bar in Figures 3-2 through 3-7 reflect the high average of the subsystem utilization resulting from an Atomic Task. The second bar in each group reflects the standard deviation of these high averages which is representative of how choppy the data are. A tall standard deviation bar implies a choppy data set when graphed, and a short standard deviation bar implies a flat data set when graphed. In contrast, choppy data sets contain intervals of lower CPU utilization which means that the CPU is free during that time to perform other tasks.

## High Averages

At first, the raw data was summarized in the bar charts by simple averaging. However, this data was then trimmed to reflect the high average of the data. Practically speaking, a high average is a measure of the maximum sustained stress that the server will encounter in a given test. This means that the highest sustained flat portions of the graphs were selected for this relative analysis. In our tests, sustained means more than 30 seconds of activity. The one exception is the Indexed Full Text Search. Since the entire test lasted only about 10 seconds, the high average was computed over a period less than 30 seconds.

Figure 3-1 provides an example of a high average for CPU utilization.
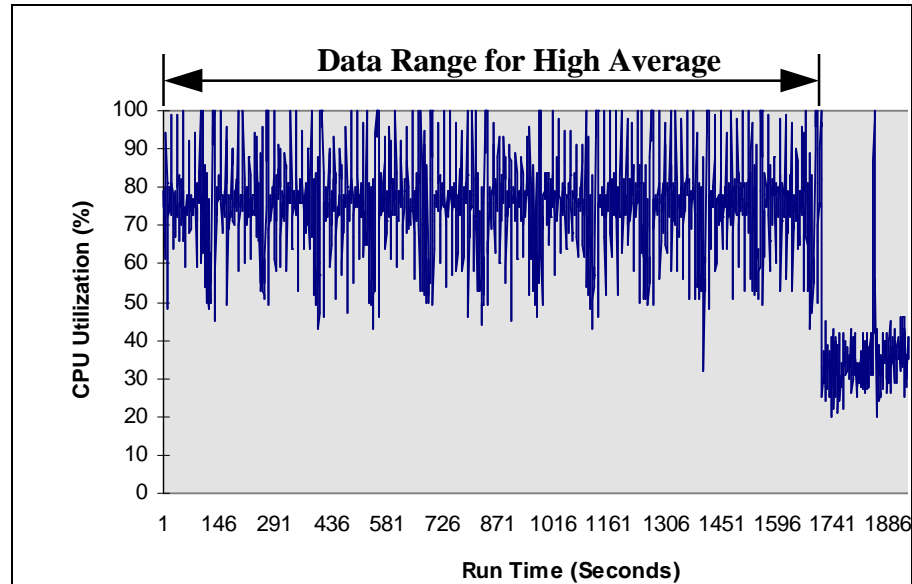
**Figure 3-1.** CPU Utilization: High Average

## High Average Standard Deviations

Since some of the tests produce significant amounts of data fluctuation, a standard deviation for each high average is included as a second bar in each cluster of each graph. This bar provides a visual representation of the data spread. Theoretically, flat data sets with short standard deviation bars are more stressful to a server than are choppy data sets with tall standard deviation bars. This is because a flat data set implies a constant CPU utilization which means that the CPU is not free to multitask as rapidly. In contrast, choppy data sets contain intervals of lower CPU utilization which means that the CPU is free during that time to perform other tasks.

## Axis Scales

The axis scales of the raw data graphs have been adjusted to visually reflect the relative impact on the three measured subsystems: CPU, disk, and LAN. In each of the profile bar graphs that follow, tall bars indicate a strong impact on the particular subsystem and short bars indicate a weak impact. The graphs are displayed as follows:

■ The CPU utilization was recorded in percentages and varied between 0% and 100%. Hence, the y-axis upper limit is set to 100% for each of the CPU graphs.

■ The disk throughput was recorded in bytes per second. Unlike a percentage measurement that has an obvious upper limit of 100%, a realistic disk upper limit is difficult to determine. However, this upper limit directly effects the visual information that is derived from the graphs. Previous disk throughput measurements at Compaq have shown 1,700 kilobytes per second (KBps) to be a reasonable upper limit under similar conditions.

**NOTE:** Disk throughput depends upon a variety of factors. The upper limit can vary depending upon the hardware and the operating system environment.

■ The LAN throughput was also recorded in bytes per second. A realistic upper limit of 70% of the Ethernet theoretical maximum has been selected for display purposes. Hence, 70% of a 10 megabits per second (Mbps) maximum is 7 Mbps which equates to 875 KBps (kilobytes per second). An upper limit of 900 KBps was selected.

## Profile Graphs

Three sets of graphs (CPU, Disk, LAN) are displayed in this section to show the relative impact of each of the Atomic Tasks on a specific subsystem. For display purposes, each subsystem graph has been split into two separate graphs which should be viewed as a single chart.

**NOTE:** The graphs reflect only a single instance of each Atomic Task. Actual loads will vary because multiple instances of User Atomic Tasks can be run simultaneously.

Table 3-1 shows the Atomic Task abbreviations used in the profile graphs.

**Table 3-1**
**Atomic Task Abbreviations**

| Abbreviations | Atomic Task |
|---|---|
| Rebld View | Rebuilding a View Index |
| Create Indx | Creating a Full Text Index |
| N Indx Srch | Executing a Non-Indexed Text Search |
| S->S W Repl | Replicating Server to Server - Write |
| S->S R Repl | Replicating Server to Server - Read |
| Indx Srch | Executing an Indexed Full Text Search |
| Expand | Expanding or Collapsing a Category |
| W->S Repl | Replicating Workstation to Server |
| Scroll | Scrolling in a View |
| Mail | Sending a Mail Message |
| Macro | Executing a Background Macro |
| Edit | Editing a Document |
| Detach | Detaching a File |
| S->W Repl | Replicating Server to Workstation |
| Read | Reading a Document |

## CPU Utilization

Of the three subsystems analyzed, the CPU Utilization was most affected The four Atomic Tasks with the highest impact on the CPU are: Rebuilding a View Index, Creating a Full Text Index, Executing a Non-Indexed Text Search and Replicating Server to Server (Write). Figures 3-2 and 3-3 show the high averages for CPU utilization. Tables 3-2 shows the percentage for each task.

**CPU Utilization (%)**
**High Average**
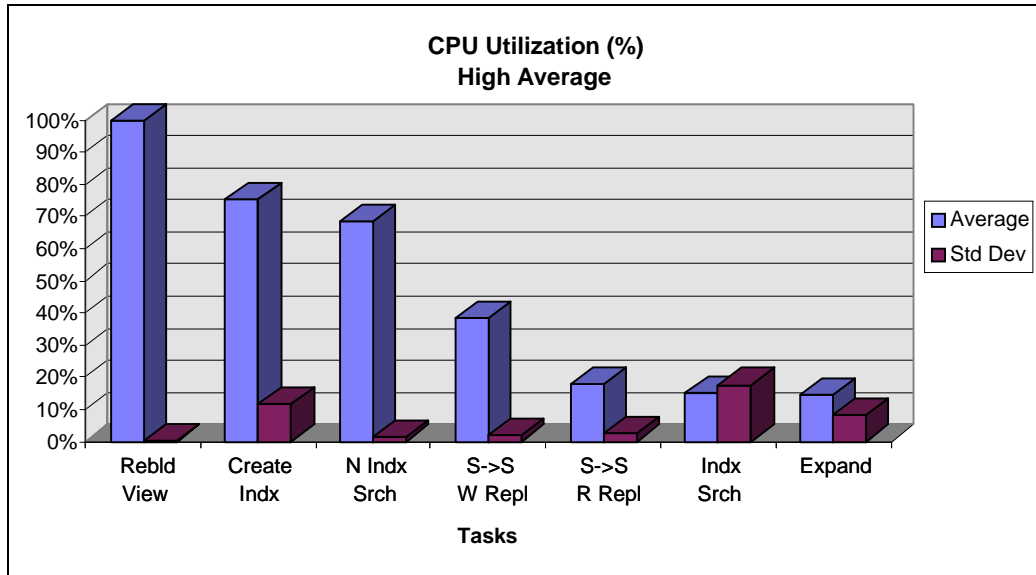
Figure 3-2. CPU Utilization - Part 1

**CPU Utilization (%) Continued**
**High Average**
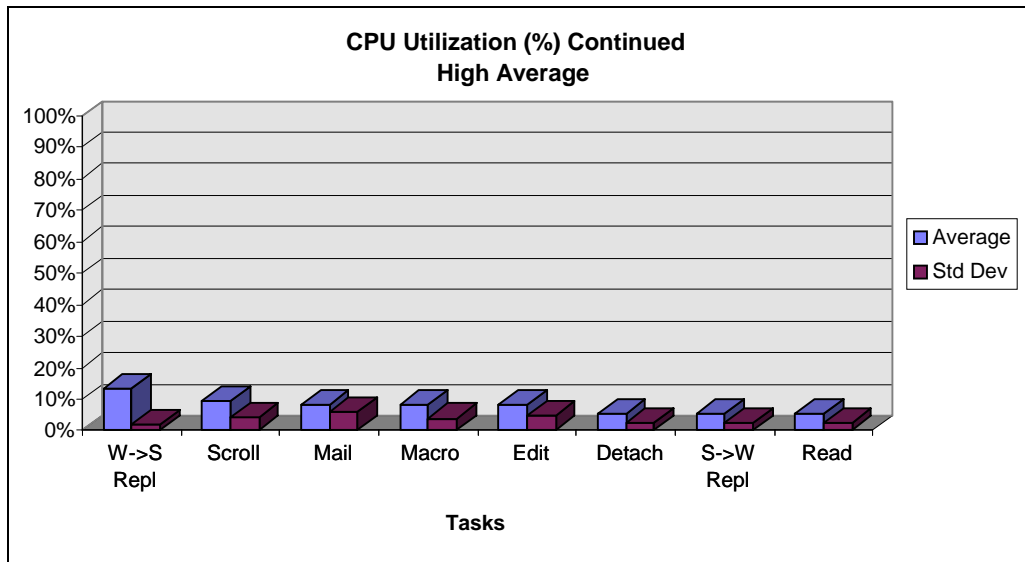
Figure 3-3. CPU Utilization - Part 2

**Table 3-2**
**CPU Utilization by Task**

|  | Average (%) | Standard Deviation (%) |
|---|---|---|
| Rebld View | 99.9 | 0.3 |
| Create Indx | 75.4 | 11.5 |
| N Indx Srch | 68.6 | 1.3 |
| S->S W Repl | 38.3 | 1.7 |
| S->S R Repl | 17.7 | 2.6 |
| Indx Srch | 14.8 | 17.5 |
| Expand | 14.4 | 8.0 |
| W->S Repl | 13.2 | 2.1 |
| Scroll | 9.2 | 4.5 |
| Mail | 8.4 | 5.8 |
| Macro | 8.3 | 4.0 |
| Edit | 8.2 | 4.7 |
| Detach | 5.6 | 2.4 |
| S->W Repl | 5.5 | 2.5 |
| Read | 5.3 | 2.4 |

## Disk Throughput

Disk Throughput is only moderately impacted by a Non-Indexed Full Text
Search. All other Atomic Tasks have very little impact on the server disk
subsystem. Figures 3-4 and 3-5 show the high averages for disk throughput.
Tables 3-3 shows the KBps for each task.

**Disk Throughput (KBps)**
**High Average**
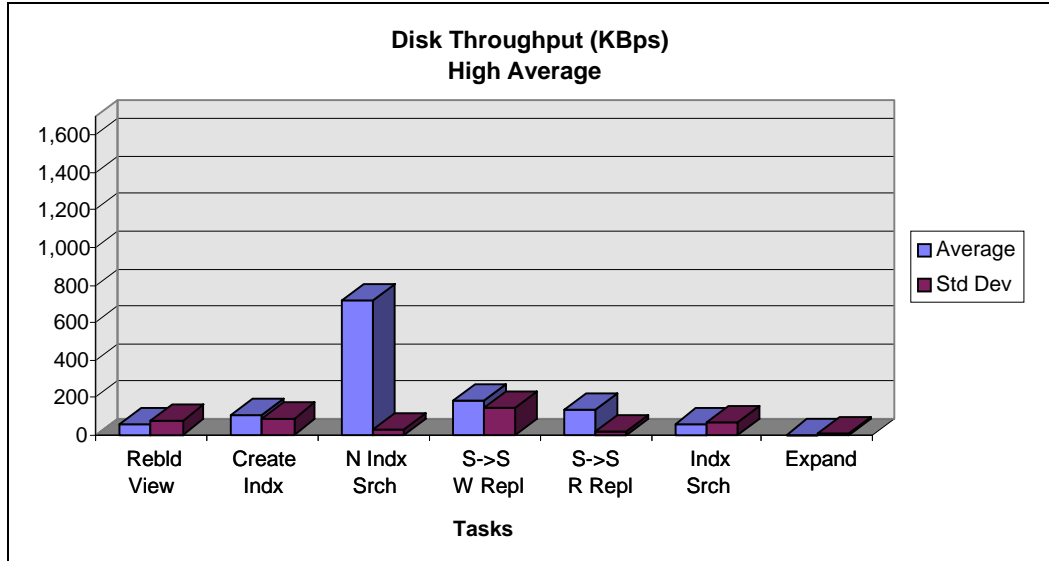


**Figure 3-4**. Disk Throughput - Part 1

**Disk Throughput (KBps) Continued**
**High Average**
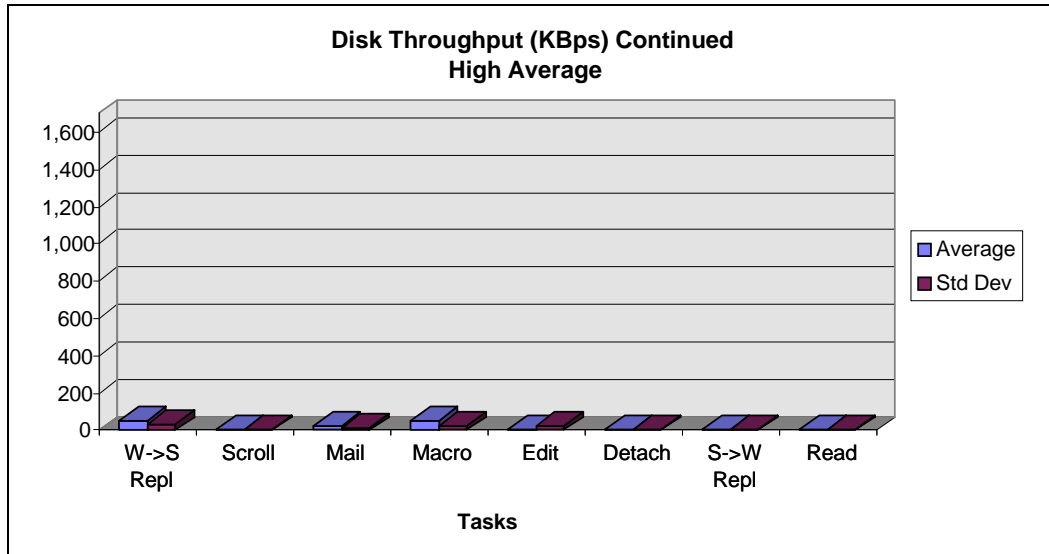


**Figure 3-5**. Disk Throughput - Part 2

**Table 3-3**
**Disk Throughput by Task**

|  | Average (KBps) | Standard Deviation (KBps) |
|---|---|---|
| Rebld View | 0.05 | 0.11 |
| Create Indx | 0.05 | 0.10 |
| N Indx Srch | 0.15 | 0.08 |
| S->S W Repl | 219.98 | 10.02 |
| S->S R Repl | 173.01 | 21.07 |
| Indx Srch | 0.94 | 1.70 |
| Expand | 6.46 | 2.82 |
| W->S Repl | 59.32 | 4.63 |
| Scroll | 8.38 | 1.80 |
| Mail | 0.78 | 0.87 |
| Macro | 0.02 | 0.05 |
| Edit | 11.03 | 8.11 |
| Detach | 13.62 | 4.00 |
| S->W Repl | 17.00 | 5.50 |
| Read | 8.81 | 5.26 |

## LAN Throughput

LAN Throughput is only slightly impacted by Server to Server Replication. All other Atomic Tasks generate very little impact on the network performance. Figures 3-6 and 3-7 show the high averages for LAN throughput. Tables 3-4 shows the KBps for each task.
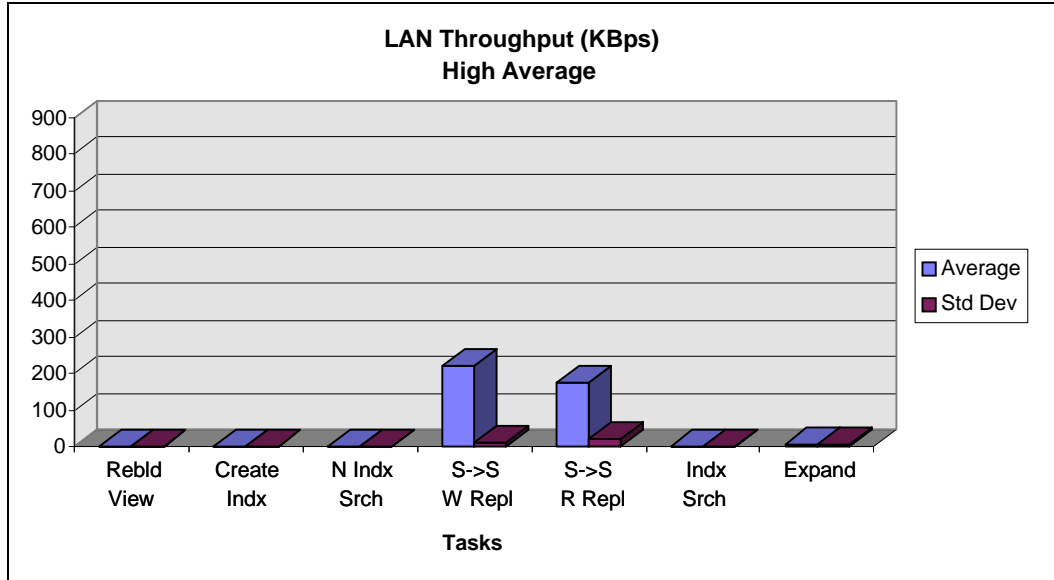
**Figure 3-6**.    LAN Throughput - Part 1
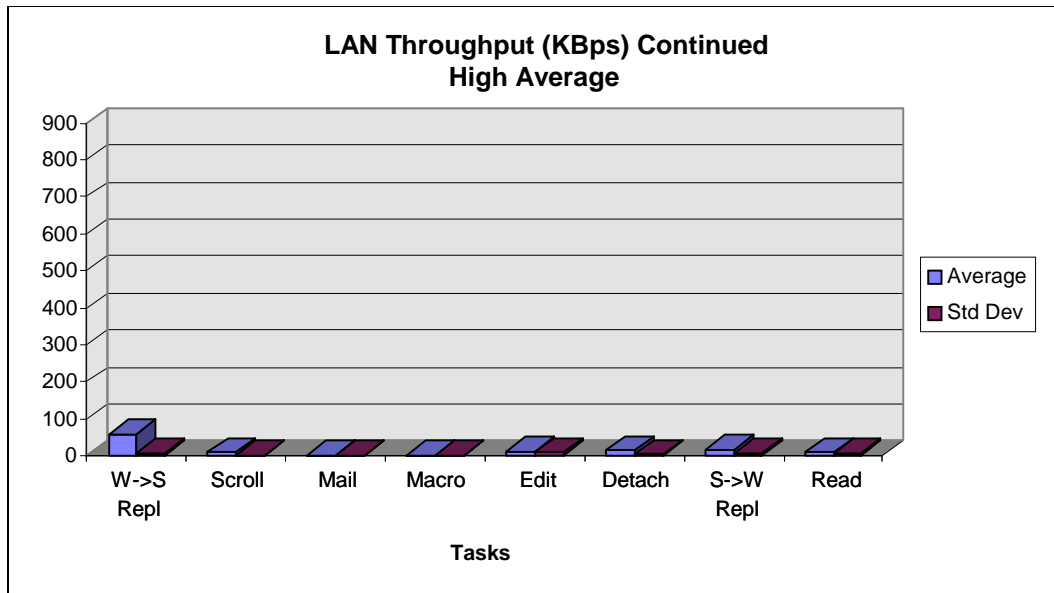


**Figure 3-7**.    LAN Throughput - Part 2

### Table 3-4
### LAN Throughput by Task

|  | Average<br>(KBps) | Standard Deviation<br>(KBps) |
|---|---|---|
| Rebld View | 61.30 | 77.66 |
| Create Indx | 104.93 | 89.79 |
| N Indx Srch | 718.03 | 28.79 |
| S->S W Repl | 186.14 | 142.81 |
| S->S R Repl | 139.07 | 16.93 |
| Indx Srch | 58.16 | 71.81 |
| Expand | 2.06 | 7.65 |
| W->S Repl | 52.84 | 38.13 |
| Scroll | 0.49 | 1.65 |
| Mail | 21.26 | 16.80 |
| Macro | 51.69 | 26.22 |
| Edit | 8.88 | 23.67 |
| Detach | 5.08 | 6.79 |
| S->W Repl | 0.50 | 5.03 |
| Read | 1.75 | 4.28 |

# Atomic Task Profiling Conclusions

The following sections describe the research and administrator conclusions for Atomic Task Profiling.

## Research Conclusions

The following list describes the research conclusions for Atomic Task Profiling.

■ Lotus Notes is a highly CPU intensive program. This suggests that the CPU capacity, multi-processor systems, clock speed, and memory caches should be the focal points of further research. The Atomic Tasks that create the greatest stress on the server are:

   ❑ Rebuilding a View Index

   ❑ Creating a Full Text Index

   ❑ Executing a Non-Indexed Text Search

   ❑ Replicating Server to Server - Write

■ Lotus Notes does not significantly stress the disk subsystem except when performing a non-indexed full text search. This Atomic Task is useful for an analysis to optimize the disk subsystem.

■ Lotus Notes does not significantly stress the LAN subsystem. Only the Replicating Server to Server (Read and Write) Atomic Task moderately impacts the LAN subsystem. This Atomic Task is somewhat useful for an analysis to optimize the LAN subsystem.

■ Replicating Workstation to Server is significantly slower than Replicating Sever to Server. Hence, this Atomic Task is useful in investigating workstation hardware configurations and what impact the client has on system performance. Generally the slower the client, the greater capacity of the server for workstation-oriented Atomic Tasks.

## Administrative Conclusions

The following are the administrative conclusions for Atomic Task Profiling.

■ Rebuild view indexes during non-peak hours to prevent system delays. Keep in mind, however, that your users can still manually rebuild a view index at any time and you should encourage them to limit this activity to non-peak hours.

The most stressful Atomic Task is Rebuild A View Index. In a Lotus Notes Server for NetWare, it utilizes 100% of the CPU capacity. It can be initiated manually with the UPDALL Lotus Notes Server console command or when you press **Shift**+**F9** for the current view or **Ctrl**+**Shift**+**F9** for all views in the database.

**NOTE:** If a view is created using formulas that require immediate recalculation like @Now, then the view index may be repeatedly rebuilt during peak operations. Avoid views like these, if possible.

■ Create full text indexes during non-peak hours to prevent system delays.

Creating a Full Text Index is the second most stressful Atomic Task. It utilizes 75% of the CPU capacity. Additionally, it is the only Atomic Task that stresses the disk subsystem. It uses approximately 42% of the disk channel if the maximum throughput is taken to be 1700 KBps.

Indexed full text searches are very fast compared to non-indexed full text searches. Also, a non-indexed full text search utilizes 69% of the CPU capacity. Thus, a 75% CPU hit during non-peak hours (Create Index) is much better than a 69% CPU hit during peak hours (Non-Indexed Search).

**NOTE:** The administrator has the option of adjusting the frequency of the full text index updates. The list box under *File→Full Text Search→Information* contains various options of frequency of index updates. By reducing the frequency, the impact on the CPU during peak hours can be delayed. However, the index will not be current until it is updated.

Perform server to server replications during non-peak hours to prevent system delays.

Replicating Server to Server is the third most stressful Atomic Task, impacting both the server CPU (an average of 27%) and the LAN channel (an average of 22%). In our test configuration, the LAN throughput utilized by this task was approximately 220 KBps for the write portion and 173 KBps for the read portion of replication. If the maximum LAN throughput is taken to be 875 KBps, then an average of 22% of the LAN throughput is utilized by this task.

*Chapter 4*
# Performance Analysis

Performance analysis is an ongoing interactive process that includes:

■ Understanding your user requirements

■ Monitoring your network load pattern

■ Making appropriate modifications to your configuration to achieve optimal use of resources

The meaning of the term "performance" depends on your viewpoint; whether you are the administrator or the end user. If you are the administrator, performance means effective management of the system resources. If you are the user, performance means how fast the system responds to your requests. Therefore from an administrator's viewpoint, you measure performance by analyzing the system throughput and utilization. From a user's viewpoint, you measure performance by checking the response time.

In practice, it is necessary to balance the two perspectives because the results may require you to make certain tradeoffs. For example, the lab tests reveal that it is possible to upgrade your system processor to reduce the stress on the CPU subsystem and to provide faster response times. However, with certain disk subsystems, you can only achieve faster response times at the cost of greater stress on the CPU. Your system might be able to accept this additional stress when the CPU utilization is around 60%, but not when the utilization is around 80 to 90%. At high levels of CPU utilization, any additional stress can adversely impact the capacity of your system to handle additional tasks or users.

For the performance analysis investigation, Compaq Engineers looked at the following areas:

■ Hardware performance comparison

■ Comparing NetWare 3.11 with 3.12

■ NetWare tuning considerations for Lotus Notes

■ Preliminary study of boundary conditions

---

From the Profiling results, it is easy to see how each Atomic Task uses server resources. For example, Rebuilding a View takes 100% of the CPU. So naturally it follows to use this Atomic Task to test CPU performance. As another example, Executing Non-Indexed Text Search stresses the disk subsystem. It makes sense to use this Atomic Task to test disk performance.

In this phase, the performance analysis was performed by using up to 20 clients to stress a specific server subsystem (CPU, Disk, LAN). Then Compaq Engineers varied the components of the subsystem to see the effect. For example, the team used different CPUs to measure Rebuilding a View Atomic Task and compared the results.

# Hardware Performance Comparison

The following section offers guidelines for obtaining the optimum price and performance from your Compaq server. These guidelines are based on tests designed by Compaq Engineers. The tests are based on the analysis of the Atomic Task profiling mentioned earlier in this TechNote.

## System Processor (CPU)

In contrast to a resource sharing (file server) environment, a faster processor in a Lotus Notes Server for NetWare yields faster client response times. In a resource sharing environment, the system processor is less important for performance than the memory, disk, and network interface card. However, for Lotus Notes, the processor is the most important subsystem for high performance.

In order to study how Lotus Notes stresses the CPU, we used tests based on three Atomic Tasks:

■ Rebuilding a View. This is the most CPU-intensive Atomic Task since the CPU utilization is fairly constant at 100%.

■ Creating a Full Text Index. This Atomic Task is less stressful on the CPU. It stresses the CPU from 60 to 80%.

■ Editing a Document. This Atomic Task is the least stressful. It stresses the CPU with a high average of 8% and a standard deviation of 5%.

The following results validate the conclusion regarding the importance of the processor. The results also quantify the performance gain you might expect when you upgrade your server to a faster CPU.

**NOTE:**   If you use the Pentium/100 MHz processor in your Lotus Notes Server, be sure to verify that the system ROM in your Compaq ProLiant Server is dated 09/06/94 or later for optimal performance. You can observe the ROM date on your screen when you power up the server.

### Rebuilding a View

Figure 4-1 shows that Pentiums yield faster response times than a 486.

■   The Pentium/100 processor typically provides a 20% faster response time when Rebuilding a View index than the Pentium/66 processor.

   **NOTE:**   Although the clock speed is 50% faster we do not expect to see a 50% faster response time because the 100 MHz still accesses the memory at 66 MHz, while processing internal instructions at 100 MHz. Therefore, there is not a 1 to 1 increase in performance relative to the clock speed.

■   The Pentium/100 processor typically provides a 156% faster response time when Rebuilding a View index than the 486DX/50 processor.
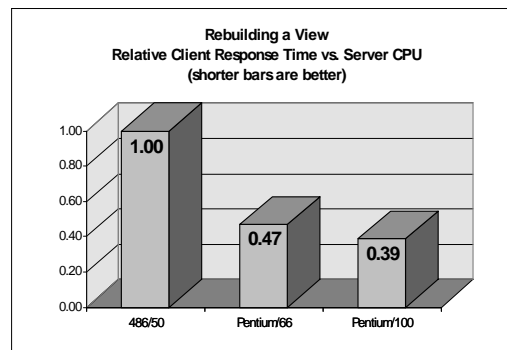


**Figure 4-1.**   Rebuilding a View

### Creating a Full Text Index

Figure 4-2 shows that the performance improvements provided by a faster CPU are not just limited to better response time.

■ CPU utilization is reduced with faster processors. This increases server capacity.

■ Disk throughput is increased with faster processors, even though disk usage is quite light.

■ LAN traffic is near zero. This is typical of a client server application where the client makes a request, the server processes it, and only sends the response over the network.
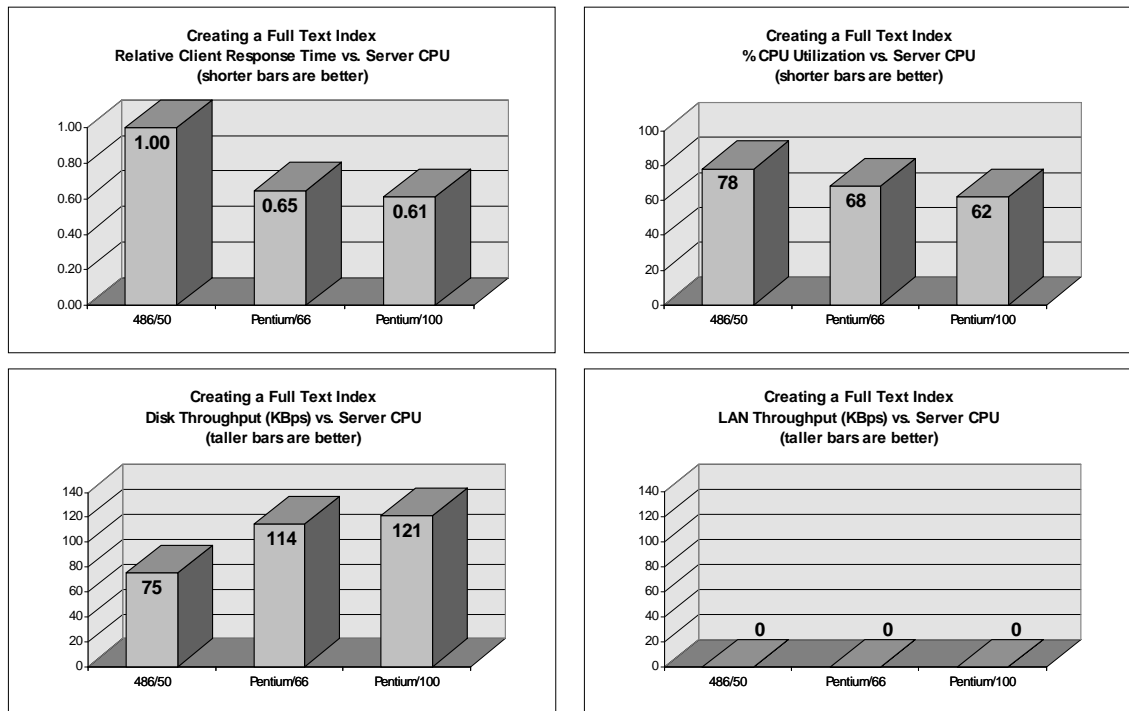


**Figure 4-2.** Creating a Full Text Index

These results also show how important it is to select the right tool to do performance testing. The test result should cover not only the end user's viewpoint, but also the system administrator's perspective.

### Editing a Document

Figure 4-3 demonstrates the benefits of a faster processor, which are as follows:

■ A faster processor yields better response time.

■ A faster processor decreases server stress by reducing CPU utilization.

■ The Pentium/100 processor provides 5% faster response time than the Pentium/66 while reducing the CPU utilization by 12%.

■ The Pentium/100 processor provides 44% faster response time than the 486/50 while reducing the CPU utilization by 58%.
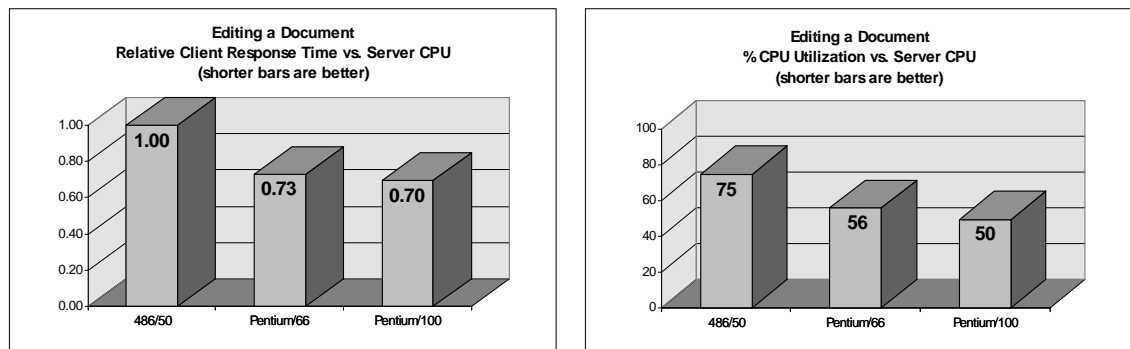


**Figure 4-3.** Editing a Document

**NOTE:** Compared to the two previous CPU tests, this Atomic Task represents a moderate CPU load. That is why the Pentium/100 only shows marginal improvement over the Pentium/66. However, it still demonstrates a difference both in client response time and in system CPU utilization.

## Transaction Blaster

Compaq has developed a product called the Transaction Blaster, which is a
2 megabyte Level 3 Memory Cache, that can be placed with each 90 MHz or
100 MHz Pentium processor in the Compaq ProLiant. This cache is intended to
complement the 512 megabyte high-speed Level 2 Memory Cache that is
standard on these processor cards. The purpose of the Transaction Blaster is to
improve processor scalability in a ProLiant that is configured with multiple
processors. For application environments that are running on multiple
processors and are very CPU intensive, the Transaction Blaster improves the
overall performance and scalability of the system by reducing the amount of
host bus contention between each of the processors.

Internal testing has indicated that the Transaction Blaster does not provide a
performance benefit in single processor configurations, such as the Lotus Notes
Server for NetWare. There is no host bus contention with only one processor.
Therefore, Compaq Engineers do not recommend the Transaction Blaster in
single processor configurations.

## Memory

Figure 4-4 shows that for Editing a Document, increasing the memory helps to
improve the response time. The gains are slight because the workload generated
on the server by the test is not enough to stress the system. As the CPU
utilization graph shows, the average CPU utilization is only 10%. Compaq
Engineers expect the performance gains with increased memory to be higher
when the CPU subsystem is under greater stress.

Compaq Engineers recommend that the Lotus Notes Server for NetWare have
at least 64 megabytes of RAM, especially for more stressful tasks, such as
concurrent replication, that require a lot of memory. The Lotus Notes Server
for NetWare will not handle memory exhaustion gracefully, so plenty of RAM
is essential. Otherwise, clients may experience disconnected sessions.
Furthermore, overall performance in the NetWare environment is typically
better with more memory. The actual performance gains in the Lotus Notes
Server are still qualitative at this point, and more real world tests must be
performed before quantifying the actual performance gains.

**Editing a Document**
**Response Time vs. Memory Configuration**
**(shorter bars are better)**

**Editing a Document**
**% CPU Utilization vs. Memory Configuration**
**(shorter bars are better)**
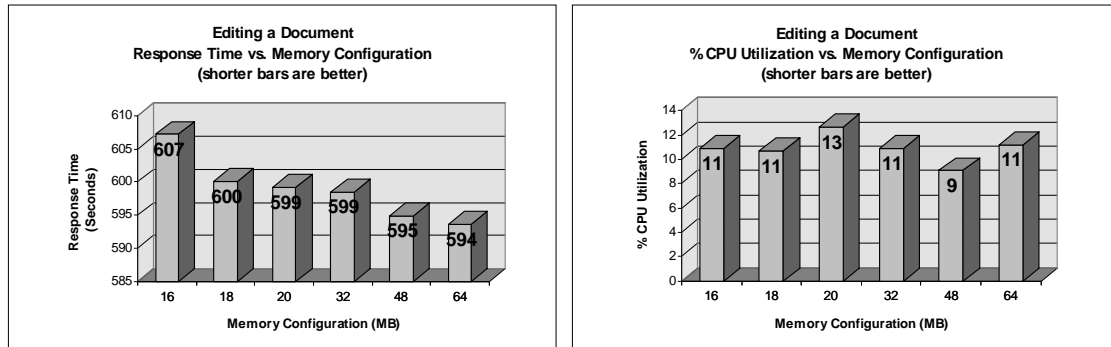
**Figure 4-4.**    Memory Configuration

## Disk Subsystem

The analysis of the disk subsystem involves the following factors:

■    Number of Drive spindles

■    Fault tolerance (Hardware versus Software)

■    Striping (Hardware versus Software)

■    Controller type (SMART versus Fast-SCSI-2)

## Drive Spindles

If your applications generate significant disk I/O, there will likely be a lot more concurrent use of system services. You can improve the performance of your disk subsystem under load conditions by having your NetWare volume span multiple physical drives. This will provide more concurrent disk accesses, thus improving your total system performance.

Table 4-1 shows multiple drive spindles can improve the response time and throughput with minimal CPU overhead. Since this test uses a single workstation, greater performance gains can be expected in a multiple user environment.

**Table 4-1**
**Drive Spindles**
**Atomic Task: Executing a Non-Indexed Text Search, 1 Workstation**

|  | CPU Utilization Rate (%) | LAN Channel Throughput (Kbps) | Disk Channel Throughput (Kbps) | Response Time (Seconds) |
|---|---|---|---|---|
| One Drive | 70 | 0.04 | 739.25 | 94 |
| Four Drives (striped) | 72 | 0.11 | 763.14 | 90 |

## Fault Tolerance

Software fault tolerance with NetWare 3.x involves controller duplexing or drive mirroring using the "Split seeks" feature to enhance performance by alternating read operations between primary and secondary drive arrays. However, this takes up additional disk space. By contrast, hardware fault tolerance using data guarding (RAID 4) and distributed data guarding (RAID 5) use up less disk space. Hardware fault tolerance duplicates the data by using a single parity drive or parity "area" that stores encoded data.

Table 4-2 shows practically no performance degradation with hardware fault tolerance (RAID 5). Therefore, Compaq Engineers recommend that you use distributed data guarding to protect the data on your Lotus Notes Server, while delivering performance equal to that of a non-tolerant system.

**Table 4-2**
**Fault Tolerance**
**Atomic Task: Editing a Document, 20 Workstations**

|  | CPU Utilization Rate (%) | LAN Channel Throughput (KBps) | Disk Channel Throughput (KBps) | Response Time (Seconds) |
|---|---|---|---|---|
| No Fault Tolerance | 88 | 146.25 | 70.63 | 1569 |
| Distributed Data Guarding (RAID5) | 88 | 145.74 | 70.96 | 1569 |

## Striping

Table 4-3 shows that between hardware and software striping, the response time is comparable, but hardware striping uses slightly less CPU bandwidth. With more users, software striping performance will decrease.

**Table 4-3**
**Hardware and Software Striping**
**Atomic Task: Editing a Document, 20 Workstations**

|  | CPU Utilization Rate (%) | LAN Channel Throughput (KBps) | Disk Channel Throughput (KBps) | Response Time (Seconds) |
|---|---|---|---|---|
| Hardware Striping | 88 | 146.25 | 70.63 | 1569 |
| Software Striping | 89 | 147.78 | 71.15 | 1569 |

## Controller Type

Table 4-4 shows for a light or medium load environment (less than 60% CPU utilization), the SMART Controller can deliver better response time with slightly higher CPU utilization.

**Table 4-4**
**Controller Type**
**Atomic Task: Editing a Document, 10 Workstations**

|  | CPU Utilization Rate (%) | LAN Channel Throughput (KBps) | Disk Channel Throughput (KBps) | Response Time (Seconds) |
|---|---|---|---|---|
| SMART Controller | 57 | 97.73 | 38.82 | 1184 |
| Fast SCSI-2 | 54 | 97.2 | 49.62 | 1191 |

Table 4-5 shows for a heavily loaded environment (more than 60% CPU utilization), the SMART Controller delivers lower CPU utilization at the cost of slightly higher response time.

**Table 4-5**
**Controller Type**
**Atomic Task: Executing a Non-Indexed Text Search, 1 Workstation**

|  | CPU Utilization Rate (%) | LAN Channel Throughput (KBps) | Disk Channel Throughput (KBps) | Response Time (Seconds) |
|---|---|---|---|---|
| SMART Controller | 71 | 0.16 | 693.97 | 87 |
| Fast SCSI-2 | 79 | 0.17 | 736 | 80 |

In a high load situation, the SMART Controller suffers a slight performance degradation but saves 10% CPU bandwidth. Compaq Engineers believe that CPU utilization is more important in a loaded system because system performance begins to degrade in a highly loaded environment. Thus, 10% less CPU utilization means more system capacity.

## Comparing NetWare 3.11 with 3.12

When Compaq Engineers examined the performance of the Atomic Tasks mentioned previously in this TechNote, NetWare 3.12 performed slightly better than NetWare 3.11 in almost all the tests. The results showed not only faster response times with NetWare 3.12 but also less stress on the CPU. This is primarily due to the code efficiency of NetWare 3.12.

As seen from the analysis of Atomic Tasks, the network does not play a significant role in the total performance. Therefore, new features in NetWare 3.12 that improve network performance, such as the P-burst mode, do not provide a significant advantage for overall Lotus Notes performance. It is important to note that the performance tests were done after the appropriate patches were applied to NetWare 3.11. Without the patches, NetWare 3.11 is significantly slower than NetWare 3.12.

## NetWare Tuning Considerations for Lotus Notes

When tuning NetWare for Lotus Notes, be sure that you have applied the appropriate patches and have tuned the NetWare parameters as recommended.

### Required Patches for NetWare 3.11

Lotus recommends that you apply the patches and updates as shown in Table 4-6.

**Table 4-6**
**Recommended Patches And Updates**

| Patches and Updates | File Names |
|---|---|
| Server Patches | PATCHMAN.NLM<br>BIGRFIX.NLM<br>CPQDAOPT.NLM |
| Server Updates | STREAMS.NLM<br>TLI.NLM<br>IPXS.NLM<br>SPXS.NLM<br>CLIB.NLM |
| New Server Files | AIO.NLM<br>AIOCOMX.NLM |
| Client Files | NWNETAPI.DLL<br>NWIPXSPX.DLL<br>NWCALLS.DLL<br>NETBIOS.COM |

## NetWare Parameters

The recommended settings for the NetWare parameters are as follows:

1. Set Dirty Cache Delay Time = 7.5. This is especially effective for many concurrent small write transactions.

2. Set Minimum Packet Receive Buffers = 500

3. Set Maximum Packet Receive Buffers = 1000

4. Set Minimum File Cache Buffers = 1000

5. Set Maximum Alloc Short Term Memory = 5000000

   Set the Volume Block Size to 16 Kbytes. Table 4-7 illustrates the benefits of setting the Volume Block Size to this value, based on Editing a Document.

**Table 4-7**
**Volume Block Size**
**Atomic Task: Editing A Document, 20 Workstations**

| Volume Block Size | CPU Utilization Rate (%) | LAN Channel Throughput (KBps) | Disk Channel Throughput (KBps) | Response Time (Minutes) |
|---|---|---|---|---|
| 4 KB | 55.72 | 98.48 | 38.94 | 19.93 |
| 16 KB | 56.30 | 97.17 | 46.33 | 19.66 |
| 32 KB | 54.45 | 96.92 | 46.88 | 19.71 |

The data shows that the 16-Kbyte and 32-Kbyte Volume Block Sizes are better than 4 Kbytes for increased Disk Channel Throughput. However, although the 16-Kbyte and 32-Kbyte Volume Block Sizes provide comparable performance, using the 32-Kbyte block can result in inefficient use of disk space, by failing to fill the block with data. Therefore, Compaq Engineers recommend a 16-Kbyte Volume Block Size. This gives you a better performance without wasting too much disk space. For details on the benefits of a 16-Kbyte Volume Block Size, refer to the Compaq TechNote: *Performance Management in a NetWare v3.1x Environment*, P/N 133399-002.

6. Set the Cache Buffer Size equal to or less than the Volume Block Size (16 Kbytes as previously recommended). This matches the hardware striping factor recommended by Compaq and provides optimal performance. When the Cache Buffer Size does not match the Volume Block Size, the cache needs multiple operations to service a single request. For example, if you set the Cache Buffer Size to 4 Kbytes and the Volume Block Size to 8 Kbytes, a read request requires two cache operations to match the Volume Block Size. This slows the cache when performing many disk requests. Table 4-8 illustrates the benefits of setting the Cache Buffer Size to the match the Volume Block Size of 16 Kbytes, based on Executing a Non-Indexed Text Search.

**Table 4-8**
**Volume Block Size**
**Atomic Task: Executing A Non-Indexed Text Search, 1 Workstation**

| Volume Block Size | CPU Utilization Rate (%) | LAN Channel Throughput (KBps) | Disk Channel Throughput (KBps) | Response Time (Seconds) |
|---|---|---|---|---|
| 4 KB | 67.64 | 0.17 | 707.81 | 92 |
| 8 KB | 71.84 | 0.15 | 815.15 | 86 |
| 16 KB | 72.38 | 0.14 | 941.60 | 84 |

## Performance Conclusions

Based upon performance tests and data analysis, the performance conclusions are as follows:

**OS version:** Although the Compaq Engineers saw a slight performance gain with NetWare 3.12, the performance alone does not justify a buying decision for NetWare 3.12. However, both new and existing installations might want to select NetWare 3.12 for support purposes or other significant reasons. These reasons, combined with the slight performance increase that the engineering team found, make NetWare 3.12 a better choice than NetWare 3.11 in the Lotus Notes environment.

**CPU:** The CPU is the most important server subsystem for Lotus Notes. Therefore, purchase the fastest CPU available. Our tests show you can expect 20% to 156% improvement in client response time and up to 58% improvement in server CPU utilization by selecting the fastest CPU available. Another benefit is the fact that reducing CPU utilization is quite important in a stressed server environment and under server boundary conditions.

**Memory:** The Compaq Engineers recommends at least 64 megabytes of RAM for the Lotus Notes Server for NetWare. This is especially true for tasks such as concurrent replication, which requires a large amount of memory. The Lotus Notes Server will not handle memory exhaustion gracefully, and your end users may get disconnected.

**Fault Tolerance:** The engineering team recommends configuring the server with Distributed Data Guarding (RAID5). This is because there is no performance loss. Additionally, RAID5 provides the highest reliability of data protection while maximizing usable disk space.

**Number of Disk Drives (Spindles):** Although there is relatively little I/O contention in the Lotus Notes environment, stripe as many drives as possible into each volume or drive array. Using multiple drive spindles helps improve concurrent drive access. For applications with multiple large concurrently accessed Lotus Notes databases, distribute the databases to different striped volumes.

**Hard Disk Controller:** The engineering team strongly recommends the SMART Controller over Fast SCSI-2 for two reasons. First, it performs better in a medium load situation. Furthermore, in a high load situation it suffers only very slight performance degradation, but its bus-master feature saves up to 10% of CPU bandwidth. Second, it provides hardware fault tolerance features like RAID5 as recommended above.

**Hardware or Software Striping:** The engineering team strongly recommends using hardware striping rather than the NetWare software striping because hardware striping requires less CPU and provides increased fault tolerance benefits.

**Client Performance Capacity:** Lotus Notes is a typical Client/Server model application: the processing labor is distributed between the server and client. Depending on the task, Lotus Notes could impact the overall system performance. Faster clients will have better response time but be aware that they can cause higher stress on the server. Therefore, you will always need to balance your client response time with your server capacity for optimal performance.

**Hardware Platform Recommendation:** Based on the above subsystem recommendations, Compaq can recommend various server products for use as a Lotus Notes Server for NetWare. It is important to note that although our recommendations are based upon performance, this feature should not be your only criterion for choosing the best server for your environment. You will need to look at other factors such as the ease of use, serviceability, and reliability offered by different Compaq server products, in addition to performance, prior to making your hardware platform decision.

Since the speed of the CPU is the most important component in determining your overall performance in a Lotus Notes environment, you should consider the following configuration:

■   A Compaq ProLiant 2000 with 64 megabytes of RAM and 1 System Processor. This server offers either a Pentium/90 (standard) or a Pentium/100 (optional) CPU as well as the SMART Controller (standard) which provides the recommended Distributed Data Guarding (RAID5) fault tolerance. Additionally, the ProLiant 2000 provides you with future scalability as the NetWare operating system evolves to multi-processing.

■   Compaq  has additional servers such as the ProLiant 1000, the ProSignia Family of Servers, and the ProSignia VS. Each of these servers is fully capable of performing well as a Lotus Notes Server for NetWare, generally at lower cost. Keep in mind that specific models of these servers may not provide you with the complete set of standard features you may need. However, depending upon the server model and the feature you desire, optional upgrades may be available.

## *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.

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| | FAX:   1-331-64-46-51-81 |

## Current TechNotes

The current TechNotes available are listed in the following tables.

| COMPAQ TECHNOTES | AVAILABLE ON SMARTSTART | PART NUMBER |
|---|---|---|
| *Insight Management Agents* | | |
| Integrating Compaq Insight Management Agents (10/94) | √ | 145806-002 |
| *NetWare* | | |
| Performance Management in a NetWare v3.1x Environment (4/93) | | 133399-002 |
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| Configuration and Tuning of Oracle7 for NetWare on Compaq Servers (11/94) | √ | |

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| COMPAQ TECHNOTES | AVAILABLE ON SMARTSTART | PART NUMBER |
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| 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 |
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| Performance Tuning for SCO UNIX on Compaq Systems (5/93) | | 145730-001 |
| Configuration and Tuning of Oracle7 for SCO UNIX on Compaq Servers (11/94) | √ | 184329-001 |
| The Compaq, SCO UNIX, and ORACLE7 Database Server (9/93) | | 195818-001 |
| *IBM* | | |
| Compaq Answers to Technical Support Questions for OS/2 Environments (11/94) | √ | |
| *Technology Overview* | | |
| 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. |
| Abnormal end | See Abend. |
| Atomic Task | A fundamental operation initiated either from the Lotus Notes Server (Server Atomic Task), or from the Lotus Notes client (User Atomic Task), which is executed by one of the Lotus Notes Server Programs. |
| 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. |

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|---|---|
| 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. |
| PALM | See Profiling and Load Modeling Tool. |
| Performance management | "Tuning" the network components to maximize performance and address user productivity issues, application software design, and data structure. |
| Profiling and Load Modeling Tool (PALM) | There were no readily available performance monitoring and load generation test tools for Lotus Notes. Therefore, the Compaq Groupware Engineering Team developed a custom tool called the **P**rofiling **A**nd **L**oad **M**odeling (PALM) Tool. The PALM Tool consists of an editor, a script execution program, and a set of Lotus Notes Atomic Task scripts. The editor was written with Visual Basic 3.0 and the scripts were written using Microsoft Test 2.0. |
| 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. |

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|---|---|
| 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. |
| Server Atomic Task | See Atomic Task. |
| User Atomic Task | See Atomic Task. |

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