

COMPAQ

# ORACLE Server Planning in a NetWare v3.x Environment

Compaq TechNote

Includes information on:

- System processor selection
- Fixed disk planning and optimization
- NetWare SET parameters

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

#### ***ORACLE SERVER PLANNING IN A NETWARE v3.11 ENVIRONMENT***

Second Edition (May 1993)  
Part Number 145143-002

**Compaq Computer Corporation**

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# CONTENTS

Overview	2
Client-Server Computing	2
NetWare Version 3.11	2
ORACLE Server for NetWare	3
ORACLE Tools	4
ORACLE Server Structure	5
System Global Area (SGA)	5
Program Global Area	5
ORACLE Server Kernel Processes	6
System Components	8
Hardware	8
Software	8
ORACLE Server Planning	9
System Processor	10
Hard Drive Subsystem	11
Selecting the Type of Hard Drive Subsystem	12
Determining the Method of System Fault Tolerance	13
Controller Duplexing	14
Drive Mirroring	14
Data Guarding	14
Distributed Data Guarding	15
Evaluating the Type of Application	15

---

**Hard Drive Subsystem** *Continued*

<u>Estimating the Amount of Disk Space</u>	<u>18</u>
<u>    NetWare Operating System</u>	<u>18</u>
<u>    ORACLE Server for NetWare</u>	<u>18</u>
<u>    Database Files for Table and Index Data</u>	<u>19</u>
<u>        Size of Database Table and Associated Indexes</u>	<u>19</u>
<u>        Rollback Segments</u>	<u>23</u>
<u>    Redo Log Files</u>	<u>24</u>
<u>    Future Growth</u>	<u>27</u>
<u>    Example Disk Space Estimate</u>	<u>28</u>
<u>System Memory</u>	<u>33</u>
<u>    System Memory Requirements for NetWare</u>	<u>33</u>
<u>    System Memory Requirements for ORACLE Server</u>	<u>34</u>
<u>        ORACLE NLMs</u>	<u>35</u>
<u>        INIT.ORA File</u>	<u>36</u>
<u>        Program Global Area (PGA) and Client Connections</u>	<u>36</u>
<u>        Added System Memory for System Global Area (SGA)</u>	<u>38</u>
<u>    Example System Memory Estimate</u>	<u>40</u>
<u>NetWare Planning</u>	<u>41</u>
<u>    Cache Buffer Size and Volume Block Size</u>	<u>42</u>
<u>    Hot Fix Redirection Area</u>	<u>43</u>
<u>        Intelligent Drive Array Subsystems</u>	<u>44</u>
<u>        Intelligent Array Expansion System</u>	<u>46</u>

---

 NetWare Planning *Continued*


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SET Parameters	48
SET MAXIMUM PHYSICAL RECEIVE PACKET SIZE = [VALUE]	48
SET MINIMUM PACKET RECEIVE BUFFERS = [VALUE]	49
SET MAXIMUM PACKET RECEIVE BUFFERS = [VALUE]	50
SET MAXIMUM SERVICE PROCESSES = [VALUE]	50
Summary	51
ORACLE Server Planning Worksheet for Disk	52
ORACLE Server Planning Worksheet for System Memory	55

**TABLES**

Table 1	ORACLE Tools	4
Table 2	System Processor Speed	11
Table 3	Recommended Hard Drive Subsystem Options for COMPAQ SYSTEMPRO Line	12
Table 4	Supported Fault Tolerance Methods	13
Table 5	Data Types	20
Table 6	Estimated Column Width	21
Table 7	Recommended Number of Rollback Segments	23
Table 8	Column Description of Example CUSTOMER Table	28
Table 9	Character Estimate of Example CUSTOMER Table	29
Table 10	Disk Space Requirements for Example Database	30
Table 11	Total Disk Space Requirements for Example Database Server	32
Table 12	Memory Recommendations for Client Connections	37
Table 13	Recommended Volume Block and Cache Buffer Sizes	42

Table 14	120-MB Hard Drives	44
Table 15	210-MB Hard Drives	45
Table 16	340-MB Hard Drives	45
Table 17	510-MB Hard Drives	46
Table 18	1.3-GB Hard Drives	48
Table 19	Maximum Packet Sizes	49

## FIGURES

Figure 1	ORACLE Server Kernel Processes	6
Figure 2	Effect of db_block_buffer Parameter on Server Performance	39
Figure 3	Effect of Aligned and Misaligned Striping	43



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## **ACKNOWLEDGMENT**

Compaq Computer Corporation would like to acknowledge the contribution of Oracle Corporation to the development of this COMPAQ TechNote. Compaq would like to thank Oracle Corporation for reviewing and providing input to ensure the accuracy of this information.

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# ORACLE SERVER PLANNING IN A NETWARE v3.11 ENVIRONMENT

Carefully planning your ORACLE database server is key to server optimization, because most of the optimization occurs during the planning and installation phases of your implementation. This *COMPAQ TechNote for NetWare* focuses on the planning process for configuration of ORACLE Server for NetWare (ORACLE RDBMS version 6.0.x) on a COMPAQ network server product. Use this information to plan a server configuration that can meet your ORACLE database requirements. This COMPAQ TechNote includes the following topics:

- System processor selection
- Disk space requirements based on the size of the database
- Fault tolerance options
- System memory requirements
- NetWare planning

This COMPAQ TechNote is for system integrators with knowledge of COMPAQ server products in a NetWare environment and little familiarity with ORACLE Server for NetWare. It provides some basic information about ORACLE Server to allow you to make informed decisions when planning your server configuration.

**NOTE:** The information in this COMPAQ TechNote is specific to ORACLE RDBMS version 6.0.x.

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! **IMPORTANT:** This COMPAQ TechNote is for database server *planning purposes only*. It provides general guidelines for selecting the appropriate hardware for your server configuration. Once you configure your server, you must tune your server based on the type of application that your server runs.

Use the "ORACLE Server Planning Worksheets," at the end of this COMPAQ TechNote, to estimate the amount of disk space required and the amount of system memory required for your ORACLE database server.

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The ORACLE manuals may cover multiple hardware and operating system platforms. This *COMPAQ TechNote for NetWare* supplements these manuals with the following NetWare and COMPAQ product information:

- NetWare and ORACLE Server description
- Guidelines for ORACLE database server planning for NetWare

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! **IMPORTANT:** For detailed information on ORACLE database object planning, review the *ORACLE Server Database Administrator's Guide*.

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## OVERVIEW

The following sections describe the client-server computing environment, NetWare as an operating system platform for ORACLE Server, and ORACLE Server processing.

### CLIENT-SERVER COMPUTING

In a client-server environment, the server and workstation divide processing functions. The workstation performs data entry, SQL statement creation, and display functions. The server performs SQL statement processing, file read and write operations, and results processing, returning the results to the client. Dividing the processing functions between client and server can improve the performance of a database application.

Client-server computing provides centralized management and security. It also efficiently shares network resources and reduces network traffic, thereby increasing overall network performance. Client-server computing also provides for interoperability. This is especially important in an ORACLE application, because you can port ORACLE applications to multiple operating systems.

### NETWARE VERSION 3.11

NetWare Version 3.11 is a full 32-bit, multithreaded operating system for 386 and 486 processors, providing operating system services, such as memory and task management, and network operating system services, such as file, print, and mail services.

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NetWare is a non-preemptive operating system that relies on individual applications, like ORACLE Server, to return control of the system processor to the operating system. NetWare schedules and runs tasks (threads), passing control of the system processor to ORACLE Server until ORACLE Server completes its tasks; however, ORACLE Server requires NetWare to perform scheduling and task management frequently. To avoid monopolizing the system processor, ORACLE Server is designed as a "well-behaved" system that passes system processor control back to NetWare at optimal times, allowing critical database tasks to complete.

## **ORACLE SERVER FOR NETWARE**

ORACLE Server for NetWare Version 1.x is a collection of NetWare Loadable Modules (NLMs) that run as integrated parts of the operating system. ORACLE Server can run on the primary network server. However, ORACLE Server performs best on a dedicated NetWare server, especially when the primary network server is heavily burdened. A separate primary network server should be used to provide operating system services and task management, as well as file, print, and mail services.

ORACLE Server is a multiuser relational database management system that runs on a variety of operating systems. ORACLE Server includes database software for the server, communications software (SQL\*Net) for clients and database servers, and tools for database creation and administration.

ORACLE Server for NetWare includes the following:

- *SPXSRV.NLM* (SQL\*Net SPX Listener)
- *SQLSPX.NLM* (SQL\*Net SPX driver)
- *IMP.NLM* and *EXP.NLM* (IMPORT and EXPORT utilities)
- *SQLLOAD.NLM* (SQL\*Loader)
- *ORACLE6.NLM* (relational database management system)
- *PLSQL.NLM* (PL/SQL)
- *SQLDBA.NLM* (SQL\*DBA)

## ORACLE Tools

Table 1 lists the ORACLE tools for database creation, management, administration, and access.

<b>Table 1 ORACLE Tools</b>	
<b>Server Tools</b>	<b>Description</b>
IMP and EXP ( <i>IMP.NLM</i> and <i>EXP.NLM</i> )	Store or retrieve data in ORACLE format. Archive data or physically transfer data between different ORACLE applications on different operating systems. Can also be used to back up and restore the database.
SQL*Loader ( <i>SQLLOAD.NLM</i> )	Loads data from standard file formats (ASCII, dBase III, and Lotus 1-2-3) into an ORACLE database.
SQL*DBA	Allows you to perform database administration and to monitor database performance.
<b>Client Tools</b>	<b>Description</b>
Pro*C	Enables you to embed SQL statements in procedural language to access an ORACLE database.
Pro*COBOL <sup>◆</sup> and Pro*FORTRAN <sup>◆</sup>	Enable you to embed SQL statements in procedural language to access an ORACLE database.
SQL*Plus <sup>◆</sup>	Lets you use SQL statements to access database information.
SQL*Forms <sup>◆</sup>	Lets you develop and run form-based applications for data entry, query, update, and deletion.
SQL*ReportWriter <sup>◆</sup>	Lets you produce and maintain complex reports that include database information.
SQL*Menu <sup>◆</sup>	Allows developers to design custom menu interfaces more quickly than with conventional programming.
◆ Must be purchased separately.	

**NOTE:** *IMP.NLM*, *EXP.NLM*, *SQLLOAD.NLM*, and *SQL\*DBA.NLM* are also provided as .EXE files for DOS and OS/2 clients.

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## ORACLE Server Structure

ORACLE Server takes advantage of the multithreaded capabilities of NetWare Version 3.11. The *ORACLE6.NLM* software architecture includes the System Global Area (SGA), six kernel background processes, and a Program Global Area (PGA) for each client connection.

### SYSTEM GLOBAL AREA (SGA)

The System Global Area (SGA) is a set of control structures that include shared memory buffers, database buffers, redo log buffers, and data dictionary information (cached). The SGA and all ORACLE background processes make up an *ORACLE instance*.

### PROGRAM GLOBAL AREA

When a client requests data from the server, it generates a client process that communicates with the database server via SQL\*Net. This process is called a shadow process. The shadow process obtains memory for a program global area (PGA). A PGA contains the information on how the server communicates with the client, so that the client can communicate with ORACLE Server. A PGA also shares the common code to parse SQL statements, optimize queries, and enforce data security for client processes.

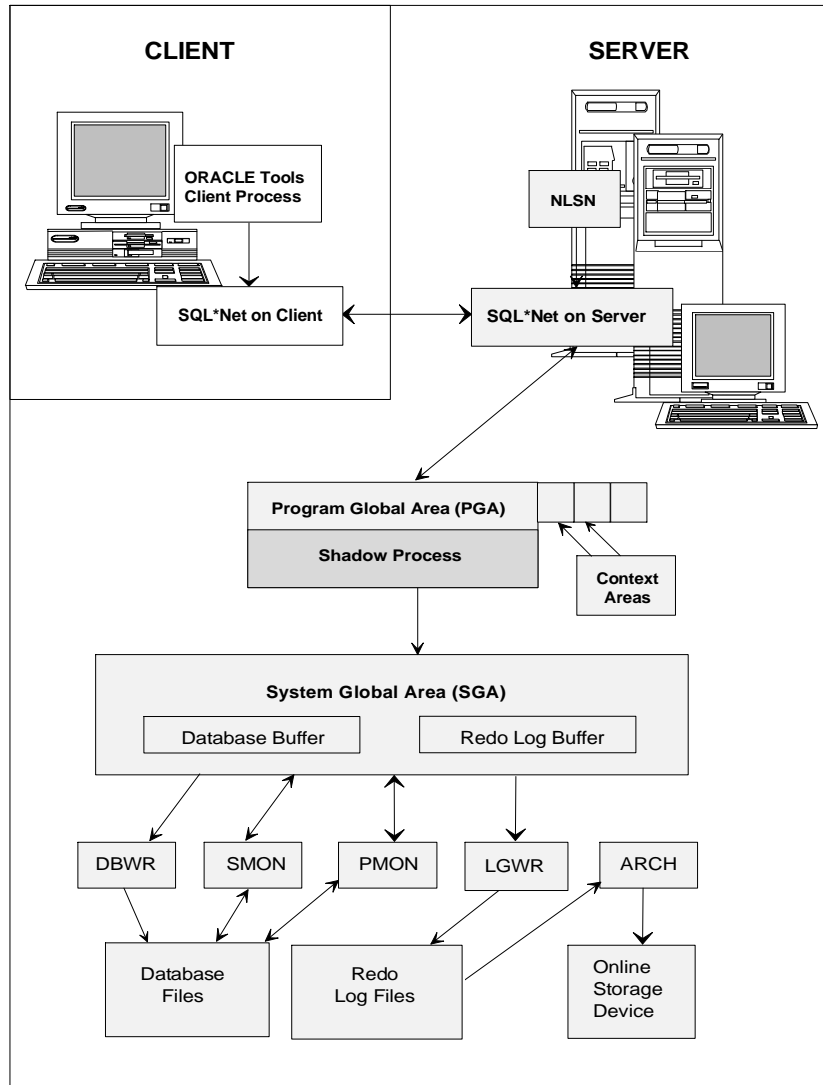
The context area, within the PGA, is a database server memory buffer that contains the current status and data structure of each SQL statement executed by a client. Every SQL statement issued by a client requires a context area. A PGA can contain multiple context areas for multiple SQL statements. The context area includes the following:

- SQL statement text
- Translated SQL statement
- One row of the result and intermediate values
- Cursor status information to execute the statement
- Control information for sorting

## ORACLE SERVER KERNEL PROCESSES

Figure 1 illustrates the relationship among the kernel processes, and the paragraphs that follow briefly describe these processes.

**Figure 1**  
**ORACLE Server Kernel Processes**



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**Database Writer (DBWR)** writes modified blocks of data to the database files on disk. If ORACLE Server requires more buffers for the modified data blocks, DBWR writes the least recently used data to the database files first, using the Least-Recently-Used (LRU) algorithm.

**Process Monitor (PMON)** watches all shadow processes to detect the loss of a connection with a client. When PMON discovers a disconnection before commitment of the transaction, PMON rolls back the incomplete transaction. PMON returns the data to its original state, releasing client locks and other server resources for other clients to use.

**System Monitor (SMON)** performs database recovery. During database startup, SMON performs the appropriate automatic recovery if the database did not shut down properly. SMON also flushes temporary segments that are not in use. ORACLE Server enables SMON in one of two ways:

- SMON regularly "wakes up" to determine whether it is needed by ORACLE Server.
- Another process calls SMON when SMON is needed.

**Log Writer (LGWR)** writes redo log entries from the redo log buffers of the SGA to the online redo log file. This process protects any changes that have not been written to the database files. Redo log entries generally occur synchronously with database write operations to the database files. However, LGWR can also write redo log entries to the online redo log files before the transaction is committed. This usually happens when the redo log buffers are full or when the redo log entries reside in the same buffer as entries of a committed transaction.

**Network Listener (NLSN)** listens for connection requests from clients or other database servers. When NLSN recognizes a request, it issues a shadow process that performs communication with the client.

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- ! **IMPORTANT:** Each active SQL\*Net protocol (either SPX/IPX or TCP/IP) requires one NLSN process on the server. ORACLE Server may have multiple NLSN processes active at a given time.
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*Archiver (ARCH)* is an optional process that copies the online redo log files to another part of the disk. You can enable ARCH only when the database is operating in ARCHIVELOG mode with automatic archiving enabled.

## SYSTEM COMPONENTS

The following sections discuss the **MINIMUM RECOMMENDED** requirements for configuration of an ORACLE database server.

### HARDWARE

ORACLE Server requires a high-performance system, such as a COMPAQ 386- or 486-based PC System or PC Server, with a **RECOMMENDED MINIMUM** of the following:

- 16 megabytes of system memory  
(4 megabytes for NetWare, and 12 megabytes for ORACLE Server)
- 60 megabytes of disk space  
(30 megabytes for NetWare, and 30 megabytes for ORACLE Server)
- Network Interface Card (NIC) that supports SPX/IPX
- DOS client workstation configured with hardware and software necessary to log into the server

### SOFTWARE

An ORACLE database server requires the following software:

- MS-DOS Version 3.31 (or later) as published by Compaq
- NetWare Version 3.11 (or later)
- ORACLE Server for NetWare

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## ORACLE SERVER PLANNING

Planning your ORACLE database server configuration requires a thorough knowledge of NetWare and ORACLE Server for NetWare. It also requires a knowledge of database and application design. A well-designed database and a well-designed application are important performance requirements. A poorly designed database performs poorly, regardless of how you plan, configure, and tune your server. However, because the concepts of database and application design are beyond the scope of this COMPAQ TechNote, database and application design are not discussed in detail.

Since ORACLE Server is a collection of NLMs, it runs as an integral part of the NetWare operating system that shares system memory, hard disk, and system processor resources with other NLMs on the server. Determining the amount of system memory required, the type of hard drive subsystem to be installed, and the amount of disk space needed to support all NetWare and ORACLE Server functions requires careful planning.

This COMPAQ TechNote focuses on ORACLE database server planning. It provides information to help you determine the following:

- Appropriate system processor
- Type of hard drive subsystem
- Available methods of fault tolerance
- Amount of disk space required for your configuration
- Amount of system memory required for your configuration
- NetWare SET parameters that may affect your ORACLE database server performance

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! **IMPORTANT:** This COMPAQ TechNote is for *planning purposes only*. It provides guidelines for selecting the appropriate hardware for your server configuration. Once you configure your server, you must tune your server based on the type of application that your server runs.

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## SYSTEM PROCESSOR

When identifying the appropriate system processor for your ORACLE database server, the bus clock speed is a significant factor in the measurement of ORACLE database server performance. Unlike most resource-sharing applications, ORACLE Server performs computation and database functions that divert the system processor cycles from file service processing. Offload ORACLE Server to a dedicated server that can focus on computation and database functions, and implement a primary network server to manage resource sharing and file service processing.

In CPU-intensive environments, using a more powerful system processor can significantly increase performance. The *recommended minimum* system processor for an ORACLE database server is the Intel 386/33. In CPU-intensive environments, a system processor with a 25-MHz bus clock speed, cannot provide the power needed to process data in a timely manner. System processors with less power, such as the Intel 386SX, also use a 16-bit memory bus. When the 386SX runs NetWare, the narrow bus width hinders NetWare operations, because NetWare uses server system memory to cache disk I/O requests. The 386SX must make twice as many fetches to system memory as the 386DX system processor does to service the same requests.

Table 2 provides current available Intel system processors for the COMPAQ SYSTEMPRO Line, their clock and bus speeds, and their NetWare "speed" ratings.

The NetWare speed rating is based on the following:

- Bus clock speed (internal)
- Type (for example, 386 or 486)
- Number of memory wait states

The NetWare speed rating can provide *some* information on the system processor's capabilities, but you must also consider the bus clock speed and the core speed when selecting a system processor. For example, the highlighted rows in Table 2 show the 486DX/50 speed rating to be equal to the 486DX2/50 speed rating, even though the bus clock speeds are different.

**Table 2**  
**System Processor Speed**

Microprocessor Type	NetWare Speed	Core Speed	Bus Clock
486DX2/66	1830	66 MHz	33 MHz
486DX/50	1372	50 MHz	50 MHz
486DX2/50	1372	50 MHz	25 MHz
486/33	915	33 MHz	33 MHz
486/25	686	25 MHz	25 MHz
386/33	322	33 MHz	33 MHz
386/25	242	25 MHz	25 MHz

**NOTE:** Highlighted rows show comparison of bus clock, core speed, and speed ratings for 486DX/50 and 486DX2/50.

In another example, the NetWare speed rating in Table 2 for the 386/33 is 322, and the NetWare speed rating for the 486/33 is 915. This does not indicate that the 486/33 system processor performs three times faster than the 386/33 system processor. You may *not* notice a large performance improvement when configuring a server system processor with a higher NetWare speed rating.

To find the NetWare speed rating, type the following at the NetWare server console prompt:

```
:speed
```

## HARD DRIVE SUBSYSTEM

The COMPAQ SYSTEMPRO Line of PC Servers provides a variety of hard drive configuration options, from non-arrayed drive subsystems to multiple drive array subsystems with intelligent bus master controllers. In most ORACLE Server applications, single hard drives cannot efficiently support ORACLE Server. Furthermore, single drives do not provide adequate fault tolerance. Use multiple hard drives when configuring your ORACLE database server.

Table 3 shows the recommended hard drive subsystem options for the COMPAQ SYSTEMPRO Line.

**Table 3  
Recommended Hard Drive Subsystem Options for  
COMPAQ SYSTEMPRO Line**

Supported Hard Drive Controllers	Hard Drive Options				
	120-MB	210-MB	340-MB	510-MB	1.3-GB
IDE			✓	✓	
32-Bit IDA	✓	✓	✓	✓	
IDA-2	✓	✓	✓	✓	
32-Bit IDA Expansion					✓

Planning the hard drive subsystem for your ORACLE database server includes the following:

- Selecting the type of hard drive subsystem for your server
- Determining the method of fault tolerance for your server
- Evaluating the type of application your server will run
- Estimating the amount of disk space your server requires

### Selecting the Type of Hard Drive Subsystem

Recent advances in drive array technology provide viable options for hard drive subsystems in NetWare environments. The COMPAQ Intelligent Drive Array Controller-2 (IDA-2), like the 32-Bit IDA Controller, provides parallel data transfers and simultaneous request services. It also manages drive array access by queuing and servicing multiple read requests in priority order. However, the IDA-2 Controller includes two additional enhancements over the 32-Bit IDA Controller: distributed data guarding (RAID 5) and the Array Accelerator Write Cache.

Most data guarding methods require overhead to write data to disk and then encode and write data to the parity drive, resulting in a performance degradation. Distributed data guarding avoids this overhead by writing to multiple disks, rather than to a single parity drive. Because database applications inherently require large amounts of disk space, distributed data guarding, requiring only 25 percent of the available disk space, is a solution for applications that are not inherently hard-disk-bound.

The IDA-2 Controller also includes the COMPAQ 4-Megabyte Array Accelerator Write Cache, a memory module that caches up to 2 megabytes of data before sending the data to disk. The Array Accelerator provides non-volatile buffer memory for write operations and includes onboard batteries to preserve the data in the buffer for up to 5 to 8 days in the event of a power loss. The Array Accelerator uses the remaining 2 megabytes of memory to mirror the data, so that if a parity error occurs, the Array Accelerator retains an undamaged copy of the data.

## Determining the Method of System Fault Tolerance

In addition to the software system fault tolerance features in NetWare (such as Hot Fix Redirection Area), NetWare and the COMPAQ SYSTEMPRO Line support a variety of hardware fault tolerance methods. When planning your database server, how you plan and implement system fault tolerance greatly affects both the amount of available disk space and the performance of your ORACLE database server.

Table 4 lists the methods of fault tolerance and the COMPAQ hard drive subsystems that support them.

**Table 4**  
**Supported Fault Tolerance Methods**

<b>Fault Tolerance Method</b>	<b>IDE Drives with Integrated Controller</b>	<b>IDA Subsystem</b>	<b>IDA-2 Subsystem</b>
Controller Duplexing (RAID 1)		✓	✓
COMPAQ Drive Mirroring (RAID 1)		✓	✓
NetWare Drive Mirroring (RAID 1)	✓	✓	✓
Data Guarding (RAID 4)		✓	✓
Distributed Data Guarding (RAID 5)			✓

## **CONTROLLER DUPLEXING**

Controller duplexing provides complete redundancy of the hard drive subsystem (hard drives, cables, and controller). Controller duplexing is a Novell software-dependent method of fault tolerance, relying on software support within the NetWare operating system. Since controller duplexing is software-driven, any COMPAQ server with two hard drive controller boards can support controller duplexing as a fault tolerance method.

## **DRIVE MIRRORING**

Drive mirroring provides redundancy of the hard drives only. When the system writes data to disk, it writes the data to the primary drive and then writes to the secondary drive. If a primary drive or drive array fails, the system can read the data via the same controller from the secondary drive or drive array.

Two methods of drive mirroring are supported: COMPAQ drive mirroring and NetWare drive mirroring. The method of drive mirroring you use depends on the type of COMPAQ PC System or PC Server product you configure. COMPAQ PC network servers with intelligent drive array configurations, such as the IDA and IDA-2, support both COMPAQ drive mirroring and NetWare drive mirroring. PC Servers with non-arrayed drives, such as IDE drives, support NetWare drive mirroring.

Both methods provide mirrored drives. The only difference is that COMPAQ drive mirroring offloads the burden of fault tolerance from the operating system to hardware. This alleviates the need for additional NetWare cycles to support fault tolerance and makes the fault tolerance transparent to NetWare.

## **DATA GUARDING**

Data guarding, specific to COMPAQ IDA controllers, protects against the loss of data due to a drive failure. Data guarding uses 25 percent of the available drive capacity as a "parity drive" to store encoded data. When a drive fails, the system reconstructs the data by combining the encoded data on the parity drive with the data from the remaining drives. Since data guarding is specific to IDA controllers, any COMPAQ network server configured with an IDA controller and a multiple of four drives (four or eight) can support data guarding.

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The COMPAQ EISA Configuration Utility designates the parity drive while configuring the system so that it is transparent to NetWare and to network users.

### **DISTRIBUTED DATA GUARDING**

Like COMPAQ drive mirroring and data guarding, distributed data guarding is independent of the operating system, and like data guarding, distributed data guarding uses 25 percent of the drive array as a parity "drive" to store encoded data. Instead of storing all encoded data on one drive, distributed data guarding uses a portion of each drive to store the data. Distributed data guarding enhances write operation performance by writing to multiple drives simultaneously. If a single drive fails, then the data is rebuilt from the encoded data that resides on the remaining drives.

Data guarding and distributed data guarding use less disk space than controller duplexing and drive mirroring by using a single parity drive or parity "area" that stores encoded data. With data guarding, encoding the data for the parity drive requires overhead that can impede performance. However, with distributed data guarding, NetWare writes data to multiple disks rather than to a single disk. This compensates for some of the overhead that is generated when using data guarding, thereby improving fault tolerance performance.

Since distributed data guarding is specific to the IDA-2 Controller, any COMPAQ PC product configured with a multiple of four drives and an IDA-2 Controller can support distributed data guarding in a NetWare environment.

### **Evaluating the Type of Application**

Whether you employ any method of fault tolerance for your ORACLE database server configuration depends primarily on the type of application that runs on the server. You can implement fault tolerance for your entire hard drive subsystem, for the portion of your subsystem that contains key files (such as redo log files), or for none of your hard drive subsystem.

To determine the level of fault tolerance for your database server, consider the following factors:

- Nature and volatility of the data
- Amount of server downtime you can incur
- Level of financial risk involved

Applications that require few updates, such as decision-support applications, contain "static" data. For example, in an employee database, each record may require updates only a few times each year, but these records may require frequent access (such as every payday). If the database is relatively small and a failure occurs, the employee records can be restored from backup. For databases that contain easily restored, "static" data, the database may require less protection against corruption. You can choose not to implement fault tolerance, or you can choose to implement drive mirroring for only the logical drive that contains the redo log files.

Applications that require constant updating, such as online transaction-processing applications, contain volatile data. An example is a financial database with records that are updated daily and a report that is generated weekly. In this example, a limited amount of downtime to restore the lost data may be acceptable although you must still protect this volatile data by using some method of fault tolerance. Since incurring some downtime is acceptable, you can implement fault tolerance only for the logical drive that contains the redo log files. Separating the redo log files from the data and index tables can also reduce I/O contention.

With mission-critical or time-sensitive applications, the data is volatile, and server downtime and data loss are unacceptable. A failure can result in the loss of productivity and/or loss of revenue. For these applications, implement full fault tolerance (fault tolerance for the entire subsystem), such as distributed data guarding or drive mirroring.

When analyzing fault tolerance options, consider the effect of fault tolerance on server performance and capacity. When you implement full fault tolerance, controller duplexing, drive mirroring, and distributed data guarding are all viable options. Controller duplexing and drive mirroring provide some limited performance advantages over distributed data guarding in write-intensive environments; however, controller duplexing and drive mirroring use 50 percent of the available disk space for fault tolerance.

Distributed data guarding uses 25 percent of the available disk space; however, distributed data guarding requires a multiple of four physical drives. In many configurations, a total of four or eight physical drives is far more disk space than necessary for storing redo log files.

If you want to provide fault tolerance for redo log files in an environment in which the redo log files are on a separate logical drive from the data tables and indexes, controller duplexing or drive mirroring are the best options.

For example, if you determine that the hard disk capacity requirements equal 600 megabytes and you select COMPAQ drive mirroring, you can configure your server in a variety of ways:

- Four 420-megabyte drive array pairs for a total of 1.68 gigabytes of hard drive storage: one drive array for data storage and one drive array available for fault tolerance.
- Two 680-megabyte drive array pairs (four 340-megabyte drives) for a total of 1.36 gigabytes of hard drive storage: one drive array pair for data storage and one drive array pair available for fault tolerance.
- Two 1020-megabyte drive array pairs (four 510-megabyte drives) for a total of 2.04 gigabytes of hard drive storage: one drive array pair for data storage and one drive array pair available for fault tolerance.

Data guarding requires only 25 percent of available disk space, but can degrade performance in a write-intensive environment, such as in a transaction-processing application where tables are constantly updated. Distributed data guarding also uses only 25 percent. However, because the encoded data is distributed among the drives in the drive array, write operations occur simultaneously, providing acceptable performance in a write-intensive environment.

For example, if your hard disk capacity requirements equal 800 megabytes and data guarding is required, you can use two 680-megabyte drive array pairs, with 1020 megabytes of disk space available for data storage and 340 megabytes available for fault tolerance. In this case, to maintain acceptable performance and conserve disk space, you can use an IDA-2 Controller and implement distributed data guarding.



## Estimating the Amount of Disk Space

The amount of disk space your ORACLE database server requires is also based on the amount of space required for each of the following:

- NetWare operating system
- ORACLE Server for NetWare
- Database files that contain tables, indexes, and rollback segments
- Redo log files
- Future growth of the database

To help you determine the amount of disk space your ORACLE database server requires, the following sections discuss each of these factors.

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! **IMPORTANT:** This COMPAQ TechNote is for *planning purposes only*. It provides guidelines for selecting the appropriate hardware for your server configuration. Once you configure your server, you must tune your server based on the type of application that your server runs.

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### NETWARE OPERATING SYSTEM

An ORACLE database server requires a minimum of 30 megabytes of disk space for NetWare. This includes a 10-megabyte DOS partition and a 20-megabyte partition for the SYS volume. A 10-megabyte DOS partition allows installation of MS-DOS Version 5.0 (as published by Compaq) and required DOS files.

When estimating the required amount of disk space for your server, include this 30-megabyte estimate for NetWare in your calculations.

### ORACLE SERVER FOR NETWARE

Although ORACLE Server occupies some disk space on the server, the amount required is relatively insignificant when compared to the size of the database and its associated tables, indexes, rollback segments, and redo log files.

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ORACLE Server uses a recommended minimum of 30 megabytes of disk space for operation. This 30-megabyte space contains the ORACLE Server NLMS, sample database files, and supporting script files and utilities. Include this 30-megabyte requirement in your estimate.

- 
- ! **IMPORTANT:** Review the *ORACLE Server Database Administrator's Guide* for detailed information on database object planning.
- 

## DATABASE FILES FOR TABLE AND INDEX DATA

The amount of disk space reserved for the database files includes the following:

- Database tables and associated indexes
- Rollback segments

### Size of Database Table and Associated Indexes

An ORACLE Server database contains the system tablespace and optional tablespaces for the following items:

- Data dictionary
- Rollback segments
- Bootstrap segments
- Temporary segments
- User data objects

Of these, the user data objects, including user tables and indexes, occupy most of the required disk space for the database. The number and size of user data objects are important factors in disk space planning in an ORACLE application. The formulas for estimating required space are provided in this section.

**NOTE:** For detailed information, refer to the *ORACLE Server Database Administrator's Guide*.

To use these formulas, you must know the following:

- Data types
- Number of data tables and index tables
- Number of rows and columns in each table
- Average column width for each table
- Number of indexed columns
- Average indexed column width

To estimate the size of each table in your database, you must define the types of data that should be included in each column of each table. This determines the maximum column width. Each of the three main data types (character, number, and date) requires a minimum amount of space.

Use the following table to estimate the width of each column in your table.

**Table 5  
Data Types**

<b>Data Type</b>	<b>Space Required</b>
Character	1 byte
Number	
Exponent	1 byte
Mantissa	x/2 bytes
Negative Value	1 byte
Date	7 bytes

For example, an employee database may include columns for the employee name, employee number (up to 8 digits), and hire date. Each character of the employee name requires 1 byte, the employee number requires 1 + 8/2 + 1 bytes (6 bytes), and the hire date requires 7 bytes.

Once you have defined and planned your tables, use the following formula to determine the space in blocks required for each non-clustered table:

$$\# \text{ blocks} = \frac{x \text{ rows} * [5 \text{ bytes} + y(1 \text{ byte} + z)]}{(\text{block size in bytes} - 90 \text{ bytes}) * (1 - \text{PCTFREE}/100)}$$

Where:

*x* is the number of rows in the table.

*y* is the number of columns in the table.

*z* is the average column width (sum of all column widths divided by total number of columns).

*block size* is **db\_block\_size**; indicated in *INIT.ORA* (default is 4096 bytes).

A block requires 90 bytes of overhead.

A row requires 5 bytes of overhead.

PCTFREE is the percentage of free space in a block to allow for update of rows in the block; use default (10) in the estimate.

To determine the amount of disk space required in bytes, use the following formula.

$$\# \text{ bytes} = \# \text{ blocks} * \text{block size}$$

For example, you can estimate the number of blocks that a database requires for a table that has approximately 1,000,000 rows, 4-Kbyte database block size, and PCTFREE value set to the default of 10. The following table provides the data types and column width information.

**Table 6**  
**Estimated Column Width**

Column Name	Data Type	Space Required (Bytes)
order_id	number (9)	1 + 9/2 + 1 = 7
order_date	date	7
customer_id	number (6)	1 + 6/2 + 1 = 5
ship_date	date	7
product_id	number (6)	1 + 6/2 + 1 = 5
quantity	number (6)	1 + 6/2 + 1 = 5
price	number (8)	1 + 8/2 + 1 = 6
<b>Column Widths</b>		<b>42 Bytes</b>

Calculate the average column width as follows:

$$\frac{\text{sum of all column widths}}{\text{total number of columns}} = \text{average column width}$$
$$\frac{42}{7} = 6$$

To estimate the number of database blocks that this table will occupy, use the formula as follows:

$$\frac{1,000,000 \text{ rows} * [5 \text{ bytes} + 7(1 + 6)]}{(4096 \text{ bytes} - 90 \text{ bytes}) * (1 - 10/100)} = 14,978 \text{ blocks}$$

Multiply the result (14978) by the database block size (4096) for the size of your table.

$$14978 \text{ blocks} * 4096 \text{ bytes/block} = 61,349,888 \text{ bytes or } 60 \text{ megabytes}$$

Once you have estimated the size of a table, use this information when specifying the INITIAL storage parameter in your corresponding CREATE TABLE statement. Using the example calculation, build a table on the ORACLE database server as follows:

```
SQLDBA> CREATE TABLE order
2> (order_id number (9),
3> order_date (date),
4> customer_id number (6),
5> ship_date (date),
6> product_id number (6)
7> quantity number (6)
8> price number (8,2))
9> TABLESPACE users
10> STORAGE (INITIAL 60,000K)
```

After you estimate the size of all planned tables, you can add these results to determine the total amount of disk space needed for the tables.

Use the following formula to estimate the space required for an index:

$$\# \text{ blocks} = \frac{x \text{ rows} * (11 \text{ bytes} + y + z)}{(\text{block size in bytes} - 90 \text{ bytes}) * (0.75 - \text{PCTFREE}/200)}$$

Size of space needed = # blocks \* block size in bytes

Where:

x is the number of rows per table.

y is the number of columns indexed.

z is the average column width (sum of all column widths divided by total number of columns).

A non-unique index requires a row overhead of 11 bytes and a unique index requires a row overhead of 10 bytes.

PCTFREE is the percentage of free space in a block to allow for update of rows in the block; use the default 10 percent in the estimate (for example, 20/200).

## Rollback Segments

Rollback segments are sections of the database that store the original value of updated columns. When a failure occurs due to hardware, process, or media failure, the rollback segments roll back the uncommitted transactions to restore the database to its original state.

The number and size of the rollback segments depend on the number of database users and the volume of activity. This number must accommodate the expected maximum number of simultaneous transactions. For planning purposes, use the following table to estimate the number of rollback segments needed for your database server.

**NOTE:** For detailed information on rollback segments, refer to the *ORACLE Server Database Administrator's Guide*.

**Table 7**  
**Recommended Number of Rollback Segments**

Number of Concurrent Transactions	Recommended Number of Rollback Segments
fewer than 16 transactions	4 segments
16 to 32 transactions	8 segments
32 or more transactions	n/4 but no more than 50

Use the following rules to estimate the size of the rollback segments.

- 
- IMPORTANT:** These rules are for *planning purposes only*.
- ! When you implement your database server, refer to the *ORACLE Server Database Administrator's Guide* for detailed information on the proper configuration of rollback segments.
- 

- If you know your application well, designate the size of the rollback segment to be slightly larger than the size of a typical transaction.

However, if you are not sure of your application, designate the size of the initial extent of each rollback segment to be approximately 10 percent of the largest table in the database. For example, if the largest table is 75 megabytes, each initial extent for each rollback segment should be 7.5 megabytes.

- Make all rollback segments for a database the same size. ORACLE Server randomly selects the rollback segments, and you cannot predefine which rollback segments ORACLE Server uses.
- Make rollback segments large enough to hold the rollback entries of the largest anticipated transaction.
- If your front-end application generates large queries and large transactions, create only a few large rollback segments. If your application performs online transaction-processing with small queries and small transactions, create many small rollback segments.

## REDO LOG FILES

Every ORACLE Server database requires at least two redo log files, and ORACLE Server supports up to 256 redo log files per database. ORACLE Server stores these log files separately from the database. The disk space reserved for these log files is based on the size of these log files and the total number of log files. You can specify the size and number of log files when you create a database, and change the number of redo log files when needed.

The size and number of your redo log files are based on your database application: a transaction-processing application or a decision-support application. Most implementations are a combination of both applications. If your database application provides characteristics of both, then you must consider the requirements of your planned application.

For planning purposes, use the following guidelines for estimating the size your redo log files. Once you configure your server and load your application, monitor your server performance. You may need to tune your server by adjusting the number of redo log files once the server is running.

- For online transaction processing, use the following estimation formula:

$$\left( \begin{array}{c} 1 \text{ KB per} \\ \text{Transaction per} \\ \text{Second} \end{array} \right) * 60 \text{ sec} * \left( \begin{array}{c} \text{Minutes} \\ \text{between log} \\ \text{switches} \end{array} \right)$$

For example, a system that performs an average of 20 transactions per second (TPS) with a desired 30 minutes between log switches requires the following redo log file size:

$$20 \text{ TPS} * 60 \text{ seconds} * 30 \text{ minutes} = 36,000 \text{ KB or } 36 \text{ MB}$$

This estimate assumes that 1 Kbyte of data is changed with each transaction. Your database transactions may alter more data or less data with each transaction. When you implement your database server, adjust the size and number of redo log files to reflect the transaction activity of your database application.

- For query-only applications, plan the redo log file size for 2 megabytes.
- For mixed applications, use the online transaction-processing formula. Most applications provide a combination of decision support and transaction processing.

The number and size of the database redo log files are determined by the following factors.

- **Amount of database traffic** - The heavier the traffic is, the more entries are needed for the log files for efficient operation.
- **Chance of media failure** - The probability of a catastrophic media failure is minimal in most applications. With fault tolerance implemented, when a drive in an array fails, the fault tolerance method minimizes the risk of catastrophic failure.
- **Type of application** - If your application requires frequent updates to the database, as in online transaction processing, use many large log files. For decision-support applications, use fewer small log files.



- ***NOARCHIVELOG Mode*** - In some operating system environments, such as UNIX, you can enable ORACLE Server to archive the redo log files to tape or other medium. When you enable the archiving mode in a NetWare environment, ORACLE Server archives the redo log files to disk, not tape. This means that ORACLE Server copies the redo log files from one part of the disk to another part of the disk, and the amount of disk space used for the redo log file grows dynamically. For example, a server may archive redo log files every hour. Each time ORACLE Server archives these files, they use more disk space. Compaq integration testing indicates that in a heavy transaction-processing application, as much as 2 gigabytes of disk space are needed per day to archive the redo log files.

Decision-support environments generally do not require archiving, because the information in a decision-support database remains relatively constant. As long as you back up your server regularly and consistently, you should not need automatic archiving.

Configuring ORACLE Server with automatic archiving mode disabled can yield a 3 to 10 percent performance increase; however, without automatic archiving, the system is vulnerable to media failure, user error, and system processor failure.

- ***ARCHIVELOG Mode*** - There are some instances where you must enable automatic archiving. For example, processing environments with very large databases may make daily offline tape backups impossible. Consider databases that require more than 10 hours for backup to tape to be too large for daily backups. If daily tape backups are impossible, enable automatic archiving to maintain data reliability.

In mission-critical environments, where the database administrator must be cognizant of user errors and process failures, enable automatic archiving. User errors are common occurrences. For example, a database administrator accidentally drops a table. When a user error occurs, with automatic archiving enabled, the system recovers the entire database by rolling forward the redo log files.

- ***ORACLE architectural factors*** - The ORACLE Server internal operations of redo logs and checkpoints are also factors in the planning and performance of disk space. For information, refer to the *ORACLE Server Database Administrator's Guide*.

If you plan to install ORACLE Server with automatic archiving disabled (NOARCHIVELOG mode), implement some method of fault tolerance, plan nightly offline tape backups, and configure *at least two* redo log files for your database. In fact, you can configure enough redo log files to satisfy a full day of activity (for example, 48 redo log files to be switched every 30 minutes). Should a catastrophic failure occur, you can rebuild one full day of activity and use the tape backup from the previous day to recover almost all of your data.

If you plan to install ORACLE Server with automatic archiving enabled (ARCHIVELOG mode), plan *at least three* redo log files and configure the archiving file destination for offline redo log files to be located on a separate logical drive.

Create redo log files so that log switches occur only often enough to maintain data integrity. During a log switch operation with automatic archiving enabled, clients accessing the server can notice a slight degradation in performance.

## FUTURE GROWTH

When planning disk space requirements, you must also plan for future growth of your database. Use the following formula to estimate the growth potential for your database.

$$\text{Total disk space} = \text{size of database} * \text{rate of growth}^{(x/y)}$$

Where:

$x$  is the life cycle of the database server.

$y$  is the unit of growth.

For example, you can estimate the amount of disk space required to support a 680-megabyte database that is planned to grow to 1.5 times its current size every 2 years as follows. The life cycle of the server is planned for 5 years.

$$\text{Total disk space} = 680 * 1.5^{(5/2)}$$

$$\text{Total disk space} = 1873.86 \text{ MB (or approximately 1.88 GB)}$$

### EXAMPLE DISK SPACE ESTIMATE

To estimate the total disk space needed for your ORACLE database server, you must know the sum of the individual estimates for the following:

- Tables and indexes
- Rollback segments
- Redo log files
- NetWare
- ORACLE Server NLMs and supporting files

To clarify the process for estimating disk space, this section includes an example table and the procedure for estimating the required disk space.

A planned database contains a CUSTOMER table of 1,000 records. The column names and types for the table are shown in Table 8. The ORDER\_ID, AREA\_CODE, and CONTACT\_ID columns have predefined widths. Estimate and define the column width for each of the other columns as shown in Table 9.

**Table 8**  
**Column Description of Example CUSTOMER Table**

Column Name	Column Type
order_id	number (9)
name	char (30)
address	char (20)
zip	char (5)
state	char (2)
area_code	number (3)
phone	char (7)
fax	char (7)
contact_id	number (6)
description	char (50)
starting_date	date

**Table 9**  
**Character Estimate of Example CUSTOMER Table**

Column Name	Average Number of Characters	Width
order_id	$1 + (9/2) + 1$	7
name	30 characters	30
address	20 characters	20
zip	5 characters	5
state	2 characters	2
area_code	$1 + (3/2) + 1$	4
phone	7 characters	7
fax	7 characters	7
contact_id	$1 + (6/2) + 1$	5
description	50 characters	50
starting_date	7	7
<b>Total Characters</b>		<b>144</b>

Once you have estimated the number of characters per table, use the following formula to calculate the number of database blocks per table.

$$\# \text{ blocks} = \frac{x \text{ rows} * [5 \text{ bytes} + y(1 \text{ byte} + z)]}{(\text{block size in bytes} - 90 \text{ bytes}) * (1 - \text{PCTFREE}/100)}$$

Where:

$x$  is the number of rows per table.

$y$  is the number of columns in the table.

$z$  is the average column width (sum of column widths divided by total columns).

$block \text{ size}$  is **db\_block\_size**; indicated in *INIT.ORA* (default is 4096 bytes).

A block requires 90 bytes of overhead.

A row requires 5 bytes of overhead.

PCTFREE is the percentage of free space in a block to allow for update of rows in the block; use default (10) in the estimate.

$$\begin{aligned} 44.4 \text{ blocks} &= \frac{1,000 \text{ rows} * (5 \text{ bytes} + 11(1 \text{ byte} + 13.1))}{(4096 - 90) * (1 - 10/100)} \\ \text{or } 45 \text{ blocks} & \end{aligned}$$

Use the following formula to convert the number of blocks to to the number of bytes.

$$\# \text{ bytes} = \# \text{ blocks} * \text{block size}$$

$$45 \text{ blocks} * 4096 \text{ block size} = 184,320 \text{ bytes or } 180 \text{ KB}$$

Repeat this procedure for each table in your planned database, then add the space requirements for each table together for total disk space required. For this example, the CUSTOMER table requires 180 Kbytes of space.

Table 10 shows estimates for the other tables in the example database.

**Table 10**  
**Disk Space Requirements for Example Database**

<b>Example Tables</b>	<b>Required Space (Blocks)</b>	<b>Required Space (Bytes)</b>
ORDER	14,978	65,011,712
INVENTORY	137	561,152
CUSTOMER	45	184,320
CONTACT	2,333	9,555,968
<b>Total Space</b>		<b>75,313,152 (72 MB)</b>

The total disk space required for the tables in this example database is 72 megabytes. However, you must also add disk space for rollback segments and redo log files to your estimate. You must also include disk space requirements for NetWare and for ORACLE Server.

To estimate the amount of disk space required for rollback segments, you must know the maximum number of concurrent transactions that may occur in your environment. For this example, the maximum number of concurrent transactions equals 40.

Using the information from Table 7, the recommended number of rollback segments should equal  $n/4$  but no greater than 50 (where  $n$  equals the maximum number of concurrent transactions). The largest table in the hard disk example is the ORDER table (see Table 10), which is approximately 62 megabytes.

Calculate the number of rollback segments as follows:

$$\begin{aligned} n/4 &= \text{number of rollback segments} \\ \text{size of the largest table} * 10\% &= \text{size of rollback segment} \\ \text{size of rollback segment} * \text{number of rollback segments} &= \text{total space} \end{aligned}$$

For example:

$$\begin{aligned} 40/4 &= 10 \\ 62 \text{ MB} * .10 &= 6.2 \text{ MB} \\ 6.2 \text{ MB} * 10 &= 62 \text{ MB} \end{aligned}$$

The size of the redo log file depends on the planned type of processing application: decision support or transaction processing. For this example configuration, the planned application is a mixed application with more transaction processing than decision support; use the formula for online transaction processing as follows:

$$\left( \begin{array}{c} 1 \text{ KB per} \\ \text{Transaction per} \\ \text{Second} \end{array} \right) * 60 \text{ sec} * \left( \begin{array}{c} \text{Minutes} \\ \text{between log} \\ \text{switches} \end{array} \right)$$

The results for this example database configuration would equal:

$$40 \text{ TPS} * 60 \text{ seconds} * 30 \text{ minutes} = 72 \text{ MB}$$

For this example configuration, three redo log files are used. Multiply the size of the redo log file by the number of redo log files as follows for the total amount of required space for redo log files:

$$72 \text{ MB} * 3 \text{ redo log files} = 216 \text{ MB required}$$

Table 11 shows the total disk space requirements for the example database.

**Table 11**  
**Total Disk Space Requirements**  
**for Example Database Server**

	Required Disk Space (MB)
Tables and Indexes	72
Rollback Segments	62
Redo Log Files	216
NetWare Requirements	30
ORACLE Server Requirements	30
<b>Total Space Required</b>	<b>410</b>

Include the method of fault tolerance in your estimate of total disk space. For this example, the planned server includes an IDA-2 subsystem, and the method of fault tolerance is distributed data guarding. Multiply the total disk space required by 1.25 as follows:

$$410 * 1.25 = 512.5 \text{ MB or } 513 \text{ MB}$$

After estimating *current* disk space, estimate the future growth of the database over the life cycle of your server configuration. For this example, the estimated life cycle is 4 years, and the size of the database should double every 2 years. Calculate the amount of disk space required for the life cycle of the server as follows:

$$\text{Total disk space} = \text{size of database} * \text{rate of growth}^{(x/y)}$$

Where:

x is the life cycle of the database server.

y is the unit of growth.

$$2050 = 512.5 * 2^{(4/2)}$$

To support the example database, the server requires at least 2.05 gigabytes of disk space.

**!** **IMPORTANT:** The "ORACLE Server Planning Worksheet for Disk" at the end of this COMPAQ TechNote provides the required formulas for estimating disk space. Use this to estimate the disk space needed for your server.

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## SYSTEM MEMORY

In an ORACLE database server implementation, inadequate system memory can cause both disk I/O contention and system processor overload, which are major contributors to poor server performance. To understand the memory requirements for your ORACLE database server, review the following procedure, and then analyze your specific server application.

NetWare is a "real" system memory operating system that does not allocate disk space as virtual memory. As a rule, provide your server with a generous amount of system memory.

The following sections discuss the most important factors to consider for system memory planning before configuring your database server:

- Requirements for NetWare and NLMs.
- Requirements for ORACLE NLMs and overhead.
- Additional requirements for ORACLE Program Global Area (PGA) and client connections.
- Additional requirements for ORACLE System Global Area (SGA).

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! **IMPORTANT:** This COMPAQ TechNote is for *planning purposes only*. It provides guidelines for selecting the appropriate hardware for your server configuration. Once you configure your server, you must tune your server based on the type of application that your server runs.

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### System Memory Requirements for NetWare

The amount of system memory needed for NetWare is based on the amount of disk space in the database server.



Use the following Novell formulas to estimate the system memory requirements for each volume on your server.

<b>Volume Type</b>	<b>Calculation</b>
DOS Volume	$\frac{(0.023 * \text{volume size in MB})}{\text{volume block size in KB}}$
DOS + Name Space Volume	$\frac{(0.032 * \text{volume size in MB})}{\text{volume block size in KB}}$

Use the following formula to estimate the system memory needed for NetWare on your database server:

$$\begin{array}{r} \text{DOS Volume} \\ \text{DOS Volume that Includes Name Space} \\ + \quad 4 \text{ MB NetWare Recommended Minimum} \\ \hline \text{Total NetWare System Memory Requirements} \end{array}$$

### **System Memory Requirements for ORACLE Server**

In addition to the NetWare system memory requirements (4 megabytes + size of DOS volumes), ORACLE Server requires an absolute minimum of 12 megabytes of system memory. Therefore, your server should have a minimum 16 megabytes of system memory (4 megabytes for NetWare and 12 megabytes for ORACLE Server). ORACLE Server uses the 12 megabytes of system memory to load the following:

- ORACLE NLMs
- Associated files such as the *INIT.ORA* file

The minimum system memory requirement (16 megabytes to load NetWare and ORACLE Server) also addresses a small amount of the system memory for the PGA and SGA. You must determine the amount of *additional* system memory needed for the PGA based on the number of anticipated client connections.

You can also add system memory for the SGA, as database block buffers, based on the size of the database tables, indexes, and rollback segments. Additional buffers can improve your database server performance.

When estimating the system memory for ORACLE Server, use the following formula:

	Load NetWare and DOS Volumes (At Least 4 Megabytes)
	Load ORACLE NLMs and Associated Files (At Least 12 Megabytes)
	PGA and Client Connections
+	Added Memory for SGA
	System Memory Requirements for ORACLE Server

**NOTE:** Your total system memory should be AT LEAST 16 megabytes to load NetWare and ORACLE Server.

## ORACLE NLMs

When you bring up your ORACLE database server, the ORACLE Server RDBMS and associated utilities require some system memory to execute. These utilities are listed below. The minimum recommendation of 16 megabytes includes enough system memory to load NetWare and the following ORACLES Server NLMs:

<i>STREAMS.NLM</i>	<i>SPXSRV.NLM</i>
<i>CLIB.NLM</i>	<i>SQLSPX.NLM</i>
<i>MATHLIB.NLM</i>	<i>SQLDBA.NLM</i>
<i>PLSQL.NLM</i>	<i>PATCH311.NLM</i>
<i>ORACLE6.NLM</i>	<i>DIRECTFS.NLM</i>

**NOTE:** If installing version 1.1 of ORACLE Server, you must also load *PATCH311.NLM* and *DIRECTFS.NLM*.

NetWare first allocates this system memory as part of the Cache Buffers Pool. As you initiate an ORACLE instance, NetWare reallocates the cache buffers to the Cache Non-Movable Memory Pool as ORACLE needs them. ORACLE Server uses buffers from the Cache Non-Movable Memory Pool to operate.

When you load *MONITOR.NLM* and analyze the system memory distribution, a Cache Non-Movable Memory Pool that is larger than the Cache Buffers Pool is usual. However, once your ORACLE database server is operating, ensure that the Cache Buffers Pool contains a minimum of 1,000 buffers.

### ***INIT.ORA* FILE**

ORACLE Server provides four sample *INIT.ORA* files in the **SYS:oracle6\db**s directory: *INIT.ORA*, *INITSML.ORA*, *INITMED.ORA*, and *INITBIG.ORA*. The *INITSML.ORA* file requires 500 Kbytes of system memory, the *INIT.ORA* and *INITMED.ORA* files require 2 megabytes of system memory, and the *INITBIG.ORA* file requires 10 megabytes of system memory. These sample files eliminate the need for you to create your own *INIT.ORA* file.

**NOTE:** The minimum recommendation of 16 megabytes (required to load NetWare and ORACLE Server) includes enough system memory to load any of these *INIT.ORA* files.

Once ORACLE Server is operating, you can reallocate system memory resources by changing the database block buffer, log, and dictionary cache parameters in the *INIT.ORA* file to enhance performance.

### **PROGRAM GLOBAL AREA (PGA) AND CLIENT CONNECTIONS**

A PGA contains the information on how the server communicates with the client, so that the client can communicate with ORACLE Server. A PGA also shares the common code to parse SQL statements, optimize queries, and enforce data security for client processes.

ORACLE Server allocates one PGA on the server per client connection. ORACLE Server maintains this information while the client accesses the server. The size of each PGA depends on the type of application, but is generally the same for all clients that perform similar tasks. Each client connection uses approximately 250 Kbytes to 1 megabyte of server system memory. In some rare applications, the client can use as much as 1.5 megabytes of server system memory.

The PGA also includes *context areas*. A context area is a memory buffer that contains the status of one SQL statement. A *cursor* in the PGA points to a context area. Applications use cursors to declare and reuse information in specific context areas to improve memory usage and enhance application performance. The number of context areas that the client opens and the size of these context areas can affect the size of the PGA.

The amount of system memory that each client connection uses depends on the following parameters in the *INIT.ORA* file: **open\_cursors**, **open\_links**, **savepoints**, and **sort\_area\_size**.

**NOTE:** The minimum recommendation of 16 megabytes of system memory (required to load NetWare and ORACLE Server) includes enough system memory to address these parameters, but may not include enough system memory to manage all of your client connections.

Consider the number of anticipated client connections when estimating server system memory. Estimate the additional system memory needed for PGAs by multiplying the number of client connections by one of the recommended factors in Table 12. Select one of these recommendations based on your processing application.

---

**Table 12**  
**Memory Recommendations for Client Connections**

Processing Application	Minimum Recommendation	Performance Recommendation
Online Transaction Processing	250 KB	500 KB
Decision-Support	500 KB	1 MB
Mixed Application	400 KB	750 KB

**NOTE:** When running ORACLE Financial Systems software, estimate 1.5 megabytes per client connection.

### ADDED SYSTEM MEMORY FOR SYSTEM GLOBAL AREA (SGA)

When you start an ORACLE Server instance, an SGA is created. The SGA is a set of control structures that include shared memory buffers, database buffers, redo log buffers, and data dictionary information (cached). The SGA contains the following items:

- Database block buffer pool of data blocks, index blocks, and rollback and temporary segment blocks.
- Redo log buffer.
- Dictionary cache area.
- Internal data structures.

**NOTE:** The minimum recommendation of 16 megabytes (required for NetWare and ORACLE Server) includes enough system memory to load the dictionary cache area, internal data structures, redo log buffers, and *some* database block buffers.

The size of the SGA is defined at instance startup. To view the system memory allocation for the SGA, load *SQLDBA.NLM* and type the following at the server console prompt:

```
SQLDBA> connect [username]/[password]
SQLDBA> show SGA
```

A screen similar to the following should display:

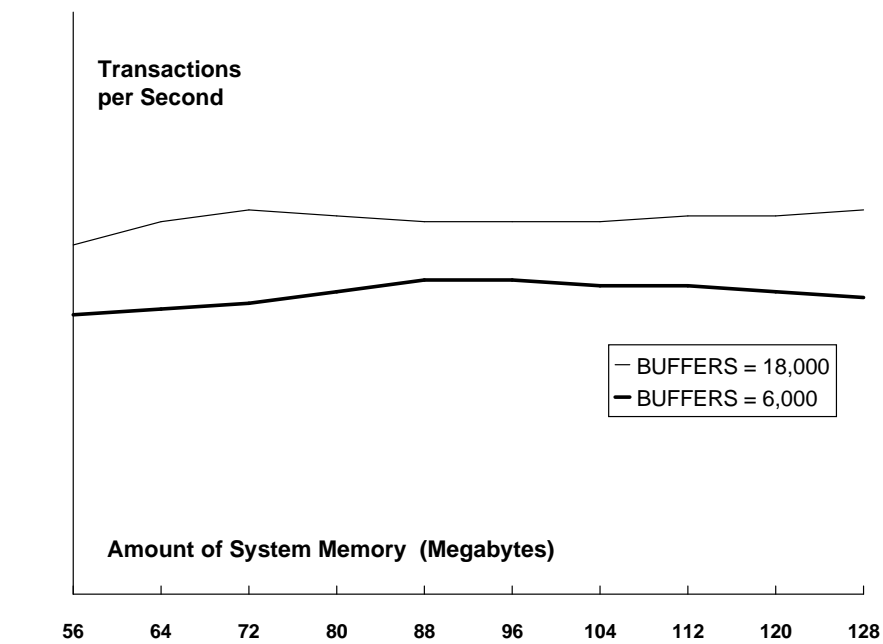
Total System Global Area	3021131
Fixed Size	17055
Variable Size	718108
Database Buffers	2252800
Redo Buffers	32768

For improved performance, plan for more system memory to increase the size of the database block buffer pool. When you implement your ORACLE database server, you can allocate more system memory for database block buffers by using the *db\_block\_size* and *db\_block\_buffer* parameters. The *db\_block\_size* parameter (default equals 4 Kbytes) and the *db\_block\_buffer* parameter allow you to specify the amount of server system memory that you want to allocate as database buffers.

When planning your ORACLE database server, specify the `db_block_buffer` parameter as 3 to 5 percent of the size of the database (size of tables, indexes, and rollback segments), but no smaller than 250 Kbytes. For example, for a 200-megabyte database, you can allocate 6 to 10 megabytes of system memory (1,500 to 2,500 buffers) for the `db_block_buffer` parameter using the default value of 4 Kbytes for the `db_block_size` parameter. Once your server is running, monitor the performance and "tune" this parameter for your application.

Figure 2 illustrates example results of Compaq integration testing. While testing a 300-megabyte database, engineers added system memory without tuning these parameters and observed very little change in performance. When engineers changed the `db_block_buffer` parameter from 6,000 to 18,000 buffers, performance improved by approximately 20 percent.

**Figure 2**  
**Effect of `db_block_buffer` Parameter on Server Performance**



Not all environments, however, experience a large increase in performance when system memory is added to the server. If you configure your server with enough system memory, adding system memory and increasing the number of db\_block\_buffers does not always increase the server performance. If you consider your server performance inadequate after you add system memory and increase the number of db\_block\_buffers, monitor your server performance over a period of time and check for bottlenecks in other server subsystems.

### Example System Memory Estimate

To estimate system memory requirements for your ORACLE database server, use the example in this section as a guideline. This example is based on the same configuration used in the hard drive subsystem example. The disk space required for the example is about 2.05 gigabytes.

---

**! IMPORTANT:** The recommended minimum system memory for NetWare and ORACLE is 16 megabytes (4 megabytes for NetWare and 12 megabytes for ORACLE Server). Always plan your server with at least 16 megabytes of system memory.

---

To estimate the system memory needed for an ORACLE database server with 2.05 gigabytes of disk space, perform the following procedure:

1. Based on the amount of disk space in the database server (2.05 gigabytes) and the NetWare volume block size (8 Kbytes), use the Novell formula as follows to define the NetWare system memory requirements:

$$\frac{(0.023 * 2050)}{8} + 4 \text{ MB} = 9.89 \text{ MB (approximately 10 MB)}$$

**NOTE:** For an explanation of volume block size, see the "Cache Buffer Size and Volume Block Size" section of this COMPAQ TechNote.

2. Add the NetWare system memory requirements calculated in step 1 (at least 4 megabytes) to the minimum system memory recommendation for loading ORACLE Server (12 megabytes to load ORACLE NLMs and associated files).
3. Estimate requirements for additional system memory for the PGA and client connections by using your estimate of the number of anticipated client connections and the factor-per-client connection based on the

processing application. The average number of client connections is 40. For this example, the processing application is a mixed application; therefore, use 750 Kbytes per connection.

$$40 * 750 \text{ KB} = 30000 \text{ KB (approximately 29 MB)}$$

4. Estimate the requirement for additional system memory for the SGA based on the database size (size of tables, indexes, and rollback segments). In the example disk estimate, the size of tables, indexes, and rollback segments for the configuration (Table 11) is 134 megabytes ( $72 + 62 = 134$ ). The additional system memory for the SGA should equal 3 to 5 percent of the size of the database, making the amount of system memory required for the SGA between 4.0 and 6.7 megabytes. For this example configuration, use 3 percent.

$$134 * .03 = 4.0 \text{ MB}$$

5. Calculate total required system memory as follows:

10.0 MB	NetWare (includes 4 MB minimum)
12.0 MB	ORACLE and associated files
29.0 MB	PGA and client connections
4.0 MB	Added system memory for SGA
<hr/>	
<b>55.0 MB</b>	<b>Total amount of system memory required</b>

## NETWARE PLANNING

In the NetWare environment, your ORACLE database server configuration should comply with the following key rules:

- Do not use the ORACLE database server as the primary file or print server. In many environments, the server performance is not adequate for providing resource sharing as well as client-server functions.
- Although ORACLE Server does not require a dedicated database server configuration, configure your ORACLE database server as a dedicated server to yield the highest performance.
- Load only the NLMs that are required for your server. When these NLMs are not in use, unload them.
- Ensure that all system memory resources on the server are available for ORACLE Server.



As part of the NetWare installation, consider the following NetWare settings when planning your ORACLE database server configuration:

- Volume block size and cache buffer size
- Hot Fix Redirection Area
- NetWare SET parameter values

### Cache Buffer Size and Volume Block Size

The default volume block size for NetWare is 4 Kbytes; however, when implementing a COMPAQ PC Server with a drive array, you can improve disk performance if you ensure that the volume block size matches the striping factor of the drive array and that the cache buffer size matches the volume block size.

In the NetWare environment, the striping factor for the IDA and IDA-2 subsystems is 16 sectors (8 Kbytes), and the striping factor for the COMPAQ 32-Bit Intelligent Array Expansion System is 32 sectors (16 Kbytes). For optimal performance, set the volume block size for the IDA or IDA-2 subsystem to 8 Kbytes, and the volume block size for the Array Expansion System to 16 Kbytes. Use Table 13 to determine the volume block size and the matching cache buffer size for your planned server.

**Table 13**  
**Recommended Volume Block and Cache Buffer Sizes**

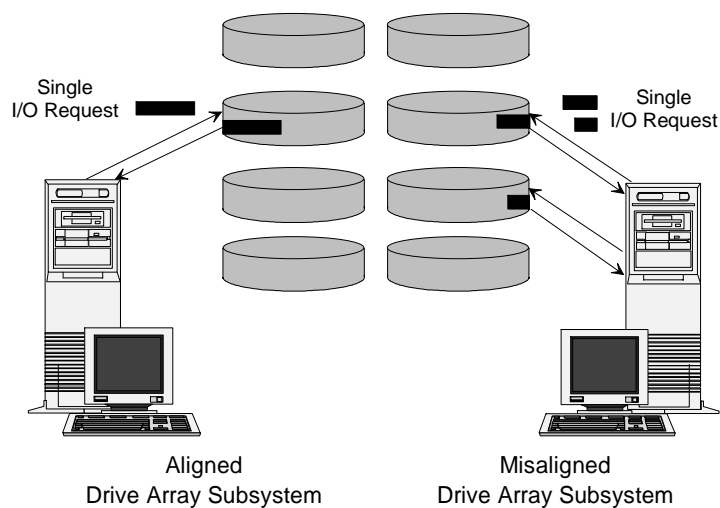
Subsystem	Volume Block Size	Cache Buffer Size
IDA	8 KB	8192
IDA-2	8 KB	8192
Array Expansion System	16 KB	16384
IDE	4 KB	4096

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

## Hot Fix Redirection Area

Modify the size of the Hot Fix Redirection Area to improve performance of your COMPAQ drive array subsystem by ensuring that the NetWare volume blocks align with the drive array striping factor. If you accept the system default and do not align the volume blocks with the drive array striping factor, the NetWare volume blocks (which immediately follow the Hot Fix Redirection Area on the drive) may cross the stripe boundaries. A significant number of write requests crossing the stripe boundaries results in decreased performance. Figure 3 illustrates this concept.

**Figure 3**  
**Effect of Aligned and Misaligned Striping**



The following sections provide guidelines for configuring Hot Fix Redirection Area for COMPAQ drive array subsystems.

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

**INTELLIGENT DRIVE ARRAY SUBSYSTEMS**

1. Begin optimization of the logical drive by creating a DOS partition.
2. Load *INSTALL.NLM* at the NetWare prompt.
3. Load the *CPQDA386.DSK* device driver for the IDA controller.
4. Select *Device #0* (primary logical drive) from the Available Disk Drives menu, and press the **ENTER** key to display the current partition information for the IDA controller and logical drive 1.
5. Select *Create NetWare Partition* from Partition Options menu.
6. Modify the number of Hot Fix Redirection Area blocks based on Tables 14 through 17. For example, configure an 840-megabyte array with a 10-megabyte DOS partition (11 cylinders) as follows:

In Table 15, the optimal number of Hot Fix Redirection Area blocks for two 420-megabyte drive array pairs configured for no fault tolerance is *even*. Specify any even number of blocks to align the file system data area with the drive array striping factor.

**Table 14  
120-MB Hard Drives**

Number	Fault Tolerance	Drive Type	Number of Hot Fix Redirection Blocks
1 pair	None	69	Even or odd if DOS cylinders are even or odd, respectively
1 pair	Mirroring	50	Even or odd if DOS cylinders are even or odd, respectively
2 pairs	None	71	Even number
2 pairs	Mirroring	69	Even or odd if DOS cylinders are even or odd, respectively
2 pairs	Data Guarding	70	Even number
3 pairs	None	76	Even number
3 pairs	Mirroring	70	Even number
4 pairs	None	82	Even number
4 pairs	Mirroring	71	Even number
4 pairs	Data Guarding	76	Even number

**Table 15**  
**210-MB Hard Drives**

<b>Number</b>	<b>Fault Tolerance</b>	<b>Drive Type</b>	<b>Number of Hot Fix Redirection Blocks</b>
1 pair	None	84	Even number
1 pair	Mirroring	51	Even number
2 pairs	None	87	Even number
2 pairs	Mirroring	84	Even number
2 pairs	Data Guarding	85	Even number
3 pairs	None	94	Even number
3 pairs	Mirroring	85	Even number
4 pairs	None	100	Even number
4 pairs	Mirroring	87	Even number
4 pairs	Data Guarding	94	Even number

**Table 16**  
**340-MB Hard Drives**

<b>Number</b>	<b>Fault Tolerance</b>	<b>Drive Type</b>	<b>Number of Hot Fix Redirection Blocks</b>
1 pair	None	72	Even number
1 pair	Mirroring	63	Even number
2 pairs	None	96	Even number
2 pairs	Mirroring	72	Even number
2 pairs	Data Guarding	90	Even number
3 pairs	None	74	Even number
3 pairs	Mirroring	90	Even number
4 pairs	None	80	Even number
4 pairs	Mirroring	96	Even number
4 pairs	Data Guarding	74	Even number

**Table 17  
510-MB Hard Drives**

<b>Number</b>	<b>Fault Tolerance</b>	<b>Drive Type</b>	<b>Number of Hot Fix Redirection Blocks</b>
1 pair	None	90	Even number
1 pair	Mirroring	61	Even number
2 pairs	None	74	Even number
2 pairs	Mirroring	90	Even number
2 pairs	Data Guarding	102	Even number
3 pairs	None	92	Even number
3 pairs	Mirroring	102	Even number
4 pairs	None	98	Even number
4 pairs	Mirroring	74	Even number
4 pairs	Data Guarding	92	Even number

**INTELLIGENT ARRAY EXPANSION SYSTEM**

With large-volume hard drive subsystems (more than 2 gigabytes of disk space), the Hot Fix Redirection Area can become larger than is actually necessary. For example, 2 percent of two Array Expansion System configurations with 18.2 gigabytes of disk space equals approximately 364 megabytes of Hot Fix Redirection Area. For some implementations, 364 megabytes of space may be excessive.

You can resize the Hot Fix Redirection Area to accommodate a more practical amount of disk space. This also allows you to align the NetWare volume blocks with the drive array striping factor, ensuring that read and write requests do not cross the stripe boundaries. When a significant number of read and write requests cross the stripe boundaries, the result is decreased performance.

---

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

---

---

Use the following procedure to resize the Hot Fix Redirection Area for the Array Expansion System and to align NetWare volume blocks with the drive array striping factor.

1. Configure the Array Expansion System using EISA Configuration Utility version 2.07 or later.

---

**△ CAUTION:** Reconfiguring a logical drive on the Array Expansion System with COMPAQ EISA Configuration Utility version 2.07 causes the loss of all data on the logical drive.

To reconfigure an existing logical drive in the Array Expansion System (configured with an EISA Configuration Utility version prior to 2.07), you must back up and then restore the data on the drive.

- 
2. Load the *CPQDA386.DSK* device driver for the 32-Bit IDA Expansion Controller.
  3. Select *Device #1* (secondary logical drive) from the Available Disk Drives menu.

Since the Array Expansion System does not support a bootable DOS partition, the entire logical drive 2 is available for installing a NetWare partition.

4. Select *Create NetWare Partition* from the Partition Options menu to display the Partition Information screen for the logical drive.
5. Modify the number of Hot Fix Redirection Area blocks based on the values provided in Table 18.

For example, a 5.2-gigabyte drive array (four 1.3-gigabyte drives) with no fault tolerance would be configured with a multiple of four blocks plus one block.

**Table 18  
1.3-GB Hard Drives**

<b>Number of Drives</b>	<b>Method of Fault Tolerance</b>	<b>Number of Hot Fix Redirection Blocks</b>
1	None	multiple of four
2	None	multiple of four
2	Mirroring	multiple of four
3	None	multiple of four
4	None	multiple of four plus one
4	Mirroring	multiple of four
5	None	multiple of four plus one
6	Mirroring	multiple of four
6	None	multiple of four
7	None	multiple of four

**SET Parameters**

When implementing an ORACLE database server, check the following NetWare SET parameters to ensure that values for these parameters provide optimal performance for your server.

**SET MAXIMUM PHYSICAL RECEIVE PACKET SIZE = [VALUE]**

When installing a NIC, ensure that it is configured according to the manufacturer's specification, and configure the SET MAXIMUM PHYSICAL RECEIVE PACKET SIZE parameter to the largest supported packet size as stated by the manufacturer. This allows NetWare to transmit and receive larger packets on the network, which can substantially improve network performance.

---

**⚠ CAUTION:** If you configure the workstation device driver with a larger packet size than the size defined for the server in the SET parameter, problems may occur. These problems can surface during activities such as file copying. Ensure that both the workstation and the server are using the same packet size.

---

Use the following values as a guideline to set the SET MAXIMUM PHYSICAL RECEIVE PACKET SIZE parameter accordingly.

**Table 19**  
**Maximum Packet Sizes**

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

\* If using the IBM 16/4 Token-Ring Adapter, set packet size to 4202.

**NOTE:** Many NIC manufacturers provide device drivers that support larger packet sizes. When configuring network servers and workstations, ensure that you are using the largest supported packet size.

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

The SET MINIMUM PACKET RECEIVE BUFFERS parameter allows you to adjust the minimum number of communication buffers that the server can allocate at startup, rather than waiting for the server to reallocate communication buffers automatically. NetWare dynamically increases this value if you set it too low, but you can expect delays when processing packets until NetWare increases this value to allow for enough buffers. An indication that this number is too low is if "No ECB Available Count" errors are generated. When configuring your ORACLE database server, use the following values for your configuration:

For fewer than 41 ORACLE users:  
SET MINIMUM PACKET RECEIVE BUFFERS = 100

For more than 41 ORACLE users:  
SET MINIMUM PACKET RECEIVE BUFFERS = 150

**NOTE:** You can only set the SET MINIMUM PACKET RECEIVE BUFFERS parameter in the *STARTUP.NCF* file.



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

The SET MAXIMUM PACKET RECEIVE BUFFERS parameter establishes the maximum number of communication buffers that the server can allocate. Set this parameter according to the value of the SET **MINIMUM PACKET RECEIVE BUFFERS** parameter. For most configurations, set this parameter according to the following:

$$\frac{\text{MINIMUM PACKET RECEIVE BUFFERS Value} + 100}{\text{MAXIMUM PACKET RECEIVE BUFFERS Value}}$$

- 
- ! **IMPORTANT:** Increasing the SET MAXIMUM PACKET RECEIVE BUFFERS parameter takes buffers from the Cache Buffers Pool. If you increase this value, check the "Resource Utilization" option in *MONITOR.NLM* to ensure that there are enough buffers for other processes. Your server should have no fewer than 1,000 cache buffers in the Cache Buffers Pool.
- 

**SET MAXIMUM SERVICE PROCESSES = [VALUE]**

When a client sends a request to the database server, ORACLE Server builds a packet with the appropriate NetWare Core Protocol (NCP) request, and a File Service Process (FSP) services the request. Bottlenecks can occur if there are too few FSPs to service requests. As the server receives other requests, they cannot be processed until FSPs become available to handle them.

The SET MAXIMUM SERVICE PROCESSES parameter controls the maximum number of FSPs that NetWare can create. The supported values are 5 to 40, and the default value is 20. Usually, the default value is adequate; however, a server that supports many users may need more than the default 20 FSPs. Increasing this value can enhance performance if your server consistently receives more requests than available FSPs.

- 
- ! **IMPORTANT:** Increasing the SET MAXIMUM SERVICE PROCESSES parameter takes buffers from the Cache Buffers Pool. These buffers are not released from the Cache Buffers pool until the server is "brought down." Your server should have no fewer than 1,000 cache buffers in the Cache Buffers Pool.
-

---

## SUMMARY

Server planning is a key element to configuring an optimal ORACLE database server for the NetWare v3.11 environment. The server planning process begins before you acquire the server hardware components. To select the optimal server configuration, you must plan the size of the database at server implementation, the number of users who will access the database, the method of fault tolerance to be used, and the growth potential for the database over the life cycle of the server hardware configuration.

Carefully planning your ORACLE database server can also reduce the need for server hardware updates in the near future. In mission-critical environments, server "down time" reduces productivity and costs money. A well-planned server can help to reduce your ORACLE management time and increase your productivity. Use the following ORACLE Server Planning Worksheets when planning your database server to ensure that your configuration meets your current and future application needs.

Once you configure your server, monitor your server performance and tune your server based on the type of application that your server runs.

## ORACLE SERVER PLANNING WORKSHEET FOR DISK

\_\_\_\_\_ Tables

### Disk Space for Each Table

$$\frac{\text{# of rows} * \left[ \frac{5}{\text{row overhead}} + \frac{\text{# of columns}}{\left( \frac{1}{\text{column overhead}} + \frac{\text{average column width}}{\text{column width}} \right)} \right]}{\left( \frac{\text{blocksize} - 90}{\text{blocksize}} \right) * \left( 1 - \frac{10}{100} \right)}$$

Disk Space Needed = \_\_\_\_\_ \* \_\_\_\_\_  
# of blocks                      blocksize

\_\_\_\_\_ Indexes

### Disk Space for Indexes

$$\left( \frac{\text{# of rows} * \left( \frac{11}{\text{row overhead}} + \frac{\text{# of columns}}{\text{average column width}} \right)}{\left( \frac{\text{blocksize} - 90}{\text{blocksize}} \right) * \left( 0.75 - \frac{20}{200} \right)} \right)$$

Disk Space Needed = # of Blocks \* Blocksize

\_\_\_\_\_ Rollback  
Segments

### Disk Space for Rollback Segments

#### Number of Rollback Segments

> 16 Concurrent Transactions: 4 rollback segments

16 to 32 Concurrent Transactions: 8 rollback segments

< 32 Concurrent Transactions: n/4, but no more than 50 segments

#### Size of Rollback Segments

$$\frac{\text{size of the largest table}}{\text{size of rollback segment}} * 10\% = \text{size of rollback segment}$$

#### Space for Rollback Segments

$$\frac{\text{size of rollback segment}}{\text{size of rollback segment}} * \frac{\text{# of rollback segments}}{\text{# of rollback segments}} = \text{Total Space}$$

## ORACLE SERVER PLANNING WORKSHEET FOR DISK *Continued*

_____	Redo Log Files	<div style="border: 1px solid black; padding: 5px;"> <p><b>Disk Space for Redo Log Files</b></p> <p><b>Online Transaction Processing</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center;">_____</td> <td style="text-align: center;">*</td> <td style="text-align: center;">60</td> <td style="text-align: center;">*</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;"># of Transactions per Second</td> <td></td> <td style="text-align: center;">Seconds</td> <td></td> <td style="text-align: center;"># of Minutes Between Log Switches</td> </tr> </table> <p><b>Decision-Support Processing</b></p> <p style="text-align: center;">Plan for Redo Log File size of 2 MB.</p> <p><b>Space for Redo Log Files</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center;">_____</td> <td style="text-align: center;">*</td> <td style="text-align: center;">_____</td> </tr> <tr> <td style="text-align: center;">Size of Redo Log File</td> <td></td> <td style="text-align: center;">Number of Redo Log Files (minimum of 3)</td> </tr> </table> </div>	_____	*	60	*	_____	# of Transactions per Second		Seconds		# of Minutes Between Log Switches	_____	*	_____	Size of Redo Log File		Number of Redo Log Files (minimum of 3)
_____	*	60	*	_____														
# of Transactions per Second		Seconds		# of Minutes Between Log Switches														
_____	*	_____																
Size of Redo Log File		Number of Redo Log Files (minimum of 3)																

_____		Tables	
_____		Indexes	
_____		Rollback Segments	
_____		Redo Log Files	
30 MB		Minimum Disk Space Required for NetWare	
+	30 MB	Minimum Disk Space Required for ORACLE	
_____		Total Disk Space Required for the Database	

**ORACLE SERVER PLANNING**  
**WORKSHEET FOR DISK** *Continued*

\_\_\_\_\_ Total Disk  
Space  
Required for  
Database

**Fault Tolerance Method**

**Data Guarding or Distributed Data Guarding**

\_\_\_\_\_ \* 125%

Total Disk Space  
for Database

**Drive Mirroring or Controller Duplexing**

\_\_\_\_\_ \* 150%

Total Disk Space  
for Database

\_\_\_\_\_ Total Disk  
Space  
Required for  
Database

**Future Growth**

\_\_\_\_\_ \* \_\_\_\_\_ ( \_\_\_\_\_ / \_\_\_\_\_ )

Total Disk Space  
Required  
for Database      Rate of Growth      Life Span Growth  
of Server      Period

## ORACLE SERVER PLANNING WORKSHEET FOR SYSTEM MEMORY

\_\_\_\_\_ Total  
DOS  
Volume

**Memory to Load DOS Volume**

$$\left( \frac{.023 * \text{Volume Size in MB}}{\text{Volume Block Size}} \right)$$

\_\_\_\_\_ Total  
DOS +  
Name  
Space  
Volume

**Memory to Load DOS + Name Space Volume**

$$\left( \frac{.032 * \text{Volume Size in MB}}{\text{Volume Block Size}} \right)$$

\_\_\_\_\_ = \_\_\_\_\_ + \_\_\_\_\_ + 4.0 MB

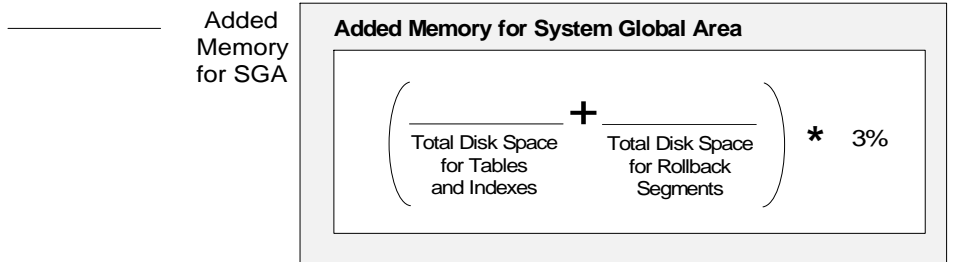
Total NetWare Memory      DOS Volume      DOS/Name Space Volume      NetWare Minimum

\_\_\_\_\_ PGA and  
Client  
Connections

**Memory for ORACLE PGA and Client Connections**

# of Users	*	Type of Application
Online Transaction Processing	500 Kbytes	
Decision-Support Processing	1 Megabyte	
Mixed Environment	750 Kbytes	
ORACLE Financial Systems	1.5 Megabytes	

**ORACLE SERVER PLANNING**  
**WORKSHEET FOR SYSTEM MEMORY** *Continued*



$$\frac{\text{Total ORACLE System Memory}}{\text{Total ORACLE System Memory}} = \frac{12.0 \text{ MB}}{\text{ORACLE Minimum}} + \frac{\text{PGA and Client Connections}}{\text{PGA and Client Connections}} + \frac{\text{Added Memory for SGA}}{\text{Added Memory for SGA}}$$

$$\frac{\text{Total NetWare System Memory}}{\text{Total NetWare System Memory}} + \frac{\text{Total ORACLE System Memory}}{\text{Total ORACLE System Memory}} = \text{Total System Memory}$$



---

## *Appendix A*

# **MULTIVENDOR INTEGRATION FROM COMPAQ**

Compaq is taking the lead in addressing your systems integration needs. To help you successfully integrate and optimize your network or multivendor system, Compaq has developed a library of systems integration documents, COMPAQ ToolKits and COMPAQ TechNotes.

## **COMPAQ TOOLKITS**

ToolKits are for you if you are currently evaluating, installing, or supporting the COMPAQ SYSTEMPRO in a Novell NetWare, SCO UNIX, or Microsoft LAN Manager operating environment. Delivered straight from the Compaq integration labs, ToolKits provide you with the step-by-step information you need to quickly install, configure, and support the COMPAQ SYSTEMPRO in advanced multivendor environments.

With ToolKits, you can tap into the combined expertise of engineers from Compaq and our industry partners -- Novell, The Santa Cruz Operation (SCO), and Microsoft. ToolKits are based on jointly tested configurations that are fully supported by Compaq and our partners.

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\*Plus shipping & handling

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**TOOLKIT AND TECHNOTE INDEX**

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Compaq and Novell Integration ToolKit: Novell NetWare v3.11 on the COMPAQ SYSTEMPRO	111175-001
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