LEGATO

NetWorker™

Cross-Platform Version

Performance Tuning Guide

Legato NetWorker Performance Tuning Guide

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Contents

Preface

This guide provides information on how to configure and manage the Legato NetWorker® software to maximize backup and recovery performance. It includes tips and instructions for testing and modifying the NetWorker server settings to ensure the most efficient configuration for your environment.

NetWorker software must be installed on the server and clients to use the information presented here. For installation instructions, refer to the *Legato NetWorker Installation Guide*.

Audience

The information in this guide is intended for system administrators who are responsible for installing software and maintaining the servers and clients on a network. Operators who monitor the daily backups may also find this manual useful. Users of this guide should already be familiar with basic NetWorker processes and services.

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This document uses the following typographic conventions and symbols to make information easier to access and understand.

Convention	Indicates	Example
boldface	Names of line commands, daemons, options, programs, or scripts	The **nsradmin** command starts the command line version of the administration program.
italic in text	Pathnames, filenames, computer names, new terms defined in the Glossary or within the chapter, or emphasized words	Displayed messages are also written to */nsr/logs/daemon.log*.
italic in command line	A variable that must be provided in the command line	`nwadmin -s` *server-name*
`fixed-width`	Examples and information displayed on the screen	`media waiting: recover waiting for 8mm 5GB tape volume name`
`fixed-width, boldface`	Commands and options that must be typed exactly as shown	**`nsr_shutdown -a`**
Menu_Name> Command	A path or an order to follow for making selections in the GUI	Volume>Change Mode>Appendable
Important:	Information that must be read and followed to ensure successful backup and recovery of data	⚠ **Important:** Use the **no_verify** option with extreme caution.

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Chapter 1: NetWorker Features

The NetWorker product is a network storage management application that is optimized for high-speed backup and recovery operations on large amounts of complex data across an entire network of computers. The NetWorker software is available in four editions. Brief descriptions and distinctions between these editions are covered in this chapter, as well as an overview of hardware and software performance, in the following sections:

Introduction to NetWorker Editions

The four editions of the NetWorker software are as follows:

- Workgroup Edition

  The Workgroup Edition supports small networks that do not require clustering or contain large databases and/or filesystems. The Workgroup Edition comes with a limited number of client connections, but can easily be upgraded to the Network Edition as needed.

- Business Edition

  The Business Edition is similar to the Workgroup Edition in that it is designed for small business needs. It includes eight client connections and support for a 2-drive/1-26 slot autochanger.

- Network Edition

  The Network Edition supports large, distributed networks and a full range of add-on products.

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- Power Edition

  The Power Edition addresses the storage management and data protection needs of enterprises that have high-performance database servers and fileservers, such as very large database (VLDB) applications, online transaction processing (OLTP) applications, data warehouses, and web servers.

Table 1 on page 16 lists the preconfigured support features for each of the NetWorker editions.

Table 1. Preconfigured Support Features of NetWorker Editions

Features	Workgroup Edition	Business Edition	Network Edition	Power Edition
Number of Client Connections	8	8	10	10
Number of Simultaneous Parallel Data Streams	12	12	32 + 32 per storage node	64 + 32 per storage node
Number of Devices	4	4	16 per server and/or storage node	32 per server and/or storage node
Cluster Support	Not supported	Client	Client	Server/Client

In addition to the preconfigured features for each of the NetWorker editions, several optional features are also supported. Table 2 on page 16 lists these options.

Table 2. Supported Options of NetWorker Editions

Options	Workgroup Edition	Business Edition	Network Edition	Power Edition
ClientPak®	Yes	Yes	Yes	Yes
Additional Client Connections	No	No	Yes	Yes
Library Sharing	No	No	Yes	Yes
Dynamic Drive Sharing	No	No	Yes	Yes

Overview of Hardware and Software Performance

Performance is the speed and efficiency with which a task is completed. Backup and recovery performance is dependent on several hardware and software variables, but in general, backups can go no faster than the speed of their slowest component.

This guide provides tests you can use to measure and maximize the various components of your computer. By identifying the slowest component in the data path between the location of the data and the storage device, you can change software settings or replace a hardware component to improve performance.

- Factors that affect the speed of the server include the following:
  - CPU
  - Memory
  - Input/output (I/O) bandwidth
  - SCSI bandwidth
  - Number of ports
- Factors that affect the speed of the devices include the following:
  - I/O transfer rate
  - Built-in compression and initialization characteristics

  Note: Device speed is combined for all storage devices used concurrently.

If clients are backed up over a network, the following factors can also affect performance:

- Client speed
  - CPU
  - Memory
  - Disk speed

  Note: Client speed is combined for all clients active at a single point in time.
- Network speed
  - Network I/O bandwidth
  - Network path
  - Network load

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Factors impacting software performance include:

- Filesystem management
- Application-specific optimization
- Backup application (for example, the NetWorker software)

Chapter 2: NetWorker Configuration

This chapter briefly describes the features and configurations available with the NetWorker software, including details on how the NetWorker product performs backups and recoveries, in the following sections:

- "NetWorker Software Services and Programs" on page 19
- "NetWorker Configurations" on page 25

NetWorker Software Services and Programs

This section provides an overview of how the NetWorker products perform backup and recovery operations.

All NetWorker servers consist of services and programs that do the following:

- Coordinate the tasks associated with a backup and recovery.
- Record information about what was backed up.
- Track the media that contains the backed-up data.
- Manage storage management client configurations, client file indexes, and the media database.

The NetWorker client software includes a client service and user interface programs. The services and programs in NetWorker products communicate by using the RPC protocol.

Services and Programs on the NetWorker Server

This section describes the NetWorker master service, as well as other services and programs that reside on the NetWorker server. These services and programs contact the client for a backup and maintain the client file indexes and media database on the server.

The nsrd Service

The NetWorker master service, **nsrd**, provides an RPC-based **save** and **recover** program function to NetWorker clients, including:

- Starts other services.
- Allocates media services on server computers.
- Authorizes backup and recovery services for the client.
- Contacts clients for scheduled backups.
- Maintains NetWorker configuration information.
- Monitors backup and recovery sessions.
- Maintains server statistics and message logs.

Other Services and Programs

Table 3 on page 20 lists the other services and programs that reside on the server.

Table 3. Services and Programs on the Server

Service or Program	Function
ansrd	This service monitors an active **save** or **recover** program session. This is an agent process spawned by **nsrd** in response to a **save** or **recover** session.
nsrck	This service checks the consistency of the client file index. It is invoked by **nsrd** whenever the consistency of the client file index needs to be confirmed.
nsrim	This service automatically manages the server media database. This service is invoked by **nsrmmdbd** when it starts up, at the end of the **savegrp** program, and by **nsrd** when a user removes the oldest backup cycle.
nsrindexd	This service provides a method for inserting entries into the client file index based on information passed by the **save** program.
nsrmmd	This service provides device support, generates mount requests, and multiplexes save set data during a multi-client backup. The **nsrd** service can start several **nsrmmd** services, up to twice the number of devices specified in the server.
nsrmmdbd	This service provides media database management services to the local **nsrd** and **nsrmmd** services and records entries in the media database. This is the media management database service.
savegrp	This program runs a group of NetWorker clients through the **save** process.

Services and Programs on the NetWorker Client

The **nsrd** service calls upon the NetWorker client service, **nsrexecd**, and several programs on the client when a scheduled or on-demand backup request is received. A temporary server agent, the **ansrd** service, starts on the NetWorker server to monitor the progress of the backup session.

Table 4 on page 21 describes the services and programs on the NetWorker client.

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Table 4. Services and Programs on the Client

Service or Program	Function
nsrexecd	This service authenticates the NetWorker server remote execution request and executes the **save** and **savefs** commands on the client.
recover	This program browses the NetWorker server client file index and restores the specified file to primary disk storage.
save	This program sends specified files in a multiplexed data stream to the NetWorker server for backup to media by **nsrmmd** and entry in the client file indexes by **nsrindexd** and the media database by **nsrmmdbd**. A level-based system is used to save only those files which have been modified since some previous save (a partial save).
savefs	This program gathers all the necessary information, such as filesystem and level, and sends it to **savegrp**. **savegrp** then requests that the **save** program sends the data to the NetWorker server.

How the NetWorker Software Backs Up Data

When you configure a backup group on the NetWorker server, you schedule a start time for the backup group. The **nsrd** service starts the **savegrp** program on the server for the backup group at the scheduled time.

The savegrp Program

The **savegrp** program queries the Client resources configured on the NetWorker server to determine the following:

- Which clients configured on the server are members of the scheduled group.
- What level of backup (**save**) to perform.

- How many save sets to run concurrently, determined by the parallelism value set on the NetWorker server.
- When the most recent backup of the group occurred.

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If any of this information is not available on the NetWorker server, the **savegrp** program sends a request (sometimes called a probe) to the **nsrexecd** client service to run **savefs** on each client assigned to the backup group to gather the necessary details.

The **savefs** program tells **savegrp** which objects to back up for the client. After **savegrp** receives information about the objects to back up, **savegrp** assembles a work list for the server. The work list specifies the order in which clients are contacted for backup. The order of the work list is determined by the Client Priority attribute in the Client resource. The client with the lowest value in the Client Priority attribute is contacted first.

If problems were encountered with the client file index during the previous backup session, **nsrd** invokes the **nsrck** service to check the consistency and state of the NetWorker server client file indexes. Then, **nsrd** starts the **nsrindexd** client file index insertion service.

The **savegrp** program contacts the first client on the server work list. The **nsrexecd** of the client is invoked and starts a **save** session of the first save set listed on the server work list. The **save** program passes all save criteria to **nsrd**, such as group, client, save sets, and level of the save data. With this information, **nsrd** determines the pool of volumes that will store the data and forwards the information to the appropriate media service on the NetWorker server.

The nsrmmd Service

The media service, **nsrmmd**, performs the following:

- Sends a message to the NetWorker server console, requesting a mount of the media assigned to the volume pool indicated by **nsrd**.
- Writes the data sent by **save** to storage media.
- Forwards storage information to **nsrmmdbd** for recording in the NetWorker server media database.

Any time there is a lull in save set activity from the client, the NetWorker server attempts to find another save set in the group to keep the process moving. The **savegrp** program attempts to concurrently back up as many save sets as possible, up to the limit set by the Parallelism attribute in the NetWorker server configuration. This way, backup devices are utilized to their maximum potential.

The **savegrp** program repeats the process for each item on the server work list until all clients in the group are backed up. Before the **savegrp** program finishes, if the NetWorker server is part of the group being backed up or the server is not part of any enabled group, the NetWorker server bootstrap file is backed up.

If you have set up the bootstrap notification and installed and configured TCP/IP print services, a bootstrap printout is sent to the default printer configured for the NetWorker server after the bootstrap backup finishes.

Note: Keep the bootstrap printout in a safe place in case you need to restore the NetWorker server.

The final results of the **savegrp** execution are as follows:

- On Windows NT and Windows 2000 systems, results are returned to the server and appended to the *\nsr\logs\savegrp.log* file.
- On UNIX and Linux systems, results are appended to the */nsr/logs/savegrp.log* file.

shows how all of the NetWorker client and server services and programs interact during a scheduled save.

2

Figure 1. NetWorker Services and Programs During a Scheduled Backup
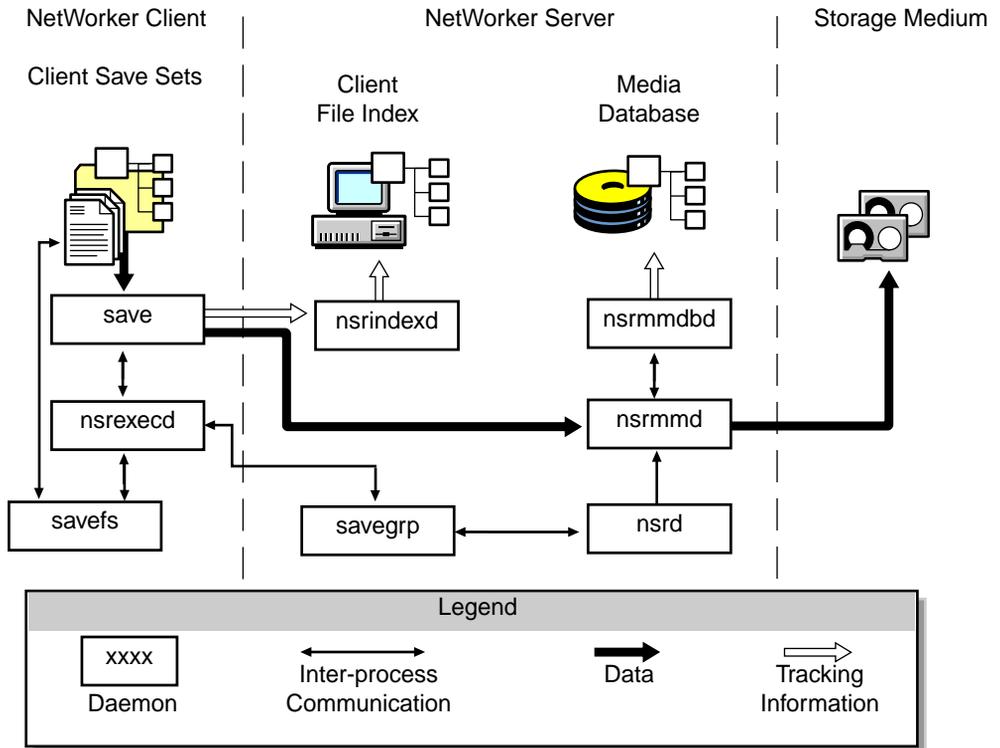
How the NetWorker Server Recovers Data

When the NetWorker server receives a **recover** request from a client, the **nsrd** master service of the server contacts the **nsrmmd** media service on the server. The **nsrmmd** service contacts the **nsrmmdbd** media database service of the server to determine which media contain the save set requested by the **recover** program. After **nsrmmd** finds the save set on the media, **nsrmmd** issues a mount request, the media is positioned to the beginning of the save set, and the save set stored on the mounted media is passed to **nsrmmd**. The media service forwards the save set to the **recover** program of the client, which restores the data to the client's filesystem.

shows how the NetWorker server and client services and programs interact while recovering data to a NetWorker client.

Figure 2. Processes and Programs During a Recover Session
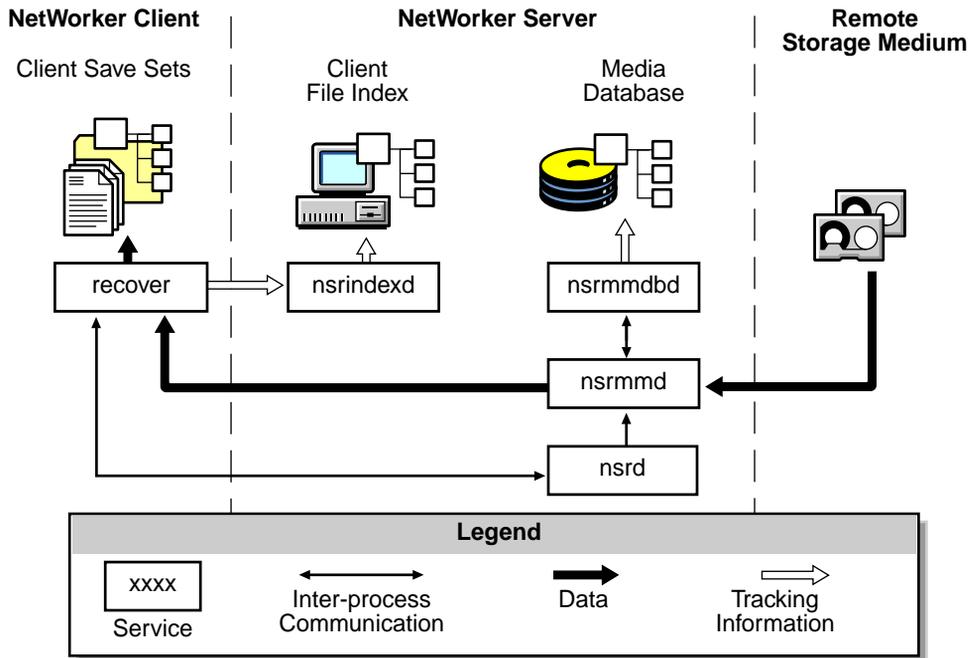
NetWorker Configurations

This section describes various NetWorker configurations. Immediate save and recovery is a special feature available in all NetWorker editions of the NetWorker software (release 6.0 and later). The text and figures provided here illustrate various setups, including:

Immediate Save and Recovery

During a backup session on a NetWorker server or storage node, the NetWorker software distinguishes whether the data resides on the same or remote computer.

- When the data resides on the same computer, immediate saves and immediate recoveriess are invoked automatically. Instead of transferring data across the network, local data is transferred within memory on the NetWorker server or storage node.
- When the data resides on a remote client, the data is transferred over the network by using TCP/IP.

Performance for remote backup is improved through RPC enhancements. The examples in the following sections illustrate when immediate save can, and cannot, be invoked.

Local Backup and Recovery of a Client

When one computer includes either both the client and server software, or the storage node software, and they have storage devices attached, the data is backed up through immediate save. shows an example of a local backup of a NetWorker server. The NetWorker software can back up data of any type supported by a NetWorker client, including a range of databases.

Figure 3. Local Backup and Recovery

NetWorker Server

Storage Device

SCSI Connection

NetWorker Client
NetWorker Module Client
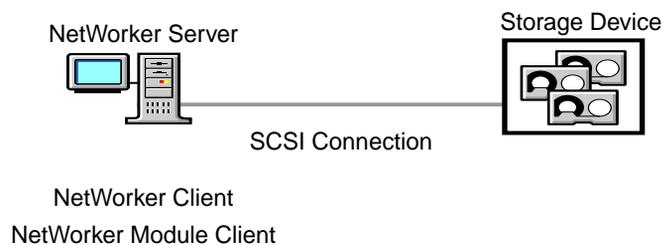
Processes and data that travel through a protocol stack in a standard setup are passed in memory on the same computer. With immediate save, the network transmission blockage is eliminated. The same is true for recovery operations.

If a database is offline, that database can take advantage of immediate save for local backup with a NetWorker client. Some NetWorker Module clients can also take advantage of immediate save for online database backups. To determine whether immediate save for online backup is supported, refer to the documentation that accompanied the NetWorker Module software.

Backup and Recovery of Remote Client

Figure 4 on page 27 shows an example of the NetWorker server installed on a computer other than the one where the data resides.

2

Figure 4. Remote Backup and Recovery
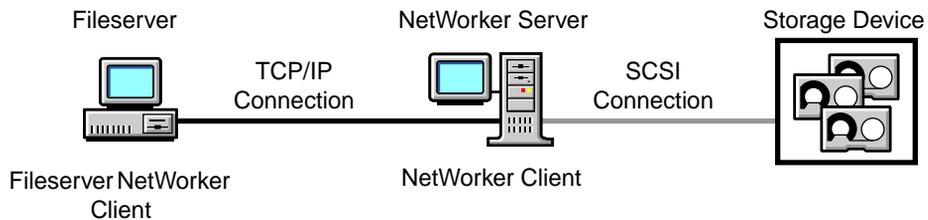
Because the NetWorker client and the fileserver data reside on a remote computer, the data is transferred across the network during backup.

For a recovery, the process is reversed. When the NetWorker client on the fileserver computer makes a recovery request, the data is again transferred across the network.

Backup and recovery performance over the network is enhanced because of Remote Procedure Call (RPC) protocol enhancements. They prevent slower clients from slowing down the backup of faster clients. Data that resides on the NetWorker server is automatically backed up through immediate save (or automatically recovered by using immediate recover).

If the data is backed up to a high-speed device, performance is improved. The device can transfer data in less time and write it in larger blocks.

Backup and Recovery to a Storage Node

Figure 5 on page 28 shows an example of a NetWorker server that uses a storage node for backup and recovery operations. This feature is only available with the Power Edition or Network Edition of the NetWorker software.

Data hosted on each NetWorker storage node is backed up and recovered by using immediate save and immediate recover technology. The metadata associated with backups is transferred over the network to the controlling NetWorker server, and the data is transferred directly to devices attached to the storage node.

NetWorker storage nodes enable you to design scalable configurations.

- Multiple devices can be attached to multiple storage nodes.
- Data transfer operations can run concurrently.

Figure 5. Backup and Recovery with a NetWorker Storage Node

NetWorker Server   Storage Node   Storage Device

TCP/IP Connection   SCSI Connection

NetWorker Client   Storage Node
                                    NetWorker Client
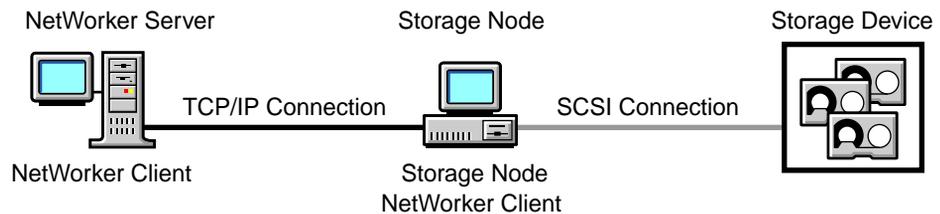
Local Backup to a Silo

When you add a silo to the local backup scenario, performance may improve because of the speed and number of devices in the silo. The silo requires another computer to be the silo server, which controls the robotics in the silo. The silo server cannot be the same computer as the NetWorker server.

In Figure 6 on page 29, a silo and its silo server are used in the NetWorker local backup and recovery configuration.

Figure 6. Local Backup to a Silo
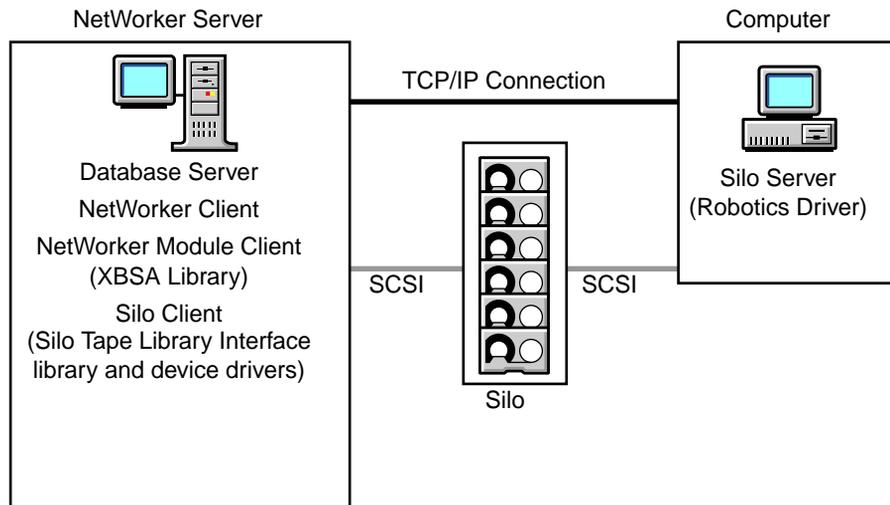
During Backup

During backup, save is invoked to transfer data from the NetWorker client processes to the NetWorker server processes in the memory of the NetWorker server computer. If the data is written to a device in a silo, the **nsrmmd** service initiates a Silo Tape Library Interface (STLI) call to the silo server, for example, to mount a tape.

The STLI call is transferred across the network connection to the silo server, then over a SCSI connection to the device in the silo. The data is transferred over a SCSI connection from the NetWorker server to the device.

During Recovery

During a recovery, the process is similar to a backup. Media handling information is transferred across the network connection from the NetWorker server to the silo. The silo mounts the tapes, and then the data is transferred over the SCSI connection to the NetWorker server computer, where the data is transferred in memory to the NetWorker client process.

For more information about silos and how they interact with the NetWorker software, refer to the *Legato NetWorker Administrator's Guide*.

2

Chapter 3: Testing and Tuning Basics

Improving the performance of data storage management is more an art than a science. If the data storage management process is operating poorly or not at all, the cause can be traced to a single problem. If the storage management environment seems generally OK, but is not reaching the performance levels you want, you might need to investigate and tune multiple elements in the environment.

This chapter identifies the different hardware and software components that make up the data storage management environment, discusses their impact on storage management tasks, and provides general guidelines for locating problems and solutions in the following sections:

The last two chapters of this guide address specific performance tests and fixes, particularly those that pertain to the specific operating system on which you are using the NetWorker software.

Overview of Performance Testing and Tuning

The benchmark tests used in the computer industry are done in controlled environments, to simplify analysis and show products at their greatest advantage. When you test the performance of the NetWorker server in your environment, you must decide the degree to which the test is controlled.

- To run a *fully-controlled* test, turn off all extraneous processes to isolate the performance of the NetWorker server. The results of this type of test show you the optimal performance of the NetWorker server with the current hardware and software configuration.

- To run a *less-controlled* test, do *not* shut down other applications and network traffic. The results of this type of test show you how the NetWorker server performs while the computer is running other programs and processes.

3

If you run both a controlled test and one with a normal or simulated load, the difference between the results can help you determine the following:

- How to schedule the backups.
- Whether to run other programs on the NetWorker server.

The tests in this and the following chapters follow a basic process:

1. Measure the current performance of the NetWorker server.

2. View the results to find a blockage or limiting factor.

3. Adjust the hardware and software to correct the blockage.

4. Measure the performance of the NetWorker server.

Although there will always be some blockage in a system, you can use this process to eliminate the greatest obstacles to fast backup performance.

Note: You must have sufficient computer and network hardware installed to support a storage application. Failure to meet minimum system requirements, particularly for memory, free space, and CPU speed, can have an obvious and immediate negative impact on the storage management processes.

Server Hardware

The following sections address different hardware components of the NetWorker server, as well as tests on the performance of these components.

Physical Disks

The physical disks in a computer system are in constant motion, reading and writing data for storage and recovery and maintaining the client file indexes and media database. Problems with these disks can negatively affect every level of performance within a storage management environment.

The type of data you back up and how it is laid out on the disk can cause backup performance to vary. If you have large files that are fragmented, or if you have many small files, the efficiency of the disk suffers because the disk head has to move frequently from one fragment or file to another. The backup process is most efficient for large files with minimal fragmentation.

If the data is compressed on the disk, the operating system or application has to decompress the data before transferring it for backup. The CPU spends cycles to decompress the files, and the disk can rarely go at its maximum speed.

Disk Read Speed Testing Methods

Follow these guidelines to determine the read speed of disks:

- Test the read speed of each individual disk, while NetWorker software is *not* running.
- Test the read speed of all disks, while the NetWorker software is *not* running.
- Test the read speed of each individual disk, while NetWorker software is running.
- Test the read speed of all disks, while NetWorker software is running.

You can use the NetWorker **uasm** program, which saves and recovers filesystem data, to test how fast the system can read from disk.

The syntax is as follows:

uasm -s [**-benouv**] [**-ix**] [**-t** *time*] [**-f** *proto]* [**-p** *ppath*] *path*

uasm -r [**-nuv**] [**-i** {**nNyYrR**}] [**-m** *src = dst*] [**-z** *suffix*] *path*

uasm -c [**-nv**] *path*

For example, enter the following command at the system prompt:

```
uasm -s filename > /dev/null
```

where *filename* is a fairly large file that has not been accessed recently. If the file was recently accessed, it may still be in memory and **uasm** would not actually read the file from disk.

The **uasm** program reads from the disk at the maximum speed. In this example, the data is written to a null location so the disk read is not slowed down to allow time for writing.

The **uasm** program has three modes: save, recover, and compare. For a description of how the **uasm** program performs in the three modes, see .

Table 5. uasm Program Modes

In this mode:	The uasm program performs the following:
save	Scans directory trees and generates a save stream on its standard output (**stdout**) representing the files and organization of the directory tree. Symbolic links are never followed by application specific modules (ASMs), except **rawasm**, which enables NetWorker to process data in raw disk partitions.
recover	Reads a save stream from its standard input (**stdin**) and creates the corresponding directories and files.
compare	Reads a save stream from its **stdin** and compares the save stream with the files already on the filesystem.

In save mode, **uasm** can be controlled by directive files. Directive files control the following:

*   How descendent directories are searched.
*   Which files are ignored.
*   How the save stream is generated.
*   How to process subsequent directive files.

All ASMs accept the options described in Table 6 on page 35. ASMs can also have additional options. The additional options for a particular ASM are in capital letters.

Note: Either **-s** (save), **-r** (recover) or **-c** (compare) mode must be specified when using the **uasm** program and must precede any other options. When saving, at least one path value must be specified. The path value can be either a directory or a filename.

Options Valid for All Modes of uasm

Table 6 on page 35 lists the options that are valid with *all* modes of **uasm**.

Table 6. uasm Options

Option	Usage
-n	Use the -**n** option to perform a dry run.
	When saving, scan the filesystem but do not attempt to open files and produce the save stream.
	When recovering or comparing, consume the input save stream and do basic checks, but do not create directories or files when recovering or do the work of comparing the file data.
-v	Use the **-v** option to turn on verbose mode. The current ASM, its specified options, and the file it is processing are displayed. When an ASM is operating in filtering mode (that is, processing the save stream of another ASM) and modifies the stream, its name, specified options, and the current file appear within square brackets.

3

Options for Save Mode

Table 7 on page 36 lists the options that can be used in save mode.

Table 7. Save Mode Options (Part 1 of 2)

To	Use this option
Produce a byte count. This is similar to the **-n** option, but byte count estimates the amount of data to be produced, instead of actually reading file data. This option is faster but less accurate than the **-n** option. Byte count mode produces three numbers: the number of records (files and directories), the number of bytes of header information, and the approximate number of bytes of file data. Byte count mode does not produce a save stream, so its output cannot be used as input to another ASM in recover mode.	-**b**
Produce an "old style" save stream that can be handled by older NetWorker servers.	**-o**
Do *not* specify the **-e** option, because **uasm** does not generate the final "end of save stream" boolean. Use this option only when both of the following apply: • ASM invokes an external ASM. • An optimization does *not* consume the generated save stream itself.	**-e**
Ignore all save directives from *.nsr* directive files found in the directory tree.	**-i**
Specify the location of a *.nsr* directive file to interpret before processing any files. Within the directive file specified by *proto*, path directives must resolve to files within the directory tree being processed, otherwise their subsequent directives will be ignored.	**-f**
Specify the path with *ppath*. When you specify **-p** *ppath,* this string is added to the beginning of each filename as it is output. This option is used internally when one ASM execs another external ASM. The path you enter for *ppath* must be a properly formatted path that is either the current working directory, or a trailing component of it.	-**p**

Table 7. Save Mode Options (Part 2 of 2)

To	Use this option
Specify a date with **-t** *date* to set the date after which files must have been modified before they are saved.	**-t**
Specify **-x** to cross filesystem boundaries. Normally, filesystem boundaries are not crossed when walking the filesystem. Symbolic links are never followed, except in the case of **rawasm**.	**-x**

Options for Recover Mode

lists the options that can be used in recover mode.

Table 8. Recover Mode Options

To:	Use this option
Define the initial default overwrite response option. Only one overwrite response option is allowed. When the name of the file being recovered conflicts with an existing file, the user is prompted for overwrite permission. The default response option, selected by pressing Return, is displayed within square brackets. For additional information about the -**i** option, see .	**-i** {*nNyYrR*}
Map the filenames to be created. Any files that start exactly with *src* are mapped to have the path of *dst* replacing the leading *src* component of the pathname. This option is useful if you want to perform relocation of the recovered files that were saved using absolute pathnames into an alternate directory (for example, **-m c:\win32app=.**).	**-m** *src=dst*
Specify the suffix to append when renaming conflicting files. The default suffix is **R**.	**-z** *suffix*

3

The -i Option

The -**i** option defines the initial default overwrite response option. Table 9 on page 38 lists the overwrite response options and their meanings:

Table 9. Overwrite Response Options

Option	Meaning
n	Do not recover the current file. This is the initial default overwrite response option. Each time a response option other than the default is specified, the new response option becomes the default.
N	Do not recover any files with conflicting names.
y	Overwrite the existing file with the recovered file.
Y	Overwrite all files with conflicting names.
r	Rename the conflicting file. A dot, ".", and a suffix (by default "R") are appended to the recovered filename. If a conflict still exists, the NetWorker software prompts you again.
R	Automatically renames conflicting files by appending a dot, ".", and a suffix. If a conflicting filename already ends in a "." suffix, the NetWorker software prompts you to avoid potential auto-rename looping conditions.

When you specify either **N**, **R**, or **Y**, you are prompted only when the NetWorker server cannot auto-rename a file that already ends with the rename suffix, and each subsequent conflict is resolved as if the corresponding lower-case letter had been selected.

Disk Performance Tuning Methods

If you find a blockage in the disk system, you can make the following changes to improve performance:

- Defragment files to reduce the number of disk seeks.
- Use larger files or fewer files to reduce the number of disk seeks.
- Change to a faster SCSI adapter, with synchronous I/O support and bus mastering.
- Use stripe sets on multiple disks to accommodate large files and databases, so the physical disks can work in parallel to read data.
- Spread disk-intensive programs onto different servers.
- Purchase disks with higher transfer rates.

Memory and CPU Usage

Each backup session requires CPU and memory resources on the NetWorker server. If other applications are running concurrently with the backup, they impose an additional load on the system. Heavy swapping or paging activities indicate that the server is CPU- or memory-bound.

Memory Usage

A NetWorker server or storage node computer can never have too much memory. Data transfer within memory is much faster than over a network. Memory holds frequently used data so the disk does not have to be read as often. Open applications, processes in run mode, and disk cache all use memory. If the operating system is capable, disk storage space can be used as simulated memory, often known as virtual memory.

For best results, install the maximum amount of memory that your computers will sustain, especially for the NetWorker server and storage nodes.

CPU Usage

To increase CPU performance and bandwidth:

- Upgrade to a faster CPU.
- Add additional CPUs if the NetWorker server supports multiple processors.
- Shut down other processes during backup time.

  This may reduce the processor load and improve backup performance.

Set scheduled backups for low-traffic periods to avoid performance degradation or excessive network traffic. The default NetWorker backup start time is 3:33 a.m.

The operating system of a computer might contain various utilities for testing and tuning CPU speed. Additionally, you can check the CPU utilization of each NetWorker function. The processes involved in a NetWorker backup are the following:

- These NetWorker services
  - **nsrexecd**
  - **nsrd**
  - **nsrmmd**
  - **nsrmmdbd**
  - **nsrindexd**

- The **save** program for NetWorker backups
- Application-specific services, such as for a database server

Note: To measure and record CPU speed for the NetWorker server on the Windows platform, you can use the Windows NT or Windows 2000 Performance Monitor. See "Testing CPU Performance" on page 79.

Server Input/Output

The following performance variables relate to the input/output (I/O) throughput on the NetWorker server.

Input/Output Backplane

3

On a well-configured NetWorker server, the maximum data transfer rate of the server's I/O backplane is the limiting factor for backup throughput. The theoretical backup throughput limitation is the following formula:

Backup throughput = Maximum I/O throughput/2

At a minimum, the NetWorker server requires two I/O transactions per data block:

- A read from the disk to memory
- A write from memory to media

SCSI I/O Bandwidth

SCSI bus performance depends on the technology deployed. Some specifications for different types of SCSI technology include the following:

- SCSI-2 single-ended, 10 MB/sec
- FWD (fast-wide-differential), 20 MB/sec
- UltraSCSI, 40 MB/sec
- Fibre

Note the following:

- The rated speeds of SCSI buses are defined as "best case".
- The selection of UltraSCSI-compatible devices is limited.

NetWorker Settings

The NetWorker software has several attributes that control the speed and volume of data being backed up. You can adjust these attribute settings to modify backup levels to attain the best performance on the NetWorker server.

The following sections address the various NetWorker settings in principle. Because these attributes appear in different locations in the Windows and UNIX versions, refer to the *Legato NetWorker Administrator's Guide* for specific instructions on how to access these settings based on the server platform.

Server Parallelism

The server Parallelism attribute controls how many savestreams the server accepts at the same time. The more savestreams the server can accept, the faster the devices and client disks run, up to the limit of their performance or the limits of the connections between them.

Client Parallelism

The client Parallelism attribute controls how many savestreams a client can send at the same time. To avoid disk contention, do not set a value for client parallelism that is higher than the number of physical disks on the client.

Multiplexing

The Target Sessions attribute sets the target number of save streams to write to a device at the same time. Because this value is not a limit, a device might receive more sessions than the attribute specifies. The larger the number of sessions you specify for target sessions, the more save sets that can be multiplexed (or interleaved) onto the same volume.

Performance tests and evaluation can help determine whether multiplexing is appropriate for the system. Follow these guidelines when evaluating the use of multiplexing:

- Find the backup rate of each disk on the client. Use the **uasm** test described in "Disk Read Speed Testing Methods" on page 33.
- Find the maximum rate of each device. Use the **bigasm** test described in "Test Device Performance with bigasm" on page 48.

If the sum of the backup rates from all disks involved in a backup is greater than the maximum rate of the device, do not increase server parallelism. If more save groups are multiplexed in this case, backup performance will not improve, and recovery performance could slow down.

Modifying Settings for Performance Tuning

This section describes measures you can take to improve NetWorker server performance related to the following:

- Parallelism and Target Sessions attribute settings
- Workload balance
- Multiplexing
- Backups across a network

3

Parallelism and Target Sessions Attribute Settings

Follow these guidelines to adjust the Parallelism and Target Sessions attributes for the best server performance:

- Set the server Parallelism and Target Sessions attributes so that the total of the performance of the disk drives equals the total performance of the tape drives. If you set the Parallelism attribute to a higher value, there is no benefit.

  To select the right values for the Parallelism and Target Sessions attributes, use the following equation:

  ```
  Parallelism = Number of Devices * Target Sessions
  ```

  For example, if you have three tape drives available for backup, and you want each tape drive to accept two savestreams, set the value of server parallelism to 6 and the value of target sessions to 2.

- When a NetWorker server is saving a large number of save sets, such as 500 or more, memory consumption and file descriptor consumption can reach values that are close to operating system limitations. In this event, the parallelism may need to be lowered.

- Decrease the server Parallelism and Target Sessions attributes to unload an overworked NetWorker server. With the correct settings, the normal operation of the computer should not be interrupted by backups or other NetWorker server activities.

- Add more memory to handle a higher parallelism setting.

Workload Balance

The following are recommended to avoid overloading the server:

- Increase CPU power by upgrading the CPU or adding additional CPUs to the server (if possible).
- Reduce server load by spreading backups across multiple servers or storage nodes.
- Balance the number of disks and devices, so that the backups finish at about the same time. For instructions on how to change these settings, refer to the *Legato NetWorker Administrator's Guide*.

  Here are some methods of balancing the work load on disks and devices:

  - In general, start backups for the slowest or the biggest disk volumes first, because other disks can join in later to match the maximum bandwidth of the device.
  - Use pools of media to force the bigger and faster disk volumes to back up to faster devices.
  - If you have a very large and fast disk volume and many tape drives, you can manually divide the volume into several save sets, such that each of them can go to each tape drive in parallel.
  - Balance data load for simultaneous sessions more evenly across available devices by adjusting the Target Sessions attribute. This parameter specifies the minimum number of save sessions that must be established before the NetWorker server attempts to assign save sessions to another device.

Multiplexing

Refer to the following guidelines for improving server performance through multiplexing:

- To fully use the bandwidth of a high-speed device when you have many slow clients or disks, multiplex the save sets on the media. You maximize the performance of the devices, since they do not have to start and stop to wait for data.
- To improve recovery performance, multiplex save sets that you will recover together onto the same tape. For example, multiplex the disks of the same computer onto the same media, because it is likely that the data from all the disks would be recovered at the same time.

Backups Across a NetWork

In cases where you back up data across a network, the following suggestions can also improve performance:

- Increase the client Parallelism attribute, especially for clients with a logical volume manager and several physical disks. The bandwidth of the network could limit the number of savestreams you can transmit at one time.
- To reduce server load, split backups across multiple servers.
- Turn on data compression in the NetWorker client to improve effective data throughput and reduce network traffic.
- Configure clients with high transfer rate requirements to have a preference for a particular backup server on the same subnet; avoid router hops between the NetWorker server and its clients.

3

Backup Devices

NetWorker software and other storage management products use backup devices to do the following:

- Write backed-up data to the storage media volume.
- Read saved data from the storage media during recoveries.

Devices pass data to and from the NetWorker server itself, or from a NetWorker storage node through a SCSI connection. Backup devices can include optical disks, and in most cases, tape drives. When a backup device has multiple drives, such as for autochangers, each drive is considered a separate device.

Device Write Performance Tuning Methods

If the disk read speed is noticeably faster than the ability of the device to write, that might indicate a problem with the write performance of the device. To perform a thorough evaluation of device performance, follow these guidelines:

1. Measure the write speed of each individual device, while the NetWorker software is *not* in run mode.

2. Measure the write speed of all devices, while the NetWorker software is *not* in run mode.

3. Measure the write speed of each individual device, while the NetWorker software is in run mode.

4. Measure the write speed of all devices, while the NetWorker software is in run mode.

First evaluate the device performance without the NetWorker software running, and then evaluate the devices again with the NetWorker software running.

To ensure consistency in the measurements, make sure you use the same tape drives for all tests.

Testing Tape Device Performance without Running NetWorker

The **mt** program can be used to determine tape device performance when the NetWorker software is not running. Use it to evaluate the tape device without a need to consider the overhead incurred when using the NetWorker software.

The **mt** program allows you to operate a magnetic tape device, which includes rewinding, fast-forwarding, and ejecting tapes.

Note: The **mt** program cannot be used to measure the writing data rate, but can indicate performance rates related to having tapes start off loaded and rewound prior to measuring write speeds to tape.

How to Determine Tape Device Performance

To determine tape device performance when NetWorker software is not running, enter the following at the command line:

```
mt -f devicename command count
```

By default, the **mt** program performs the requested operation once. To perform the operation more than once, specify a value in place of *count*.

The **mt** program returns the following exit status:

- 0 if the operations were successful.
- 1 if the command was unrecognized or **mt** was unable to open the specified tape drive.
- 2 if an operation failed.

Table 10 on page 46 lists the available commands to use with the **mt** command.

⚠

Important: Older UNIX systems may have different options for the **mt** command. Before using the **mt** command, check the **mt** man page on your system for the available options.

Table 10. Commands to Use with the mt Command

To:	Enter this Command:
Write *count* end of file (EOF) marks at the current position on the tape.	**eof, weof**
Forward space over *count* EOF marks. The tape is positioned on the first block of the file.	**fsf**
Forward space *count* records.	**fsr**
Backspace over *count* EOF marks. The tape is positioned on the beginning-of-tape side of the EOF mark.	**bsf**
Backspace *count* records.	**bsr**
Backspace *count* files. The tape is positioned on the first block of the file. This is equivalent to count + 1 **bsf** followed by one **fsf**.	**nbsf**
Absolute space to *count* file number. This is equivalent to a rewind followed by **fsf** count.	**asf**

Table 11 on page 46 lists the available commands where *count* is ignored.

Table 11. Available mt Commands with Count Ignored (Part 1 of 2)

To:	Enter this Command:
Space to the end of recorded media on the tape. This is useful for appending files onto previously written tapes.	**eom**
Rewind the tape.	**rewind**

Table 11. Available mt Commands with Count Ignored (Part 2 of 2)

To:	Enter this Command:
Rewind the tape and, if appropriate, take the drive unit offline by unloading the tape.	**offline, rewoffl**
Print status information about the tape unit.	**status**
Rewind the cartridge tape completely, then wind it forward to the end of the reel and back to the beginning-of-tape to smooth out tape tension.	**retension**
Erase the entire tape.	**erase**
Format the tape at a low level.	**format**

3

Limitations

Not all tape devices support all options. Some options are hardware-dependent. For example, by entering the following command on a Windows computer:

```
D:\>mt -f \\.\Tape0 status
```

the following output is displayed:

```
\\.\Tape0:
Media Capacity  = 2.12GByte
Media Remaining = 3.06GByte
Media Block size = 0
Media Partition Count = 0
Media is not write protected
default block size = 8192
maximum block size = 1040384
```

The maximum block size value limits the maximum number of bytes per SCSI transfer on disk reads and volume writes.

How to Test Device Performance with bigasm

To measure SCSI throughput and the write speed of a device while the NetWorker software is running, run the **bigasm** module. The **bigasm** module is run from a directive and generates a file of the specified size, transfers it over a SCSI connection, and writes it to a tape or optical device.

The description and options of **bigasm** (and all other application specific modules) are the same as for the **uasm** module. For a full description of the **uasm** module, see .

To set up a **bigasm** test:

1. Create a file, *bigasm.file*, that contains the following command:

   bigasm -S*size* **:** *filename*

   For example:

   bigasm -S100M : bigfile

2. Save the file using the NetWorker server. For example, if the directive file is called *bigasm.file* and the NetWorker server is called *jupiter*, enter the following command:

   save -s jupiter -f /bigasm.file /tmp/*filename*

   The amount of time it takes for the backup to complete indicates the efficiency of the SCSI throughput and the write speed of the device.

   The **bigasm** module can also be used in a scheduled backup by creating a directive for it in the **nwadmin** program.

Device Performance Tuning Methods

The following sections address specific device-related areas where you can improve performance.

Input/Output Transfer Rate

Input/output (I/O) transfer rates can affect device performance. The I/O rate is the rate at which data can be written to the device. Depending on the device and media technology, device transfer rates can range from 500 KB per second to 20 MB per second. Default block size and buffer size of a device affect its transfer rate. If you believe that I/O limitations are hampering improved performance of the NetWorker server, try upgrading the equipment to affect a better transfer rate.

Built-In Compression

Turn on device compression to increase effective throughput to the device. Some devices have a built-in hardware compression feature. Depending on how compressible the backup data is, this can improve effective data throughput, from a ratio of 1.5:1 to 3:1.

Drive Streaming

To obtain peak performance from most devices, stream the drive at its maximum sustained throughput. Without drive streaming, the drive must stop to wait for its buffer to refill or to reposition the media before the drive can resume writing. This can cause a delay in the cycle time of a drive, depending on the device.

Device Load Balancing

Balance data load for simultaneous sessions more evenly across available devices by adjusting sessions per device. This parameter specifies the minimum number of save sessions that must be established before the NetWorker server attempts to assign save sessions to another device.

3

File Type Device and Staging

The NetWorker software includes file type and advanced file type devices and save set staging features, which you can use to improve backup performance. Since reading and writing data to disk is generally faster than to tape or optical media, you can use the file type or advanced file type device feature to direct the backups to disk media instead of tape or optical media.

The advanced file type (adv_file) is designed for very large disk devices. It differs from the file type device because the volume for the advanced file type device is never marked full.

When an advanced file type device runs out of disk space, the current backup is suspended. The following message is displayed:

```
Filesystem full - recover adv_file space
```

Immediately after the message is displayed, the NetWorker software begins deleting expired save sets until more space is made available. If enough space has been cleared, the backup continues.

Use save set staging in conjunction with backups to the file type or adv_file device. Save set staging lets you move save sets you have backed up from one medium to another according to criteria you set, such as:

- Space remaining on the disk.
- Age of the save set.

With staging, you can automate transferring older backups from the file type device or adv_file device to a less expensive storage media. This frees up hard disk space for new backups.

Configuration of File Type and adv_file Devices

3

A possible configuration to maximize performance of file type or an adv_file device is as follows:

1. Create one directory per user, preferably with a mnemonic name matching a client.

2. Create one file type or adv_file device per directory, setting the volume size to 1 GB.

3. Create one client per system, setting the device that is always used to have the matching mnemonic device name.

This configuration limits the system to 64 users or less with the NetWorker software, since one user equals one device, and that is how many devices Power Edition supports. However, if you use storage nodes, then you can have 64 devices per each node up to a maximum of 256 devices total for the NetWorker server and all attached storage nodes.

If you back up the data to file type devices or adv_file devices, you get high-speed backups to a hard drive in near real time, but the disk tends to fill quickly with backups.

Without Save Set Staging

Without save set staging, you would have to closely monitor disk usage to avoid running out of space for the backups, and you would either have to move save sets to other storage media manually or create very short browse and retention policies.

With Save Set Staging

With save set staging, the process of moving data from disk storage to tape or optical disk is automated, and the space that was occupied by the save set is freed to make space for new backups. The browse and retention policies for the save sets on tape or optical disk can be as long as you like. You can also use save set staging to move files from other types of media, but the space is only reclaimed on the file type device.

If you are worried about disk contention when you back up to file type or adv_file devices, you can use many smaller drives (for example, 6 drives of 4 GB each and 4 users per drive, instead of one 23 GB drive).

You can also use a RAID array, which provides redundancy in case of a drive failure. Windows NT and Windows 2000 include a software RAID capability that works well, but uses many CPU cycles. A hardware RAID solution is more efficient, but this solution is more expensive.

3

Network Hardware

If you back up data from remote clients, the routers, network cables, and network interface cards affect the backup and recovery operations. This section lists the performance variables in network hardware and suggests some basic tuning for networks. The following items address specific network issues:

- Network Input/Output Bandwidth

    The maximum data transfer rate across a network rarely approaches the specification of the manufacturer because of network protocol overhead.

- Network Path

    Networking components such as routers, bridges, and hubs consume some overhead bandwidth, which degrades network throughput performance.

- Network Load

    Other network traffic limits the bandwidth available to the NetWorker server and degrades backup performance. As the network load reaches a saturation threshold, data packet collisions degrade performance even more.

How to Tune NetWork Hardware Performance

Employ the following measures to improve network hardware performance:

- Add additional network interface cards to client systems to expand network bandwidth available to clients.
- Upgrade to faster LAN media, such as 100 MB Ethernet or FDDI, to improve network bandwidth. Note, however, that TCP packet overhead can reduce the total transfer rate.
- Configure clients that have high transfer rate requirements to show a preference for a particular backup server (or storage node) on the same subnet; avoid router hops between the NetWorker server and clients.
- Minimize the number of network components in the data path between the client and server.

3

Chapter 4: Testing and Tuning on UNIX and Linux

This chapter provides additional performance testing and tuning information for the NetWorker server on a UNIX or Linux platform. Information pertaining to a specific performance issue or tuning method is covered in both this chapter and "Testing and Tuning Basics" on page 31. However, the information here was written specifically for the UNIX and Linux environments, and provides UNIX and Linux-based examples.

The following topics are discussed:

- "Physical Disks" on page 54
- "Devices" on page 57
- "Using the System Activity Reporter" on page 60
- "Recoveries" on page 63

The multitude of platform- and network-specific variables that can impact UNIX or Linux system performance cannot be covered comprehensively in a single chapter. The scope of this chapter is therefore limited to the detection and analysis of processes that have an impact on how efficiently the NetWorker server can perform backups and recoveries.

While there are no simple solutions to performance issues, this chapter provides a general testing strategy for locating performance blockages. The testing strategy uses benchmarks and baselines derived from common utilities.

Note: This chapter assumes that you are familiar with the following:

- UNIX or Linux system infrastructure, including networking and devices.
- Writing shell scripts and using Linux or UNIX utilities, such as **tar**.

The scripts in this chapter use standard utilities. The examples are specific to Solaris, but the scripts can be applied to most UNIX and Linux platforms with minimal changes.

The testing strategy and scripts use the following scenario:

- All backup processes are local (that is, not over a network).
- All tape devices operate at the same speed.
- Data is stored on a filesystem (no databases are used).

Physical Disks

The following sections provide information and suggestions on testing and evaluating the read speed performance on the physical disks of the NetWorker server. The UNIX and Linux operating systems provide several utilities for determining disk read speed. The following sections detail their usage.

Apply the following testing strategy to collect baselines to measure tape drive performance:

- Test the read speed of each individual disk, while the NetWorker software is *not* in run mode.
- Test the read speed of all disks, while the NetWorker software is *not* in run mode.
- Test the read speed of each individual disk, while the NetWorker software is in run mode.
- Test the read speed of all disks, while the NetWorker software is in run mode.

Benchmark Evaluation

The utility **/bin/time** reports the amount of time required to execute a program, breaking down the total time into three components:

- Real time — the time that the program takes to run as it would be measured by a user sitting at the terminal using a stopwatch.
- User time — the actual time that the computer spent executing code in the user state.
- System time — the time the computer spent executing UNIX or Linux system code on behalf of the user.

4

Note: When running the **tar** or **uasm** command, do not specify a file or mountpoint that has been accessed recently. The file may still be in memory and not read from the disk.

Example:

The result of running the **/bin/time tar cvf** - **/space2** > **/dev/null** command on a Solaris computer provides the following result for the mount point */space2*:

```
RESULTS:
real    6:53.4
user      18.2
sys     1:48.1
```

How to Test the Read Speed of a Single Disk

To test the read speed of an individual disk:

1. Enter the **df** command to display a list of mounted filesystems and their respective sizes.

2. Run the **/bin/time** utility to determine how long it takes to read each filesystem. For example, on Solaris, enter:

   /bin/time tar cf - *mount_point* **> /dev/null**

   To achieve a consistent result, no other disk or system activity should be running when you run this command.

How to Test the Read Speed of Several Disks

After you execute the **/bin/time** utility for each individual filesystem, measure the read time for all the filesystems on each SCSI bus. If you are running the disks in parallel, develop a baseline for the number of parallel disks. For example, if there are 300 disks, and 10 are in parallel, measure the baseline for the 10 disks.

To streamline this task, create a shell script using the editor of your choice. Following is an example shell script from a Solaris computer that was created for multiple disks (*/space, /space2,* and so forth):

```
/bin/time tar cf - /space > /dev/null &
/bin/time tar cf - /space2 > /dev/null &
/bin/time tar cf - /space3 > /dev/null &
...
```

How to Test the Read Speed of a Single Disk While Running the NetWorker Software

To test the read speed of an individual disk using the NetWorker software:

1. Enter the **df** command to display a list of mounted filesystems and their respective sizes.

2. Run the **uasm** program for each disk. For example, on Solaris, enter:

   /bin/time uasm -s *mount_point* **> /dev/null**

   Depending on the configuration of the computer, you might need to specify the path for **uasm** in the command.

For more information on the **uasm** command, see "Disk Read Speed Testing Methods" on page 33.

How to Test the Read Speed of Several Disks While Running the NetWorker Software

Test the read speed for all the disks on a SCSI channel. If you are running the disks in parallel, develop a baseline for the number of parallel disks. For example, if there are 300 disks, and 10 are in parallel, measure the baseline for the 10 disks.

To streamline this task, create a shell script using the editor of your choice. Following is an example shell script for a Solaris computer that was created for multiple disks (*/space, /space2*, and so forth):

```
/bin/time uasm -s /space > /dev/null &
/bin/time uasm -s /space2 > /dev/null &
/bin/time uasm -s /space3 > /dev/null &
...
```

To calculate the read speed of the disk:

1. Enter the **df** -**k** command to obtain the file size (in kilobytes) of */space2*:

```
%  df -k

Filesystem         kbytes    used     capacity  Mounted on
/dev/dsk/c0t1d0s0  1952573   797935   46%       /space2
```

2. Divide the real time by the size (in kilobytes) of */space2*.

   For example, based on the result and size of */space2* above, the read speed of */space2* is 1932 KB per second.

Compare the results of the benchmarks generated from the following:

- First, from the individual disks *without* the NetWorker software running, as compared to the results of individual disks running the NetWorker software.

- Then, from multiple disks *without* the NetWorker software running, as compared to the results of multiple disks running the NetWorker software.

Devices

4

Apply the following testing strategy to collect baselines to measure tape drive performance:

- Test the write speed of each individual tape drive, while the NetWorker software is *not* in run mode.
- Test the write speed of all tape drives, while the NetWorker software is *not* in run mode.
- Test the write speed of each individual tape drive, while the NetWorker software is in run mode.
- Test the write speed of all tape drives, while the NetWorker software is in run mode.

To ensure consistency in the measurements, test the same tape drives both when the NetWorker software is running and when it is not.

Benchmark Evaluation

Compare the results of the benchmarks generated from the following:

- First, from individual drives writing data *without* the NetWorker software running, as compared to the results of individual drives writing data when the NetWorker software is running.
- Then, from multiple drives writing data *without* the NetWorker software running, as compared to the results of multiple drives writing data while running the NetWorker software.

How to Test the Write Speed of a Single Tape Drive

You can also test just a single tape drive by using the commands in this section.

Important: Using the **mt rewind** command, followed by the **dd** command, can cause the erasure of a tape. Exercise caution when using these commands.

To test the write speed of a single tape drive, enter the following commands for each tape drive:

```
mt -f /dev/rmt/drive_name rewind

dd if=/dev/zero of=/dev/rmt/drive_name \
bs=block_size count=1;\

/bin/time dd if=/dev/zero of=/dev/rmt/drive_name \
bs=block_size count=1000
```

Although the block size can vary depending on the environment, a block size value of 32 can be used for purposes of testing and examples.

How to Test the Write Speed of Several Tape Drives

Test the write speed of all the tape drives on the SCSI channel. To streamline this task, create a shell script using the command demonstrated in .

The following is an example of a shell script for a Solaris computer that was created for multiple drives (*0mbn, 1mbn, 2mbn,* and so forth):

Example:

```
mt -f /dev/rmt/0mbn rewind; dd if=/dev/zero \
of=/dev/rmt/0mbn bs=32k count=1; \
/bin/time dd if=/dev/zero of=/dev/rmt/0mbn \
bs=32k count=1000 &

mt -f /dev/rmt/1mbn rewind; dd if=/dev/zero \
of=/dev/rmt/1mbn bs=32k count=1; \
/bin/time dd if=/dev/zero of=/dev/rmt/1mbn \
bs=32k count=1000 &

mt -f /dev/rmt/2mbn rewind; dd if=/dev/zero \
of=/dev/rmt/2mbn bs=32k count=1; \
/bin/time dd if=/dev/zero of=/dev/rmt/2mbn \
bs=32k count=1000 &
...
```

4

How to Test the Write Speed of a Single Drive while Running the NetWorker Software

To test the write speed of a single drive while running the NetWorker software:

1. Set target sessions to 1.

2. Label the tape.

3. Set up **bigasm**:

   a. Enter the following command at the prompt to create an empty directory:

      mkdir /empty

   b. Enter the following command at the prompt to go to the directory *empty:*

      cd /empty

   c. Enter the following command at the prompt to create an empty file:

      touch e

   d. Using a text editor, create a *.nsr* file.

e. Edit the *.nsr* file by adding the following directive:

bigasm -S100M : e

f. Save the file and edit the text editor.

4. Run the following script to determine the baseline:

save -s *server_name* **/etc/motd; /bin/time save -s**
server_name **/empty/e**

When NetWorker encounters the *.nsr* file, the directive results in a 100 MB
file being written to tape.

The NetWorker server automatically assigns each command to a tape, since
target sessions are set to 1.

How to Test the Write Speed of Several Drives While Running the NetWorker Software

To test the write speed of several drives, repeat steps 1-4 in
for every drive on the SCSI channel at the same time.

4

Using the System Activity Reporter

The System Activity Reporter (**sar**) is a standard UNIX utility for most systems
that monitors and reports on system performance, including buffer and block
device activity, kernel memory allocation, and CPU utilization. Use this utility
to evaluate and tune a UNIX system. For more information, refer to the **sar**
man page.

How to Monitor Buffer Activity

If the read and write buffer cache hit rates (%rcache and %wcache) are
consistently low, increase the size of the buffer cache to improve disk I/O
performance.

To monitor buffer read activity, enter the following command:

sar -b %rcache

To monitor buffer write activity, enter the following command:

sar -b %wrcache

The values of %rcache and %wrcache depend on the combination of applications that the system is running, the speed of its disk subsystems, and the amount of memory available. The ideal value for both is 100%, but that value is unlikely on an average system. If either value is consistently below 50%, increase the size of the buffer cache.

How to Monitor Block Device Activity

To monitor block device activity, enter the following command:

sar -d

Results similar to the following appear:

```
23:59:44 device  %busy   avque  r+w/s blks/s  avwait  avserv
23:59:49 Sdsk-0  99.42   4.18   39.39 166.28  80.26   25.24
23:59:54 Sdsk-0  100.00  4.18   38.73 163.64  82.35   25.87
23:59:59 Sdsk-0  100.00  3.98   38.07 171.95  78.32   26.32
```

where:

- *device* is the device on which the activity is being measured.
- *%busy* is the percentage of time that the system was transferring data to and from the device.

  A consistently high value for %busy indicates a heavily utilized disk. Increasing CPU power will create a bottleneck worse because the processor produces more I/Os for a disk that is already overloaded.
- *avque* is the average number of requests pending on the device including any on the device itself.
- *r+w/s* is the number of read and write transfers to and from the disk.
- *blks/s* is the number of 512-byte blocks transferred per second.

  The values for r+w/s and blks/s can be used to calculate the average size of data transfers by using the following formula:

  Average size of data transfer = blks/s / r+w/s
- *avwait* is the average time in milliseconds that the request waits in the driver before being sent to the device.
- *avserv* is the average time in milliseconds that it takes a request to complete. The length of time is calculated from the time that the request was sent to the device to the moment that the device signals that it has completed the request. The value of avserv varies depending on the type of disk and any caching on the disk controller.

Use the values generated by **sar** -**d** to determine which disks are overused and which are underused. To avoid bottlenecks, balance the disk load by moving some users from the busier disks to the less active disks.

How to Test CPU Utilization

The **sar** -**u** command identifies disks to which the NetWorker software writes frequently, which could be I/O bottlenecks. To enhance performance, optimize these disks.

To test I/O-related CPU activity, enter the following command:

```
sar -u
```

The following is reported:

- *%usr* is the percentage of time the system is in user mode (that is, running user or application code).
- *%sys* is the percentage of time system programs or system calls are run from user programs.
- *%wio* is the percentage of time the system is waiting for I/O.

    The *%wio* value should generally not exceed 25%. A higher percentage may indicate that you need to speed up disk throughput or add I/O bus capacity.

- *%idle* is the percentage of time the system is completely idle.

    If *%idle* is frequently equal to zero, the system is CPU bound. If the system throughput is too low, upgrade to a faster processor or reduce computational load on the system.

The following example shows how to test CPU utilization by taking five samples at 60 second intervals.

Example:

To test CPU utilization, enter the following command:

```
sar -u 60 5
```

The following results appear:

```
18:22:46   %usr  %sys  %wio  %idle
18:23:46   13    9     6     73
18:24:46   25    16    13    45
```

```
18:25:46    21    9     1     68
18:26:46    22    10    1     66
18:27:46    22    11    1     66
```

Recoveries

Recovery performance can fluctuate based on a variety of issues, including network traffic, bottlenecks, and file sizes. One method of recovering data efficiently is to start multiple **recover** commands simultaneously through the save set recovery method.

For example, you can start three different save set **recover** programs instead of one **recover** program with three save sets. Separate **recover** programs provide the maximum parallelism possible given the number of daemons and the actual volume and save set layout.

Important: If multiple, simultaneous **recover** programs are being run from the same tape, do not let the tape mount and start until all recoveries are ready. If the tape is used before all recoveries are ready, the tape will be read through multiple times and recovery performance will be slower, rather than faster.

4

How to Perform Multiple, Simultaneous Recoveries

To perform multiple recoveries:

1. Open one command window for each save set that needs to be recovered.

2. In each window, enter the **recover** command with the save set to be recovered, but do not press [Return].

3. Once all three **recover** commands are ready, execute each command consecutively.

4. Measure the time it takes to recover all three save sets.

5. Once the recoveries are finished, perform another recovery with all three save sets in the same recover request.

6. Compare the time needed for the multiple recovery requests to the time needed for the single recovery request.

The multiple recoveries should have finished *before* the single recovery of multiple save sets. If the single recovery completed faster:

- The tape may have been mounted before all recoveries could start.
- The computer is CPU-bound rather than I/O-bound.

To determine the cause of the bottlenecks, use the performance and activity monitoring tools available with the operating system.

4

Chapter 5: Testing and Tuning on Windows

This chapter addresses specific performance testing and tuning tasks you can perform on a NetWorker server in a Windows environment. For a discussion of general performance issues affecting all versions of the NetWorker software, see "Chapter 3: Testing and Tuning Basics" on page 31.

The following topics are discussed in this chapter:

Windows Performance Monitor

Use the Windows Performance Monitor program to test system performance. In the Performance Monitor, you can choose:

- Which objects to watch, for example, the processor or memory.
- Which counters to test, for example, available bytes of memory.
- How to display the data.

The default view of the data is a real-time line chart. However, the data can also be logged or formatted as a report, or alerts can be created that warn when a counter reaches a certain limit.

How to Start the Windows NT Performance Monitor

To start the Windows NT Performance Monitor on the NetWorker server:

1. Select Start>Programs>Administrative Tools>Performance Monitor.

2. From the View menu, select Report.

   The default viewing mode of the Performance Monitor is Chart, but the Performance Monitor-related tasks in this chapter use the Report mode.

3. From the Edit menu, select Add To Report.

4. From the Object list, select which component of the NetWorker server you want the Performance Monitor to track.

   This Object choice determines the Counter and Instance choices available to you.

5. From the Counter list box, select a choice. Click Explain to view descriptions of each counter.

6. From the Instances list box, select a choice.

7. When all choices are selected, click Add.

   The Performance Monitor window reflects the NetWorker server and the component to be monitored.

8. Repeat steps 4-7 for each component on the NetWorker server you want to test.

   The Performance Monitor window lists each component separately under the name of the NetWorker server.

9. Once all the NetWorker server components to be tested have been added, click Done.

10. Start a backup, and view or capture the results.

To save the performance monitoring information in log form:

1. Place the Performance Monitor in Log mode.

2. From the Options menu, select Log.

3. Specify a filename and location and save the log file.

To test the maximum performance of the NetWorker software:

1. Shut down all extraneous processes.

2. Run just the necessary software on the NetWorker server.

How to Start the Windows 2000 Performance Monitor

To start the Windows 2000 Performance monitor on the NetWorker server:

1. Select Start>Programs>Administrative Tools>Performance.

2. Right-click anywhere in the System Monitor details pane and select Properties.

3. In the General tab, select Report.

   Note: The default viewing mode of Performance Monitor is Graph, but the Performance Monitor-related tasks in this chapter use the Report mode.

4. To open the Add Counters dialog box, select the Data tab and click Add.

5. To make sure the local computer is the one that is monitored, select Use Local Computer Counters.

6. From the Performance Object list, select the NetWorker server component to be tracked by the Performance monitor.

   The Object choice selected determines which Counter and Instance choices are available.

7. From the Counter list box, select a choice. Click Explain to view descriptions of each counter.

8. From the Instances list box, select a choice.

9. When all choices are selected, click Add.

10. Click Close.

    The Performance Monitor window displays the NetWorker server and component to be monitored.

11. Repeat steps 4-10 for each component on the NetWorker server whose performance you want to test.

    Performance Object window lists each component separately under the name of the NetWorker server.

12. Once all the NetWorker server components to be tested have been added, click OK.

13. Start a backup, and view or capture the results.

To save the performance monitoring information in log form, select Performance Logs and Alerts in the Performance window.

5

To test the maximum performance of the NetWorker software:

1. Shut down all extraneous processes.

2. Run just the necessary software on the NetWorker server.

Testing a NetWorker Server from Another Computer

Because the Performance Monitor uses system resources, you might want to run the Performance Monitor on a different Windows computer on the network during controlled tests of the NetWorker server.

When the Performance Monitor is run on a different Windows system, it still uses some resources on the NetWorker system, especially adding to network traffic during remote backups. However, the performance of the processor and SCSI throughput on the NetWorker system are not affected.

How to Test a NetWorker Server from Another Windows NT Computer

To test the performance of one or more NetWorker servers from another Windows NT computer:

1. Select Start>Programs>Administrative Tools>Performance Monitor on the monitoring Windows NT computer.

2. From the View menu, select Report.

3. From the Edit menu, select Add To Report.

4. Enter the name of the NetWorker server to be tested in the Computer text box, either by entering the name directly or by clicking the "..." button that allows you to browse to the appropriate NetWorker server.

5. From the Object list, select a choice. The Object choice selected determines which Counter and Instance choices are available.

6. From the Counter list box, select a choice. Click Explain to view descriptions of each counter.

7. From the Instances list box, select a choice.

8. When all choices are selected, click Add.

   The Performance Monitor window displays the NetWorker server and components to be monitored.

9. Repeat steps 5-8 for each component on the NetWorker server to be tested.

   The Performance Monitor window lists each component separately under the NetWorker server name.

5

10. Repeat steps 4-8 if you want to monitor the performance of any other NetWorker servers (or any other Windows NT computers in general).

11. When you have added all the NetWorker server components to be tested, click Done.

12. Start a backup, and view or capture the results.

You can save, add to, and redirect the performance monitoring information that results from this procedure. For more detailed information about the Performance Monitor and Windows NT, refer to the Microsoft Windows NT operating system documentation.

How to Test a NetWorker Server from Another Windows 2000 Computer

To test the performance of one or more NetWorker servers from another Windows 2000 computer:

1. Select Start>Programs>Administrative Tools>Performance.

2. Right-click anywhere in the System Monitor details pane and select Properties.

3. In the General tab, select Report.

   Note: The default viewing mode of Performance Monitor is Graph, but the Performance Monitor-related tasks in this chapter use the Report mode.

4. To open the Add Counters dialog box, select the Data tab and click Add.

5. Select Counters from Computer and type in the name of the NetWorker server.

6. From the Object list, select an object. The Object choice selected determines the Counter and Instance choices that are available.

7. From the Counter list box, select a choice. Click Explain to view descriptions of each counter.

8. From the Instances list box, select a choice.

9. When all choices are selected, click Add.

10. Click Close.

   The Performance Monitor window displays the NetWorker server and the component to be monitored.

5

11. Repeat Steps 6-10 for each component on the NetWorker server to be tested.

    The Performance Monitor window lists each component separately under the NetWorker server.

12. Repeat Steps 5-10 if you want to monitor the performance of any other NetWorker servers (or any other Windows 2000 computer in general).

13. When you have completed adding all the NetWorker server components to be tested, click OK.

14. Start a backup, and view or capture the results.

You can save, add to, and redirect the performance monitoring information that results from this procedure. For more detailed information about the Performance Monitor and Windows 2000, refer to the Microsoft Windows 2000 operating system documentation.

Physical Disk

This section describes how to use Performance Monitor to test and evaluate physical disk performance problems related to the NetWorker server. For a general discussion of disk-related performance problems and solutions, see "Physical Disks" on page 33.

How to Test Disk Performance for Windows NT

5

To test the disk performance of the NetWorker server in the Windows NT environment:

1. Select Start>Programs>Administrative Tools>Performance Monitor.

2. From the View menu, select Report.

3. From the Edit menu, select Add To Report.

4. From the Object list, select Physical Disk.

5. From the Counter list box, select the following counters:

    – % Disk Time
    – Current Disk Queue Length

    To view details on each counter, click Explain.

    If the NetWorker server has more than one physical disk, select these counters for each disk.

6. When all choices are selected, click Add.

    The Performance Monitor window reflects the NetWorker server and the component whose performance you want to monitor.

7. Click Done.

8. Start a backup, and view or capture the results.

Note: If the disk performance counters do not work, you must set Windows NT to turn them on. Open an MS-DOS window and enter the following command at the prompt:

```
diskperf -y
```

Restart the NetWorker server to activate the counters.

How to Test Disk Performance for Windows 2000

To test the disk performance of the NetWorker server in a Windows 2000 environment:

1. Select Start>Programs>Administrative Tools>Performance.

2. Right-click anywhere in the System Monitor details pane and select Properties.

3. In the General tab, select Report.

4. To open the Add Counters dialog box, select the Data tab and click Add.

5. From the Object list, select Physical Disk.

6. From the Counter list box, select the following counters:

    –   % Disk Time
    –   Current Disk Queue Length

    To view details on each counter, click Explain.

    If the NetWorker server has more than one physical disk, select these counters for each disk.

7. When all choices are selected, click Add.

8. Click Close.

    The Performance Monitor window displays the NetWorker server and the component to be monitored.

5

9. Click OK.

10. Start a backup, and view or capture the results.

Note: If the disk performance counters do not work, open a command prompt window and enter the following command:

```
diskperf -y
```

Restart the NetWorker server to activate the counters.

Disk Performance Evaluation Methods

To determine if the NetWorker server has a disk-related blockage, check the values gathered from the performance testing.

*   If the value for the Percent Disk Time counter exceeds 90 percent, tune the disk performance as suggested in "Disk Tuning Methods" on page 72.

    This counter measures the percentage of operating time the disk is occupied with read or write requests.

*   If the value for the Disk Queue Length counter exceeds 2, tune the disk performance as suggested in "Disk Tuning Methods" on page 72.

    This counter measures the average number of read or write requests that were waiting to be serviced during the sampling interval.

Disk Tuning Methods

5

The methods for tuning disk performance on the NetWorker server in a Windows environment are the same for tuning computer disks in general, including:

*   Defragment files to reduce the number of disk seeks.
*   Use larger files or fewer files to reduce the number of disk seeks.
*   Change to a faster SCSI adapter, with synchronous I/O support and bus mastering.
*   Use stripe sets on multiple disks to accommodate large files and databases, so the physical disks can work in parallel to read data.
*   Spread disk-intensive programs onto different servers.
*   Purchase disks with higher transfer rates.

Memory

This section describes how to use the Performance Monitor to test and evaluate memory-related performance problems related to the NetWorker server. For a general discussion of memory-related performance problems and solutions, see "Memory Usage" on page 39.

How to Test Memory Performance for Windows NT

To test the memory-related performance of the NetWorker server in a Windows NT environment:

1. Select Start>Programs>Administrative Tools>Performance Monitor.

2. From the View menu, select Report.

3. From the Edit menu, select Add To Report.

4. From the Object list, select Memory.

5. From the Counter list box, select the following counters:

   – Available Bytes
   – Commit Limit
   – Committed Bytes
   – Pages/sec

   To view details on each counter, click Explain.

6. When all choices are selected, click Add.

   The Performance Monitor window displays the NetWorker server and the component to be monitored.

7. Click Done.

8. Start a backup, and view or capture the results.

To analyze the results of these tests, see "Memory Performance Evaluation Methods" on page 75.

5

How to Test Memory Performance on Windows 2000

To test the memory-related performance of the NetWorker server in a Windows 2000 environment:

1. Select Start>Programs>Administrative Tools>Performance.

2. Right-click anywhere in the System Monitor details pane and select Properties.

3. In the General tab, select Report.

4. To open the Add Counters dialog box, select the Data tab and click Add.

5. From the Object list, select Memory.

6. From the Counter list box, select the following counters:

   – Available Bytes
   – Commit Limit
   – Committed Bytes
   – Pages/sec

   To view details on each counter, click Explain.

7. When all choices are selected, click Add.

8. Click Close.

   The Performance Monitor window displays the NetWorker server and the component to be monitored.

9. Click OK.

10. Start a backup, and view or capture the results.

To analyze the results of these tests, see "Memory Performance Evaluation Methods" on page 75.

5

Memory Performance Evaluation Methods

Use the values gathered from the performance testing to determine if the NetWorker server has a memory-related blockage. Table 12 on page 75 lists the counters and which values indicate that tuning is required.

Table 12. Counter Values

Counter	Values
Available Bytes	This counter measures how much memory is not already occupied. The smaller the value of Available Bytes, the slower the performance. If the value is less than 4 MB, the memory performance requires tuning.
Pages/sec	This counter measures virtual memory activity; that is, how often the memory writes to disk. When the computer is memory-bound, it pages to the virtual memory on disk more often. A value of 20 or greater indicates that tuning is required.
Committed Bytes	This counter is the total memory of all applications in use at the moment. Applications generally reserve more memory than they use during regular operation. But an application does not write data to memory without committing the memory first. So the value for Committed Bytes shows the amount of memory the applications currently need.
	If more memory is committed than you have physical memory to accommodate, the computer pages memory contents to disk (virtual memory), and the computer works more slowly, because physical memory is faster than virtual memory.
Commit Limit	This counter is the size of virtual memory that can be committed without having to extend the paging file. Every time the Windows computer extends the paging file, it goes to disk and searches for more space to use for virtual memory. This process has a high performance cost, and you might run out of disk space. The Committed Bytes value should not consistently exceed the Commit Limit value.

5

Tuning Memory Performance in Windows

The following section explains how to tune memory performance on the NetWorker server.

Note: To determine a good baseline size for the virtual memory file (*pagefile.sys*), log the Committed Bytes counter over a period of time, add 10 to 20 percent to the maximum value, and enter that value in the Initial Size (MB) text box in the Virtual Memory dialog box.

How to Adjust the Virtual Memory for Windows NT

To adjust the allocated size of virtual memory on the NetWorker server in a Windows NT environment:

1. Select Start>Settings>Control Panel.

2. Double-click the System icon, then click the Performance tab.

3. To open the Virtual Memory dialog box, click Change.

4. As needed, adjust the size and location of the disk space allocated to virtual memory.

5. Click OK.

How to Adjust the Virtual Memory for Windows 2000

5

To adjust the allocated size of virtual memory on the NetWorker server in a Windows 2000 environment:

1. Select Start>Settings>Control Panel.

2. Double-click the System icon to open the System Properties dialog box.

3. Select the Advanced tab and click Performance Options.

4. In the Performance Options window, click Change to open the Virtual Memory dialog box.

5. As needed, adjust the size and location of the disk space allocated to virtual memory.

6. Click OK.

How to Adjust the Physical Memory Allocation for Windows NT

To adjust physical memory allocation on the NetWorker server in the Windows NT environment:

1. Select Start>Settings>Control Panel.

2. Double-click the Network icon, then click the Services tab.

3. From the Network Services list box, select Server.

4. To open the Server dialog box, click Properties.

5. Select one of the following options:

   – Minimize Memory Used: Use when the server has fewer than 10 users, such as a local backup on a NetWorker server.

   – Balance: Use when the server has 10 to 64 users.

   – Maximize Throughput for File Sharing: Allocate most of the memory to the fileserver module, for systems with more than 64 users.

   – Maximize Throughput for Network Application: Use for a client-server application server, such as a NetWorker server with remote clients.

6. Click OK.

How to Adjust the Physical Memory Allocation for Windows 2000

To adjust physical memory allocation on the NetWorker server in a Windows 2000 environment:

1. Select Start>Settings>Control Panel.

2. Double-click the Network and Dial-Up Connections icon.

3. Right-click Local Area Connection and select Properties.

4. In the Local Area Connection Properties dialog box, select File and Printer Sharing for Microsoft Networks and click Properties.

5. Select one of the following options:

   – Minimize Memory Used: Use when the server has fewer than 10 users, such as a local backup on a NetWorker server.

   – Balance: Use when the server has 10 to 64 users.

   – Maximize Throughput for File Sharing: Allocate most of the memory to the fileserver module, for systems with more than 64 users.

5

      – Maximize Throughput for Network Application: Use for a client-server application server, such as a NetWorker server with remote clients.

6. Click OK.

Memory-Related Server Tuning Methods

To speed up virtual memory, you can implement the disk recommendations in "Disk Tuning Methods" on page 72. You can also defragment the disks where *pagefile.sys* resides.

Note: It is *not* recommended to put *pagefile.sys* on either of the following:

- A stripe set, because virtual memory is less efficient when it is fragmented.
- A mirrored drive, because every write is done twice, which slows down writes to virtual memory.

You can also reduce the memory that the NetWorker server uses. Suggestions to reduce memory requirements include the following:

- Reduce the number of other applications that run on the NetWorker server. Dedicate the NetWorker server to run the database server, NetWorker client, NetWorker Module client, and NetWorker server.
- Stop services that you do not use. For example, if you have only SCSI devices, stop the ATDISK service, which is for IDE devices only.
- Remove communications protocols you do not use. For example, if you only use TCP/IP but you also have SPX installed, remove SPX.

5

CPU

The following sections address testing and tuning issues for the NetWorker server CPU(s). For a general discussion of how CPU issues affect NetWorker software performance, see "CPU Usage" on page 39.

Testing CPU Performance

Total CPU utilization and CPU utilization for each individual process demonstrate the CPU performance of the NetWorker server.

How to Test Total CPU Utilization on Windows NT

To test total CPU utilization of the NetWorker server during backup in a Windows NT environment:

1. Select Start>Programs>Administrative Tools>Performance Monitor.

2. From the View menu, select Report.

3. From the Edit menu, select Add To Report.

4. From the Object list, select Processor.

5. From the Counter list box, select % Processor Time. Click Explain to view details on this counter.

6. Select the processors to be tested from the Instance list box if the NetWorker server has more than one processor.

7. When all choices are selected, click Add.

   The Performance Monitor window displays the NetWorker server and the component to be monitored. Click Done.

8. Start a backup, and view or capture the results.

How to Test Total CPU Utilization on Windows 2000

To test total CPU utilization of the NetWorker server in a Windows 2000 environment during backup:

1. Select Start>Programs>Administrative Tools>Performance.

2. Right-click anywhere in the System Monitor details pane and select Properties.

3. In the General tab, select Report.

5

4. Select the Data tab and click Add.

5. From the Object list, select Processor.

6. From the Counter list box, select % Processor Time. Click Explain to view details on this counter.

7. Select the processors to be tested from the Instance list box if the NetWorker server has more than one processor.

8. When all choices are selected, click Add.

9. Click Close.

   The Performance Monitor window displays the NetWorker server and the component to be monitored.

10. Click OK.

11. Start a backup, and view or capture the results.

How to Test CPU Performance by Process for Windows NT

You can also test CPU utilization for each process involved in the backup, to determine which processes use most of the CPU capacity.

To test total CPU utilization of the NetWorker server in a Windows NT environment during backup:

1. Select Start>Programs>Administrative Tools>Performance Monitor.

2. From the View menu, select Report.

3. From the Edit menu, select Add To Report.

4. From the Object list, select Process.

5. From the Counter list box, select the % Processor Time. Click Explain to view details on this counter.

6. Select the individual services, programs, or other processes to be tested from the Instance list box.

7. When all choices are selected, click Add.

   The Performance Monitor window displays the NetWorker server and the component to be monitored.

8. Click Done.

9. Start a backup, and view or capture the results.

There is a CPU blockage if total CPU utilization remains above 90% for long periods during the backup process.

How to Test CPU Performance by Process for Windows 2000

You can also test CPU utilization for each process involved in the backup, to determine which processes use most of the CPU capacity.

To test total CPU utilization of the NetWorker server in a Windows 2000 environment during backup:

1. Select Start>Programs>Administrative Tools>Performance.

2. Right-click anywhere in the System Monitor details pane and select Properties.

3. In the General tab, select Report.

4. Select the Data tab and click Add.

5. From the Object list, select Process.

6. From the Counter list box, select the % Processor Time. Click Explain to view details on this counter.

7. From the Instance list box, select the individual services, programs, or other processes to be tested.

8. When all choices are selected, click Add.

9. Click Close.

   The Performance Monitor window displays the NetWorker server and the component to be monitored.

10. Click OK.

11. Start a backup, and view or capture the results.

There is a CPU blockage if total CPU utilization remains above 90% for long periods during the backup process.

5

Server Input/Output

The following sections address testing and tuning issues for the NetWorker server input/output (I/O). For a general discussion of how I/O issues affect NetWorker software performance, see "Server Input/Output" on page 40.

To test the I/O of the NetWorker server most effectively, you must start and configure the Performance Monitor, and then run specific NetWorker server I/O-related tests. For more information about these tests, see " Server Input/Output" on page 40.

How to Test Input/Output Performance on Windows NT

To start and configure the Performance Monitor to test the NetWorker server I/O in a Windows NT environment:

1. Select Start>Programs>Administrative Tools>Performance Monitor.

2. From the View menu, select Report.

3. From the Edit menu, select Add To Report.

4. From the Object list, select System.

5. From the Counter list box, select File Write Bytes/sec. Click Explain to view details on this counter.

6. When all choices are selected, click Add.

   The Performance Monitor window displays the NetWorker server and the component to be monitored.

7. Click Done.

8. Run the following tests, and view or capture the results:

   – For the **uasm** program: See "Disk Read Speed Testing Methods" on page 33.

   – For the **mt** program: See "Testing Tape Device Performance without Running NetWorker" on page 45.

   – For the **bigasm** program: See "Test Device Performance with bigasm" on page 48.

How to Test Input/Output Performance on Windows 2000

To start and configure the Performance Monitor to test the NetWorker server I/O in a Windows 2000 environment:

1. Select Start>Programs>Administrative Tools>Performance.

2. Right-click anywhere in the System Monitor details pane and select Properties.

3. In the General tab, select Report.

4. Select the Data tab and click Add.

5. From the Object list, select System.

6. From the Counter list box, select File Write Bytes/sec. Click Explain to view details on this counter.

7. When all choices are selected, click Add.

8. Click Close.

   The Performance Monitor window displays the NetWorker server and the component to be monitored.

9. Click OK.

10. Run the following tests, and view or capture the results:

    – For the **uasm** program: See "Disk Read Speed Testing Methods" on page 33.
    – For the **mt** program: See "Testing Tape Device Performance without Running NetWorker" on page 45.
    – For the **bigasm** program: See "Test Device Performance with bigasm" on page 48.

Tuning Input/Output Performance

The rate at which a SCSI device can write data to media is limited by the amount of data that transfers over the SCSI bus in a single I/O operation. To tune SCSI performance, change the number of memory pages the SCSI host bus adapter (HBA) can scatter and/or gather in a single direct memory access (DMA). The number of bytes that can be transferred in a single I/O with a SCSI device is limited by the number of memory pages that the SCSI host bus adapter can scatter and/or gather in a single DMA.

5

The SCSI driver of each vendor specifies the maximum number of pages that the HBA can scatter and/or gather for the DMA transfer. When you multiply the page size by the number of scatter and/or gather entries, the product is the effective limit to the number of bytes that can be transmitted in a single I/O operation.

The equation is the following:

I/O operation size = Page size * (# of scatter/gather entries -1)

User memory is not necessarily page-aligned; therefore:

If MaximumSGList = 255 then the I/O transfer size is 4K * 254 = 1016K.

For the drivers of some SCSI host adapters, you can change the maximum number of scatter and/or gather pages. Many tape drives and disk drives perform better with a larger I/O limit. A change in the number of scatter and/or gather pages can make a large performance difference. For example:

- The Ampex DST tape drive writes only 3 MB per second with 64 KB SCSI transfers and 20 MB per second with 992 KB SCSI transfers.
- The SCSI disk "CYBERNET 10XP" reads 1.7 MB per second with a 32 KB read buffer size and 17 MB per second with a 200 KB read buffer size.

To change the maximum scatter and/or gather pages setting in the Windows Registry, add the following new Registry subkey to specify the maximum number of scatter and/or gather list elements for each device on a given bus:

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\ DriverName\Parameters\Device *number*\MaximumSGList

5

⚠

Important: Modifying the Registry is very dangerous. Do *not* attempt to modify the Registry unless you have an up-to-date backup of the Registry to which you can revert and you are convinced that the modification you are about to make is correct. Inappropriate changes to the Registry can result in the need to reinstall the Windows software.

How to Add a Subkey Entry to the Windows Registry

To add the subkey entry to the Windows Registry:

1. Start the Windows Registry Editor program as follows:

    a. Select Start>Run.

    b. Enter the following value in the Open text box:

        regedt32

    c. Press [Enter].

    Note: You can also open this program at the following location:

    %SystemRoot%\Winnt\System32\regedt32.exe

2. Select Window>HKEY_LOCAL_MACHINE to make that window active.

3. Select Edit>Add Key and enter Parameters for Key Name to create a key named Parameters, if one does not exist.

4. To create a key named Device, open the Parameters key by selecting Edit>Add Key and enter Device for Key Name.

5. To create a DWORD named MaximumSGList, open the Device key by selecting Edit>DWORD and entering MaximumSGList for DWORD Name.

6. Open the MaximumSGList Value Name and replace the existing Value Data in Decimal with a number at least as large as the block size you need for the device.

    To calculate the value, use the following equation:

    (Block_Size / 4) + 1 = Value

    Table 13 on page 85 provides block size and corresponding decimal and hex values.

5

Table 13. Block Sizes

Block Size	Decimal Value	Hex Value
64k	17 decimal	11 hex
96k	25 decimal	19 hex
128k	33 decimal	21 hex
256k	65 decimal	41 hex
512k	129 decimal	81 hex

7. Reboot the machine.

8. To locate the drives, run the **inquire** program:

   `C:\>`**inquire**

   Results similar to the following appear:

   ```
   scsidev@0.5.0:NEC CD-ROM DRIVE:4661.06|CD-ROM
   scsidev@0.6.0:ARCHIVE Python 06408-XXX8071|Tape,
   \\.\Tape0
   scsidev@1.0.0:HP C5173-7000 3.02|Autochanger (Jukebox)
   scsidev@1.2.0:QUANTUM DLT7000 1732|Tape, \\.\Tape1
   scsidev@1.3.0:QUANTUM DLT7000 1732|Tape, \\.\Tape2
   scsidev@2.0.0:SEAGATE ST39204LC 0002|Disk,
   \\.\PHYSICALDRIVE0
   scsidev@2.1.0:QUANTUM ATLAS V  9 SCA  0201|Disk,
   \\.\PHYSICALDRIVE1
   scsidev@2.6.0:DELL 1x4 U2W SCSI BP 5.35|Processor
   ```

9. To check if the maximum blocksize has changed, run the **mt** program:

   `C:\>`**mt -f \\.\Tape1 status**

   Results similar to the following appear:

   ```
   \\.\Tape1:
   Media Capacity  = 15.20GByte
   Media Remaining = 13.60GByte
   Media Blocksize = 0
   Media Partition Count = 0
   Media is not write protected
   default blocksize = 65536
   maximum blocksize = 131072
   minimum blocksize = 1
   MaximumPartitionCount = 0
   Partition = 0
   Logical block position = 44815
   EOTWarningZoneSize = 0
   CompressionEnabled
   Features: ...
   ```

   In the above example, the maximum block size is 128 KB (131072 divided by 1024).

5

Other suggestions for tuning I/O performance are as follows:

- Move the hardware configuration around; for example, move some disks off a SCSI bus that is overloaded.
- If possible, use PCI adapters in the NetWorker server. If you must use other adapters, EISA adapters are better than ISA adapters, because ISA adapters have bus contention problems that degrade system performance.
- Use a dual PCI backplane system, rather than a bridged PCI backplane.
- Use multiple SCSI buses with devices of the same type (for example, UltraSCSI) on the same bus.
- Use short, high-quality cables with active terminators.
- Ensure that SCSI communications are occurring synchronously, not asynchronously.

Devices

The following sections address testing and tuning issues for the NetWorker backup devices within the Windows environment. For a general discussion of how device issues affect NetWorker software performance, see "Backup Devices" on page 44.

How to Test Device Performance

To test device input/output, see the **bigasm** program test described in "How to Test Device Performance with bigasm" on page 48.

5

Tuning Device Performance

Most tape drives come with hardware data compression enabled by default. When compression is enabled, device performance and media capacity can double.

Hardware data compression is controlled by the NSR_NO_HW_COMPRESS environment variable. When you set this environment variable to Yes, data is *not* compressed by the hardware before it is written to media.

Notes:

- For data that is already compressed before it reaches the device, additional compression might increase the size of the data. If the data comes to the device already compressed, you can disable compression on the storage device.
- When you change the name of an existing variable, Windows NT treats it as a new variable and does *not* overwrite or delete original variable.

How to Tune Device Performance on Windows NT

To tune the hardware compression system variable on a Windows NT computer:

1. Select Start>Settings>Control Panel.

2. Double-click the System icon and click the Environment tab.

3. Review the variables and values listed in the System Variables list box. Depending on whether the NSR_NO_HW_COMPRESS variable already exists or not, follow the appropriate step:

   – If the NSR_NO_HW_COMPRESS variable is already listed, and you simply want to change its value, select it. The variable name and its value appear in the Variable and Value text boxes.

      a. Change its value to Yes.

      b. Click Set to confirm the change.

   The updated value of the NSR_NO_HW_COMPRESS variable is reflected in the System Variables list box.

   – If the NSR_NO_HW_COMPRESS variable is not listed, you need to create it.

      a. Select any variable so that its name and value are displayed in the Variable and Value text boxes.

      b. Change the existing variable name to NSR_NO_HW_COMPRESS.

      c. Enter the value yes.

      d. Click Set to confirm the new variable.

   The new variable and its value are reflected in the System Variables list box, and the original one you selected remains unchanged.

4. Click OK when you have completed adding or modifying the NSR_NO_HW_COMPRESS variable and/or its value.

5. Restart the NetWorker server.

5

To see the device compression setting, enter the following at the command line:

```
mt -f \\.\Tape0 stat
```

In the output of a device with compression enabled, the following appears:

```
Compress Enabled
```

How to Tune Device Performance on Windows 2000

To tune the hardware compression system variable:

1. Select Start>Settings>Control Panel.

2. Double-click the System icon.

3. Select the Advanced tab and click Environment Variables.

4. Review the variables and values listed in the System Variables list box. Depending on whether the NSR_NO_HW_COMPRESS variable already exists or not, follow the appropriate step:

   – If the NSR_NO_HW_COMPRESS variable is already listed, and you simply want to change its value, select it. The variable name and its value appear in the Variable and Value text boxes.

      a. Change its value to Yes.

      b. Click OK to confirm the change.

      The updated value of the NSR_NO_HW_COMPRESS variable is reflected in the System Variables list box.

   – If the NSR_NO_HW_COMPRESS variable is not listed, you need to create it.

      a. Click New.

      b. Enter the variable name NSR_NO_HW_COMPRESS

      c. Enter the value Yes.

      d. Click OK.

5. When you have completed adding or modifying the NSR_NO_HW_COMPRESS variable and/or its value, click OK.

6. Restart the NetWorker server.

5

To see the device compression setting, enter the following on the command line:

```
mt -f \\.\Tape0 stat
```

In the output of a device with compression enabled, the following appears:

```
Compress Enabled
```

Windows Software

The following variables affect the overall Windows operating system performance and the speed of backup:

- Filesystem overhead

  Filesystem input/output (I/O) can degrade I/O performance. If you integrate logical volume managers with the filesystem, you can increase disk performance and add a host of other features to improve manageability of large filesystems. Also, depending on the level of RAID (Redundant Array of Independent Disks) you implement, RAID can improve or adversely affect backup performance.

- Server memory usage setting

  You can set server memory use to be optimized for the following:
  - Small number of clients
  - Large number of clients
  - Fileserver
  - Domain controller

  For more information, see "Memory Performance Evaluation Methods" on page 75.

- Page file size

  You can adjust the size and location of the virtual memory file (*pagefile.sys*) on the local disks. For more information, see "Memory Performance Evaluation Methods" on page 75.

5

Recoveries

Recovery performance can fluctuate based on a variety of issues, including network traffic, bottlenecks, and file sizes. One method of recovering data efficiently is to start multiple **recover** commands simultaneously through the save set recovery method.

For example, you can start three different save set recover programs instead of one save set recover program with three save sets. Separate recover programs provide the maximum parallelism possible given the number of daemons and the actual volume and save set layout.

Important: If multiple, simultaneous **recover** programs are being run from the same tape, do not let the tape mount and start until all recoveries are ready. If the tape is used before all recoveries are ready, the tape will be read through multiple times and recovery performance will be slower, rather than faster.

How to Perform Multiple, Simultaneous Recoveries

To perform multiple recoveries:

1. Open one NetWorker User program for each save set that needs to be recovered.

2. In each window, select the save set to be recovered, but do not start the recovery process.

3. Once all three save sets have been selected in their respective window, execute each recovery consecutively.

4. Measure the time it takes to recover all three save sets.

5. Once the recoveries are finished, perform another recovery with all three save sets in the same recover request.

6. Compare the time needed for the multiple recover requests to the time needed for the single recover request.

The multiple recoveries should have finished *before* the single recovery of multiple save sets. If the single recovery completed faster, the tape may have been mounted before all recoveries could start or the computer is CPU-bound rather than I/O-bound. To determine the cause of the bottlenecks, use the performance and activity monitoring tools available with the operating system.

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Appendix A: Troubleshooting

RPC Error Messages

When trying to connect to the NetWorker server, you may encounter the following error messages:

```
Error: 'save: RPC error: Remote system error'
Error: 'save: Cannot open save session'
```

Problem

When under stress, the current RPC implementation can only handle a small burst of connection requests. The server services only one connection request each time it goes through the select() loop. When the server is busy serving other connections, it takes more time to do one select() loop, and the server services a lower number of connection requests per second.

For example, there are 10 clients calling the service, and each client takes 10ms to service. It takes 200ms to go around the select loop, and it can only service 10 connection requests per second.

In some customer environments, over 400 clients could be attempting to connect to the same server over a short period of time. If the server is under stress and can only handle 10 connection request per second, it will not be able to handle the burst of 400 connection requests. The server can only queue up twenty requests. The connection requests that are not queued up may attempt to retry, or they may fail with multiple RPC errors.

Solution

To avoid this problem, increase the SOMAXCONN parameter, a kernel parameter that governs the maximum number of unaccepted socket connections that can be waiting in queue. It is also referred to as the listen() queue limit. When NetWorker (NSRD) starts, it requests a listen() queue of 200. Ensure that the value for SOMAXCONN is set to 200 or higher. This parameter must be set before NSRD starts.

The following are examples of setting the SOMAXCONN parameter on various platforms:

- For Solaris, enter the following commands:

    /usr/sbin/ndd -set /dev/tcp tcp_conn_req_max_q 1024

    where the q queue holds sockets awaiting an accept() call.

    /usr/sbin/ndd -set /dev/tcp tcp_conn_req_max_q0 2048

    where the q0 queue contains half-open sockets.

- For Tru64 UNIX:

    a. Enter the following command:

       /sbin/sysconfig -r socket sominconn=65535

       The value of **sominconn** determines how many simultaneous incoming SYN packets can be handled by the system.

    b. **/sbin/sysconfig -r socket somaxconn=65535**

       The value of **somaxconn** sets the maximum number of pending TCP connections.

- For HP-UX, enter the following commands:

    /usr/sbin/ndd -set /dev/tcp tcp_syn_rcvd_max 1024

    /usr/sbin/ndd -set /dev/tcp tcp_conn_request_max 200

- For Linux, enter the following command to increase the size of the socket queue (effectively, q0):

    /sbin/sysctl -w net.ipv4.tcp_max_syn_backlog=1280

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Troubleshooting Target Sessions

The Target Sessions attribute sets the number of backup sessions accepted by an active device. The Target Sessions attribute is configured in the Device resource, and a different value can be specified for each device.

If the Target Session value is set too high, the performance of the backup does not always improve. For example, suppose the Parallelism attribute is set to 16, which means the NetWorker server can handle up to 16 streams of data from the NetWorker clients. If the Target Session attribute for each device is set to 16, then each device can also handle 16 streams. In this case, the 16 data streams from the clients may be sent to the same device, since each device can handle 16 streams. No benefit is gained by using the Target Sessions attribute.

To optimize device usage, set the Target Session attribute to less than the Parallelism attribute so more than one device is selected for multiple backup streams.

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Glossary

This glossary contains terms and definitions related to this manual. Most of the terms are specific to Legato NetWorker products.

1-9	Intermediate backup levels. Each number represents a backup level. Lower levels back up more files.
Administrators group	Windows NT user group whose members have all the rights and abilities of users in other groups, plus the ability to create and manage all the users and groups in the domain. Only members of the Administrators group can modify Windows NT OS files, maintain the built-in groups, and grant additional rights to groups.
annotation	A comment that you associate with an archive save set, to help identify that data later on. Annotations are stored in the media index for ease of searching and are limited to 1024 characters.
Application-Specific Module (ASM)	A program that, when used in a directive, specifies the way a set of files or directories is to be backed up and recovered.
archive	The process by which NetWorker backs up directories or files to an archive volume and then optionally deletes them to free up disk space.
archive clone pool	A volume pool composed exclusively of archive clone save sets.
archive pool	A volume pool composed exclusively of archive save sets.

archive volume	A tape or other storage medium used for NetWorker archives, as opposed to a backup volume.
ASM	See *Application-Specific Module (ASM)*.
autochanger	A mechanism that uses a robotic arm to move media among various components located in a device including slots, media drives, media access ports, and transports. Autochangers automate media loading and mounting functions during backups and recovers.
Backup Operators group	A Windows NT group whose members have the capability of logging on to a domain from a workstation or a server, backing it up, and restoring the data. Backup Operators also can shut down servers or workstations.
backup volume	Backup media, such as magnetic tape or optical disk.
bootstrap	Information that includes the server index, media index, and configuration files needed for recovering NetWorker after a disk crash.
browse policy	The policy that determines how long entries for the files remain in the online file index.
carousel	A tray or tape cartridge that holds multiple backup volumes.
client	A computer that accesses the NetWorker server to back up or recover files. Clients may be workstations, PCs, or fileservers.
clone	The process by which NetWorker makes an exact copy of saved data (save sets). NetWorker can clone individual save sets or the entire contents of a backup volume.
clone volume	A duplicated volume. NetWorker can track four types of volumes: backup, archive, backup clone, and archive clone. Save sets of different types may not be intermixed on one volume.
command line	The shell prompt, where you enter commands.

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compressasm	A NetWorker directive used for compressing and decompressing files.
device	The backup device (tape drive, optical drive, or autochanger) connected to the NetWorker server; used for backing up and recovering client files.
directive	An instruction directing NetWorker to take special actions on a given set of files.
enabler codes	Special codes provided by Legato that allow you to run the NetWorker software product.
file index	A database of information maintained by NetWorker that tracks every file or filesystem backed up.
fileserver	A computer with disks that provides services to other computers on the network.
filesystem	1. A file tree on a specific disk partition or other mount point. 2. The entire set of all files. 3. A method of storing files.
full (f)	A backup level in which all files are backed up, regardless of when they last changed.
grooming	The process of removing files after a successful archive.
group	A client or group of clients that starts backing up its files at a designated time.
heterogeneous networks	Networks with systems of different platforms that interact meaningfully across the network.
himt	A choice in the Devices window; represents half-inch magnetic tape.
incremental (i)	A backup level in which only files that have changed since the last backup are backed up.
interoperability	The ability of software and hardware on multiple computers from multiple vendors to communicate meaningfully.

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level (1-9)	A backup level that backs up files that have changed since the last backup of any lower level.
media	Magnetic tape or optical disks used to back up files.
media index	A database of information maintained by NetWorker that tracks every backup volume.
media manager	The NetWorker component that tracks save sets to backup volumes.
NetWorker	A Legato network-based software product to back up and recover filesystems.
NetWorker client	A computer that can access the backup and recover services from a NetWorker server.
NetWorker server	The computer on a network running the NetWorker software, containing the online indexes and providing backup and recover services to the clients on the same network.
notice	A response to a NetWorker event.
nsrhost	The logical *hostname* of the computer that is the NetWorker server.
online indexes	The databases located on the server that contain all the information pertaining to the client backups and backup volumes.
operator	The person who monitors the server status, loads backup volumes into the server devices, and otherwise executes day-to-day tasks using NetWorker.
override	A backup level that takes place instead of the scheduled one.
pathname	Instructions for accessing a file. An *absolute pathname* tells you how to find a file beginning at the root directory and working down the directory tree. A *relative pathname* tells you how to find the file starting where you are now.

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preconfigured	Existing selections or configurations for different NetWorker features.
print	Send data to a printer.
qic	A choice in the Devices window; represents quarter-inch cartridge tape.
recover	The NetWorker command used to browse the server index and to recover files from a backup volume to a clients disk.
recycle	A volume whose data has passed both its browse and retention policies and is available for relabeling.
Registry	A database of configuration information central to Windows NT operations. The overall effect centralizes all Windows NT settings and provides security and control over system, security, and user account settings.
retention policy	A NetWorker policy that determines how long entries will be retained in the media database and thus be recoverable.
retrieval	The process of locating and copying back files and directories that NetWorker has archived.
save	The NetWorker command that backs up client files to backup volumes and makes data entries in the online index.
save set	A set of files or a filesystem backed up onto backup media using NetWorker.
save set ID	An internal identification number assigned to a save set by NetWorker.
scanner	The NetWorker command used to read a backup volume when the online indexes are no longer available.
server	The computer on a network running the NetWorker software, containing the online indexes and providing backup and recover services to the clients on a network.
shell prompt	A cue for input in a shell window where you enter a command.

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skip (s)	A backup level in which files are skipped and not backed up.
stand-alone device	A backup device that contains a single drive for backing up data. Stand-alone devices cannot store or automatically load backup volumes.
system administrator	The person normally responsible for installing, configuring, and maintaining NetWorker.
user	A person who can use NetWorker from his or her workstation to back up and recover files.
volume	Backup media, such as magnetic tape or optical disk.
volume ID	The internal identification assigned to a backup volume by NetWorker.
volume name	The name you assign to a backup volume when it is labeled.
volume pool	A feature that allows you to sort backup data to selected volumes. A volume pool contains a collection of backup volumes to which specific data has been backed up.

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