Legato NetWorker®
Power Edition™

Performance Tuning Guide

All Platforms

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Preface

The *Legato NetWorker® Power Edition™ Performance Tuning Guide* tells you how to configure and maximize the performance of NetWorker Power Edition software.

This guide also discusses the enhancements in the Power Edition product and shows you how to configure and measure the performance of your NetWorker system. Use this guide in conjunction with your NetWorker documentation, which is included in Adobe PDF format on the NetWorker product CD.

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 might also find this manual useful.

About This Guide

To use the information presented in this guide, you must install the NetWorker software on your server and NetWorker client software on your client machines. If the software is not installed, refer to your platform's *Installation Guide* for installation instructions.

Legato Product Manuals and Documentation

Legato offers an extensive archive of product documentation at our web site (*www.legato.com*). You can search the archive by *part number*, *title*, *publication date*, *version*, or *OS/platform*. Most of the documents are in Portable Document Format (PDF) that you can easily view by downloading Adobe Acrobat Reader, which is also available from our web site. To access the archive, select *Document Library* from our home page, then make your selection from the Legato *Product Manuals and Documentation* search choices.

Conventions

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

- **boldface** – Indicates DOS or UNIX line commands. For example:

  Run the **jbconfig** command to add and configure the autochanger.

- *italic* – Indicates directory pathnames, files, machine names, new terms defined in the Glossary or chapter, and words or ideas that require emphasis. For example:

  Rename the original *\nsr\res* directory to *\nsr\res.orig*.

- `fixed-width` – Represents examples and information displayed on the screen. For example:

  ```
  media waiting: recover waiting for 8mm 5GB tape
  volume name
  ```

- Pull-down_menu>Command>Command – Depicts a path or an order to follow for making selections in the GUI. For example:

  Volume>Change Mode>Appendable

- **`fixed-width, boldface`** – Represents commands and text you type exactly as shown. For example:

  % **`dkinfo sd0a`**

- ***`fixed-width, boldface italic`*** – Represents commands and text that is replaced with user-defined text. For example:

  C:\win32app\nsr\bin **`scanner -B \\.\`*`Tape0`***

- 

  Important: Important information and cautionary notes that prevent you from making a mistake.

Year 2000 Compliance

NetWorkerPower Edition supports dates in the year 2000 and beyond. For additional information and details about related test cases, see the Year 2000 Compliance (Y2K) section on the Legato web site at *www. legato.com*.

Information and Services

Table 1 provides a list of Legato's services, including electronic, telephone, and fax support that provide company, product, and technical information.

Table 1. Legato Services and Resources

Legato Service or Resource	Technical Bulletins	Binary Patches	Company & Product Information	Training Programs
www.legato.com	Yes	Yes	Yes	Yes
ftp.legato.com, Internet address 137.69.200.1 (log in as *anonymous*)	Yes	Yes		
Legato Inside Sales, (408) 530-3000 or *sales@legato.com*			Yes	
Legato Education Services, (650) 812-6096 or *training@legato.com*				Yes
Note: For detailed information about our services, support policies, and software subscriptions, please refer to the *Legato Customer Service and Support Guide* included in the media package.				

Technical Support

Table 2 provides a list of Legato's sources available to fulfill your technical support needs.

Table 2. Legato Technical Support Services

Technical Support Service	Address
Hotline	(650) 812-6100
e-mail	*support@legato.com*
Tech Dialog (requires password)	*www.legato.com/tech_dialog*

Customer Service

Table 3 lists the Legato customer services resources available to you. Contact Legato Customer Service if you have questions about licensing, registering, or authorizing your Legato products. Customer Service also supplies instructions for transferring licenses to a different server (rehosting) and provides status on product orders.

Table 3. Legato Customer Services

Customer Service	Address
telephone number	(650) 812-6000 (option 3)
fax number	(650) 812-6220
e-mail	*service@legato.com*
e-mail for order status	*orderadmin@legato.com*

Customer Feedback

Legato welcomes your comments and suggestions about software features, disaster recovery procedures, and documentation. Please send any suggestions and comments to *feedback@legato.com*. You will receive a notice confirming receipt of your e-mail. Although we cannot respond personally to every request, we consider all your comments and suggestions during product design.

Chapter 1: Power Edition Features

Legato NetWorker is an enhanced NetWorker server product for Windows NT and UNIX operating systems. It is optimized for high-speed backup and recover operations on large amounts of complex data.

Power Edition Advantages

Power Edition addresses the storage management and data protection needs of enterprises that have high-performance database servers and file servers. To protect very large database (VLDB) applications, online transaction processing (OLTP) applications, data warehouses, and web servers, the backup software has to work quickly, often while the data and application are online and available to other users.

Power Edition takes advantage of the high throughput of the leading enterprise-class tape devices. Performance is scaled linearly as additional fast storage devices are added to the system, up to the limit of the server's I/O bandwidth.

In order to allow the server to maintain high data transfer rates, Power Edition uses a minimum of the processor capacity. In benchmarking tests, Power Edition rarely uses more than 15 percent of the CPU capacity during backup.

Performance Enhancements in Power Edition

The major performance enhancements of Power Edition include:

- Immediate save and recover

  When you back up data from the Power Edition server or storage node, this automatic feature speeds up data transfer. CPU load is reduced because data is transferred within memory. Power Edition enables local backup and recover to bypass the CPU overhead of networking protocols.

- Storage nodes

  A Power Edition server can have several storage nodes attached, each with multiple devices, enabling the transmission of up to a maximum of 512 parallel backup sessions with a maximum of 256 devices. Because Power Edition storage nodes store data locally and maintain all of the metadata associated with the controlling Power Edition server, backup speed and efficiency is enhanced. You can use immediate save and immediate recover to back up and recover data hosted on a storage node.

- High-speed device support

  Power Edition supports a broad range of autochangers and silo tape library models. Autochangers and silos can contain multiple storage devices (tape drives or optical drives). They also can automate the tasks of loading, unloading, and labeling storage media, so backups can proceed without your intervention. High-speed devices are configured for higher throughput, so they can write data to media faster, in larger blocks.

- File device type and save set staging

  Support for the file device type enables backup to disk. Save set staging enables automated transfer of data from one medium to another according to user-defined policies.

- Remote procedure call (RPC) enhancements

  Power Edition includes improvements to RPC, the communications between processes, to improve the efficiency of both local and remote backup and recover operations.

Power Edition reduces the time it takes to back up data locally, because the data and the Power Edition server are hosted on the same computer. Data does not have to travel through a protocol, such as TCP/IP, before it is directed to a storage device. Instead, data is transferred within memory on the server. Thus, network throughput is eliminated as a potential blockage. The same is true for recover operations.

When you back up data from remote clients, the data travels over the network through a protocol, such as TCP/IP. Enhancements to RPC and high-speed devices improve the performance of both remote and local backups.

Architecture Shared with the NetWorker Base Product

The Power Edition server, like the NetWorker server, schedules backup of data and automates the process so that you do not have to change media or start the backup procedure manually. You can create schedules that back up your data at times when it is least used, for instance, at night or on weekends.

The Power Edition server also maintains records of the data backed up by the Power Edition server and its storage nodes, to make recover operations easier. In client file indexes, the server records the filename of each piece of data. In the media database, the server records the contents of each media volume. Browse policies and retention policies determine how long these records are kept. Backups you make on a Power Edition server or storage node can be read by a NetWorker server, and vice versa.

Power Edition also supports the file device type, for backup to disk, as well as save set staging, which enables automated transfer of data from one medium to another according to policies you define.

Because these functions are the same for Power Edition as for the NetWorker base product, refer to your platform's *Administrator's Guide* for more information about the scheduling, media management, and index management features of the NetWorker product line.

Overview of Performance

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

This guide provides tests you can use to measure and maximize the performance of your computer. When you find 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 backup and recover performance.

Hardware performance is limited by the lowest data rate of the following computer components and related performance factors:

- Server speed
  - CPU
  - Memory
  - Input/output (I/O) bandwidth
  - SCSI bandwidth
  - Number of ports
- Device speed (combined for all storage devices used concurrently)
  - I/O transfer rate
  - Built-in compression and initialization characteristics

If you back up clients over a network, the following hardware performance factors can also affect performance:

- Client speeds (combined for all clients active at a point in time)
  - CPU
  - Memory
  - Disk speed
- Network speed
  - Network I/O bandwidth
  - Network path
  - Network load

Software performance factors include:

- Filesystem performance
- Application-specific optimization
- Backup application (for example, Power Edition)

Chapter 2: Power Edition Configuration

This chapter provides the details on the features and functionality unique to the Power Edition version of NetWorker, including details on how Power Edition works.

Power Edition Configuration

Power Edition is a specialized NetWorker server, so the configurations you implement for Power Edition are somewhat different than for the NetWorker server. This section describes immediate save and recovery, a special feature of Power Edition. It also provides examples and illustrations that describe configuration considerations that are specific to Power Edition.

How Immediate Save and Recover Works

During a backup session on a Power Edition server or storage node, Power Edition can recognize whether the data resides on the same computer or a remote computer. When the data resides on the same computer, immediate saves and immediate recovers are invoked automatically. Instead of transferring data across the network, data is transferred within memory on the Power Edition server or storage node.

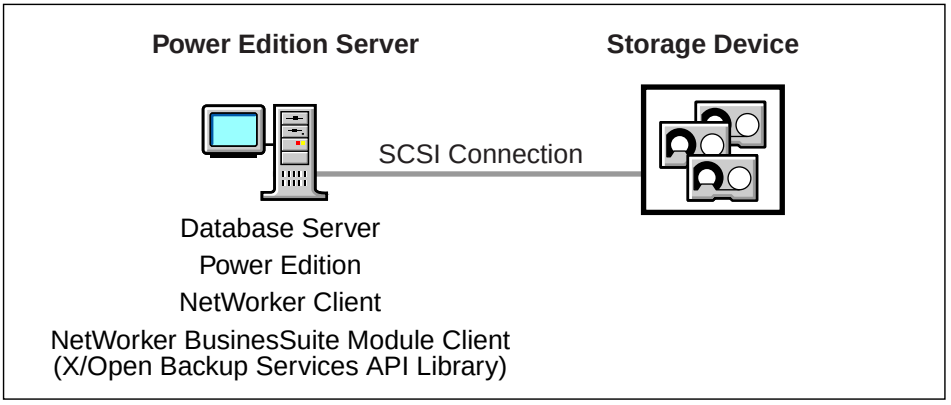
Immediate saves and recovers are available only in the case of local data transfer, where the data and the Power Edition server or storage node are hosted on the same computer. If the data is on a remote client, the data is transferred over the network using TCP/IP.

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

Power Edition Local Backup and Recover

When one computer includes both client and server or storage node software, with storage devices attached, the data is backed up using immediate save. Figure 1 shows an example of local backup of a Power Edition server. Power Edition can back up data of any type supported by a NetWorker client, including a range of databases.

Figure 1. Local Backup and Recover



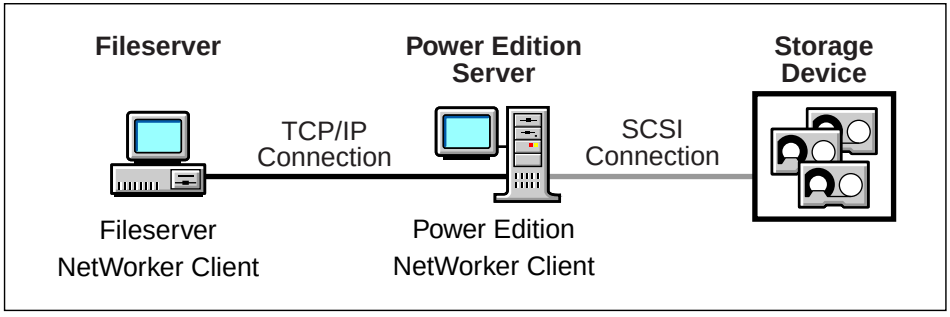
Backup is faster in this setup for Power Edition than for the NetWorker base product, because Power Edition can use the immediate save technology. Processes and data that travel through a protocol stack in a standard NetWorker setup are instead passed in memory on the same computer. The network transmission blockage is eliminated. The same is true for recover operations.

If the database is offline, any database can take advantage of immediate save for local backup with a NetWorker client. Some NetWorker BusinesSuite Module clients can also take advantage of immediate save for online database backups. Refer to the documentation you received with your BusinesSuite Module to determine whether immediate save for online backup is currently supported.

Power Edition Backup and Recover of Remote Client Data

Figure 2 shows an example of the Power Edition server installed on a different computer than the data. To back up data from a fileserver of a particular platform, the NetWorker client for that platform is installed on the fileserver computer. The Power Edition server software and a NetWorker client (to back up data that resides on the Power Edition server itself) are installed on the Power Edition server.

Figure 2. Remote Backup and Recover



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 recover request, the data is again transferred across the network.

Backup and recover performance over the network is enhanced for the Power Edition server compared to standard NetWorker servers, because of RPC enhancements that keep slower clients from slowing down the backup of faster clients. Data that resides on the Power Edition server is automatically backed up using immediate save (or automatically recovered using immediate recover).

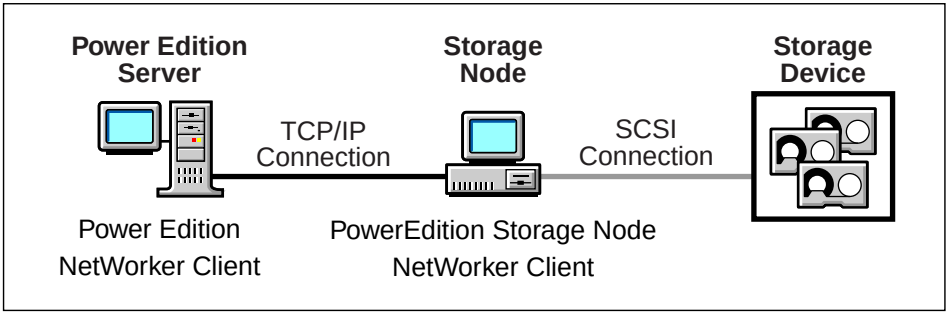
If the data is backed up to a high-speed device, performance is improved because the device can transfer data faster and write data in larger blocks.

Power Edition Storage Nodes

Figure 3 shows an example of a Power Edition server using a storage node for backup and recover operations. Data hosted on each Power Edition storage node is backed up and recovered using immediate save and immediate recover technology. The metadata associated with backups is transferred over the network to the controlling Power Edition server, and the data is transferred directly to devices attached to the storage node.

Power Edition storage nodes enable you to design scalable configurations, since multiple devices can be attached to multiple storage nodes, and data transfer operations can run in parallel.

Figure 3. Power Edition Storage Node Backup and Recover

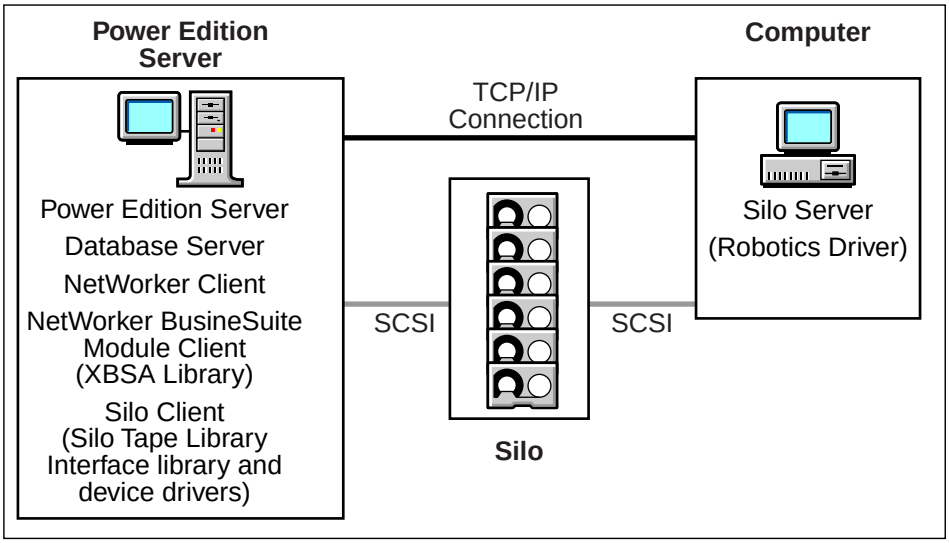


Power Edition Local Backup to a Silo

When you add a silo (specialized high-speed storage device) to the local backup scenario, performance increases 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 4, a silo and its silo server are added to a Power Edition local backup and recover configuration.

Figure 4. Local Backup to a Silo



During backup, immediate save is invoked to transfer data from the NetWorker client processes to the Power Edition server processes in the memory of the Power Edition server computer. If the data is written to a device in a silo, the **nsrmmd** service initiates an 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 Power Edition server to the device.

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

For more information about silos and how they interact with Power Edition, see your NetWorker *Administrator's Guide*.

How NetWorker Power Edition Works

Because Power Edition is a NetWorker server product, it shares a similar architecture with the NetWorker base product. This section provides an overview of how the NetWorker products perform backup and recover operations.

All NetWorker servers consist of services and programs that oversee the backup and recover processes and 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 using the RPC (remote procedure call) protocol.

NetWorker Services and Programs

The services and programs in the NetWorker software coordinate the tasks associated with a backup or recover operation, record information about what was backed up, and track the media that contains the backed-up data.

Services and Programs on the NetWorker Server

This section describes the services and programs on the NetWorker server, which contact the client for a backup and maintain the client file indexes and media database on the server.

Table 4 lists these services and programs.

Table 4. Services and Programs on the Server

Service/ 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.
asavegrp	This service monitors the progress of individual save sets. This is an agent process invoked by the **savegrp** program.
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.
nsrd	This service provides an RPC-based **save** and **recover** program function to NetWorker clients. This is the master NetWorker service.

Table 4. Services and Programs on the Server (Continued)

Service/ Program	Function
nsrim	This service automatically manages the server's 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.

The NetWorker master service, **nsrd**:

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

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 service, **ansrd**, starts on the NetWorker server to monitor the progress of the backup session.

Table 5 describes the services and programs on the NetWorker client.

Table 5. Services and Programs on the Client

Service/ Program	Function
nsrexecd	This service authenticates the NetWorker server's remote execution request and executes the **save** and **savefs** commands on the client.
recover	This program browses the NetWorker server's 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 and media database by **nsrindexd**.
savefs	This program sends information about the save sets to back up for the client and identifies save set data modified since the previous level save.

How NetWorker 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 server's **savegrp** program for the backup group at the scheduled time.

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

- 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

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 Clients 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's client file indexes. Then, **nsrd** starts the **nsrindexd** client file index insertion service.

The **savegrp** program contacts the first client on the server's work list. The client's **nsrexecd** is invoked and starts a **save** session of the first save set listed on the server's work list. The **save** program passes to **nsrd** all save criteria, 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 media service, **nsrmmd**:

- 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's 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's configuration, to utilize the backup devices to their maximum potential.

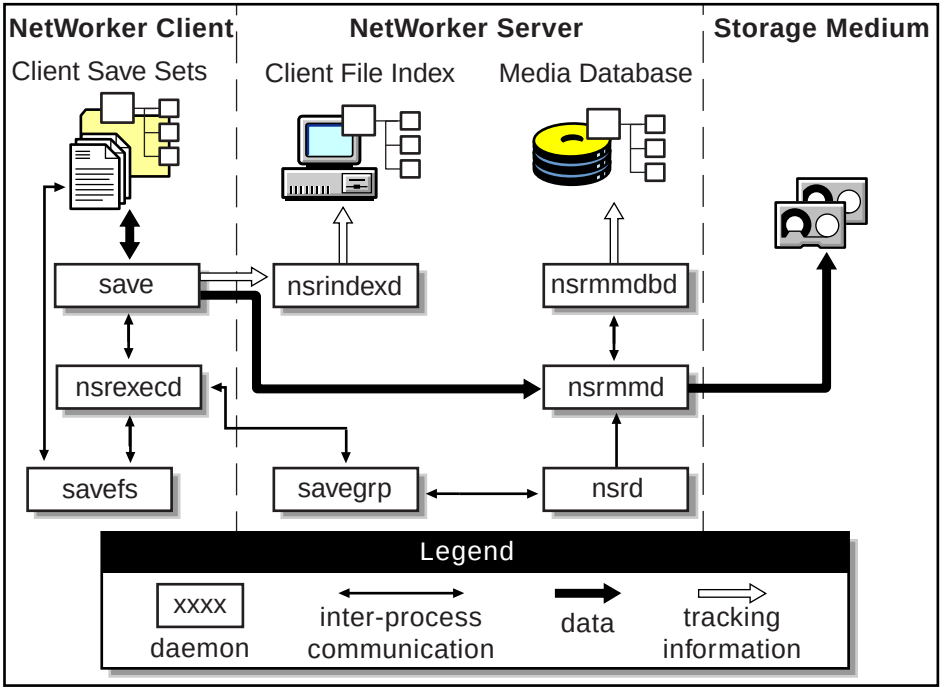
The **savegrp** program repeats the process for each item on the server's work list until all clients in the group are backed up. Before the **savegrp** program finishes, if the NetWorker server is part of the group backing up or the server is not part of any enabled group, the NetWorker server's bootstrap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

If you have set up the bootstrap notification and you have 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. Keep the bootstrap printout in a safe place in case you need to restore the NetWorker server.

On Windows NT systems, the final results of the **savegrp** execution are returned to the server and appended to the *\nsr\logs\savegrp.log* file. On UNIX systems, the results are appended to the */nsr/logs/savegrp.log* file.

Figure 5 shows how all of the NetWorker client and server services and programs interact during a scheduled save.

Figure 5. How NetWorker Services and Programs Interact During a Scheduled Backup

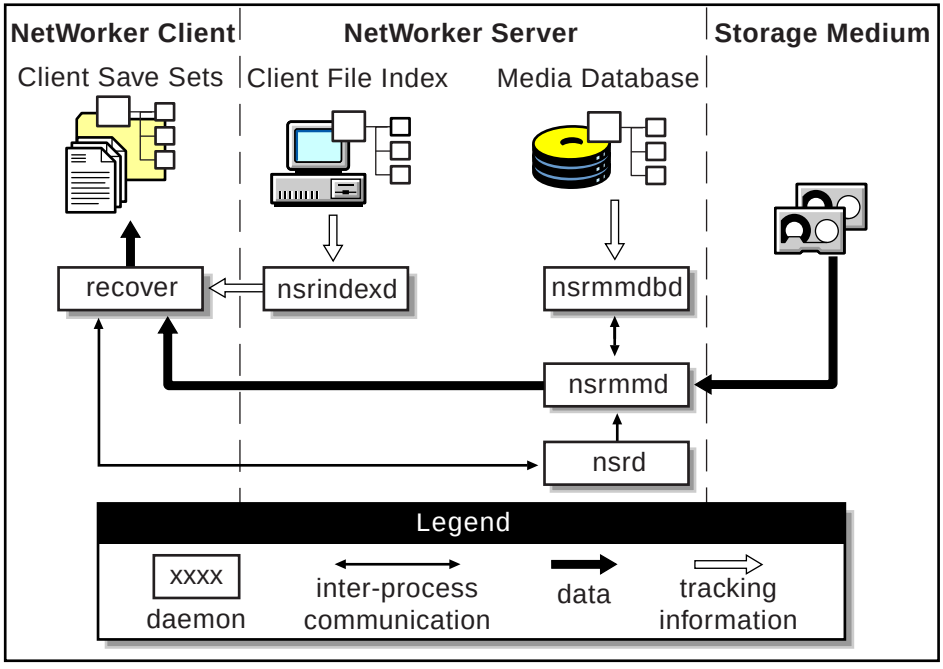


How NetWorker Recovers Data

When NetWorker receives a **recover** request from a client, the server's **nsrd** master service contacts the server's **nsrmmd** media service. The **nsrmmd** service contacts the server's **nsrmmdbd** media database service to determine which media contain the save set requested by the **recover** program. After **nsrmmd** finds the save set on 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 client's **recover** program, which restores the data to the client's filesystem.

Figure 6 shows how the NetWorker server and client services and programs interact while recovering data to a NetWorker client.

Figure 6. How NetWorker Services and Programs Interact During a Recover Session



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 very poorly or not at all, the cause can be traced to a single problem. If your 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 your data storage management environment, discusses their impact on storage management tasks, and provides general guidelines for locating problems and solutions. The two subsequent chapters address specific performance tests and fixes, particularly those that pertain to the specific operating system on which you are using Power Edition.

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 Power Edition in your environment, you must decide how controlled a test to run.

To run a controlled test, turn off all extraneous processes to isolate the performance of Power Edition. The results of this type of test show you the optimal performance of Power Edition with your 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 Power Edition performs while the computer is running other programs and processes.

If you run both a controlled test and a test with normal or simulated load, the difference between the results can help you decide how to schedule your backups and whether to run other programs on your Power Edition server.

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

1. Measure the current performance of Power Edition 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 Power Edition 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.

Meeting Minimum System Requirements

Before installing and using Power Edition or other storage management products, read the minimum system requirements to ensure you have sufficient computer and network hardware installed to support the application.

System requirement information is usually located in your NetWorker installation documentation. Failing to meet the system requirements, particularly for memory, free space, and CPU speed, will have an obvious and immediate negative impact on your storage management processes.

Server Hardware

The following sections address different hardware components of the Power Edition server, including providing tests on improving 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 for maintaining the client file indexes and media database. Problems with the disks can negatively affect every level of performance within your storage management environment.

The type of data you back up and how it is laid out on disk can cause backup performance to vary. If you have large files that are fragmented, or if you have many small files, the disk performance suffers because the disk head has to move to go from one fragment or file to another. Backup 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 your disks:

- Test the read speed of each individual disk, without NetWorker running.
- Test the read speed of all disks, without NetWorker running.
- Test the read speed of each individual disk, while NetWorker is running.
- Test the read speed of all disks, while NetWorker is running.

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

The syntax is as follows:

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

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

uasm -c [-nv] *path*

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

uasm -s *filename* > NUL

The **uasm** module 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** module has three modes: save, recover, and compare.

- In save mode, **uasm** walks directory trees and generates a save stream on its **stdout** representing the files and organization of the directory tree. Symbolic links are never followed by application specific modules (ASMs), except **rawasm**.
- In recover mode, **uasm** reads a save stream from its **stdin** and creates the corresponding directories and files.
- In compare mode, **uasm** 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 how descendent directories are searched, which files are ignored, how the save stream is generated, and how to process subsequent directive files.

All ASMs accept the options described below. These options are generally referred to as the "standard asm arguments." ASMs can also have additional options. A particular ASM's additional options are in capital letters.

Either **-s** (save), **-r** (recover) or **-c** (compare) mode must be specified and must precede any other options. When saving, at least one path argument must be specified. The path argument can be either a directory or a filename.

Options Valid for All Modes of uasm

- Use the **-n** option to perform a dry run. When saving, walk 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 actually create any directories or files when recovering or do the work of comparing the actual file data.
- Use the **-v** option to turn on verbose mode. The current ASM, its arguments, and the file it is processing are displayed. When a filtering ASM operating in filtering mode (that is, processing another ASM's save stream) modifies the stream, its name, arguments, and the current file are displayed within square brackets.

Options for Save Mode

- Use the **-b** option to produce a byte count. This option is like the **-n** option, but byte count mode estimates the amount of data to be produced, instead of actually reading file data, so 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.
- Use the **-o** option to produce an "old style" save stream that can be handled by older NetWorker servers.
- Do not specify the **-e** option, because **uasm** does not generate the final "end of save stream" boolean. This option should be used only when an ASM invokes an external ASM and when an optimization chooses not to consume the generated save stream itself.
- Use the **-i** option to ignore all save directives from *.nsr* directive files found in the directory tree.
- Use the **-f** *proto* option to 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.

- Use the **-p** option to specify <<path>> with *ppath*. When you specify **-p** *ppath*, this string is added to the beginning of each file's name as it is output. This argument is used internally when one ASM exec's 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 the current working directory.
- Specify a date with **-t** *date* to set the date after which files must have been modified before they are saved.
- Specify **-x** to cross filesystem boundaries. Normally, filesystem boundaries are not crossed during walking. Symbolic links are never followed, except in the case of **rawasm**.

Options for Recover Mode

- Specify **-i {nNyYrR}** to define the initial default overwrite response option. Only one letter 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.

  Unless otherwise specified with the **- i** option, **n** 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.

  When you specify either **N**, **R**, or **Y**, you are prompted only when NetWorker 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.

  Table 6 lists the overwrite response options and their meanings:

Table 6. Overwrite Response Options

Option	Meaning
n	Do not recover the current file.
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 file's name. If a conflict still exists, NetWorker prompts you again.
R	Automatically renames conflicting files by appending a dot, ".", and a suffix. If a conflicting filename already ends in a "." suffix, NetWorker prompts you to avoid potential auto-rename looping conditions.

- Use the **-m** *src=dst* option to 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=.**).
- Enter **-z** *suffix* to specify the suffix to append when renaming conflicting files. The default suffix is **R**.

Disk Performance Tuning Methods

If you find a performance blockage in your 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

Each backup session requires CPU and memory resources on your Power Edition 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.

A Power Edition 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, running processes, 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 your Power Edition server and storage nodes.

CPU

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

To increase CPU performance and bandwidth, upgrade to a faster CPU or add additional CPUs if your Power Edition server supports multiple processors. You can also shut down other processes during backup time to see if that reduces the processor load and improves backup performance.

Similarly, you should always 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.

Your computer's operating system 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 Power Edition backup are the following:

- NetWorker services
  - **nsrexecd**
  - **nsrd**
  - **nsrmmd**
  - **nsrmmdbd**
  - **nsrindexd**
- **save**, the NetWorker backup program

- Application-specific services, such as for a database server

You can use the Windows NT Performance Monitor to measure and record CPU speed for your NetWorker for Windows NT Power Edition server. See "Test CPU Performance" on page 59.

Server Input/Output

The following performance variables relate to the input/output (I/O) throughput on your Power Edition server:

Input/Output Backplane

On a well-configured Power Edition 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 minimum, Power Edition 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 are:

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

Note, however, the following:

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

Power Edition Settings

Power Edition has several attributes that control the speed and volume of data being backed up. You can adjust these attribute's settings to modify backup levels to attain the best performance on your Power Edition server.

The following sections address the various Power Edition settings in principle. Because these attributes appear in different locations in the Windows NT and UNIX versions of Power Edition, look in the subsequent chapters 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 clients' 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 savestreams to write to a device at the same time. Because this value is not a limit, a device might receive more sessions than the target sessions attribute specifies. The larger the number of sessions you specify for target sessions, the more save sets are multiplexed, or interleaved, onto the same volume.

Some performance testing and evaluation is helpful in deciding whether multiplexing is appropriate for your 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 29.
- Find the maximum rate of each device. Use the **bigasm** test described in "Device Performance While Running NetWorker" on page 41.

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 you multiplex more save groups in this case, backup performance does not improve, and recover performance could slow down.

Immediate Save and Immediate Recover

The Power Edition server selects immediate save technology automatically for local backup and recover operations. There are no settings to adjust for immediate save or immediate recover.

To verify that the immediate save function is working when you expect, run a local backup in debug mode, and look at the output for using immediate save.

For example, on a Windows NT computer named *mars*, you would enter the following command at the prompt:

```
save -D 1 -s mars c:\autoexec.bat
```

The output is would be as follows:

```
save: using `C:\AUTOEXEC.BAT' for `c:\autoexec.bat'
save: ssid 56420 using immediate save to `mars'
asm -s C:\AUTOEXEC.BAT
save: access(C:\nsr\debug\NSR_NTBUFFERED) sets
NT_buffered to 0
asm -s C:\
save: mars.legato.com:C:\AUTOEXEC.BAT size 3 KB, 2
file(s), took   0 min 2 sec
save: C:\AUTOEXEC.BAT 3 KB 00:00:09      2 files
save completion time:  7-24-97  5:25p
```

Power Edition Settings Performance Tuning Methods

Here are some measures related to Power Edition settings that can improve your 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.

- Decrease the server Parallelism and Target Sessions attributes to unload an overworked Power Edition server. With the correct settings, the computer's normal operation should not be interrupted by backups or other Power Edition activities.
- Add more memory to handle a higher parallelism setting.
- 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 the backups finish at about the same time. For instructions on how to change these settings, refer to your *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 Power Edition attempts to assign save sessions to another device.
- To fully use the bandwidth of a high-speed device when you have many slow clients or disks, multiplex the save sets on media. You maximize the performance of your devices when they do not have to start and stop to wait for data.
- To improve recover 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 would be recovered at the same time.

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 your 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.

Backup Devices

Backup devices are used by Power Edition and other storage management products to write backed-up data to the storage media volume, and for reading saved data from the storage media during recoveries. Devices pass data to and from the Power Edition server itself, or 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 device's ability to write, that might indicate a problem with the device's write performance. To be thorough in evaluating your device's performance, follow these testing guidelines:

- Measure the write speed of each individual device, without NetWorker.
- Measure the write speed of all devices, without NetWorker.
- Measure the write speed of each individual device, while NetWorker is running.
- Measure the write speed of all devices, while NetWorker is running.

It is recommended that you evaluate your device performance without NetWorker running first, and then evaluate your devices again with NetWorker running.

Ensure that you use the same tape drives for your tests both when NetWorker is running and when it is not, to ensure consistency in the measurements.

Device Performance Without Running NetWorker

Use the **mt** program to determine device performance when NetWorker is not running. Using the **mt** program allows you to evaluate your device performance without considering the overhead incurred when using NetWorker.

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

The **mt** program comes with NetWorker and is entered at the command line, using the following syntax:

```
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 available commands are listed below:

- **eof, weof**

  Writes *count* end of file (EOF) marks at the current position on the tape.

- **fsf**

  Forward spaces over *count* EOF marks. The tape is positioned on the first block of the file.

- **fsr**

  Forward spaces *count* records.

- **bsf**

  Backspaces over *count* EOF marks. The tape is positioned on the beginning-of-tape side of the EOF mark.

- **bsr**

  Backspaces *count* records.

- **nbsf**

  Backspaces *count* files. The tape is positioned on the first block of the file. This is equivalent to count + 1 **bsf** followed by one **fsf**.

- **asf**

  Absolute space to *count* file number. This is equivalent to a rewind followed by **fsf** count.

For the following commands, *count* is ignored:

- **eom**

  Spaces to the end of recorded media on the tape.This is useful for appending files onto previously written tapes.

- **rewind**

  Rewinds the tape.

- **offline, rewoffl**

  Rewinds the tape and, if appropriate, takes the drive unit offline by unloading the tape.

- **status**

  Prints status information about the tape unit.

- **retension**

  Rewinds the cartridge tape completely, then winds it forward to the end of the reel and back to beginning-of-tape to smooth out tape tension.

- **erase**

  Erases the entire tape.

- **format**

  Formats the tape at a low level.

The **mt** program returns a 0 exit status when the operations were successful, 1 if the command was unrecognized or if **mt** was unable to open the specified tape drive, and 2 if an operation failed.

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

```
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.

Device Performance While Running NetWorker

To measure SCSI throughput and the write speed of a device while NetWorker is running, use the **bigasm** module provided with NetWorker. The **bigasm** module 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 **usam** module. See "Disk Read Speed Testing Methods" on page 29 for a full description of the **uasm** module.

To set up a **bigasm** test, follow these steps:

1. Create a directive file, *nsr.dir*, that contains the following command:

   bigasm -S*size* : *filename*

   For example:

   bigasm -S100M : bigfile

2. Create a file with the name you specified in your directive, for example, *bigfile*, in the same directory as your directive.
3. Back up the file using Power Edition. For example, if your file is called *bigfile* and your Power Edition server is called *jupiter*, enter:

   save -s jupiter bigfile

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 Power Edition, try upgrading your equipment to affect a better transfer rate.

Built-In Compression

Turn on a device's 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 Drives

Add more tape drives or upgrade to higher speed tape devices for increased throughput.

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 NetWorker attempts to assign save sessions to another device.

File Type Device and Staging

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

Use save set staging in conjunction with backups to the file type 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 or the age of the save set. With staging, you can automate transferring older backups from the file type device to a less expensive storage media and free up hard disk space for new backups.

A possible configuration to maximize performance of file type devices would be the following:

1. Create one directory per user, preferably with a mnemonic name matching a client.
2. Create one file type 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 your system to 64 users with Power Edition, 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 NetWorker and all attached storage nodes.

If you back up your data to file type 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, you would have to closely monitor disk usage to avoid running out of space for your backups, and you would either have to move save sets manually or create very short browse and retention policies.

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 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 includes 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.

Network Hardware

If you back up data from remote clients, the routers, network cables, and network interface cards you use affect the performance you get. This section lists the performance variables in network hardware and suggests some basic tuning for networks. The following section address specific network performance areas.

Network Input/Output Bandwidth

The maximum data transfer rate across a network rarely approaches the manufacturer's specification 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 Power Edition and degrades backup performance. As 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 NetWorker server and clients.
- Minimize the number of network components in the data path between the client and server.

Chapter 4: Testing and Tuning on UNIX

This chapter provides additional performance testing and tuning information for your Power Edition server on UNIX. The information provided in this chapter supplements the material on general Power Edition performance issues covered in the previous chapter. See ": Testing and Tuning Basics" on page 27 to familiarize yourself with these general issues before continuing on to this chapter. In some cases, information pertaining to a specific performance issue or tuning method is covered in both chapters. The information here is specifically written for the UNIX environment, and provides UNIX-based examples.

Given the multitude of platform- and network-specific variables that can impact UNIX system performance, it is not possible to discuss them all comprehensively in a single chapter. Instead, the scope of this chapter is limited to the detection and analysis of processes that have an impact on the ability of Power Edition to efficiently perform backups.

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 UNIX utilities.

The information in this chapter assumes that you are familiar with the UNIX system infrastructure, including networking and devices. In addition, you should be familiar with writing UNIX shell scripts and using UNIX utilities such as **tar**.

The scripts in this chapter use standard UNIX utilities. The examples are specific to Solaris, but the scripts can be applied to most UNIX 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 your Power Edition server's physical disks. The UNIX operating system provides 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, without NetWorker running.
- Test the read speed of all disks, without NetWorker running.
- Test the read speed of each individual disk, while NetWorker is running.
- Test the read speed of all disks, while NetWorker is running.

Benchmark Evaluation

The UNIX utility **/bin/time** reports the amount of time required to execute a program, breaking down the total time into three components: real time, user time, and system time. Real time is 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 is the actual time that the computer spent executing code in the user state. System time is the time the computer spent executing UNIX system code on behalf of the user.

For example, the result of running the **/bin/time tar cvf - /space2 > /dev/null** command on a Solaris computer named *passport* 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, follow these steps:

1. Use 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*, *etc.*):

```
/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 NetWorker

To test the read speed of an individual disk using NetWorker, follow these steps:

1. Use the **df** command to display a list of mounted filesystems and their respective sizes.
2. Run the **uasm** command for each disk. For example, on Solaris, enter:

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

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

See "Disk Read Speed Testing Methods" on page 29 for more information on the **uasm** command.

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

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*, *etc.*):

```
/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 your disk, follow these steps:

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

   ```
   % df
   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/sec.

Compare the results of the benchmarks generated from individual disks without NetWorker to the results of individual disks running NetWorker. Then, compare the results of the benchmarks generated from multiple disks without NetWorker to the results of multiple disks running NetWorker.

Devices

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

- Test the write speed of each individual tape drive, without running NetWorker.
- Test the write speed of all tape drives, without running NetWorker.
- Test the write speed of each individual tape drive, while NetWorker is running.
- Test the write speed of all tape drives, while NetWorker is running.

Ensure that you test the same tape drives both when NetWorker is running and when it is not, to ensure consistency in the measurements.

Benchmark Evaluation

Compare the results of the benchmarks generated from individual drives writing data without NetWorker to the results of individual drives writing data when NetWorker is running. Then, compare the results of the benchmarks generated from multiple drives writing data without NetWorker to the results of multiple drives writing data while running NetWorker.

How to Test the Write Speed of a Single Tape Drive

To test the write speed of a single tape drive, run 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 your environment, we use a block size value of 32 for our testing and examples.

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

How to Test the Write Speed of Several Tape Drives

Test the write speed of all the tape drives on your SCSI channel. To streamline this task, create a shell script using the command above. The following is an example of a shell script for a Solaris computer that was created for multiple drives (*0mbn, 1mbn, 2mbn, etc.*):

```
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 &
...
```

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

To test the write speed of a single drive while running NetWorker, follow these steps:

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. Enter the following command at the prompt to create a *.nsr* file with a **bigasm** directive in the empty directory:
      `bigasm -S100M : e`

      This command results in writing a 100 MB file to the tape.
4. Run the following script to determine the baseline:

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

   Note: In the command above, there is a space between */.nsr* and */empty.*

NetWorker 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 NetWorker

To test the write speed of several drives, repeat steps 1-4 in "Test the Write Speed of a Single Drive While Running NetWorker" for every drive on the SCSI channel at the same time.

Chapter 5: Testing and Tuning on Windows NT

This chapter addresses specific performance testing and tuning tasks you can perform on your NetWorker for Windows NT Power Edition server. For a discussion of general performance issues affecting all versions of Power Edition, see "Chapter 3: Testing and Tuning Basics" on page 27.

Windows NT Performance Monitor

Use the Windows NT Performance Monitor program to test system performance. In the Performance Monitor, you can choose which objects (for example, the processor or memory) to watch, which counters to test (for example, available bytes of memory), and how to display the data. The default view of the data is a real-time line chart. However, you can also choose to log the data, format it as a report, or create alerts that warn you when a counter reaches a certain limit.

How to How to Start the Windows NT Performance Monitor

To start the Windows NT Performance Monitor on your NetWorker for Windows NT Power Edition server, follow these steps:

1. Select Start>Programs>Administrative Tools>Performance Monitor to open the Performance Monitor window.
2. Select Report from the View menu.

   The default viewing mode of Performance Monitor is Chart, but the Performance Monitor-related tasks in this chapter use the Report mode.
3. Select Add To Report from the Edit menu to open the Add to Report dialog box.

4. Select what component of your NetWorker for Windows NT Power Edition server you want the Performance Monitor to track from the Object drop-down list. The Object choice you make determines the Counter and Instance choices available to you.
5. Select a choice from the Counter list box. Click Explain to view descriptions of each counter.
6. Select a choice from the Instances list box.
7. Click Add when you complete all your choices. The Performance Monitor window now reflects your Power Edition server and the component whose performance you want to monitor.
8. Repeat Steps 4-7 for each component on the Power Edition server whose performance you want to test. Each component is listed separately under the Power Edition server's name in the Performance Monitor window.
9. Click Done when you have completed adding all the Power Edition server component you want to test.
10. Start a backup and view or capture the results.

You can save the performance monitoring information in log form by placing the Performance Monitor in Log mode and selecting Options from the Log menu.

Later in this chapter you will use the Performance Monitor to test and evaluate specific areas of your NetWorker for Windows NT Power Edition server.

To test the maximum performance of Power Edition, shut down all extraneous processes, and run just the necessary software on your Power Edition server.

How to Test a Power Edition Server from Another Computer

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

When you run the Performance Monitor on a different Windows NT system, the Performance Monitor still uses some resources on the Power Edition system. It especially adds to network traffic during remote backup. But the performance of the processor and SCSI throughput on the Power Edition system are not affected.

To test the performance on one or more Power Edition servers from another Windows NT computer, follow these steps:

1. Select Start>Programs>Administrative Tools>Performance Monitor on the monitoring Windows NT computer to open the Performance Monitor window on that computer.
2. Select Report from the View menu.
3. Select Add To Report from the Edit menu to open the Add to Report dialog box.
4. Enter the name of the Power Edition server you want to test in the Computer text box, either by entering it directly or by clicking the "..." button that allows you to browse to the appropriate Power Edition server.
5. Select a choice from the Object drop-down list. The Object choice you make determines the Counter and Instance choices available to you.
6. Select a choice from the Counter list box. Click Explain to view descriptions of each counter.
7. Select a choice from the Instances list box.
8. Click Add when you complete all your choices. The Performance Monitor window now reflects the Power Edition server and the component whose performance you want to monitor.
9. Repeat Steps 5-8 for each component on the Power Edition server whose performance you want to test. Each component is listed separately under the Power Edition server's name in the Performance Monitor window.
10. Repeat Steps 4-8 if you want to monitor the performance of any other Power Edition servers (or any other Windows NT computers in general).
11. Click Done when you have completed adding all the Power Edition server components you want to test.
12. Start a backup and view or capture the results.

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

Physical Disk

This section describes using the Windows NT Performance Monitor to test and evaluate physical disk performance problems related to your NetWorker for Windows NT Power Edition server. For a general discussion of disk-related performance problems and solutions, see "Physical Disks" on page 28.

How to Test Disk Performance

To test the disk performance of your NetWorker for Windows NT Power Edition server using the Windows NT Performance Monitor, follow these steps:

1. Select Start>Programs>Administrative Tools>Performance Monitor to open the Performance Monitor window.
2. Select Report from the View menu.
3. Select Add To Report from the Edit menu to open the Add to Report dialog box.
4. Select Physical Disk from the Object drop-down list.
5. Select the following counters from the Counter list box:
   - % Disk Time
   - Current Disk Queue Length

   Click Explain to view details on each counter.

   You can select multiple items in the Counter list box by holding down the [Shift] or [Ctrl] key while selecting each item.

   If your Power Edition server has more than one physical disk, select these counters for each disk.
6. Click Add when you complete all your choices. The Performance Monitor window now reflects your Power Edition server and the component whose performance you want to monitor. Click Done.
7. Start a backup and view or capture the results.

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

```
diskperf -y
```

You must restart your Power Edition server after using this command in order to turn on the counters.

Disk Performance Evaluation Methods

Use the values gathered from your performance testing as follows to determine if your Power Edition server has a disk-related blockage.

- If the value for the Percent Disk Time counter exceeds 90 percent:

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

- If the value for the Disk Queue Length counter exceeds 2:

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

Disk Tuning Methods

The methods for tuning disk performance in your NetWorker for Windows NT Power Edition server is the same for tuning computer disks in general, including the following:

- 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 using the Windows NT Performance Monitor to test and evaluate memory-related performance problems related to your NetWorker for Windows NT Power Edition server. For a general discussion of memory-related performance problems and solutions, see "Memory" on page 33.

How to Test Memory Performance

To test the memory-related performance of your Power Edition server, follow these steps:

1. Select Start>Programs>Administrative Tools>Performance Monitor to open the Performance Monitor window.
2. Select Report from the View menu.

3. Select Add To Report from the Edit menu to open the Add to Report dialog box.
4. Select Memory from the Object drop-down list.
5. Select the following counters from the Counter list box:
   - Available Bytes
   - Pages/sec
   - Committed Bytes
   - Commit Limit

   Click Explain to view details on each counter.

   You can select multiple items in the Counters list box by holding down the [Shift] or [Ctrl] key while selecting each item.
6. Click Add when you complete all your choices. The Performance Monitor window now reflects your Power Edition server and the component whose performance you want to monitor. Click Done.
7. Start a backup and view or capture the results.

To learn more about the Windows NT Performance Monitor, see "How to Start the Windows NT Performance Monitor" on page 51.

Memory Performance Evaluation Methods

Use the values gathered from your performance testing as follows to determine if your Power Edition server has a memory-related blockage:

- If the value for Available Bytes is less than 4 MB:

  This counter measures how much memory is not already occupied. The smaller the value of Available Bytes, the slower your performance.
- If the value for Pages/sec is greater than 20:

  This counter measures virtual memory activity; that is, how often the memory writes to disk. When your computer is memory-bound, it pages to the virtual memory on disk more often.
- If the value for Committed Bytes is greater than the amount of physical memory on your computer.

  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, your computer pages memory contents to disk (virtual memory), and your computer works more slowly, because physical memory is faster than virtual memory.

- If the value for Committed Bytes consistently exceeds the value for Commit Limit

  The Commit Limit counter is the size of virtual memory that can be committed without having to extend the paging file. Every time Windows NT 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.

How to Tune Memory Performance in Windows NT

The following section explains how to tune memory performance on your NetWorker for Windows NT Power Edition server.

Virtual Memory

To adjust the allocated size of virtual memory on your Power Edition server, follow these steps:

1. Select Start>Settings>Control Panel to open the Control Panel window.
2. Double-click the System icon to open the System Properties dialog box.
3. Click the Performance tab to make it active.
4. Click Change to open the Virtual Memory dialog box.
5. Change the size and location of the disk space allocated to virtual memory to meet your needs. Click OK.

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.

Physical Memory Allocation

To adjust physical memory allocation on your Power Edition server, follow these steps:

1. Select Start>Settings>Control Panel to open the Control Panel window.
2. Double-click the Network icon to open the Network dialog box.
3. Click the Services tab to make it active.

4. Select Server from the Network Services list box.
5. Click Properties to open the Server dialog box.
6. Select one of the following options:
   - Minimize Memory Used: Use when the server has fewer than 10 users, for example, Power Edition local backup.
   - Balance: Use when the server has 10 to 64 users.
   - Maximize Throughput for File Sharing: Allocate most of the memory to the file server 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.
7. Click OK.

Memory-Related Server Tuning Methods

To speed up virtual memory, you can implement the disk recommendations in "Disk Tuning Methods" on page 55. You can also defragment the disks where *pagefile.sys* resides. It is not recommended to put *pagefile.sys* on a stripe set, because virtual memory is less efficient when it is fragmented. It is also not recommended to put *pagefile.sys* on a mirrored drive, because every write is done twice, which slows down writes to virtual memory.

You can also reduce the memory your Power Edition server uses. Suggestions to reduce memory requirements include the following:

- Reduce the number of other applications that run on the Power Edition server. Dedicate your Power Edition server to run the database server, NetWorker client, BusinesSuite Module client, and Power Edition 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.

CPU

The following sections address testing and tuning issues for your NetWorker for Windows NT Power Edition server CPU(s). For a general discussion of how CPU issues affect Power Edition performance, see "CPU" on page 33.

How to Test CPU Performance

You can determine your NetWorker for Windows NT Power Edition server's CPU performance by total CPU utilization and by CPU utilization for each individual process.

Total CPU Utilization

To test total CPU utilization of your NetWorker for Windows NT Power Edition server during backup, follow these steps:

1. Select Start>Programs>Administrative Tools>Performance Monitor to open the Performance Monitor window.
2. Select Report from the View menu.
3. Select Add To Report from the Edit menu to open the Add to Report dialog box.
4. Select Processor from the Object drop-down list.
5. Select % Processor Time from the Counter list box. Click Explain to view details on this counter.
6. Select the processors you want to test from the Instance list box if your Power Edition server has more than one processor.

   You can select multiple items in the Instance list box by holding down the [Shift] or [Ctrl] key while selecting each item.
7. Click Add when you complete all your choices. The Performance Monitor window now reflects your Power Edition server and the component whose performance you want to monitor. Click Done.
8. Start a backup and view or capture the results.

To learn more about the Windows NT Performance Monitor, see "How to Start the Windows NT Performance Monitor" on page 51.

CPU Performance by Process

You can also test CPU utilization for each process involved in the backup, to determine which processes use most of the CPU capacity. The processes involved in a Power Edition backup are the following:

- NetWorker services
  - **nsrd**: Server process
  - **nsrexecd**: Client process
  - **nsrindexd**: Client file index process
  - **nsrmmd**: Device process
  - **nsrmmdbd**: Media database process
- **save**: The NetWorker backup program
- Application-specific services, such as for a database server

To test total CPU utilization of your NetWorker for Windows NT Power Edition server during backup, follow these steps:

1. Select Start>Programs>Administrative Tools>Performance Monitor to open the Performance Monitor window.
2. Select Report from the View menu.
3. Select Add To Report from the Edit menu to open the Add to Report dialog box.
4. Select Process from the Object drop-down list.
5. Select the % Processor Time from the Counter list box. Click Explain to view details on this counter.
6. Select the individual services, programs, or other processes you want to test from the Instance list box.

   You can select multiple items in the Instance list box by holding down the [Shift] or [Ctrl] key while selecting each item.
7. Click Add when you complete all your choices. The Performance Monitor window now reflects your Power Edition server and the component whose performance you want to monitor. Click Done.
8. Start a backup and view or capture the results.

CPU Performance Evaluation Methods

You know you have a CPU blockage if total CPU utilization remains above 90% for long periods during the backup process.

Server Input/Output

The following sections address testing and tuning issues for theNetWorker for Windows NT Power Edition server input/output (I/O). For a general discussion of how I/O issues affect Power Edition performance, see "Server Input/Output" on page 34.

How to Test Input/Output Performance

To test the I/O of your NetWorker for Windows NT Power Edition server most effectively, you must start and configure the Windows NT Performance Monitor, and then run specific NetWorker I/O-related tests. These tests are detailed in the chapter of this guide covering general performance guidelines.

To start and configure the Windows NT Performance Monitor to test your NetWorker for Windows NT Power Edition server I/O, follow these steps:

1. Select Start>Programs>Administrative Tools>Performance Monitor to open the Performance Monitor window.
2. Select Report from the View menu.
3. Select Add To Report from the Edit menu to open the Add to Report dialog box.
4. Select System from the Object drop-down list.
5. Select File Write Bytes/sec from the Counter list box. Click Explain to view details on this counter.
6. Click Add when you complete all your choices. The Performance Monitor window now reflects your Power Edition server and the component whose performance you want to monitor. Click Done.
7. Run the following tests, and view or capture the results:
   - **uasm**: See "Disk Read Speed Testing Methods" on page 29.
   - **mt**: See "Device Performance Without Running NetWorker" on page 39.
   - **bigasm**: See "Device Performance While Running NetWorker" on page 41.

How to Tune 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/gather in a single direct memory access (DMA). In Windows NT, the number of bytes that can be transferred in a single SCSI I/O is limited by the number of memory pages that the SCSI host bus adapter can scatter/gather in a single DMA.

Each vendor's SCSI driver specifies the maximum number of pages that the HBA can scatter/gather for the DMA transfer. When you multiply the page size by the number of scatter/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/gather pages. Many tape drives and disk drives perform better with a larger I/O limit. A change in the number of scatter/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/gather pages setting in the Windows NT Registry, add the following new Registry subkey to specify the maximum number of scatter/gather list elements for each device on a given bus:

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

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 re-install Windows NT.

To add the subkey entry to the Windows NT Registry, follow these steps:

1. Start the Windows NT Registry Editor program by selecting Start>Run and entering the following value in the Open text box and pressing [Enter]:

   `regedt32`

   You can also open this program at the following location:

   %SystemRoot%\Winnt\System32\regest32.exe

2. Select Window>HKEY_LOCAL_MACHINE to make that window active.
3. Expand the following folders within the directory tree of the HKEY_LOCAL_MACHINE window to display their contents:

   SYSTEM\CurrentControlSet\Services

4. Select the appropriate driver for your SCSI controller; for example, AIC78xx for Adaptec's 294x/394x series.
5. Select Edit>Subkey to open the Add Key dialog box.
6. Enter the name of the miniport driver in the Key Name text box and click OK. The name of the miniport driver now appears as a subkey to the Services folder.
7. Select the newly added miniport driver entry in the HKEY_LOCAL_MACHINE window and repeat Step 6 for each of the following subkey terms in sequence:
   - Parameters
   - Device *number* (where *number* is the bus number assigned at initialization)
   - MaximumSGList

   When completed, these terms form the following path:

   `HKEY_LOCAL_MACHINE\CurrentControlSet\Services\`*`DriveName`*`\Parameters\Device `*`number`*`\MaximumSGList`

   Remember that both "DriveName" and the number for the "Device" entries are variables whose values you must determine.

   If a value is defined for MaximumSGList in this subkey when the device initializes, the SCSI port driver uses MaximumSGList as the initial value for NumberOfPhysicalBreaks. The miniport driver can set NumberOfPhysicalBreaks to a lower value, if appropriate. The maximum value for MaximumSGList is 255, but you should use this adjustment sparingly because scatter/gather lists consume non-paged memory.

8. Restart your Power Edition server.
9. Open an MS-DOS window and enter the following command at the prompt:

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

   Entering this command displays the new value for maximum block size.

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 your Power Edition 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 Power Edition backup devices within the Windows NT environment. For a general discussion of how device issues affect Power Edition performance, see "Backup Devices" on page 38.

How to Test Device Performance

To test device input/output, see the **bigasm** module test described in "How to Test Input/Output Performance" on page 61.

How to Tune 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.

Note: For data that is already compressed before it reaches the device, however, additional compression might actually increase the size of the data. If the data comes to the device already compressed, you might want to disable compression on the storage device.

To tune the hardware compression system variable, follow these steps:

1. Select Start>Settings>Control Panel to open the Control Panel window.
2. Double-click the System icon to open the System Properties dialog box.
3. Select the Environment tab to make it active.
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. Change its value to "yes" and click Set to confirm the change. The NSR_NO_HW_COMPRESS variable's updated value is now reflected in the System Variables list box.
   - If the NSR_NO_HW_COMPRESS variable is not listed, you need to create it. Select any variable so that its name and value are displayed in the Variable and Value text boxes. Change the existing variable name to "NSR_NO_HW_COMPRESS," enter the value "yes," and and click Set to confirm the new variable.

     When you change the name of an existing variable, Windows NT treats it as a new variable and does not overwrite or delete the original variable. The new variable and its value is now reflected in the System Variables list box, and the original one you selected remains unchanged.
5. Click OK when you have completed adding or modifying the NSR_NO_HW_COMPRESS variable and/or its value.
6. Restart your NetWorker for Windows NT Power Edition server.

To see the device compression setting, open an MS-DOS window and enter the following at the prompt:

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

In the output of a device with compression enabled, you see a line that says the following:

```
Compress Enabled
```

Windows NT Software

The following variables affect the overall Windows NT 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 Windows NT server memory use to be optimized for a small number of clients, a large number of clients, a file server, or a domain controller. See "Physical Memory Allocation" on page 57 for more information.

- Page file size

  You can adjust the size and location of the virtual memory file (*pagefile.sys*) on your local disks. See "How to Tune Memory Performance in Windows NT" on page 57 for more information.

Glossary

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

1-9	*See level [1-9].*
active group	A group with its autostart attribute enabled.
Administrators group	A 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 that 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).*
attribute	A property of a resource, shown in the graphical user interface as an entry field, push button, or a list from which you select. *See also resource*.
auto media management	A feature that enables NetWorker to automatically label, mount, and overwrite a volume it considers unlabeled. NetWorker also automatically recycles volumes eligible for reuse.
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. The term "autochanger" refers to a variety of backup devices, including jukebox, carousel, library, near-line storage, datawheel, and autoloader.
backup cycle	The period of time from one level full backup to the next level full backup.
backup group	A group of NetWorker clients that begin their scheduled backups at the same time.

backup levels	Backup settings that determine how much data NetWorker saves during a scheduled or manual backup. The backup levels are: **full** - backs up all files, regardless of whether they have changed. **levels 1-9** - back up files that have changed since the last lower numbered backup level. **incremental (incr)** - backs up only files that have changed since the most recent backup.
backup volume	Backup media, such as magnetic tape or optical disk.
benchmarking	Tests in a controlled environment to measure the performance of a product as it performs specific tasks.
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.
bootstrap	Information that includes the server index, media index, and configuration files needed for recovering NetWorker after a disk crash.
bottleneck	The slowest point in a system, which restricts the system from operating any faster.
browse policy	A policy that determines how long entries for your backup data remain in the client 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.

client file index	A database of information maintained by the NetWorker server that tracks every file or filesystem backed up. The NetWorker server maintains a single client index file for each client computer.
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 interface	An interface with the NetWorker software, based on command text entered from the shell prompt. *See also shell prompt*.
compressasm	A NetWorker directive used for compressing and decompressing files.
database	A collection of related data that can serve multiple purposes and support multiple users.
device	The backup device (tape drive, optical drive, or autochanger) connected to the NetWorker server; used for backing up and recovering client files.
directed recover	A method of recovery that recovers data and re-creates it, either on the machine where the backup originated, or on the machine where the administrator requests the directed recover.
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 your 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 is on a specific disk partition or other mount point (for example, the C: drive). 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 files at a designated time.
heterogeneous network	Networks with systems of different platforms that interact meaningfully across the network.
immediate save	A technology employed in NetWorker that makes the local backup process faster. Data is transferred in memory instead of through a networking protocol.
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 machines from multiple vendors to communicate meaningfully.
level [1-9]	A backup level that backs up files that have changed since the last backup of any lower level.
manual backup	A type of backup that a user requests from the client's **save** program. The user specifies participating files, filesystems, and directories. A manual backup does not generate a bootstrap save set.
media	Magnetic tape or optical disks used to back up files.

media database	A database of information maintained by NetWorker that tracks every backup volume.
media manager	The NetWorker component that tracks save sets to backup volumes.
multiplexing	A NetWorker feature that permits data from more than one save set to be interleaved and then written to one storage volume.
NetWorker	The Legato network-based software product for backing up and recovering 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.
notification	A message generated by the NetWorker server to alert the administrator when the NetWorker server needs attention, for example, to clean a device or mount a tape.
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.

parallelism	A NetWorker feature that enables the NetWorker server to back up save sets from several clients, or many save sets from one client, at the same time. Parallelism is also available during recovers.
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.
performance	The speed and efficiency with which an operation is performed.
pool	A feature that allows the NetWorker administrator to sort backup data to selected volumes. A volume pool contains a collection of backup volumes to which specific data has been backed up.
preconfigured	Existing selections or configurations for different NetWorker features.
print	To 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 recover files from a backup volume to a client's disk.
recovery	A method that recreates an image of the client filesystems and database on the NetWorker server machine.
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.
resource	An entity that describes a NetWorker server state. In the NetWorker administration program, resources are represented as windows or dialog boxes that contain attributes, which you can use to view or set features of NetWorker. *See also attribute*.
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 group	A group of backup clients sharing the same **save** characteristics.
save set	A set of files or a filesystem backed up onto backup media using NetWorker.
save set ID	An internal identification number that NetWorker assigns to a save set.
save set recover	The recovery of specified save sets to the NetWorker server.
save set status	An indication of whether a given save set is restorable, recoverable, or recyclable. The save set status also indicates whether or not the save set has been successfully backed up.
savestream	The data and save set information being written to a storage volume during a backup. A savestream originates from a single save set.

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.
service	A program that is not invoked explicitly, but lies dormant waiting for a specified condition(s) to occur.
shell prompt	A cue for input in a shell window where you enter a command. *See also command line interface*.
silo	A storage peripheral that can hold hundreds or thousands of volumes. Silo volumes are identified by barcodes, not by slot numbers. The robotics in a silo are controlled by silo management software on a silo server machine.
skip (s)	A backup level in which files are skipped and not backed up.
stand-alone device	A storage device that contains a single drive for backing up data.
storage device	The hardware that reads and writes data during backup, recover, or other NetWorker operations.
system administrator	The person normally responsible for installing, configuring, and maintaining NetWorker and the system software.
user	A person who can use NetWorker from his or her workstation to back up and recover files.
versions	The date-stamped collection of available backups for any single file.
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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