TECHNICAL BRIEF

LEGATO NetWorker and BladeStore performance benchmark

Tape and disk backup comparative benchmark

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1 EXECUTIVE SUMMARY

Motivated by the reality that data loss can bring productivity to a standstill, push customers to competitors, cost staggering sums in lost revenue and send IT (information technology) staff scrambling, businesses are now focusing more than ever on the ability to quickly recover data, protect their environments faster and optimize storage resources. Historically, tape-based solutions have been the most economical and predominate method for performing data protection operations. However, disk-based protection is gaining favor due to the advent of economical ATA/IDE arrays and the promise of enhanced performance.

LEGATO provides enterprises with flexible backup and recovery solutions by supporting both tape- and disk-based data protection. At the cornerstone of LEGATO's industry-leading tape- and disk-based solutions is LEGATO NetWorker. NetWorker simplifies, centralizes and automates backup and recovery operations across heterogeneous enterprise environments, which can result in lower downtime costs, less management overhead and greater return on investment (ROI) on storage resources.

LEGATO delivers advanced disk-based data protection via NetWorker and the NetWorker DiskBackup Option (DBO). NetWorker DBO leverages high-capacity, cost-effective storage systems such as the BladeStore Disk Subsystem (a part of the B-Series™ disk system) and the advanced data protection capabilities of NetWorker to deliver:

> Faster data recovery
> Faster backup
> Improved disaster recovery capabilities
> Increased ROI on tape storage.

StorageTek's BladeStore disk system has an intelligent architecture that utilizes the economies of scale inherent in high-capacity ATA (Advanced Technology Attachment) disk drive technology to provide customers with an excellent capacity-centric online solution in a small footprint. The BladeStore disk system delivers high-performance, storage density, ease of use and flexibility advantages over competing ATA-based systems.

The lower price point and performance of disk combined with the unique capabilities of NetWorker make disk a compelling enhancement to traditional tape-based backup and recovery. LEGATO and StorageTek deliver a joint backup-to-disk solution consisting of LEGATO NetWorker, NetWorker DBO and StorageTek's BladeStore. This comprehensive solution can help customers improve backup and recovery performance, reduce downtime costs and lower storage total cost of ownership.

To provide businesses with a point of reference, LEGATO and StorageTek conducted comparative benchmarks measuring the performance of data protection operations using tape compared to StorageTek's BladeStore disk system.

In the environment tested[1], benchmark results show the following:

> Backup of Microsoft Exchange data to the BladeStore disk system was two times faster than to tape
> Recovery of Microsoft Exchange data from StorageTek's BladeStore was 33 percent faster than recovery from tape.

The results of the comparative benchmark validate that disk-based data protection delivers faster recovery and backup compared to tape, while simultaneously facilitating the functionality necessary to optimize tape and storage resources.

2 INTRODUCTION

LEGATO and StorageTek conducted a comparative benchmark for the purpose of measuring the performance of data protection operations involving disk versus tape. This technical white paper provides an overview of the LEGATO and StorageTek products involved, scope of the testing, the results and a competitive overview.

2.1 THE CURRENT PROBLEM

Exponential data growth, rising downtime costs, restricted IT budgets; enterprises are focusing more than ever before on the ability to quickly recover mission-critical data, protect environments faster and achieve greater ROI on tape resources. To attain these goals, two forms of data protection exist: backup to tape and backup to disk.

2.2 MULTI-TIERED SOLUTIONS

Over the past decade, businesses have relied on tape-based backup and recovery as the primary method of data protection. This was in part due to the economical price-point of tape, the value of tape in facilitating disaster recovery and archiving solutions, and its portability. In recent years, the use of disk as a backup and recovery medium has gained significant momentum and acceptance.

2.2.1 LEGATO Systems

LEGATO supports both tape- and disk-based backup and recovery with industry-leading NetWorker. NetWorker protects the critical business data of enterprise customers worldwide by simplifying, centralizing and automating backup and recovery operations across heterogeneous environments. Built upon an open, highly scalable architecture, NetWorker enables corporate, government and educational organizations to standardize on one application to provide thorough, fast and reliable data protection.

NetWorker, in conjunction with the LEGATO NetWorker DiskBackup Option, also delivers a comprehensive, high-performance, disk-based backup and recovery solution. The NetWorker DiskBackup Option (DBO) leverages the high-capacity, cost-effective BladeStore disk system and the advanced data protection capabilities of LEGATO NetWorker to protect vast, growing amounts of data in direct-attached, network-attached and Storage Area Network (SAN) environments in less time, and provide greater ROI on tape resources.

Note[1]: See Section 2.6 of this paper.

2.2.2 BladeStore disk system

StorageTek's BladeStore disk system is built upon an intelligent architecture that utilizes lower cost ATA disk drive technology to provide customers with large storage capacity in a small footprint. A key difference between the BladeStore and other disk-based storage products is that the StorageTek device uses high capacity ATA/IDE disk rather than the more expensive SCSI or Fibre Channel disk drives (which have been traditionally used in enterprise disk systems). BladeStore disk system uses StorageTek's Intelligent BladeStore Architecture to deliver performance, storage density, ease of use and flexibility advantages over competing ATA-based systems.

StorageTek's BladeStore disk system can be configured from 6.25 TB to 150 TB. A 6 U (Unit) chassis contains 10,800 GB Blades for storage density of 12.5 TB. Up to 12 Blade array enclosures can be configured behind one RAID (Redundant Array of Independent Disks) controller. The system has redundant power supplies, fans and hot-swappable components for high availability. Storage management software for configuration, monitoring and storage partitioning is available through BladeStore storage management software or LSI SANtricity Storage Manager software available from StorageTek. The B150 disk array has been designed and developed by StorageTek with seven patents pending.

2.2.3 LEGATO and StorageTek disk backup solution

LEGATO Systems and StorageTek recognize that today's data-intensive organizations are under extreme pressure to improve the manner in which information is recovered and protected, and storage resources utilized. To that end, the two companies have joined forces to leverage respective strengths to provide a robust, cost-effective, disk-based data protection solution. The joint effort translates directly into customer value by delivering faster backup and recovery, and enhancements to the use of tape resources.

2.3 RECOVER DATA FASTER

With NetWorker DBO, data is recovered at the processing speed of the BladeStore disk system and is read in a contiguous manner, enabling users to gain the benefits of protecting clients in parallel without sacrificing recovery performance. Tape mounting and unmounting delays are also eliminated. As a result, NetWorker DBO and StorageTek's BladeStore users may experience significant improvement in recovery time from disk in comparison to tape.

2.4 PROTECT ENVIRONMENTS FASTER

NetWorker DBO users can back up multiple clients simultaneously to DBO devices at the write speeds of the BladeStore disk system. Customers can also specify as many DBO devices as necessary — the equivalent to adding tape drives on demand — further enabling more data to be protected in less time.

2.5 HIGH-SPEED STAGING AND CLONING — SINGLE STEP RECOVERY

To meet disaster recovery and data retention requirements, organizations often mandate removable media and subsequent offsite storage. NetWorker DBO enables companies to protect their environment quickly by first staging backups on the BladeStore disk system, and then moving them automatically to tape based on policies. Data can also remain "Nearline®" on the BladeStore for faster recovery and be automatically cloned to tape for disaster recovery purposes. In either scenario, data is written to tape contiguously and at tape streaming rates.

For enterprises seeking improved staging and cloning performance, NetWorker delivers the perfect solution. Utilizing NetWorker DBO, data can be written to and read from the backup disk simultaneously, enabling faster recoveries and faster completion of staging and cloning operations. Once a saveset has been written to disk, it can be automatically migrated to tape/disk (staging), or copied to tape/disk (cloning), while other savesets are still being backed up. Staging and cloning operations can be completed in a fraction of the time compared to traditional tape backups, as they lag only behind the backup of the last saveset, not the entire save group.

2.5.1 Single-step recovery from tape

When staging or copying to tape, the ability to recover data in a single step is critical to achieving a viable backup-to-disk solution. Because NetWorker's media database always maintains a record of where data resides, restores from disk or tape can be completed in a single step to minimize downtime and costs. Again, data copied to tape via staging or cloning is written in a contiguous, non-multiplexed manner, further enhancing recovery speed.

2.5.2 Lower TCO of tape storage

NetWorker DBO also enables customers to reduce the start-stop and wear and tear on expensive tape drives and cartridges when protecting small amounts of data. By performing incremental backups to disk (e.g. daily) and full backups to tape (e.g. weekends), users can meet enterprise data protection requirements and reduce storage total cost of ownership (TCO). Benchmark details provided later in this document validate the performance viability of the LEGATO/StorageTek solution.

2.6 THE SCOPE OF EFFORT

The following outlines the environment variables and tests performed and illustrates the power of the LEGATO/StorageTek backup-to-disk solution. The scope of the work encompasses performance benchmark testing of LEGATO NetWorker backing up and restoring file system and application data to tape and to disk. LEGATO NetWorker DiskBackup Option was used to back up to disk. The target disk array to host the NetWorker DBO device was the BladeStore disk system. The applications backed up were Microsoft Exchange on the Windows system and Oracle on the Sun system. A set of local file system data was created on locally accessible file systems for each of the clients/storage nodes that were also backed up. The local file system data set was generated by a Storage Networking Industry Association (SNIA) executable, creating approximately 10 GB in 1,100 directories.

Application tuning was not performed. This benchmark is not of the application, but of the DBO device and tape device performance under the same conditions.

Benchmark performance was not done on the individual systems, as this is not an operating system benchmark. Standard system resource configuration and default file system creation was used for both Windows and Sun.

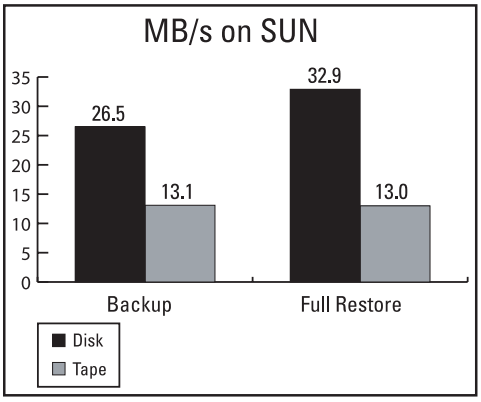
The benchmark was executed to provide performance data on elapsed time for backup/restore for each of the following environments: NetWorker for UNIX, NetWorker for Windows, NetWorker Module for Exchange, NetWorker Module for Oracle, and operating system copy tools. Each of the following tests was run for each of the previously mentioned setups. This document details performance of NetWorker and NetWorker Modules to both tape and DBO device (BladeStore) as target medium. System copy functionality was measured using disk for target medium for the purpose of giving a performance baseline. Tape load and unload times were not included. The comparison involved data transfer only.

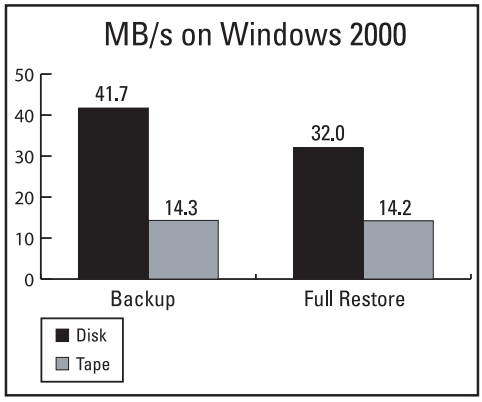
2.7 BENCHMARK

This benchmark effort and resulting performance numbers are for comparative purposes between backup/recovery with a tape device and a DBO device in the same environment. Regular file system data and application data were used. Not all results are posted in this section. Full results are posted in the Appendix. The results delivered here highlight the regular file system data performance numbers. The application data performance numbers are located in the Appendix of this document.

2.7.1 Throughput

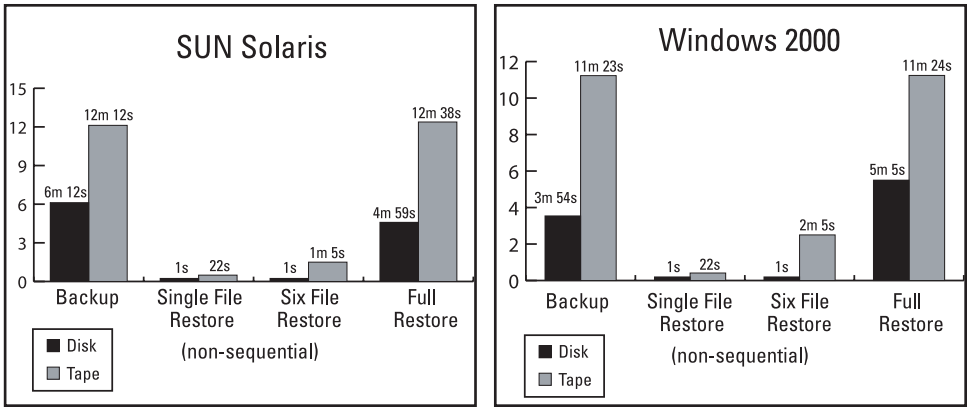
The following charts show the megabytes per second throughput on both the Sun system and the Windows system. These numbers are for the backup and recovery of the SNIA (1-megabyte files) dataset.





2.7.2 Completion time

The following charts show the completion time (minutes:seconds) on both the Sun system and the Windows system. These numbers are for the backup and recovery of the SNIA (1-megabyte files) dataset.



2.7.3 Understanding the results

Even though the results of this benchmark were exceptional, the importance of tape for offsite or disaster recovery purposes should not be undermined. Instead, backup to disk provides an additional strategy to help customers meet their ever-changing service level requirements. If a customer is experiencing shortened backup windows or requires frequent recoveries, the BladeStore disk system and NetWorker DiskBackup Option solution is a perfect fit. The BladeStore disk system (DBO device) results clearly show performance advantages on both backup and recovery. These performance figures will save customers time and resources when protecting their storage assets.

2.8 ENVIRONMENT

2.8.1 Software

Application	NetWorker	SANtricity	Exchange	Oracle
Version	6.1.2	8.36	2000	9i
O/S	All	Windows 2000	Windows 2000	Sun
Patch/SP Level	6.1.2	N/A	SP3	N/A

2.8.2 Hardware

	Manufacturer	Model	Firmware
Switch	Brocade	Silkworm® 3800 enterprise Fibre Channel switch v.3.0.2 (fabric OS)	5.3.1 (kernel)
Source Computer	StorageTek	OPENstorage D280 N5884-530885-001	05.30.02.00
Source Disk	StorageTek	D280	MS09
Target Disk Controller	StorageTek	BladeCtlr BC84	95.36.03.00 N4884-536855-001
Target Disk	StorageTek	BladeStore 150	0C3D
Library	StorageTek	L180	3.01.02
Tape Device	StorageTek	9840A	1.32

2.8.3 System

Server	Intel	SUN
Model	Dell PowerEdge 2650	SunFire 4800
O/S	Windows 2000	Solaris 8
Patch/SP Level	SP2	NA
# of CPU's	2	4
CPU Speed	2.2 GHz	900 MHz
HBA #1	Emulex LP9000	JNI FCE-6460
HBA FW	3.90a7	3.8.9
HBA Driver	5-4.82a4	5.1.1
HBA #2	Emulex LP9000	JNI FCE-6460
HBA FW	3.90a7	3.8.9
HBA Driver	5-4.82a4	5.1.1
HBA #3	JNI FCX2-6562-N (dual port HBA)	JNI FCE-6460
HBA FW	1.1	3.8.9
HBA Driver	5.1	5.1.1
HBA #4	See #3	JNI FCE-6460
HBA FW	See #3	3.8.9
HBA Driver	See #3	5.1.1
Memory	1024 MB	4096 MB

2.8.4 Setup

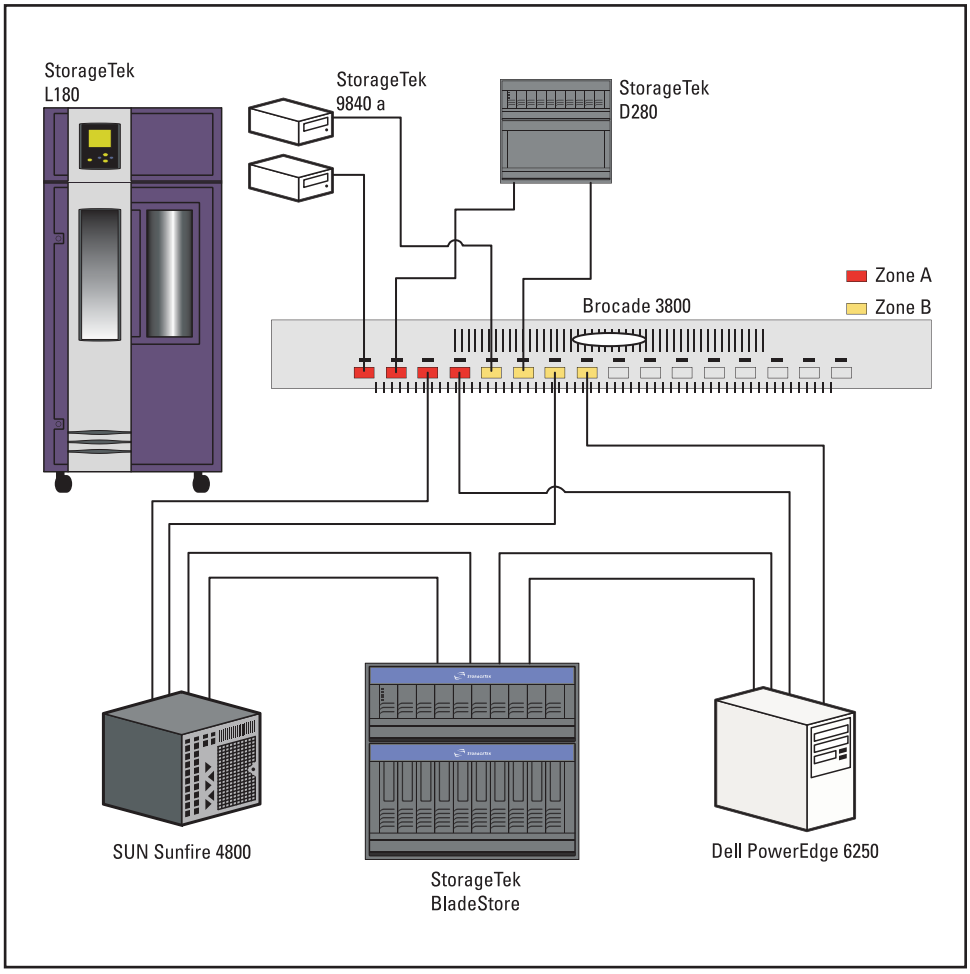


Figure 1.

2.8.5 Disk, volume, LUN details for D280 disk system

For both the Windows 2000 and Solaris systems, a D280 disk system was used as the primary data array containing the system files and application data (Exchange for Windows 2000 and Oracle for Solaris). The LUNs were 10 or 50 gibabytes 12+1 RAID 5 volume with a segment size of 128 kilobytes, with Read and Write Cache enabled and Write Cache With Mirroring and Write Cache Without Battery disabled and the Cache Read Ahead Multiplier set to 32.

2.8.6 Disk, volume, LUN details for BladeStore disk system

For both the Windows 2000 and Solaris systems, the BladeStore disk system volume used as a DBO backup device was a 500 gigabytes 2+1 RAID 5 volume with a segment size of 256 kilobytes, with Read and Write Cache enabled and Write Cache With Mirroring and Write Cache Without Battery disabled and the Cache Read Ahead Multiplier set to 16.

2.8.7 SNIA system data file configuration

The system file data was created from a 1-megabyte SNIA test data file. The test data file was copied into a directory structure containing 1,100 folders and 10,000 files totaling 10,485,760,000 bytes or 10 gigabytes on the Windows 2000 system and totaling 10,347,619,840 bytes or 9.87 gigabytes on the UNIX system.

2.8.8 Oracle database configuration

The Oracle database was generated from scripts to simulate an order entry system. It contained 2,045,553 orders in 19,556,934 order line items. It was allocated into 57 gigabytes of tablespace spread across 55 .dbf files on 8 UNIX mount points. The database was populated with 4.3 gigabytes of data.

2.8.9 Exchange database configuration

The 16.4-gigabyte Exchange database was populated with 2,500 users using a program that took as input the following:

- Number of messages in inbox
- Number of messages in deleted items
- Number of new folders
- Messages per new folder
- Number of calendar appointments
- Number of contacts

2.8.10 Best practices

The following recommendations were lessons learned during the setup and configuration of each of the components used. It is important to note that each environment may give differing results; but, overall, the following can be applied to most default environments.

BladeStore disk system: The best results were discovered by using 500 gigabytes 2+1 RAID 5 volume with a segment size of 256 kilobytes, with Read and Write Cache enabled and Write Cache With Mirroring and Write Cache Without Battery disabled and the Cache Read Ahead Multiplier set to 16.

D280 disk system: The best read results were discovered by having the LUNs set to 10 or 50 gigabytes 12+1 RAID 5 volume with a segment size of 128 kilobytes, with Read and Write Cache enabled and Write Cache With Mirroring and Write Cache Without Battery disabled and the Cache Read Ahead Multiplier set to 32.

NetWorker: The configuration used two servers. One server was used as the NetWorker server, the other was configured as a client /storage node. The NetWorker server shared the L180 tape library, and the FC (FIbre Channel) T9840A tape drives by using DDS (Dynamic Drive Sharing). The DBO devices were created on the mounted file system seen by the NetWorker storage node, while keeping the NetWorker server available for meta data collection.

Library and T9840A tape drives: The L180 tape library was SCSI attached to the NetWorker server and shared by the NetWorker storage node. The T9840A tape drives were connected directly to the SAN (switch). The T9840A tape drives were assessable by both the NetWorker server and storage node via the SAN.

FC switch: The Brocade switch was not zoned for the benchmark testing. The Windows 2000 and Sun servers, tape drive and connections to the D280 disk system were connected to the SAN. Zoning the switch can be done, but is not necessary.

3 CONCLUSION

Enterprises are now focusing more than ever on the ability to achieve high-performance, cost-effective data protection operations. With the changing economics of disk technology, the benefits of faster recovery and backup performance and increased storage ROI, disk-based solutions have become desirable and affordable.

LEGATO and StorageTek have partnered to offer a comprehensive disk-based data protection solution that delivers faster recovery, faster backup and increased ROI on tape resources.

Below is a summary of additional benefits associated with the LEGATO/StorageTek backup-to-disk solution:

Performance: The testing reflects superior performance using the BladeStore disk system compared to high-speed FC tape drives. The BladeStore disk system results indicate nearly 50 percent faster backups compared to T9840A tape drives. This performance advantage will clearly assist customers meeting the ongoing need to shorten backup windows and increase throughput. A customer using the recovery feature will see up to 500 percent performance increase over the T9840A tape drive depending on the data being restored. Recovery speeds this fast are a direct benefit to the customer when it counts most and allows them to deliver on higher service level agreements.

Elimination of traditional tape limitations: In tape environments, customers may experience bad media, old media, media incompatibility and slower tape transports. These limitations can often affect a customer's backup and recovery operations. The use of DBO devices hosted on the BladeStore disk system helps eliminate these obstacles that can sometimes plague an IT department. Tape drive wear and tear and resulting expensive service calls are also reduced.

Elimination of traditional tape delays: Depending on the tape technology used, a customer can see valuable backup time being used for tape mounting, unmounting and positioning. These delays can prove lengthy if the tape library is shuffling many tapes to complete backup and recovery jobs. These delays can be as little as a few seconds to 2–3 minutes. During testing, a tape mount or unmount commonly took 90–120 seconds.

Two-tier backup strategy: This paper certainly does not support excluding a tape backup and recovery strategy from a customer's data protection requirements, but defines how tape backup and recovery can be enhanced. A customer should consider using a backup-to-disk option to meet shrinking backup windows, and then write to tape outside of the backup window for disaster recovery and offsite needs. Furthermore, a customer can use the NetWorker DiskBackup Option and BladeStore disk system solution where a high number of restores are required within the immediate time following a backup with a need to recover rapidly.

Lower cost of ownership: The results of this paper truly point to increased hardware redundancy/protection, less media handling, less tape drive/media wear, faster backup, faster restore, integrated backup to disk and tape, and disaster recovery capabilities with a single point of management. The full impact of these benefits considerably drives down the total cost of operation with increased ability to meet service level agreements.

3.1 ADDITIONAL DATA PROTECTION STRATEGIES

LEGATO NetWorker provides additional data protection strategies. The following highlights these options and how NetWorker can be used to further meet the demands of the customer.

Cloning: The NetWorker server can make duplicates of a saveset or the entire volume. This feature will allow customers to make a second copy of the data to transport to an offsite location for further protection. Cloning can be configured to run manually or automatically. It's important to understand cloning would require two (2) devices, one to read and one to write. If a customer so chooses, the original copy can remain on disk, the clone can be written to tape. Therefore, the saveset resides on disk for quick recovery and on tape for longer-term retention. It's important to note, restores can be performed on the original and the cloned version of the saveset.

Staging: Saveset staging is a process of moving data from one storage medium to another and removing the saveset from its original location. If the saveset is on a disk or DBO device, the space is reclaimed and used for other purposes. Staging policies are very easy to configure and NetWorker will continue to track the saveset once it has been moved. Staging is an ideal strategy when using targets such as a BladeStore disk system as a DBO device.

Retention policies: NetWorker offers two separate retention policies. The Browse policy is a customized time value that determines how long the meta data remains in the client file index. The retention policy is a customized time value that determines how long the saveset entries remain in the NetWorker Server's media database. These policies can be configured to meet any customer data protection requirement and strategy.

4 APPENDIX

APPENDIX A:

Performance text chart

SUN File System	Effective Data DBO Device	Transfer MB/sec	Effective Data Tape	Transfer MB/sec
Backup	6:12	26.5	12:12	13.1
Single File Restore	:01	N/A	:22	N/A
Six File Restore Non-sequential	:01	N/A	1:05	N/A
Full Restore	4:59	33	12:38	13

W2K File System	DBO Device	Effective Data Transfer MB/sec	Tape	Effective Data Transfer MB/sec
Backup	3:54	42.7	11:23	14.6
Single File Restore	:01	N/A	:22	N/A
Six File Restore Non-sequential	:01	N/A	2:05	N/A
Full Restore	5:05	32.8	11:24	14.6

Exchange 2000	DBO Device	Effective Data Transfer MB/sec	Tape	Effective Data Transfer MB/sec
Backup	6:56	40.1	12:09	22.9
Restore	9:42	28.7	12:25	22.4

Oracle 9i	Effective Data DBO Device	Transfer MB/sec	Effective Data Tape	Transfer MB/sec
Backup	6:55	9.0 1	12:06	5.9[1]
Restore Tablespace	36:00	1.98 1	36:33	1.95[1]
Restore Datafile	3:46	N/A	6:20	N/A

System Tool Copy	D280 to BladeStore	Effective Data Transfer MB/sec	BladeStore to D280	Effective Data Transfer MB/sec
Solaris "dd"	3:58	42.5	6:01	40.9
Solaris "cp"	14:38	11.2	14:45	11.1
Windows copy	254s	38.4	236s	41.3

NOTE 1 The Oracle database was set up with a total size of 57 GB. The total populating the database was between 4–5 GB. During backup and restore, the Oracle RMAN utility was used to process data into and out of the database. This procedure was not optimized or tuned for top performance. It was run against a default environment that provided the same environment for tape and disk backup. Performance numbers are for tape/disk comparison and do not show an optimal backup/restore strategy.

Performance analysis - full volume backup filesystem data

Operating System	DBO Drive	Tape	DBO Device % Faster	Tape to DBO Drive Ratio
Solaris	372 sec	752 sec	51%	2:1
Windows	234 sec	683 sec	66%	3:1

Performance analysis - full volume restore filesystem data backup

Operating System	DBO Drive	Tape	DBO Device % Faster	Tape to DBO Drive Ratio
Solaris	299 sec	758 sec	61%	3:1.5
Windows	305 sec	684 sec	55%	2:1

Performance analysis - application backup

Operating System	DBO Drive	Tape	DBO Device % Faster	Tape to DBO Drive Ratio
Oracle 9i	475 sec[2]	726 sec[2]	35%	3:2
Exchange 2000	416 sec	729 sec	43%	2:1

Performance analysis - application restore

Operating System	DBO Drive	Tape	DBO Device % Faster	Tape to DBO Drive Ratio
Oracle 9i	2160 sec	2193 sec	2%	1:1
Exchange 2000	582 sec	745 sec	22%	5:4

NOTE 2 The Oracle database was set up with a total size of 57 GB. The total data populating the database was between 4-5 GB. During backup and restore, the Oracle RMAN utility was used to process data into and out of the database. This procedure was not optimized or tuned for top performance. It was run against a default environment that provided the same environment for tape and disk backup. Performance numbers here are for tape/disk comparison and do not show an optimal backup/restore strategy.

LEGATO®

Keeping the World's Business-Critical Information Available

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