



Racing Ahead

A performance comparison of SDLT vs. LTO

Testing conducted by
Percept Technologies
Boulder, Colorado
October 2002

SDLT
Super DLTtape™ Technology

Executive Summary	2
Testing Objective.....	4
Tape Drive Specifications	4
Test Setup and Process	4
Testing Results	6
<i>Media Cartridge Capacity Performance Results</i>	6
<i>Write Data Transfer Rate Performance Results</i>	6
<i>Read Data Transfer Rate Performance Results</i>	7
<i>Application Backup Performance Results</i>	8
Summary of Analysis	9

Disclaimer Statement

The testing data referenced in this document was derived from testing performed by an independent laboratory, Percept Technology, Inc., in a controlled environment using specific systems and data sets. Actual results in other environments may vary. These results do not constitute a guarantee of performance. Testing was conducted using Linear Tape-Open (LTO) drives and media from several different LTO consortium manufacturers.

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Executive Summary

The purpose of the Competitive Performance Analysis was to distinguish performance variations between Super DLTape™ technology and LTO technology. For this study, Quantum Corporation contracted Percept Technologies, an independent Product Test and Development Firm, to conduct performance testing of Super DLTape tape drives and LTO tape drives. The chosen drives were the Quantum SDLT 320, IBM 3580 Ultrium LTO, HP Ultrium 230 LTO, and the Seagate Viper 200 LTO.

The performance testing focused on media cartridge capacity, data transfer rate performance and backup application performance.

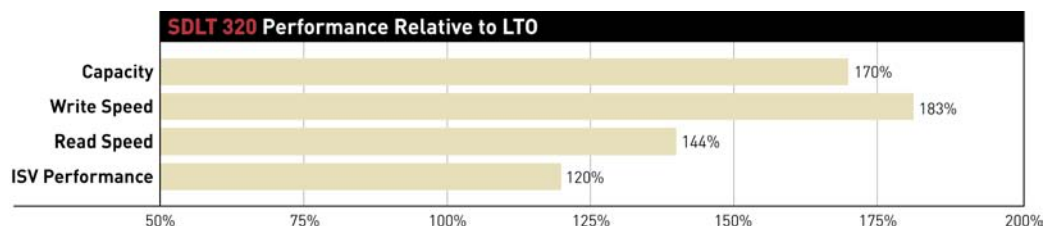
The measurements of media cartridge capacity were done for differing data block sizes. Measurements of data transfer rates were done for differing compression ratios. Both tests used the Percept's SCSI Competitive Analysis Test Suite.

For the application performance tests, two industry standard backup applications packages were chosen: Computer Associates BrightStor Enterprise Backup and Veritas NetBackup DataCenter. Current released versions of these software packages were used for the tests. Each application was tested using a Dell PowerEdge server operating Windows 2000, and a Sun Ultra 10 server operating Solaris 8. Full backups of 200 GB and incremental backups of 40 GB were performed on each server / application / tape drive combination.

General conclusions:

The SDLT 320 showed a clear performance advantage over the IBM 3580 Ultrium, HP Ultrium 230, and the Seagate Viper 200 LTO tape drives. Specifically:

1. The SDLT 320 stored up to 70% more data per cartridge than LTO, under media cartridge capacity tests.
2. The SDLT 320 wrote data up to 83% faster than LTO, under write data transfer tests.
3. The SDLT 320 read data up to 44% faster than LTO, under read data transfer tests.
4. The SDLT 320's Veritas NetBackup performance was, on average, 20% faster than LTO and the SDLT 320 had the fastest CA Enterprise Backup performance.



Testing Objective

This White Paper describes the results of a performance study of Super Tape Drives. The study's requirements were to compare the performance of the SDLT 320 manufactured by Quantum against the Linear Tape Open (L.T.O.) drives from HP, IBM, and Seagate. Comparisons would include:

- Cartridge Capacity
- Data Transfer Rates
- Full backups of 200GB
- Incremental backups of 40GB

Quantum contracted Percept Technologies, an independent Product Test and Development Firm, to perform this performance testing. Percept Technologies audited the test methodologies and procedures, performed the tests and evaluated all test results according to the test plan provided by Quantum Corporation.

Tape Drive Specifications

The tape drives were the SDLT 320, IBM 3580 Ultrium LTO, HP Ultrium 230 LTO, and the Seagate Viper 200 LTO. A summary of all each tape drive's specifications is shown in the table below.

	SDLT 320	IBM 3580 Ultrium	HP Ultrium 230	Seagate Viper 200
Capacity (native)	160 GB	100 GB	100 GB	100 GB
Transfer Rate (native)	16 MB/sec	15 MB/sec	15 MB/sec	16 MB/sec
Cartridge Load Time (from BOT)	12 sec	21 sec	25 sec	30 sec
AVG File Access Time (from BOT)	70 sec	73 sec	71 sec	76 sec
8 TB Library Storage Density	50 Cartridges	80 Cartridges	80 Cartridges	80 Cartridges
Interfaces	LVD or HVD	LVD or HVD, FC	LVD or HVD	LVD or HVD
Tape Format	Linear serpentine	Linear serpentine	Linear serpentine	Linear serpentine
Servo Method	Optical Servo	Magnetic Servo	Magnetic Servo	Magnetic Servo
Encoding Method	PRML	RLL 1,7	RLL 1,7	RLL 1,7
Data Compression Algorithm	DLZ	LTO ALDC	LTO ALDC	LTO ALDC
Backward Compatibility	Yes	No	No	No
MTBF	250,000 @ 100%	250,000 @ 100%	250,000 @ 100%	250,000 @ 100%
Uncorrected Bit Error Rate	< 1 in 10 ¹⁷ bits read	< 1 in 10 ¹⁷ bits read	< 1 in 10 ¹⁷ bits read	< 1 in 10 ¹⁷ bits read

Test Setup and Process

The test set-up consisted of one Dell Windows 2000 server, one Sun Solaris server, one Quantum SDLT 320 tape drive and an IBM 3580 Ultrium, HP Ultrium 230 and Seagate Viper 200 LTO tape drives. To ensure the best possible performance, all the tape drives were direct attached to the servers via a separate Ultra SCSI host adapter to isolate the tape drive bus from the source data bus. Test set-up configuration information is given below:

UNIX:	Windows:
Sun Ultra 10 440 MHz UltraSPARC-IIi Sparc 256MB Ram 18GB SCSI hard disk Solaris 8 Sun, single-channel, single-ended, Ultra SCSI host adapter 1 - Internal source data drive Sun, single-channel, single-ended, Ultra SCSI host adapter 2 - External attached tape drive	Dell PowerEdge 1300/400 400 MHz Pentium 2 128 MB RAM 18GB SCSI Hard disk Windows 2000 server Adaptec 29160 Ultra SCSI host bus adapter -Internally attached source data drive On-board Ultra SCSI host bus adapter - Externally attached tape drive
Tape Drives:	ISV Software:
SDLT 320: Firmware revision 46 Hewlett Packard Surestore Ultrium 230: Firmware revision E15D Seagate Ultrium Viper 200: Firmware revision 1360 IBM Ultrium StorageSmart 3585: Firmware revision 0BN1	<u>Veritas NetBackup DataCenter v3.4.1</u> Veritas - Windows 2000 - NetBackup - SP2 P0836A Veritas - RedHat Linux 7.1 - NetBackup - SP2 Veritas - Solaris 2.8 - Netbackup - no SP <u>Computer Associates BrightStor Enterprise Backup v10.0</u> CA - Windows 2000 - BrightStor Enterprise Backup - SP2 CA - Solaris 2.8 - BrightStor Enterprise Backup - SP2, upgraded to SP4 for SDLT320

Given the testing objective stated above, the test process was designed to get the best representative performance of each tape drive for Cartridge Capacity, Data Transfer Rates, Backup application performance.

All tests were repeated three times for each tape drive under the same server configuration. The average of the three test runs was recorded.

Cartridge capacity test

32,768 byte records with compression off were written until an End of Media was reported. A log sense command was issued every 10 GB to record the write performance. A rewind command was issued and a read pass performed. A log sense command was issued every 10 GB to record the read performance. The same test was repeated with compression on. Performance data recorded after the issuance of a log sense command included: start and stop time, elapsed time, block size, number of records, number of bytes, and the reported number of write or read retries.

Data transfer rates test

A data file was created that would give the desired compression ratio, 2:1 & 5:1, for a block size of 128K. The total amount of data written for each test was < 2.0 GB to ensure that no back hitching occurred during test (thus effecting the final data transfer rate). The write transfer rate and the read transfer rate were recorded separately.

ISV application performance test

For each test, the most current version of application's tape drive device driver was used. 3 GB performance-tuning backups were done to optimize application parameters (e.g. shared memory buffer size, number of shared memory buffers, tape data fragment size) observing elapsed time, data transfer rate and buffer statistics. Once optimization was completed, full 200 GB and incremental 40 GB backup test were run

Testing Results

Media Cartridge Capacity Performance Results

SDLT 320 uses a Super DLTtape™ I media cartridge with a native capacity of 160GB. The IBM 3580 Ultrium, HP Ultrium 230, and the Seagate Viper 200 use a LTO media cartridge with a native capacity of 100GB. This test determined media cartridge capacity in native (1:1) mode and compressed (2:1) mode when writing 32k records.

Using the average of three test runs, the SDLT 320 backed up 50% to 70% times more data on to a single Super DLTtape I cartridge than the LTO drives on a single LTO cartridge. As a group, there were wide variations in the LTO tape drives cartridge capacity performance. The IBM 3580 Ultrium and HP Ultrium 230 performed roughly the same in native and compressed modes. The Seagate Viper 200, while performing roughly the same as the IBM and HP LTO tape drives in compressed mode, backed up almost 10% less data than the other LTO tape drives in native mode.

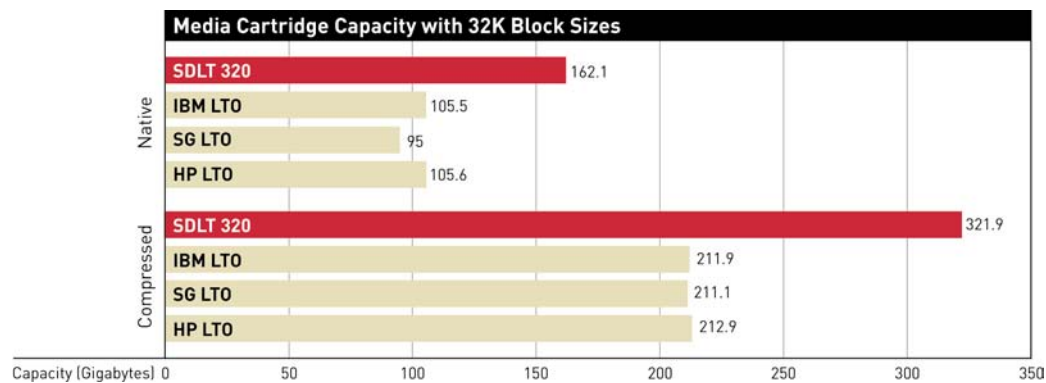


Figure 1 - In media cartridge capacity tests the SDLT 320 backed up 70% more data than Seagate Viper 200 LTO tape drive.

Write Data Transfer Rate Performance Results

The SDLT 320, in all Write Data Transfer tests, was significantly faster than the IBM 3580 Ultrium, HP Ultrium 230, and the Seagate Viper 200 LTO tape drives. Overall, the SDLT 320 write data transfer rate out performed LTO by an average of up to 31%.

Average Write Data Transfer Rate (MB/s) for all drives:

Compression Ratio	SDLT 320	IBM 3580 Ultrium	HP Ultrium 230	Seagate Viper 200
2:1	33.3	28.4	29.3	29.3
5:1	62.7	34.1	42.4	56.7

The SDLT 320 wrote data 83% faster than the IBM 3580 Ultrium at a 5:1 compression ratio.

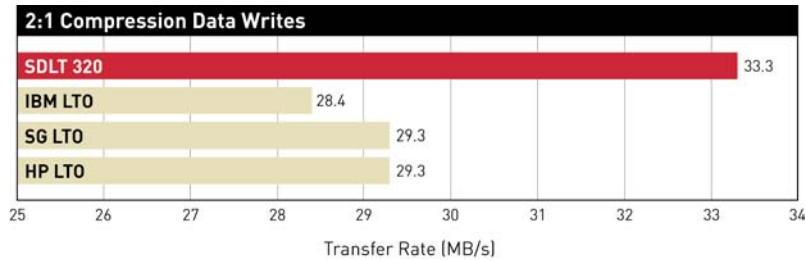


Figure 2 - In write data transfer tests the SDLT 320 wrote data 83% faster than the IBM 3580 Ultrium. On average the SDLT 320 was 31% faster than LTO.

The SDLT 320 achieves this outstanding performance in part because of its Pivoting Optical Servo (POS). The POS gives the SDLT 320 precise tracking capabilities for very high track densities and more efficient use of media.

Read Data Transfer Rate Performance Results

The SDLT 320, in all Read Data Transfer tests, was faster than the IBM 3580 Ultrium, HP Ultrium 230, and the Seagate Viper 200 LTO tape drives. Overall, the SDLT 320 Read data transfer rate out performed LTO by an average of up to 15%.

Average Read Data Transfer Rate (MB/s) for all drives:

Compression Ratio	SDLT 320	IBM 3580 Ultrium	HP Ultrium 230	Seagate Viper 200
2:1	30.7	28.5	28.4	28.8
5:1	55.1	38.1	44.1	54.1

The SDLT 320 read data 44% faster than the IBM 3580 Ultrium at a 5:1 compression ratio. SDLT 320 read data 24% faster than HP Ultrium 230. The SDLT 320 was able achieve superior read performance because of two unique technology enablers: Partial Response Maximum Likelihood (PRML) and Magneto-Resistive Cluster Heads (MRC).



Figure 3 - In read data transfer tests the SDLT 320 read data 44% faster than the IBM 3580 Ultrium and 24% faster than the HP Ultrium 230.

The SDLT 320's PRML read channel technology is 47% more efficient than the Peak-Detect method used by LTO tape drives. The MRC enables the SDLT 320 to read eight channels of data at the same time. The combination of the two means the SDLT 320 can read more data faster with fewer errors.

Backup Application Performance Results

Testing real world backup application performance, the SDLT 320 was faster than the IBM 3580 Ultrium, HP Ultrium 230, and the Seagate Viper 200 LTO tape drives. Overall, the SDLT 320 using Veritas NetBackup with Windows 2000 out performed LTO up to 20% during the full 200GB backup test and the SDLT 320 was up to 20% faster during the 40GB incremental backup test. Similarly, using Veritas with Solaris the SDLT 320 out performed LTO drive by up to 14% during the full 200GB backup test and by up to 23% under the 40GB incremental test.

Average Veritas NetBackup Data Transfer Rate (MB/s) for all drives:

Veritas NetBackup	SDLT 320	IBM 3580 Ultrium	HP Ultrium 230	Seagate Viper 200
<i>Windows 2000</i>				
200GB Full	15.67	15.1	15.02	12.99
40GB Incr.	15.97	15.12	15.10	13.22
<i>Solaris 8</i>				
200GB Full	15.02	14.21	14.14	13.15
40GB Incr.	15.88	14.23	13.9	12.91

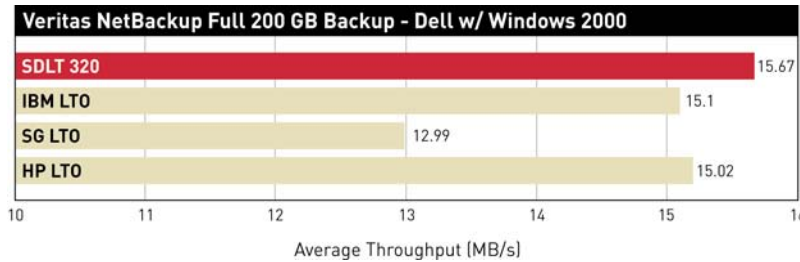


Figure 4 - Overall the SDLT 320 out-performed the IBM 3580 Ultrium, HP Ultrium 230, and the Seagate Viper 200 LTO tape drives by to up 20%.

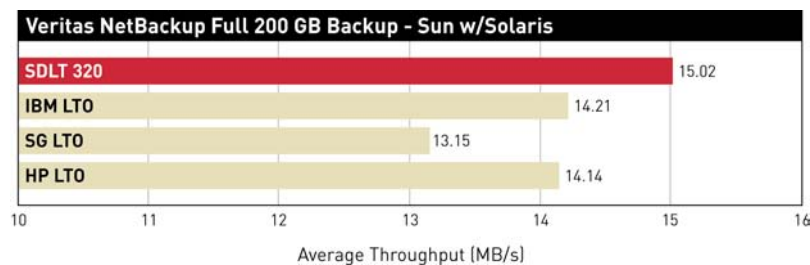


Figure 5 - Overall the SDLT 320 out-performed the IBM 3580 Ultrium, HP Ultrium 230, and the Seagate Viper 200 LTO tape drives by to up 14%.

Using CA Enterprise Backup under Windows 2000 and Solaris, the SDLT 320 was faster than the IBM 3580 Ultrium, HP Ultrium 230, and the Seagate Viper 200 LTO tape drives.

Average CA Enterprise Backup Data Transfer Rate (MB/s) for all drives: (note: testing of the Seagate Viper 200 under Solaris was not available)

CA Enterprise Backup	SDLT 320	IBM 3580 Ultrium	HP Ultrium 230	Seagate Viper 200
<i>Windows 2000</i>				
200GB Full	16.18	15.6	15.94	15.97
40GB Incr.	16.91	15.32	15.7	15.94
<i>Solaris 8</i>				
200GB Full	13.97	13.96	13.95	NA
40GB Incr.	14.2	14.04	14.07	NA

Summary of Analysis

Under a series of benchmark tests to compare the performance of a new class of midrange tape drives the Quantum Corporation's SDLT 320 displayed a significant performance advantage over the competing IBM 3580 Ultrium, HP Ultrium 230, and the Seagate Viper 200 LTO tape drives. Specifically:

1. The SDLT 320 backed up 70% more data per cartridge than LTO, under media cartridge capacity tests.
2. The SDLT 320 wrote data up to 83% faster than LTO, under write data transfer tests.
3. The SDLT 320 read data up to 44% faster than LTO, under read data transfer tests.
4. The SDLT 320's Veritas NetBackup performance was on average 20% faster than LTO and SDLT 320 has the fastest CA Enterprise Backup performance.

In conclusion, Quantum's SDLT 320 is the best tape drive on the market. The SDLT 320 has the fastest performance and the largest capacity of all the super tape drives tested. When failure is not an option SDLT 320 is the answer.

Performance test results were achieved under controlled laboratory conditions, actual results may vary depending on environmental conditions and do not constitute a warranty of performance.