

ABC Storage Devices, Inc.

Device Performance and ISV Certification Report



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Version	Date	Comments	Contributors
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1 Introduction

1.1 Executive Summary

The analysis centered primarily on measuring the ABC LTO drive data throughput with two industry standard ISV (Independent Software Vendor) packages. The ISVs chosen were Computer Associates BrightStor Enterprise Backup and Veritas NetBackup DataCenter. Current released versions of these software packages were used.

Each ISV was tested on three computer server platforms:

- Compaq ML370 with Windows 2000
- Compaq ML370 with RedHat Linux 7.2
- Sun Ultra 10 with Solaris 2.8

Full spanning backups of 200 GB were performed on each platform / ISV.

Additional analysis was conducted by Percept utilizing the SCSI Competitive Analysis Test Suite based on the OPPCO Test Card System. These tests included measurements of tape capacity using differing data block sizes, throughput for 32k and 64k block sizes and compression ratios, and minimum throughput that causes back hitching conditions.

Under ideal conditions, data transfer rates for the ABC LTO drive tops out at compression ratios greater than about 2:1 and remain consistent at compressions greater than 3:1.

1.2 Overview

The requirements for performance testing of the ABC Linear Tape Open (LTO) drive are to independently observe and record drive performance using the following performance tests:

- Standardized block size testing with 32K and 64K blocks
- Full backups of 200GB with 2 leading ISV backup software packages, on 3 operating systems

ISV device certification requirements for the ABC LTO specify for Percept to test and obtain certification on the following ISV packages:

- Legato NetWorker 6.2 on Windows 2000
- Legato NetWorker 6.2 on RedHat Linux 7.2

1.3 ABC LTO Drive - ISV Performance Test Matrix

ISV Package	Windows 2000 Server	RedHat Linux 7.2	Sun Solaris 2.8
CA BrightStor ARCserve			
CA BrightStor Enterprise Backup	tested		tested
Veritas Backup Exec			
Veritas NetBackup DataCenter	tested	tested	tested
Legato NetWorker			
IBM Tivoli TSM			
HP Openview OmniBack II			
Yosemite TapeWare			
Knox Arkeia			
Dantz Retrospect			
NovaStor NovaBack			

1.4 ABC LTO Drive - ISV Certifications Obtained by Percept

ISV Package	Windows NT/2000	RedHat Linux 7.2	Sun Solaris 2.8
CA BrightStor ARCserve			
CA BrightStor Enterprise Backup			
Veritas Backup Exec			
Veritas NetBackup DataCenter			
Legato NetWorker	certified	certified	
IBM Tivoli TSM			
HP Openview OmniBack II			
Yosemite TapeWare			
Knox Arkeia			
Dantz Retrospect			
NovaStor NovaBack			

2 Device Performance Testing - ABC LTO

2.1 Performance Testing Hardware and Software

2.1.1 ISV Performance Test Systems - Hardware

Windows 2000 Server

- Compaq ML370 G2
- 1.2 GHz, Dual Pentium 3
- 256 MB RAM
- 18 GB Ultra 160 Hard Disk
- SCSI Adapter 1: Adaptec 29160 Ultra 160 HBA
- SCSI Adapter 2: On-board Ultra 160 SCSI HBA

RedHat Linux 7.2 Server

- Compaq ML370 G2
- 1.2 GHz, Dual Pentium 3
- 256 MB RAM
- 18 GB Ultra 160 Hard Disk
- SCSI Adapter 1: Adaptec 29160 Ultra 160 HBA
- SCSI Adapter 2: On-board Ultra 160 SCSI HBA

Sun Solaris 2.8 Server

- Sun Ultra 10
- 440 Mhz UltraSPARC-IIi
- 256 MB RAM
- 18 GB Ultra 160 Hard Disk
- SCSI Adapter 1: Sun, single-channel SE Ultra 160 HBA
- SCSI Adapter 2: Sun, single-channel SE Ultra 160 HBA

ABC LTO Tape Drive

- Hardware Version: 3.6
- Firmware Version: v8.1

2.1.2 ISV Performance Test Systems - Software

- Computer Associates BrightStor Enterprise Backup v10.0
- Veritas NetBackup DataCenter v3.4.1

2.1.3 SCSI Test Hardware - The OPPCO Test Card System

The OPPCO Test Card System was chosen as the development platform to create the SCSI EVT test suite. The OPPCO 1820 and 1850 SCSI Test Cards are capable of both 16-bit wide and 8-bit narrow operation. They are capable of auto-detecting single-ended and low-voltage differential (LVD) interfaces. The OPPCO 1850 card can operate in LVD mode. In addition, the Rancho Technology RTLVD-PSE single-ended-to-LVD conversion units are used for testing with the OPPCO 1820 card.

Additional features of the OPPCO cards are summarized as follows:

- Data Buffer Compare – Standard 256K buffer, which compares incoming SCSI data with the contents of the buffer and takes place at a full sustained 40 MB per second.
- ODD Byte Transfers – Transfer of odd bytes on both the narrow and wide busses, which is a must for variable-length recording device development such as the LTO tape drive.
- Operating Modes – Both normal and micro programming modes are supported. Normal mode allows for command level testing such as arbitration, selection, status, data, etc. Micro programming mode allows the bus to be controlled at the phase, bit and byte levels for maximum flexibility in tape drive testing.
- Processor – Each OPPCO is RISC Processor controlled.
- Devices – Each OPPCO runs up to 16 LUN devices or 15 SCSI target devices. For the purposes of our testing, no more than 6 target devices are run on a single workstation at any given time.
- Bus Trace Logging – The OPPCO keeps track of bus activity. Additionally, 16 individual device buffers log the activities of each device and contain bus phase information along with fault symptom codes.
- SCSI Commands – All SCSI-1, SCSI-2 and SCSI-3 commands are implemented including the user defined 6-, 10- and 12-byte commands.

2.2 SCSI Performance Analysis Test Suite

Tests were developed to exercise every possible aspect of drive operation that could be expected in customer installations. These tests were written in the OPPCO macro control language.

The SCSI Performance Analysis Test Suite fully tests the following cases:

- Appends
- Compression Efficiency
- Data Integrity
- Logical Block Sizes (from 64 kb to 128 mb)
- Multiple Initiator
- Read / Write Media Error Reporting
- Backup and Restore
- Tape Capacity
- Tape Spanning
- Synchronous / Asynchronous Data Transfer Rates
- Read / Write Access Times
- Read / Write Raw and Corrected Error Rate

2.3 Conditions Continuously Monitored During Testing

Conditions:

- Tape Drive and SCSI Host Bus Command Protocol
- Read Error Rates
- Write Error Rates
- Mechanical Failure
- Media Failure

2.4 Standardized Block Size Testing - Capacity Writing 32k Records

Objective:

To determine the tape capacity in native (1:1) and compressed (2:1) mode when writing 32k records.

Test Engineers:

Jim Werder, Chris Poore

Method:

Percept SCSI Performance Analysis Test Suite will be used to conduct this testing.

Test "WR32K1" writes 32,768 byte records with compression off, until End of Media is reported. A log sense command was issued every 10 GB to record the write performance.

A rewind command is issued and a read pass performed. A log sense command was issued every 10 GB to record the read performance.

The test was repeated three times, and the tape capacity recorded was the average of the three test runs.

Test "WR32K2" writes 32,768 byte records with compression on, until End of Media is reported. The data used was a pattern that the ABC LTO drive compressed at a ratio of 2:1. 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 test was repeated three times, and the data transfer rate and tape capacity recorded were the average of the three test runs.

Results:

Figure 1: Native (1:1) Capacity with 32K Block Sizes

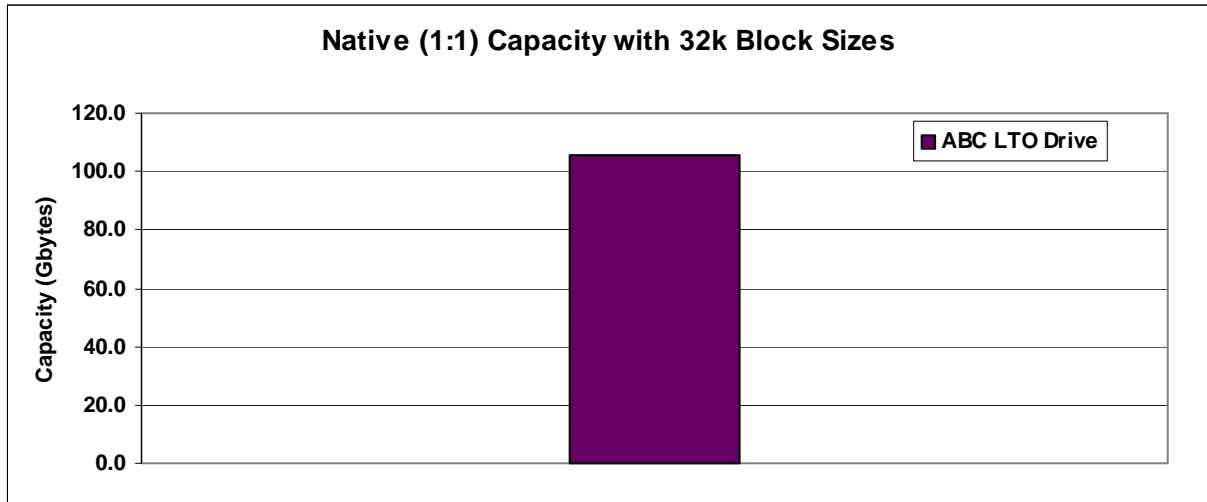
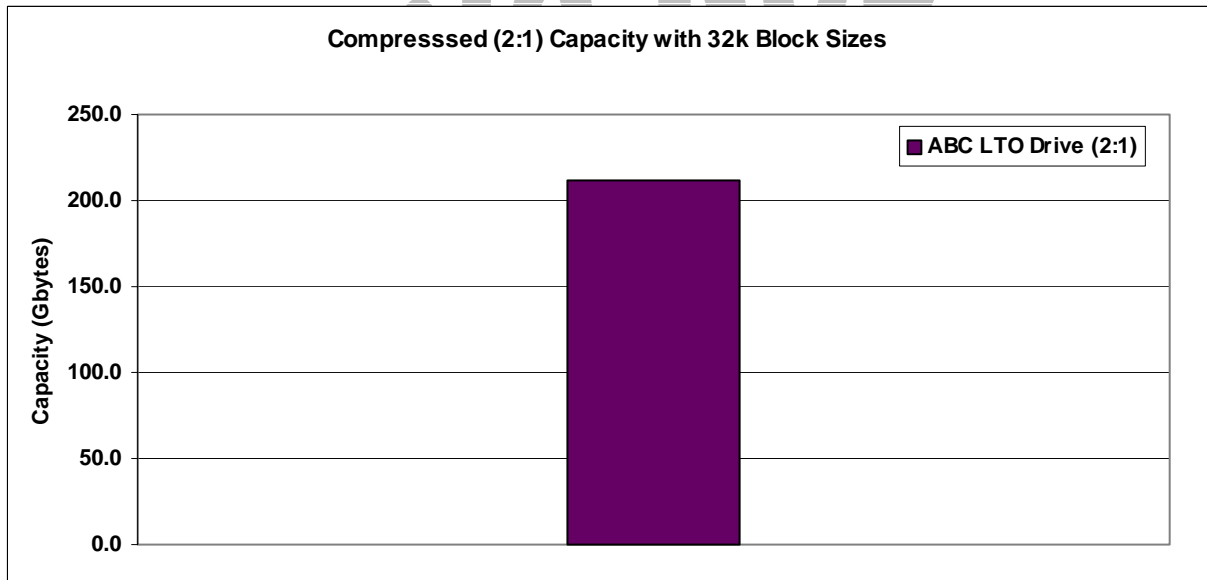


Figure 2: Compressed (2:1) Capacity with 32K Block Sizes



Drive	Native Capacity with 32k Blocks	Compressed Capacity with 32k Blocks
ABC LTO	105,507,115,179	211,986,020,224

2.5 Standardized Block Size Testing - Capacity Writing 64k Records

Objective:

To determine the tape capacity in native (1:1) and compressed (2:1) mode when writing 64k records.

Test Engineers:

Jim Werder, Chris Poore

Method:

Percept Technology Competitive Analysis Test Suite will be used to conduct this testing.

Test "WR64K1" writes 65,536 byte records with compression off, until End of Media is reported. A log sense command was issued every 10 GB to record the write performance.

A rewind command is issued and a read pass performed. A log sense command was issued every 10 GB to record the read performance.

The test was repeated three times, and the tape capacity recorded was the average of the three test runs.

Test "WR64K2" writes 65,536 byte records with compression on, until End of Media is reported. The data used was a pattern that the ABC LTO drive compressed at a ratio of 2:1. 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 test was repeated three times, and the data transfer rate and tape capacity recorded were the average of the three test runs.

Results:

Figure 3: Native (1:1) Capacity with 64K Block Sizes

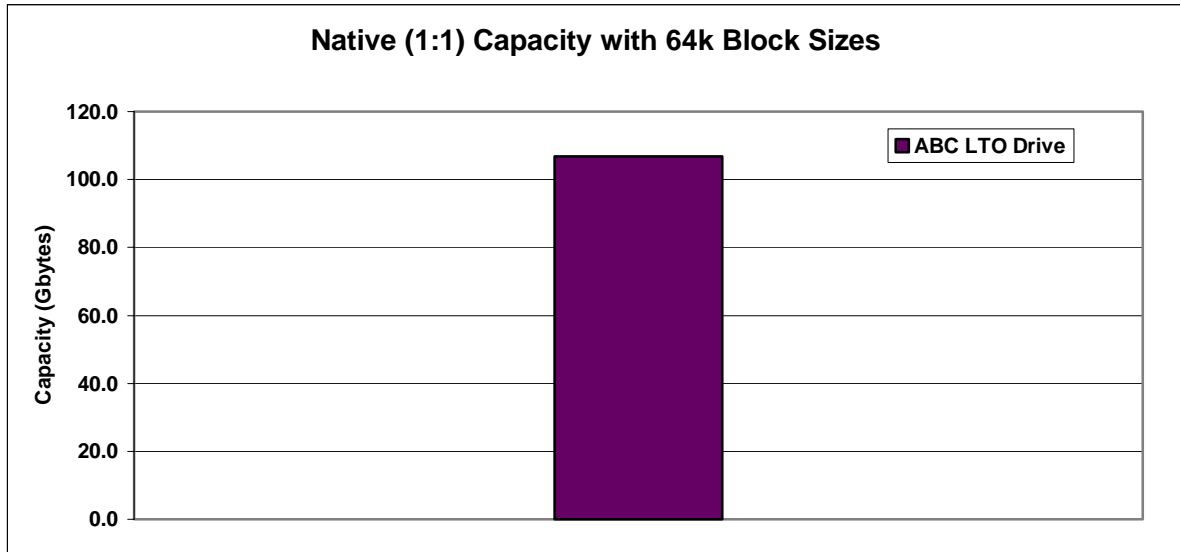
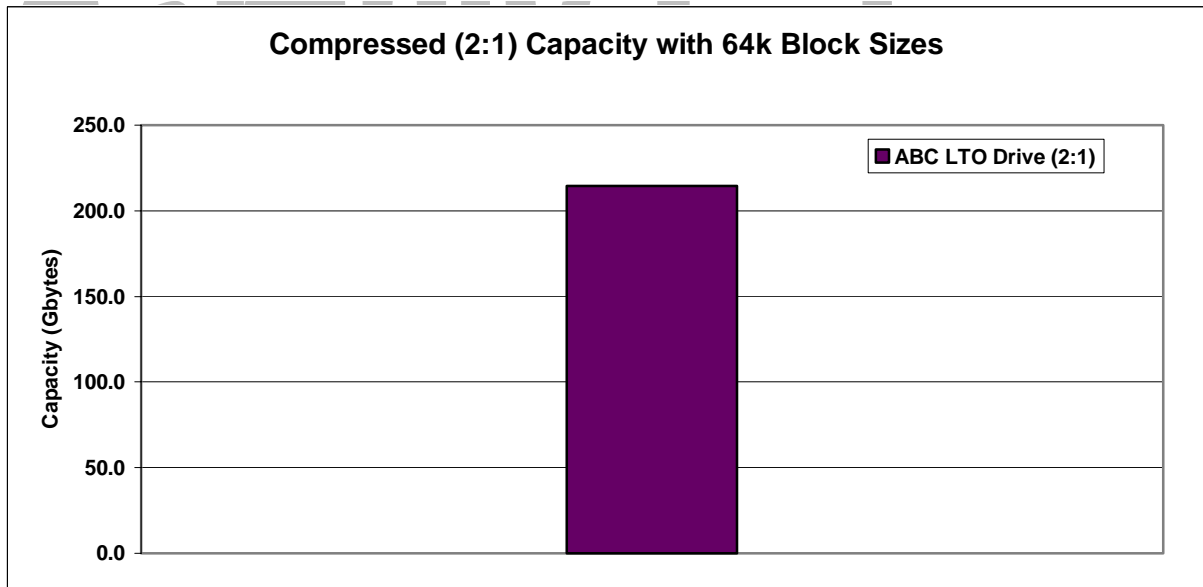


Figure 4: Compressed (2:1) Capacity with 64K Block Sizes



Drive	Native Capacity with 64k Blocks	Compressed Capacity with 64k Blocks
ABC LTO	106,778,634,923	214,572,204,032

2.6 Data Transfer Rates

Objective:

Measure and record the various drive's data transfer rates with different record lengths and compression ratios.

Test Engineers:

Jim Werder, Chris Poore

Method:

Percept Technology Competitive Analysis Test Suite will be used to conduct this testing.

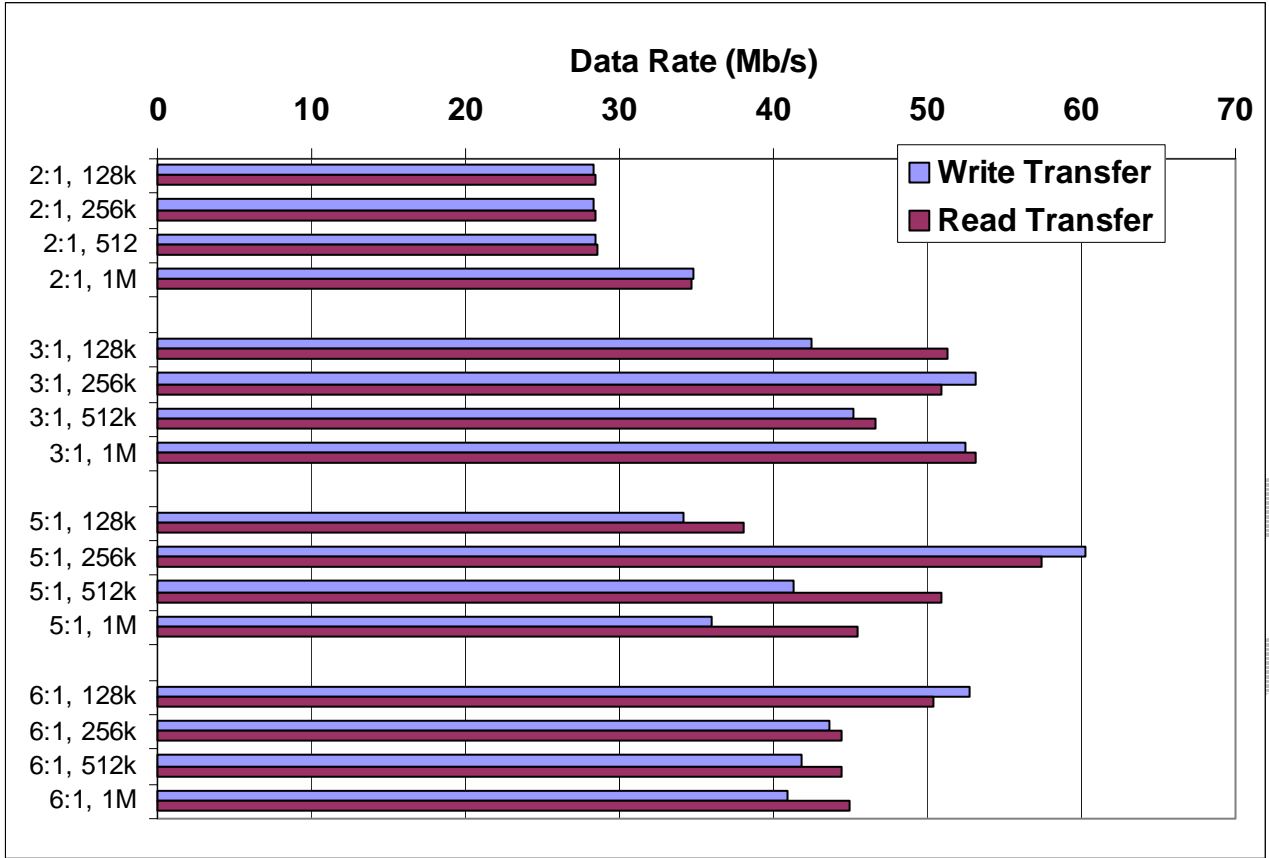
The following block sizes and compression ratios were tested:

Data Block size	Compression Ratio
128k (131,072)	2:1, 3:1, 5:1, 6:1
256k (262,144)	2:1, 3:1, 5:1, 6:1
512k (524,288)	2:1, 3:1, 5:1, 6:1
1 Meg (1,048,576)	2:1, 3:1, 5:1, 6:1

The data used was a pattern that the ABC LTO drive compressed at the desired compression ratio. The data consisted of evenly distributed '1's and '0's for each desired block size. 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).

For each block size and compression ratio, the test was performed three times. The three transfer rates were averaged and recorded as the final data transfer rate. The write transfer rate and the read transfer rate were recorded separately.

Figure 5: ABC LTO Data Transfer Rates:



Compression Ratio	Block Size	Write Transfer	Read Transfer
2:1	128k	28,358,228	28,493,913
	256k	28,358,228	28,493,913
	512k	28,497,904	28,633,589
	1Meg	34,836,412	34,683,368
3:1	128k	42,516,196	51,296,734
	256k	53,137,297	50,876,632
	512k	45,236,238	46,628,928
	1Meg	52,518,381	53,139,415
5:1	128k	34,096,165	38,056,350
	256k	60,198,788	57,339,133
	512k	41,262,353	50,900,535
	1Meg	35,968,373	45,475,822
6:1	128k	52,671,181	50,412,308
	256k	43,690,667	44,382,432
	512k	41,831,489	44,382,432
	1Meg	40,854,577	44,948,439

2.7 ISV Performance - 200 GB Full Backup Tests

Objective:

Perform optimized 200 GB continuous streaming full backups to the ABC LTO tape drive on three hardware/os platforms, with Veritas NetBackup DataCenter and CA BrightStor Enterprise Backup ISV software packages to determine comparative performance characteristics.

Test Platform Matrix:

Compaq ML370 Windows 2000 Server	Compaq ML370 RedHat Linux 7.2	Sun Ultra 10 Sun Solaris 2.8
CA BrightStor Enterprise Backup Veritas NetBackup DataCenter	Veritas NetBackup DataCenter	CA BrightStor Enterprise Backup Veritas NetBackup DataCenter

Method:

Perform full backups using typical customer data.

Veritas NetBackup DataCenter

- Attach the ABC LTO tape drive.
- Install tape drive device driver:
 - Sun: Update st.conf storage configuration file
 - Windows: Install Windows driver obtained from the ABC website
 - Linux: No special driver required
- Run 3 10 GB calibration tuning backups:
 - Format tape for 10 GB backup
 - Run 10 GB backup
 - Adjust ISV tunable settings (as instructed by Veritas, some undocumented) including:
 - Shared memory buffer size
 - Number of shared memory buffers
 - Data fragment size
 - Observe results including:

- Elapsed time
- Data transfer rate
- Buffer statistics
- Run additional 10 GB performance tuning backups until fastest throughput is observed.
- Run 200 GB backup:
 - Format 2 tapes for 200 GB backup (second tape required for spanning)
 - Run 200 GB backup

CA BrightStor Enterprise Backup

- Attach the ABC LTO tape drive.
- Install tape drive device driver:
 - Windows: Install Windows driver obtained from the ABC website
 - Linux: n/a
 - Sun: Update st.conf storage configuration file
- Run 3 10 GB calibration tuning backups:
 - Format tape for 10 GB backup
 - Run 10 GB backup
 - Adjust ISV tunable settings:
 - Shared memory buffer size
 - Number of shared memory buffers
 - Observe results including:
 - Elapsed time
 - Data transfer rate
 - Buffer statistics
 - Run additional 10 GB performance tuning backups until fastest throughput is observed.
- Run 200 GB backup:
 - Format 2 tapes for 200 GB backup (second tape required for spanning)
 - Run 200 GB backup

Dataset

The full backup dataset was comprised of representative customer data.

The "Base" data set used was approximately 3.5 GB of data that was repetitively copied to the tape drive to achieve approximately 200 GB.

- Average file size: Appx. 200 KB
- Max file size: 769 MB
- Min file size: 1 KB
- Appx. 24% compressible data (primarily text files)
- Appx. 76% non-compressible data (executables, binary, zip files)

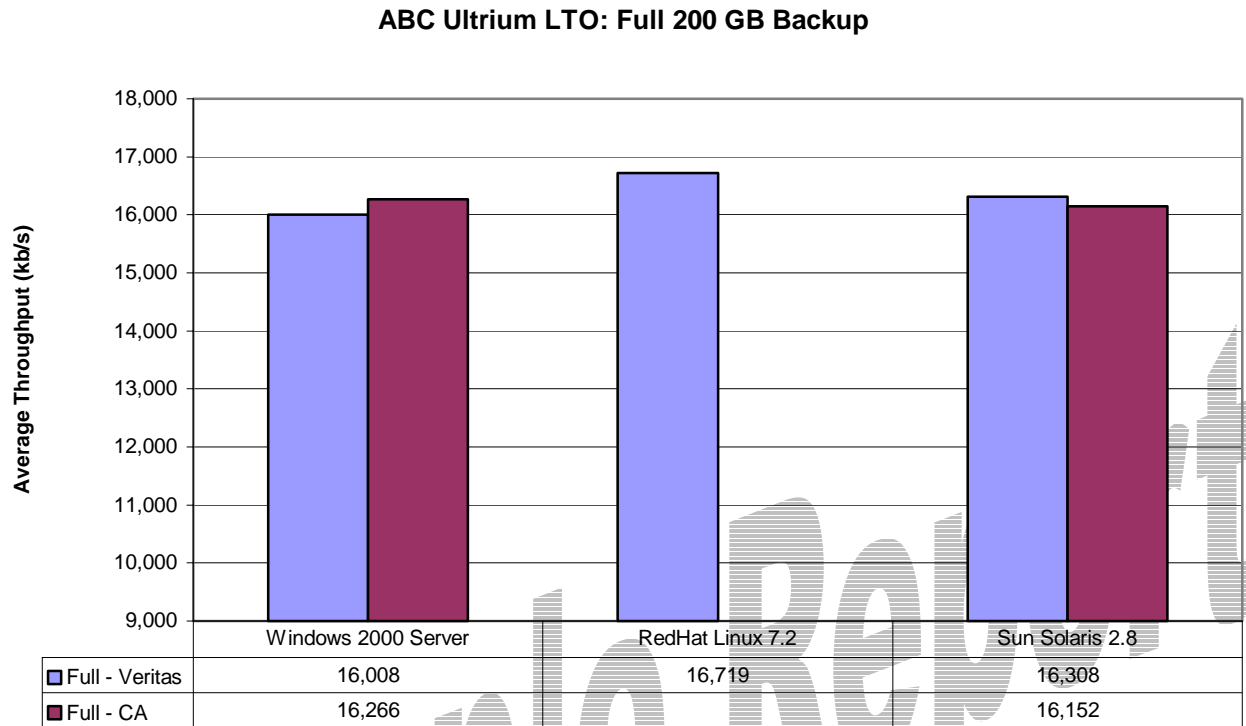
Backup Environment

- Backups were performed direct-connect, with both the internal SCSI 200 GB dataset and the external SCSI tape drive residing on the same test platform machine.
- Software compression off
- Hardware compression on
- To isolate SCSI disk source data traffic from SCSI tape drive traffic, the source data disk resided on one SCSI adapter, and the tape drive resided on a second SCSI adapter.

Sample Report

Results:

Figure 6: ABC LTO: Full 200 GB ISV Backup Transfer Rates



The ABC LTO drive performed consistently across all ISVs and platforms. The best performance was observed on the Linux platform.

3 ISV Device Certification Testing - ABC LTO

3.1 ISV Certification Test Systems - Hardware

Windows 2000 Server

- Intel D850MV Mainboard
- Intel 1.6 GHz Pentium 4
- 512 MB 800MHz RDRAM
- Sony 52x IDE CDROM
- Seagate 18.4 GB 15,000 RPM SCSI Hard Drive
- 32 MB AGP Video Adapter
- Adaptec 29160 SCSI Adapter (#1)
- Adaptec 29160 SCSI Adapter (#2)

RedHat Linux 7.2 Server

- Intel D850MV Mainboard
- Intel 1.6 GHz Pentium 4
- 512 MB 800MHz RDRAM
- Sony 52x IDE CDROM
- Seagate 18.4 GB 15,000 RPM SCSI Hard Drive
- 32 MB AGP Video Adapter
- Adaptec 29160 SCSI Adapter (#1)
- Adaptec 29160 SCSI Adapter (#2)

ABC LTO Tape Drive

- Hardware Version: 3.6
- Firmware Version: v8.1

3.2 ISV Certification Packages and OS Platforms Tested

- Legato NetWorker 6.2 on Windows 2000
- Legato NetWorker 6.2 on RedHat Linux 7.2
- Legato Device Qualification Test (DQT) Suite, v140

3.3 ISV Certification Server Platform Setup: Legato NetWorker 6.2 - Windows 2000

3.3.1 Prepare Hardware

- Power-off certification server
- Attach external SCSI bootable disk drive to SCSI adapter 1
- Attach external ABC LTO to SCSI adapter 2
- Power-on certification server

3.3.2 Install Windows 2000 Server OS and ABC LTO Device Driver

- Perform fresh format on external SCSI disk drive
- Install Windows 2000 Server, SP2 image (fast restore from ghost image)
- Install ABC LTO device driver

3.3.3 Install Windows 2000 Version of Legato NetWorker 6.2 and Legato Device Qualification Test v140

- Install Legato NetWorker 6.2 ISV software
- Install NetWorker Device Qualification Test (DQT) v140 test script package and tools
- Install DQT-required tools:
 - Perl
 - Cygwin
 - TCL

3.3.4 Prepare ABC LTO Tape Slot Insertions

- Insert autoloader tapes into slot assignments, per Legato specifications

3.3.5 Configure NetWorker and DQT Software

- Verify that the autoloader can communicate on the SCSI bus by issuing the NetWorker command `inquire`.
- Using the NetWorker GUI, configure appropriate settings for certification testing
- Using the DQT configuration tools, create the configuration for the ABC LTO DQT settings
- Run a short library tape-labeling and backup test (using the Legato jukebox tool `nsrjb`) to validate that the certification hardware and software environment is fully ready to begin the automated DQT tests

3.3.6 Run the Legato NetWorker DQT Certification Tests

- Invoke the automated test script in attended mode
- Make selections to configure automated test behavior, then choose to start the test

The DQT scripts generate log files that contain the results of the automated tests. Percept submitted these log files, as required, to the Legato Device Certification Group.

3.4 ISV Certification Platform Setup: Legato NetWorker 6.2 - RedHat Linux 7.2

3.4.1 Prepare Hardware

- Power-off certification server
- Attach external SCSI bootable disk drive to SCSI adapter 1
- Attach external ABC LTO to SCSI adapter 2
- Power-on certification server

3.4.2 Install RedHat Linux 7.2 Server OS and ABC LTO Device Driver

- Perform fresh format on external SCSI disk drive
- Install RedHat Linux 7.2, kernel 2.4.18 image (fast restore from ghost image)

3.4.3 Install RedHat Linux 7.2 Version of Legato NetWorker 6.2 and Legato Device Qualification Test v140

- Install Legato NetWorker 6.2 ISV software
- Install NetWorker Device Qualification Test (DQT) v140 test script package and tools

3.4.4 Prepare ABC LTO Tape Slot Insertions

- Insert autoloader tapes into slot assignments, per Legato specifications

3.4.5 Configure NetWorker and DQT Software

- Verify that the autoloader can communicate on the SCSI bus by issuing the NetWorker command `inquire`.
- Using the NetWorker GUI, configure appropriate settings for certification testing
- Update NetWorker Linux shell scripts to point to appropriate tool paths
- Using the DQT configuration tools, create the configuration for the ABC LTO DQT settings
- Run a short library tape-labeling and backup test (using the Legato jukebox tool `nsrjb`) to validate that the certification hardware and software environment is fully ready to begin the automated DQT tests

3.4.6 Run the Legato NetWorker DQT Certification Tests

- Invoke the automated test script in attended mode
- Make selections to configure automated test behavior, then choose to start the test

The DQT scripts generate log files that contain the results of the automated tests. Percept submitted these log files, as required, to the Legato Device Certification Group.

4 ISV Device Certification Testing Results

4.1 Windows 2000 Certification Test Exceptions - Legato NetWorker 6.2

The Windows 2000 testing completed successfully, with no exception conditions.

4.2 RedHat Linux 7.2 Certification Test Exceptions - Legato NetWorker 6.2

During the RedHat testing, the DQT interactively reported an exception condition that arose during a "read element status" operation. Upon discussion with Legato DQT engineers, it was determined that this was not a critical error, and that the RedHat DQT testing should be resumed.

A second exception occurred when the DQT attempted to invoke the "tapeexercise" command. Legato engineers instructed Percept to manually invoke the command from a bash shell, and cut-and-paste the command output back into the DQT log file. The manual invocation of the "tapeexercise" command completed successfully.

4.3 Submission of Results to Legato

The DQT log files from Windows 2000 and RedHat Linux 7.2 were submitted directly to the Legato Device Certification Group for review.

No re-testing was required, and Legato approved the Windows 2000 and RedHat Linux 7.2 Percept DQT submissions for the ABC LTO Firmware v8.1.

The Windows 2000 certification was posted to the Legato website "Hardware Compatibility Guide" on August *n*, 2002.

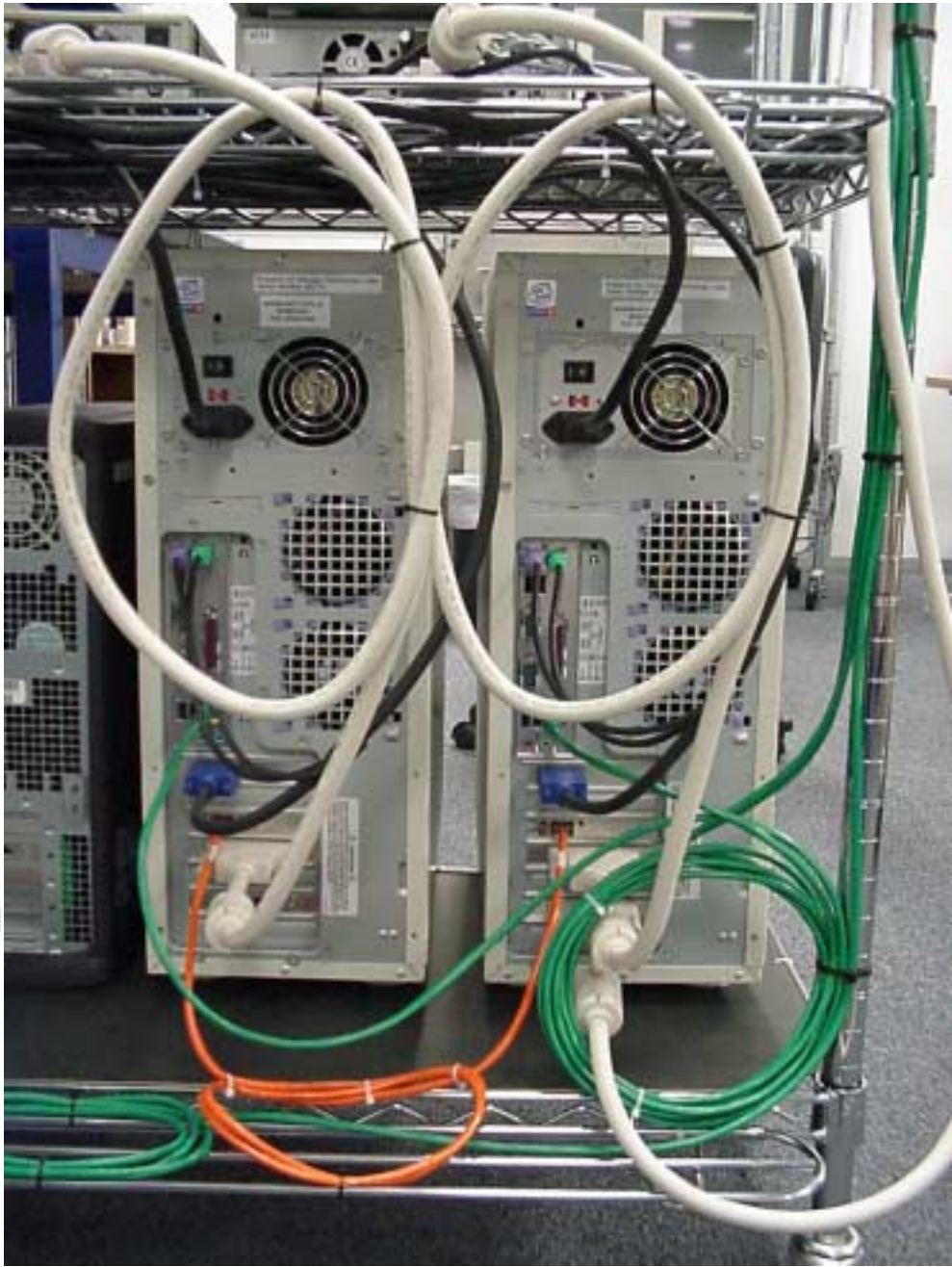
The RedHat Linux 7.2 certification was posted to the Legato website "Hardware Compatibility Guide" on August *n*, 2002.

5 Percept ISV Lab Photos

5.1 Photo 1: ISV Device Certification Servers - Front View



5.2 Photo 2: ISV Device Certification Servers - Rear



5.3 Photo 3: ISV Device Certification Server - Interior



5.4 Photo 4: External Seagate Ultra-160 SCSI Disk Drive



Sample Report

5.5 Photo 5: Compaq ML370 ISV Performance Test Servers



5.6 Photo 6: Sun Ultra 10 ISV Performance Test Server

