

Business Case Analysis: Implementation of LTO-2 Tape Drive Technology For a Large Business

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Overview

Explosive data growth, 24x7 operations, and business-critical applications have made data backup and storage a central issue for large businesses. These large businesses represent financial institutions, media, retail, transportation, and shipping industry leaders. New solutions are required to meet these quickly increasing demands. Periodically these companies evaluate a variety of options including improvement in the backup/restore rates, data reliability, drive reliability, and tape capacity to meet business objectives.

In this white paper we compare the capability of the existing DLT 8000 and LTO-1 tape drives with the latest LTO-2 technology for a large business having hundreds of terabytes of business critical data. This paper will describe how LTO-2 tape drives can provide twice the performance and capacity of the current system.

Existing System

For this white paper, we consider a scenario where a large business has an Enterprise Tape Backup System (ETBS) that uses central backup servers, tape libraries, and COTS (commercial off-the-shelf) software to back up operating system configuration, database schema, and data files for hundreds of servers and clients within a large enterprise. The ETBS must support servers that run a variety of operating systems including the following: HP-UX, Solaris, Linux, AIX, and Windows NT/2000/XP.

In this scenario the business collects, generates, and manages a vast amount of critical data. While much of this data is static, a significant portion of it changes daily. Managing this information effectively requires an enterprise-wide data backup and archive solution. ETBS uses tape libraries from Quantum, Hewlett Packard, ADIC and tape drives from IBM and Quantum. Veritas NetBackup 4.5 is used as the backup application software.

Tape Drive Technology Comparison

In this section we compare the current and potential tape drive technologies that are available in the backup industry.

DLT 8000

DLT 8000 is suitable for backup/recovery, archiving for mid-range systems. It is practical and affordable for a wide range of applications, and is supported on a variety of operating systems. The important characteristics of DLT 8000 are as follows:

- Native capacity of 40GB at 6 MB/s
- 80GB (2:1 Compression) at 12 MB/s
- Read and Write backward compatible with all DLT tape formats
- Scalability for future storage needs
- Four read/write channels for high performance
- Open system, supported by many manufacturers
- 250,000 hours MTBF (mean time between failure) at 100% tape motion

LTO Four-Generation Roadmap

Linear Tape Open (LTO) Technology is a joint initiative of Hewlett-Packard, IBM and Seagate. The Four-generation roadmap provides up to 1600 GB per cartridge (2:1 compression) in Generation 4 with compressed transfer rate of up to 320 MB per second.

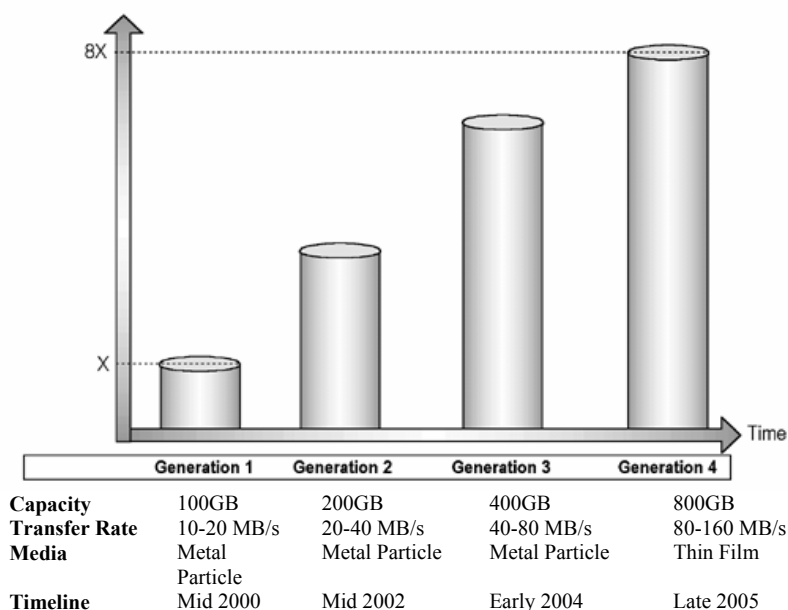


Exhibit A – LTO Four-Generation Roadmap

LTO-1

LTO-1 Ultrium Tape Drive is the first of the LTO Ultrium Four-Generation roadmap. It is ideally suited for backup/restore applications and provides excellent performance and reliability. It is designed to handle multiplatform tape storage requirements in automated storage, SAN (Storage Area Network), and NAS (Network Attached Storage) environments. The important characteristics of LTO-1 are as follows:

- Native capacity of 100GB at 10-20 MB/s
- 200GB (2:1 Compression) at 20-40 MB/s
- Adheres to widely supported LTO design specifications
- Scalability for future storage needs

LTO-2

LTO-2 Ultrium Tape Drive is the second generation of the LTO Ultrium Four-Generation Roadmap. The benefits of the LTO-2 tape drive are increased capacity, data transfer rates, and reliability. The important characteristics of LTO-2 are as follows:

- Native capacity of 200GB at 20-40 MB/s
- 400GB (2:1 Compression) at 40-80 MB/s
- 2GB FC (Fibre Channel) and Ultra-160 SCSI (Small Computer System Interface) LVD (Low Voltage Differential) interface
- Backward read/write compatible with LTO-1 media
- Digital speed matching adjusts drive to its native data rate to match host data rate
- 64MB buffer masks the impact of data rate fluctuations
- PRML (Partial Response Maximum Likelihood) channel is used to read/write new tapes and enable backward read/write compatibility

LTO-3

LTO-3 Ultrium Tape Drive is the third generation of the LTO Ultrium Four-Generation Roadmap. LTO-3 technology will begin to be available during the first half of 2004. It provides double the capacity and performance over LTO-2. The important characteristics of LTO-3 are as follows:

- Native capacity of 400GB at 40-80 MB/s
- 800GB (2:1 Compression) at 80-160 MB/s
- 2GB FC and Ultra-160 SCSI LVD interface
- Backward read/write compatible with LTO-2 media
- Digital speed matching adjusts drive to its native data rate to match host data rate

- PRML (Partial Response Maximum Likelihood) channel is used to read/write new tapes and enable backward read/write compatibility

Capacity and Performance Comparison

Table A gives the side-by-side capacity and performance comparison for the LTO-1, LTO-2 and LTO-3 tape drives. DLT 8000 tape drives are excluded from the comparison because of significantly lower capacity and data transfer rates.

	LTO-1	LTO-2	LTO-3
Capacity (Native)	100GB	200GB	400GB
Capacity (Compressed)	200GB	400GB	800GB
Transfer Rate (Native)	10-20 MB/s	20-40 MB/s	40-80 MB/s
Transfer Rate (Compressed)	20-40 MB/s	40-80 MB/s	80-160 MB/s
Read/Write	4 m/s	6.2 m/s	*
Search/Rewind	6 m/s	8 m/s	*
Load Time to BOT (beginning of tape)	15 s	15 s	*
Average Access Time (from BOT)	73 s	46 s	*
Maximum Rewind Time	110 s	80 s	*
Speed Matching	No	Yes	*
Power Consumption	SCSI: 41W FC: 47W	SCSI: 29W FC: 32W	*
Connectivity	SCSI 1Gb FC	SCSI 2Gb Fabric	*

Source: LTO Ultrium Four-Generation Roadmap

* - Manufacturer data not available yet

Table A: Capacity and Performance Comparison for LTO-1, LTO-2, and LTO-3

Next Generation Enterprise Tape Backup System

The next generation of ETBS will use newer backup technologies such as: SAN connected tape libraries, dynamic tape sharing, multiplexing, multi-streaming, and a multi-tiered storage incorporating disk as near line storage. These technologies will help to generate larger data streams and can therefore make use of the capacity and performance of LTO-2 tape drives.

The challenge is, however, to generate a sufficiently large data stream in any of the backup domains to use LTO-2 technology. Without the implementation of the enhancements, it will be very difficult to generate these data streams.

LTO-2 Technology Lab Testing

Various backup and restore tests were performed to evaluate the performance and reliability of the LTO-2 tape drive:

- Full backup and restore for Direct Attached tape drive including multiplexing and multi-streaming
- Full backup and restore using Shared Storage Option (dynamic tape sharing) including multiplexing and multi-streaming

These tests were performed for both the LTO-1 and LTO-2 tape drive and results were documented. The maximum data transfer from the tests on the LTO-2 tape drive was 38.41 MB/s, as compared to 15 MB/s for LTO-1. In addition, the following functionalities were successfully tested for the LTO-2 tape drive:

- High native capacity per tape cartridge
- High compressed capacity per tape cartridge
- High drive transfer rate (both native and compressed) for backup, restore and archiving applications
- Backward read/write compatibility
- Supported on all the operating systems
- Data Reliability
- Increased speed and throughput as compared to LTO-1
- Faster load and unload as compared to LTO-1
- Faster data access as compared to LTO-1
- Integration with existing tape libraries

Cost Estimation

Assumptions

- Payback for replacing existing LTO-1 drives with new LTO-2 drives is not considered
- LTO-1 and LTO-2 tape drives can co-exist in the same tape library
- The price quotes include the acquisition and the installation cost
- The cost for maintenance or service renewal is not considered, as it is the same for both LTO-1 and LTO-2 tape drives
- Four drives are added at a time to get maximum benefit from the fibre channel bridge
- All existing FC230 bridge cards in a tape library must be replaced when adding FC470 2GB cards. Therefore, it is not possible to partially upgrade a Quantum library.

Scenario(s) for Cost Estimation

- **Cost Estimation for adding new tape drives to an existing library**

We have estimated that the cost of adding LTO-2 tape drives in an existing Quantum P7000 library is approximately 40% more than the cost of adding LTO-1 tape drives.

- **Cost Estimation for purchasing a new library**

We have estimated that the cost of purchasing a new Quantum P7000 library with 16 LTO-2 tape drives is approximately 33% more than the cost of purchasing the same library with 16 LTO-1 tape drives.

- **Upgrade existing P7000 tape library with LTO-2 tape drives**

The acquisition and installation cost for upgrading existing tape library containing 16 LTO-1 drives with the same number of LTO-2 drives is approximately \$250,000.

Limitations

The limitation with LTO-2 is that it **may be slower in a configuration where the user is unable to generate a sufficiently large data stream** to keep the tape running continuously. Time is wasted when the tape must stop, wait for data and then start again. LTO-2 technology should be evaluated on a case-by-case basis and used only in conditions of large data capacity throughout.

Conclusion

LTO-2 technology represents an important step forward in LTO-4 Generation roadmap. It does not immediately replace the older technologies, such as DLT and LTO-1, that are adequate in many of the existing applications. We summarize here some of the most important benefits of this technology and follow with specific recommendations for large businesses to consider.

Highlights of LTO-2 Technology

- LTO-2 technology requires only half the number of tape drives to get the same amount of backup capacity (as compared to LTO-1 at only 33% extra cost). With LTO-2 technology, the user gets double the backup speed (40-80 MB/s as compared to 20-40 MB/s for LTO-1 tape drives).
- LTO-2 tape cartridges are backward compatible with LTO-1 to read and write with reduced capacity.

- Existing tape libraries can be upgraded to LTO-2 technology or can co-exist within the same library with LTO-1 drives.
- LTO-2 provides increased reliability over LTO-1.
- LTO-2 provides 2GB SAN connection when used with a FC470 bridge card.
- LTO-2 can double performance at only a 33% increase in cost.
- LTO-2 technology can be easily incorporated into existing architecture with minimal expense.
- No additional training or changes to operating procedures are required.

Recommendations

It is recommended that large businesses should consider investing in the LTO-2 technology where there is a need to reduce the backup window and the associated servers, and the application software can utilize the increased speed and capacity. Large businesses should evaluate the use on a case-by-case basis, as it would not be appropriate for all systems especially where only a small amount of data are required to be backed up. In addition, the following factors should be considered for maximizing the benefits associated with LTO-2 tape drive technology:

- **Replace 1Gb FC230 bridge with 2Gb FC470 bridge**

The FC230 bridge is a potential bottleneck that will limit the performance of LTO-2 because it supports a maximum 1Gb (100 MB/s) transfer rate, thus allowing only two LTO-2 drives to be connected. In addition, two LTO-2 tape drives with compression enabled could process an aggregated 160 MB/s (Refer to Table A) and exceed the bandwidth of the bridge. This bandwidth limitation leads to the primary reason for adhering to the design rules in Table B. The FC470 bridge supports 2Gb (200 MB/s), thus allowing up to four LTO-2 drives or eight LTO-1 drives per bridge.

FC Card	Drive Type	Maximum drives supported
FC230	LTO-1	4
FC230	LTO-2	2
FC470	LTO-1	8
FC470	LTO-2	4

Table B: FC Card and Drives Supported

- **Use LTO-2 Tape Cartridge**
LTO-2 tape cartridges provide double the native capacity as compared to LTO-1 (200GB as compared to 100GB for LTO-1). In addition, backup time is reduced because the library will spend less time swapping and managing tapes.
- **Perform block level backup as compared to file level backup**
Use block level backup where possible (e.g. Veritas Flash Backup). Block level backup can generate larger data streams, thereby enabling the user to maximize the performance of LTO-2 technology.

Abbreviations and Acronyms

AIS	Automated Information System
ATL	Automated Tape Library
BOT	Beginning of Tape
COTS	Commercial off-the-shelf
DLT	Digital Linear Tape
ETBS	Enterprise Tape Backup System
FC	Fibre Channel
Gb	Gigabit
GB	Gigabyte
GSA	General Services Administration
HP	Hewlett-Packard
IT	Information Technology
LTO	Linear Tape Open
LVD	Low Voltage Differential
Mb	Megabit
MB	Megabyte
MTBF	Mean Time Between Failure
OS	Operating System
PRML	Partial Response Maximum Likelihood
SAN	Storage Area Network
SCSI	Small Computer System Interface

References

1. www.qualstar.com/sales_literature/IBM_LTO2_Technology.pdf
2. <http://www.quantum.com/AM/products/dlt/dlt8000/default.htm>
3. DLT Solutions, Inc. – www.dlt.com/storage
4. <http://www.storage.ibm.com/tape/lto/index.html>