SPECTRA

2022

Understanding LTO-9 Tape Technology

Introduction

This 2022 Spectra Logic Report on new methods for migrating to LTO-9 sheds light on the technological advancements achieved with the latest LTO generation. This white paper guides users on what types of data should be migrated and when, and explains the benefits of the three types of migrations available – hard, soft and hybrid

Table Of Contents

Incorporating LTO-9 Tape Technology

"Growth is never by chance; it is the result of forces working together" – James Cash Penney

You may recognize the name 'James Cash Penney' better by his initials – JC Penney – as in the JC Penney department stores. A renowned U.S. businessman, Penney's quote above has been proven time and time again, but never so resolutely as in the storage world by the Linear Tape Open (LTO) Consortium. It was unprecedented when, in 1998, IBM, Hewlett Packard and Seagate/Certance* jointly developed LTO tape technology. The goal was to create an open format tape technology allowing users to draw from multiple sources for tape media and tape drives with compatibility between the three manufacturers. The results have been astounding. Leading in tape and tape drive shipments, the LTO consortium has produced 9 generations of technology, with at least three more generations on the roadmap.

**The Certance division was later sold to Quantum who is the third alliance member today*

Drive	LTO-1	LTO-2	LTO-3	LTO-4	LTO-5	LTO-6	LTO-7	LTO-8	LTO-9
Year	2000	2003	2005	2007	2010	2012	2015	2018	2021
Capacity (native)	100 GB	200 GB	400 GB	800 GB	1.5 TB	2.5 TB	6 TB	12 TB	18 TB
Performance (native)	20 MBs	40 MBs	80 MBs	120 MBs	140 MBs	160 MBs	300 MBs	360 MBs	400 MBs

LTO Roadmap

Drive	LTO-10	LTO-11	LTO-12
Year	TBD	TBD	TBD
Capacity (native)	Up To 36 TB**	Up To 72 TB**	Up To 144 TB**
Performance (native)	TBD	TBD	TBD

***Projected by LTO Consortium*

Earlier versions of LTO tape drives used Giant Magnetoresistive (GMR) read/write heads which have reached their density limits. With LTO-8 and now LTO-9 rising to the ever-increasing demand for capacity, speed and reliability by incorporating Tunneling Magnetoresistive (TMR) read/write heads. These heads provide a four times improvement in signal sensitivity, are less susceptible to noise and media discrepancies, and run cooler than previous GMR heads. Not only do the new TMR heads provide greater density and performance, they also provide greater reliability.

LTO-9 utilizes Barium Ferrite media, similar to LTO-7 and LTO-8 (vs. metal particle), in order to continue the significant gains in capacity as shown via the above roadmap. The new TMR heads and Barium Ferrite media affect how LTO-9 interfaces with earlier versions of LTO tape.

A Break from Tradition

Historically, new versions of LTO technology have been able to "read back" two generations and "write back" one generation. LTO-7 was able to read both LTO-5 and LTO-6 tape cartridges and could write to LTO-6 cartridges. With LTO-8 and LTO-9, the move to new TMR read/write heads, as well as new Barium Ferrite media, has limited this backward compatibility to a single generation. LTO-8 reads and writes to LTO-7, but does not read from LTO-6 tape cartridges, and LTO-9 reads and writes to LTO-8, but does not read from LTO-7 tape cartridges. This may affect how current LTO users approach an upgrade to LTO-9. Below are possible scenarios for both upgrading to new drive technology as well as some considerations around the migration of older media.

Upgrade Considerations

It's not uncommon for users of LTO tape technology to "skip" a generation between upgrades. In large part, this has been influenced by the increase in capacity and/or performance as well as the ability to read back two generations. The increase in capacity from LTO-5 to LTO-6 was modest – going from 1.5TB to 2.5TB per tape cartridge (native). Understandably, many felt the increase in capacity was not significant enough to compel an upgrade. Those users may have chosen to wait until LTO-7 was available. The increase from LTO-6 to LTO-7 was much greater in both capacity and performance. At 300 MB/s performance and 6TB per cartridge capacity (both native), LTO-7 was an impressive upgrade. Users who skipped the LTO-6 upgrade (remaining on LTO-5 until the release of LTO-7), saw an increase in capacity of 300 percent and an increase in performance of 115 percent over their prior LTO-5 tape technology.

Skipping a single generation still allowed users to read all of the media in their tape library with the new drive technology since we had the ability to read back two generations. Most users upgraded all of the tape drives in their system, continued to do reads or restores from their older LTO-5 media, and used new LTO-7 media for all writes. There was no drawback to skipping a generation between releases. If users skipped two generations – LTO-4 to LTO-7 – they had to consider what to do with a generation of tape (LTO-4, in this case) which could no longer be read by the new LTO drives (LTO-7).

Today, both of the above scenarios have changed. We are seeing much larger increases in capacity between LTO-7 and LTO-8 (6 TB) and between LTO-8 and LTO-9 (6TB). The LTO roadmap suggests these significant increases will continue to increase between future LTO releases. This makes for a much more compelling argument for upgrading between each release. Likewise, the ability to read/write back a single generation makes a more convincing argument for upgrading between each release to make forward migration and data access easier.

Migration Considerations

Which data tapes need to be migrated and which do not?

Most data centers will have a very large number of tapes, not only in the library but also archived – onsite, offsite or both. Obviously, it would be ideal to simply have all data stored on old media be converted to the new media. But in many cases this is not necessary, or for that matter, practical. It may be helpful to determine which data sets need to be migrated before determining the tape technology needed for the migration. Ideally users can categorize to some extent which media will be migrated and which will not. Media aging out in the near future ("near future" being defined by the user) should be allowed to age out and be removed from the migration pool. There are data sets which are highly likely to never be accessed again on one end of the spectrum and data sets which are very likely to be recalled on the other end. Below is a general categorization of parameters to consider when embarking upon migration and calculating both the time and resources which will be required.

1. **Active Archives**

   We use the term "active archive" to refer to archived data that has a high likelihood of being accessed in the future and also has a significant retention life.

   a) The tapes which hold this type of archived data are the highest priority for either soft or hard migration (explained in the following section).

   b) Active Archive tapes will hereinafter be referred to as "high-touch" media.

2. **Backup Tapes**

   Here we're referring to the tapes used to perform ongoing daily and weekly backups. The value of any given backup set diminishes quickly. Once a given set of full and incremental backups is followed by the next week's set of full and incrementals, the value of the first set is significantly reduced. Users typically go to the most recent backup copy for restoration. Although the words "backup" and "archive" are sometimes used interchangeably, in this discussion we do not consider a set of backups as "archive" data. Archive data will be discussed next.

   a) New backups will immediately be directed to the new partition of the library.

   b) In most instances, existing backup tapes are never migrated to the new tape technology. In some instances, approximately 90 days' worth of backup sets may be migrated.

   c) Backup tapes will hereinafter be referred to as "no-touch" media.

3. **Compliance Archives**

   Here we're referring to data which has specifically been archived for compliance mandates – usually dictated by government or industry policies.

   a) Definite expiration date.

   b) User usually has a long window for finding and recalling.

c) We are suggesting it not be migrated if lifespan is down to less than three additional years.

d) If not migrated to new media, the user will require at least one drive for the duration of the compliance retention period which is compatible with the media set retained.

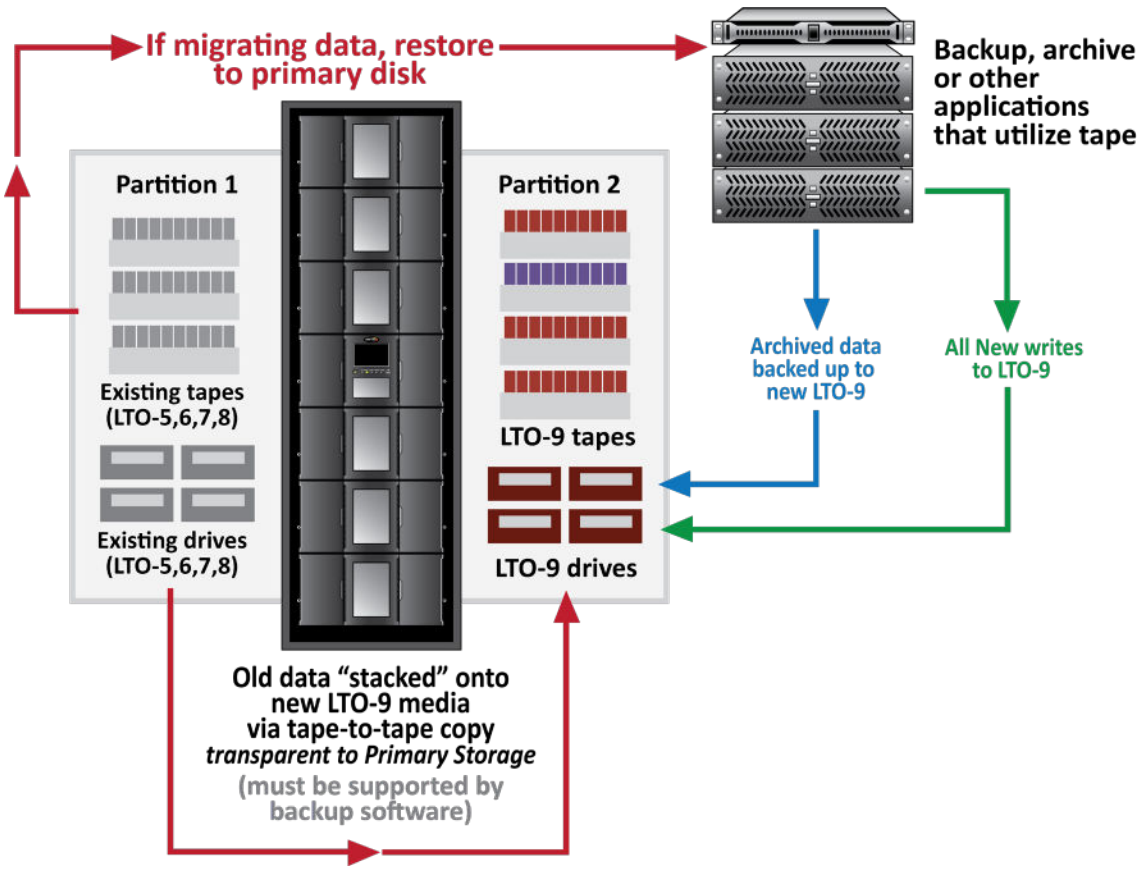
e) Compliance archive tape will hereinafter be referred to as “low-touch” media.

Even a low-level categorization of which tapes need to be migrated and which can remain on current media generation will greatly help in laying out the migration plan and/or how new tape drive generations will be incorporated into the existing system.

Migration Considerations – Hard Migration

A “hard migration” refers to restoring data from existing backup and archive tapes to primary storage and then backing it up again to the new tape drives and media. One might also refer to this as a “traditional” migration.

Hard Migration Scenario



The current tape library will be partitioned for LTO-6 (or older) LTO media and drives as well as a separate partition for new LTO-9 media and drives. Partitions which are dedicated to older LTO generation drives and tapes will hold the existing "high-touch" and "low-touch" data mentioned above.

The backup/archive software will be directed to restore the data from older generations of LTO media to disk. The backup/archive software will then be scheduled to re-write those data sets to the new LTO-9 media. This process will continue until all media designated for migration is moved to LTO-9 media. Since this requires a full restore and rewrite, it is performed in the background as time and resources allow. Simultaneously, new writes will be directed to the LTO-9 partition.

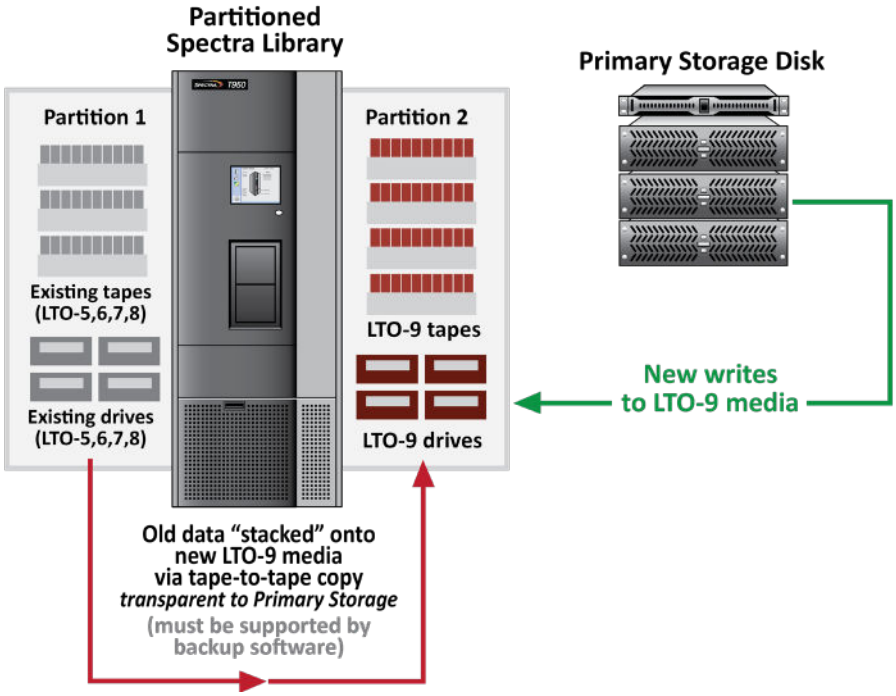
When all data/media is migrated, the library partitions dedicated to older generation media and drives can be reduced in size and used for the rare restoration of data designated as "no-touch" until the retention period for that remaining data has passed. At that point, all older LTO partitions will be decommissioned.

Migration Considerations – Soft Migration

The challenge of the hard migration, outlined above, is that there must be sufficient storage space in primary data storage to restore older information before backing it up again to the new media. As will be mentioned below, Spectra often offers short-term rental/lease of Spectra's NAS storage solution for this process. "Soft" migration refers to a migration process which does not require the older information be restored before being written to the new media. This is a function of the specific backup/archive software application being used. It's often referred to as "tape stacking" or "tape-to-tape copy." Not all backup applications support these features and not all support them in the same manner. For those that do, information from older tapes can often be "stacked" onto the new tape media without having to be restored first.

Due to the fact that data doesn't need to be restored first, the process can run in the background during low periods of use for the tape library. A soft migration is typically completed more quickly.

Soft Migration Scenario



The above diagram for soft migration also denotes partitions being setup for older media and drives to keep them segregated from the new media and drives. This can always be done via the Spectra Tape Library. It is possible to accomplish this via the backup/archive software if the software supports a feature often referred to as "Media Pool Functionality." This feature allows the software to designate media pools and identify media and drive type without creating a virtual partition within the library. This can be preferable as software applications often charge a license fee for virtual partitions created by the library itself because the software would see this as two libraries.

Obviously, a full understanding of both the software and hardware involved in migration is imperative. In the appendix of this white paper we show a partial list of independent software vendors we believe are able to support tape stacking and media pool functionality which may make soft migration possible. These terms may vary from vendor to vendor, but the concepts will be clear. Please confirm your software's ability with the given manufacturer before planning migration.

The goal of both hard and soft migration is to eventually move all data from older LTO media to LTO-9 media. While multiple partitions, or divisions of media and drive types, can be maintained in the tape library indefinitely, as mentioned above, some backup applications may charge licensing fees based on number of drives or partitions being used. In that situation, it would be ideal to minimize the number of partitions and/or drives being used.

Migration Considerations – Hybrid Migration

A hybrid approach, utilizing both hard and soft migration, could be used by data centers who wish to maintain older LTO media in the tape library for an extended period of time. All new writes go to LTO-9, high-touch data could be migrated in the background, and the low-touch data could be left on older media indefinitely as long as a partition configured with that LTO drive type is maintained. The only "forced" migration would occur as LTO drive types reach end of support life. This approach may become more common with newer generation tape drives only reading back one generation.

Migration Considerations – The Backup/Archive Application Being Used

As mentioned above, the backup or archive application used to create backups or archives can play a key role in introducing new generations of tape drives or migrating existing backup/archive tapes from one generation, or even a different type of media, to another.

If an organization is preparing to do a full migration of all data and media, it may be a good time to evaluate their current backup/archive software. If a new backup or archive application is being considered, this would be an ideal time to make such a change. The ability to designate media pools and stack older tapes onto newer tapes without a full restore (described above under soft migration) are two features which will assure that future migrations are performed as easily as possible.

How Spectra Can Help

Spectra has been dedicated to storage for over 40 years. Our experience in maintaining and migrating long-term data is second to none. We are the only manufacturer capable of running all three major media types in a single tape library – LTO, IBM® TS Tape Technology, and all generations of Oracle's T10000. Our professional services organization consults with customers regularly to create and implement the most effective and economical migration path possible. We even offer customized leasing of hardware to help implement migration when needed.

Contact your Spectra Sales Representative to find out how Spectra can support your organization in all aspects of long term retention and migration of data.

APPENDIX*

Software Package	Supports Tape Stacking	Supports Media Pool Functionality	Duplication of Backup Sets	Soft Migration May Be Possible	Hard Migration Required
ArcServe (CA)*	X	X	X	X	
Avamar (EMC)					X
Backup Exec (Veritas)	X	X	X	X	
Backup Express (SyncSort)					X
DIVA (Oracle)					X
DMF (SGI)	X	X	X	X	
Flashnet					X
HPSS (IBM)	X	X	X	X	
MassStore (MassTech)					X
NetBackup (Veritas)	X	X		X	
NetVault (BakBone)			X	X	
NetWorker (EMC)	X	X	X	X	
Simpana and Galaxy (CommVault)					
Time Navigator (Atempo)		X			X
TSM (IBM)	X	X	X	X	
Veeam	X				X

*Confirm all aspects of your specific backup or archive application directly with the manufacturer. Various release versions, OS platforms, and other factors may affect the software's ability to perform soft migrations.

About Spectra Logic Corporation

Spectra Logic develops a full range of Attack Hardened™ data management and data storage solutions for a multi-cloud world. Dedicated solely to data storage innovation for more than 40 years, Spectra Logic helps organizations modernize their IT infrastructures and protect and preserve their data with a broad portfolio of solutions that enable them to manage, migrate, store and preserve business data long-term, along with features to make them ransomware resilient, whether on-premises, in a single cloud, across multiple clouds, or in all locations at once.

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