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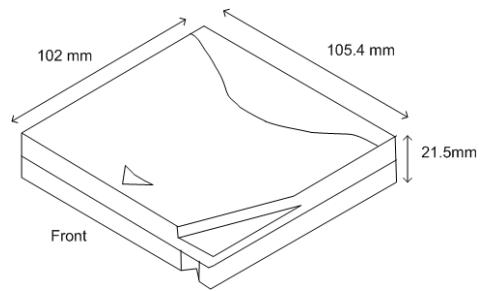
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# LTO Roadmap: LTO-5 and Beyond



*LTO tape cartridge*



October 2010

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## Abstract

With the release of LTO-5 and the commitment of the LTO consortium to an extended roadmap, tape's future looks brighter than ever. The newly announced LTO file-system standard opens new avenues for how tape can be used. This standard describes a directory structure on tape that permits application-independent access to data on tape. The increases in capacity and throughput are significant, as well. LTO-5 tape storage is the fifth generation of the Linear Tape Open Consortium's technology. The tape cartridge stores 1.5 TB of data (native/no compression), and the drive is rated at up to 140 MB/s native and can stream up to 1 TB/hour of compressed data to an LTO-5 cartridge. The consortium recently extended the roadmap for the open LTO technology to eight generations.

## Introduction

Tape continues to thrive, with LTO dominating the market. IDC, an information technology analyst group, notes that "more than 3.3 million LTO drives<sup>1</sup> have been shipped since the format was introduced." With the undisputed success of LTO technology, the Linear Tape Open (LTO) Consortium<sup>2</sup> has extended the roadmap out to LTO-8.

## A Little History—Starting with the LTO Consortium

The LTO Program was founded in 1997 by Seagate (later Certance), Hewlett-Packard, and IBM. At that time, only proprietary tape formats were in use, with Quantum's DLT and Sony's AIT as the market leaders for high-capacity, high speed tape storage for PC servers and UNIX systems. The Consortium changed this by creating an open standards alternative, and continues to direct development and manage licensing of certification of media and drive manufacturers. The format of the media is referred to as Ultrium; it is also referred to as half-inch tape.

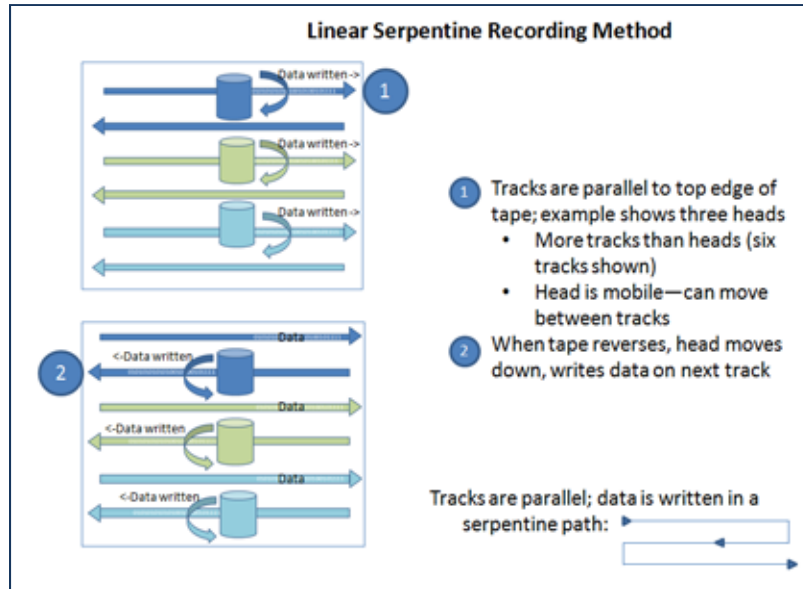
Currently, three companies -- Quantum purchasing Certance in around 2004, along with IBM and HP -- jointly oversee the development and roadmap of Linear Tape-Open (LTO) technology. Providing open format specifications has resulted in a technology that has dominated the market almost since its inception, in part because of the drive's superior design stemming from the strong technical skills of the companies behind the consortium, and partly thanks to its relative affordability compared to proprietary technologies. The open nature of LTO technology ensures compatibility between different vendors' offerings of drives and media.

## LTO Technology: Linear Serpentine Recording

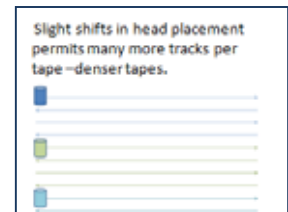
LTO writes linear serpentine data tracks parallel to the edge of the tape, shown below.

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<sup>1</sup> Simpson, Dave. "HP Ships LTO-5 Tape Drives, Libraries, Media," INFOSTOR, March 28, 2010. [\\_\\_\\_\\_\\_](#)



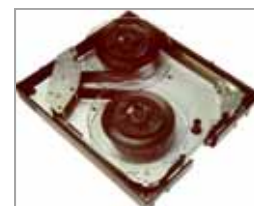
Using linear serpentine recording, a half-inch tape moves linearly past a head that houses the carefully aligned read and write heads. To create the serpentine pattern on the tape, the head assembly moves up or down to precise positions at the ends of the tape. Once the head assembly is in position, the tape motion is resumed and another data track is written parallel to and in between the previously written tracks.



## Tape Drive Mechanics

In all tape drive systems, the tape is pulled from the cartridge, guided through the tape path, and then pulled across the read-write head assembly. Tape mechanics have improved significantly over time, with extra error checking and media handling sophistication that largely eliminates concerns about tape damage due to its handling in the cartridge.

When a tape cartridge is inserted into a linear tape drive, a load mechanism inside the drive engages with a positioning tab at the beginning of the tape. The tab pulls the tape out of the cartridge and onto a take-up hub inside the drive compartment. As the drive reads or writes, the drives spools the tape between the take-up hub inside the drive and the cartridge supply reel inside the media cartridge.



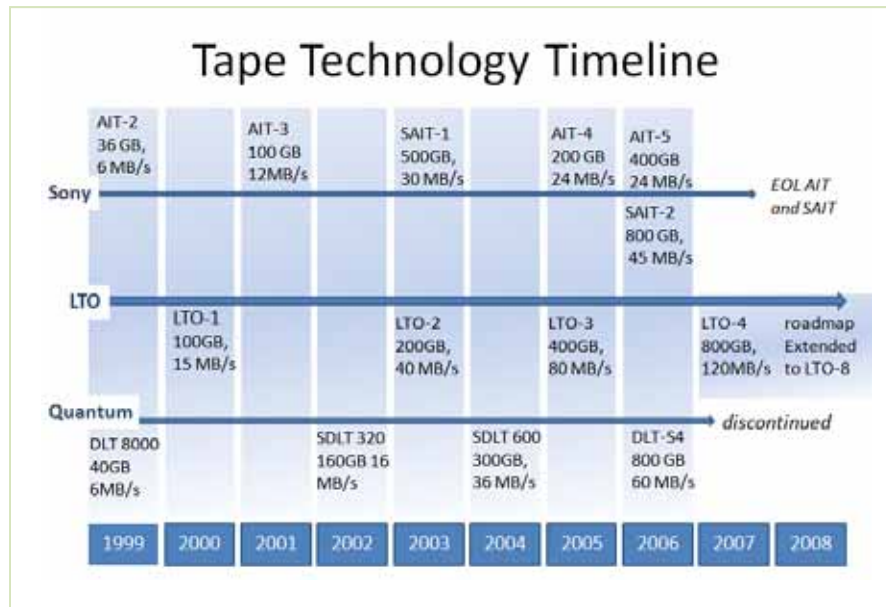
## Speed Mechanical Control

In all drives, the tape must be precisely moved through the tape path and across the heads during read and write operations. Also, the relative speed between the tape and the heads must be precisely controlled. Linear recording technology controls tape speed using a servo mechanism and pick-up and take-up spools. These linear mechanisms employ a very tight and positive control of the spool-to-deck mechanism, which forces the spool gears into the corresponding deck gears. These and other

improvements in tape technology have lead to more than 700 percent reliability increase over last 10 years.<sup>3</sup>

## Released Generations of LTO Drives and Tape

The first release of LTO, in the year 2000, supported a 100 GB tape cartridge and drive throughput of 15 MB/s, which was more than twice the storage and speed of competing tapes. Ten years later, LTO dominates the market with an 83.3% total<sup>4</sup> of tape drive revenues and according to staff at HP, “99% share of the mid-range tape drive market.”<sup>5</sup>



The LTO Consortium solidified that lead by announcing this year an extension of the LTO roadmap, from six generations to eight.

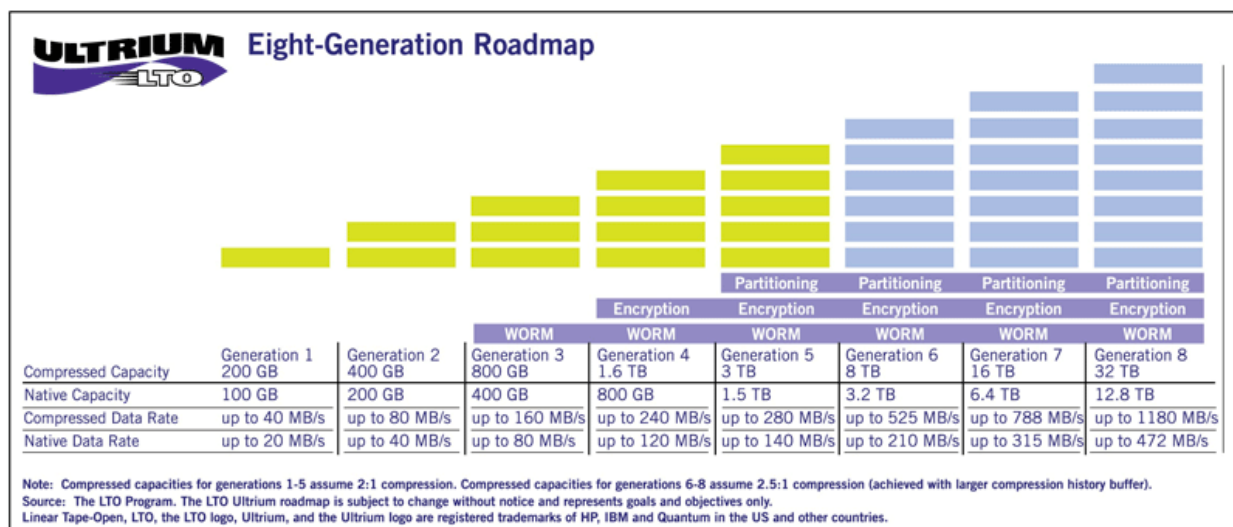
<sup>3</sup> Beech, Debbie. “Best Practices for backup and long-term data retention” Sylvatica Whitepaper. *The evolving role of disk and tape in the data center*. June 2009.

<sup>4</sup> Santa Clara Consulting. “Back-up Tape Tracker,” Report Q2 2010, <http://www.sccg.com/documents/BUExum210.pdf>

<sup>5</sup> Loreda, Laura. “10 Years and 3.3 Million Tape Drive Shipments Later...Happy Birthday LTO!” StorageWorks blogger, HP, <http://h30507.www3.hp.com/t5/Around-the-Storage-Block-Blog/10-years-amp-3-3-million-tape-drive-shipments-later-Happy/ba-p/82473>

## Roadmap

With LTO-5's release, the LTO family continues to dominate the tape market. The tape drive performs at 140 MB/s without compression and the tape capacity is 1.5 TB without compression.



## Features

Initially, and across the first four generations, the LTO program doubled throughput and capacity with every generation. However, IBM's representative on the consortium, Bruce Master, and Quantum's representative Tom Hammond said that "back in generation three of LTO, we looked at the roadmap which at that time had the performance for each generation doubling... We had a lot of input ... that many customers were not able to push the drive to its full rated performance. So we reduced the growth from doubling speed in each generation to a 50% increase."<sup>6</sup>

At the same time, vendors continue to enhance LTO generations, adding new features, bigger buffers, and more speed matching rates to ensure streaming. In addition, as new generations are released, they also support interface speeds as they become available. LTO-5 supports Fibre Channel 8 Gb/s and SAS 6 Gb/s.

Future Generations	Transfer Rate	Tape Capacity <i>Native</i>
LTO-6	270 MB/s	3.2 TB
LTO-7	315 MB/s	6.4 TB
LTO-8	472 MB/s	12.8 TB

## File System/Partitions

LTO-5 has a new feature that has the potential to change the way tape is used, and the idea is simple—section the tape into two partitions. With this a single tape can store both descriptive information

<sup>6</sup> Sharwood, Simon. "LTO 5: Fast, Vast but Still in the Past?" Search Storage.com.au, July 30, 2009. <http://searchstorage.techtarget.com.au/news/2240019182/LTO-5-Fast-vast-but-still-the-past>

about the data on the tape (in the first partition), and the data itself (in the second partition). That means users can mount a tape and see what's on it, then restore the data.

The Linear Tape File System (LTFS) Format<sup>7</sup>, announced in April 2010, takes advantage of the partitions to provide a file system for data stored on tape. This simplifies access to data on tape, with data organized and displayed in a fashion that users are accustomed to: a directory structure. LTFS is an open source file system.<sup>8</sup> The IBM-specific<sup>9</sup> implementation is called the Long Term File System.

With a partition set up for metadata (like an index to a book), and a second with the data (the rest of the book), you can look up files and restore them without having to go through another application. The implications of this are contributing to a push to use tape as an active, searchable archive for data. Instead of simply functioning as a repository for aging data, tape suddenly fits into the networked data model. It may take more time to get the data—but not a lot more time. And for data that is accessed only occasionally, this is an excellent option. Organizations can move their data from expensive spinning disk to a platform that is more affordable, and still have the data readily available.

## Conclusion

Tape, especially the LTO format, is going to be around for years to come. With the advent of LTO-5 and the promise it holds for a combination of accessible AND long-term storage, tape's future is bright as development of the format continues.

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<sup>7</sup> "Linear Tape File System (LTFS) Format Specification," version 1.0. April 12, 2010.  
[http://www.trustlot.com/LTFS\\_Format\\_To%Print.pdf](http://www.trustlot.com/LTFS_Format_To%Print.pdf).

<sup>8</sup> Ferelli, Mark. "LTO-5 and LTFS: Shaking the Pillars of Heaven." Editorial, *Computer Technology Review*, August 17, 2010.

<sup>9</sup> Pariseau, Beth. "IBM Launches Long Term File System (LTFS) for LTO-5 Tape Management," *SearchStorage.com Storage Technology News*, April 22, 2010. [http://searchstorage.techtarget.com/news/article/0,289142,sid5\\_gci1510444,00.html](http://searchstorage.techtarget.com/news/article/0,289142,sid5_gci1510444,00.html)