



March 28, 2018. The [Tape Storage Council](#), which includes representatives of BDT, Frontier BV, Data Protection Association, FUJIFILM, GazillaByte, Hewlett Packard Enterprise, IBM, Imagine Products, Insurgo, Integra, Iron Mountain, Park Place Technologies, Oracle, Overland Storage, Qualstar, Quantum, REB Storage Systems, Recall, Spectra Logic, StorageDNA, StrongBox Data Solutions, Tandberg Data, Turtle and XpresspaX has issued the following memo to highlight the current trends, usages and technology innovations occurring within the tape storage industry.

Tape Raises the Bar for Higher Capacity, Reliability, and Security

Tape Technology Continues to Change the Game

Introduction

Tape continued to expand its offerings and reach in 2017. The tape industry has been fueled by a full decade of strong technological development and this trend shows no signs of letting up. Highlighted by two new drive announcements, LTO roadmap extensions and new use cases, tape is improving its capability to cost-effectively tackle many data intensive challenges including cloud storage, entertainment, surveillance, High Performance Computing (HPC), and hyperscale data centers while positioning for the unknown appetite of the emerging IoT. Demand for tape technology is being fueled by widespread data growth, tape's highly favorable economics, the industry's lowest energy requirements, and mounting pressure to address the surging wave of cybercrime. Steady technology improvements have given tape the lowest cost, highest capacity, fastest data transfer rates, and most reliable storage medium available, having surpassed the reliability of HDDs by three orders of magnitude. In the last 10 years, LTO tape has increased capacity 1,400%, performance 200%, and reliability 9,900%. *Tape isn't just raising the bar, it is the bar.*

2017 Highlights Include New Tape Drives and Media

On May 16, 2017 [the TS1155](#) enterprise tape drive was announced by IBM® with a 15 TB native capacity (45 TB compressed) offering a 50% greater capacity than the IBM TS1150 drive and has a data rate of 360 MB/sec. The TS1155 tape drive consists of two new models designed for the TS4500 tape library and includes traditional Fibre Channel and Ethernet host interfaces for cloud-based and open-compute environments.

On July 5, 2017 [LTFS](#) (Linear Tape File System) announced [connection](#) with [OpenStack Swift](#) to enable movement of cold (archive) data from object storage to more economical tape storage for long-term retention. LTFS now provides a back-end connector for open source [SwiftHLM](#) (Swift High Latency Media), a high-latency storage back end that makes it easier for users to perform bulk operations using tape within a Swift data ring.

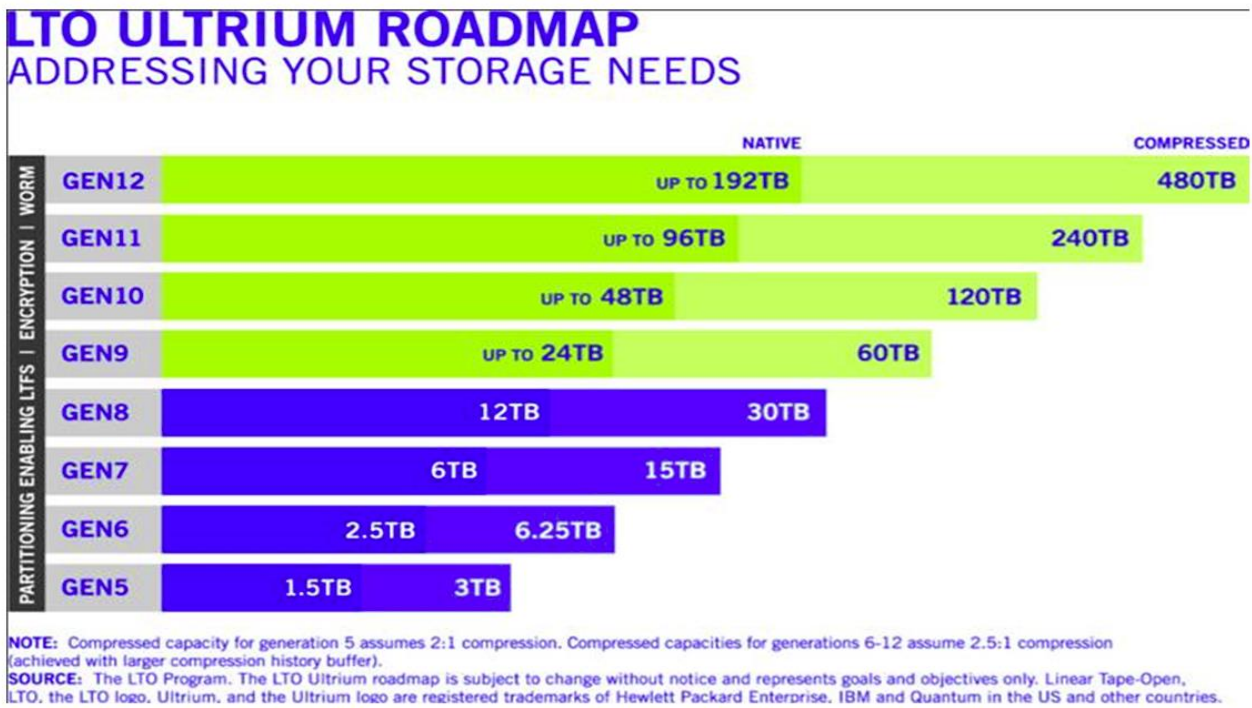
On October 17, 2017 the [LTO Ultrium Generation 8](#) tape drive (LTO-8) was announced by the LTO Program Technology Provider Companies (TPCs), Hewlett Packard Enterprise, IBM and Quantum. The LTO-8 drive doubles the native capacity from its previous generation to 12 TB (30 TB compressed), improves throughput rates by 20% to 360 MB/sec. and drives down acquisition costs below the half-cent per gigabyte level. To push the innovation and capacity boundaries of LTO going forward, the current LTO format required a recording

technology transition that supports high capacity growth for future LTO generations. As a result, the LTO-8 specification is only backwards compatible with the former generation LTO-7. The new 12 TB LTO-8 cartridge can hold 7,140,000 photos, 8,000 movies or 2,880,000 songs.

Type M media was introduced along with the launch of LTO-8 tape drives. LTO-8 drives can initialize new unused LTO-7 cartridges, yielding the LTO-7 Type M media, to an increased capacity of 9 TB native and 22.5 TB compressed instead of 6 TB and 15 TB in a standard LTO-7 drive. The new LTO-7 Type M is manufactured and logoed as LTO Ultrium 7 media but labelled with a barcode label ending with the last 2 characters “M8”.

Tape Roadmaps - LTO Roadmap Extended to Generation 12 with Oct. 17 Announcement

The LTO Program also released a new [LTO technology roadmap](#), detailing specifications up to twelve (12) generations of LTO tape technology, extending the total capacity of data held on one LTO-12 tape cartridge to 480 TB with 2.5x compression – an increase of 32 times the compressed capacity of LTO-7 cartridges.



The newest LTO roadmap projects that native capacities of LTO drives will double with every subsequent generation. Therefore, the compressed capacities are projected to increase from 60 TB with LTO-9, 120 TB with LTO-10, 240 TB with LTO-11, and 480 TB with LTO-12.

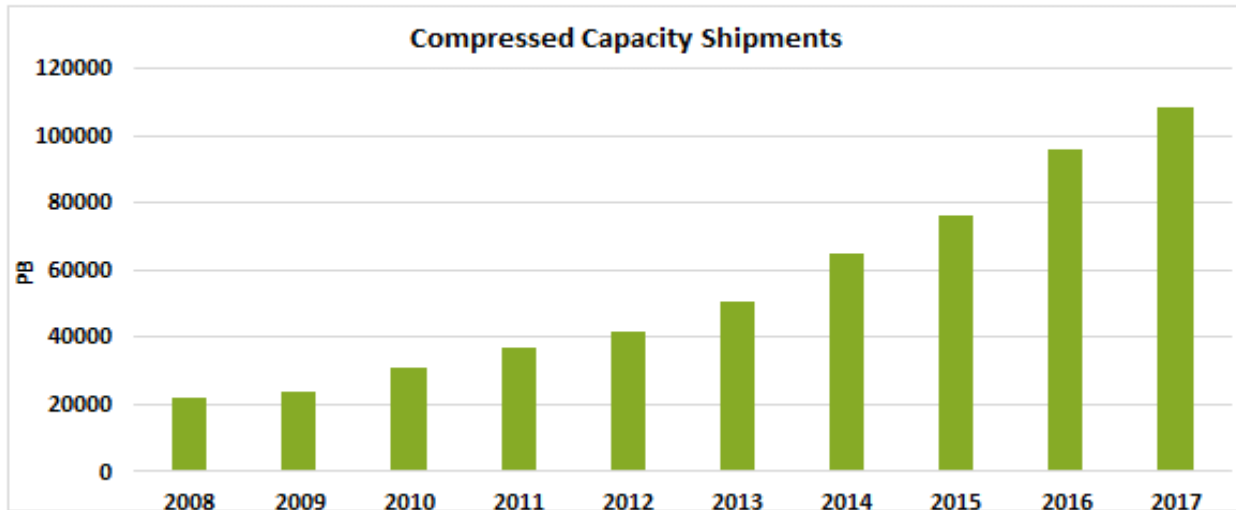
The INSIC 2015-2025 International Magnetic Tape Storage Roadmap

The [INSIC](#) indicates the current areal density scaling rate of HDD to be about 16% CAGR and tape be at 33% CAGR indicating the current cost advantage of tape systems over HDDs will grow even wider in the future. The INSIC roadmap also projects tape data rates to increase at 22.5% annually and are expected to be as much as five times faster than HDD drives by 2025. This is great news for businesses whose archives include data from the IoT and big data analytics, mobile and social systems, as well as content from higher density video streaming, hybrid cloud workloads and traditional data center applications.

2017 LTO Capacity Shipments

The annual tape media shipment report from the LTO TPC's detailing year-over-year shipments showed a record 108,457 petabytes (PB) of total tape capacity (compressed) shipped in 2017, an increase of 12.9 percent over the previous year as the tape industry continues to expand into many new markets.

Total LTO Tape Capacity Shipped: Calendar Year 2017



Source: The LTO Program Technology Provider Companies (TPCs), Hewlett Packard Enterprise, IBM Corporation and Quantum

Media Manufacturers Push Future Tape Recording Developments and Density Growth

[Sony Corporation with IBM Research](#) in Zurich, Switzerland, has demonstrated magnetic tape storage recording areal density at 201Gb/in². The recording areal density of 201Gb/in² is approximately 20x greater than conventional magnetic tape storage media (9.6Gb/in²). The resulting technology can support native high-capacity storage of approximately 330 TB per cartridge.

[Fujifilm](#) continues to commercialize Barium Ferrite magnetic particles but has also filed for patents for a new magnetic particle for future generations of tape using "Strontium Ferrite" (SrFe) that has the potential to store 400 TBs native per cartridge, or 67 times more than LTO-7 capacity.

Tape TCO (Total Cost of Ownership) Calculators Become Available

Tape's growing cost per gigabyte and TCO advantage compared with other storage mediums makes it the most cost-effective technology for long-term data retention. Two new easy to use publicly available TCO calculators were made available in 2017 from [Brad Johns Consulting](#) and the [LTO consortium](#). These tools help assess the TCO of automated tape systems compared to HDDs and cloud-based storage.

Tape Systems Improving Performance and Access Time

In addition to tape's continual capacity improvements, tape is improving access time and data rate (throughput) with Active Archive, RAIT, RAO, while tape offers the storage industry's fastest data rates.

Active Archive

Tape's favorable economics for storing archival data are fueling increased interest in [Active Archive](#) solutions. An active archive is a combined solution providing users an automated means to store and manage all their

archive data by integrating HDDs, SSDs, and tape in the data center or cloud. The active archive greatly improves tape access time by serving as a HDD or SSD cache buffer for a tape library. The active archive enables a high percentage of accesses to the tape subsystem to be satisfied from SSD or HDDs (cache hit ratio) improving access time to first byte of data.

Tape Delivers the Fastest Data Rates

Tape capacities and data rates are growing faster than other storage technologies. When comparing native data rates, the TS1155 and LTO-8 both transfer data at 360 MB/sec. which is significantly faster than the typical 7,200 RPM HDD at 160 MB/sec. Future tape transfer rate increases are projected to yield tape data rates 5x faster than HDDs by 2025 with no fundamental technology limitations in sight.

RAIT Improves Throughput and Offers Fault Tolerance [RAIT](#) (Redundant Arrays of Independent Tape) aggregates bandwidth across multiple tape drives significantly increasing throughput. RAIT requires multiple tapes to be loaded in parallel for writing and reading data and is like RAID for HDDs. Interest in RAIT is expected to increase taking advantage of significant increases in future tape transfer rates.

RAO (Recommended Access Order) Improves Tape File Access Times

The [RAO](#) capability is available for enterprise tape drives for improving tape access times (time to first byte). Presently, files are written on tape in sequential order but are most often accessed (reading data) in random order. This inefficiency has been tolerated in the past, but as tape capacities and therefore the number of files on a cartridge continue to increase, file access times can be expected to increase. The RAO determination produces an optimized list called “best access order” and provides the least amount of time that is needed to locate and read all files or data sets on a tape.

Tape Addressing Key Applications and Demand Drivers

Tape has become an ideal storage solution for several next-generation applications that are quickly outgrowing their traditional infrastructures. This includes addressing the storage and data security requirements for Big Data, cloud storage services, entertainment, Hyperscale computing, IoT, and surveillance that are all projected to drive enormous storage demand.

- Big Data – Big Data is the massive amount of data that inundate businesses on a constant basis, and its supporting infrastructure is expected to grow from \$34 billion to \$92 billion by 2026.
- Cloud Storage Services – [Allied Market Research](#), (June 2017) forecasts that the global market size for the complete cloud solution package was valued at \$21.175 billion in 2015, and is projected to reach \$97.415 billion by 2022, a CAGR of 24.8% from 2016 to 2022.
- Entertainment - It is [forecast](#) that over 106 exabytes of new digital storage will be used for digital archiving, content conversion and preservation by 2022.
- [Hyperscale, HPC and enterprise data centers](#) – The massive amounts of storage in these data centers favor increased tape usage as tape energy costs are typically less than 5% of the equivalent amount of disk capacity.
- [IoT](#) – The IoT is viewed as a main driver of the digital transformation. By 2020, the IoT is expected to be in 95% of new electronic product designs creating vast storage and security requirements.
- Surveillance – By 2020, video surveillance using fixed, body and mobile cameras is expected to capture **859 PB** of video daily. The data may be stored for extended periods of time before access making it an ideal candidate for tape archival systems.

Tape's Value Proposition is Compelling

Continued development and investment in tape library, drive, media and data management software has effectively addressed the relentless demand for improved reliability, higher capacity, better power efficiency, ease of use and the lowest cost per GB and TCO of any storage solution. Below is a summary of tape's value proposition followed by key metrics for each function.

Function	Tape Value Proposition Summary
Price/TCO	Tape Has the Lowest Acquisition Price \$/GB, HDD TCO up to 15x Higher Than Tape.
Performance	<ul style="list-style-type: none"> Active Archive Addresses 1) Tape "Random" Access 2) Time to First Byte. Tape Data Rates @360MB/sec. Expected to be 5X Greater Than HDD by 2025. RAIT Provides Higher Data Transfer Rates and Fault Tolerance. RAO Improves Recall Time and Access Time (Time to First Byte).
Capacity	Tape Cartridge Capacity Max. @15TB (45TB compressed), Max. HDD @14TB. Lab Demos Demonstrate Native Cartridge Capabilities to Reach 100's of TB's.
Scaling Capacity	Tape Adds Capacity by Adding Media, HDDs Add Capacity by Adding Drives.
Reliability	Tape (BER) 1×10^{19} , HDD (BER) 1×10^{16} Tape Reliability is 1000x Higher Than HDD and is the Most Reliable Storage Technology Available. Note: BER (Bit Error Rate).
Energy Usage	Tape Uses Much Less Energy Than HDDs and is the Greenest Storage Technology. Energy costs for tape are typically < 5% of the equivalent amount of disk capacity.
Portability	Tape Media Easily Portable, HDDs Difficult to Move. Tape Transport Moves Massive Amounts of Data w/o Electricity Faster Than Broadband for Large Amounts of Data.
Encryption/WORM	All Tape Drives Offer Encryption, Option on Some HDDs but Seldom Used.
Cyber Security	Tape Air Gap Helps Prevent Cybercrime and Ransomware Attacks.
Media Life Span	>30 Years for all Modern Tape Media, Avg. ~4-5 Years for HDDs.
Recording Limits	No Foreseen Limits for Tape, HDDs Facing Areal Density Limits.
Cloud	Improves Cloud Reliability and Data Security, Lowers Storage Costs, Unlimited Capacity Scaling. Tape Creates a "Green Cloud".
Standard File System (LTFS)	LTFS is an open standard tape file system that enables direct, intuitive and graphical access to manage data stored in LTO tape drives and libraries.

Using Tape for Cybersecurity Prevention

The U.S. Department of Justice reports that an average of 4,000 daily ransomware attacks have been taking place since Jan. 1, 2016 and it's now estimated that the global cost for organizations was nearly \$5 billion by the end of 2017. Forty percent of the attacks took longer than 2 hours to detect ([Druva survey 2017](#)). Eighty-two percent of the survey respondents reported their organizations recovered from ransomware attacks—not by paying the ransom - but by relying on their backup copies to recover and restore business operations.

The [Tape Air Gap](#) has ignited new interest in backing up data on tape. An air-gap means that there is no electronic connection to the data on the removeable tape cartridge preventing a malware attack. Disk systems remain online and are vulnerable to an attack. Backup data using the tape air gap is quickly regaining popularity as a key part of a comprehensive data security plan.

Additional Resources

In Sept. 2017, The Wall Street Journal published an article citing tape's new role in cybersecurity.
<https://www.wsj.com/articles/companies-look-to-an-old-technology-to-protect-against-new-threats-1505700180>

Case Studies

Several case studies listed below demonstrate the many new and innovative use cases for tape technology.

Fujifilm – [Chainsaw](#) Chainsaw Edit Delivers History's Most Popular TV Show With Dternity.

ORNL – [Oak Ridge National Labs](#) Enhances Data Integrity and Accessibility with Active Archive Solutions

Quantum - [ACRI-ST](#) Provides Understanding of Earth with Satellite Data Using Tiered Storage, Tape and LTFS.

Spectra – [NASA Ames](#) Efficiently and cost-effectively manages 33% annual data growth with tape archive.

Summary

Tape shares the data center storage hierarchy with SSDs and HDDs and the ideal storage solution optimizes the strengths of each. However, the role tape serves in today's modern data centers is quickly expanding into new markets because compelling technological advancements have made tape the most economical, highest capacity, and most reliable storage medium available. Tape is serving multiple roles for the enormous hyperscale, internet and cloud data centers as tape capacity can easily scale without adding more drives – this is not the case with HDDs where each capacity increase requires another drive and quickly becomes costlier than tape as capacity demand increases. Using tape for cloud archives, rather than HDDs, greatly reduces cloud TCO and creates a "green cloud". The steady innovation, compelling value proposition and new architectural developments demonstrate tape technology is not sitting still; expect this promising trend to continue indefinitely as the march to exascale storage solutions draws near. Clearly tape technology delivers the most reliable, safe and efficient data storage solution available to the storage industry today and well into the future.