

Tape Takes Aim on Unprecedented Data Growth

Tape Has Greatest Potential to Address Soaring Capacity Demand



The Tape Storage Council, which includes representatives of **BDT, Detron, Frontier BV, FUJIFILM, GazillaByte, Hewlett Packard Enterprise, IBM, Imagine Products, Insurgo Media, Integra, Iron Mountain, Park Place Technologies, Oracle, Overland Storage, Qualstar, Quantum, REB Storage Systems, Spectra Logic, StrongBox Data Solutions, Tandberg Data, Turtle, and XpresspaX**, has issued this report to highlight the current trends, usages and technology innovations occurring within the tape storage industry.

Introduction

Tape continues to expand its offerings and reach, and its growth has been fueled by more than a decade of significant technological development. This trend shows no signs of letting up. Steady technology improvements continue to give tape the lowest cost, highest capacity, fastest data transfer rates, and most reliable storage medium available, with the reliability of tape outperforming the best HDDs by three orders of magnitude. Since the first LTO drive, LTO-1, was announced in 2001 with a native capacity of 100 GB, the LTO roadmap has expanded and now defines generations through LTO-12, which provides 192 TB native capacity, representing a 1,920x capacity increase from LTO-1. Modern tape continues to drive reliability, capacity, and data rates to the highest levels in the storage industry, making it the most cost-effective, long-term storage solution available.



New Enterprise Tape Drive

The arrival of the IBM TS1160 enterprise tape drive has helped tape tackle mounting storage-intensive challenges, including cloud storage, high-performance computing (HPC), and the expanding number of hyperscale data centers. The new drive has also positioned tape well to serve the unknown appetite of entertainment, surveillance, and the rapid emergence of IoT and edge computing. The TS1160 enterprise tape drive has lifted tape technology to the next level with a 20 TB native capacity (up to 60 TB with 3x compression), offering a 33% greater capacity than the IBM TS1155 drive while delivering a data rate of 400 MB/sec. The large 2 GB internal data buffer offers Digital Speed Matching and minimizes speed mismatches between the tape drive and the host application, improving throughput and reducing wear and tear on the drives and media. Interfaces support additional connectivity by offering 8 Gb/s Fibre Channel or 16 Gb/s Fibre Channel and 10GbE or 25GbE RoCE Ethernet options.

Media Manufacturers Push Future Tape Developments & Density Growth

[Fujifilm](#) continues to commercialize Barium Ferrite magnetic particles and has filed for patents for a new magnetic particle for future generations of tape using “Strontium Ferrite” (SrFe), which has the potential to store more than 400 TB native per cartridge, or 33 times more than LTO-8 cartridge capacity.

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

The [LTO Ultrium Generation 8](#) drive doubles the native capacity from LTO-7 to 12 TB (30 TB compressed). To push the innovation and capacity boundaries of LTO going forward, the legacy LTO format required a recording technology transition from GMR to TMR heads that supports higher capacity growth for future LTO generations. As a result, the LTO-8 specification is only backwards compatible with the former LTO-7 generation.

The LTO Program Technology Provider Companies (TPCs), Hewlett Packard Enterprise, IBM Corporation and Quantum are pleased to announce Fujifilm and Sony are now licensees of Generation 8 technology, meaning that both companies are planning to produce LTO-8 media moving forward. Products from these two companies will be certified officially by the TPCs, with global availability of Generation 8 media now available.

Tape Roadmaps - LTO Roadmap Extended to Generation 12

The current [LTO technology roadmap](#) details specifications of 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 16 times the compressed capacity of LTO-8 cartridges.

The LTO roadmap projects that native capacities of LTO drives will approximately 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.

LTO Ultrium Roadmap

Addressing Your Storage Needs



NOTE: Compressed capacity for generation 5 assumes 2:1 compression. Compressed capacities for generations 6-12 assume 2.5:1 compression (achieved with larger compression history buffer).

SOURCE: The LTO Program. The LTO Ultrium roadmap is subject to change without notice and represents goals and objectives only. Linear Tape-Open, LTO, the LTO logo, Ultrium, and the Ultrium logo are registered trademarks of Hewlett Packard Enterprise. IBM and Quantum in the US and other Countries.

The INSIC 2015-2025 International Magnetic Tape Storage Roadmap

The [INSIC](#) roadmap indicates the current areal density scaling rate of HDD to be about 16% CAGR and tape to be at 33% CAGR which suggests that the current cost advantage of tape systems over HDDs will grow wider in the future.



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 are available 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 file access times and data rate (throughput) with Active Archive, RAIT, RAO, and TAOS, while offering the storage industry's fastest data rates.

[LTFS](#) (Linear Tape File System – aka [Spectrum Archive](#)) continues to gain momentum and now has 36 companies as licensed implementers.

Active Archive Addresses Complexity with an Intelligent Data Management Layer

[Active Archive](#) solutions are gaining momentum and significantly improve access time to tape data by using HDDs or SSDs as a cache buffer in conjunction with a tape library. The active archive enables a high percentage of read requests to the tape subsystem to be satisfied from SSDs or HDDs (the cache hit ratio), improving access time to the first byte of data. An active archive can serve onsite, offsite, and cloud environments. New use cases such as [AI](#), machine learning, big data analytics, the [IoT](#), including intelligent vehicles, homes, and offices, are driving increased demand for active archives. This demand is particularly evident with organizations that need to effectively manage and analyze data from terabytes to exabytes across multiple storage tiers.

Tape Delivers the Fastest Data Rates

Tape capacities and data rates are growing faster than other storage technologies. When comparing native data rates, the TS1160 drive has an industry-leading transfer rate of 400 MB/sec, and LTO-8 transfers data at 360 MB/sec. This rate compares to the 7,200 RPM HDDs, which typically range between 160 – 200 MB/sec. The [INSIC roadmap](#) signals that future 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. RAIT usage is expected to increase, taking advantage of the significant increases in future tape transfer rates.

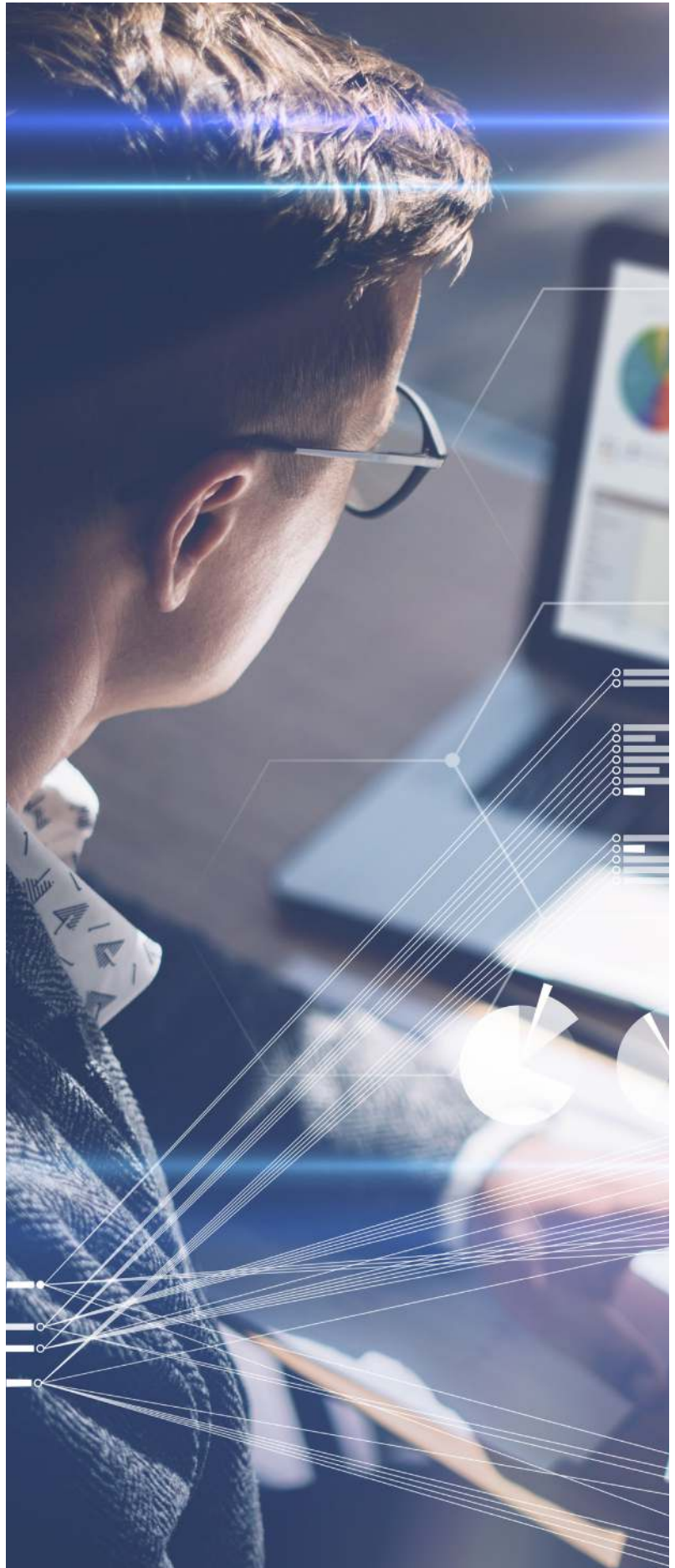
RAO and TAOS Improve Tape File Access Times

RAO (Recommended Access Order) was released with the IBM TS1140 tape drive and 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. Customers tolerated this inefficiency in the past, but as tape capacities and, therefore, the number of files on a cartridge continues to increase, file access times will 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.

For LTO drives, Spectra Logic introduced **TAOS™** (Time-based Access Ordering System) in 2018, which is similar to the RAO feature for enterprise drives improving tape access time (time to first byte). With TAOS, the order in which the files are retrieved can be reordered for “best access” using shortcuts on the tape, reducing the tape movement time required to retrieve a file. Access time reductions as much as 50% are attainable for RAO and TAOS. Before 2018, no such access time functionality had existed for LTO tape-drive-based systems.

Tape Addressing Key Applications & Demand Drivers

Tape has become the optimal storage solution for many next-generation applications that are quickly exceeding the capabilities of traditional infrastructures. New infrastructure challenges include addressing the storage and data security requirements for Big Data, cloud storage services, entertainment, Hyperscale computing, IoT, and surveillance, which are all projected to drive enormous storage demand. Up to 90% of data is rarely touched once it's been stored. That's why data storage managers are putting infrequently accessed (or cold data) on high capacity, cost-efficient tape instead of keeping it on expensive, constantly spinning disks.





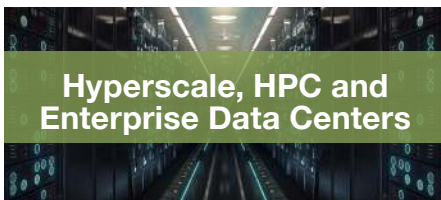
Big Data is the massive amount of data that inundate businesses constantly. The global market for just storage in big data is projected to cross \$61.44 B, expanding at a CAGR of 20.4% during the forecast period (2016–2026).



[Allied Market Research](#), forecasts that the global cloud storage market is expected to reach \$97.42 B by 2022, a CAGR of 24.8% from 2016 to 2022. Other research companies project similar revenues.



It is [forecast](#) that increased storage requirements will result in media and entertainment storage revenue growth of about 1.9x between 2017 and 2023 (from \$6.9 B to \$12.8 B).



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. Large enterprises are becoming hyperscale data centers as the role of the traditional data center is evolving to support more specific services that cannot be supported elsewhere.



The [IoT](#) spending neared the \$800 B mark in 2018 and is viewed as a main driver of the digital transformation. By 2020, the IoT is expected to be in up to 95% of new electronic product designs creating vast storage and security requirements for data to be analyzed at a later time.



By 2023, the daily volume of [surveillance](#) data is projected to reach 3,500 petabytes. Certain types of surveillance data may be stored for extended periods (up to 40 years if involved in terrorism) before access or analysis, making it an ideal candidate to store in tape archival systems until needed.

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. On the next page is a summary of tape's value proposition, followed by key metrics for each function.

Function	Remarks – Current State of the Tape Industry
Price/TCO	Tape has the lowest acquisition price \$/GB, HDD TCO 5-8x higher than tape.
Performance & Access Time	Much Improved - Active Archive, fastest data rates, RAIT, smarter and faster robotics, access time to first-byte features (RAO, TAOS) have arrived. Few HDD performance gains identified.
Recovery	Faster recovery for large data sets and files than HDD or cloud.
Capacity	Tape cartridge capacity max. @20 TB (60 TB compressed) with 200x more surface area than HDD @14 TB. Lab demos demonstrate native cartridge capabilities to reach hundreds of TB.
Scalability	Tape adds capacity by adding media, HDDs add capacity by adding drives.
Reliability	Tape (BER) 1×10^{19} HDD (BER) 1×10^{16} Tape BER is 1000x higher than the best HDD.
Energy Usage	Tape uses much less energy than HDDs, can move tape data without electricity.
Portability	Tape media easily portable during electrical outage, HDDs more difficult to move.
Encryption/WORM	All tape drives offer Encryption/WORM, optional on some HDDs but seldom used.
Cybersecurity	Tape air gap prevents cybercrime attacks, strong defense against malware.
Media Life	>30 years for all modern tape, average ~4-5 years for HDDs.
Recording Limits	No foreseen limits for tape, HDDs facing areal density and performance limits.
Cloud Storage	Tape improves cloud reliability and security, lowers storage costs, provides unlimited capacity scaling. Hyperscale will require tape to manage extreme growth.

Using Tape for Cybersecurity Prevention

[Cryptojacking](#) is one of the newest and most lucrative threats to cybersecurity joining ransomware in the last two years. Easy to carry out and very difficult to detect, these attacks involve cybercriminals taking control of a user's CPU. Cases of cryptojacking reached a staggering 13 million in 2018, which is up 400% on the 2017 total of 3.5 million. Cryptojacking is a term used to describe malicious activity in regard to cryptocurrency mining. Ransomware remains a significant threat. The latest U.S. Department of Justice report states that an average of more than 4,000 daily ransomware attacks occurred in 2017 with damages totaling up to \$5 billion.

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 removable tape cartridge or other media 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 vital part of a comprehensive data security plan.

Additional Resources

In September 2017, The Wall Street Journal published an article recognizing tape's new role in addressing cybersecurity with the tape air gap.



Companies look to an old technology to protect against new threats



Tape Storage Council - provided collateral

Summary

Today's storage technology hierarchy consists of three technologies – SSDs, HDDs, and tape, and the ideal storage implementation 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 the most reliable and secure storage medium available. The value of the tape air gap in cybercrime prevention has provided a distinct advantage over other mediums. Tape serves multiple roles for the rapidly expanding hyperscale, enterprise, internet, and cloud data centers as tape capacity can more 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. Using tape rather than HDDs for cloud archives greatly reduces cloud TCO and creates a much more energy-efficient cloud service and data center. With these advancements, tape technology delivers the most reliable, safe, and efficient data center storage solution available from the storage industry today. Roadmaps signal this trend of steady technological innovation to continue well into the future.