White Paper

Oracle T10000D: A Storage Investment With Enterprise-scale Value

By Mark Peters, Senior Analyst; and Monya Keane, Research Analyst

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The Economics of Data Storage: Aligning Storage Solutions to Data Characteristics

The maxim that "not all data is created equal" is true. So is the assertion that the *value* of data can change significantly over time. Thus, storing all enterprise data on the same class of storage is highly inefficient and can even be detrimental to a company's risk profile and financial performance.

In many enterprises today, a dominant percentage of data can be classified as low in value, inactive, or both. Storing a large amount of such data exclusively on high-performance, relatively expensive disk systems (or worse, on relatively *more* expensive flash-based storage) is a financially prohibitive and unsound business practice.

Ideally, protecting and archiving large quantities of old or low-value data involves deploying a *tiered storage infrastructure,* invariably managed (for speed and efficiency) by hierarchical storage management software. In the case of cold-storage archiving, "tier-3" storage can be deployed alone, as long as it meets the organization's access and retrieval requirements.

The range of contemporary data storage options *and* demands is increasing and is drawing us into an age of changing storage economics. At one end of the spectrum, the business world has begun reaping the benefits of renewed innovations in tape technology, including drives with capacities of more than 8TB and significant management improvements such as the Linear Tape File System (LTFS). At the other end of the spectrum are dramatic advances in flash storage. The value proposition of spinning disks is under attack from both sides.

The Resurgence and Modern Relevance of Tape

Advances in drives, media, heads, and formats—as well as management capabilities such as LTFS—are repositioning tape not only as a viable, but also often an *optimal* high-capacity storage solution. Tape has moved beyond its traditional role in nightly backup: Disk-based, purpose-built backup appliances increasingly shoulder that responsibility instead. Instead, it is common now to see tape technology supporting multi-petabyte archives of fixed content, unstructured data, and video, as well as supporting modern business continuity/disaster recovery (BC/DR) architectures.

THE TAPE INDUSTRY is expanding the market applications it serves, going beyond backup and recovery to support compliance and long-term storage. New and strengthened regulations, along with exploding unstructured-data archival requirements, are redefining tape's future.

Despite—or perhaps because of—having played a role in IT environments for more than 60 years, tape today is, if anything, increasing its significance. For example:

- Tape storage is re-emerging as the most economically efficient alternative for low and inactive data. Many organizations consider modern tape technology to be a solid foundation for compliance and preservation, and those activities are potentially lucrative for cloud service providers (CSPs).
- CSPs (including Google, whose infrastructure can be seen online) are deploying large, automated tape systems to leverage tape's good economics and reliability.
- With applications being rewritten to support the LTFS format, tape is seeing increased use as the last source of record for deep archiving, regulatory/internal compliance, and other "boring but important" use cases.

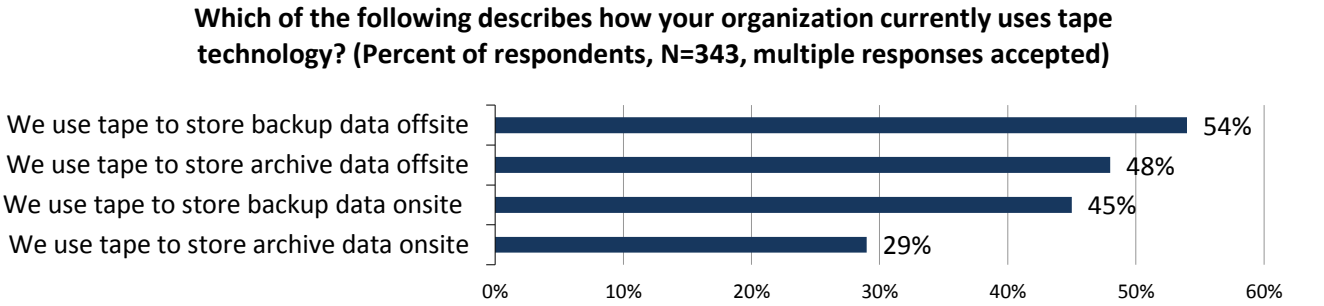
In fact, 82% of respondents to a 2012 ESG research survey reported using tape storage to some extent in their enterprise.[1]

In general, it is wise to refrain from indulging in the notion that tape is a medium *just* for backup or even *just* for archiving. Those use cases are popular (see Figure 1), but again, tape's economics and portability also make it ideal for storing offsite disaster-recovery copies and adhering to compliance requirements. Even organizations sending

[1] Source: ESG Research Report, *2012 Storage Market Survey*, November 2012.

data to the cloud should realize—and indeed *appreciate*—that tape is likely to be the offsite service's underlying infrastructure.[2]

Figure 1. How Organizations Currently Use Tape



Source: Enterprise Strategy Group, 2014.

Data protection is a priority, and for good reason. Globally, a growing list of compliance regulations and laws are dictating how organizations must protect data and for how long they must do so. Data-preservation lifespans are becoming essentially infinite in some cases—which is increasing archives' size, security, and management requirements.

Back to the Future: Tape Returns to the Enterprise Fold

For commercial IT, one successful tape format in recent years has been the midrange Linear Tape Open (LTO) offering. LTO is a technology originally developed by a vendor consortium in the late 1990s as an alternative to proprietary tape formats. Today, it continues to achieve and hold a significant market share. In some cases, however—like many technologies before it—LTO ended up deployed in environments and for workloads not optimally matched to its capabilities. That state of affairs unfolded mainly because:

- IT organizations often loved the perceived advantages of a non-proprietary technology—namely, that LTO combined "plenty good enough" capacity and performance with an open IT format, potentially helping them avoid vendor lock-in. Sometimes, however, organizations did not sufficiently gauge whether those "pros" might be outweighed by the "cons" of using a midrange technology for enterprise workloads.
- Enterprise tape technology, which many large organizations should have been using, was regarded (certainly with some historical justification) as a significantly more expensive option. After all, enterprise-class tape was a proprietary product carrying the typical "price premium" burdens/fears that can accompany a single-vendor-sourced offering.

Those organizations may, however, want to reconsider their long-term data retention strategies and tape technology choices. The newest enterprise tape drives (such as Oracle's StorageTek T10000D) are turning out to be pretty darn cost effective after all, and they offer levels of capacity, performance, and reliability from which petabyte-scale environments, in particular, can truly benefit.

IT Continues to Face Challenges

Time and again, tape solutions well-matched to an IT organization's enterprise-level needs have helped overcome challenges in archiving, backup, information security, retained data scalability, data integrity, data accessibility, limited footprint, and more.

Those challenges are real. For example, as has been the case since 2010, ***managing data growth*** remains a nearly universal IT concern, and it seems that the bigger an organization is, the bigger its data-growth challenges actually become. According to ESG research, 25% of large enterprises surveyed cite managing data growth as a priority.[3]

[2] Ibid.

[3] Source: ESG Research Report, *2014 Spending Intentions Survey*, February 2014.

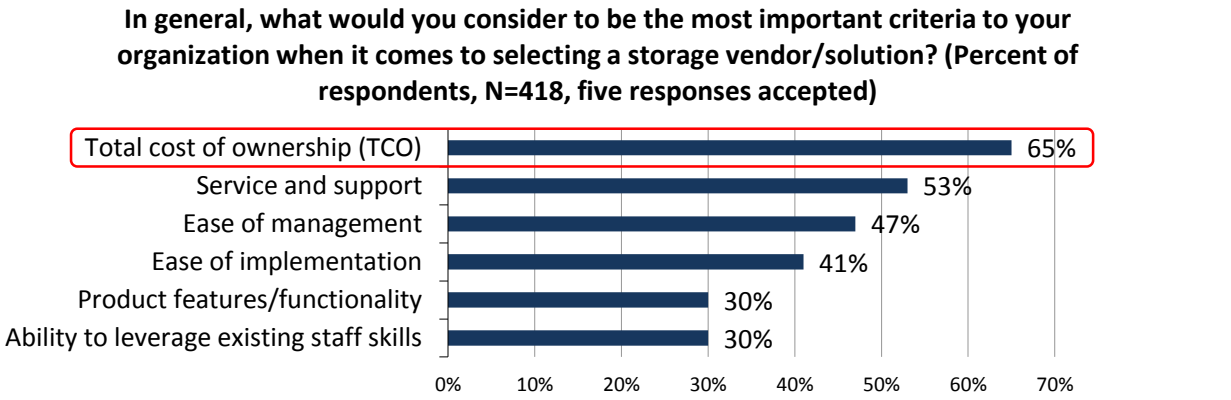
Data retention and protection, in the form of improved data backup and recovery and BC/DR planning, continue to be challenging as well. IT's attempts to improve data protection and retention can be hampered by increasing data volumes; ongoing virtualization projects; proliferating regulations; and the emergence of an often-confusing array of nontraditional alternatives for snapshotting, replication, and cloud storage.[4] Bolstering data protection is definitely a top-of-mind issue. Every year since 2010, improving backup and recovery has appeared as one of the top three most-cited IT priorities among respondents to ESG's annual spending intentions survey.[5]

Additionally, ***cost reduction*** is both a major concern and a major IT spending *driver*. (It's a case of needing to spend money to save money.) Business-process improvement programs, security and risk-management initiatives, and regulatory compliance efforts are just a few of the kinds of projects spurring IT investment—with the return on those investments (ROI) being regarded by IT managers as cost-reduction and containment successes. Buying technology with improved ROI was the top IT investment justification metric reported by IT professionals to ESG for 2014, with ROI appearing especially prominently on the priority lists of leading-edge IT organizations.[6]

Cost Efficiency: What Storage Buyers Want Most

One might assume that features and functionality would be the key evaluation criteria for IT departments trying to pick a storage vendor/solution. In actuality, far more of them appear to rely on total cost of ownership (TCO) to choose (see Figure 2).[7] In light of this trend, ESG is seeing an increase in the use of both ROI and TCO tools for validating IT investments.[8]

Figure 2. Top Six Criteria for Selecting Storage Vendors/Solutions



Source: Enterprise Strategy Group, 2014.

The fact that nearly two-thirds of organizations identify TCO as their top storage-selection criterion—and the fact that organizations cite hardware costs as their top storage challenge—could indicate they are willing to make upfront investments to increase efficiency and thus reduce their storage-related costs long-term.

Oracle's StorageTek T10000D Embodies the Best New Developments in Tape Efficiency

The pace of innovation in tape storage appears to have quickened of late, and Oracle's StorageTek T10000D tape drive is one product leading the way. It isn't too much of a stretch to state that right now, **tape innovations are outpacing disk innovations** in terms of improvements to capacity, speed, reliability, and durability/shelf life. Equally important, tape is making faster relative strides than disk in investment protection, including dramatic recent improvements in backward read/write capability, drive-migration capability, and data accessibility via LTFS.

[4] Source: ESG Research Report, *Trends in Data Protection Modernization*, August 2012.
[5] Source: ESG Research Report, *2014 Spending Intentions Survey*, February 2014.
[6] Ibid.
[7] Source: ESG Research Report, *2012 Storage Market Survey*, November 2012.
[8] Source: ESG Research Report, *2014 Spending Intentions Survey*, February 2014.

Comparing Midrange LTO Tape Storage with Enterprise Tape Technologies

Although enterprise-class tape technologies such as Oracle's StorageTek T10000D carry a higher per-unit cost than midrange LTO technology (in terms of both drives and media), that fact doesn't fairly reflect the whole comparative picture. A higher capacity per cartridge and higher throughput must be taken into consideration when comparing enterprise tape with LTO. For example, at 8.5TB per cartridge, the T10000D boasts the highest uncompressed capacity of any tape drive available—more than three times that of an LTO-6 drive and more than twice the 4TB native capacity of IBM's TS1140 enterprise tape drive. Organizations will likely consume far fewer cartridges to support their tape workloads as a result. So, although enterprise tape cartridges are indeed more expensive than LTO cartridges unit for unit, users will invariably spend less money overall because they purchase far fewer of them. As with many things in the storage world, the appropriate metric here is cost per terabyte, not unit cost.

The capacity advantage is important because it can translate directly to a lower TCO. With the T10000D's 8.5TB-per-cartridge capacity—enabled and supported by its 252MB/sec native throughput—organizations can manage with significantly fewer cartridges than they could with prior-generation technologies. The savings can really add up, especially when one considers the large number of cartridges needed to store multiple petabytes of data.

In terms of *uncompressed* throughput, the higher interface speeds of the T10000D also give it a performance advantage. As mentioned, the T10000D has a rated throughput of 252MB/sec, which is 57% faster than the rated specification of 160MB/sec for LTO-6. Simply put, jobs complete much sooner. In an era when efficiency is everything, enterprise tape technology is faster, which means it demands fewer drives to do the same amount of work. That advantage, in turn, equates to significant initial CapEx and ongoing OpEx savings. Furthermore, users will benefit from greater advantages when they take into account the compression ratios on their data. In a 2.5:1 compression example, the T10000D can achieve 630MB/sec, compared with 400MB/sec for LTO-6.

T10000D KEY SPECIFICATIONS

- Up to 8.5TB native capacity
- 252MB/sec data rate (uncompressed)
- Up to 800MB/sec data rate (compressed)
- 16Gb/sec Fibre Channel, 10Gb/sec FCoE, or FICON
- Reads Oracle T10000A, T10000B, and T10000C data
- Reuses existing T10000C-written cartridges
- Compatible with SL8500, SL3000, and rack-mount configurations

Greater per-cartridge capacity translates to consolidation advantages as well. Although T10000D can store an uncompressed petabyte of data in as few as 118 cartridges, it would require 1,250 LTO-4 cartridges or 400 LTO-6 cartridges to do the same. For IT organizations storing a petabyte of data on LTO-4 technology, switching to the T10000D drive would not only let them reduce their cartridge count significantly (from 1,250 to 118), but also (according to Oracle's analysis) typically enable them to reduce their optimum drive count from five to two, equating to less "stuff" to buy and manage. Furthermore, by making a move to the T10000D, an organization's costs could drop more than if it attempted to consolidate using LTO technologies alone: In other words, going from LTO-4 to LTO-6 could be a more expensive, larger, and more complex proposition than going from LTO-4 to T10000D.

Oracle supplied ESG with five-year TCO comparative data related to a user transitioning from 1PB of LTO-4 to LTO-6, compared with moving from 1PB of LTO-4 to T10000D (in each case, this was within a pre-existing SL3000 library). According to that data, and despite LTO-6 media pricing declining as T10000 T2 media pricing remained stable, the T10000D solution would still be less expensive at the end of five years. The pricing model included costs of service, electricity, and floor space; typical discounts on hardware and media; and it assumed 35% annual capacity growth.

Beyond the Feeds and Speeds

Digging beyond the top-line specifications, materials, and tolerances, it is apparent that Oracle's T10000D enterprise tape technology includes other reliability and efficiency features, which again distinguish it from more midrange technology options such as LTO.

Application/Performance Matching

Some organizations that use tape worry a lot about performance, especially in regard to their ability to meet backup windows and satisfy concurrent data-access requests from many users worldwide. The T10000D drive has "Performance Matching," which allows drives to match their own performance to the host performance accurately when the host is streaming data slowly or, alternatively, when it is sending lots of discrete files. For people who are not intimate with tape operations, this might not sound like a big deal. But it is a *huge* deal in terms of both operational **efficiency** (a faster write performance means meeting backup/archiving windows with fewer tape drives) *and* drive **reliability** (less wear and tear occurs with shorter run times and fewer backhitch operations).

Three features enable the T10000D to match its performance to the host performance:

- **A 2GB data buffer** improves the efficiency of writing data that is coming from slower-streaming servers. The 2GB buffer ensures that data is written to the tape system at the same rate as it is received from the server, so that the application never experiences a drop in performance.
- Oracle designed the drive to support environments in which an application sends many files of varying sizes to the drive rather than streaming a single large file to it. The **File Sync Accelerator** is an always-on feature that virtually eliminates backhitches, enabling streaming writes of small files by taking advantage of the 2GB buffer, multiple tape speeds, and spare wraps on the tape. (In contrast, after an LTO drive writes a file to tape, the buffer normally needs to be flushed, and the drive has to stop, wait for the next file, back up, and start again. It will backhitch every time a file is written successfully to tape, which impairs performance and increases wear and tear on the tape drive.) The File Sync Accelerator in the T10000D eliminates these backhitches and allows data to stream to tape efficiently.
- The **Tape Application Accelerator** is a user-enabled feature that further improves small-file streaming writes at maximum speed by ignoring syncs and converting tape marks to buffered tape marks. A drive with a capability such as this can stream data down-tape efficiently regardless of the fact that an application on a server still expects confirmation after each file is successfully written to tape.

Backward Compatibility Offers Investment Protection

One way a tape technology can offer investment protection is by letting an organization read and write older data across "x" number of generations. In a recovery scenario or e-discovery situation, that backward compatibility not only can come in *very* handy, but also can help an organization save money.

The T10000D reads any tape cartridge originally written by its predecessor T10000A, T10000B, or T10000C drives. The ability to read from old formats becomes more interesting from a cost-efficiency standpoint when one realizes that the new drive can also *reuse* media previously used by the T10000C at a capacity of 5.5TB … while **increasing the written capacity to 8.5TB**. An organization gets a significant, financially rewarding media-related investment-protection boost by reusing already-purchased media at a *higher* capacity (up to 55% more). It therefore avoids having to buy quite as many new tapes.

Aramid and Barium Ferrite: The Media Can Really Make a Difference

The substrate matters: Traditionally, media wear has been a source of concern for tape users. A tape used for archiving ideally should have a life span of at least 30 years; this is a "good" number, generally agreed upon by vendors and users. However, not all tape media use the same substrate material or magnetic coating, which can make a significant difference in both reliability and capacity.

A substrate consisting of aramid—a strong, lightweight, heat-resistant synthetic aromatic polyamide—gives StorageTek T10000 T2 media its strength and offers dimensional stability[9] superior to the PEN substrate used for LTO media. That stability makes T10000 T2 tapes ideal for archival applications in which tapes may be recalled after

[9] Oracle states that accelerated media testing shows the aramid substrate offers four times the dimensional stability of a PEN substrate.

being stored offsite for long periods. After all, the less change that a medium's dimensional properties undergo over time, the more likely it is that the data it holds can be read successfully much later.

The recording material matters: Barium Ferrite (BaFe) is a naturally stable crystalline particle that won't corrode or change chemically over time. When used for tape media, it offers significantly higher capacities than can be achieved with the alternative—metal particle (MP)—coatings. Oracle's T10000 T2 cartridge was the first cartridge to use BaFe, and both its StorageTek T10000C and T10000D tape drives use that cartridge to record their respective native capacities of 5.5TB and 8.5TB.

Interestingly, LTO-6 cartridges are available in both MP and BaFe formulations. In fact, those two media are compatible with LTO-6 tape drives from IBM and HP. However, the capacity of LTO-6 is 2.5TB, which is lower than what BaFe media is capable of and lower than the early roadmaps the LTO consortium had aimed for with LTO-6. It would be wrong to attribute certainty in the consortium's motivation for this shift, but it is reasonable to assume that MP media was perfectly fine at the eventual 2.5TB capacity but wasn't showing good ability to go beyond that with the LTO-6 drive technologies. Moreover, because the consortium needs to remain consistent across its members and offerings to maintain a standard, it aims to offer a choice in media supply when possible. MP achieves this goal. Although BaFe is seen as the future of tape media, Fujifilm is the only manufacturer that today offers it in an LTO format. This is clearly not an ideal scenario for LTO customers who value having multiple sources of media. Users do have these options:

- LTO drives combined with MP media will be the choice of IT users who want to leverage multiple drive and tape media vendors.
- LTO-6 drives combined with BaFe media will suit IT departments that seek out multiple drive vendors but are willing to accept a single media vendor in order to enjoy the increased reliability and performance margins of BaFe.
- Enterprise drives from Oracle or IBM will be optimal for IT professionals who are willing to accept single-source drives and media in exchange for fewer cartridges, fewer drives, higher reliability, and higher performance.

Media Validation

The ability to validate the integrity of tape archives periodically in an automated fashion has long been a request of tape users. The good news is that tape drive vendors have listened, and every new tape drive on the market today offers some form of media validation. Although the work of validating media goes on in the background, the speed at which data is validated is an important factor when limited time exists to allocate hardware and personnel to the task before production activities retake priority.

Software applications such as Oracle's StorageTek Tape Analytics (more on that later) enable users to set policies based on fixed-time intervals, tape volume serial number (VOLSER) range, time span since the tape was last read, etc., to speed up the validation process. At a drive level, two methods are typically used to validate data:

- The first method involves recalling data from a cartridge back to a server, where cyclic redundancy checking (CRC) is performed.
- The second method involves a tape drive performing the CRC internally and simply sending a status of that validation operation to the server. This approach clearly requires less network and server bandwidth and, as a result, it can operate faster.

Oracle's StorageTek T10000C and T10000D tape drives are compatible with both methods. Competing tape drives are constrained to employing the first method.[10]

[10] Users should decide which method suits their operations and should check with vendors during their decision-making process.

Can Oracle's StorageTek T10000D Be the Myth Buster that Tape Needs?

As stated earlier, tape is moving faster than disk right now in terms of its *pace* of innovation. Today, tape is more reliable than disk; tape protects data from software bugs, viruses, and hackers more effectively than online disks can; it is *far* less expensive; it is greener; and it keeps data safer in extreme conditions (earthquakes, electrical surges, etc.).

The bottom line is that in certain use cases, the T10000D is part of a solution almost guaranteed to be less expensive than disk but still able to cover the same bases in capacity, performance, longevity, advanced features, and reliability—including (and this may come as a surprise to many) a better bit error rate, as Table 1 shows. The raw reliability of today's enterprise and midrange tape drives and media ranges from one to three orders of magnitude higher than the most reliable Fibre Channel disk drive. Of course, many tools and design functions (RAID, replication, etc.) help keep users safe from experiencing actual bad production effects from bit errors. However, given the typical uses of tape media (archive, backup, or the "media of last resort"), it is both necessary and reassuring to have it be as inherently reliable as possible.

Table 1. Comparing Tape and Disk Raw Bit Error Rates

Tape and Disk Raw Reliability Comparison	Bit Error Rate
Enterprise Tape (exemplified by Oracle's StorageTek T10000D)	1 x $10E^{19}$
Midrange Tape (LTO-5, LTO-6)	1 x $10E^{17}$
Enterprise HDD (FC/SAS)	1 x $10E^{16}$
Enterprise HDD (SATA)	1 x $10E^{15}$
Desktop HDD (SATA)	1 x $10E^{14}$

Source: ESG, constructed from vendors' published product specifications and other sources.

Advances in Data Access, Speed, Longevity, and Analytics

IT managers have often shied away from tape over the years because they considered it to be a hard-to-use medium. For instance—even if this happened decades ago—conventional wisdom asserted that one could not always realistically determine if data was successfully written to a tape. That perception became fixed in many users' minds over the years as an absolute given. The assertion is no longer generally true, and it certainly isn't true for enterprise systems,[11] yet the myth endures. Indeed, it is hard to think of another IT technology today that suffers from so many pejorative "certainties" that are simply false.

A Brief List of Tape Myths

Some IT professionals declare and believe that:

- "Tape is less reliable than disk." The truth is, tape is an exceptionally reliable medium, both in terms of error rate (lower than disk, as mentioned earlier) and longevity (longer than disk).
- "Tape is slower than disk." Although it is all-too-often stated as an absolute truth, this is really an "it depends" statement. Tape is, of course, usually much slower to access the first byte than a rotating disk would be. But it is much faster than disk for data-streaming operations (e.g., recalling a massive backup file for disaster recovery or hours of HD content as part of a video production workflow).
- "It's hard to retrieve data from tape." In this case, the belief is that (1) finding data on tape can be hard, and (2) an uncomfortable degree of uncertainty can arise regarding whether data is readable. In reality, modern file system integration and tape analytic/data-verification packages have pretty much nullified those concerns.

[11] Tape drives have separate read heads that verify the robustness of the written data pattern *as data is being written*. This write-verify process prevents data from ever being written to tape that doesn't meet error-margin requirements. If written data does not pass muster, then it is written again—usually to a different section of tape—until it does pass verification.

A Deeper Analysis

It is also important to be aware of other developments and improvements contributing to a rebirth of tape storage in the enterprise (especially now that the "enterprise" increasingly includes—in some form or fashion—a cloud element or approach):

- **LTFS**—It's no exaggeration to say that the Linear Tape File System (LTFS) removes one of the biggest traditional drawbacks of tape technology. With LTFS, files and their indices are stored *together* on the tapes. As a result, LTFS has brought true portability to tapes, and by logical extension, to tape drives/libraries when needed. LTFS also provides a quick and easy way to search a cartridge's contents without needing separate backup/archiving software, or, in the case of TAR (tape archive) files, to read the entire contents of the cartridge.

  Simply put, LTFS—the T10000D is one of many platforms to use it—makes tape more user friendly. Tape becomes self-describing: You can think of it as a massive-capacity USB fob that any PC knows how to read and write to. The portability factor is appealing for DR planning especially. It is no longer necessary to send huge tape data capacities slowly over a wire; just truck the whole load of tapes to the DR site and load them onto the same kind of drive: The drives will be able to read the information.

  That's an instance of how an *existing* use case for tape can be significantly improved with LTFS. What's also important is that LTFS opens up *new* use cases for tape. For example, video file transfers between sets/stages of film and TV productions can be done faster and less expensively than transferring the large files across public networks that are potentially insecure/slow[12]/expensive (take your pick).

- **Speed**—Tape is also faster than disk, or at least, it is faster when streaming data (not in random access). And in a tape-versus-tape comparison, the T10000D is the fastest of today's tape drives. Thanks to its 16Gb FC interface speed, the T10000D offers a throughput advantage over LTO, being able (based on manufacturer ratings and a 2.5:1 compression ratio) to achieve 630MB/sec compared with LTO-6's 400MB/sec. And, of course, higher compression ratios can mean even higher throughputs.

- **Restore Predictability**—It may be faster to back up to a dedupe appliance, but will it be faster to restore a few hundred servers from that same appliance versus restoring from full secondary copies on tape? Massive data restores are more predictable with tape than with disk and are not hampered by the multi-step reconstruction and "rehydration" process that a disk restore would invariably require.

- **Longevity**—Accelerated aging tests show that tape has a longer shelf life than disk. Tape does need to "live" a very long life if it is going to be suitable for archival applications. The T10000D drive uses advanced media with an archival life expectancy of 30 years or more. According to tests conducted by Fujifilm, the

WHAT ABOUT GOING TAPELESS FOR DR?

Some tape users consider getting rid of tape altogether—especially for DR. They should keep in mind that:

- Disk has appropriate uses. It's perfect for business continuity and should be the first line of defense to ensure fast operational restoration. But it's not the best technology for disaster recovery. Most enterprises cannot afford to run three or four mirrored sites, so if the primary or single mirrored DR site is wiped out, their existence hangs on one remaining site—that's a major exposure.
- Tape is still used for backup, but not in the way it used to be. Its backup role today is to ensure disaster recovery, as opposed to disk's backup role, ensuring business continuity.
- Tape can mean the difference between an enterprise's predictable recovery from a major disaster and not recovering at all.

[12] To put this in perspective, moving a petabyte of data across the internet—even under optimum conditions—can take about ten days. Doing the math for a fully capacity-utilized T10000D-written tape (without factoring in compression but with encryption), the choice could boil down to 85 days of across-the-web transmission … or shipping to nearly any global destination within 24 hours.

barium ferrite coating used by the T10000D shows no change in magnetization over a 30-year simulated time span.[13]

- **Analytics**—Tape manufacturers including Oracle are now simplifying the day-to-day management of tape storage environments by offering sophisticated but easy-to-use analytics software. For example, Oracle offers StorageTek Tape Analytics, which provides users with real-time information on the health of every tape cartridge and tape drive in their environment through a single graphical user interface. Instead of reacting to failures when they occur, users can use software analytics to flag components in the system that are showing signs of degradation, allowing targeted monitoring and proactive steps to be taken before a failure occurs. The tools can even be set up to validate the integrity of the tapes on a regular basis and send a warning alert if anything looks awry, further simplifying management of the environment.

LTO Certainly Has Its Place, but Caveats Exist

Admittedly, LTO serves its purpose for many applications and customer segments. The technology definitely sells well and works well. Many users like it. And it's worth mentioning that Oracle has LTO tape solutions in its offering portfolio. Nothing in this paper is designed to suggest that LTO is not a sound technology, but merely to point out that it may not be the *optimal* solution for large and/or growing, enterprise-class environments that are seeking the ultimate tape infrastructure in terms of capacity, reliability, duty cycle, and value/ROI.

The key is to use LTO appropriately, according to a cost and workload basis, and avoid using it in places or ways that are unsuitable. LTO is optimized for midrange environments. It is an excellent choice for, say, storing less than a petabyte of data with non-dramatic growth expectations. Conversely, in a growing enterprise environment storing a petabyte or more, LTO-6 can actually mean added expense, added footprint, added complexity, lower performance, and lower reliability than an enterprise tape solution. Data center planning and budgeting often occur years in advance, and the stakes surrounding platform decisions are high for users, which means that a balanced understanding of the options is vital.

Some users might hesitate to have "too many eggs in one basket" if they move from a 2.5TB form factor to the T10000D's 8.5TB form factor. However, the probability of losing any given 2.5TB cartridge is no different than the probability of losing any given 8.5TB cartridge. And with encryption and, ideally, retaining two copies of data on tape, the business impact of such incidents drops close to zero. The real difference is that a user of a fully utilized 8.5TB cartridge has to manage just one cartridge for every *four* cartridges that the LTO-6 user must manage. And, if applicable to the particular environment, one-fourth the number of cartridges also means one-fourth the offsite storage costs.

It All Ties Back to Contemporary Business and Operational Requirements

The trend today is to have a great deal of information not only available, but also available for a very long time, so the process needs to be economical.

If an organization engages in a long-term data retention effort that will *not* involve frequent data access and recovery—which is almost always the case with long-term retention efforts—the only sensible place to put that data is where it is most cost efficient: tape. In general, tape has always tended to "follow" disk technology. In other words, advances developed for disk-based storage filtered down and eventually made their way to tape. A lot of headroom still exists in terms of tape technology advances to come. That means the cost-per-TB of tape storage should continue to decline well into the future—at a pace faster than disk storage.

Key Takeaways: Enterprise Compared with LTO

As with most things in the world of business and technology, a balance must exist between cost and value. When it comes to tape technology, overall value is, arguably, more important than unit cost.

[13] Source: Fujifilm news release, *Long-term Archivability and Stability of Fujifilm Magnetic Tape Using Barium Ferrite (BaFe) Particle*, September 2010.

And by now, almost everyone in IT has heard the adage, "When the only tool you have is a hammer, everything looks like a nail." For many customers, midrange LTO tape technology is the hammer. Because of the *perceived* lower cost of LTO tape technology, enterprises have been trying to apply it to every situation, even when the situation calls for a more robust solution.

Conversely, solution providers, consultants, and IT departments that possess toolboxes filled with a broad portfolio of distinct ways to solve data retention and archiving challenges are unlikely to urge their customers to apply LTO tape technology to every situation. To help an organization overcome enterprise-scale challenges, IT departments need an enterprise-caliber tape solution, one that adds value through:

- **Capacity**—Higher-capacity cartridges can mean fewer cartridges to buy and manage, a smaller library footprint, and lower total cost.
- **Performance**—Improved performance can mean increased storage efficiency and shorter run times that improve IT operations and reduce their cost.
- **Reliability**—Higher innate reliability can result in better data availability, longer life, and reduced maintenance and support expenditures.

In suitable use cases, Oracle's StorageTek T10000D delivers these enterprise-class capabilities—capacity, performance, and reliability—for petabyte-scale environments at a lower TCO … and therefore, invariably, with a higher value than LTO.

The Bigger Truth

Ever since 2009, when Oracle bought Sun (which had previously purchased StorageTek in 2005), the company has been making impressive strides to renew IT's focus on, and understanding of, the tape business—both its operational and financial attractions.

It is commonly believed that Oracle did not buy Sun for its tape technologies. Oracle more likely bought Sun to gain a vast user base, the popular Solaris operating system, the Java programming language, and so on. Actually, no one outside of Oracle has much deep insight into what Oracle thought specifically about the StorageTek tape systems that came along with the rest of the acquisition. But none of that matters now. Oracle clearly figured out—either right away or at some point later—that having a full, hierarchical storage portfolio, including enterprise tape, is a good thing. As many users (at varying rates) are discovering, just because tape is a technology with a long history, that fact does not make it "bad." Disk is barely any younger, and we all see how much it has changed from the old washing machine- and freezer-like devices to today's sleek rack-mount systems.

Oracle continues to work to revitalize people's opinions about tape solutions. It is putting marketing programs in place to fan the embers of interest and knowledge, and it is aggressively driving the kind of technology improvements that can keep the resulting flames growing. Oracle's efforts are more admirable in light of the fact that Sun never really gave its StorageTek acquisition the "care and feeding" it deserved. However, Oracle is now both invested *and* investing. As a result, IT organizations and service providers have access to and can reap the considerable—and surprisingly affordable—benefits of enterprise solutions such as the T10000D.

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20 Asylum Street | Milford, MA 01757 | Tel: 508.482.0188 Fax: 508.482.0218 | www.esg-global.com