



## Enterprise Tape for Archival Storage? — Why This Just Might Make Sense (Updated)

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### Enterprise Archive Storage Requirements

We need to put an end to at least one data center myth: **Tape is not dead!** Tape, in fact, is thriving in a myriad of environments, including as an active platform for NAS on tape, long-term archiving, and even backup. While some vendors continue to propagate the myth, a number of companies are availing themselves of a billion dollar market opportunity, including HP, IBM, Oracle, Quantum, Spectra Logic, and a litany of others, with innovation arriving yearly in terms of both hardware and software.

This innovation is necessary because over the past decade, storage requirements have exploded throughout the enterprise, not only in the data center, but also in departments and remote locations, such as regional branches. However, this is most evident in the enterprise data center. Moreover, within the data center, requirements for Tier-3 storage in support of long-term archiving have placed a tremendous strain on enterprise resources, both human and financial. In December 2010, The Clipper Group published an exhaustive study comparing the effects of both disk and tape on the enterprise budget, on a total cost of ownership (TCO) basis<sup>1</sup>. For disk, we used 2TB SATA drives, the most commonly used high-capacity disk storage unit, *at that time*. For tape we used *LTO-5* technology<sup>2</sup>, the most commonly used tape architecture with the highest capacity open tape media, *at that time*. **Tape TCO came out the winner by well over an order of magnitude!** Well, *LTO* has changed over the past year with the specification announcement (in October, 2012) of *LTO-6*<sup>3</sup> technology by The LTO Program, directed by a consortium of HP, IBM, and Quantum, followed more recently by product announcements. *LTO-6* technology (when compared to *LTO-5* technology) has increased the native capacity of a single cartridge from 1.5TB to 2.5TB, increasing the compressed capacity from up to 3.0TB to up to 6.25TB, with a 2.5:1 compression ratio; a significant increase in storage capacity. As a result of this evolution in *LTO-6*, earlier this year The Clipper Group updated the 2010 TCO study, incorporating technology and pricing changes for both tape and disk, including increasing the capacity of SATA disks to 3TB at the onset of the study. The results of this study were similar to those from 2010 and were published in May 2013<sup>4</sup>, reaffirming our conclusions that tape, *LTO-6* in this examination, was a better economic value than disk for long-term storage. This increased capacity raised an interesting question: *Are there any economic or technical advantages to using an open tape architecture (i.e., LTO-6 tape) over enterprise tape, as offered by IBM and Oracle, in an open systems environment?*<sup>5</sup> *Or, perhaps, might enterprise tape offer a better*

<sup>1</sup> See the issue of *Clipper Notes* dated December 20, 2010, entitled *In Search of the Long-Term Archiving Solution – Tape Delivers Significant TCO Advantages over Disk*, and available at <http://www.clipper.com/research/TCG2010054.pdf>.

<sup>2</sup> See *The Clipper Group Navigator* dated January 29, 2010, entitled *LTO Program Announces Next Gen Tape – LTO-5 Raises the Bar for Tier-3 Storage*, available at <http://www.clipper.com/research/TCG2010002.pdf>.

<sup>3</sup> See *The Clipper Group Navigator* dated July 12, 2012, entitled *Magnetic Tape Turns 60 – The IT Industry Receives Another Gift*, available at <http://www.clipper.com/research/TCG2012015.pdf>.

<sup>4</sup> See the issue of *The Clipper Group Calculator* dated May 13, 2013, entitled *Revisiting the Search for Long-Term Storage – A TCO Analysis of Tape and Disk*, and available at <http://www.clipper.com/research/TCG2013009.pdf>.

<sup>5</sup> The origins of enterprise tape lead back to the IBM mainframe and, later, to the *System i* operating environment (which now runs on *Power Systems*).

### *value than LTO tape for open systems data?*

In 2011, we at The Clipper Group followed up our TCO study by publishing a bulletin potentially justifying the use of enterprise tape over LTO-5 tape, in any environment, open systems or mainframe.<sup>6</sup> That *Captain's Log* compared IBM's *TS1140*<sup>7</sup> enterprise tape drive and media, with a native capacity of 4TB, and Oracle's *StorageTek T10000C* enterprise tape drive and media<sup>8</sup>, with a native capacity of up to 5TB<sup>9</sup>, to the industry-standard *LTO-5* architecture. Based upon capacity alone, the older enterprise drives would still appear to be superior when compared to the LTO-6 technology. However, **capacity is definitely not the only factor that determines an enterprise decision on this tier of storage.** There are many factors that go into this decision, including acquisition cost, performance, availability, reliability, the TCO, and what already is on the floor of your data center, any of which may be the most important factor in your next tape procurement decision.

With new data at hand, in March 2013<sup>10</sup> we updated that study to ascertain what advantages, if any, existing enterprise tape has over LTO-6 tape. Many of the conclusions that we drew in that study were based upon the assumption that enterprise tape would retain its then current capacity and performance levels until sometime in 2014. Well, less than six months later, **Oracle has announced a new enterprise tape architecture<sup>11</sup>, with significant changes in capacity and moderate improvements in throughput.** Consistent with our policy to keep our readership updated in the latest changes in IT technology, herein we have revised that comparison. To learn more, please read on.

### **Total Cost of Ownership Factors**

First, we must define the data center environment: To be clear, this is not about small businesses with a standalone drive or autostacker or a very small library with up to 10 or 12 slots and a single drive. However, there are some small enterprises with large collections of historical data that may benefit from the performance, reliability, and capacity available from enterprise drives. Strictly speaking, this is about the largest data centers; the ones with mission- and business-critical tape libraries, with more than a petabyte of data on hundreds or even thousands of cartridges.<sup>12</sup> These data centers are using tape libraries as the primary long-term storage target for most, if not all, of their enterprise archiving requirements<sup>13</sup>. Some, but not all, of these data centers will be equipped with both mainframes and open systems servers, the latter running *Windows*, *Linux*, or some variant of *UNIX*, but others *only* will have open systems storage architectures. **If you already have both enterprise tape and LTO in your data center, it may be easier to consider using enterprise tape to store open systems data, as you already are committed to the enterprise format. However, if you only have LTO libraries, then adding enterprise tape may require further justification.**

It goes without saying that enterprise tape has a higher per-cartridge cost than LTO tape, even when compared to LTO-6 tape (which, in turn, has a higher per-cartridge cost than LTO-5 tape). However, this is not necessarily true when calculating that *cost on a per TB* basis. Moreover, calculating the contribution of tape media towards the TCO requires us to consider the quantity of cartridges and library slots needed to achieve the desired storage capacity. Deployed in enterprise-class tape libraries, Fibre Channel (FC) enterprise drives<sup>14</sup> also have somewhat higher per-unit costs than FC LTO drives. But, using the same logic as is used to determine media costs, the tape drive contribution towards the TCO must consid-

<sup>6</sup> See the issue of *The Clipper Group Captain's Log* dated July 12, 2011, entitled *Ten Reasons Why You should Consider Enterprise-Class Tape for Open Systems Storage*, and available at <http://www.clipper.com/research/TCG2011025.pdf>.

<sup>7</sup> See **The Clipper Group Navigator** dated June 6, 2011, entitled *IBM's New Enterprise Tape Extends Data Retention Capabilities and Lowers the Cost of Data Protection*, available at <http://www.clipper.com/research/TCG2011021.pdf>.

<sup>8</sup> See **The Clipper Group Navigator** dated January 31, 2011, entitled *Oracle Fulfills Commitment – StorageTek T10000C Takes Leap Ahead*, available at <http://www.clipper.com/research/TCG2011003.pdf>.

<sup>9</sup> Up to 5.5TB, with the Oracle T10000C StorageTek Maximum Capacity Feature.

<sup>10</sup> See the issue of *The Clipper Group Captain's Log* dated March 31, 2013, entitled *Enterprise Tape for Archival Storage? – Why This Just Might Make Sense*, and available at <http://www.clipper.com/research/TCG2013005.pdf>.

<sup>11</sup> See **The Clipper Group Navigator** dated September 12, 2013, entitled *Oracle T10000D Further Reduces the TCO for Storing Data on Tape*, available at <http://www.clipper.com/research/TCG2013017.pdf>.

<sup>12</sup> As a general rule, SMBs do not have the capacity requirements to justify the deployment of enterprise-class tape.

<sup>13</sup> To be clear, this is not a reference to storing backup data for a long time. This is about archiving business data, usually files or objects, for a long time.

<sup>14</sup> In an open systems environment, FICON, a more expensive interface, is not required.

er the quantity of tape drives needed to achieve a desired overall throughput. **As you will see below, when comparing the TCO of enterprise tape to LTO, cost tends to fall away as the key factor for deciding between the two technologies.** Enterprise tape simply delivers more in quantifiable values, such as capacity per cartridge and throughput, than LTO-6 technology. This, in turn, could mean fewer drives and cartridges to manage, fewer library slots to hold the cartridges, and potentially fewer frames to acquire than with LTO-6 tape. With fewer drives, cartridges, slots, and frames, and less floor space, the cost per TB for archiving might be reduced significantly.<sup>15</sup> Then there is reliability. If you have a mainframe, you already know about the reliability attributes of enterprise tape drives. They are worth every penny that you paid for them. Moreover, if you have deployed spare drives (LTO or enterprise drives), the drive availability concern is lessened significantly in terms of downtime.<sup>16</sup>

The roadmap for enterprise tape also is a significant factor in the IT solution. The previous generation of enterprise drives and cartridges (released between January 2011 (Oracle StorageTek T10000C) and June 2011 (IBM *System Storage TS1140*)) had significantly higher native capacity and delivered significantly higher throughput than the latest LTO-6 technology. LTO-6 technology is at 2.5 TBs per cartridge (uncompressed) and has a native transfer rate of 160 MB/second. With a 5TB standard capacity (native), the Oracle StorageTek T10000C was the industry leader in capacity, while the IBM TS1140 with a native transfer rate of up to 252MB/second was the performance leader, but just barely. However, now the Oracle StorageTek T10000C cartridges are no longer the industry leader. **A year ahead of best estimates, Oracle has announced the StorageTek T10000D drive and media with a native uncompressed capacity of 8TBs, and 8.5 TBs with the Maximum Capacity option.** In fact, the StorageTek T10000D uses Oracle's T10000 T2 media, the same as that used for the StorageTek T10000C. With a 2.5:1 compression ratio, the same as assumed for LTO-6 or the TS1140, the StorageTek T10000D has a compressed capacity of 21.25TB per cartridge, more than a great many enterprises ever expected to need in total just a few years ago. In addition, with an improvement to 250MB/second, the StorageTek T10000D virtually matches the performance of the TS1140.

In addition, we can expect that the next generation of Oracle enterprise drives<sup>17</sup>, likely out by 2015, will have even greater densities than they do today<sup>18</sup>, somewhere in the range of 60% higher, matching the growth rate of the StorageTek T10000D. That should put the next generation of enterprise cartridges above 10 TBs (uncompressed)<sup>19</sup> per cartridge. That would be about four times the uncompressed capacity of LTO-6. (It must be noted that some of today's enterprise drives have been quoted with a compression ratio of up to 3:1<sup>20</sup>). For large data collections, greater compressed capacity equates to fewer library slots, less floor space consumption, and, probably, fewer drives. In addition to these quantitative capacity calculations, there also is the benefit of using what likely will be enterprise drives that are capable of delivering higher reliability and availability. In addition, future enterprise drives may be able to continue to use the existing enterprise media at higher capacities, while LTO media is expected to remain at currently stated capacities until the next generation arrives. (As of this date, IBM has not made any announcement with regard to the follow-on drive to the TS1140, although we most certainly expect them to do so by next year. As a result, when we refer to enterprise tape in the rest of this discussion, we will be referencing the capacity, performance, and functionality of Oracle's StorageTek drive and StorageTek T10000 T2 media.) **Nonetheless, the economic question almost always comes down to TCO per TB. Put more specifically, if enterprise media costs about the same per TB as LTO media, and if the performance per dollar invested in libraries and tape drives is about the same, which should you buy for large-scale archiving?**

Let's take a deeper look at the TCO considerations that go into any tape storage acquisition and the

<sup>15</sup> This is situation dependent. While we think that these conclusions are generally true, there may be situations where the savings might be less. For example, if you need a certain number of drives for simultaneous access (writing and/or reading), using drives that can write or read faster might not result in reducing the number of drives that are required, potentially negating the TCO savings.

<sup>16</sup> A drive can be considered a spare when it is above and beyond the number needed to handle the largest expected peak activity.

<sup>17</sup> The Clipper Group has not yet seen a roadmap for the next enterprise tape from IBM.

<sup>18</sup> At this point in time, LTO tape and enterprise tape generations seem to be on staggered announcement schedules. This is being played out as a game of leapfrog. We expect that the next announcement should come from, IBM, to compete with Oracle's T10000D. LTO-7 might appear in 2015, maybe a little earlier.

<sup>19</sup> The current LTO roadmap calls for LTO-7 to have a native capacity of 6.4TB and is expected in 2015.

<sup>20</sup> Actual compression definitely will vary depending upon the data being compressed.

components that comprise it.

- 1. Drive acquisition cost – The acquisition cost of a tape drive is relatively minor in comparison to the cost of the media and frames required to hold and store the data.** We have noticed that the list price of an LTO-6 tape drive for installation in an enterprise library may be \$5K-\$15K less (per drive) than the price of one of the existing enterprise drives. However, now we have seen from Oracle the introduction of the StorageTek T10000D drive at the same price as the StorageTek T10000C. **Moreover, because of the throughput advantages of enterprise drives, their larger capacities, and their higher compression ratios (than older commodity drives before LTO-6), you may need fewer drives to do the same amount of work.** In addition, if the data center has a heterogeneous environment with both open systems servers and mainframes, fewer frames may be required as the enterprise libraries from IBM and Oracle can support both LTO-6 and enterprise media.<sup>21</sup> In these cases, **enterprise drives may end up costing less than LTO-6 drives because the drives' cost contribution to TCO per TB may be less when enterprise tape drives are deployed.**
- 2. Media acquisition cost – The cost for a drive is not nearly as important as the cost per TB for the media.** An LTO-6 cartridge may cost less than \$100 while some enterprise cartridges might cost more. The difference in cost/TB, however, is not nearly as significant. In fact, enterprise tape likely will even have a lower cost per TB for the media. As stated above, some enterprise drives enable the IT staff to reformat the previous-generation media to a higher density. Future enterprise drives may also use the existing media at higher capacities, while LTO media is generationally bound to its native capacity. This can be a TCO bonus. In addition, the Oracle StorageTek T10000D can read-back three generations to preserve the investment made in existing media. You get to reuse older media and can store more capacity on the T10000 T2. LTO drives require new media to achieve the higher capacity of newly released drives.
- 3. Number of slots needed – With a capacity of up to 8.5TB today, the enterprise drive has a significant advantage over LTO-6 tape, in terms of the fewer number of cartridges (and slots) needed and, therefore, (potentially) a need for fewer library frames.** The number of enterprise cartridges required to hold one PB of archived data today is significantly more for LTO-6 tape – 400 slots compared to 118 slots for Oracle's enterprise cartridges at 8.5 TBs each. Today's enterprise drives require only 45-65% of the slots required by LTO-6 tape. We assume that the next generation of IBM drives, expected by 2014, also will have a higher density, in order to compete with the T10000D, when announced. It also may be assumed that the next generation of Oracle drives, expected by 2015, will have 50% to 100% higher capacity and the gap will increase until LTO-7 technology finally appears (presumably in 2015).
- 4. Less floor space – With significantly fewer enterprise cartridges (and slots), the data center is able to support a digital archive in less floor space with enterprise tape than with LTO tape.** Fewer slots usually means fewer frames need to be deployed, potentially increasing the useful life of the existing floor space, and possibly saving millions of dollars in new construction costs.
- 5. Throughput performance – The native sustained data rate of an enterprise drive is 250 MB/second, while an LTO-6 drive has a native sustained data rate of 160 MB/second, potentially giving an enterprise drive more than 50% higher throughput.** With two enterprise drives installed, the data center can deliver up to 500 MB/second of throughput. Achieving a comparable throughput with LTO-6 drives would require four drives. If the data center needs three enterprise drives (an investment of \$90K or \$120K, depending on the vendor), they would require five LTO-6 drives (at a cost of approximately \$125K). Reducing the number of drives required lowers the TCO, due to lessened acquisition and maintenance costs. Obviously, if you need a lot of drives, this might be a significant reduction in capital costs and future maintenance. This leaves the current generation of enterprise drives with a noticeable edge over the current LTO technology. In addition, the number of exchanges can be significantly less with the higher capacity enterprise cartridges as more data can be written or recalled in a single cartridge exchange. While we can only estimate the throughput for the next generation of enterprise drives, it would not be unreasonable to expect an increase in performance when compared to the previous generation.<sup>22</sup>

<sup>21</sup> IBM requires that LTO and enterprise tape cartridges be segregated into separate frames. Oracle does not.

<sup>22</sup> And while we can only look at the past, the price of a drive tends to go up a little between generations, but far less than the proportional increase in capacity, etc.

6. **Other performance metrics – Comparing performance metrics between LTO and enterprise drives also reveals advantages for enterprise tape.** The average access time for LTO-6 drives is about 50 seconds for a 2.5TB cartridge. The average access time for an enterprise drive is now 50 seconds for a full-length cartridge with over triple the capacity of LTO-6 cartridges. The access time for an Oracle Sport cartridge is only 14 seconds for its 1.6 TB capacity. The rewind time is also interesting, with a maximum rewind time of 90-100 seconds for LTO-6 cartridges, while the maximum rewind time of for a full length enterprise cartridge is 97 seconds, again with triple the capacity. This may equate to noticeably better operational performance for the enterprise tape solution.
7. **Maintenance – While it goes without saying, fewer drives and possibly fewer frames can mean reduced maintenance costs, after the warranty expires.**
8. **Reliability – Enterprise tape drives and cartridges historically have delivered higher reliability and more features** than more open designs. Enterprise tape's superiority comes from a mainframe heritage where the required duty cycles are higher and superior reliability is expected. Furthermore, the Uncorrected Bit Error Rate (UBER) for enterprise drives can be up to 100 times more reliable. This may not be a meaningful TCO issue, but it is a noteworthy difference.
9. **I/O Interface – LTO-6 drives come with both a 6 Gb/second SAS interface and an 8 Gb/ second FC interface for automation. Enterprise drives come with up to a 16 Gb/second FC interface in addition to a 10 Gb/second FCoE interface.** Your existing IT infrastructure may well dictate which direction you need to take. **The question being raised in this paper is whether you should be using enterprise drives for open systems use, which implies Fibre Channel connectivity.** If you have mainframes and open systems, only enterprise drives offer connectivity to both network.
10. **Energy consumption – The total energy consumption of enterprise drives continues to go down given that fewer drives are required with each new generation.** This factor also is relevant when comparing enterprise drives with LTO-6 drives, based upon the total tape drive throughput required. For an equivalent amount of tape drive throughput, an enterprise solution will require fewer drives, and thus less energy for powering the drives and cooling the environment. However, the amount of energy consumed is inconsequential, especially when compared to the energy consumed by disk in an archival environment.
11. **Other Features – Enterprise tape drives tend to offer a more robust set of features than LTO drives,** mostly designed to improve efficiency in writing data with a high frequency of syncs and tape marks. While some LTO drives offer a variety of enhanced data integrity features, enterprise drives offer a more robust set of features for validating data integrity.

## Conclusion

From a pure capacity and performance standpoint, the new enterprise drives from both IBM and Oracle have distinct advantages over LTO-6 drives, not only today, but seemingly for the foreseeable future, while Oracle's new T10000D has a distinct edge over the TS1140. **From a TCO standpoint, the total cost of ownership of an enterprise tape solution may not be any (or much) higher at all than a midrange LTO solution. In fact, depending upon your configuration and your environment, enterprise tape's TCO could be lower for an equivalent capacity and performance than for the same library with LTO-6.**

From a functionality standpoint, LTO-6 technology has features and functions quite comparable to those offered with enterprise drives. From a usage and reliability standpoint, however, enterprise drives have been designed to support the unique applications of the mainframe environment and are regarded as superior to midrange drives, proving themselves in the most demanding of mainframe environments.

**In the long run, the capacity, throughput, and reliability advantages of an enterprise tape solution could allow you to do more with less – fewer tape drives, fewer cartridges, fewer library frames, and less hassle. Doing the math may prove that you need to spend less, too! You need to check this out!**



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