AberdeenGroup

LTO Tape Has It All: Reliability, Scalability, Performance, *and* Openness

An Executive White Paper

December 2001

LTO Tape Has It All: Reliability, Scalability, Performance, *and* Openness

Preface

It's back to basics for data protection. That is the message that IS organizations are hearing — or should hear — from executive management. The rush to e-Business, the introduction of new applications such as Customer Relationship Management (CRM), and the expansion of existing applications continue to converge to drive the growth of storage. All that data must be protected — and well. The backup and restore process is essential to data protection. Efficient backup is an ongoing, indispensable task, and effective restoration of files and databases is a mandatory requirement.

Tape continues to play a rock-solid role in data protection, from recovering from accidental file deletion to remote location disaster recovery. A good tape solution (tape media, tape drives, and — as necessary — tape automation) should have three prerequisite characteristics for an effective backup/restoration process:

1. *Reliability:* Data is backed up on the first effort without time-consuming repetition, and the enterprise is able to restore all of its key data;

2. *Performance:* Backup and restore tasks are accomplished in the time frame specified by the enterprise; and

3. *Scalability:* Storage growth is easily accommodated, thus insulating the enterprise from the risks of incomplete backup/restore of all important files and databases.

Existing tape technologies may not be able to satisfy those conditions. For that reason, several new tape technologies have been introduced to meet open-system needs. This *Executive White Paper* focuses on one of those new tape technologies, Linear Tape-Open (LTO) technology.

LTO technology offers the reliability, scalability, and performance that is now demanded of tape solutions in open-systems-based Information Systems (IS) environments. Moreover, LTO technology offers openness. LTO technology is the only tape format that is not controlled by a single company, so it is an exceptionally open tape format. Hewlett-Packard, IBM, and Seagate — three well-respected companies in tape solutions — provide the solid underpinnings for LTO technology. This openness offers the IS buyer greater choice and competitive pricing.

In the past, IS may have been reluctant to move to a new tape technology until it was abundantly clear that such a move was necessary. IS no longer has that luxury since it must stay ahead of the curve in ensuring that data protection will meet both current needs, as well as projected future needs. When IS bites the data-protection bullet, LTO tape technology can very well meet those needs.

Executive Summary

Tape is dead; long live tape. The older tape technologies originated at a time when open-systems environments were not as demanding in capacity, perform-ance, and reliability. Today, Unix and Windows NT/2000 platforms support more and more mission- and business-critical applications, both for internal use and for external e-Business. As a result, older, open-system-oriented tape technologies will be gradually replaced with newer, more powerful technologies over the next several years.

Older, tape-supported applications typically revolved around single tape drives. Many of the challenging new tape-related applications demand the robustness and rigor of tape automation, such as using the robotics in a tape library to dramati-cally lessen the need for manual, tape-cartridge handling. That sophistication is necessary for the 24×7 high-capacity world and requires equally capable tape me-dia, tape drives, and tape automation.

In 1997, Hewlett-Packard, IBM, and Seagate decided to ensure that there would be at least one open-systems-supporting tape technology that would meet these re-quirements. The three companies created the Linear Tape-Open program. In 1998, the LTO sponsors issued specifications and a roadmap for two tape-program formats — Accelis technology for tape-related applications that call for high per-formance and Ultrium technology for data-devouring backup/restore tape applica-tions. To date, the focus has been on Ultrium technology rather than Accelis tech-nology. In the fall of 2000, tape media and tape drives that conform to the Ultrium format started to become generally available for use by IS organizations.

Although the three LTO technology provider companies (TPCs) prescribed the specifications for each of the two tape programs, they also established a licensing and certification process that is independent of the sponsors, both individually and collectively. Thus, suppliers licensed for LTO tape cartridges and tape drives must submit products for annual third-party compliance testing. Products that meet the verification requirements are entitled to display that approval through use of the LTO program trademark and the Ultrium trademark.

Of necessity, adoption of LTO technology requires that IS must migrate from an older tape technology to LTO technology. Most IS organizations have historically been willing to undertake the migration effort in return for significant benefits — both in terms of meeting current needs and increased flexibility for future growth. And openness — plus LTO technology itself — may well qualify.

For LTO users, openness means that the days of choosing a new tape vendor by going through the hassle of moving to a new tape format are over. LTO technology also enables IS to separate the decision to buy media, i.e., tape cartridge, from the decision to buy the tape mechanism, i.e., tape drive, from the decision to buy tape automation, e.g., a tape library. IS can instead choose on the basis of vendor rela-

tionships, product differentiation within the LTO structure, and competitive pricing.

Make Way, Make Way for the New Tape Technologies
Older, open-system tape technologies have performed well, and will continue to perform well, in IS environments that do not immediately face the tough, new challenges for reliability, scalability, and performance. And at the high end, a number of premium tape solutions fulfill the most challenging requirements for high reliability and performance. However, much of network storage will require tape solutions able to keep up with the increased data-protection challenges. These tape solutions must deliver higher capacity, greater reliability, and higher performance than the older generation of open-system tape technologies could provide.

In response to this challenge, a number of tape storage vendors are offering, or plan to offer, new tape technologies. The Linear Tape-Open initiative, in particular, is taking a leadership role in the introduction of new tape solutions that are rising to meet the challenge.

Linear Tape-Open Technology — Open to the World
The purpose of LTO technology is to ensure that a compliant tape drive from any vendor can read from and write to a piece of compliant tape media in the form of a tape cartridge. That interchangeability creates an *open* tape standard for both tape media and tape drives.

Although three storage vendors — Hewlett-Packard, IBM, and Seagate — initiated and maintained control over the LTO technology, the process itself was not open, in the sense that anyone could participate in setting program ground rules. However, enterprises did not care that the process was not open in that sense; enterprises cared only that the end result was an *open marketplace* of interchangeable, high-quality products. The process, therefore, had to encourage enough companies to bring compliant tape media and tape drives to market to actually create that open marketplace. Vendors had to believe that they could actually develop compliant products that would meet real enterprise requirements. That objective has been met. HP, IBM, and Seagate offer LTO tape drives. Five companies currently offer LTO media — EMTEC Magnetics GmbH, Fujifilm, Imation, Maxell, and TDK Electronics Corporation.

The three LTO founding companies set up three processes — specification, licensing, and compliance. The specification process is the design vehicle for the tape formats. The licensing process extends to any company that wishes to develop an LTO-compliant product access to the design requirements and the right to submit a developed product for verification testing. The compliance process describes the steps through which a product must pass before it can receive certification.

Enterprises look to the specification process to determine whether compliant products will have the characteristics necessary to fulfill their business needs. Enterprises also expect an effective compliance process to heighten their comfort level with products that they acquire, regardless of supplier.

Specification
Three major vendors in the specification process provided enough diversity of opinion to ensure the consideration of a range of ideas — and selection of the best ideas. That number also ensured that consensus-building never hit an impasse, became too time consuming, or was diluted with too much compromise.

The specification process set the design ground rules. For example, all LTO tape media are encased in sealed cartridges. That was a good idea because the days of reel-to-reel tape are waning; moreover, small form-factor tape cartridges are much easier for IS to manage and control — and a must for tape automation.

Licensing
Licensing is a legal process, so the LTO sponsors asked the law firm of Ladas & Parry to craft the terms of the contractual agreement. That way, the sponsors could ensure that the licensing process would be independent.

By contrast, the law firm issues a license to any firm that requests one. A license entitles a storage supplier to develop a product that it thinks will comply with the appropriate LTO program specifications. If the licensee does develop a product, the license ensures only that the licensee can submit the product for compliance testing — not that the product will pass the test.

Compliance
While licensing is a legal process, ensuring compliance is a technical procedure. The LTO fathers selected a third party — Measurement Analysis Corporation (MAC) of Torrance, CA — to independently administer and execute the verification testing process. The verification process determines whether or not submitted tape drives and cartridges conform to the appropriate LTO format specifications.

MAC conducts an exhaustive set of tests on tape cartridges, covering recording areas such as format parameters, media electrical and magnetic recording, cartridge shell mechanical characteristics, media mechanical properties, and media reliability and durability factors. The fundamental test for a tape drive is that cartridges written by a drive meet the format specifications and that the tape drive is able to read tape cartridges that adhere to the format.

Compliance is based only on what is necessary for interchange. Mean time between failures (MTBF), physical form factor, and other parameters not needed for LTO-compliant interchangeability are not tested. Individual vendors can thus pre-

---

serve the private intellectual property that allows them to innovate and create product differentiation within a framework of interchangeability. For example, at least one LTO tape drive has a stated MTBF of 250,000 hours on a full-duty cycle — i.e., constantly running — performing streaming backup and restore operations. IS should find that level of reliability for a tape drive quite attractive.

Licensees are entitled to use the LTO program trademarks and the trademarks of the two LTO program formats on compliant products. To maintain trademark status, a product must undergo annual testing to ensure that it still conforms to the LTO specification standards. Choosing a tape product with the LTO seal of approval assures IS that the product has withstood a rigorous testing process.

The Ultrium Program Format
The LTO initiative defines two programs — Accelis and Ultrium. Each tape format has its own tape cartridge. The Accelis program concentrates on high-performance tape, whereas the Ultrium program focuses on high-capacity tape. To date, LTO activity has been devoted exclusively to the Ultrium format.

New business applications, brought on by the demands of e-Business and the re-shaping of internal business processes, demand what once would have seemed like extraordinary amounts of storage. The LTO program initiative sponsors recognized that the capacity of individual tape media had to grow dramatically to keep pace with that storage growth. The result was the Ultrium specification. In particular, Ultrium technology was designed for streaming backup — the work-horse application for this type of new tape demand.

The Ultrium Roadmap and Capacity
Ultrium technology is a single-reel design that uses half-inch tape. The design objectives called for maximizing the amount of tape surface area (hence higher capacity) while maintaining a small form-factor tape cartridge (hence maintaining a small footprint for valuable space savings). A four-generation LTO Ultrium road-map (Figure 1) shows that both native capacity and native transfer rate — approximately — are expected to increase rapidly over the course of the next three generations. The transition from each generation to the next is expected to take from 18 months to 24 months. That means that IS should look for generation two sometime in 2002.

Although the "your mileage may vary" dictum is relevant, most enterprises use the compression feature on tape to obtain a 2:1 compression ratio. (The exception is previously compressed data, such as video. LTO technology's compression algorithm is smart enough to not attempt to compress already compressed data.) That means that a single tape cartridge can house up to 200 GB. A significant reduction in the number of tapes to be managed should please any IS administrator.

Even though a roadmap is subject to change, IS must feel confident that if it com-mits to a new tape technology, that technology will keep pace with increased busi-ness demands. The Ultrium roadmap provides a statement of direction to meet those needs.
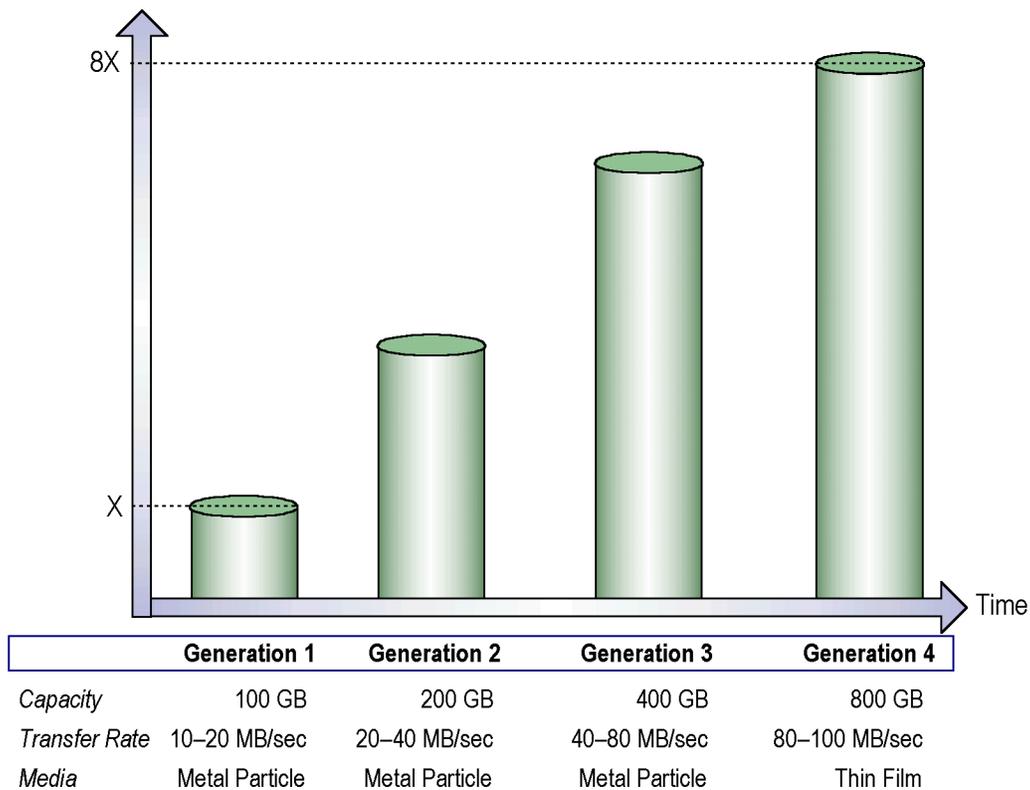
Performance
Even though the focus of Ultrium technology is higher capacity for streaming backup, it is Ultrium performance and reliability that bring smiles to IS faces. The absolute performance is much stronger than IS has experienced with a previous incarnation of open-system-based tape technologies. For example, an Ultrium tape drive can offer a sustained data transfer of up to 15 MB per second, *a two to three times increase* over a leading old tape technology.

Reliability
Improved reliability is a key objective for both LTO tape format programs. A tape system is a complex electromechanical system; a seemingly small mechanical

Figure 1: LTO Ultrium Roadmap

	Generation 1	Generation 2	Generation 3	Generation 4
Capacity	100 GB	200 GB	400 GB	800 GB
Transfer Rate	10–20 MB/sec	20–40 MB/sec	40–80 MB/sec	80–100 MB/sec
Media	Metal Particle	Metal Particle	Metal Particle	Thin Film

Source: LTO Program and Aberdeen Group, December 2001

change can have a big impact on reliability. For example, an Ultrium drive must always position read/write heads precisely over the correct tracks on a piece of tape media. Since the tape is subject to some lateral movement during tape motion and track densities are high (to provide high capacity), a very precise positioning technique must be used. The LTO sponsors chose a technique called timing-based servo that enables the servo system to dynamically control the positioning of the read/write heads across the width of the tape. The tape industry already has some experience with timing-based servo systems. For example, IBM is already on its fourth generation of a timing-based servo.

In addition to the tape cartridges and tape drives, increased reliability will be a necessity in tape automation systems, because IS will deploy Ultrium-class tape technologies with tape automation for mission- and business-critical applications. Ultrium technology was designed with tape automation in mind. For example, Ultrium tape drives offer "soft loading" — the VCR-like ability to only have to partially insert the tape cartridge within the drive before the drive senses the tape and automatically loads the tape. That approach is more reliable than the older approach of having to apply pressure to the tape cartridge until it is firmly seated within a tape drive.

Open Up to the Openness of Linear Tape-Open
IS faces three choices for a tape solution — tape automation, drives, and media. On the automation front, IS has always had a selection of alternative vendors. This has not been true for tape drives. Although alternative tape drive vendors have been available, the decision to choose a tape drive vendor was tantamount to choosing a tape media format as well. Even if by chance there was a second source for the tape media, typically one vendor made the drive. LTO technology ends that dependency.

In the open tape market of LTO technology, the basis of competition shifts from the choice of tape format to product choices within the LTO technology framework. IS can choose the LTO product feature mix, including performance and reliability, that best fits its requirements.

Choosing Vendor Relationships
An open tape market, i.e., LTO technology, gives IS buyers greater flexibility in establishing relationships that meet their needs. Some IS organizations may prefer to work with one vendor for all tape storage needs. These organizations may believe that they would expedite problem resolution with only one tape vendor in the solution feedback loop. Moreover, these organizations may feel that managing and purchasing tape solutions is easier when dealing with only one vendor. In the LTO world, for example, IS might decide that it wishes to use one vendor for the tape library, the tape drive, and the tape media.

Alternatively, IS may decide that it wants a different vendor for each of the three tape system components — tape automation, drive, and cartridges. For example, IS could select a tape library from a set of manufacturers, a tape drive from a second source, and tape media from a third source. The decision for each component could be based on conformance with IS specifications, which could vary by component, for example, reliability for tape automation, performance for tape drives, and price for tape media. The choice of one or many vendors may be made for some other reason, such as long-standing relationships, worldwide service and support, and perceived technology leadership. Whatever the reasons, IS has a choice. That user choice will almost certainly mean choice within products as well. Suppliers have an incentive to "mix-and-match" their own products, offering "one-stop shopping" that gives the user a choice of OEM products in automation, drive, and cartridges.

Accelerating Along the Technology Curve
The development of a new tape technology — whether from the ground up or via a new generation of an existing technology — is very difficult. Delay may jeopardize IS plans that were dependent on the new technology becoming available. With multiple vendors working on the same development goal, the chances that at least one of them will be able to deliver the technology on, or close to, the planned technology roadmap is much better than if only one vendor is working on the development of the technology. That is an edge for open LTO technology.

Mitigating Migration to LTO Technology
Although backward-read compatibility between a newer generation of a particular tape format family and a previous generation is usually possible, a brand-new tape format is, by definition, not compatible with the currently used tape technology. IS therefore does not take the decision to introduce a new tape technology lightly. However, when a new tape technology, such as LTO, comes along, the compelling potential advantages of capacity, performance, and reliability relative to the existing tape technology may tip the scales in favor of implementation.

At that point, IS faces a choice of a parallel or replacement strategy. A parallel strategy means that the new tape technology simply adds to the type of tape technologies on the floor of the data center. That strategy would take up space and would require system administrators to implement procedures for managing the new tape system, such as tape rotation strategy and tape labeling. To save space and simplify procedures, a tape library could be acquired and partitioned, accommodating both old and new tape technologies — that is, some of the tape drives would run the older tape technology, some the newer.

A partitioned tape library could be especially useful in a replacement strategy. With such a strategy, the new tape technology has to write the latest backup tape

and then over time step through the different generations of backup tape — grandparent, parent, and child — of the backup tape rotation cycle. When this cycle is done, the replacement is completed. The old tape technology could be kept in place during the transition to handle any recovery issues from older tapes.

The only remaining replacement issue would be older tapes that are not part of the standard rotation cycle — such as deep archive files. These tapes typically have low to non-existent requirements for access. If access to low-frequency-of-use tapes is needed, a single tape drive using the older format might be retained, or the enterprise may pay a third party to make the conversion.

Generally, therefore, although backward-read compatibility is desirable, if an enterprise decides to move to LTO technology for its benefits versus an older tape technology, the transition to LTO technology typically should not be a major barrier to implementation.

Creating LTO-Compliant Product Tape Solutions

IS may want to consider moving to LTO technology as an element of improving the design of its overall tape solution. The tape solution may advance the ability of an enterprise to consolidate storage or to take advantage of a storage area network (SAN). For example, IS may want to:

- Generate economies of scale for the investment in tape systems — as well as facilitate tape management — by having many servers share a tape library instead of each server having its own individual tape drive or a smaller scale tape automation system;

- Reduce the strain on the backup LAN and servers by installing a serverless and LANless backup over a SAN to a tape library;

- Simplify the process for using a tape library in a SAN for storage consolidation, data protection, disaster tolerance, and data sharing; and

- Ease the backup burden by using a prepackaged turnkey solution.

While LTO technology need not be the tape technology of choice, a good time to review the need for new tape technology is when employing a new tape solution for an old storage-related problem. Choosing an open tape technology, i.e., LTO technology, increases the options available to IS over time.

Aberdeen Conclusions

Magnetic tape is alive and well. The continuing surge in disk storage demand requires a corresponding growth in tape storage — of which streaming backup is a major application. But older tape formats do not have the capacity, performance, and reliability that many enterprises require for their e-Business and other applications. Hewlett-Packard, IBM, and Seagate sponsored the development of Linear

Tape-Open in response to these demands. In contrast to older generations of tape formats, LTO technology scales to offer significantly greater capacity per tape cartridge. In contrast to other new tape technologies, the LTO framework is an exceptionally open technology. IS can choose a tape solution based on product features within the LTO framework and vendor relationships rather than tape format characteristics alone.

The ultimate test for LTO technology will be within IS organizations. These organizations will typically weigh the challenges of migration versus the benefits of openness. In making that decision, IS must keep in mind not only the immediate future, but the direction that it wants to take the IT storage infrastructure in the next few years. Additional factors in the decision are the burden of growing storage demands and the adoption of new storage technologies, such as a storage area networks.

Aberdeen anticipates that enterprises' need for a new tape format that offers much higher capacity, better performance, and greater reliability than earlier tape formats will become more and more compelling. IS buyers should also consider the value add of that new tape technology's openness — choice and flexibility. For these reasons, LTO technology warrants a great deal of consideration.