Exabyte Corporation
1685 38th Street
Boulder, CO 80301
1-800-EXABYTE

www.exabyte.com
www.mammothtape.com
www.m2wins.com

An Exabyte White Paper

A Brief History of Tape

by
Lynne Avery

Executive summary

Although it has been around for almost half a century, tape is still the most cost-effective method for storing and retrieving data. It offers the capacity, reliability, and speed necessary for storing and protecting the increasing amount of data generated by businesses. The first tape storage was on reel-to-reel systems, using linear serpentine recording. In the 70s and early 80s, the half-inch open-reel systems evolved to use a closed, single-reel cartridge. These systems eventually became the basis for DLTtape technology. In 1972, 3M introduced the QIC linear format for storing data from telecommunications and data acquisition applications. Unfortunately, the QIC technology did not offer enough capacity, speed, or reliability to meet the needs of large organizations.

Exabyte introduced the first high-performance, 8mm helical scan drive in 1987. Helical scan technology, coupled with read-after-write data verification, provided the high data integrity required for data storage and retrieval. MammothTape™ technology, introduced by Exabyte in 1996, featured significant technological innovations over earlier helical scan drives. With the introduction of the M2™ tape drive and SmartClean™ media in 1999, and the scheduled introduction of a Fibre Channel interface in 2000, Exabyte continues to build on MammothTape technology's innovative beginnings. MammothTape technology is currently the best tape storage solution for the midrange IT industry.

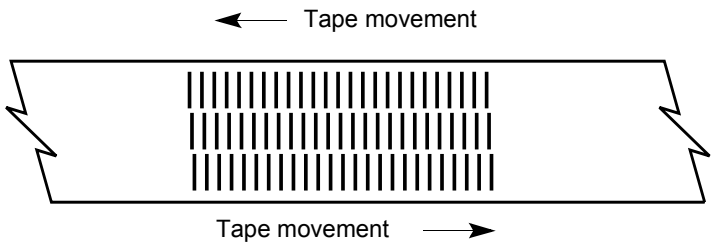
Technology is changing so quickly we can barely keep up. In our lifetimes, we've seen incredible technological advances in the computer industry: personal computers the size of a notebook, Palm Pilots™, the World Wide Web, virtual reality games — and along with advances in computers, we've seen some equally important advances in tape technology.

Despite all the technological advances, storing and protecting all of the data we're creating remains a challenge. More than ever before, IT professionals need a storage system that offers capacity, reliability, and speed. Although it has been around since the 1950s, tape is still the most cost-effective method for storing and retrieving data. By having an understanding of tape's origins and its evolution, it's easier to appreciate the technological advances that lead to a new age in data storage — the age of MammothTape™ technology.

A journey through the past

The first tape storage was on reel-to-reel systems, using linear serpentine recording.

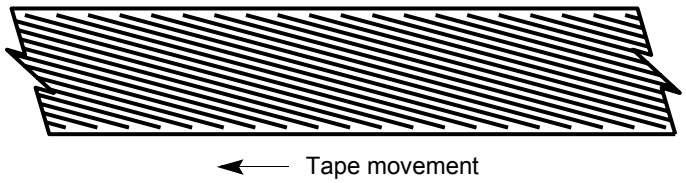
Tape began as the primary storage medium for computers in the 1950s. At that time, large mainframe computers dominated the information systems industry. Data storage and backup for these mainframes was on expensive, reel-to-reel tape systems using half-inch magnetic tape. Data was recorded in parallel tracks using a linear serpentine recording technology in which the data tracks were written in alternating bands from the beginning of the tape to the end and back again. Throughout the 60s and 70s these open-reel systems evolved by increasing the number of tracks, increasing bit density, and increasing tape speed.



Early data storage used linear serpentine recording

The birth of helical scan

By the early 1950s, there were one and a half million televisions in the United States and the number was increasing tenfold every year. With this increase came a need for a new recording technology. Linear recording, which worked well for audio, did not have the performance required for video recording. To address this need, Ampex Corporation introduced a new helical scan videotape recorder in 1956. Unlike linear technology, helical scan technology used a rotating scanner in which the recording heads were mounted. This new technology recorded data using tracks that were oriented at an angle to the edge of the tape.



Helical scan tracks are angled across the width of the tape

Although the new technology could store four times as much data per square inch of tape as the linear serpentine recording methods, the adoption of helical scan technology by the information systems industry was limited by its relatively high cost. However, because of its high performance and ability to store large amounts of data, helical scan quickly became the standard for the video and broadcast industry throughout the world. It wasn't until the mid-1970s, when manufacturing costs had dropped significantly, that helical scan tape systems began entering the consumer market in the form of home video equipment.

In the 70s and early 80s, half-inch tape technology evolved from reel-to-reel technology to using a closed, single-reel cartridge. These systems eventually became the basis for DLTtape technology.

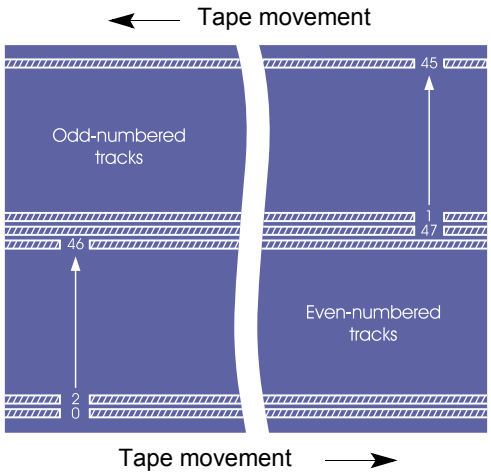
Linear technology matures

During the 70s and early 80s, half-inch tape technology evolved from using open reel-to-reel systems to using closed, single-reel cartridges. Proprietary tape systems based on these new designs were introduced by Digital Equipment Corporation (DEC) in 1984 for use with its new networked mini-computers. Ten years later, DEC sold its linear tape technology to Quantum Corporation, where it evolved into today's DLT (digital linear tape) technology.

In 1972, 3M Corporation introduced a new linear technology known as QIC (quarter-inch tape cartridge) to provide a means for storing data from telecommunications and data acquisition applications. QIC technology used a new, smaller cartridge that looked very much like an audio cassette tape, with both the supply and take-up reels inside. A belt built into the cartridge and a capstan and pinch roller system inside the tape drive moved the tape from one reel to the other, past the write and read heads. Since the entire tape path was contained inside the dual-reel cartridge, the tape drive that accepted the cartridge was relatively simple and only had to supply the heads and a motor to turn the capstan.

Although the new QIC technology used the same linear serpentine recording technology as its predecessors, it improved performance by upgrading the media, increasing bit densities and adding more parallel tracks to increase the capacity.,

3M introduced QIC (quarter inch tape cartridge) in 1972 to provide a means for storing data from telecommunications and data acquisition applications. But as business data needs grew, QIC did not offer enough capacity, speed or reliability for large organizations.



QIC linear serpentine recording increased the number of tracks

As time passed, the comparatively inexpensive QIC drive became an accepted data storage system — especially for standalone PCs. Unfortunately, QIC technology did not offer sufficient capacity to meet the needs of large organizations, nor was it fast enough or reliable enough. In addition, an overabundance of format standards — there are currently more than 120 — led to severe compatibility problems.

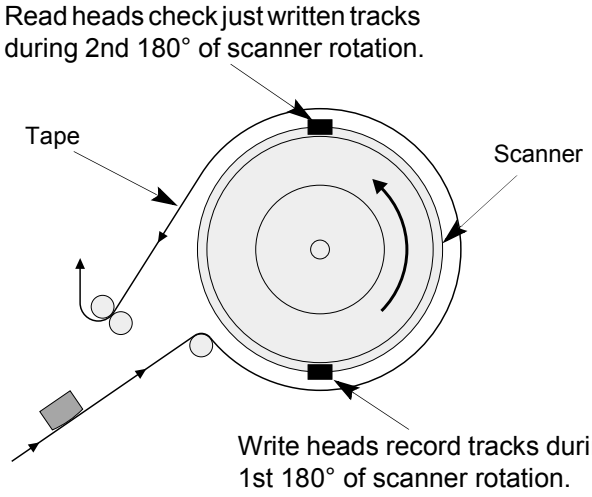
By the early 1980s, networked mini-computers were starting to enter the market. The traditional reel-to-reel data storage technology was inefficient for use with these new computers and too expensive to be practical in this environment. QIC technology was equally unsuitable and the proprietary systems developed by DEC were not compatible with systems from other manufacturers. A new technology was needed.

Helical scan comes into its own

In the mid-1980s, a group of engineers from Storage Technology Corporation (STC) looked at the growing availability of 8mm and VHS home video systems and realized that the technology was readily adaptable for use in the data storage industry. In 1985 they left STC and founded Exabyte to develop and market an affordable, high capacity tape backup solution based on helical scan technology.

Exabyte introduced the first high performance, 8mm helical scan drive in 1987. It provided the high data integrity needed for data storage and retrieval.

Working closely with Sony, who manufactured the mechanical components, Exabyte introduced the first high performance, 8mm helical scan tape drive into the UNIX market in 1987. Although this new tape drive was based on consumer video technology, Exabyte incorporated many technological improvements to provide the high data integrity required for data storage. Using read-after-write technology to ensure that all the data written to tape could be restored from tape without any errors, the new Exabyte tape drives provided a high capacity, cost-effective method for the information systems industry to reliably protect valuable data.



Exabyte's EXB-8200 helical scan recording provided read-after-write data verification

With a data transfer rate of 240 kilobytes (KB) per second and a capacity of 2.4 gigabytes (GB), the new tape drive's performance and capacity were far superior to any other tape drive available in the market. The age of unattended backup of large amounts of data on a single tape had arrived.

With helical scan's growing popularity in the data storage industry, HP and Sony entered the market by introducing a new helical scan technology, DDS (digital data storage). DDS uses a 4mm metal particle tape and is based on technology originally developed for digital audio recording (DAT). This technology initially provided a capacity of 1.3 GB on a 60-meter tape.

Over the next few years, DDS continued to evolve, eventually increasing its capacity to 12 GB on a 125 meter tape (DDS-3) in 1995. As with QIC technology, DDS is most suitable for desktop backup.

Meanwhile, Exabyte continued to develop and refine helical scan technology, making further improvements to data transfer rates and reliability, and adding features such as built-in hardware data compression. Follow-on products to that first 8mm tape drive provided transfer rates of up to 1 megabyte (MB) per second with a capacity of 7 GB. Exabyte's 8mm tape drive technology set the standard for data storage in the mini-computer and client-server network environments.

The Mammoth age begins

MammothTape technology, introduced in 1996, featured several significant improvements over earlier helical scan drives.

In 1994, Exabyte announced that it was developing a new helical scan tape drive called Mammoth. Mammoth was based on a radically new technology platform developed entirely by Exabyte. This new platform, known today as MammothTape™ technology, was designed from the ground up to meet the rigorous reliability requirements of the newly developing server market. Although still based on 8mm helical scan recording technology, the Mammoth tape drive incorporated several significant improvements over previous helical scan drives.

By 1996, Exabyte cleared the last of its development and production hurdles and introduced Mammoth, the first tape drive based on the new MammothTape technology. With a native capacity of 20 GB and a transfer rate of 3 MB per second, Mammoth featured several significant technological advances over earlier helical scan tape drives, including:

- An industrial-quality deck specifically designed for the rigors of high duty-cycle data center operations.
- A gentle tape path that, among other things, eliminated the capstan and pinch roller system traditionally used to move the tape. This patented TapeSafe tape handling system eliminated potential points of stress on the tape and improved reliability.
- A Dynamic Head Cleaner that extended the time between required cleanings from approximately 30 hours of tape motion to an unprecedented 72 hours.
- New advanced metal evaporated (AME) tape that was cleaner to use and provided significantly greater capacities than the metal particle (MP) tape traditionally used by both helical scan and linear technologies.
- A liquid crystal display (LCD) that continuously showed the status of the tape drive and its operations.

Exabyte Mammoth — the first generation of MammothTape technology drives

With the introduction of M2 and SmartClean AME media, MammothTape technology is today's best tape storage solution for the midrange IT industry.

With the introduction of M2 (Mammoth-2) and SmartClean™ AME media in 1999, Exabyte continues to build on MammothTape technology's innovative beginnings. The M2 drive is so smart it knows when it needs cleaning and activates the cleaning function without operator intervention. The cleaning function uses a short section of cleaning tape at the beginning of each AME with SmartClean data cartridge to clean the recording heads. This automatic cleaning keeps the tape drive in peak operating condition and ensures trouble-free data protection. Because it is smarter and more reliable than competing technologies, MammothTape technology is currently the best tape storage solution for the midrange IT industry.

What's in the future?

The demands for speed, capacity, and configuration flexibility in the data interface are only going to increase as time goes by. Ongoing developments in the SCSI standard will surely address these needs. In addition, new interface technologies such as Fibre Channel are beginning to appear. These new interfaces promise even better performance than SCSI.

MammothTape technology is positioned to continue its evolution by embracing new technologies as they become available. One of these new technologies, Fibre Channel, is already being incorporated into M2 and will be available shortly after M2's introduction.

A strong technological foundation and a continuing dedication to meeting the ever-increasing data storage need of businesses make MammothTape technology the roadmap to the future.

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