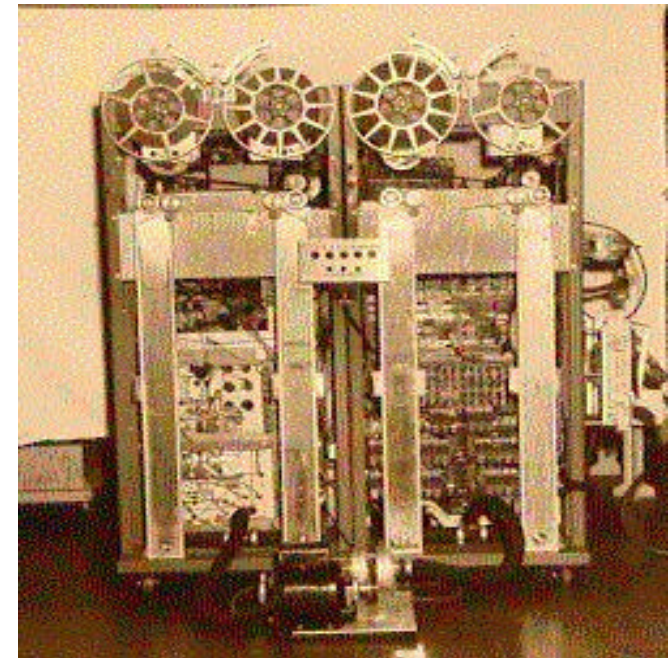




IBM Tape Systems

# Tape



**Emerging Storage Technology Panel  
IEEE/NASA Conference MSST2005  
April 14, 2005**

**Glen Jaquette  
IBM Distinguished Engineer / Architect  
Tape Drives, Automation, & Subsystems**

# The "Storage Hierarchy"

Solid state memory (nonvolatile)

> \$30.00 / GB

- Fastest access time
- Capacity/expandability limitations

Direct access storage devices (HDD)

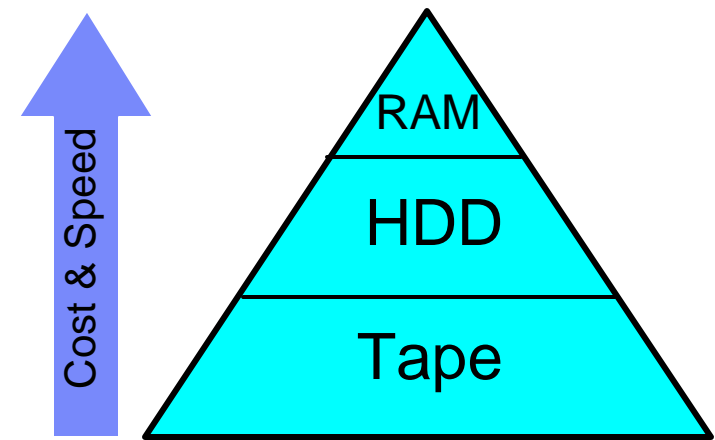
> \$ 3.00 / GB

- Slower access time, update in place
- Expandability / archivability limitations

Removable media storage devices (tape)

~ \$ 0.30 / GB

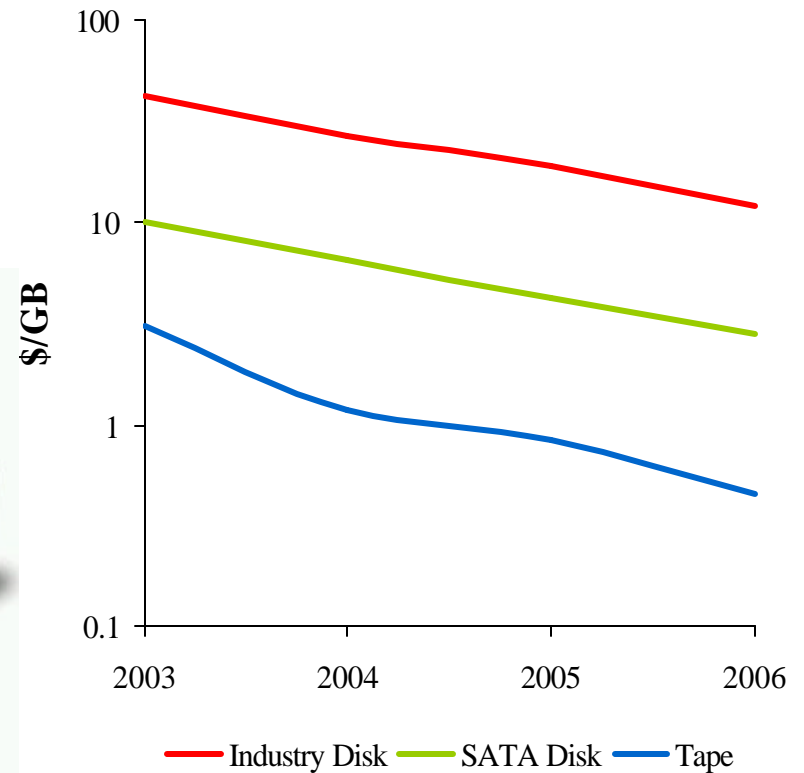
- Slowest access time, typically nearline
- Portable, interchangeable, archivable
- "Infinite capacity", volumetric efficiency
- Data Compression build into drives



# Tape is NOT Dead ...

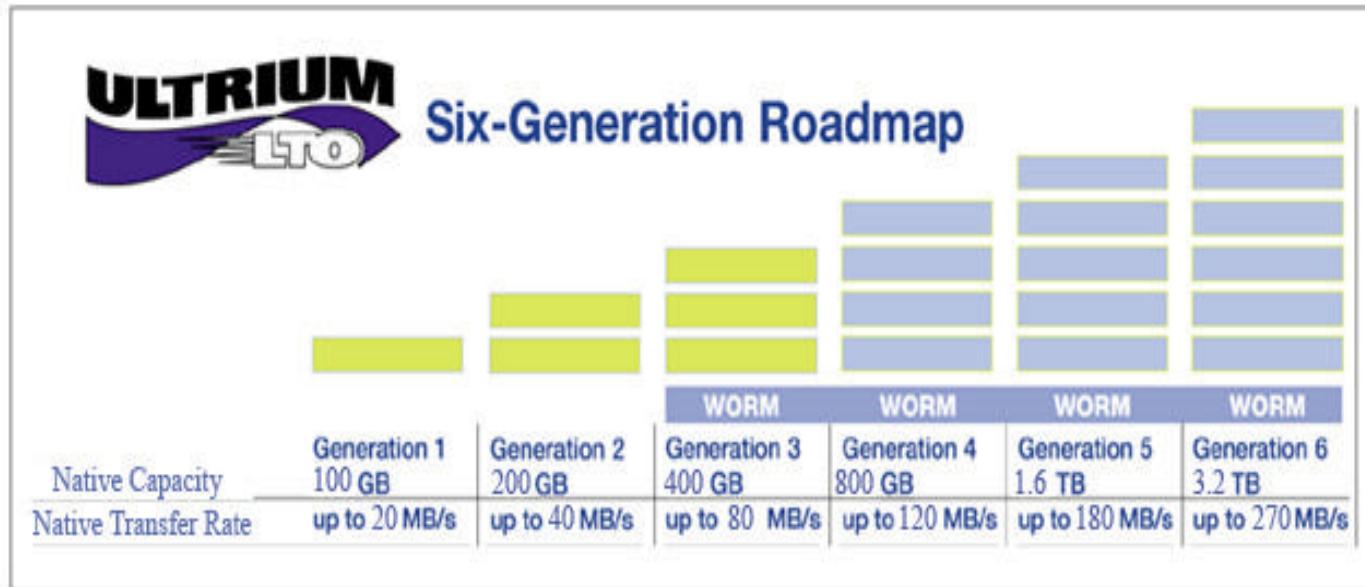
*It continues to play a vital storage role*

- Removable
- Inherently On Demand
- Transportable
- Shareable
- Cost-effective



# Linear Tape Open™ (LTO™)

LTO Drives now clear leader in Open 'super' drive category



## LTO Consortium's Roadmap extended 11/04

- Two generations, LTO-5 and LTO-6, and WORM were added
- Capacity is planned to double every generation, up to 3.2 TB/cartridge
- Data rate maximum planned to increase by 50% per generation

## Since September 2000 LTO has proliferated:

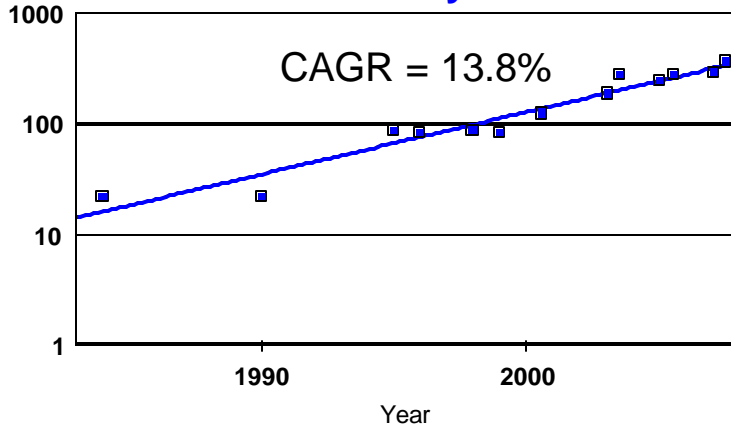
- over 30 million tape cartridges sold by YE'04\*
- nearly 900,000 tape drives have shipped by YE'04\*

\*Source: LTO 2004 Recap News Release FINAL 01-31-2005, [www.ultrium.com](http://www.ultrium.com)

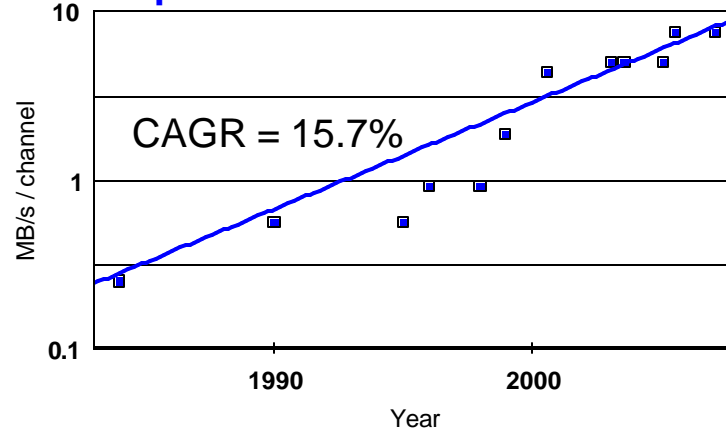


# Tape: how is storage density progressing?

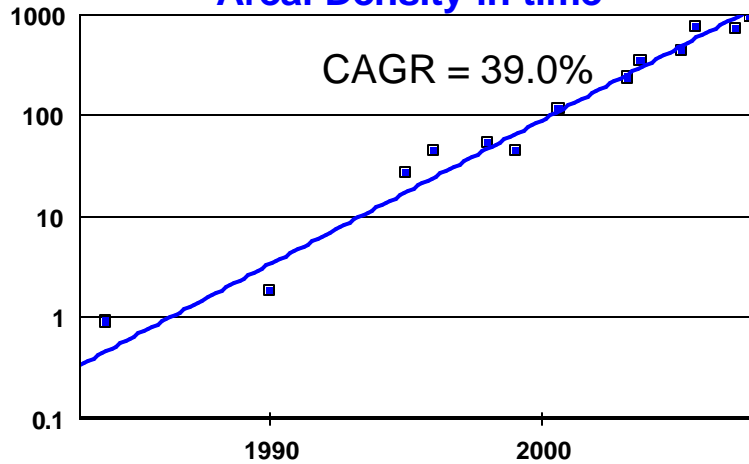
**Linear Density in time**



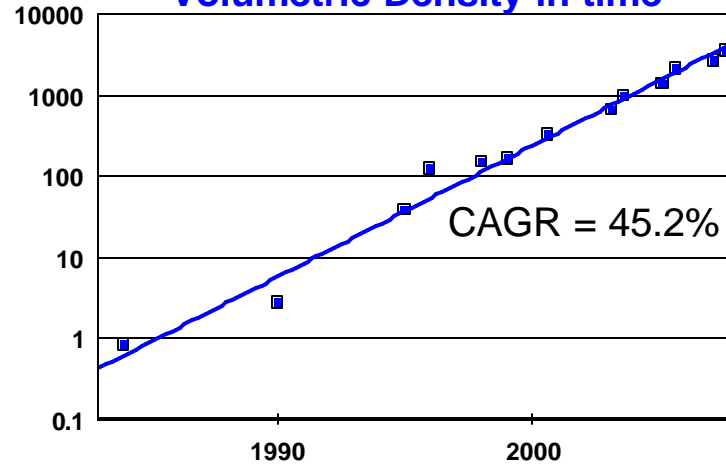
**per channel data rate in time**



**Areal Density in time**

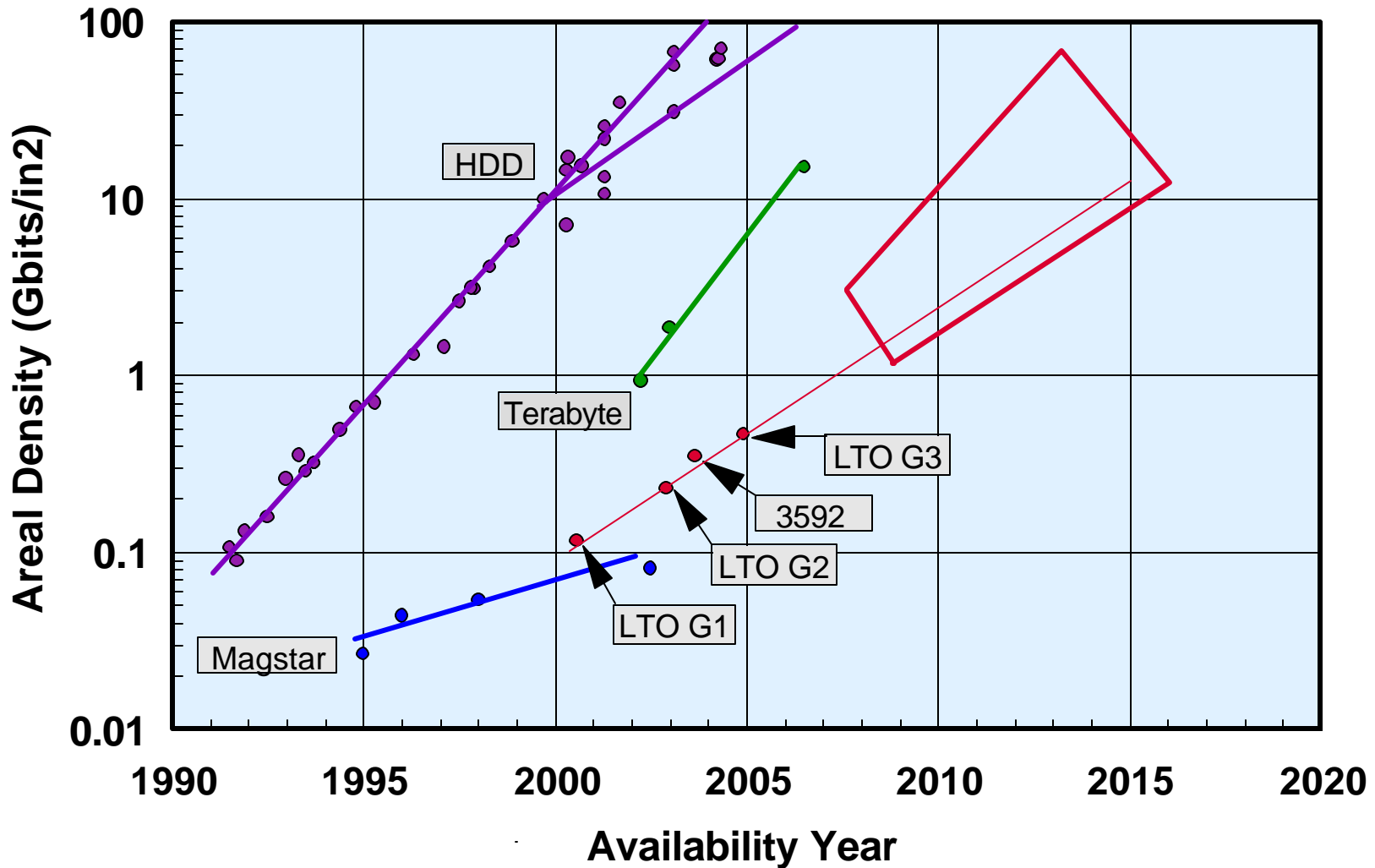


**Volumetric Density in time**



Shipped IBM and published other linear tape drive operating points + projected future LTO operating points

# HDD & Tape: Areal density roadmaps



Published HDD operating points + shipped IBM tape drive operating points + tape capacity demonstrations (1 projected)

## Summary of storage density progression

- The data cited projects that Tape can increase volumetric density by up to 45% or more per year for up to 8 years or more
- HDD has now fallen off their >80% areal density (which should ~ equal volumetric density) CAGR curves, the latest projection from INSIC is now 43%
- The data cited projects that Tape can potentially maintain a substantial cost advantage vs HDD in \$/GB for up to 8 years or more

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## About Linear Tape-Open (LTO) Technology

LTO technology is a powerful, scaleable, adaptable open tape format created by technology providers Certance (now part of Quantum), HP, and IBM Corporation to help meet the growing demands of data protection in the midrange to enterprise-class server environments. This ultra-high capacity generation of tape storage products is designed to deliver outstanding performance, capacity and reliability combining the advantages of linear multi-channel, bi-directional formats with enhancements in servo technology, data compression, track layout, and error correction.

The LTO Ultrium format has a well-defined roadmap for growth and scalability. The roadmap represents intentions and goals only. There is no guarantee that these goals will be achieved. Independent compliance verification is vital to meet the free-interchange objectives that are at the core of the LTO Program. Ultrium tape mechanism and tape cartridge interchange specifications are available on a licensee basis. For additional information on LTO technology, visit the LTO Program Web site at [www.ultrium.com](http://www.ultrium.com).

Note: Linear Tape-Open, LTO, the LTO logo, Ultrium, and the Ultrium logo are trademarks of Certance , HP and IBM in the US and other countries.