

The Death and Rebirth of Tape

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**Presented at the THIC Meeting at the Sony
Auditorium, 3300 Zanker Rd, San Jose CA 95134-
1940**

March 9-10, 2004

The Good Old Days

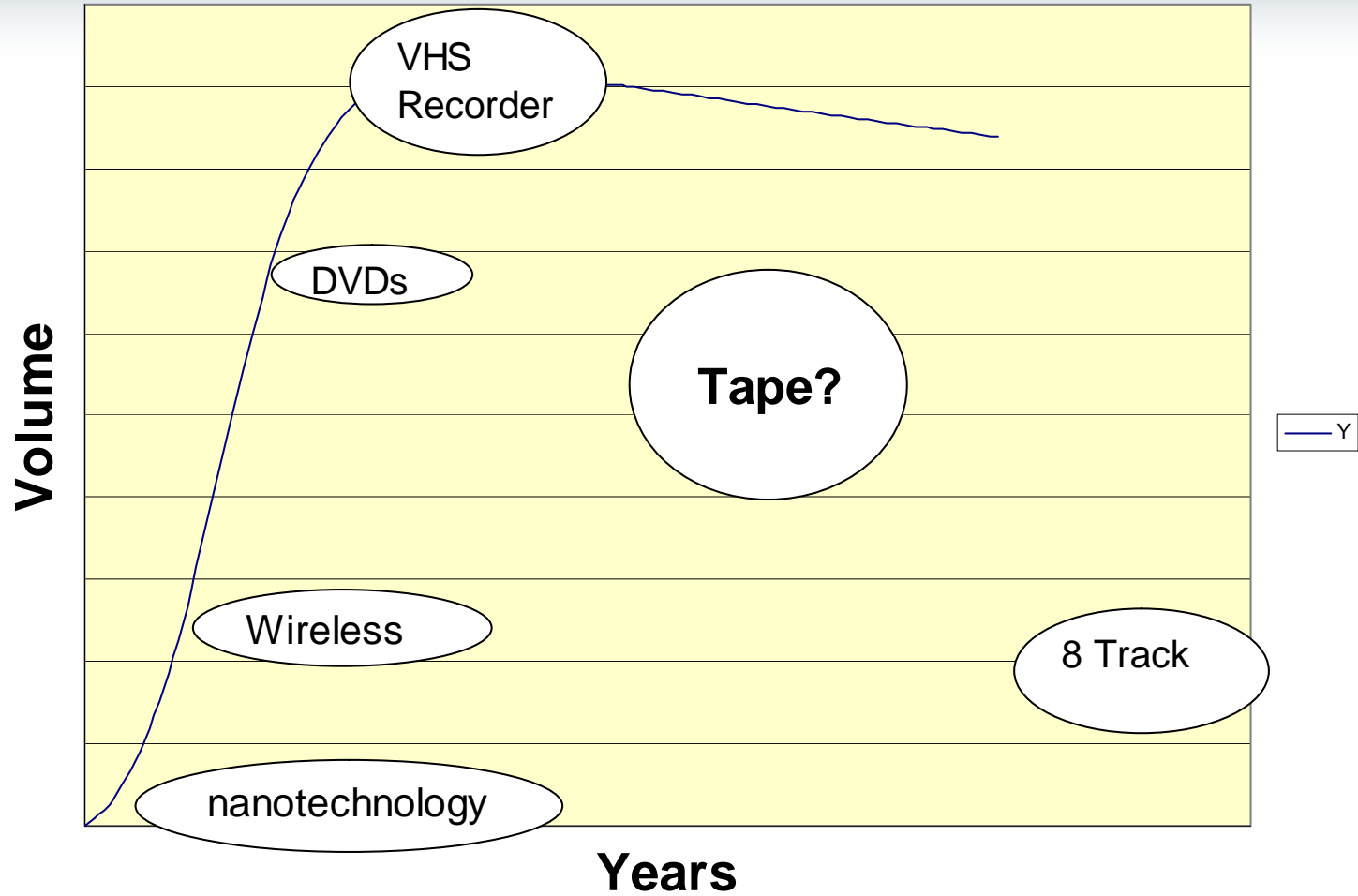
“I had seen an Ampex tape recorder in an engineering seminar at Stanford, and I can still remember thinking that it ought to be a very handy technology. To be able to store things on magnetic tape seemed to have all sorts of applications.”...“I had roughly \$15,000 and I put it all into Ampex”...“A \$20,000 investment in Ampex over 5 or 6 years became worth over \$1 million.”

Reid Dennis, International Venture Associates
(quoted in *Done Deals*, Udaayan Gupta, editor, HBS Press, 2000”

Requiem?

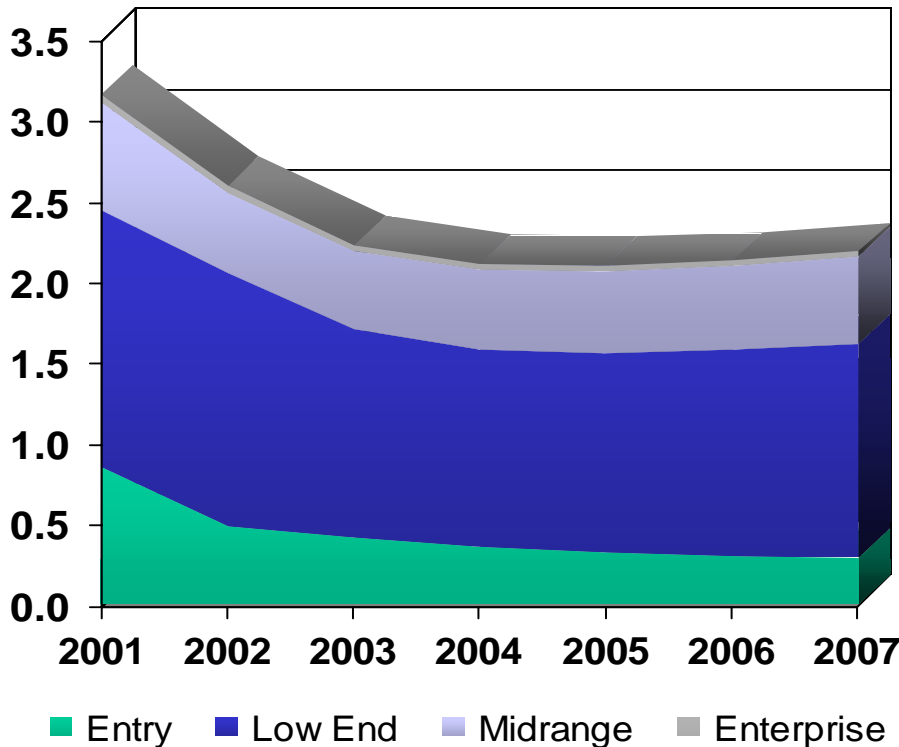
- Tape has been integral to IT for 50+ years
- It's demise has been forecast for at least the last 30
- Tape's still here
- Unit volume is growing
- But ASP is falling faster
- Could this really be the beginning of the end?

Product Life Cycle



Tape Drive Volume Continues to Decline

Worldwide Tape Drive Shipments
(Units in Millions)

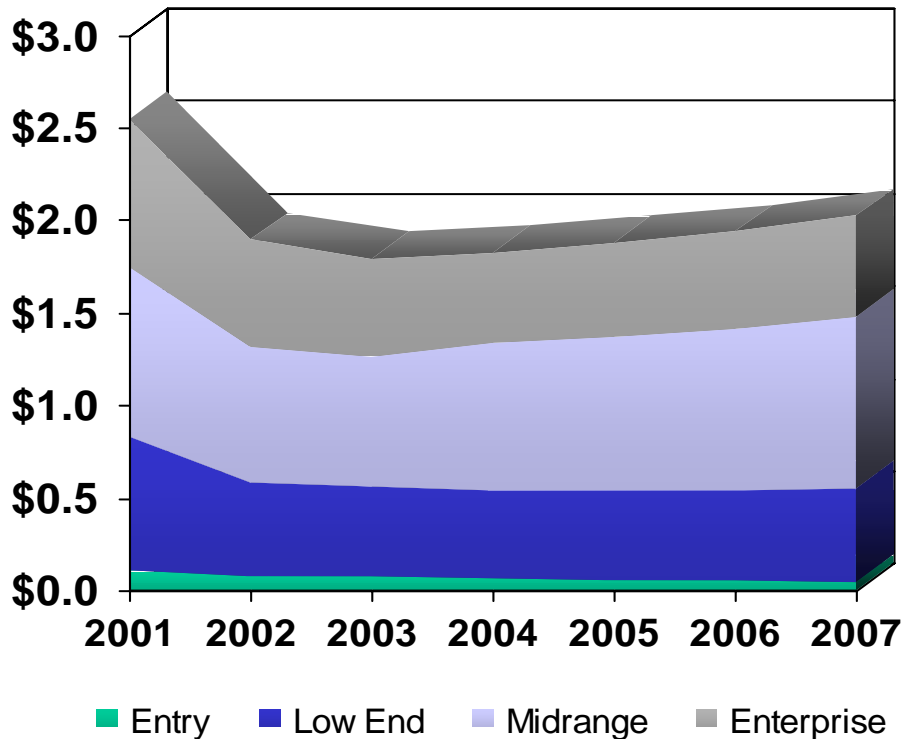


- Worldwide tape drive volume declined by 14%, 2.2 million units in 2002
- Entry and Low end down by 15% and 17%, respectively
- Enterprise declined steeply by 28%
- Outlook calls for an overall 0.2% CAGR 2002-2007

Courtesy IDC

Tape Drive Value Declines in 2002

Worldwide Tape Drive OEM Revenue
(\$Billions)



- Worldwide tape drive revenue contracted by 26%, totaling \$1.9 Billion in 2002
- Entry revenue down by 23%
- Low End declines by 30% reflects price-pressure in DDS market
- Midrange experiences 20% decline with aggressive ASV's in the Super Drive market
- Enterprise off — 28%
- Total Revenue is expected to decline by 5% in 2003
- Outlook calls for a overall 1.4% CAGR 2002-2007

Tape will die if...

- Demand dries up
 - The problems that tape solves go away
 - Better technical substitutes arise
 - The cost of the tape exceeds the value of the problem solved

OR

- The Supply Evaporates
 - Suppliers can't sell enough drives plus media for enough money to cover the cost of capital
 - Remaining offerings are less attractive, so there's a cascade to the demand side

Demand = Problem to be Solved

- Acquisition
- Primary Storage
- Backup
- Archive
- Software & Data Distribution

Related Customer Segments

- IT/Data Processing
- Scientific, Seismic, Intel etc
 - Historical use of specialized recording equipment
 - Now largely converged with IT but specialized products remain
- Video and Audio
 - Until recently completely separate technology base
 - Majority of current installed base is specialized
 - But there is substantial convergence with IT

Storage in IT/Data Processing

	Before 1980	1980 - 2004
Acquisition	Keypunch; Paper Tape	Winchester Disk/RAID
Primary Storage	Mag Tape in 1960s, supplanted by disk in the 70s.	Exclusively Winchester Disk/RAID
Backup	Tape, Punched Card, Paper Tape, Some removable disk packs	Mag Tape; Optical Disk; Mag Disk
Archive	Mag Tape, Punched Card and Paper Tape, Microfilm	Mag Tape and Optical
Distribution	Mag Tape	CD-ROM; Some Mag Tape

Storage in Scientific

	Before 1980	1980 - 2004
Acquisition	Mag Tape	Mag tape
Primary Storage	Mag Tape in 1960s, supplanted by disk by 1980	Exclusively Winchester Disk/RAID
Backup	Mag Tape	Mag Tape
Archive	Mag tape	Mag tape
Distribution	Mag Tape	Mag Tape; Direct Satellite Transmission

Storage Video and Audio

	Before 1980	1980 - 2004
Acquisition	Mag Tape and film	Mag tape; Tape challenges film for long format; optical challenges mag tape for TV
Primary Storage/Editing	Mag Tape	Disk and Tape
Backup	Mag tape	Mag Tape
Archive	Mag tape	Mag tape
Distribution	Mag Tape; Vinyl Records	Optical

IT Tape Trends

- Dominates Archive and Large Backup;
 - Has beaten off optical as an archive choice
 - Threatened in backup by disk, optical, network and no backup
- Had and lost role as distribution medium
 - CD-ROM for Software distribution
 - Some residual role in one off data sets, mainframe
- Never had much role for acquisition
- Lost role as primary storage and processing medium decades ago

Scientific Tape Trends

- Still gets most of the Acquisition
 - Mixture of specialized technology and IT open system
 - Movement is to IT open system
- No role in primary store and processing
- Strong role in distribution, challenged by optical and direct transmission
- Still holds most of the backup and archive

Tape in Audio/Video

- Still the primary acquisition medium
 - Challenge by direct to optical disk cameras
 - Acquisition tape is specialized to the industry
- Rapidly dying as consumer distribution medium
- Still dominant as industry distribution but in specialized formats
- Still relevant but shrinking as an processing (editing medium)
- Dominates Backup and Archive
 - Backup mostly in specialized formats
 - Archive moving to IT format tape (LTO, DLT, SAIT, etc)

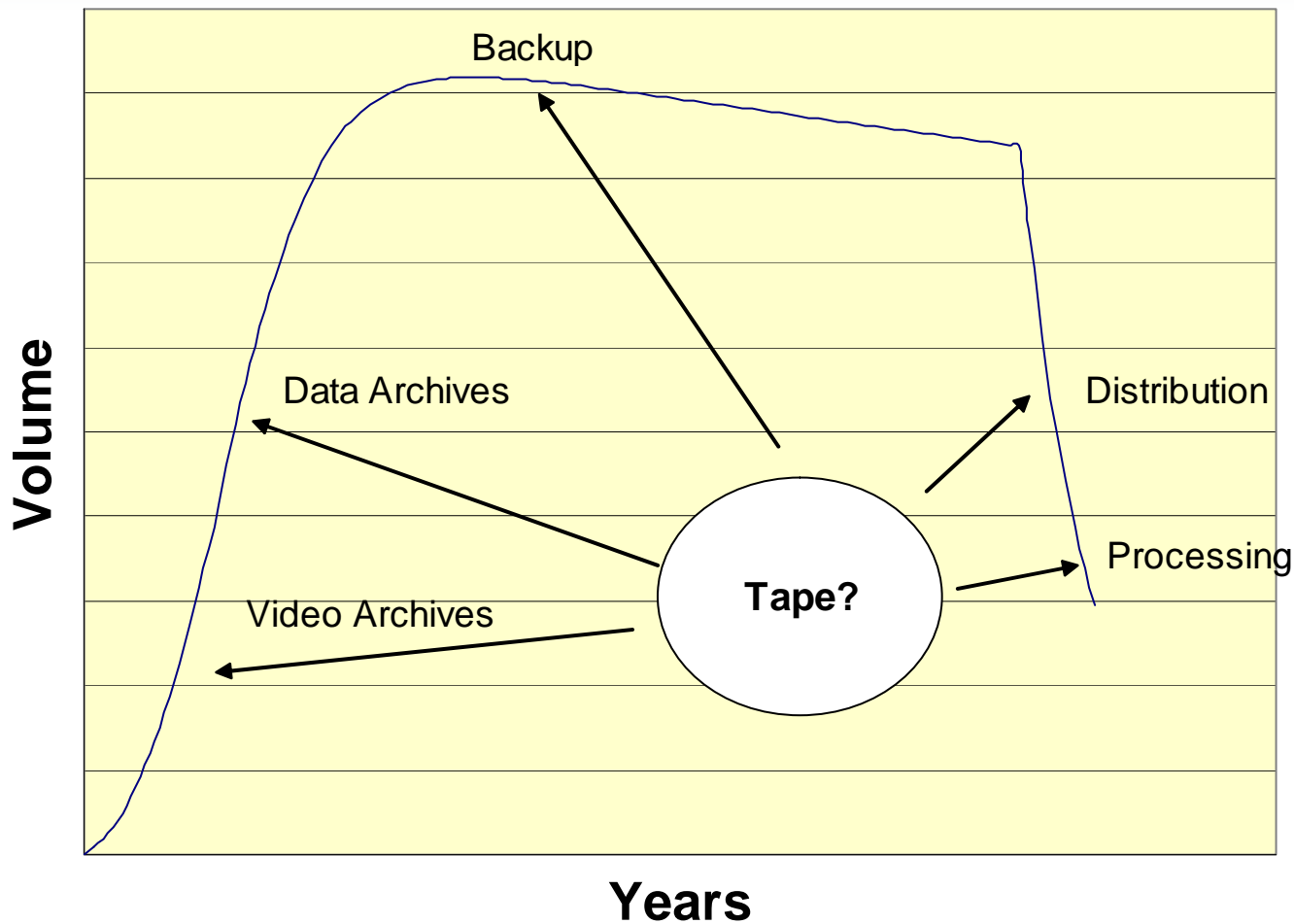
The Good, the Bad and the Ugly

- Still own Backup and Archive
- Lost consumer distribution, software distribution.
- Losing chunks of backup
 - Desktop to CD-ROM, No backup
 - Server to Disk
 - Net data volume rising but \$/MB falling faster
- Large Archiving growing
 - Long retention IT applications
 - Digital Asset Management

Scoreboard

- Beat Paper
- Beat Optical
- Win some/lose some against magnetic disk
 - Tape wins when it has compelling advantage
 - Consistently loses if disk can approach tape performance

Product Life Cycle



Tape – The Traditional View

- Strengths
 - Cheap
 - Portable
 - Long Archive Live
 - Relatively invulnerable to chance or deliberate modification
- Weaknesses
 - Sequential access: limited OS support at low end
 - Unreliable
 - At Write
 - At Read
 - Expensive

Cheap? Tape? Moi?

- 1988 Costs
 - 8" 400MB Disk ~ \$16,000 = \$40/MB
 - 5.25" 40 MB Disk ~ \$1,000 = \$25/MB
 - 2GB 8mm Tape ~ \$20 = \$0.01/MB
- 2004
 - 3.5" 80GB Disk ~ \$200 = \$2.50/GB
 - 200GB LTO=2 Tape ~ \$90 = \$0.45/GB
- Tape was 2 to 4 thousand times cheaper
- Now about 5 times cheaper

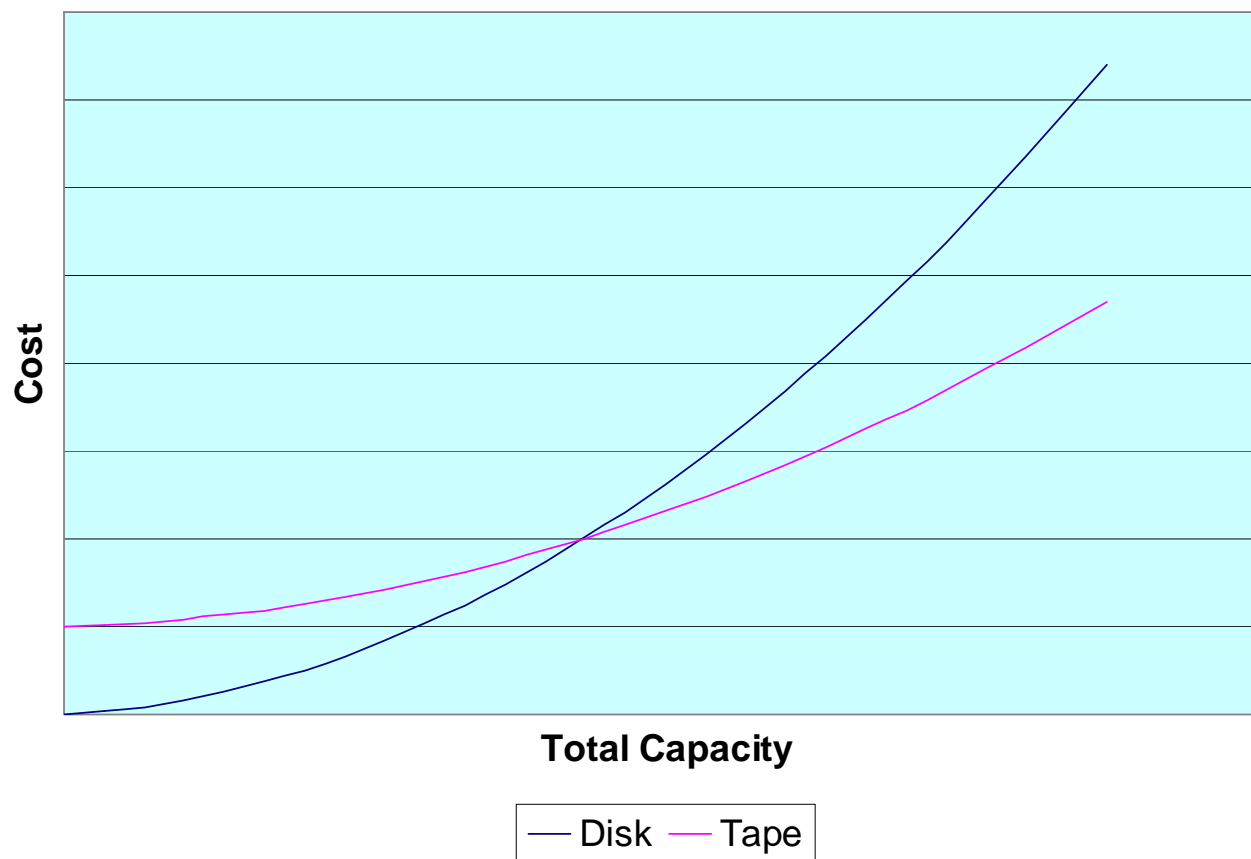
Cost of Storage Depends on Order of Magnitude

- Each Technology has fixed cost for OMB
 - Tape drives, libraries, SAN infrastructure
 - Disk Drives, RAID heads, etc, SAN infrastructure
- Then linear element: tape carts or disk platters
- Plus convexity
 - More Disk Needs More Cache = More Servers = bigger SANS, More copies of OS, more power, harder to administer
 - More tape means more carts, more space
- At low capacity, fixed cost is paramount: disk wins
- At high capacity, convexity dominates and tape provides cheaper solution.
- “low” and “high” keep moving up
- Tape loses markets as the “low” threshold shifts
- Gains have to come in the “high” space

Components of Cost

- Fixed (OMB Cost)
 - Disk: \$100 - \$20K
 - Tape: \$750 to \$200K
 - Function of aggregate volume
 - Disk: ~300 Million units/year
 - Tape: <3 Million units/year
- Cost per MB
 - Disk: \$1-\$5/GB
 - Tape: \$0.50/MB
- Non linearity (convexity)
 - Power/cooling
 - Administration
 - Cache/Servers/File System limits
 - Disadvantage: Disk. The flip side of being supported by the native OS

Cost of Storage



Two Views of Reliability

- Transactional: Out of 10,000 Cycles, how many failures?
 - Disk cycle: move head one cm and wait for data
 - Tape cycle: load tape, position tape, transfer data, rewind tape, eject tape
 - Disk is much, much more reliable
- Life Cycle: If I want to access a piece of data after 10 years, what are the chances that I can?
 - Disk gets sticky bearings, sticky heads, demagnetized
 - Tape last 30 years and can prove it
 - Disk has no history or culture around long term reliability
 - Volume economics aren't there

Implications

- Tape is going to lose for small volumes and short retention backup
- Tape's lower has lower cost and higher reliability for long term, high volume store
- Backup is a declining market. Gangrene starts at the feet
- Archive, including digital asset management, is the new refuge

Implications 2

- Shift from Backup to Archive shifts requirements
- Automation more important than the drive
- Managing single cartridges not the issue, managing tape cartridge inventory is
- Large archives persist over many generations of tape technology so automation must handle multiple formats

Introducing the Spectra T950 Library With Python Architecture



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Grouped media management
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Save time – bulk load, unload

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LTO, SDLT, SAIT, AIT



Robotic Video



Questions?