

Magnetic Tape Data Storage Trends and Products

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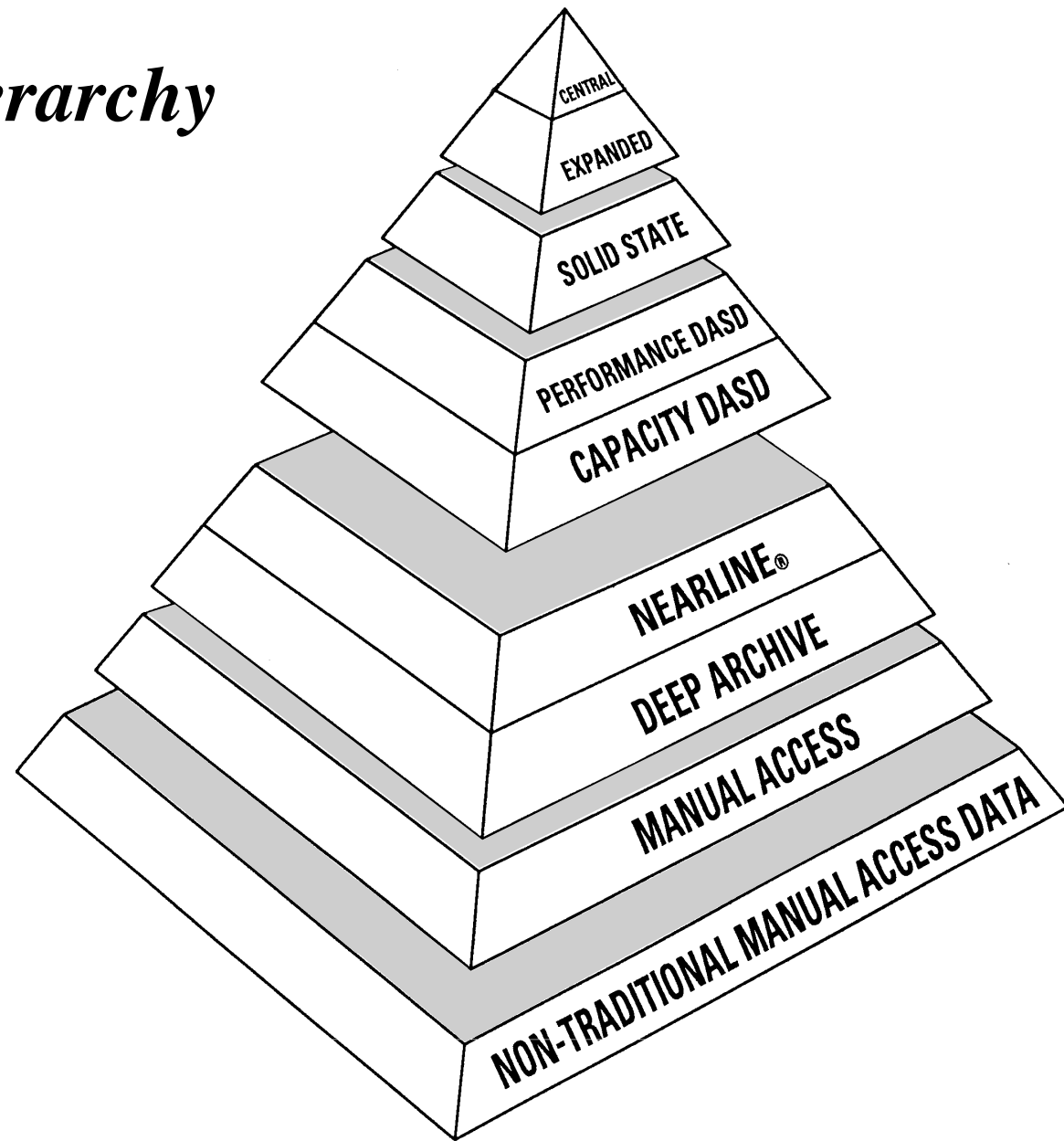
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Outline

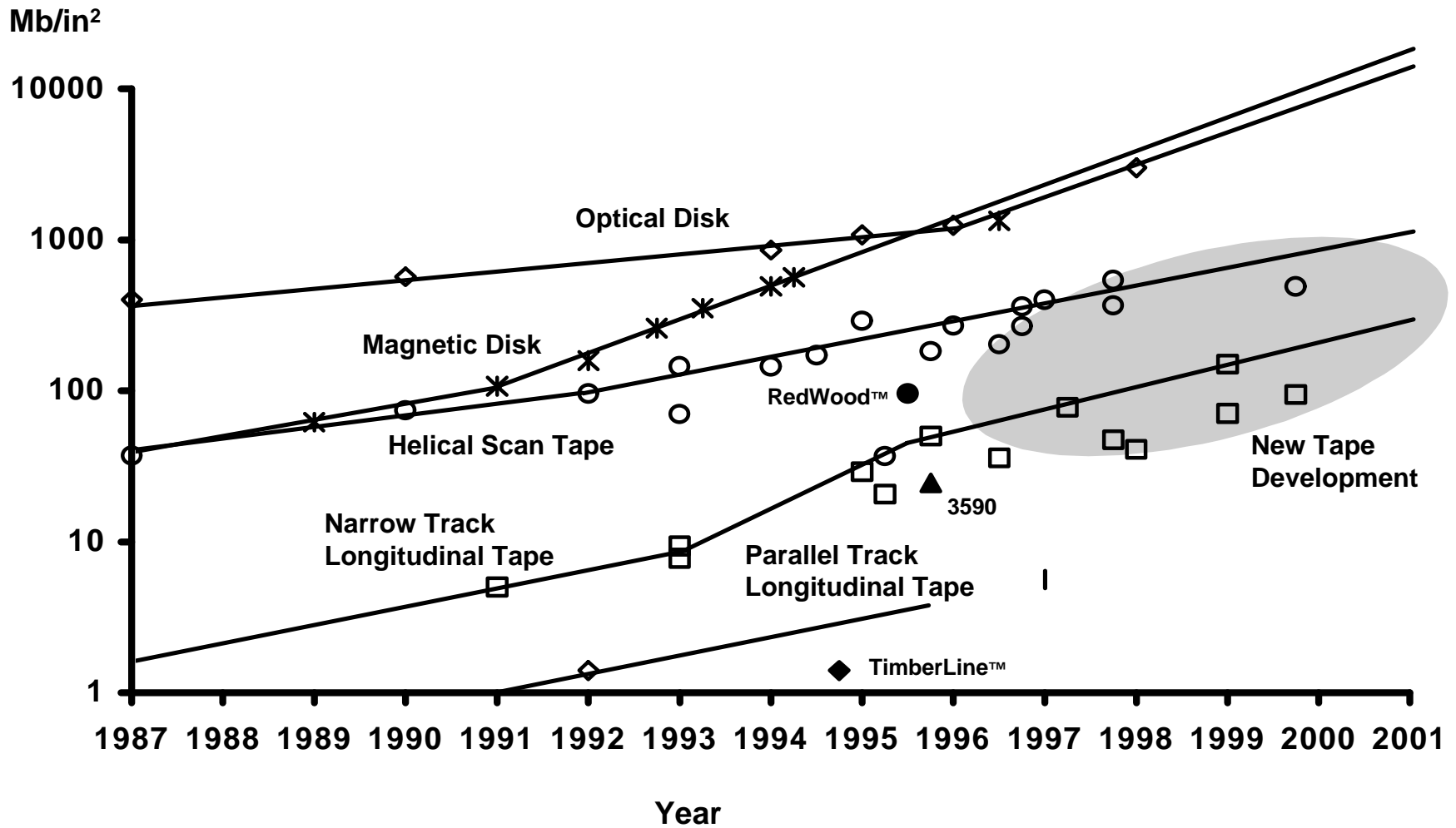
- Technology Overview
- Storage Trends
- Architecture
- StorageTek's "Building Blocks"
 - Drives
 - Automation
- Enabling Events
- Magnetic Tape Outlook

Storage Hierarchy

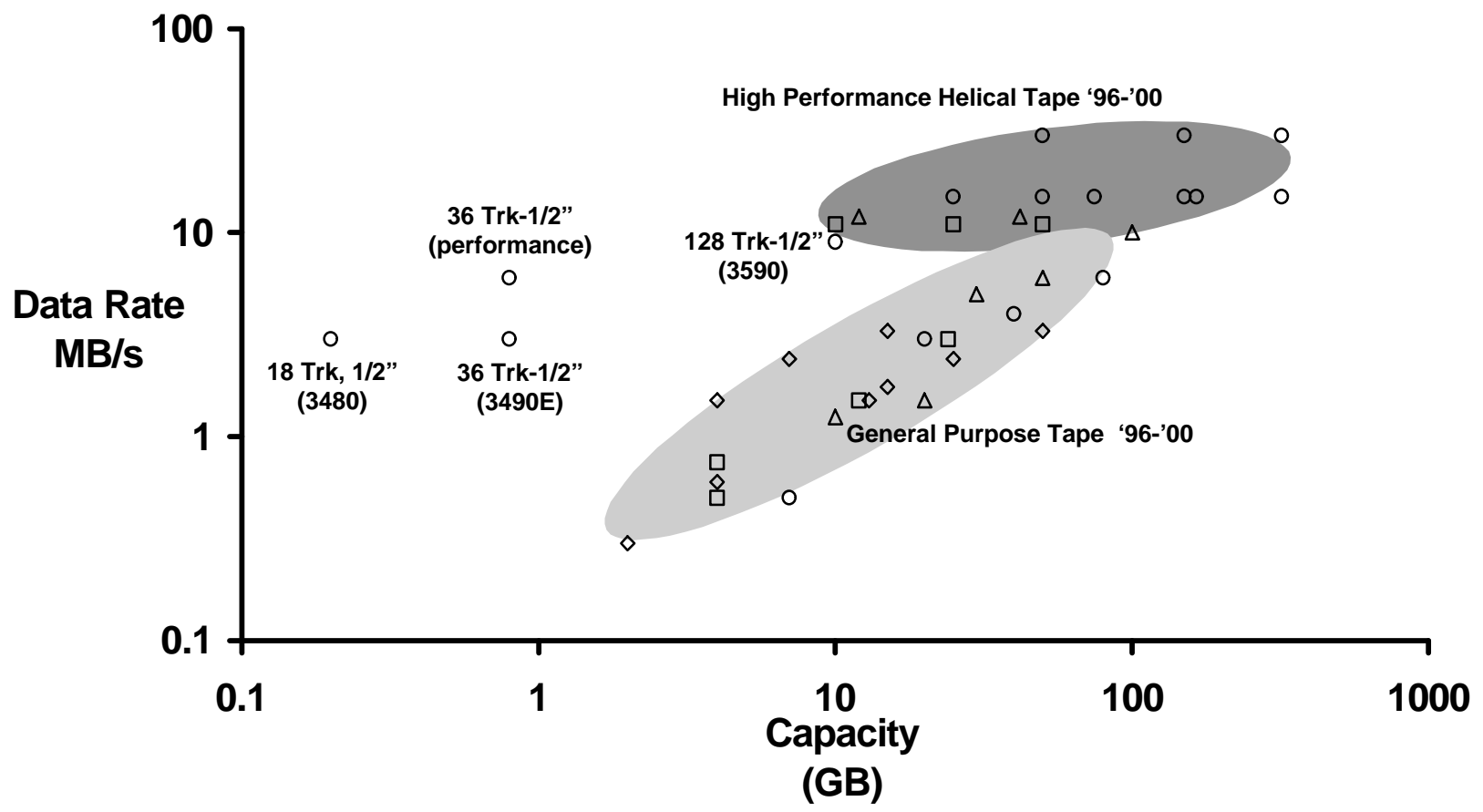


Areal Density Trends

500 Gb/in²
Holographic
(Volumetric Optical)

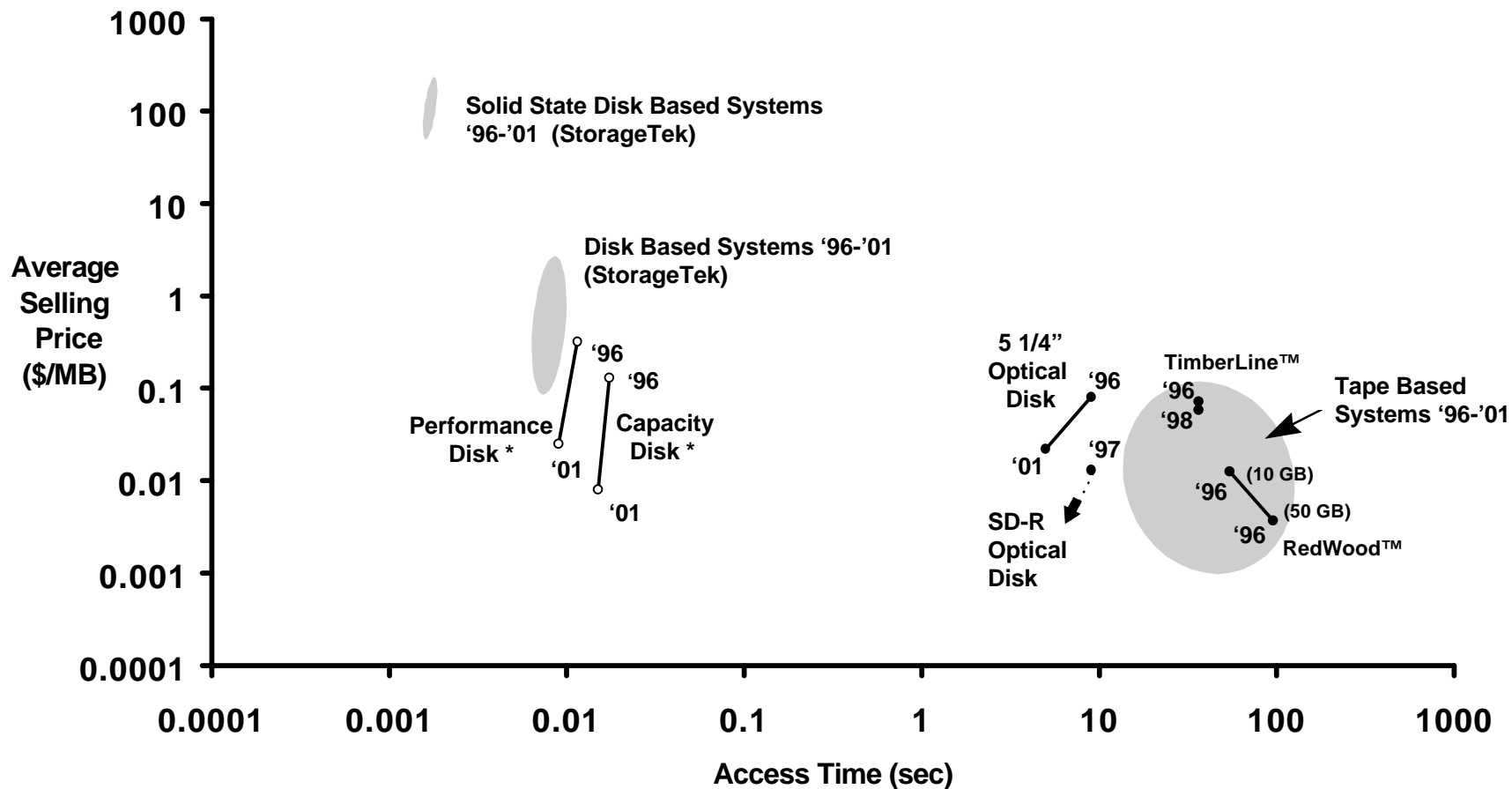


Data Rate vs. Capacity



OnLine and NearLine® Systems

Capacity Utilization: 100%



* Device Only

Storage Trends -- 5 years

- Magnetic disk fuels the technology pace of data storage.
- Holographic storage has very high data density potential but many technological challenges to overcome.
- Magnetic tape based systems continue to remain the primary technology for storage at $< \$0.1/\text{MB}$, > 30 second access time
- Magnetic tape technology is on track to support storage at $< \$0.001/\text{MB}$, > 15 second access time over the next 5 years
- A large “access gap” remains between tape and disk based systems
- Optical based systems could reach into this “gap”.
 - “Super CD” recordable optical disk technology (SD-R) will provide low cost, low data rate storage
- Magnetic disk based systems will typically remain 10 - 100 X magnetic tape system costs (for total user storage capacity)
 - But...very low end disk arrays add only 20% to the cost of commodity disk and could challenge some tape based systems

Array Tape (RAIT)

Concept

- First described by Prof. R. Katz, UCB, October '91 at IEEE Mass Storage Conference
- Borrowed from disk's redundant array of independent disks (RAID)
- Array levels include -- tape drive, tape automation and networks

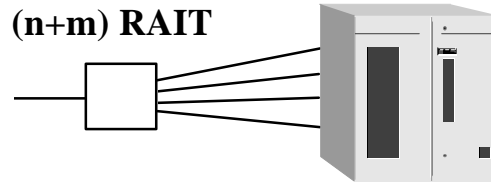
Function

- Capacity multiplying
- Data rate multiplying
 - Cost-performance benefits
- Fault tolerance (media and drive)
 - Enhanced archive data integrity
- Data reconstruction

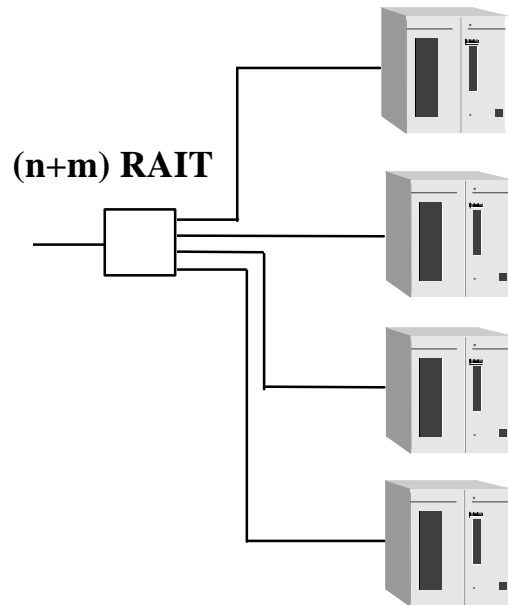
Challenge

- Data Management
 - Multiple tape sets
 - Integrate processes with non array tape
 - Use of automation
- Application Compatibility

Automation Scenarios



Data Rate	=	n MB/s	Example 3xMB/s
Performance	=	exchanges per hour (EPH)/(n+m)	EPH/4
Granularity	=	1 library	1 library



Date Rate	=	n MB/s	3xMB/s
Performance	≅	EPH	EPH
Granularity	=	(n+m) libraries	4 libraries

Drive and Automation Products

ILLUSTRATIONS OMITTED IN THIS VERSION

9704

9714
TimberWolf™
Family

9710
TimberWolf™

9360
WolfCreek™

9310
PowderHorn™

ILLUSTRATIONS OMITTED IN THIS VERSION

4890
TwinPeaks™

4480

4490
Silverton™

9490
TimberLine™

SD-3
RedWood™

Drives

ILLUSTRATIONS OMITTED IN THIS VERSION

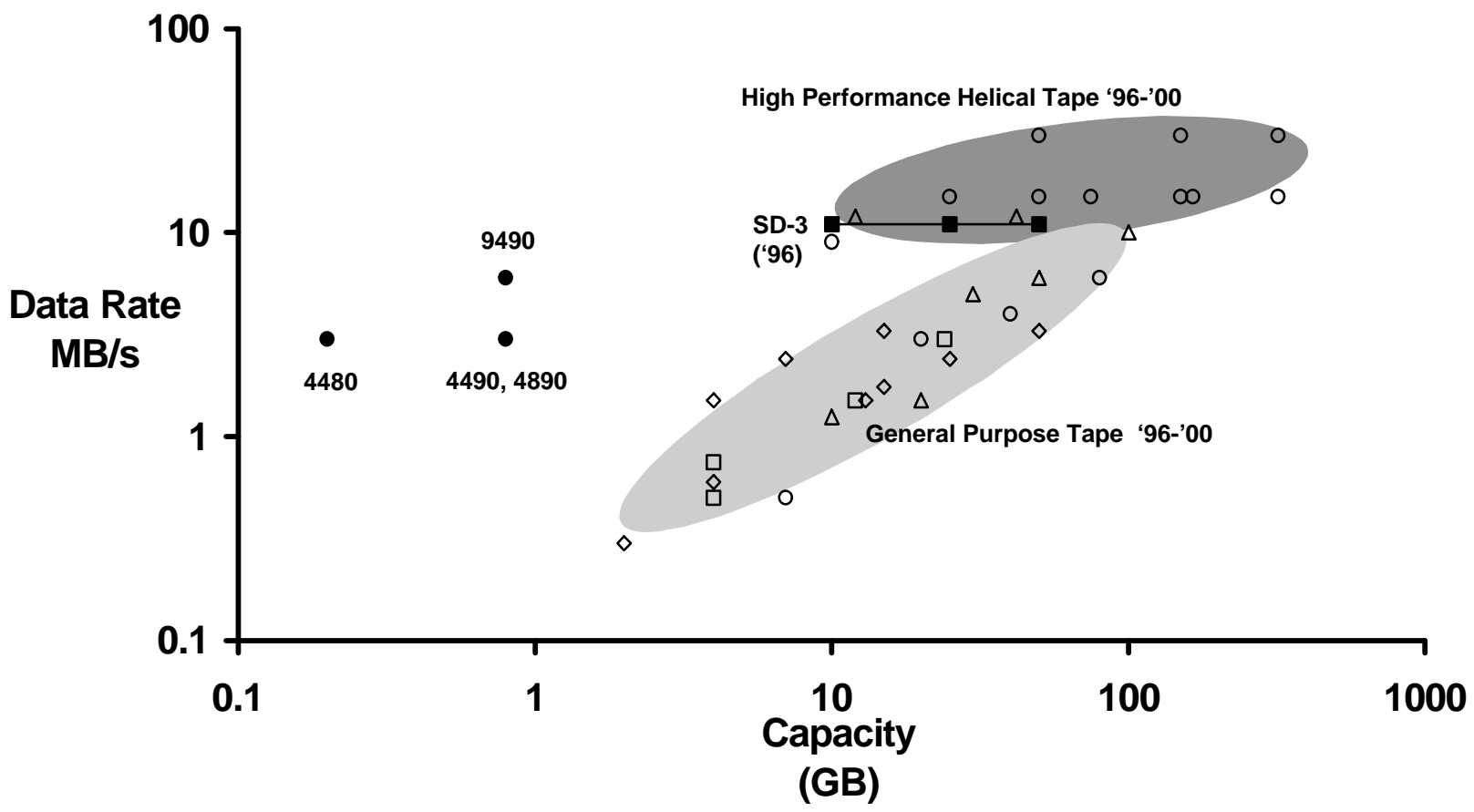
Type	SD-3 RedWood™	9490 TimberLine™	4490 Silverton™
Format	1/2" helical	1/2" 36 track	1/2" 36 track
Media	"3480 form factor", MP	3480/3490E	3480/3490E
Capacity (GBytes)	10, 25, 50	0.8	0.8
Data Rate (MBytes/sec)	11.2	6	3
Average Access Time - (sec)	44-85	26	51
Interface	ESCON, SCSI-2	ESCON, SCSI-2	ESCON, FIPS

Drives

ILLUSTRATIONS OMITTED IN THIS VERSION

Type	4890 TwinPeaks™	4480
Format	1/2" 36 track	1/2" 36 track
Media	3490E/3480	3490E/3480
Capacity (GBytes)	0.8	0.8
Data Rate (MBytes/sec)	3	3
Average Access Time - (sec)	49	29
Interface	SCSI-2, FIPS	SCSI-2, FIPS

Data Rate vs. Capacity



Automation

ILLUSTRATIONS OMITTED IN THIS VERSION

Library	9310 PowderHorn™	9360 WolfCreek™	9710 TimberWolf™
Capacity (# cartridges)	2000-6000	500-750-1000	250-420-588
Performance (exchanges/hour)	190, 350	90, 190, 350	180
Drives (max. # - type)	16 - 4480, 4490 9490, SD-3 (includes mix)	8 - 4480, 4490 9490, SD-3 (includes mix)	6 - 4890 10 - DLT 4000/7000 (includes mix)
Cartridge Access Port (# cartridges)	21, 80	20, 50	14
Typical Footprint (ft ²)	103	24 - 35	12 - 16
Other Features	pass thru to 16	pass thru to 16	office environment

Automation

ILLUSTRATIONS OMITTED IN THIS VERSION

Library	9714 TimberWolf™ Family	9704
Capacity (# cartridges)	40-60-80-100	25
Performance (exchanges/hour)	240	180
Drives (max. # - type)	6 - DLT 4000/7000	2 - DAT
Cartridge Access Port (# cartridges)	1	1, 25 (carousel)
Typical Footprint (ft ²)	6.5	1/2 rack
Other Features	office environment unannounced product, some #'s preliminary	office environment carousel access via "door"

Enabling Events -- Magnetic Tape

- New tape magnetic, backside coatings; thinner, more stable substrate materials
- First track following servo system introduced into product -- others expected
- Key tape product line advances -- 4 mm through 1/2" -- but several delays
- Strong consumer driven product technologies and data services

High density, low cost digital storage:

PC tape backup, data exchange

Digital VCR/camcorders -- Digital Video Cassette (DVC)

Competing optical technology:

CD movies -- Digital Video Disk (DVD), recordable
CD's (SD-R)

New requirements for low cost mass data storage:

Video-on-demand

Internet databases

Magnetic Tape Outlook

- Tape continues to offer the lowest cost data storage for the 5 year outlook period with capacity and data rate making significant gains
- Tape's areal density continues to increase but magnetic disk is outpacing all storage technologies in rate of advancement
 - Tape utilizes disk's technology advancements
- Media and servo technologies are poised to support continued product advancements.
- Tape development will be increasingly pushed by consumer driven products and services
- Alternate system architectures (e.g. tape array) will have an expanding role -- offering unique levels of performance and data reliability