


IBM TotalStorage™

IBM

IBM Tape Update: LTO and EnterpriseTape
TSM Symposium...Oxford University
23/9/2003

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Agenda

- IBM One TB Tape Technology
- LTO Milestones and Roadmap
- Introduction to "New Enterprise Tape Drive" and Roadmap

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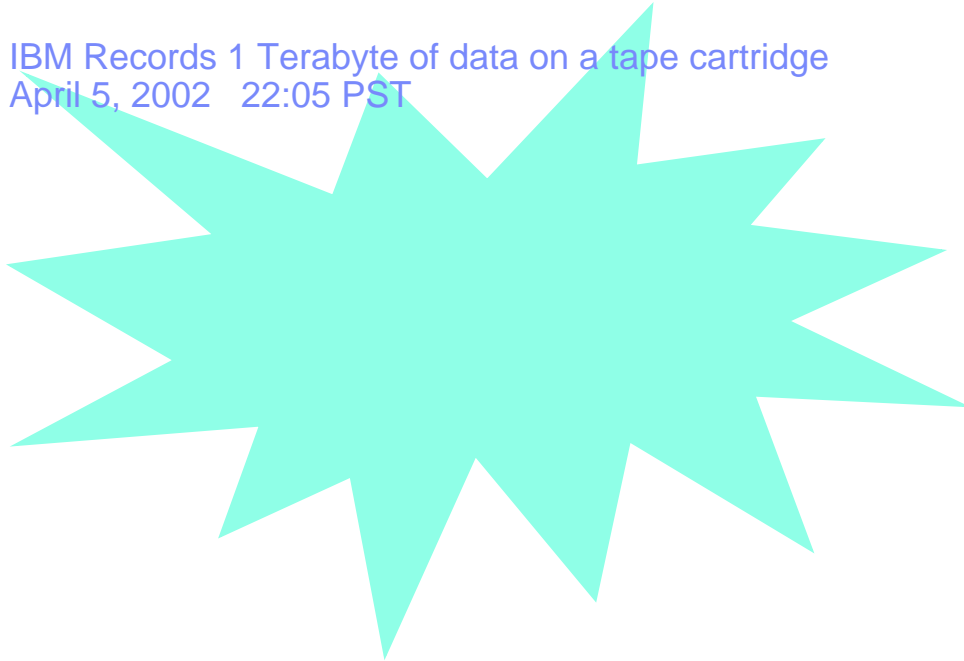
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IBM Records 1 Terabyte of data on a tape cartridge
April 5, 2002 22:05 PST




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The 1 Terabyte Roadmap Built On Generations of IBM Tape Products

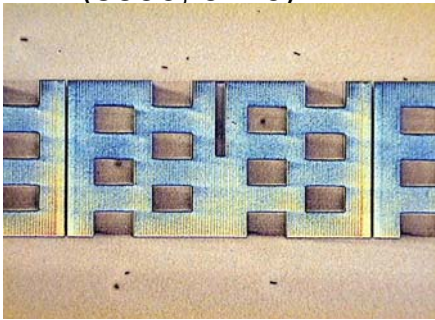
- 3592:**
 - ✓ Magneto-resistive flat lap heads
 - ✓ Surface control guiding system
 - ✓ Timing based servo
 - ✓ Dual Actuator
 - ✓ "Virtual Backhitch"
 - ✓ Improved cartridge, media reuse
- 3580:**
 - ✓ Magneto-resistive flat lap heads
 - ✓ Surface control guiding system
 - ✓ Timing based servo
 - ✓ Dual actuator
- 3590E/H:**
 - ✓ Improved track following servo
 - ✓ Track density increased to 256/384 tracks
 - ✓ Media reuse; no new media required
- 3570:**
 - ✓ First timing-based servo for a tape drive
 - ✓ High bandwidth tracking
- 3590B:**
 - ✓ Improved data channel (data rate and reliability)
 - ✓ 128 track serpentine recording introduced
 - ✓ Servo band tracking introduced
 - ✓ Introduction of metal particle tape
- 3480:**
 - ✓ Increased tape speed (increased data rate)
 - ✓ Square tape introduced
 - ✓ First magneto-resistive tape head

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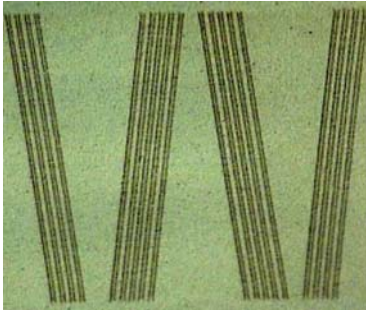
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Servo Technology Evolution

Amplitude Servo
(3590, 9x40)



Timing Based Servo
(3580, 3592)

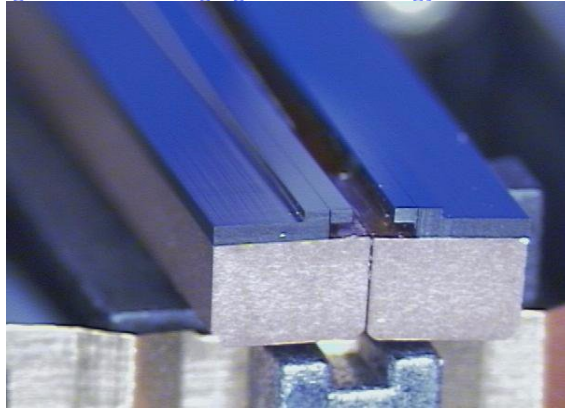


Benefits: greater precision to enable reliable recording for 1 TB as well as media compatibility within roadmap

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IBM Flat Head Technology

- Flat air bearing surface minimizes head-tape-interface pressure, wear
- IBM's head is slotless --> no blind debris traps
- Enables precision signal-based tape wrap setting
- Flat lapping enables leveraging HDD technology advances



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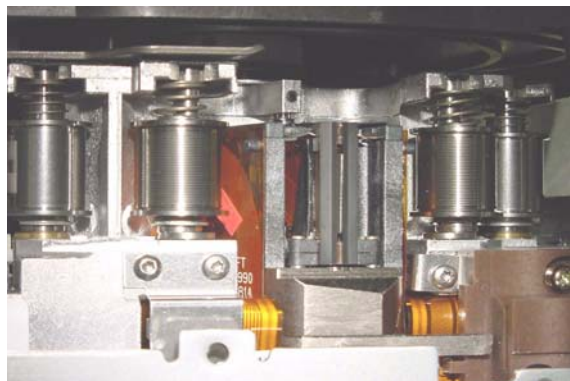
Surface Control Guiding System*

- ▶ **What is Surface Control Guiding (SCG)?**
 - ▶ SCG Technology is a revolutionary concept in tape handling which dramatically increases reliability in linear tape drives
 - ▶ Enables quality utilization of servo track following by damping tape motion

SCG Technology

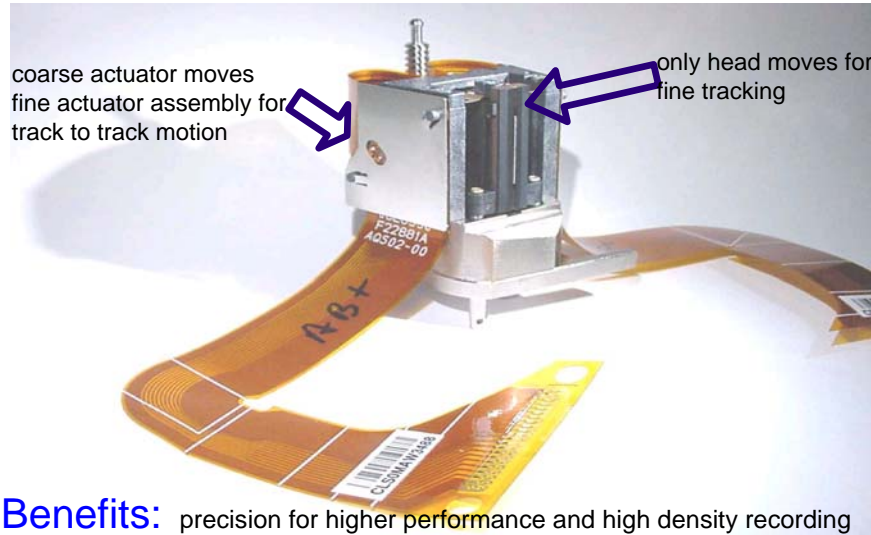
- ▶ No wear or stress on edge of tape
- ▶ Decreases debris generation
- ▶ Not sensitive to tape edge quality or pack dynamics

* IBM Patent Pending



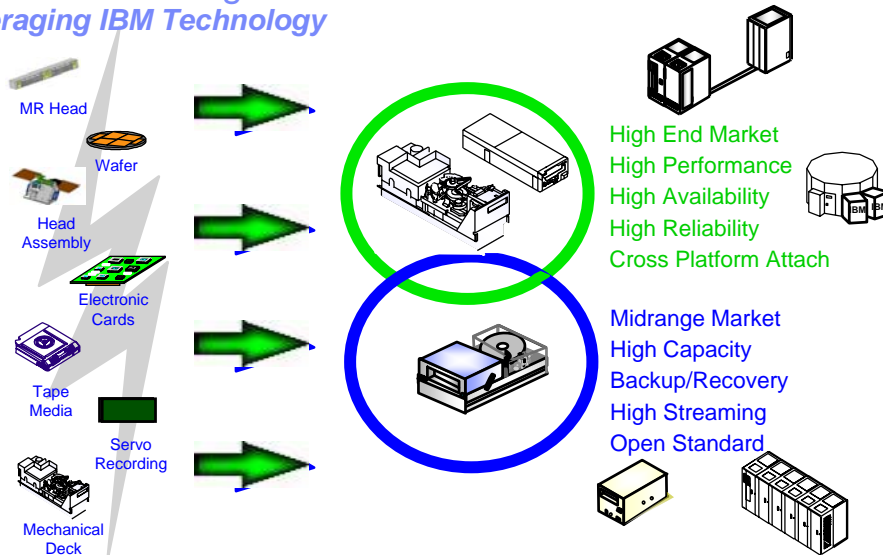
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Low Mass Fine Tracking Actuator



Benefits: precision for higher performance and high density recording
improved resistance to shock/vibration effects

The IBM Advantage: Leveraging IBM Technology



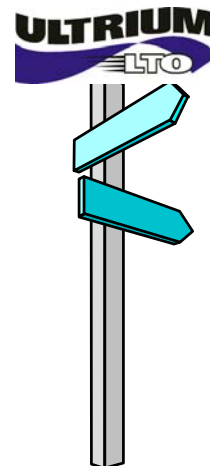
What is Linear Tape Open?

- IBM, HP and Seagate worked together (1997) for a new open tape standard
 - ▶ Targeted open systems and network server platforms
 - ▶ Made licenses to LTO spec available to entire tape industry
 - ▶ Defined 4-generation product roadmap
 - ▶ Established a 3rd party compliance verification entity
- LTO has successfully gained industry acceptance
 - ▶ Over 30 licensees covering breadth of tape industry
 - ▶ Favorable coverage from press, industry analysts, and consultants
 - ▶ **6 media licensees and 3 drive vendors have passed compliance testing**
- Ultrium is the LTO offering
 - ▶ High capacity - up to 200 GB native for generation 2
 - ▶ High performance - up to 20-40 MB/sec for generation 2
 - ▶ IBM delivered first complete Ultrium product family



IBM TotalStorage LTO Ultrium Milestones

- 2000
 - ▶ Announcement LTO Gen 1- August 2000
 - Family of LTO Tape Products
 - ▶ General Availability LTO Gen 1- Sept 2000
 - First to Market - **LTO Gen 1**
- 2001
 - ▶ LTO Gen 1 Native Fibre Channel (First to Market)
 - ▶ LTO Outships SDLT by over 2:1
- 2002
 - ▶ Universal Cleaning Cartridge
 - ▶ LTO Gen2 Specification Released
- 2003
 - ▶ LTO **Ultrium 2** Native Fibre Channel (First to Market)
 - ▶ Ten Millionth Cartridge shipped by TPC vendors
 - ▶ Over 170,000 IBM LTO Drives shipped (Program to date)
 - ▶ Over 11,000 IBM LTO Libraries shipped (Program to date)
 - 3,700 3584 (Anaconda) L32s
 - ▶ Continuing to outship SDLT by approximately 2:1



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IBM TotalStorage LTO Ultrium Products Roadmap

LTO Ultrium2
 200 GB Native Capacity
 35 MB/sec Data Rate
 Ultra160 SCSI
 2 Gb Switched Fabric
 Fibre Channel
 Backward Read/Write
 w/Ultrium 1media

4Q2002

3584 UltraScalable Library
 Ultrium2 Integration
 Control Path Failover
 110 Volt Power option
 Mixed LTO Drives & Media
 Management Enhancements

3580 Ultrium Tape Drive

2003

LTO Ultrium Family
 Ultrium2 Integration
 3581 Tape Autoloader
 3583 Scalable Tape Library
 (Native FC, Multi-Path)
 New 3582 Tape Library

2003

3584 UltraScalable Library
 16 Frames
 192 tape drives
 220V Dual Line Cord Option
 Data Path Failover & Load
 Balancing
 Web enhancements
 SNMP MIB
 Heartbeat Call Home
 Control Path Failover
 Expansion

2004 and beyond

This represents a statement of IBM's future product plans and directions.
 Such plans and directions are subject to change at any time without notice.

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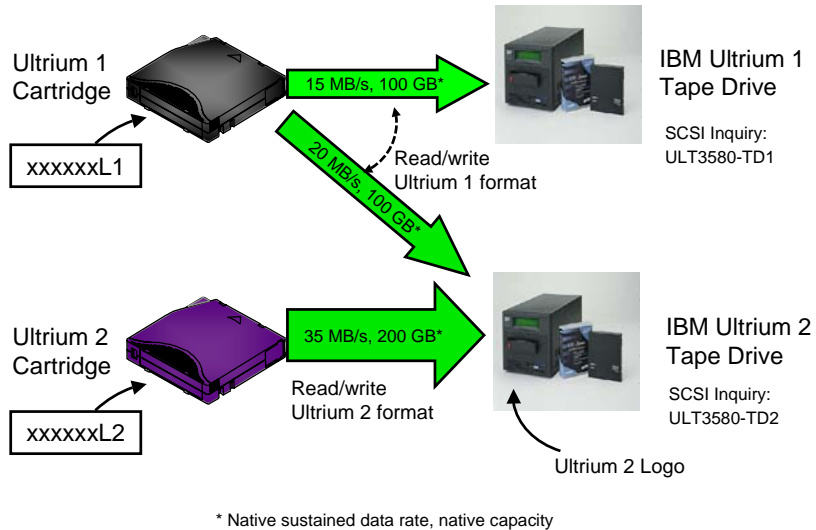
IBM LTO Ultrium 2 Tape Drive

- LTO Ultrium 2 Features
 - ▶ *200 GB Native Capacity (400 GB compressed)
 - ▶ *New IBM TotalStorage LTO Ultrium 2 Data Cartridge
 - ▶ *35 MB/s native (70 MB/s compressed)
 - ▶ *Backward Read/Write with Ultrium 1 Cartridge
 - ▶ *Speed Matching
 - ▶ *Power Management (Sleep Mode)
 - ▶ *512 Tracks
 - ▶ *64 MB Buffer
 - ▶ PRML (Partial Response Maximum Likelihood)
 - ▶ Surface Control Guiding Mechanism
 - ▶ Magnetoresistive Flat Lap Head Design
 - ▶ Timing Based Servo
 - ▶ SARS (Statistical Analysis and Reporting System) and ECC

*New with Ultrium 2

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IBM Ultrium 1 and 2 Compatibility



IBM LTO Ultrium 2 Operating Systems Support

- AIX V4.3.3, or later
- Microsoft Windows NT V4.0 with Service Pack 6
- Microsoft Windows 2000 (Build 2195, or greater) and Windows 2003 (Build 3790, or greater)
- OS/400 V5R1, or later
- Sun Solaris 7, 8, 9
- HP-UX 11.0 and HP-UX 11i (64-bit)
- Linux Red Hat 7.3
- Linux Red Hat Advanced Server 2.1
- SuSE Linux Enterprise Server 7 Update

LTO Ultrium Product Descriptions

3580 Tape Drive **3581 Autoloader** **3582 Tape Library** **3583 Scalable Tape Library**

Ultrium2 Integration
 SCSI 160 LVD & HVD
 Desktop & Rack Mount
 3 Yr Warranty
 3580 Existing Features
 1 Drive, 1 Cartridge

Ultrium2 Integration
 SCSI 160 LVD & HVD
 Desktop & Rack Mount, 4U
 3 Yr Warranty
 3581 Existing Features
 1 Drive, 7 Cartridges
 Optional Barcode Rdr

23 +1 Cartridges
 1 or 2 Drives
 4U Height
 Ultrium2 Integration
 SCSI 160 LVD & HVD
 2 Gb Native Fibre Option
 Desktop & Rack Mount
 3 Yr Warranty
 Removable Magazines
 1-Cartridge I/O
 Barcode Reader Option
 Multi-Path Architecture
 Control Path Failover

Ultrium2 Integration
 SCSI 160 LVD & HVD
 2 Gb Native Fibre Option
 Investment Protection Upgrade Path
 Desktop & Rack Mount, 14U
 1 Yr Warranty
 Multi-Path Architecture
 Control Path Failover
 Mixed Ultrium 1&2 Drives & Media
 3583 Existing Features
 1-6 Drives, 18-72 Carts
 Barcode Rdr Standard

The 3590....a History of Investment Protection!

- 1995 3590 B: Capacity, Performance, Reliability
- 1996 Axx: ESCON Connectivity
- 1997 Ultra SCSI: Performance
- 1999 3590 E: Capacity, Performance
- 2000 XL Media: Capacity with media reuse
- 2000 Fibre channel: Connectivity, Performance
- 2000 FICON: Connectivity, Performance
- 2002 3590 H: Capacity
- 2002 3590 A60 2Gb: Connectivity, Performance

*All Field Upgrades!
 All Generations fully supported and available
 A Proven History of Vendor Commitment*

Enterprise Tape Drive Roadmap

	Generation 1&2 3590B/3590E	Generation 3 3590H	Generation 4 3592	Generation 5	Generation 6
Native Capacity	10/20/40 GB	30/60 GB	300 GB	500 - 700 GB	900 - 1100 GB*
Native Transfer Rate	9-14 MB/sec	14 MB/sec	40 MB/sec	60-80 MB/sec	100-160 MB/sec
Cartridge Type	3590 Cartridge; J,K	3590 Cartridge J,K	3590 Form Factor; L	3590 Form Factor; L	3590 Form Factor; L,M
Server Attachments	Ultra-SCSI Fibre Channel ESCON FICON		Fibre Channel ESCON FICON		

* with M media

Product Road Map: These statements represent IBM's current intent, are subject to change or withdrawal, and represent only goals and objectives.

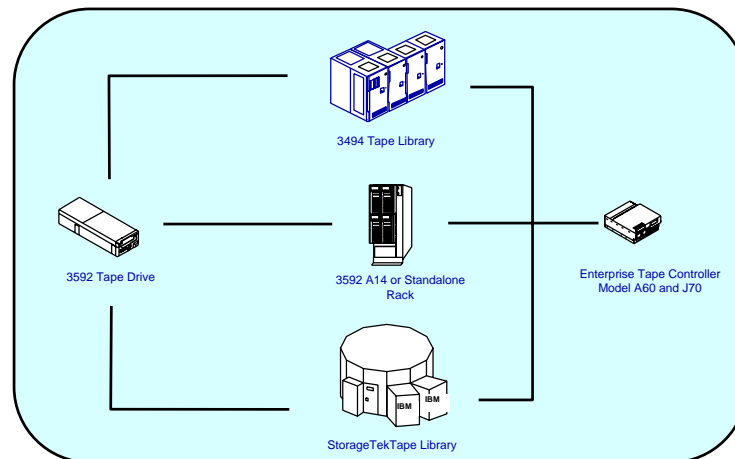
Tape Drive Roadmaps

	Generation 1&2 3590B/3590E	Generation 3 3590H	Generation 4 3592	Generation 5	Generation 6
Native Capacity	10/20/40 GB	30/60 GB	300 GB	500 - 700 GB	900 - 1100 GB
Native Transfer Rate	9-14 MB/sec	14 MB/sec	40 MB/sec	60-80 MB/sec	100-160 MB/sec

	Current Generation	Next Generation 2	Next Generation 3	Next Generation 4
Native Capacity	100 GB	200 GB	400 GB	800 GB
Native Transfer Rate	15 MB/sec	20 - 40 MB/sec	40 - 80 MB/sec	80-160 MB/sec

Product Road Map: These statements represent IBM's current intent, are subject to change or withdrawal, and represent only goals and objectives.

3592 Enterprise Tape Drive Overview



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3592 Tape Drive Description

- Small form factor drive designed for automation
- The 3592 is an Enterprise Class tape drive that
 - ▶ Increases performance to 40 MB/sec
 - ▶ Increases capacity to 300 GB per cartridge
 - ▶ Reduces time to first byte of data to 33 seconds*
 - ▶ Reduces average search time to 12 seconds*
 - ▶ Reduces rewind time to 20 seconds*
- Uses a new IBM cartridge that can be initialized as a
 - ▶ 60 GB cartridge to provide fast access to data or
 - ▶ 300 GB cartridge to provide high capacity
- Includes a dual-ported 2 Gbit FC / FC-AL interface
 - ▶ Auto-negotiate to 1 Gbit or 2 Gbit



* based on 60 GB 3592 Cartridge capacity

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3592 Tape Drive Description (continued)

- Improves Availability
 - ▶ Single Field Replaceable Unit (FRU)
 - ▶ Redundant, hot pluggable power supplies
 - ▶ Retention of Fibre Channel Worldwide Name ID during service action

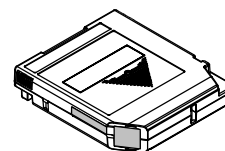
- Advanced technology
 - ▶ Robust loader mechanism designed for heavy duty cycle
 - ▶ Elimination of drive pneumatics and mechanical adjustments
 - ▶ Straighter and shorter tape path for better tape tracking
 - ▶ Longitudinal Positioning Servo (LPOS) to improve locate
 - ▶ Brushless Motors and a single cardpack
 - ▶ Speed matching to reduce backhitching
 - ▶ Channel calibration to optimizes performance and data integrity

- Builds on 3590 Microcode

3592 Cartridge Media

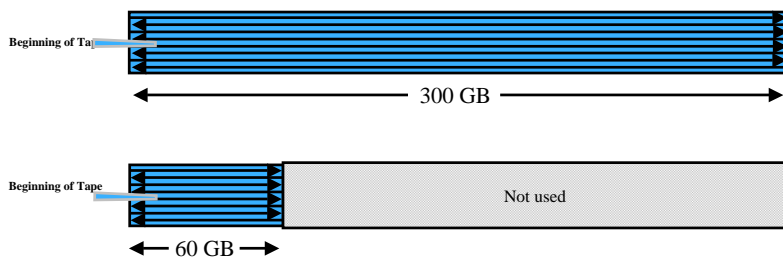
- Uses a new 'dual layer' metal particle media
- Allows greater recording density and datarate
- Enhances Statistical Analysis Recording System (SARS)
- Compatible with existing automation

- Available in a Standard Length, 600 Meter Cartridge
 - ▶ Can be initialized to two native capacities
 - 60 GB capacity to provide rapid access to data
 - 300 GB to provide a high capacity solution
 - ▶ Capacity will typically range from the native capacity
 - up to 600 GB in Open System environments
 - up to 900 GB in zSeries environments



Capacity Scaling

- Scaling provides the capability to initialize to two capacities
 - Allows standardization on a single media type
 - Initializing at 60 GB improves the time to first byte
 - Initializing at 300 GB increases cartridge storage capacity
 - Tapes can be scaled / de-scaled as requirements change

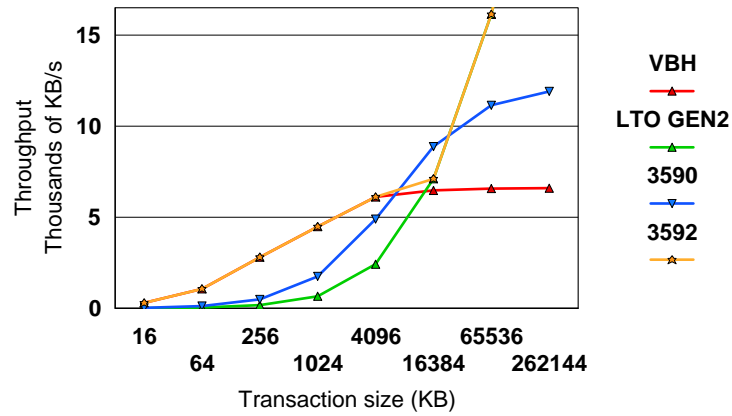


Virtual Backhitch

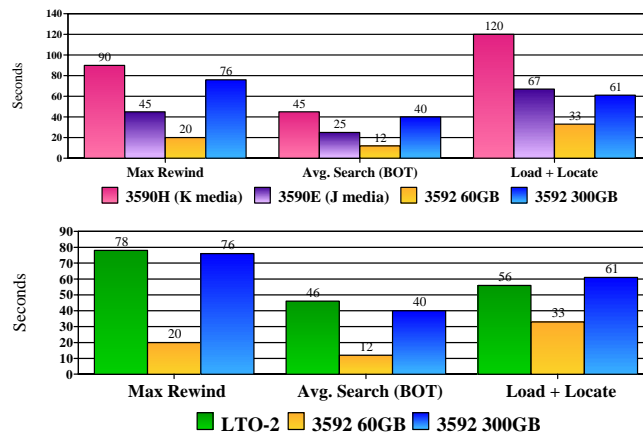
- A innovative technique to mask physical drive characteristics (backhitch) to greatly improve reliability and performance, particularly for small block sizes
- Enabled by linear positioning of Timing Based Servo
- Decreases mechanical motion and wear that can affect reliability
- Automatically enabled when drive senses synchronized write or small blocksize environment.

Virtual Backhitch Performance

Throughput, with Txn <= 256MB



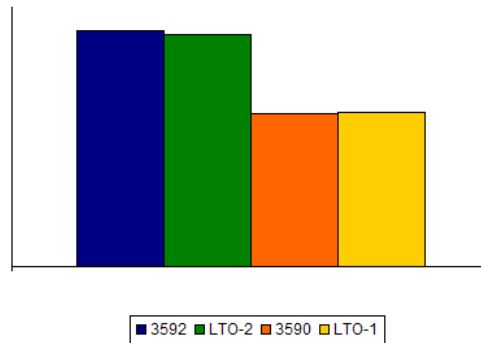
3592 Performance



Note: Performance information is provided as is and reflects early performance testing results.

3592 Performance (continued)

Tivoli Storage Manager Backup (256 MB filesize)



Note: Performance information is provided 'as is' and reflects early performance testing results. Please refer to the performance White paper at time of announcement for final results

Open System Support

- Sun Microsystems
 - ▶ SPARC, UltraSPARC, and Ultra/Enterprise Servers
 - ▶ requires supported SUN FC adapters
 - ▶ Solaris 7, Solaris 8, Solaris 9

- Hewlett Packard
 - ▶ 9000 L, N, and V class; and rp2400, rp5400, rp7400 series servers
 - ▶ requires supported HP FC adapters
 - ▶ HP/UX 11.0, HP-UX 11.i

- Microsoft Corporation
 - ▶ Requires supported Qlogic, Netfinity, or Emulex FC adapters
 - ▶ Windows NT™ Server Version 4
 - ▶ Windows 2000™
 - ▶ Windows Server™ 2003

Linux Support



- Intel based Servers
 - ▶ using supported Q Logic FC HBAs
 - ▶ RedHat Enterprise Linux
 - ▶ SuSE Linux Enterprise Server 8
 - ▶ Turbolinux Enterprise Server 8
 - ▶ Conectiva Linux Enterprise Edition

- zSeries servers
 - ▶ using supported FICON features with FC protocol support
 - ▶ SuSE Linux Enterprise Server 8.0

- pSeries servers
 - ▶ using supported FC feature codes
 - ▶ SuSE Linux Enterprise Server 8.0

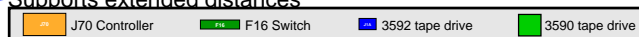
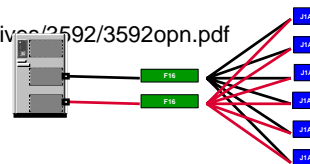
Open System Attachment

- The 3592 tape drive can be attached to FC-AL or FABRIC SANs

- Supported FC-AL and Fabric switches
 - ▶ Includes selected models from IBM, Brocade, McData, and others
 - ▶ Listed at <http://ssddom02.storage.ibm.com/techsup/webnav.nsf/support/SAN>

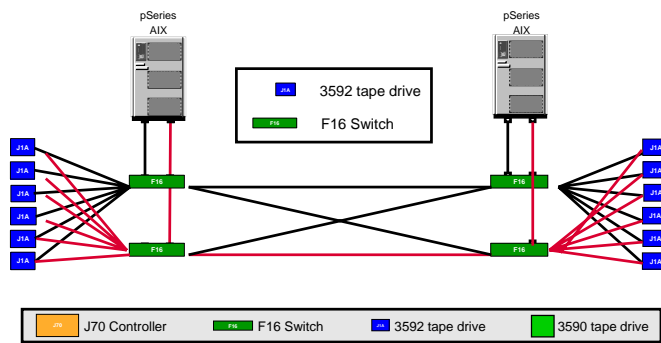
- Supported Operating Systems
 - ▶ Includes platform support for IBM, SUN, HP, Microsoft Windows and Linux
 - ▶ Listed at <http://www.storage.ibm.com/tape/drives/2592/3592opn.pdf>

- SAN Support
 - ▶ Reduces resource requirements
 - ▶ Provides redundant paths
 - ▶ Supports extended distances



Open System Attachment (continued)

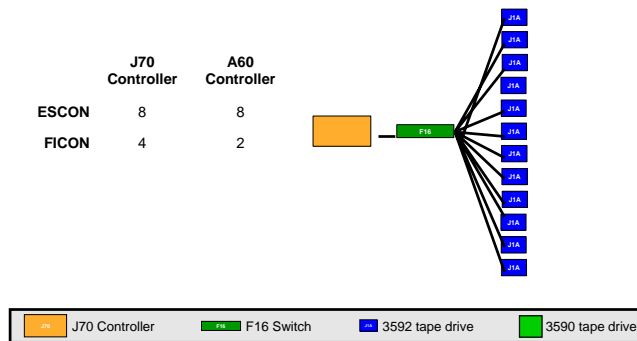
- The 3592 dual ported design
 - ▶ Hardens business continuance environments
 - ▶ Dynamically reroute I/O in the event of a SAN failure (pSeries only)
 - ▶ May improve performance through data path optimization



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zSeries Attachment

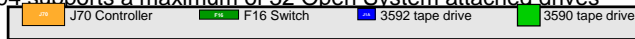
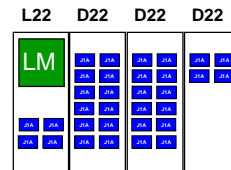
- The 3592 is supported behind the IBM J70 and A60 Controller
 - ▶ Attaches up to twelve 3592 tape drives (no 3590 intermix)
 - ▶ Requires a dedicated 2109 Model S16 or F16 SAN switch
 - ▶ Allows attachment to ESCON® and /or FICON™ hosts



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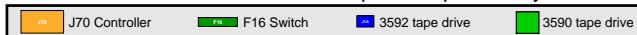
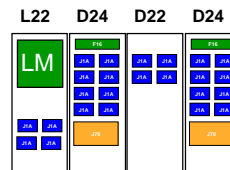
Enterprise Tape Library Support

- The 3592 is supported in three 3494 frame models
 - ▶ 3590 tape drives may not be intermixed within a frame
 - ▶ 3592, 3590 and 3490 drives and cartridges may coexist in a 3494
- L22 Library Control Frame
 - ▶ 1 - 4 3592 drives
 - ▶ 216 - 240 cartridges
 - ▶ 65 - 72 TB (native capacity)
- D22 Drive Frame
 - ▶ 1 - 12 3592 tape drives
 - ▶ 230 - 305 cartridges
 - ▶ 69 - 100 TB (native capacity)
- A 3494 supports a maximum of 32 Open System attached drives



Enterprise Tape Library Support (continued)

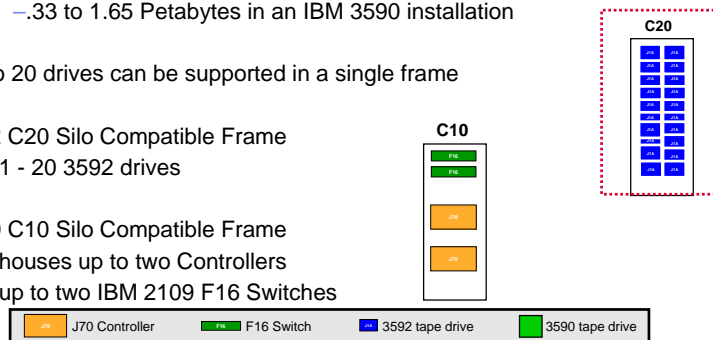
- D24 Drive Frame
 - ▶ 1- 8 3592 drives
 - ▶ Enterprise Tape Controller
 - 3592 Model J70
 - 3590 Model A60
 - ▶ 275 - 345 cartridges
 - ▶ 82 - 103 TB (native capacity)
- The J70 and A60 does not require a Library Manager Port
- 3494 L12, D12 and D24 frames can be upgraded in the field
- Increases the library storage capacity up to 1.87 petabytes* (native capacity)
- Protects investment in Enterprise Tape Library



* based on 6,280 cartridge capacity

StorageTek Silo Attachment

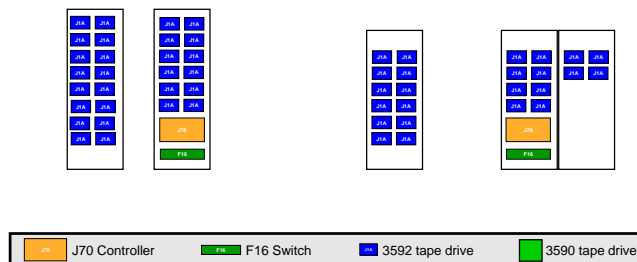
- The 3592 tape drive is supported in a StorageTek 9310 PowderHorn™
 - ▶ Increases native storage capacity from
 - .11 to 1.65 Petabytes in a StorageTek 9840B installation
 - 1.1 to 1.65 Petabytes in a StorageTek 9940B installation
 - .33 to 1.65 Petabytes in an IBM 3590 installation
- Up to 20 drives can be supported in a single frame
- 3592 C20 Silo Compatible Frame
 - ▶ 1 - 20 3592 drives
- 3590 C10 Silo Compatible Frame
 - ▶ houses up to two Controllers
 - ▶ up to two IBM 2109 F16 Switches



* based on 5,500 cartridge capacity

Standalone Support

- The 3592 is supported in a standalone 19 " rack
 - ▶ 1 - 12 tape drives in a 1.8m or 1.6m rack
 - up to eight if a A60 or J70 is required
 - ▶ 1 - 16 tape drives in a 2m rack
 - up to 12 if a A60 or J70 is required
 - ▶ Supported IBM racks include the IBM 7014 Model T00 and T42



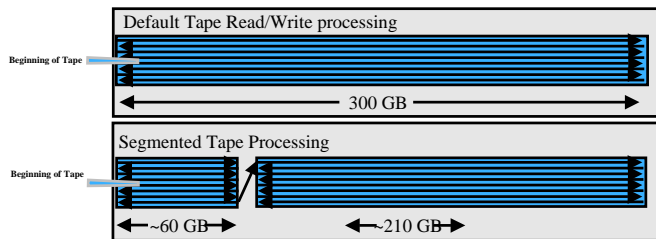
Statement of Direction

- Write Once Read Many (WORM Function)
 - ▶ Designed to work with a 3592 WORM cartridge
 - ▶ Designed to address regulatory requirements

- Virtual Tape Server Support
 - ▶ Designed to increase stacking depth
 - ▶ Designed to support higher capacities

Statement of Direction

- Cartridge Segmentation
 - ▶ Virtualize Cartridge
 - ▶ Enhance application I/O performance



- Additional Cartridge Capacities
 - ▶ Provide additional flexibility
 - ▶ Reduce Costs

3592 Enterprise Tape Drive Summary

- Designed to provide a tape drive technology that provides
 - ▶ One drive technology to meet all application requirements
 - ▶ The cartridge that can be formatted as fast access or high capacity
 - ▶ A cartridge designed to support higher capacities in future generations
- Designed to provide seamless integration and support
 - ▶ Attachment to IBM eServer and other open systems platforms
 - ▶ Integration into existing IBM and StorageTek tape libraries
 - ▶ Attachment to native Fabric and FC-AL SANs
- Designed to meet the demands of the on demand era
 - ▶ High Data Growth
 - ▶ Data sharing
 - ▶ Virtualization
 - ▶ Autonomic
 - ▶ Investment Protection

Positioning of LTO and 3592...factors to consider:

- What Automation support exists today: DLT/LTO, or 3590/9x40?
 - ▶ least expensive option is new drive in existing automation
- Requirements for multi-platform support (e.g. Open Systems, zSeries, etc)?
- Value of 300 GB versus 200 GB?
- Value of media re-use in customer application scenario?
- Application requirements for fast access or future WORM?
- Value of "open standards" as in LTO?
- Need for more robust technology as with 3590?
- Importance of price? (list prices below)
 - ▶ 3590H1a = 43,500 Euros
 - ▶ 3592J1a = 30,200
 - ▶ LTO2 FC = 18,600

Final Impressions from ECMWF Joint Study

- "Extremely impressed by the drive"
- "Very reliable (very few problems, not a single hardware problem)"
- "Performed very well in our tests for streaming and random access performance"
- "Random access locate performance is very competitive against other vendor enterprise tape offerings"
- "Drive is ready for production"
- "Plan to implement the new drive and media in silos"

Source: Francis Dequenne, Principal Systems Analyst, ECMWF

Conclusion



On Target for the One TB roadmap!