System Storage

Tape Products Update

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Lead Architect – Tape Automation Products

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Agenda

- Tape trends

- Update on IBM tape drives
  - LTO 8
  - TS1155
  - Enterprise commonality and differentiators

- Update on IBM tape libraries
  - Integrated cooling
Areal Density Scaling

2015: IBM-FujiFilm demonstration of 123 Gb/in\(^2\) on BaFe tape
2017: IBM-Sony demonstration of 201 Gb/in\(^2\) on Sputtered Tape
IBM tape storage for hyperscale computing
The more things change, the more they stay the same

How to store a zettabyte on a budget
• Aaron Ogus, Microsoft Azure
• Global IT Executive Summit - October, 2015
  • https://tapepower.fujifilmrmd.com/LA2015/video/id/presentation.5

How Google Backs up the Internet
• Raymond Blum, Google Site Reliability
• NYC Tech Talk Series - October, 2013
  • https://www.youtube.com/watch?v=eNliOm9NtCM

Lessons Learned Backing Up Google
- Ensuring durability and integrity of user data is job one
- A tape is available can be broken out, but data loss can be hard to recover from. Even possible
- Redundancy does not bring recoverability
- Complex and detailed can replicate with relency
- Distributed processing impose data consolidation
  You need to collect and share information, which view at some point
- The backup process has to scale with data volume
- If you haven’t restored, you haven’t backed up
- The Payoff: A case study
IBM tape storage for hyperscale computing
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[HPSS user testimonial here]
• [Your Name, Your Company]
• [Your testimonial URL]

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TS1155 – Ethernet interface and 15 TB tape cartridge
### IBM Tape Drive History and Roadmaps

<table>
<thead>
<tr>
<th>LTO Generations</th>
<th>LTO-6</th>
<th>LTO-7</th>
<th>LTO-8</th>
<th>LTO-9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Max Format Capacity</strong> (Native)</td>
<td>2.5 TB (L6)</td>
<td>6 TB (L7)</td>
<td>12 TB (L8)</td>
<td>Up to 25 TB (L9)</td>
</tr>
<tr>
<td><strong>Other Format Capacities</strong> (Native)</td>
<td>1.5 TB (L5) (800 GB L4 R/O)</td>
<td>2.5 TB (L6) (1.5 TB L5 R/O)</td>
<td>6 TB (L7)</td>
<td>Up to 12 TB (L8) (6 TB L7 R/O)</td>
</tr>
<tr>
<td><strong>Native Data Rate</strong></td>
<td>160 MB/s</td>
<td>300 MB/s</td>
<td>360 MB/s</td>
<td>Up to 450 MB/s</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TS1100 Generations</th>
<th>TS1140</th>
<th>TS1150</th>
<th>TS1155</th>
<th>Gen-6</th>
<th>Gen-7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Max Format Capacity</strong> (Native)</td>
<td>4 TB (JC) 1.6 TB (JB)</td>
<td>10 TB (JD) 7 TB (JC)</td>
<td>15 TB (JD) 7TB (JC)</td>
<td>Up to 20 TB (JE) 15 TB (JD) 10 TB (JC)</td>
<td>Up to 50 TB (JF) Up to 30 TB (JE) 15 TB (JD)</td>
</tr>
<tr>
<td><strong>Other Format Capacities</strong> (Native)</td>
<td>1 TB (JB) 700 GB (JB) (All JA R/O)</td>
<td>4 TB (JC)</td>
<td>10 TB (JD) 4 TB (JC, R/O)</td>
<td>10 TB (JD) 7 TB (JC) 4 TB (JC, R/O)</td>
<td>10 TB (JD)</td>
</tr>
<tr>
<td><strong>Native Data Rate</strong></td>
<td>250 MB/s</td>
<td>360 MB/s</td>
<td>360 MB/s</td>
<td>Up to 420 MB/s</td>
<td>Up to 1000 MB/s</td>
</tr>
<tr>
<td><strong>Attachment</strong></td>
<td>FC-8</td>
<td>FC-8</td>
<td>FC-8, 10 GigE (RoCEv2)</td>
<td>FC-16, 25 GigE (RoCEv2)</td>
<td>TBD</td>
</tr>
</tbody>
</table>

Any statements regarding IBM’s future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only.
IBM LTO-8 Announcement on October 10

- New generation of Tape Drive and Libraries, LTO-8
  - New! LTO-8 for TS4500 Tape Library
  - New! LTO-8 for TS4300 Tape Library
  - New! LTO-8 for TS2900 Tape Autoloader
  - New! IBM® TS2280 Tape Drive
  - New! LTO-8 for TS3100/3200/3310/3500 Tape Libraries
  - New! Spectrum Archive EE/LE/SDE support for LTO-8 tape drive

GA:
TS3100 / 3200: 11/10/17
TS3500 / TS4500 / TS2280: 11/17/17
TS3310: 12/08/17
7226: 12/08/17

TS1155 Tape Drive integration into TS3500

Announce date: October 10
GA: Nov, 17
Some LTO-8 Topics of Discussion

- Time between LTO drive generations is shorter?
  - 2 years for LTO-8 vs history of 2 ½ to 2 ¾ years

- LTO-8 capacity increase vs data rate increase?
  - Native capacity of 12 TB vs 6 TB for LTO-7
  - Sustained data rate of 360 MB/s vs 300 MB/s for LTO-7

- Lack of LTO-6 media backward read compatibility?
  - TMR (Tunnel Magneto-resistive) LTO-8 head
  - MP (Metal Particle) LTO-6 media
What is the new “LTO 8 Type M” initialization option?

“New LTO generation 7 cartridges initialized as LTO-8 Type M media will be able to store up to 22.5TB* of data.”

Source: https://www.lto.org/2017/10/lto-program-outlines-generation-8-specifications-extends-technology-roadmap-12th-generation/

IBM plans to refer to this as “M8 media”

New barcode label – check with your tape library vendor for support

<table>
<thead>
<tr>
<th>Media / Density Type</th>
<th>Barcode Label</th>
<th>Cartridge Packaging &amp; Silkscreen</th>
<th>Native Capacity</th>
<th>Drive Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>L8</td>
<td>xxxxxxxL8</td>
<td>LTO Ultrium 8</td>
<td>12 TB</td>
<td>LTO-8</td>
</tr>
<tr>
<td>M8</td>
<td>xxxxxxxM8</td>
<td>LTO Ultrium 7</td>
<td>9 TB</td>
<td>LTO-8</td>
</tr>
<tr>
<td>L7</td>
<td>xxxxxxxL7</td>
<td>LTO Ultrium 7</td>
<td>6 TB</td>
<td>LTO-7, LTO-8</td>
</tr>
</tbody>
</table>
TS1155 Tape Drive – summary

• **Enhanced Capacity**
  – Up-formats existing JD media types
    • 15 TB JD/JZ media, 3 TB JL short media
  – Supports downward compatibility with JD and JC formats
  – No change in native data rate 360 MB/s

• **Supporting both fibre and new Ethernet interface capabilities**
  – Dual 10Gb optical attachment on new 55E model
  – RoCE v2 protocols support
  – Dual FC-8 interfaces supported on 55F model

• **Introducing longer life TMR read/write head**

• Other features of TS1150 remain essentially unchanged
Underlying Common Technology Description

- Integrated 32-channel head design
  - Advanced TMR sensor for robust signal output with protective overcoat
  - Three module W-R-W 3-bump head performs read-verification in both directions

- Advanced dd-NPML data detection channel
  - Trellis dd-NPML detection with integrated timing loop
  - Auto-adaptive FIR equalization and AGC

- Simple compact Tape Path
  - Low head wrap-angle enabled by flat-head contour – low friction
  - Flangeless rollers = no edge forces

- Advanced high performance track following actuator
  - Uses the servo pattern to precisely position for recording tape
  - Maintains lock to rejects lateral tape motion and tape runout errors

- Highly Integrated, low power electronics
  - Advanced IBM foundry ASIC technology
  - Low number of interconnects

- Common technology, but unique components for enterprise
  - Hardened mechanism, loader and higher speed motors, enterprise cartridge
  - Custom circuit card with larger buffer, faster data rate support, new interface processor
  - Microcode featurization for enterprise RAS, performance features
Enterprise Tape Drive Differentiators

- Capacity and Investment Protection
- Performance
- Access
- Interfaces / Attachments
- Reliability
- Crypto
Capacity and Investment Protection

Capacity and Media Up-format

- Enterprise has the highest single cartridge capacity and roadmap maintains the capacity advantage
- Enterprise supports media up-formatting, allowing previous generation media to be re-used at higher capacities and data rates on future drive models.
- Enterprise supports field MES drive model upgrades

Advantages
- Improved density / reduced library frames reducing overall system cost
- Higher capacity and performance over time on existing media reducing media/storage costs
- Maintaining footprint with future storage growth
- Drive models may be upgraded at reduced cost and upgrades may be expensed
Performance

Native Data Rate
- Enterprise has the highest native data rate and roadmap increases differential over time. In addition, enterprise supports downward R/W of older formats at higher data rates improving migration
  - Jag5 360 MB/s, Jag6 420MB/s, Jag7 targeting 1000 MB/s (64 channel)
  - LTO7 300 MB/s, LTO8 360 MB/s, LTO9 400-450 MB/s (current outlook)
- Advantages
  - Fewer drives for given aggregate throughput, faster large file recalls
  - Significant performance benefit for higher single-threaded data rate applications
    - Some applications cannot multiplex data across many drives/tapes (seismic, etc)
  - Improved migration performance

FastSync write accelerator
- Enterprise supports the FastSync feature which is able to greatly improve performance for applications which write file marks (tape marks) with relatively small files (300MB or less).
- Advantages
  - Job times for some applications improve by a factor of 20x or greater
  - Many applications have at least some workload that writes relatively small files (under 200MB) such as audit logging where FastSync is highly effective
  - Reduces back hitches on media improving media and drive life
Access features

- **Search Speed**
  - Enterprise features highest search and rewind velocity about 30% faster than LTO

- **High Resolution Tape Directory (HRTD)**
  - Greater precision is maintained in the directory of the physical location of all blocks on tape
  - 1/64th of a tape wrap resolution per block versus ½ wrap for LTO (32x greater precision)
  - Physical motion in locating to a given file is reduced and more consistent

- **Recommended Access Ordering support**
  - Optimizes recall order for multi-file recalls
  - Improved performance for multi-file recall from a single volume

- **Advantages**
  - LTO average access to a file is 30% slower than enterprise and rewinds are 42% slower
  - Fewer enterprise drives are needed for a given recall rate
  - Applications that read or write a modest amount of data (recalls or appends) may be greatly improved due to locate/rewind operations inherent this workload
  - If multiple files are often recalled from a single cartridge, this workload performance can be greatly improved with Recommended Access Ordering
Interfaces/ Attachment

- **Ethernet Host Interfaces**
  - Enterprise drives have added support for Ethernet interfaces
  - Supports dual port 10Ge physical attachment with optical SFP moving to 25Ge as available

- **Enhanced Fibre Channel attachment**
  - Enterprise drives adding 16G FC support on Jag6 and 32G FC support on Jag7
  - Supports higher host transfer rates

- **Mainframe attachment**
  - Enterprise drives support mainframe attachment
  - May be attached to z/OS attached TS7700
  - Enables common technology in Mainframe and open system environments

Advantages
- Supports SAN elimination with move to converged Ethernet – cost and admin savings
- Supports higher Host and HBA transfer rates on faster fibre channel attachments – performance improvements and faster job execution
Reliability Features

- **Longer life loader**
  - supporting 300K cycles loader life, 3x higher than LTO
  - Consistent with faster access workload which results in more load/unloads per drive

- **Built-in, automatic in-drive Media and Drive quality management**
  - Pro-active alerts for usage and health issues (SARS)
  - Monitors the last 100 mounts for both the drive and the media
  - Automatically triggers cleaning if degradation is detected
  - Generates pro-active alerts if signs of degradation persist

- **Media near end of life alert generation**
  - Application will be notified if media is near end of life condition for loads or meters processed
  - Enables pro-active media replacement

- **Enterprise media differentiation**
  - Constructed for greater physical durability - survives one meter drops without data loss
  - All media is end point tested in drives for qualify in the factory before shipment
  - Media is designed to support re-use at higher capacity and performance
  - Media supports a longer usage life (26M motion meters)

- **Advantages**
  - In general, Enterprise drives are designed to provide maximum data reliability and operational reliability reducing possibility of data loss or drive failure
3592 Robust Cartridge Design

- Robust cartridge design
  - Thicker plastics (vs. LTO)
  - Ribs to hold a reel
  - Five screws to tighten shells
  - Spec’d to withstand 1-m drops from all 6 axes without dataloss (not recommended!)

- Dust-proof curved door design
  - Effective dust-proof design for higher recording density
  - Passed an open/close test more than 50K cycles
Enterprise Tape Drive Differentiators

- Capacity and Media Up-format
- Performance
- Access
- Interfaces / Attachments
- Reliability
- Crypto
System Storage
TS4500 Tape Library

- Scales to over 278 PB native
- Supports up to 128 tape drives
- Next-generation storage density
  - 8.7 PB native in a single frame tape library
  - Scales at up to 1.5 PB per square foot
- Simplified management
  - Magazine I/O
  - Integrated management
  - Improved ease-of-use
  - Extensible platform
TS4500 Automatic Media Verification
Pro-actively verify the ability to read data stored on tape from any open systems application

- Simple policy designates policy period, start date, and media verification drives for the logical library
- Results are viewable in the Cartridges and Events pages of the TS4500 GUI
- Notification of failure sent via SNMP, email, or syslog
- Works with any open systems application*

*Not supported with application-managed encryption (decryption required)
Why is there a need for tape library integrated cooling?

<table>
<thead>
<tr>
<th>Environmental Factor</th>
<th>Operating</th>
<th>Operational Storage¹</th>
<th>Archival Storage²</th>
<th>Shipping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>10 to 45°C (50 to 113°F)</td>
<td>16 to 32°C (61 to 90°F)</td>
<td>16 to 25°C (61 to 77°F)</td>
<td>-23 to -49°C (-9 to 120°F)</td>
</tr>
<tr>
<td>Relative humidity (noncondensing)</td>
<td>10 to 80%</td>
<td>20 to 80%</td>
<td>20 to 50%</td>
<td>5 to 80%</td>
</tr>
<tr>
<td>Maximum wet bulb temperature</td>
<td>26°C (79°F)</td>
<td>26°C (79°F)</td>
<td>26°C (79°F)</td>
<td>26°C (79°F)</td>
</tr>
</tbody>
</table>

Magnetic field: Stray magnetic field at any point on tape not to exceed 50 oersteds (4000 ampere/meter).

Notes:
1. Operational storage equals less than 6 months.
2. Archival storage equals greater than 6 months.
Integrated Cooling Requirements

Psychrometric Chart

10% RH  90% RH
80% RH
70% RH
60% RH
50% RH
40% RH
30% RH
20% RH
10% RH

Dry Bulb Temperature (deg F)

Ambient Requirement with Integrated Cooling

Ambient Requirement w/o Integrated Cooling

100% RH
90% RH
80% RH
70% RH
60% RH
50% RH
40% RH
30% RH
20% RH
10% RH

Humidity Ratio

Psychrometric Chart

15°C
26°C wet bulb
32°C
35°C
Integrated Cooling Air Flow

- Ambient air
- Hot air exhaust
- Air conditioner
- TR1
- Warm return air
- Cold air
- Front side of the library
- Back of the library
- The frames are sealed from the outside air
Thank you!

Contact:
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For additional information…
- Search the web for ‘TS4500 Knowledge Center’
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