Tape Technologies for Long-Term Data Retention
May 10, 2011

Gary Francis
Sr. Director, Storage
Welcome to
PASIG
Large manual archive
Massive film archives
Small libraries you would like to digitize
Medical records that you need to keep for a lifetime
Data from a small scientific experiment
Or just storing the data you need to keep around for awhile
How current is your technology?
Current and future tape technologies can help in all of these areas.
Tape is Dead!
True or False?
Storage Challenges Have Not Slowed
Increasing Demand for Storage Capacity

- Budgets and headcounts can’t keep up with this growth
- Disk prices are not declining at this rate
- Customers can’t afford to just “put everything on disk”

Technology Price/GB Projections

…and Tape’s Advantage Is Accelerating
“Tape is always much less expensive than disk and always uses much less power when measured on a per petabyte basis.”

- Disk is 15 times more expensive than tape
- Disk uses 238 times more energy for an archiving application with 45% annual growth over a 12 year period
- Disk energy consumption alone costs more than **ALL** the costs of tape!

From “In Search of the Long-Term Archiving Solution — Tape Delivers Significant TCO Advantage over Disk”, The Clipper Group, December 2010
# Other Considerations

<table>
<thead>
<tr>
<th></th>
<th>Disk</th>
<th>Tape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max shelf life (bit rot)</td>
<td>10 years</td>
<td>30 years</td>
</tr>
<tr>
<td>Best practices for data migration to new technology</td>
<td>4-5 years</td>
<td>8-12 years</td>
</tr>
<tr>
<td>Uncorrected Bit Error Rate, Probability (avg 1 error in x TB)</td>
<td>$10^{-14}$ (≈10’s of TB)</td>
<td>$10^{-19}$ (≈1 million TB)</td>
</tr>
<tr>
<td>Power and cooling</td>
<td>238X</td>
<td>X</td>
</tr>
</tbody>
</table>
NERSC Case Study
National Energy Research Scientific Computing Center (NERSC)

- 13PB of tape data
- Migrated data from 23,820 T10000A, T9940B & T9840A cartridges to T10000B
  - 13 tapes with some data that could not be read represented by 14 total files of just under 100 GB
  - 14,805,823 meters of tape read (the distance from San Francisco to Perth)
  - 14 files with errors equaled 108 meters of tape or 0.0007% of the total length
- 99.945% data readability after 12+ years of life

Source: Enterprise Storage Group: “NERSC: Proving Tape as Cost-Effective and Reliable Primary Data Storage” December 2010
StorageTek T10000C Tape Drive

Product Details

- 5 TB native – 10 TB compressed
- Investment protection:
  - Legacy read head that reads T10000A & B tapes
  - Media re-use at higher capacity with Generation 4 drive
- Performance: 240 MB/sec native
- 2 GB buffer
- SL8500, SL3000, rack-mount
- Dual port for full redundancy
- Native FC & FICON connectivity (without external control unit)
Capacity Comparison

25% more capacity

- StorageTek T10000C
- LTO5
- IBM TS1140
What CERN Is Saying

"We currently store 40 PB of data and expect to add another 25 PB of new data each year so having a cost-effective, scalable and reliable storage infrastructure is of the utmost importance. We are currently testing the new Oracle StorageTek T10000C tape drive and expect it to meet our requirements while its unprecedented capacity and throughput will lead to additional cost savings."

Vladimir Bahyl, Tape Service Manager, CERN
BaFe The Ultimate Archive Media

- BaFe has been shown to have superior life for long term archive applications
- 30 year accelerated test shows no change in magnetic data retention compared to current MP media\(^{(1)}\)
  - \(^{1}\) http://www.fujifilm.com/news/n100910.html
Archive End to End Data Integrity
StorageTek Data Integrity Validation

- User creates a CRC (T10 ANSI standard) for each record
- StorageTek T10000C checks CRC as each record is received
- The DIV CRC of each record is written to tape with that record
- When a record is read from tape the CRC is always checked
  - The SCSI Verify command can be used to check each record without transferring data to the application. (i.e. internally verified by the StorageTek T10000C)
## 20% TCO Savings With T10000C

### Massive Capacity

Use Fewer Libraries, Slots, Cartridges and Less Floorspace

### 10 PB Example

<table>
<thead>
<tr>
<th>Library</th>
<th>Drives</th>
<th>Libraries</th>
<th>Cartridges</th>
<th>Sq. Ft *</th>
</tr>
</thead>
<tbody>
<tr>
<td>StorageTek SL3000</td>
<td>T10000C</td>
<td>1</td>
<td>2,000</td>
<td>45</td>
</tr>
<tr>
<td>StorageTek SL3000</td>
<td>LTO-5</td>
<td>2</td>
<td>6,667</td>
<td>116</td>
</tr>
<tr>
<td>Spectra Logic T950</td>
<td>LTO-5</td>
<td>1</td>
<td>6,667</td>
<td>127</td>
</tr>
<tr>
<td>IBM TS3500 (HD)</td>
<td>LTO-5</td>
<td>1</td>
<td>6,667</td>
<td>223</td>
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<tr>
<td>HP ESL</td>
<td>LTO-5</td>
<td>10</td>
<td>6,667</td>
<td>246</td>
</tr>
<tr>
<td>Quantum i6000</td>
<td>LTO-5</td>
<td>2</td>
<td>6,667</td>
<td>269</td>
</tr>
<tr>
<td>9310</td>
<td>T10000A</td>
<td>4</td>
<td>20,000</td>
<td>839</td>
</tr>
</tbody>
</table>

* Floorspace calculations include service area

10 PB Example
First Generation Protein Robots
StorageTek 4410

- GA May 1988
- 5,000 cartridges when configured with 16 4480 18-track tape drives
- 4.5MB/s per drive / 200 MB per cart
- 72MB/s total data rate
- 1TB total capacity
A comparison

T10000C

• GA Feb. 1, 2011
• 5TB capacity uncompressed
• 240MB/s data rate
  • 2 drives = 480MB/s

=  

• 5TB capacity uncompressed
• 80 drives = 360MB/s data rate
And with 2:1 Compression
Enterprise Class Tape Automation
SL8500 Library: Best Consolidation Solution

- **Best scalability**: to 100,000 slots (500 PB native, >15X competition)
- Industry-leading **availability** with the only hot-replaceable robots and non-disruptive RealTime Growth capability to scale while in operation
- Unique design for **consolidation** with Any Cartridge Any Slot technology. Share across supercomputers, mainframes, UNIX, and Windows
- **Eco savings** with 50% less floor-space and reduce power and cooling

SL8500 Capacities
- 1,000-10,000 Slots/Library
- Up to 10 Libraries via PTP
- Up to 500 PB Native Capacity
- 1 to 64 drives / Library - 640 Complex
- Up to 55 TB / Hr Native Throughput
World’s First Exabyte Storage System

With the release of the StorageTek T10000C tape drive, Oracle raised the bar again, becoming the 1st tape vendor to offer 1 Exabyte* of storage capacity in a single tape library.

* Assumes 2:1 Compression
Enterprise Class Tape Automation
SL3000 Library: Scalable Solution to Manage Growth

- **Scale** efficiently to manage growth. Buy exactly what you need and growth non-disruptively
- Industry-leading **availability** with the only hot-replaceable robots and non-disruptive RealTime Growth capability to scale while in operation
- Industry-leading flexible partitioning solution for **consolidation**. Oracle unique Any Cartridge Any Slot technology for seamless mixed media support. Share across supercomputers, mainframes, UNIX, and Windows
- **Eco savings** with 60% less floor-space and 50-500% savings in power and cooling

**SL3000 Capacities**
- 200 to 3,000+ Cartridge Slots
- Up to 29.6 PB Native Capacity
- Up to 56 Tape Drives
- Up to 48 TB / Hr Native Throughput
Oracle Tape
Industry Leading

5 Year Trajectory

- **Tape Capacity**: 12 - 20x
- **Tape Data rate**: 3.3 – 5x
- **Archive Capacity**: 12 - 20x
- **Archive Data Throughput**: 3.3 - 5x

**SL8500**
- **100 PB Capacity**: 276 TB/hr
- **500 PB Capacity**: 553 TB/hr
- **600 – 1000 PB Capacity**: 621 – 920 TB/hr

**SL8500 (Gen5)**
- **12 - 20 TB Capacity**: 400 - 600 MB/sec
- **1.2 – 2.0 Exabyte Capacity**: 920 - 1380 TB/hr

**Gen4**
- **6 - 10 TB Capacity**: 270 - 400 MB/sec

**T10000B**
- **5 TB Capacity**: 240 MB/sec

**T10000C**
- **1 TB Capacity**: 120 MB/sec

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Conclusion

The technologies are very predictable

- Tape is and will continue to be the archive media of choice
  - Tape is the most scalable storage technology
  - Disk is 15x more expensive than tape
  - Power consumption for disk is 238x greater than tape
  - Tape shelf life is 2x – 3x that of disk – meaning less data migration

- Disk areal density CAGR could slow down by 2013

- Flash will continue to displace high IOP, lower capacity disk drives and become a separate tier for storage
  - Innovations will continue in solid state storage improving the capacity, performance and reliability of this device
  - Flash will not replace capacity disk in the near future
Oracle Broomfield, Colorado Campus
A significant investment in the future of Tape
Tape $aves
Oracle StorageTek Tape

Hardware and Software
Engineered to Work Together