Tape...It’s Dead...It’s Alive...It’s Dead...It’s Alive

PASIG
October 17, 2012
Gary Francis
Some say.....

- Tape is old technology
- Disk is cheaper than tape
- Tape is unreliable
- Tape is hard to manage
- Tape is not secure
60+ Years of Storage Innovation
Megabytes to Petabytes and more

In the beginning
- Tape – 1951 / Univac UNISERVO
  - 1.4MB / 7.2KB/sec

The elimination of protein robots
- StorageTek 4410 Automated Cartridge System
  - 5,000 cartridges / 18 track drives / 1 TB

- Oracle T10000C / SL8500
  - 5TB / 252 MB/sec
  - Up to 50PB per SL8500….500PB per library complex
A comparison

VS.

- GA Feb. 1, 2011
- 5TB capacity uncompressed
- 252MB/s data rate
  - 2 drives = 504MB/s

- 5TB capacity uncompressed
- 80 drives = 360MB/s data rate
LTFS: Top Storage Technology to Watch in 2012
Storage Magazine – December 2011

• Storage Magazine names LTFS as one of the Hot Technologies for 2012

• “Opening up new possibilities for incorporating tape into workflows”

• “Making long-term archival easier”

• “LTFS is in an early adoption phase”
LTFS Overview

- Linear Tape File System (LTFS) is an open source format for writing self-describing files to tape
  - Enables users to access files on tape media just like a thumb drive or disk device
  - Drag-and-Drop files from tape to disk
  - Oracle is the only vendor to support LTO-5 (HP & IBM) and T10000C Tape Drive
R.I.P. Tape? Not so fast…

During the last five decades, the death of tape has been declared in at least four of them. Although tape wasn’t really threatened as an archive solution, LTFS brings a new dynamic to the needs of long-term data archive and access. With Active Archive, it also makes tape a viable tier 4 repository in the data center. Seamless access and low cost should extend tape’s lease on life for at least another decade.

Phil Goodwin, Contributor – SearchStorage
Tape & Disk Data Storage Price Trends

Technology Price per GB History & Predictions

- Disk
- Tape

$/GB vs Year


Gone are the Days of Rapid Disk Price Declines
Industry Consolidation and Impact of Floods Creates Greater Pricing Power

Due to the imbalance in supply and demand that resulted from the Thailand floods, HDD vendors are taking advantage of this opportunity to reset prices and recover some of the excessive price erosion that began in 2009.

IDC Press Release
April 2012

Tape Systems Cost Much Less Than Disk Systems
Study Concludes Disk Costs 15 Times More Than Tape Solution

Study compares a 3 PB archive growing at 45% annually for 12 years on disk and tape. Assumes 1:1 compression.
## It’s Not Only About Cost/TB

<table>
<thead>
<tr>
<th>Feature</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>3-5 years</td>
<td>8-12 years</td>
</tr>
<tr>
<td>Uncorrected Bit Error Rate, Probability (avg 1 error in x TB)</td>
<td>$10^{-14}$</td>
<td>$10^{-19}$</td>
</tr>
<tr>
<td>( ~10’s of TB)</td>
<td>(~1 million TB)</td>
<td></td>
</tr>
<tr>
<td>Power and cooling</td>
<td>238X</td>
<td>X</td>
</tr>
</tbody>
</table>

Each technology refresh or migration has a cost associated with it.
Tape is Green
Study Concludes Disk Uses 75 Times More Energy Than Tape Solution

In 12 Years, tape solution saves over

6,000 megawatt-hours of electricity
... eliminating more than

4,000 metric tons of CO₂ emissions

$4 Million in electricity costs

Study compares a 3 PB archive growing at 45% annually for 12 years on disk and tape. Assumes 1:1 compression.
Tape is Environmentally Robust
Rest Easy Knowing Archive Data are Safe In Nearly Any Extreme Scenario

Safer from cooling outages
Safer from electrical surges
Safer from earthquakes
Safer to move quickly
Tape Does Not Have Bit Error Rate Burden of Disk
Uncorrectable Bit Error Rate of Tape is 10,000 Times Lower than Disk

Seagate
Constellation ES.2
Hard Drive

StorageTek
T10000C
Tape Drive

How many petabytes are transferred before an uncorrectable error?
Disk: 0.1 PB
Tape: 165 Years

Assumes 1:1 compression and sustained data rate of 155 MB/s for Constellation ES.2 and 240 MB/s for T10000C

How many RAID recoveries per year per disk?
40

Tape Does Not Have Bit Error Rate Burden of Disk
Tape Is Decoupled From Sources of Corruption

Google Recovered Thousands of Corrupted Email Accounts Using Tape

“Since the tapes are offline, they’re protected from such software bugs.”

Ben Treynor
VP Engineering, Google

Without tape
Google would have had nothing to restore from
70,000 Gmail users would have lost data

Note: Three references describing Google’s Gmail outage are provided in Appendix B
Data Integrity Can Be Validated with Tape
Disk Systems Lack Capability to Validate Integrity of Backup / Archive Data

Only tape can provide
Reassurance that backup / Archive files are validated and ready to restore.

What about integrity of disk backups that are weeks, months, or years old?

StorageTek T10000C
CRC checks any file, any time
Archive End to End Data Integrity

StorageTek Data Integrity Validation

Only T10000C supports CRCs created in the server chip

• 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)
• This feature is available in open systems applications
This is what happened when NERSC read nearly 24,000 cartridges, or approximately 15 million meters of tape...

How many cartridges does it take to prove the reliability of tape? 99.945%? Of cartridges were read 100% error free

Tape Analytics – Eliminating the “Hard to Manage”

Oracle’s StorageTek Tape Analytics software simplifies tape storage management for less than half the cost of competitive solutions, taking a proactive approach to eliminate library, drive, and media errors.
A First Look at the StorageTek Tape Analytics Interface

Simple User Interface

Quickly Identify Suspect Devices

Proactive Health Indicators
Oracle Key Manager
Eliminating Security Concerns

• AES-256 bit data encryption
• NIST FIPS140-2 Level 1 standard compliant
  – Required for government applications involving processing of sensitive data
  – Supported with the SCA 6000 cryptographic process card
• Encryption keys delivered securely, out-of-band via service port
• Encryption functionality integrated into data path
  – No performance impact with encryption enabled
  – Encryption and data integrity verified concurrently
OKM Architecture

Site 1

KMS Management Network

KMA 1

KMA 2

KMA 3

KMA 4

KMA Cluster

Wide Area Network

Ethernet Switch

T10000

T9840D

SL 8500

Oracle Database

ASO TDE

Site 2

KMS Management Network

OKM Management GUI/CLI

T10000

LTO

SL3000

Oracle Database

ASO TDE
Oracle Tape
Industry leading

5 Year Trajectory

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Tape Capacity</th>
<th>Archive Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL8500</td>
<td>12 - 20x</td>
<td>18 – 30x</td>
</tr>
<tr>
<td>T10000C</td>
<td>500 PB Capacity</td>
<td>5 TB Capacity</td>
</tr>
<tr>
<td>T10000B</td>
<td>100 PB Capacity</td>
<td>1 TB Capacity</td>
</tr>
<tr>
<td>SL8500</td>
<td>1.05 – 1.35 Exabyte Capacity</td>
<td></td>
</tr>
<tr>
<td>Gen4</td>
<td>7 - 9 TB Capacity</td>
<td></td>
</tr>
<tr>
<td>Gen5</td>
<td>12 - 20 TB Capacity</td>
<td></td>
</tr>
<tr>
<td>SL8500</td>
<td>1.8 – 3.0 Exabyte Capacity</td>
<td></td>
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Oracle Proprietary
Conclusion

• Significant investments continue to be made in Tape technology
• Disk is *NOT* cheaper than tape
  • 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
    meaning less cost
  • Tape is widening the gap!
• Uncorrectable Bit Error Rate of Tape is 10,000x lower than Disk
• New tools like StorageTek Tape Analytics make Tape easier to
  manage than ever
• Encryption eliminates security concerns
Tape...has been...still is... and will be 

The Archive media of choice
Oracle Broomfield, Colorado Campus

A significant investment in the future of Tape
Hardware and Software
Engineered to Work Together