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StorageTek T10000C Tape Drive

Robert M. Raymond
Senior Engineering Manager
Tape Engineering

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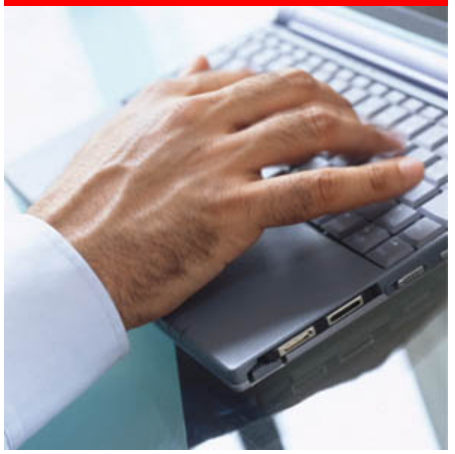
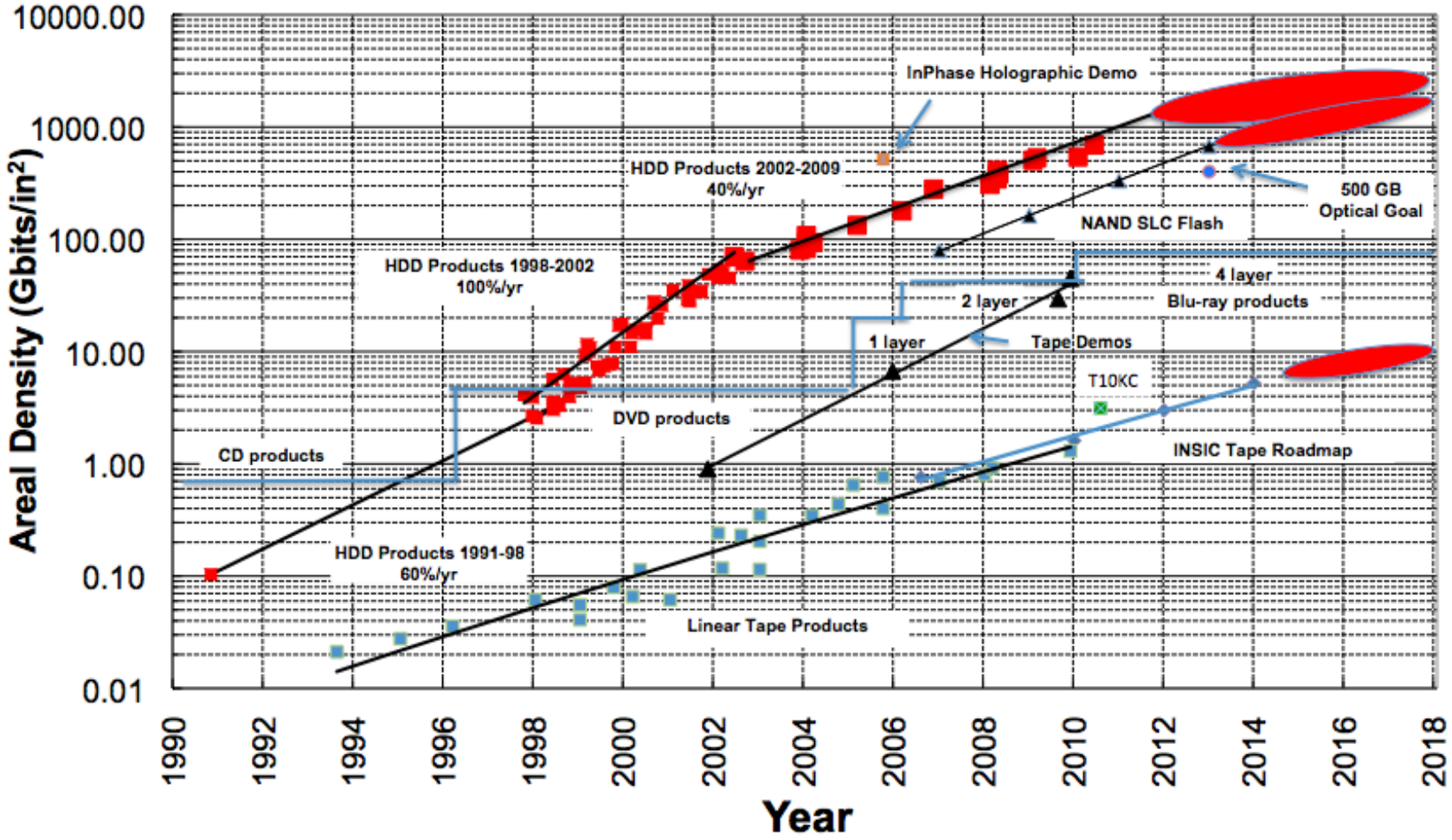
StorageTek T10000C Agenda



- Storage Technology Trends
- Product strategy
- Base Technology
- Product details
- Product features

Data Storage Trends

Storage Technologies Areal Density Trends



Tape gets its capacity by having 1000X the recording surface area comparing a 1/2 inch cartridge to a 3 1/2 inch disk.

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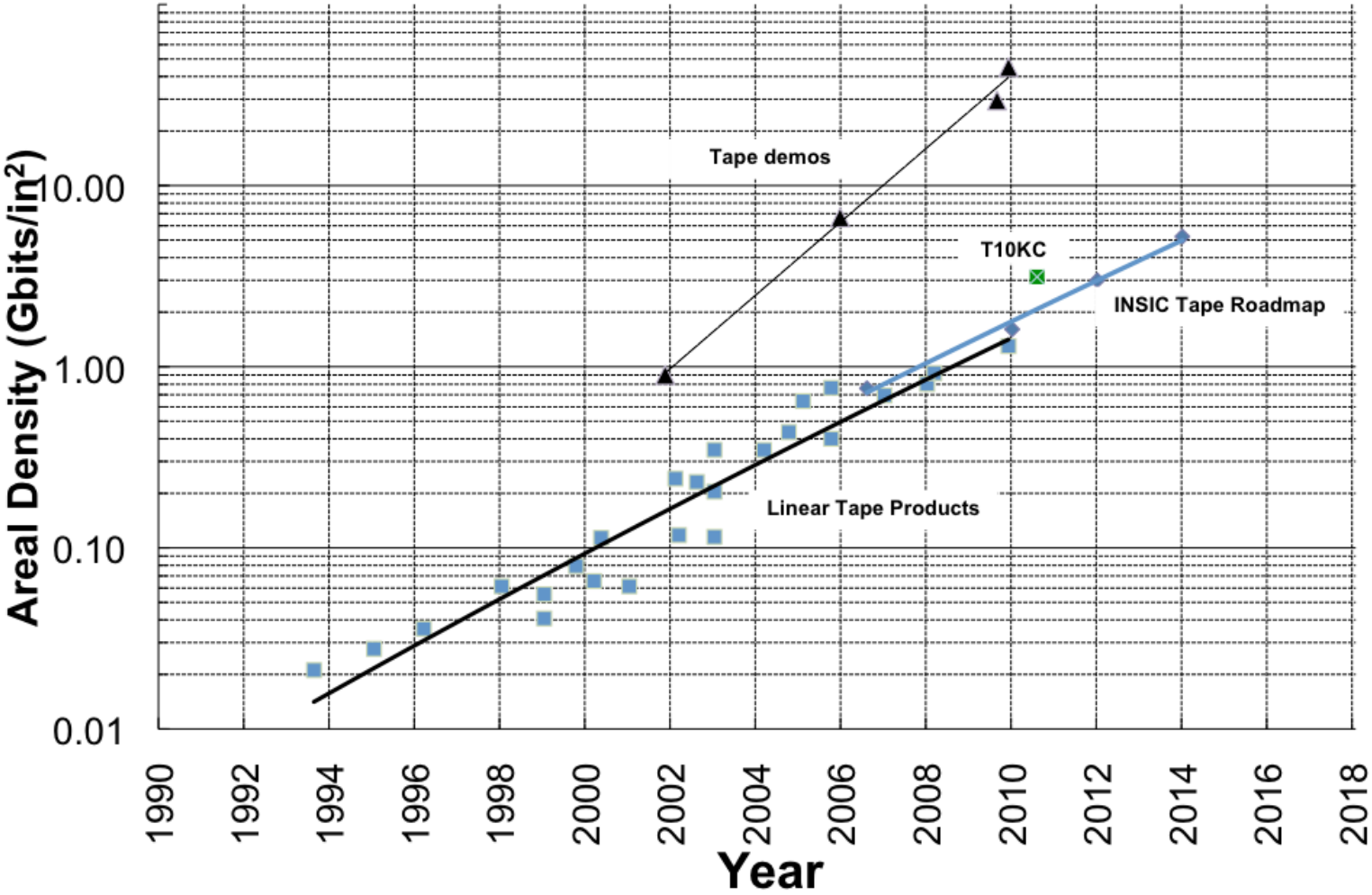
Tape Areal Density Trends



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T10000KC Tape Drive Technology

Top 5 Strategic Objectives

Oracle's StorageTek T10000C Tape Drive

1. **Increase capacity advantage**
2. **Add features to manage higher capacity tape**
3. **Lead in throughput**
4. **Preserve customer investment**
5. **Maintain robust enterprise quality**

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StorageTek T10000C Technology

- Plan: Leverage Oracle advantages
  - Media partner technical & business relationships
  - Internal recording head capability
  - Proven drive architecture

- Outcome:
  - New media utilizing BaFe media technology as the successor to MP technology
  - GMR Recording Heads
  - Drive architecture refinement

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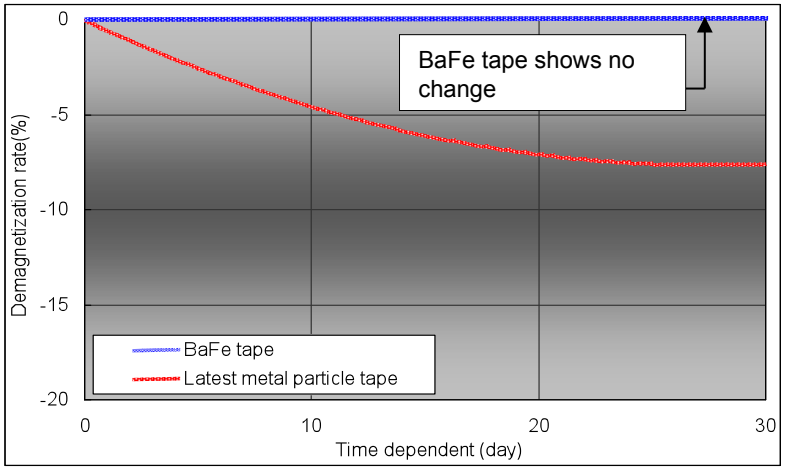
The Ultimate Archive Media

StorageTek T10000 T2 Media is Formulated Using Barium Ferrite

- BaFe has been shown to have superior life for long term applications



- 30 year accelerated tests show no change in magnetic data retention compared to current MP media[1]
  - [1] http://www.fujifilm.com/news/n100910.html

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StorageTek T10000 Head Design and Manufacturing

Oracle's Dedicated Tape Recording Head Capabilities

Tape Focus
The only dedicated tape wafer fab in the industry

- Best-in-class yields
- High mix / high volume mfg
- ISO 9001 and 14001 certified

Technology
Building blocks for future generation products

- GMR technology and beyond
- Mfg equipment technology
- Advanced materials
- Performance characterization

Supply Chain
Cost effective and reliable delivery to customers

- Low cost country supply chain
- Ability to scale to volume
- RoHS compliant

People
15+ years average thin film head experience

- Device design and validation
- Supply chain and operations
- Customer integration

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T10000C Product Details

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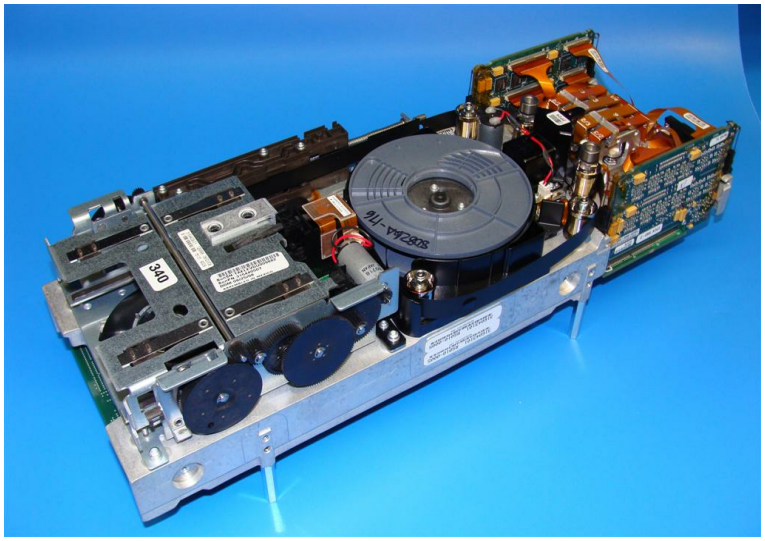
StorageTek T10000C Tape Drive

Product Details

Oracle Differentiator

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



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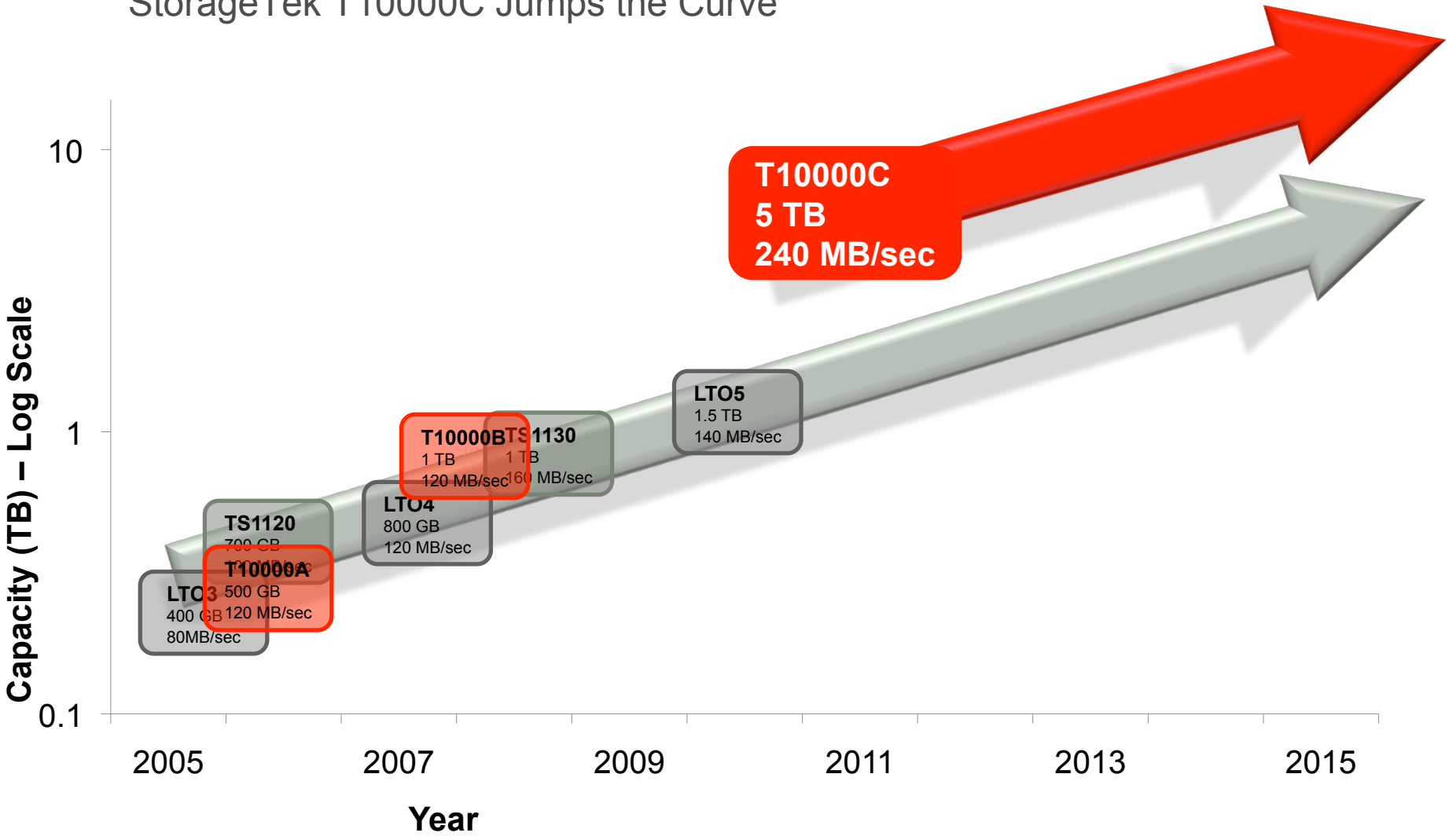
Tape Drive Capacities Over Time

StorageTek T10000C Jumps the Curve



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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

T10000B
1 TB Capacity
120 MB/sec

SL8500
500 PB
Capacity
553 TB/hr

T10000C
5 TB Capacity
240 MB/sec

SL8500
600 – 1000 PB
Capacity
621 – 920 TB/hr

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

SL8500
1.2 – 2.0 Exabyte
Capacity
920 - 1380 TB/hr

Gen5
12 - 20 TB Capacity
400 - 600 MB/sec

2010 2011 2012 2013 2014 2015

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Lowest Total Cost of Ownership

StorageTek T10000C Tape Drive

- Highest capacity requires less media, libraries and floor space
- Fastest throughput requires fewer drives and less power
- Same form factor preserves library investment
- StorageTek T10000A and T10000B backward read preserves media investment

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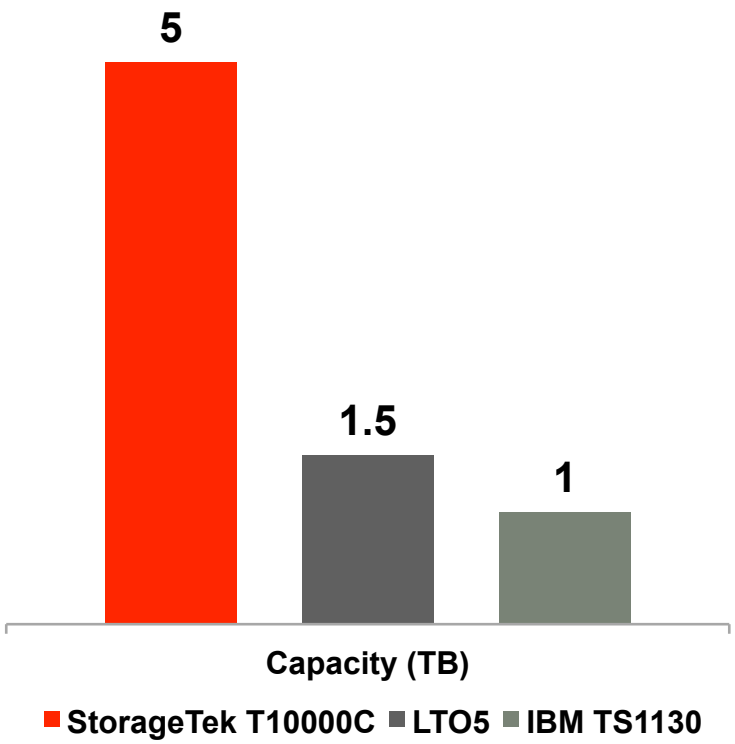
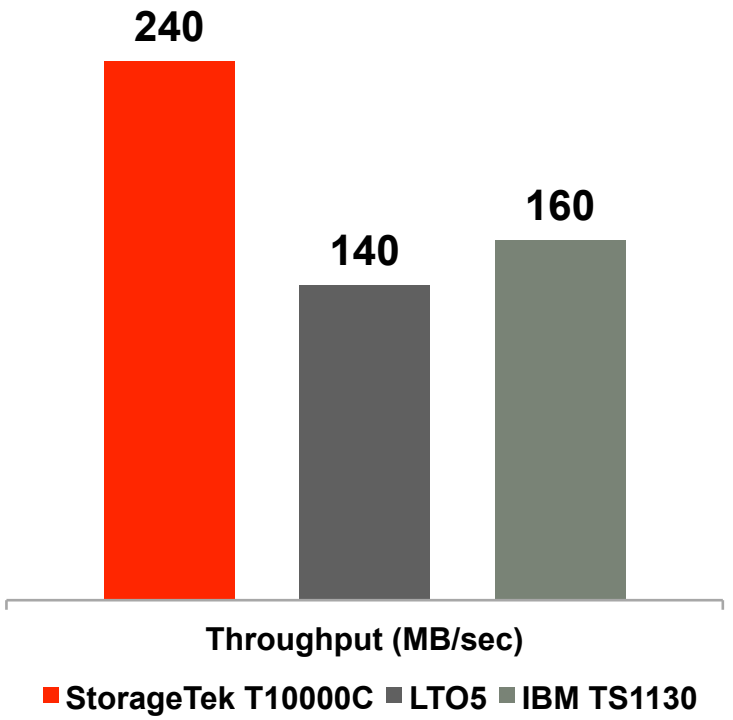
Tape Drive Capacity and Throughput Comparison

StorageTek T10000C Stores Up to 5x More Data, Nearly Twice as Fast





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20% TCO Savings With StorageTek T10000C Massive Capacity

Use Fewer Libraries, Slots, Cartridges and Less Floorspace

10 PB Example

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

* Floorspace calculations include service area

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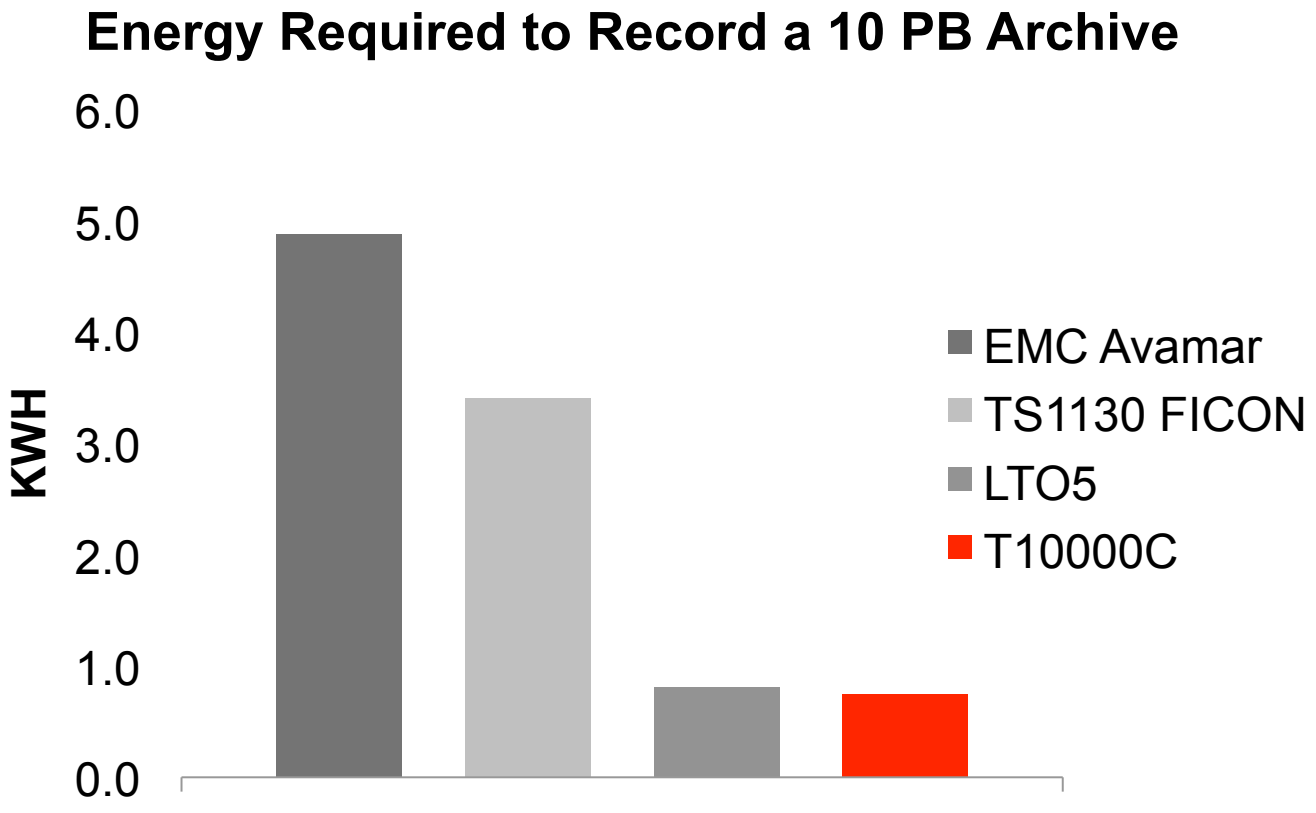
Superior Throughput Means Less Power



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Library Investment Protection

StorageTek SL8500 and SL3000 Compatible

- Use the new StorageTek T10000C tape drive with your existing SL8500 or SL3000, and existing drives and media, with Oracle's unique Any Cartridge Any Slot technology

SL8500 SL3000

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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.

Pictured: Ten string StorageTek SL8500 tape library, capable of holding 100,000 media cartridges

* Assumes 2:1 Compression

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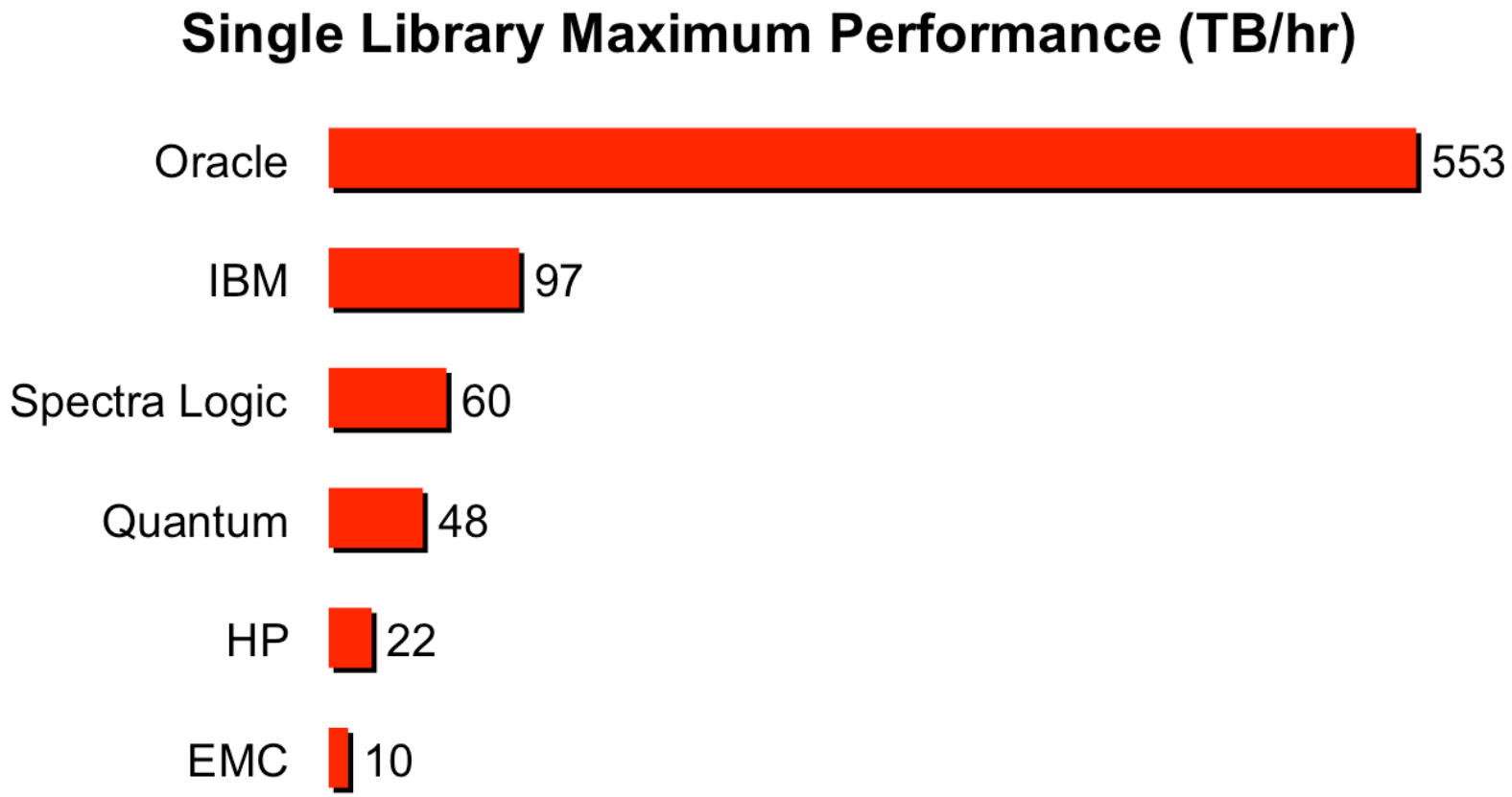
Oracle Performs Over 5x Faster Than IBM

Exceeds 500 TB/hour!



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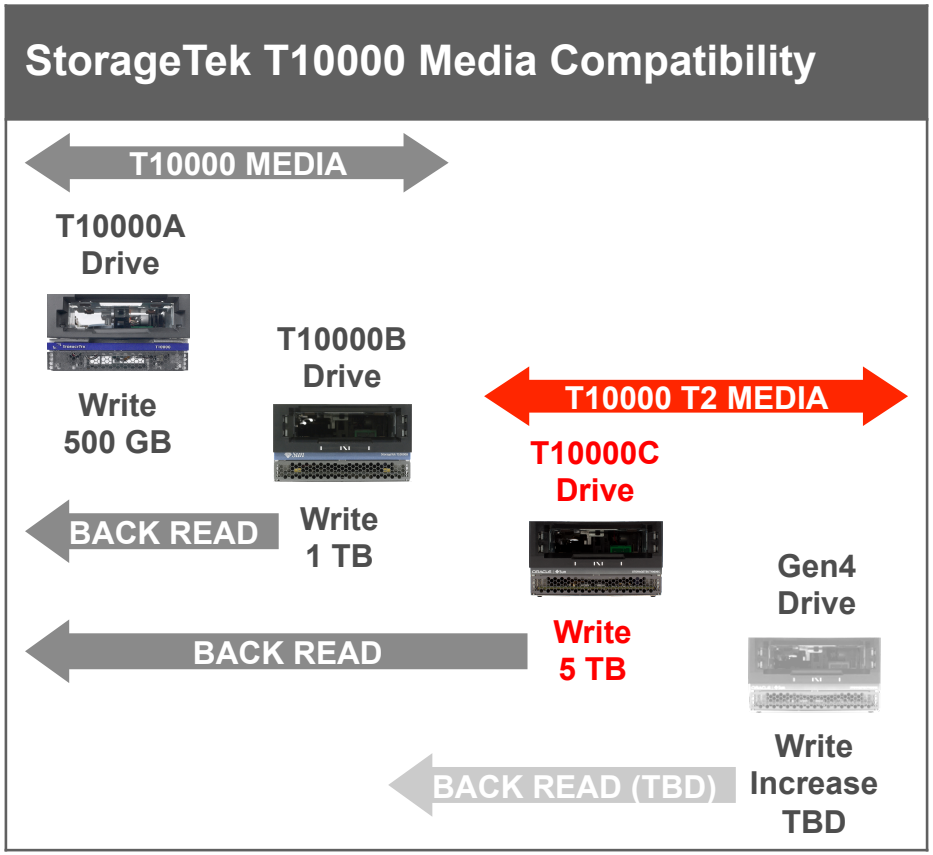
StorageTek T10000C Investment Protection

Backward Read Compatible with StorageTek T10000A and T10000B



VALUE

- Maintain backward read capability for existing StorageTek T10000 tapes
- Only Oracle's T-series tape drives provide both backward read compatibility AND media re-use
- Increased capacity in next generation without changing media
- Other tape technologies require new media to take advantage of a capacity increase

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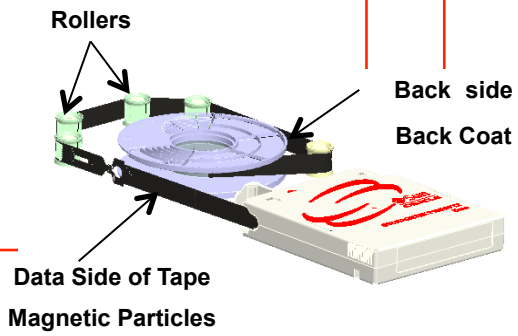
StorageTek T10000 Enterprise Design Minimizes Risk

Oracle's Unique SafeGuide Tape Path

Oracle Differentiator

FEATURE	FUNCTION	BENEFITS
SafeGuide tape path • Guides on "non-data" side of tape surface • Long tape path with flanged rollers • Improved buckler design • Encoders on both reel motors	• Tape rollers are not in contact with the data surface • Reduces edge forces • Guides without requiring additional mechanical mechanisms • Secure media threading into tape path • Better tape tension management	• No roller contact with data increases data reliability • 18x less edge force required to guide than a LTO short path • Simpler. No additional mechanical point of failure • Less edge wear and less tape edge damage • Less risk of data loss due to tape slippage • Improved long-term tape stability



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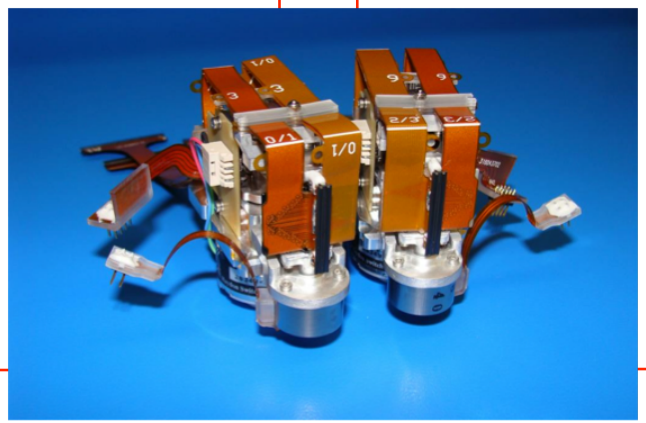
StorageTek T10000 Enterprise Design Minimizes Risk

Oracle's Unique Dual Head Technology

Oracle Differentiator

FEATURE	FUNCTION	BENEFITS
• Dual head design • Unique 32-channel head design using 2 heads	• 32 channels are written and read in parallel	Reduces tape velocity • Better servo control = fewer errors • More efficient data writes • Higher data reliability • Faster backhitching More full tape operations before wearout • Fewer passes to fill tape • Less wear on media



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Dual Head Technology

Reduces Tape Velocity Allowing Fewer Errors

Drive	Data Rate (MB/s)	Tape Velocity (m/s, R/W max)	Bit Error Correction
StorageTek T10000C	240	5.6	1x10-19
LTO-5	140	6.0	1x10-17
IBM TS1130	160	8.7	1x10-17*

*IBM TS1130 Bit Error Correction estimated based on TS1120

- Slower tape speed, allows for better servo control and fewer errors
- Tape tracking improves with lower tape speed
- Lateral Tape Motion (LTM) has lower frequency content, which results in reduced Position Error Signal (PES)
- Lower position error means we can write the data with greater accuracy and less chance of one track overwriting another track

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StorageTek T10000 T2 Media

Enterprise Engineering

Oracle Differentiator

- Standard, Sport, VolSafe, and VolSafe Sport
- Advanced media design
  - New tape film and coating used to maximize longevity
    - Whitepapers available for more detail
  - Designed for optimal match with recording head characteristics
  - Ruggedized cartridge for transport
  - Locking Hub prevents damage to media
    - Reduced media edge damage
    - Increased media life
    - Passed 30” drop test

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Unprecedented Performance

StorageTek T10000C Tape Drive

- Throughput is nearly twice that of any other tape drive
- StorageTek tape accelerator features maximize performance *
  - StorageTek File Sync Accelerator
  - StorageTek Tape Application Accelerator
  - StorageTek Search Accelerator

** Accelerator features provide a base for optimization of tape archive storage. Integration with applications is required and underway.*

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Minimize Start/Stop and Back-hitch

2 GB buffer

- Improves write efficiencies
- Fully masks back-hitch times

StorageTek File Sync Accelerator

- Stores data on nearby wraps to minimize back-hitches

StorageTek Tape Application Accelerator

- Convert tape marks to buffered tape marks
- Convert Syncs to NO-OPs

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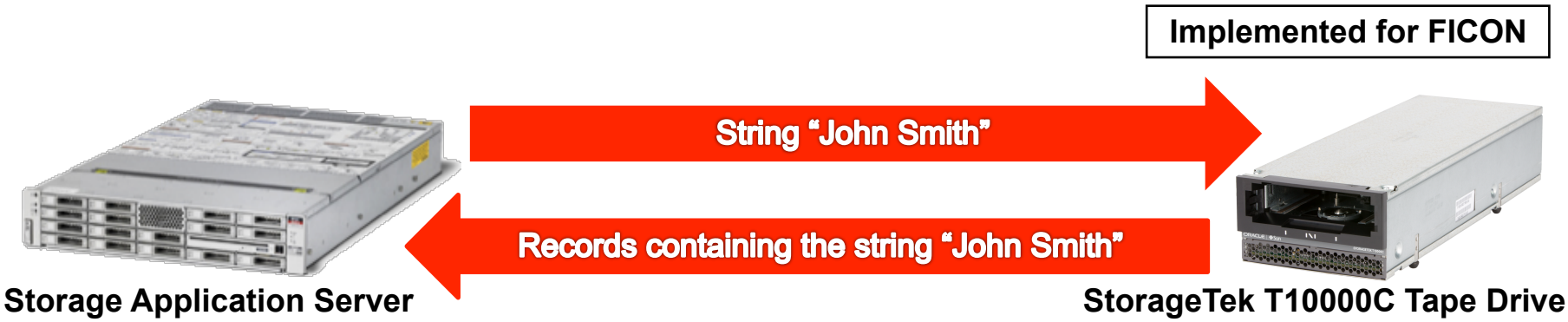
Improving Mainframe Audit Performance

StorageTek Search Accelerator

- Uses internal hardware to search for strings at drive speed
  - Searches data after it has been decompressed and decrypted
  - Allows the user to transfer only records from tape that match the search criteria
  - Can search entire tape, to a tape mark, for a specific number of records
- No external control unit required



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Best In Class Data Availability

StorageTek T10000C Tape Drive

- StorageTek Data Integrity Validation ensures data is not corrupted while traveling along the data path
- StorageTek T10000 T2 media boasts 30+ years shelf life
- StorageTek enterprise design continues with the StorageTek T10000C, ensuring robustness in the most demanding datacenters
- Device-level encryption provides peace of mind

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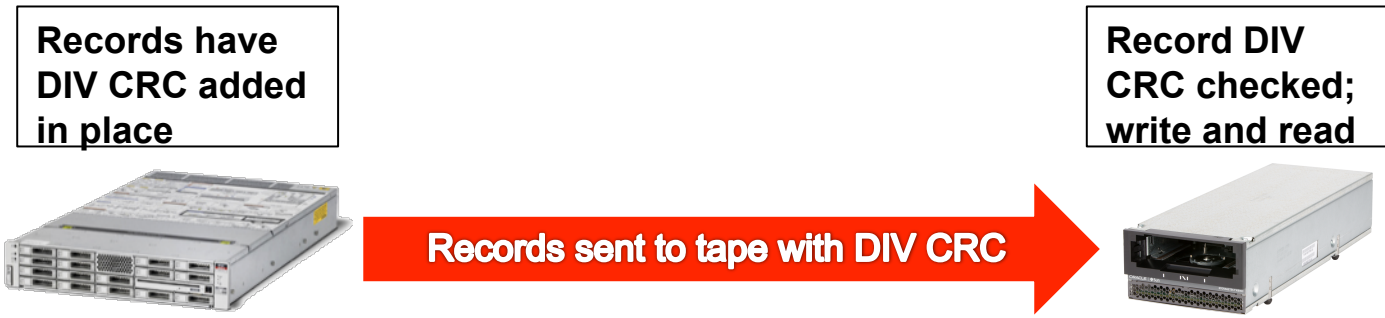
Archive End to End Data Integrity

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)
- This feature is available in Open Systems applications



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Minimize Risk Through Encryption

Oracle Key Manager Encryption Solution Provides a Secure, Cost-Effective Method to Safeguard Your Information

- Oracle Key Manager (OKM) is a cluster of servers managing keys for encrypting devices
- Simple to install and operate:
  - Automated, policy-driven system
  - Server, O/S, application neutral
- Secure:
  - Strongest encryption (AES-256) end-to-end
  - Strong key protection mechanisms
  - Conforms to stringent federal security certifications (FIPS)
- Scales economically:
  - Supports large sites & multiple storage technologies

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Simplified Management

StorageTek T10000C Tape Drive

- New data management tools facilitate the management of 5 TB of data on a single cartridge
  - StorageTek Tape Tiering Accelerator
  - StorageTek In-Drive Reclaim Accelerator

** Accelerator features provide a base for optimization of tape archive storage. Integration with applications is required and underway.*

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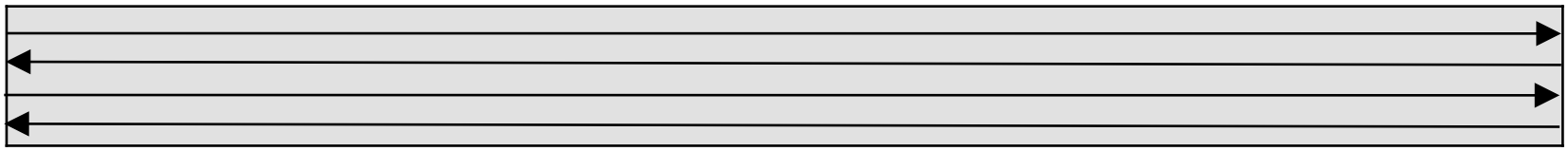
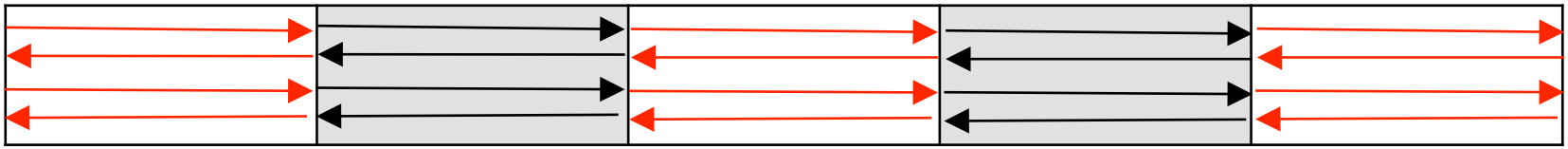
StorageTek Tape Tiering Accelerator

Faster Access to Data with Sections

- Today, tape is recorded linearly in “wraps” that span the length of tape



- With tape tiering, wraps span only one section, making it faster to seek to a certain point on the tape
  - Each section has ~1 TB capacity
  - Average access time within a section is 10-11 seconds



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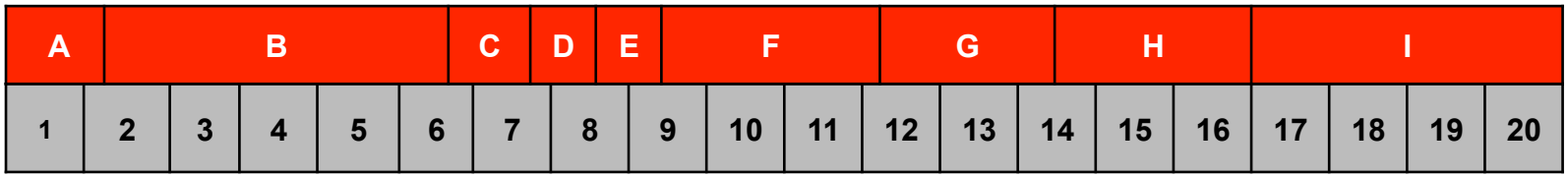
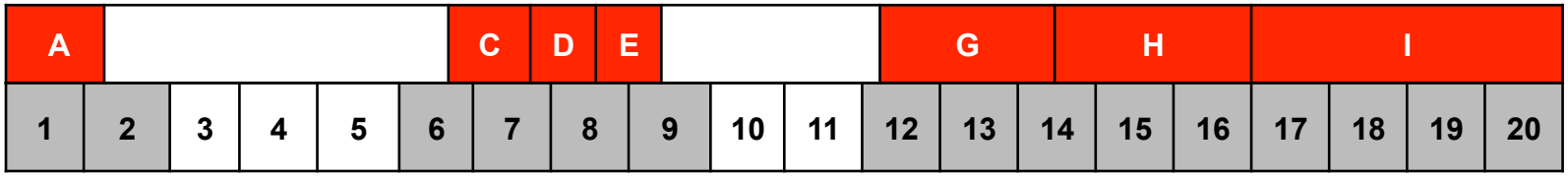
StorageTek In-Drive Reclaim Accelerator

StorageTek T10000C Partitioning Allows Reclaim of Tape When Files are Deleted

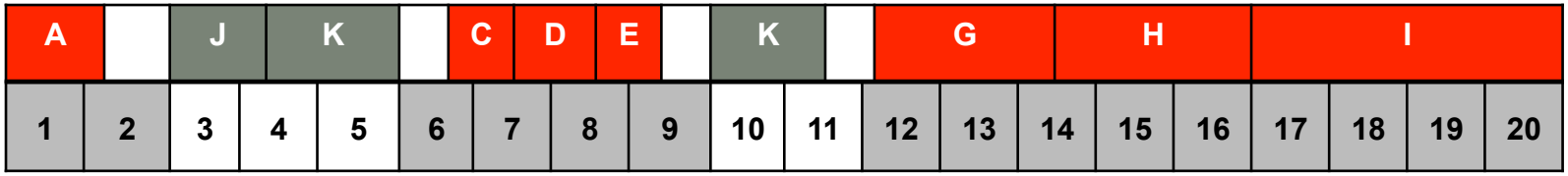
- 9 files(A-I), 20 partitions (1-20)



- Delete 2 files (B,F)



- Add 2 different files (J,K)



Currently Implemented on VSM

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StorageTek Maximum Capacity

- The recorded format allows extra space on the media to allow for defects (progressive write)
- Typically ~ 5-8%
- This insures that a fully recorded 5 TB tape can always be copied to another tape, even if the 2nd tape is of lower quality
- This “extra” capacity can be used to record data as long as the application understands that the full tape may not always fit on another tape.
- The “max capacity” mode is enabled via a standard SCSI command

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What's Being Said About the StorageTek T10000C

January 31, 2011

"All-in-all, there's simply no denying that Larry's engineers have come up with a **winner**. In term of capacity, it blows competing (tape) … out of the water."
Chris Mellor, The Register

"Oracle is **taking aim** at the fast-growing storage demands of large enterprises with the latest version of its high-end tape drive, which will be able to pack 5TB of uncompressed data onto a tape cartridge."
Stephen Lawson, IDG News

"The StorageTek T10000C drive, combined with Oracle's StorageTek SL8500 Modular Library System using 2:1 compression, is the first tape storage product to scale to an **exabyte** of capacity."
Lucas Mearian, Computerworld

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Oracle StorageTek Continues to be the #1 Innovator In Tape

What The StorageTek T10000C Can Do For You

- ✓ **Reduce costs with the lowest total cost of ownership**
- ✓ **Manage growth with unprecedented performance and simplified management**
- ✓ **Minimize risk with best in class data availability**

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Hardware and Software
Engineered to Work Together

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