

Hard Disk Storage—Caught in the Middle

HIGHLIGHTS

Contrary to general investor sentiment, tape (and solid state) storage are positioning to take significant share from hard disk drives as the primary method of cloud-based and enterprise storage according to industry expert and consultant Fred Moore of Horison. This has important implications for storage companies' revenue and earnings prospects.

Mr. Moore expects four technology trends to drive this shift:

- **Performance:** Hard-disk drive (HDD) performance (a function of seek time, latency and data input/output rate) is improving less than 5% annually even as tape, both enterprise and LTO, performance is improving dramatically.
- **Reliability:** Bit Error Rates (BERs) are the most important device reliability factor. They are now superior for tape versus HDD.
- **Rebuild/recovery time:** HDD capacity per platter continues to rise while its I/O (input/output) speed improvements have slowed to a crawl, causing RAID (Redundant Array of Independent Disks) rebuild and recovery times to expand to unacceptable levels, measured now in days and soon to be weeks. In contrast, tape I/O speeds—particularly for LTO—continue to improve.
- **Capacity:** The rate of bit density ("areal density") growth is 40% to 80% annually for tape, roughly twice the rate of HDD and flash. HDD rates are potentially heading down to 20%. This will become more disruptive as time passes.

Over time we expect the SSD industry to follow a consolidation pattern similar to that seen in mature segments of the storage industry. Today, a mere five tape companies and three HDD companies dominate their respective industry segments. In contrast, there are four to five dozen solid-state drive (SSD) vendors.

DISCERN will host a luncheon with Mr. Moore (biography on page 2) in Boston on Thursday, September 15th, 2011. To hear his insights firsthand and join our Q&A session, please contact Tim Stepan at tstepan@discern.com or 857-366-4104.

ADDITIONAL TAKEAWAYS**Tape**

- One tape storage systems provider, which has cost effective products and solid marketing, is growing revenues more than 30% annually.
- The majority of data being generated today is write-once-read-seldom-if-ever (WORSE). Thus, rapid retrieval is not a priority and this data is well suited for lower-cost storage technologies such as tape.
- Tape technology is now evolving at a much faster rate than HDD technology. Mr. Moore expects this trend to continue.
- Tape bit error rates (BERs)—the most important error factor—are now superior to BERs for HDD.
- Tape areal density is growing 40% to 80% annually, roughly twice the rate of HDD and flash.
- Tape file search technology has evolved from a slow sequential process to a faster, competitive drag-and-drop process enabling tape to behave more like a disk.
- Tape storage per-gigabyte (purchase) and operating costs are well below HDD storage costs.
- Annual price erosion of 20% or more for disk and tape continues to support exponential data growth.

Hard Disk Drives (HDDs) and HDD-Based Systems

- HDD-based storage could get "caught in the middle" between lower-cost capacity solutions (tape) and higher-cost performance solutions (SSDs) due to rapid improvements in tape performance and rapid price declines for SSD storage.
- The average improvement in HDD performance has slowed to less than five percent annually.
- HDD-based system performance improvements are limited by issues with heat / rotation speed, ever lengthening rebuild times, areal density growth and bit error rates. Rotation speeds have actually declined due to problems created by higher-speed drives.
- Erasure Coding is a new, potentially disruptive technology that might extend HDD applications to the approximately 20% of archived data that is active.

Solid State Disks (SSDs)

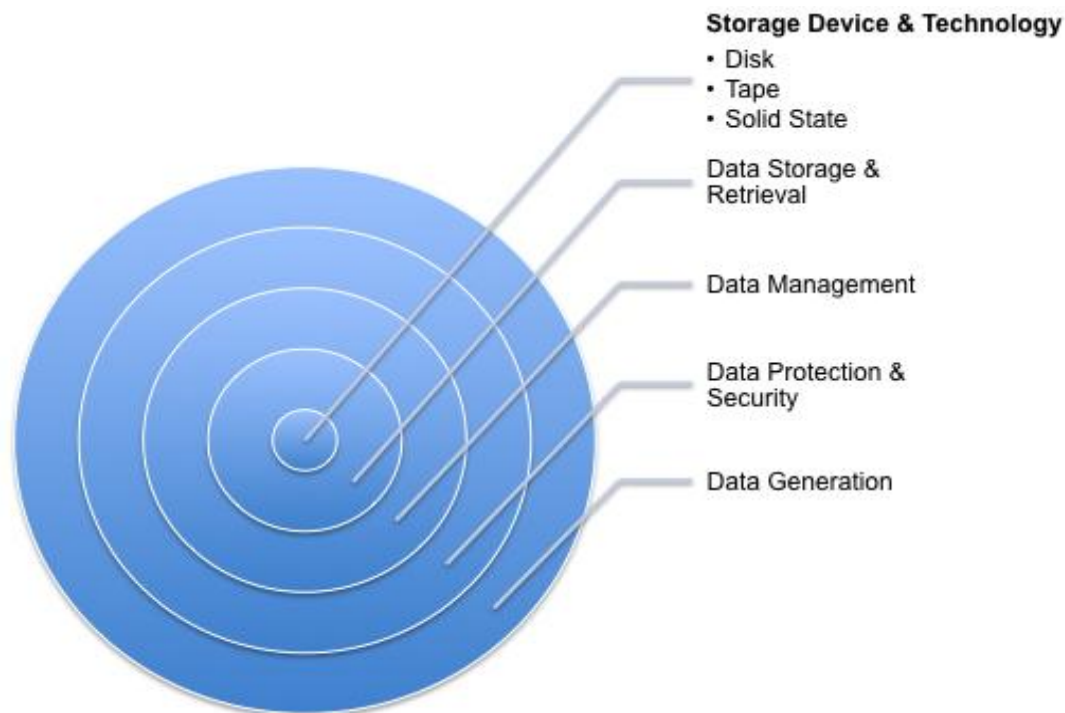
- In 1978, the first commercially successful Solid State Disks (SSDs) were a relatively high-priced high-performance solution for mainframes. The first SSD era essentially ended in 1985 when an optional virtual memory feature called Expanded Storage was introduced.

See Disclosure Appendix of this publication for important disclosures and analyst certifications

- High prices still limit demand for SSD storage, but that should change in our lifetime.
- Flash memory is also currently challenged by a limited number of write operations.
- SSD's numerous benefits over HDDs include reliability, portability, faster data transfers, a smaller footprint, lower energy consumption, faster Input/Output response times, and lower costs per Input/Output Operation per Second (IOPs).
- SSD storage currently *complements* Hard Disk Drive (HDD) storage: SSDs are a *performance* solution while HDDs are a *capacity* solution. Thus, SSDs should be measured by Input/Output Operations per Second per Dollar (IOPs/\$) while HDDs should be measured by dollar per gigabyte (\$/GB).

The Big Picture

- According to Mr. Moore, in the computer storage industry, "things are changing so fast even the future is obsolete."
- The amount of data generated is expected to increase 50x through 2020.
- Much of this data is unstructured, low activity data with infinite retention times.
- A key challenge is to filter out (rather than store/archive) the vast majority of data that is meaningless and never read.
- Currently half of data that should be protected is not.
- For every problem virtualization solves, it creates a new one. The market opportunity can be viewed as a series of concentric circles (see illustration), with the innermost circle (storage devices) being the most mature and offering the least opportunity and the outermost circle (applications / data generation) being least mature and offering the most opportunity.
 - The innermost circle is disk, tape and other storage devices, followed by
 - Data storage and retrieval technology (e.g., networking), followed by
 - Data management technology, followed by
 - Data protection and security, followed by
 - Data generation.



Fred Moore, President, Horison Information Strategies

Fred Moore founded Horison Information Strategies, an information strategies consulting firm that specializes in strategy and business development for emerging IT and storage networking companies, in 1998. Previously, he had a 21-year career at StorageTek, where he began as the company's first systems engineer and concluded as its Corporate VP of Strategic Marketing. He is a sought-after advisor and IT speaker worldwide and has published numerous papers and reports on the data storage industry. The company's website is www.horison.com.

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