Technology Trends

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Status of Disk Storage

• Displacement by flash technology for high IOPS

• Disk technology advances becoming more difficult
  – Future areal density increases will require new technology
  – Heat Assisted Magnetic Recording (HAMR), Bit Patterned Media (BPMR), Shingled Recording (SWR) or others
  – Require significant capital and R&D investment

• More and more industry consolidation
  – Western Digital (50% HDD shipment share)
    • Hitachi, IBM
  – Seagate (40% HDD shipment share)
    • Conner, Maxtor, Quantum, Samsung
  – Toshiba (10% HDD shipment share)
    • Fujitsu
Tape Marches On – Capacity Example

1987
- 6000 carts
- STK4480 – .04 GB, 3MB/s
- 1TB Capacity
- 357 sq ft
- 8200 lbs

1996
- 6000 carts
- TimberLine 9490 – 1.6 GB, 18MB/s
- 10TB Capacity
- 357 sq ft
- 8200 lbs

2011
- 2 carts
- T10000C – 5.0 TB, 240MB/s
- 10TB Capacity
- 0.3 sq ft
- 1.2 lbs
Tape Areal Density Trends
FLASH Update

**Concept of 3D-Solid State Drive**
- NAND flash memories, NAND controller, DRAM, and the boost converter are integrated with SiP\(^1\).
- Boost converter Target: \(V_{PCM} = 20\) V

- 68% energy reduction.
- 5-10% die area reduction.

**Figure 4: Voltage Reference for MLC**

- Distribution of Cells
- Reference Points
- V\(t\):
  - 1.5V
  - 3.5V
  - 4.0V
  - 5.5V
  - 6.5V

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Technology Component Price/GB Projections

- Tape
- Disk
- Optical Blu-ray
- MLC NAND Flash up to 4 bits/cell
- SLC NAND Flash

$/TB

Year

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Next-Generation Storage

Major trends shape new storage
• Storage De-capitalization
• Flash storage
• Faster CPUs
• Storage optimization
  – Consolidation
  – Virtualization

Integrated Services
• Intelligent Data Management
  – Data indexing
  – QoS
• Global Namespace
• Archiving
• Single Vendor
Hardware and Software

Engineered to Work Together