Our Growing Digital Universe, the Impact on Enterprise Storage, and the Role Solid State is Playing in the Future

Non-Volatile Memory (NVM) Summit

Jeff Janukowicz
Research Director
Transforming the Enterprise
Third Platform for Industry Growth
Transforming the Enterprise
Third Platform for Industry Growth

PC
LAN/Internet
Client-Server

Hundreds of Millions of Users

Tens of Thousands of Apps

Millions of Users

Thousands of Apps

1986

IDC
Analyze the Future
Transforming the Enterprise
Third Platform for Industry Growth

Trillions of “Things”
Billions of Users
Hundreds of Millions of Users
Millions of Users
Tens of Thousands of Apps
Thousands of Apps

PC
LAN/Internet
Client-Server
Mainframe

1986
2011

Social Business
Big Data/Analytics
Mobile Broadband
Mobile Devices & Apps
Cloud Services

Millions of Apps

IDC
Analyze the Future
New technology platforms for growth and innovation

Social Business  Mobility  Big Data  Cloud

Data
Demand for Data Keeps Growing

- More …
  - Data
  - Content
Demand for Data Keeps Growing

- More …
  - Data
  - Content
  - Applications
  - Devices

The Multi-Device Era
- US tablet owners have an average of 6 devices (plus the tablet)
- WW the average is about 5

Source: IDC 2012 Tablet MCS N=400 USA and 1,954 WW Tablet owners
Stationary vs. Portable Client Devices

Multi-Devices Era

Client Device Shipments

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Stationary vs. Portable Storage Capacity Shipped

Capacity Shipments in TBs

- Portable Storage Capacity
- Stationary Storage Capacity

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Delivering the Data …

We want …

Whenever

Wherever

On Any Device
Emergence of Flash Technology in the Enterprise

- **Higher Performance** – Need for faster access
- **Better Efficiency** – More intelligent use of assets
- **Cost Effectiveness** – Lower TCO, $/IO
Cost is a Key Driver for Adoption

Worldwide Enterprise Blended Average Price per GB Comparison

![Graph showing the decrease in cost per GB for Enterprise HDD and SSD from 2009 to 2015.](source: Worldwide Solid State Drive 2011–2016 Forecast Update – December 2012)
It is More than Just $/GB

- Storage Performance is a bottleneck
  - Processors and network performance have grown over the last decade
  - Storage Performance Metrics
    - IOPs
    - Bandwidth
    - Response Time
- Traditional approaches can be inefficient and costly
  - I/O delays cost money and time
- Optimization is key to overcome limitations
IDC compared and contrasted PCs with different storage devices

NOTE: Lower is better

Source: IDC Benchmarking Study (Doc #213285), 2008
Real-world PC performance

Internet Explorer launch

Program Launch

- SLC SDD
- MLC SSD
- Hybrid HDD
- 7200 HDD
- 5400 SSD

Milliseconds

460 480 500 520 540 560

NOTE: Lower is better

Source: IDC Benchmarking Study (Doc #213285), 2008
Storage is part of the system

- Today the system is optimized for HDDs
  - Hardware
  - Performance
  - Form Factor
- OS, BIOS, hardware and applications will need to be fine-tuned to exploit inherent advantages
- Smart system design can overcome bottlenecks
Solid State Technology will complement in system architectures

- Registers
- SRAM
- DRAM
- Flash SSDs
- Performance Optimized HDDs
- Capacity Optimized HDDs

Performance vs. Cost
Flash is Everywhere in the Enterprise
SSD Implementations: Persistent and Cached Storage

Direct Attached Storage
- External SSD Appliance
- PCIe SSD
- Internal SSD
  - sATA, SAS, FC

Networked Attached Storage
- External SSD Appliance
- Tier or Cache
- Storage Controller
- External SSD Array
- Storage Controller
Enterprise SSD Product Diversity

- **Multiple Disk Form Factors:**
  - 3.5 in, 2.5in, module
  - SSDs are Form Factor agnostic

- **Range of Capacities**
  - Very low - up to Multi-TB

- **Wide Array of Performance Attributes**
  - SLC vs eMLC vs cMLC
  - Read / Write speeds

- **Many Interfaces:**
  - SAS (3Gb/sec → 6Gb/sec)
  - FC (4Gb/sec)
  - SATA (3Gb/sec → 6Gb/sec)
  - PCIe

<table>
<thead>
<tr>
<th>Form Factor</th>
<th>SAS</th>
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SSDs Play an Important Role in Accelerating our Data

SSD Deployment Architectures

- Cache & Persistent
- Host based – Local to the server
- All Flash Array – SSD only (No spinning HDD)
- Hybrid Array – utilizes a mixture of SSD & spinning HDD with data placement between media types through defined policy
Emergence of SSDs and SSD-Based Storage Systems

Vendors

*NetApp*

*EMC*

*Oracle*

*Dell*

*IBM*

*Hitachi Data Systems*

*STEC*

*Intel*

*Samsung*

*SanDisk*

*LSI*

*Seagate*

*Western Digital*

*OCZ*

*Fusion io*

*Toshiba*

*Micron*
Emerging Players …
# Investments in SSD Technology

## SSD Related Merge and Acquisitions

<table>
<thead>
<tr>
<th>Date</th>
<th>Acquirer</th>
<th>Target Company</th>
<th>Market Segment</th>
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<tr>
<td>Jan 2013</td>
<td>Violin Memory</td>
<td>GridIron</td>
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Similar to the HDD industry of the ’80s - Expect SSD OEMs to consolidate over time as the market grows.
Putting it in Perspective – 2007

7 NAND OEMs supplying a $14B+ market

7 HDD OEMs supplying a $30B+ market

Numerous SSDs OEMs supplying a < $400M market
Putting it in Perspective – 2012

5 NAND OEMs supplying a $19B+ market

3 HDD OEMs supplying a $37B+ market
Strong Enterprise SSD Growth

2008 Revenue < $150M

2012 Revenue = ~$2.5B

Essential Guidance

- Data Growth Continues
  - Improving performance and boosting efficiencies in a cost effective manner are key to managing the data growth

- SSD play an important role
  - SSDs accelerate access to data and will be leveraged in multiple architectures through the datacenter

- The SSD market is here to stay
  - Future hardware & software optimization around solid state technology will be key
Questions

Jeff Janukowicz
jjanukowicz@idc.com
Research Director – IDC