Flash’s Role in Big Data, Past Present, and Future

Tutorial: Fast Storage for Big Data
Hot Chips Conference
August 25, 2013
Memorial Auditorium
Stanford University
OBJECTIVE ANALYSIS
Semiconductor Market Research

• Market consulting/research firm
  – Market analysis, strategies, white papers

• Highly-respected lead analysts
  – Jim Handy: Memories & SSDs
  – Lane Mason: Memory chips
  – Tom Starnes: Processors

• Industry experience & 25+ years in field

• Reports, Competitive Analysis, Consulting

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Haven’t We Seen You Before?

• HotChips 2010: *The Inevitable Rise of NVM in Computing*
Agenda

• The problem
• SSDs as a solution
• The role of future memories
• Tomorrow’s computing architecture
Big Data

• Data is exploding. By 2020:
  – Annual data production will be 35 ZB (CSC)
  – 50 billion “things” on the Internet (Cisco)
• Systems aren’t keeping pace
  – CPUs moving along nicely
  – HDD/DRAM/Flash capacities still growing
  – Interfaces are not moving fast enough
• Result: Break the system into smaller chunks
The DRAM/HDD Speed Gap

From: *Solid State Drives in the Enterprise*

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“Sharding”

• Big Data? Subdivide the problem!
Agenda

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Add Flash, Cut Server Count

Sharded System

Multiple Servers

Single Server with SSD

SSD SSD
Other Flash Benefits

- Less power & cooling
- Improved reliability
  - The fewer things there are, the fewer will fail
- Floor space reduction
- Lower licensing fees
- Faster error recovery
  - RAID rebuilds
  - Backup restore
  - Snapshots
Agenda

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How to Maintain this Inertia?

From: *Hybrid Drives: How, Why, & When?*
NAND’s Scaling Limit

• NAND will reach a limit
  – Too few electrons per gate
  – Needs constant shrinks for cost reductions
  – 4-bit/cell hard to make
    • This may be the maximum possible

• Other technologies will scale past NAND
  – PCM, MRAM, RRAM, FRAM….
    • Not yet clear which will win
An NVM Timeline

• 2013: 1Xnm planar cell
  – Requires Hi-k gate oxide
• 2015: 1Ynm planar cell
  – May be the last planar cell
• 2017: 3D NAND in volume
• 2019: 3D – “The Next Generation”
• 2021: Final (?) 3D generation
• 2023: NAND yields to new technology
How Alternatives Will Emerge

<table>
<thead>
<tr>
<th>Process Node</th>
<th>Relative Cost per Bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>180nm</td>
<td>Flash: 100</td>
</tr>
<tr>
<td>65nm</td>
<td>New Tech: 10</td>
</tr>
<tr>
<td>23nm</td>
<td>Flash: 1</td>
</tr>
<tr>
<td>8nm</td>
<td>New Tech: 0.1</td>
</tr>
</tbody>
</table>

- **Flash**
- **New Tech**
New Memories are Better

<table>
<thead>
<tr>
<th>NAND</th>
<th>New Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Serial read</td>
<td>• Random read</td>
</tr>
<tr>
<td>• Erase before write</td>
<td>• Overwrite</td>
</tr>
<tr>
<td>• Block erase/page write</td>
<td>• Byte write</td>
</tr>
<tr>
<td>• Slow write</td>
<td>• Fast write</td>
</tr>
<tr>
<td>• Inherent bit errors</td>
<td>• Lower error rates</td>
</tr>
<tr>
<td>• Wear</td>
<td>• Low/no wear</td>
</tr>
</tbody>
</table>

Opens pathway to “Storage Class Memory”
Impact of New Memories

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NVM Won’t Cross HDD $/GB

HDD Pricing Courtesy of PriceG2

Price per Gigabyte

HDD

NAND

20X the Price!
An Evolving Computing Framework

Yesterday

CPU

DRAM

HDD

Today

CPU

DRAM

SSD

HDD

Tomorrow

CPU

DRAM

NVM

HDD

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NAND Fits in Computers Today

From: *Solid State Drives in the Enterprise*
Flash as Memory

Hard Way
• It’s nonvolatile
  – Write new code
  – Create new topologies
• Worry about coherency
• Everything is new

Easy Way
• It’s cheaper than DRAM
  – It’s faster than HDD
• Who cares about volatility?
• Handle coherency like you do with DRAM
  – Use existing code
Flash More Economical than DRAM

From: How PC NAND Will Undermine DRAM
Enterprise SSD Forecast

$3.5 Billion in 2016
59% Unit CAGR
43% Revenue CAGR

From: Solid State Drives in the Enterprise

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Summary

• Flash belongs in all computers today
  – So does HDD
• Flash vs. DRAM, not flash vs. HDD
• New NVMs will require new computing architectures
  – “Flash as memory” can be used today
Thank You!

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