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

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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

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*

"Sharding"

- Big Data? Subdivide the problem!

Sharded System

Multiple Servers

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Add Flash, Cut Server Count

Sharded System

Single Server with SSD

SSD **SSD**

Multiple Servers

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

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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

New Memories are Better

NAND

- Serial read
- Erase before write
- Block erase/page write
- Slow write
- Inherent bit errors
- Wear

New Memory

- Random read
- Overwrite
- Byte write
- Fast write
- Lower error rates
- Low/no wear

Opens pathway to "Storage Class Memory"

Impact of New Memories

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NVM Won't Cross HDD $/GB

NAND

HDD

20X the Price!

Price per Gigabyte

$1,000.00
$100.00
$10.00
$1.00
$0.10
$0.01

2004 2005 2006 2007 2008 2009 2010 2011 2012

HDD Pricing Courtesy of PriceG2

An Evolving Computing Framework

Yesterday

Today

Tomorrow

NAND Fits in Computers <u>Today</u>

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

Millions of Units

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

2009 2010 2011 2012 13 2014 2015 2016

From: *Solid State Drives in the Enterprise*

Summary

- Flash belongs in <u>all</u> computers today
    - So does HDD
- Flash vs. DRAM, <u>not</u> flash vs. HDD
- New NVMs will require new computing architectures
    - "Flash as memory" can be used <u>today</u>

Thank You!

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