Session 302-F (OPEN)
Panel Discussion of
Intel/Micron 3D XPoint Announcement

Thursday August 13, 2015
9:45-10:50AM
Signal processing, detection, coding, and test methods, matched to the physics of new storage technologies

**Current focus:** Spintronics and 3D storage

Please contact me at csobey@ChannelScience.com or 972-814-3441.

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Session 302-F: 3D XPoint

Tom Coughlin, President, Coughlin and Associates

Jim Handy, Director/Chief Analyst, Objective Analysis

Dave Eggleston, Principal, Intuitive Cognition Consulting

Audience Participation
“XPoint” – Cross-Point Array (Cross-Bar Array)

The simplest structure

“Bit Lines”

“Word Lines”

Where are the storage elements?

Source: KnowledgeTek SSD Class
Storage Elements in a Cross-Point Array

The smallest structure: Storage element is at the intersection of the word and bit lines

“Word Lines”

“Bit Lines”

Source: KnowledgeTek SSD Class
Schematic of Cross-Point Array

Let

Low resistance = 1
High resistance = 0

Source: KnowledgeTek SSD Class
Reading Cells

Current flow depends on the resistance value of the cell at the cross-point.

Low resistance = 1
High resistance = 0

Source: KnowledgeTek SSD Class
Block Sneak Currents: Access Device (AD)

Make current only flow one way: Diodes
Make certain low-resistance cells are OFF: Transistors or other devices (for programming and erasing)

Word Line

Access Device

Storage Element

Bit Line

Source: KnowledgeTek SSD Class
Intel and Micron Announced 3D XPoint NVM on July 28, 2015

WHAT IS 3D XPoint™?

Source: Intel / Micron
Do We Need A New Memory Layer?

Jim Handy
OBJECTIVE ANALYSIS

Profound Analysts

Reports & Services

Custom Consulting

OBJECTIVE ANALYSIS – www.OBJECTIVE-ANALYSIS.com
## Objective Analysis

### Semiconductor Forecast Accuracy

<table>
<thead>
<tr>
<th>Year</th>
<th>Forecast</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>Zero growth at best.</td>
<td>-3%</td>
</tr>
<tr>
<td>2009</td>
<td>Growth in the mid teens</td>
<td>-9%</td>
</tr>
<tr>
<td>2010</td>
<td>Should approach 30%</td>
<td>32%</td>
</tr>
<tr>
<td>2011</td>
<td>Muted revenue growth: 5%</td>
<td>0%</td>
</tr>
<tr>
<td>2012</td>
<td>Revenues drop as much as -5%</td>
<td>-2.7%</td>
</tr>
<tr>
<td>2013</td>
<td>Revenues increase nearly 10%</td>
<td>4.9%</td>
</tr>
<tr>
<td>2014</td>
<td>Revenues up 20%+</td>
<td>9.9%</td>
</tr>
<tr>
<td>2015</td>
<td>Revenues up ~10%</td>
<td>TBD</td>
</tr>
</tbody>
</table>
Why Add A Layer?
The DRAM/HDD Speed Gap

From: *Solid State Drives in the Enterprise*

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The DRAM/HDD Speed Gap

From: Solid State Drives in the Enterprise

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Will This Be Difficult?
A New Memory Layer Needs A Lot Of Support

• Will require a new bus
  – DDR doesn’t support variable access times
• Will require new O/S support
  – Cache management?
  – Memory management?
• Persistence will require application support
  – SNIA and others working on this
  – Some instruction support now in Intel specs
The Cost Issue
Cost Brought Flash Into Computing

![Graph showing the decline in the average price per gigabyte for DRAM and NAND from 2000 to 2012. The graph indicates a significant decrease in price, with a notable drop in 2004 due to NAND crossing DRAM.]
Volume Brings Costs Down

DRAM Learning Curve

Cumulative Gigabyte Shipments Over Time (Thousands)

Average Price per Gigabyte

- $1
- $10
- $100
- $1,000
- $10,000
- $100,000
- $1,000,000
- $10,000,000
- $100,000,000
A Chicken & Egg Problem

- 3D XPoint will be sell in volume once it’s priced lower than DRAM
- 3D XPoint prices will fall below DRAM once the volume is high enough
Summary

• New layer necessary… eventually!
  – 3D XPoint shows promise

• Lots of support will be required
  – Hardware, software, standards

• Getting pricing below DRAM will be tough
  – Smaller die size isn’t the only factor

• Don’t expect big changes soon
Thank You!

Jim Handy