Understanding the Intel/Micron 3D XPoint Memory

Jim Handy
Objective Analysis
Agenda

- What Is It?
- Why Is This Happening?
- Who Wants It?
- Is The World Ready For It?
- Why Should I Care?
- When Will This Happen?
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3D XPoint Concept
The Real Thing

Column
Row
Metal 2
Poly
Metal 1
Si-Substrate
Intel Has Researched PCM For 45 Years!

![Electronics Magazine Cover](image-url)
How Many Ways Have Been Tried?

It’s a great time to be a materials engineer!
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NAND Laid The Path To Increased Hierarchy Levels

Source: *A Close Look at the Intel/Micron 3D XPoint Memory*, Objective Analysis 2015
Ratio of DRAM-NAND Prices

Source: *A Close Look at the Intel/Micron 3D XPoint Memory*, Objective Analysis 2015
Why This? Why Now?

- Semiconductor memories becoming faster and cheaper
- Disks becoming cheaper, but no faster
- Result: Speed gap is widening

Source: *A Close Look at the Intel/Micron 3D XPoint Memory*, Objective Analysis 2015
Where 3D XPoint Fits In The Memory/Storage Hierarchy

Price per Gigabyte

Bandwidth (MB/s)

Source: *A Close Look at the Intel/Micron 3D XPoint Memory*, Objective Analysis 2015
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Patents Leaked Intel’s Plans

DDR BUS 410
(SIMULTANEOUS DDR AND TRANSACTIONAL PROTOCOL OPERATION ON EVERY CHANNEL; DDR ELECTRICALS)

PCM-BASED DIMMS 411b
(FAR MEMORY)

CPU PACKAGE 401

PROCESSOR 310

IMC 331
MSC CTRL 124

DDR DIMMS 411a
(NEAR MEMORY)
How Much Does XPoint Help?

![Latency (uS) Graph]

Source: Storage Technologies Group, Intel

HDD +SAS/SATA
SSD NAND +SAS/SATA
SSD NAND +NVMe™
SSD 3D XPoint™ +NVMe™
3D XPoint’s Place in the Memory/Storage Hierarchy

- Intel® SSD with Intel® Optane™ technology
- memcache
- cloud
- in-memory key-value database
- real time analytics
- NVMe PCIe SSD
- SATA SSD

>1M

0 100 200 300 400 500 600 700 800 900 1000

Microseconds
Great Gains at Low Queue Depths

![Graph showing 4KB Read IOPS Performance vs. Concurrency/Queue-Depth]

- **NAND**
- **Projected 3D XPoint™ Technology**

- *800GB SSD Read IOPs using 16GB die*
Clear, But Complex Economic Benefits

$/Write IOPs

$10.00

$1.00

$0.10

$0.01

$0.00

*SAS HDD 100 IOPs

*SATA 24k IOPs

*PCIe 100k IOPs

3D XPoint™ technology

1ms

1us
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About That Timing…

- **Timing is good because:**
  - DRAM is running out of speed
  - NVDIMMs are catching on
  - Some sysadmins understand how to use flash to reduce DRAM needs

- **Timing is bad because:**
  - Nobody can make it economically
  - No software supports SCM
  - New layers take time to establish
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What 3D XPoint Means To You

- Better cost/performance ratio
- Lower power consumption
  - Less DRAM
  - More performance per server
  - Lower OpEx
- In-memory databases start to make sense
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When Will It Ship?

Micron DRAM / NAND Normalized Bit Output

<table>
<thead>
<tr>
<th>FY 2015</th>
<th>FY 2016</th>
<th>FY 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muted Growth in FY-15 / 1H-16</td>
<td>Stronger Growth Beyond</td>
<td></td>
</tr>
<tr>
<td>DRAM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 20nm transition-driven wafer loss</td>
<td>• Volume ramp of 20nm (to &gt;50% of bits)</td>
<td></td>
</tr>
<tr>
<td>• Mix shift from DDR3 to DDR4 and LP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 3D NAND ramp preparations</td>
<td>• 3D NAND ramp + TLC impact</td>
<td></td>
</tr>
<tr>
<td>• Mix shift towards mobile/eMCP from high density components</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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The Issue of Learning

Source: *A Close Look at the Intel/Micron 3D XPoint Memory*, Objective Analysis 2015
Server DRAM Gigabyte Forecasts: With/Without 3D XPoint

Source: *A Close Look at the Intel/Micron 3D XPoint Memory*, Objective Analysis 2015
Server DRAM Revenue Forecasts: With/Without 3D XPoint

Source: *A Close Look at the Intel/Micron 3D XPoint Memory*, Objective Analysis 2015
3D XPoint Optimistic Server Revenues

Source: *A Close Look at the Intel/Micron 3D XPoint Memory*, Objective Analysis 2015
Summary

- What Is It?
  - A New, fast, cheap crosspoint memory
- Why Is This Happening?
  - The market’s ready, and memory can’t keep up
- Who Wants It?
  - Everyone… eventually!
- Is The World Ready For It?
  - Not yet
- Why Should I Care?
  - It has a direct impact on your systems
- When Will This Happen?
  - Launch, 2016. Big impact, much later
Resources

- **A Close Look at the Intel/Micron 3D XPoint Memory**, Objective Analysis, September 2015: [http://Objective-Analysis.com/Reports.html#XPoint](http://Objective-Analysis.com/Reports.html#XPoint)


