



Emerging NVM - *Enabling Next-generation Data Storage Solutions*

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Forward-looking statements

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New Applications Drive Demand for Hot, Cold, & Mobile Storage



Solid State Storage opportunity \$25b+ in 2017¹

- NAND segment forecast \$40b+ in 2017^{1&2}
- Consuming >50% of NAND bits in 2017³

Hot Data Storage Requirements:

- More Capacity => In-memory compute
- Lower Latencies => more performance
- Lower Power => more IOPS/W

Emerging NVM impacts Compute & Storage

- Low latency NVM-storage tiers emerging
- New all non-volatile data path architectures
- Intel: ~1000x performance boost over NAND⁴

¹ Gartner, June 2014 Preliminary Forecast Analysis: NAND Flash, Worldwide 2Q14 Update

² Gartner, November 2013 Preliminary Refresh of SSA Forecast; Market Trends: Evolving HDD and SSD Storage Landscapes

³ Gartner, June 2014 Forecast: Semiconductor Consumption by Electronic Equipment Type, Worldwide 2Q14 Update

⁴ Amber Huffman, Intel, NVM Express Overview & Ecosystem Update, FMS 2013, August 13th 2013



EMERGING NVM WILL HELP TAKE COMPUTE TO THE NEXT LEVEL

How Emerging NVM Impacts Compute

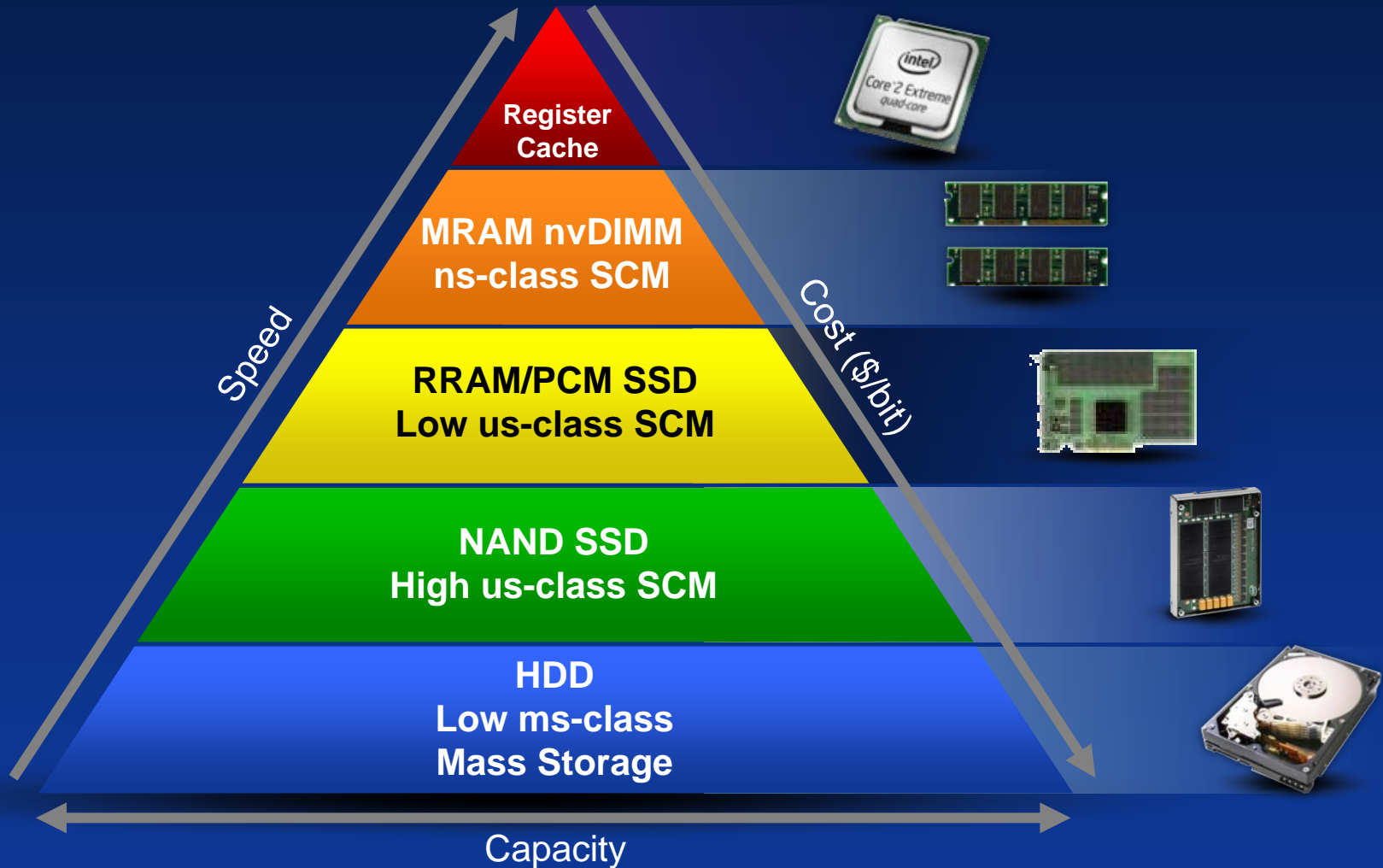
Justin Rattner, CTO Intel, IDF 2012 San Francisco:

- Three new low latency memories on the horizon:
PCM, RRAM, MRAM
- Emerging NVM enables substantial power savings and much faster data transfers
- Today's processor architectures & filing systems require dramatic redesign
- Memory hierarchy changes have major effects on how computation works
- New systems must be ready for low latency NVM in 3-5 years

Source: <http://www.zdnet.com/intel-non-volatile-memory-shift-means-chips-need-an-overhaul-7000004221/>

TWO NEW STORAGE TIERS ENABLED BY EMERGING NVM

Future Online Storage Tiering





Summary

- Three new low latency memories: MRAM, RRAM, PCM
- Closes the CPU to non-volatile data storage latency gap
- Breaks historic paradigm around volatile primary storage
- Enables new low-latency ns/us-class tiers in data storage
- Makes all non-volatile data path architectures possible
- Emerging NVM is even more disruptive than NAND SSD
- Major challenges/value creation opportunities:
 - Hardware & software architecture changes required
 - Density needs to be scaled up and cost scaled down
 - High volume tools and manufacturing infrastructure