March 2009

SOS13

Memory Update

Dean A. Klein

VP Memory System Development

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The Business Memory Sucks

Dean A. Klein

VP Memory System Development

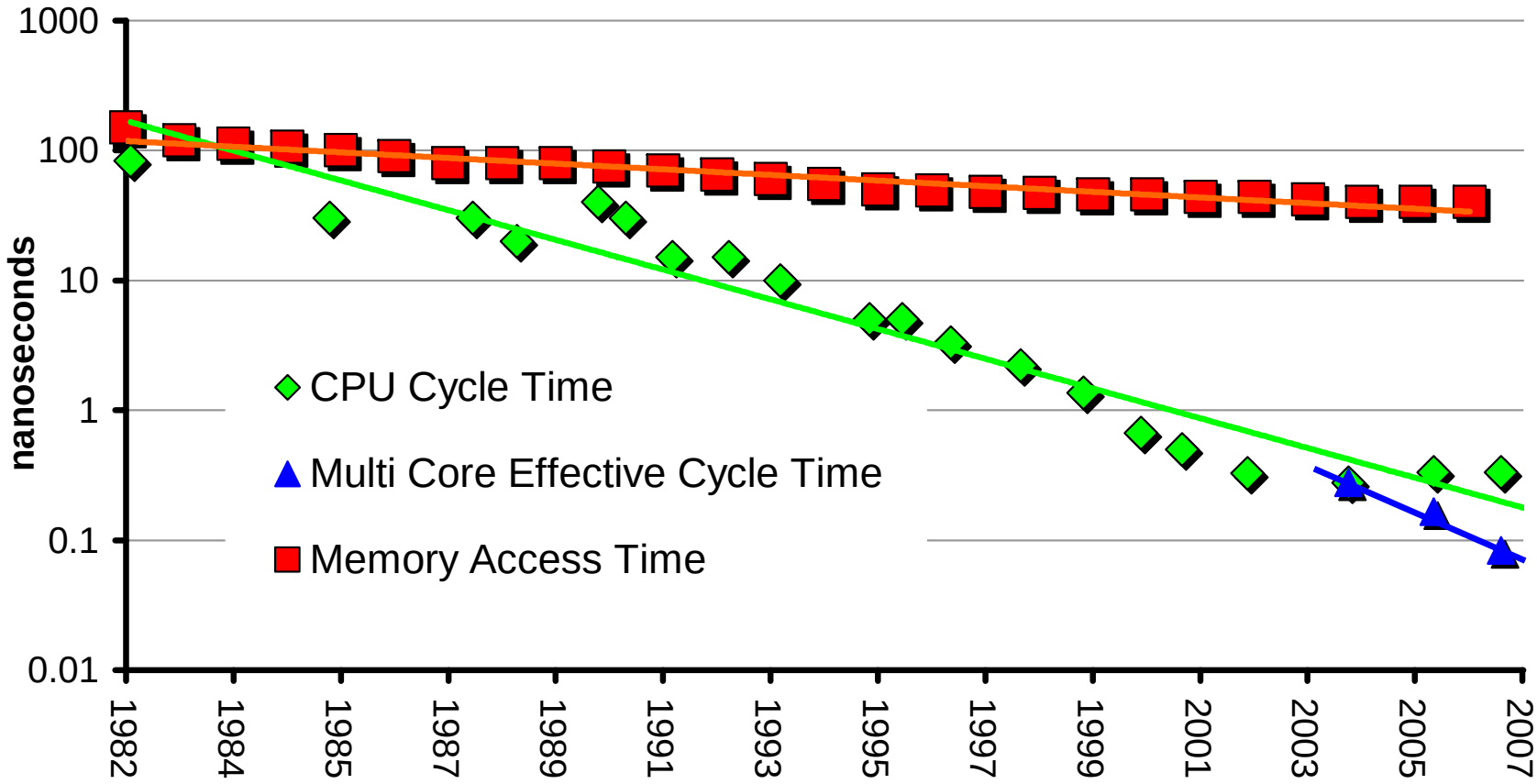
Topics

- Memory Directions
- Memory Challenges
- Memory Opportunities

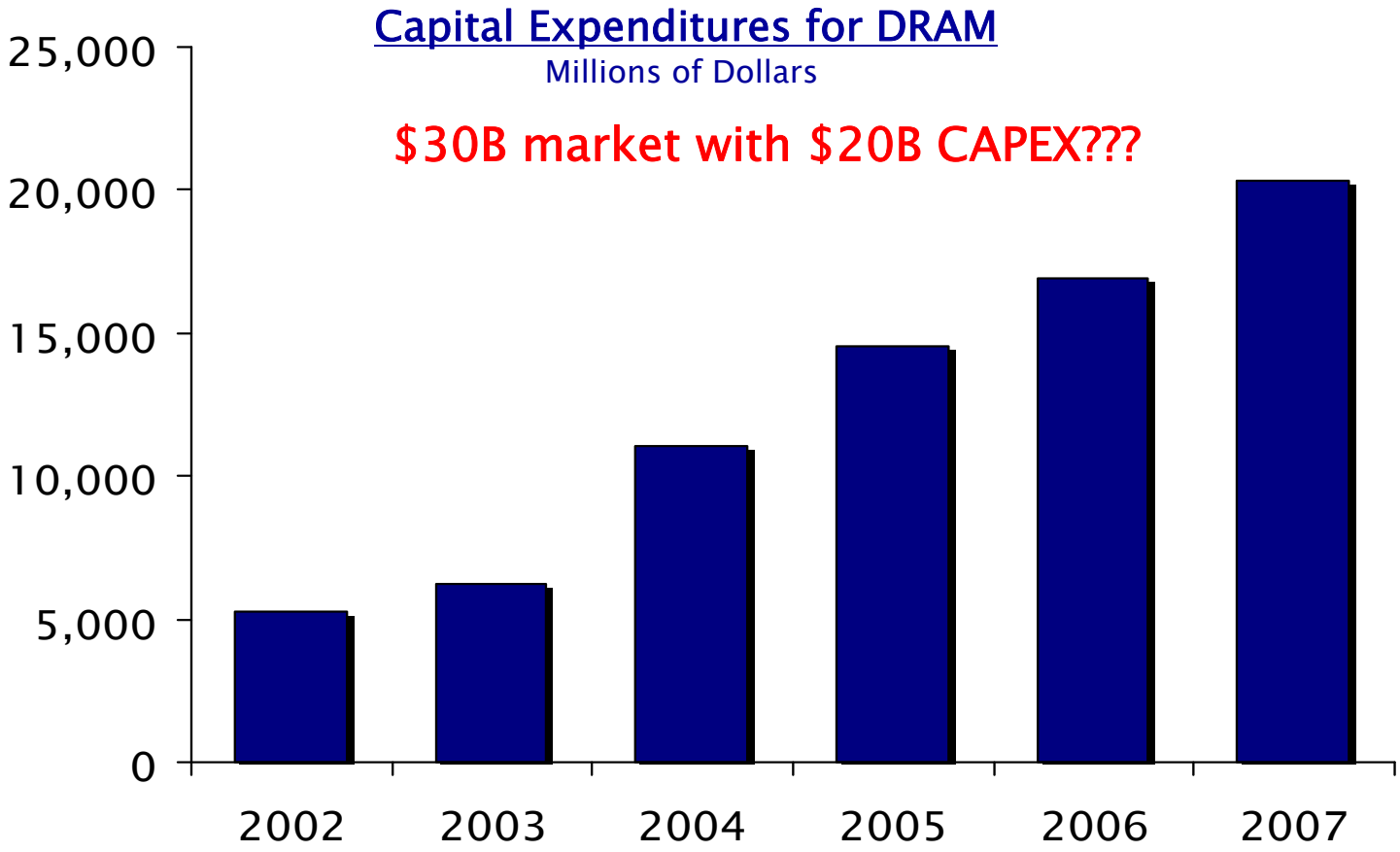
The Results of Commoditization

- Evolutionary development
  - PM, FPM, EDO, SDRAM, DDR, DDR2, DDR3…DDR4
  - Rare detours: RDRAM, BEDO, SLDRAM
  - Niche apps: RLDRAM, PSRAM, LP
- 40%/year average bit growth
- Cyclical
- Consolidating

Evolution, not Revolution

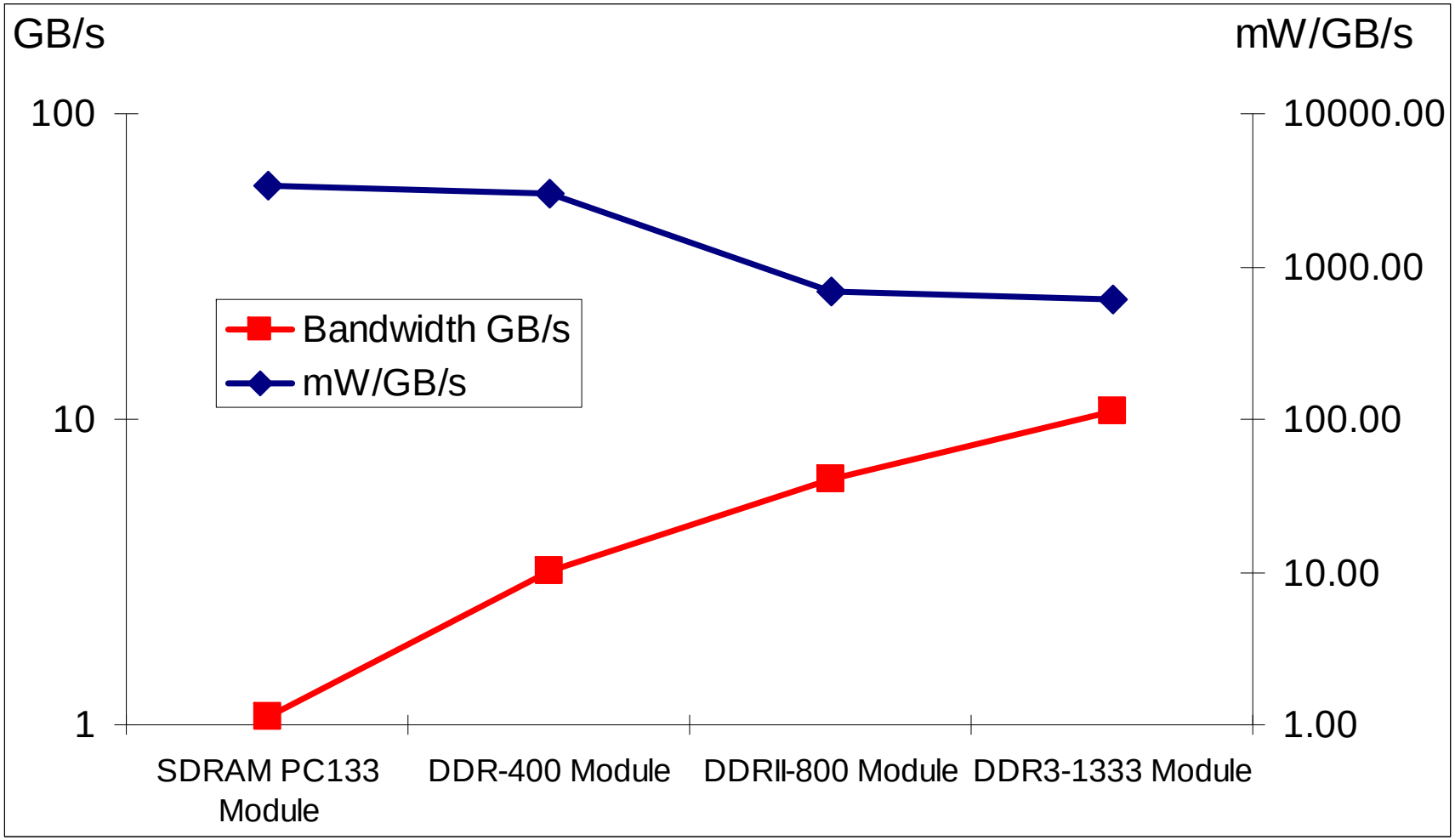


Research Firm iSuppli Estimates that Roughly $20Billion was Spent on DRAM Capex in 2007

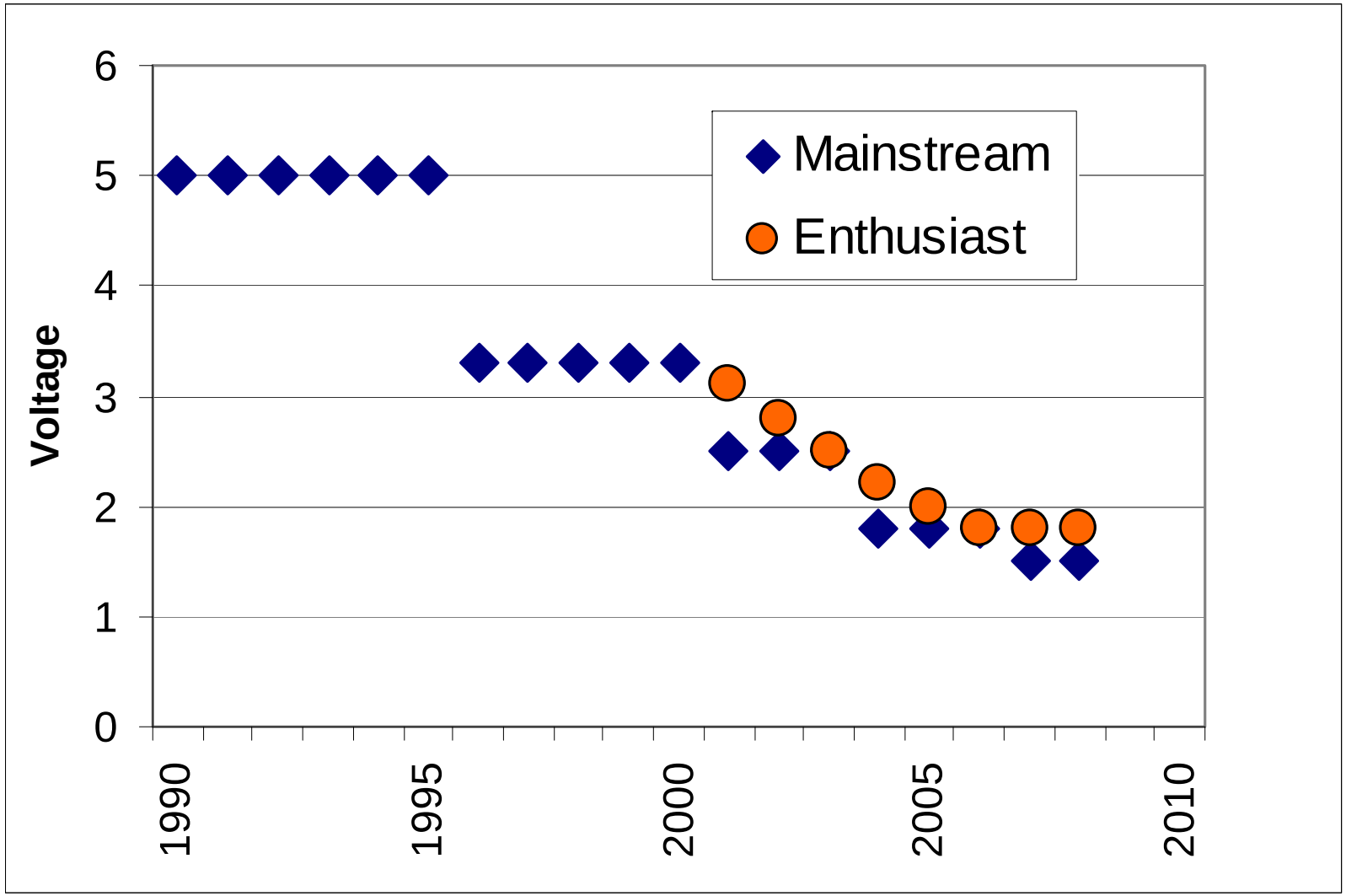


Source: iSuppli

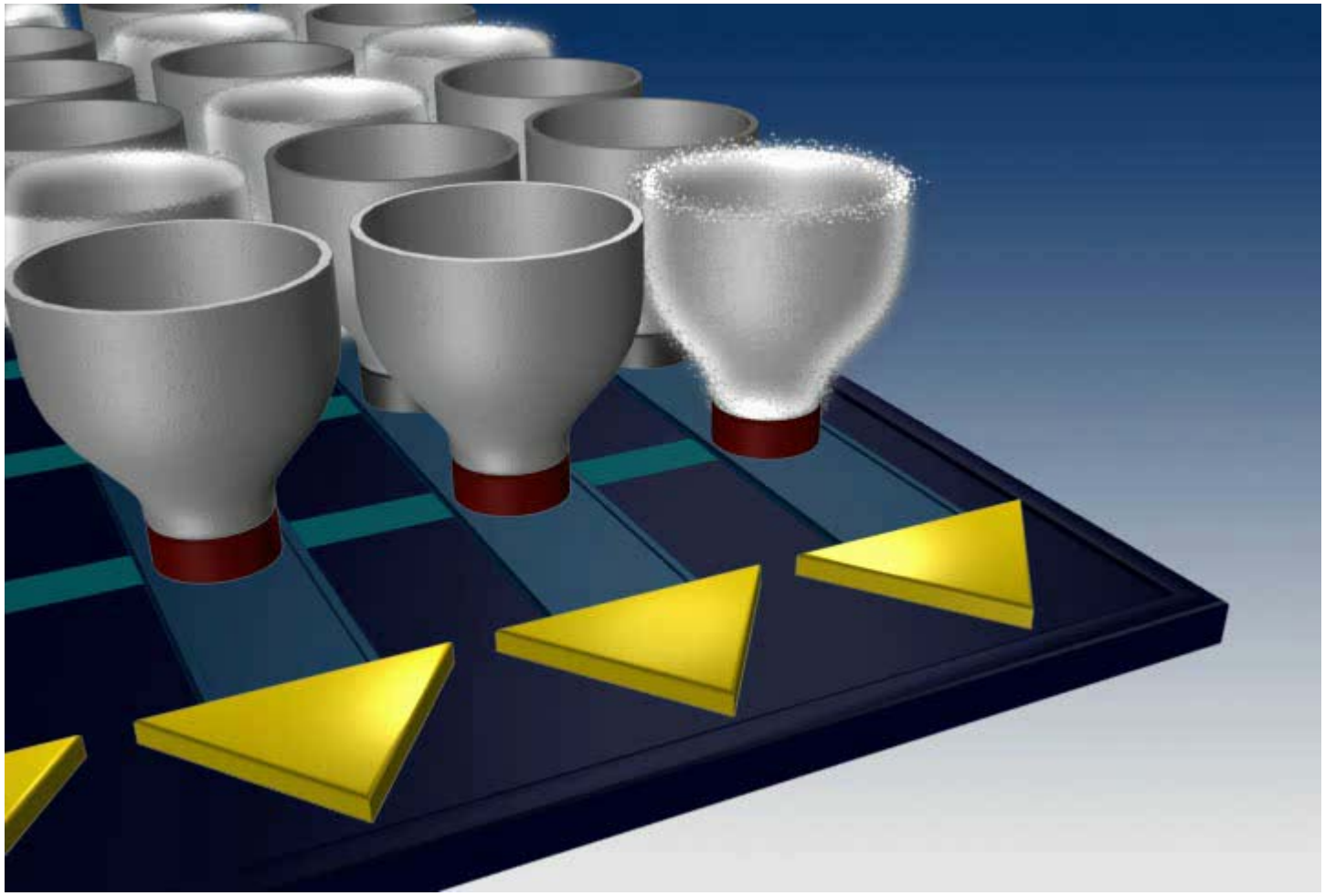
Power and Bandwidth Trends



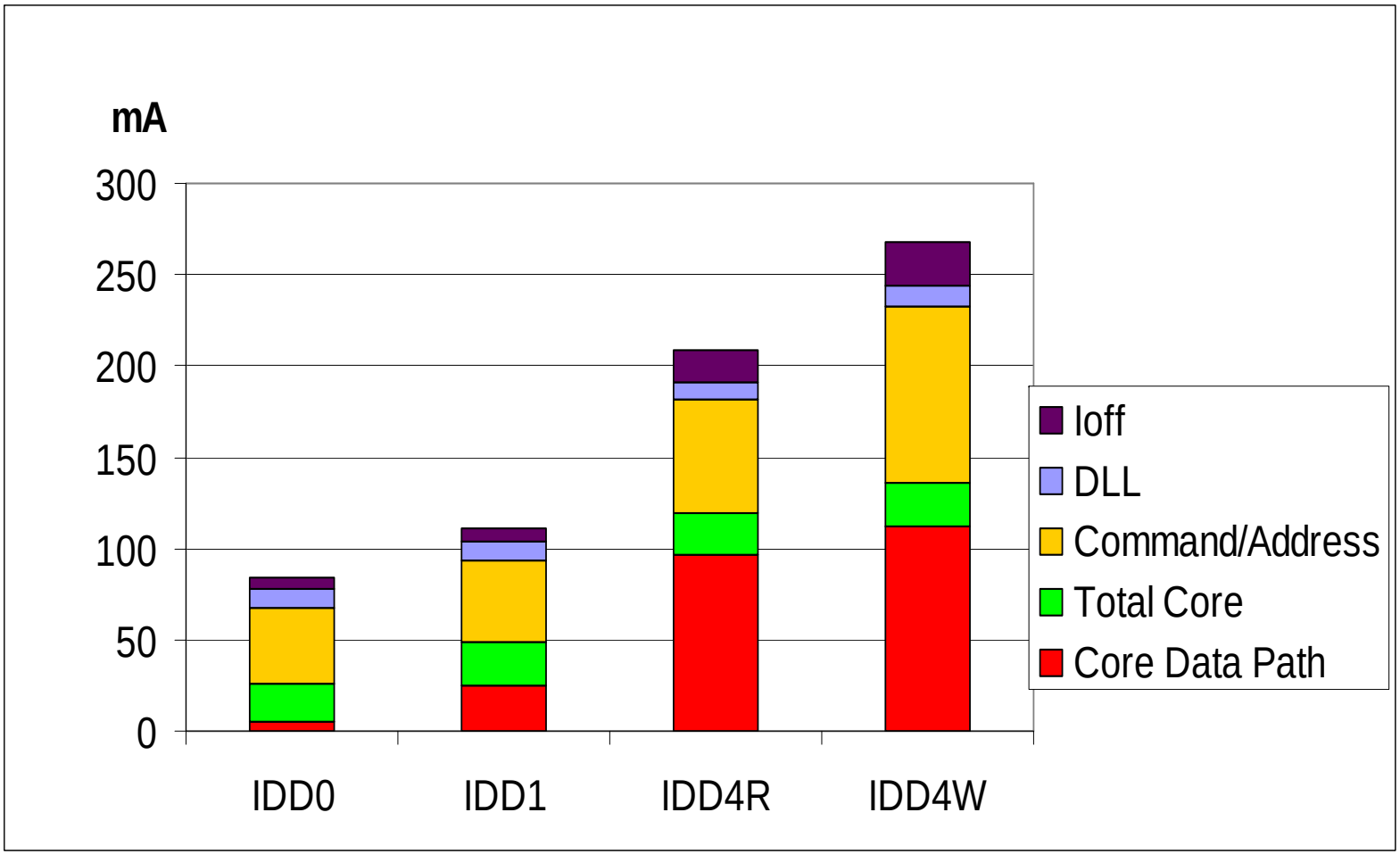
Voltage Scaling Trend



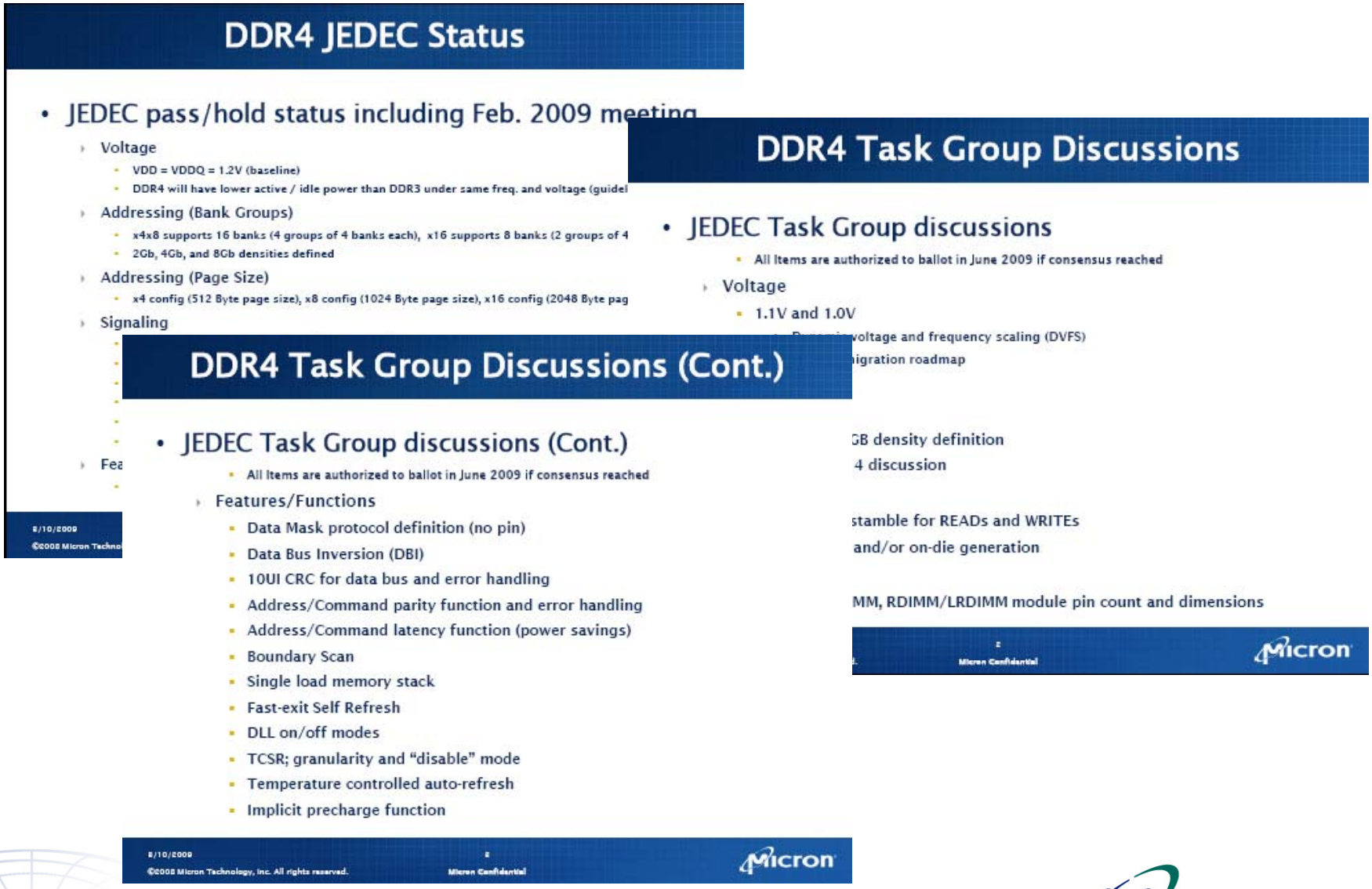
Underlying Physics



Where's the Juice?



DDR4 On Its Way. Hip, Hip…



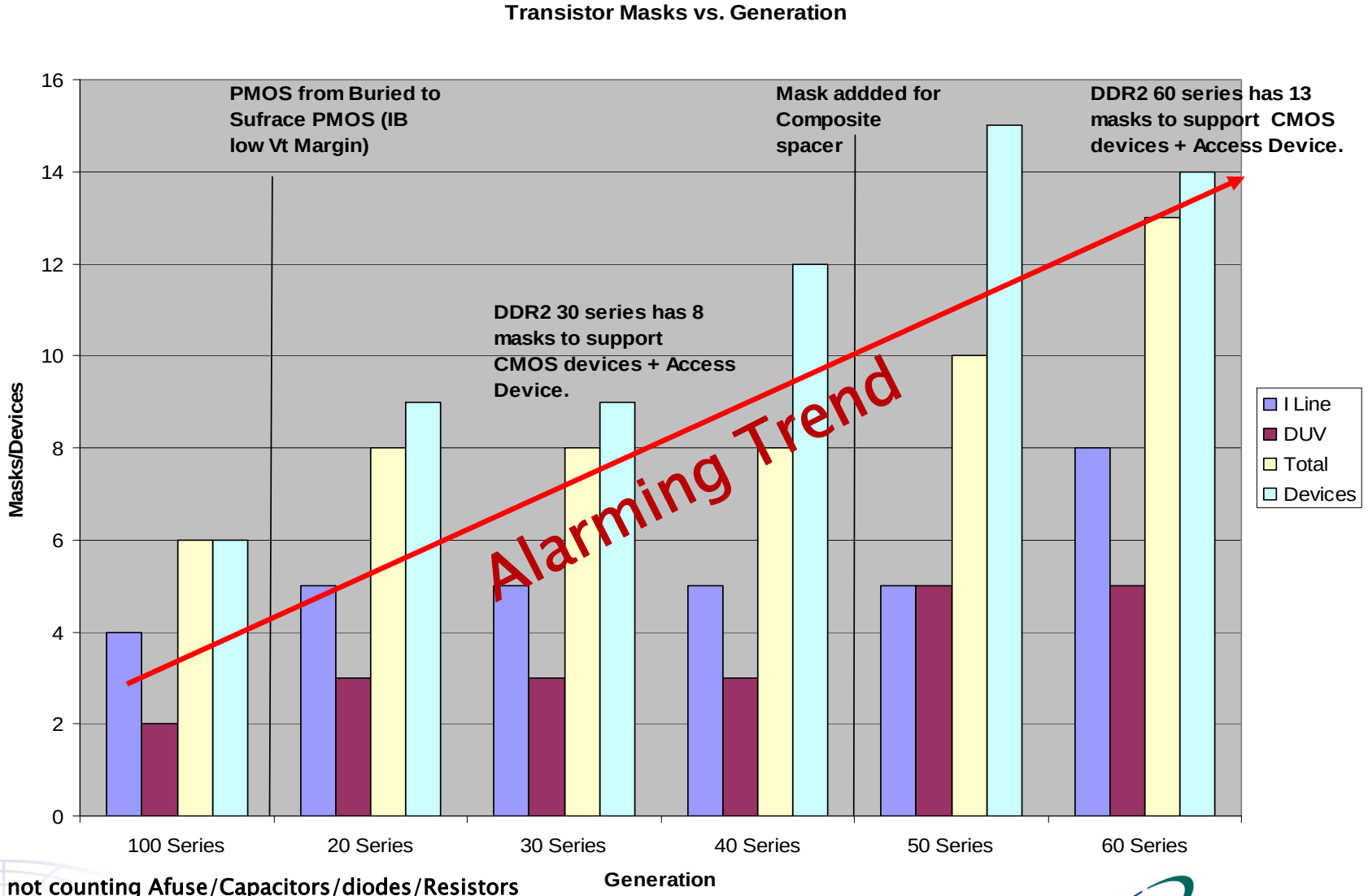
What to do???!!!

- Start a revolution?

What to do???!!!

- Start a revolution!
- Get close to the CPU
- Unlock internal bandwidth
- Allow concurrency
- Cut power dramatically

Transistor Mask Count and Device Support



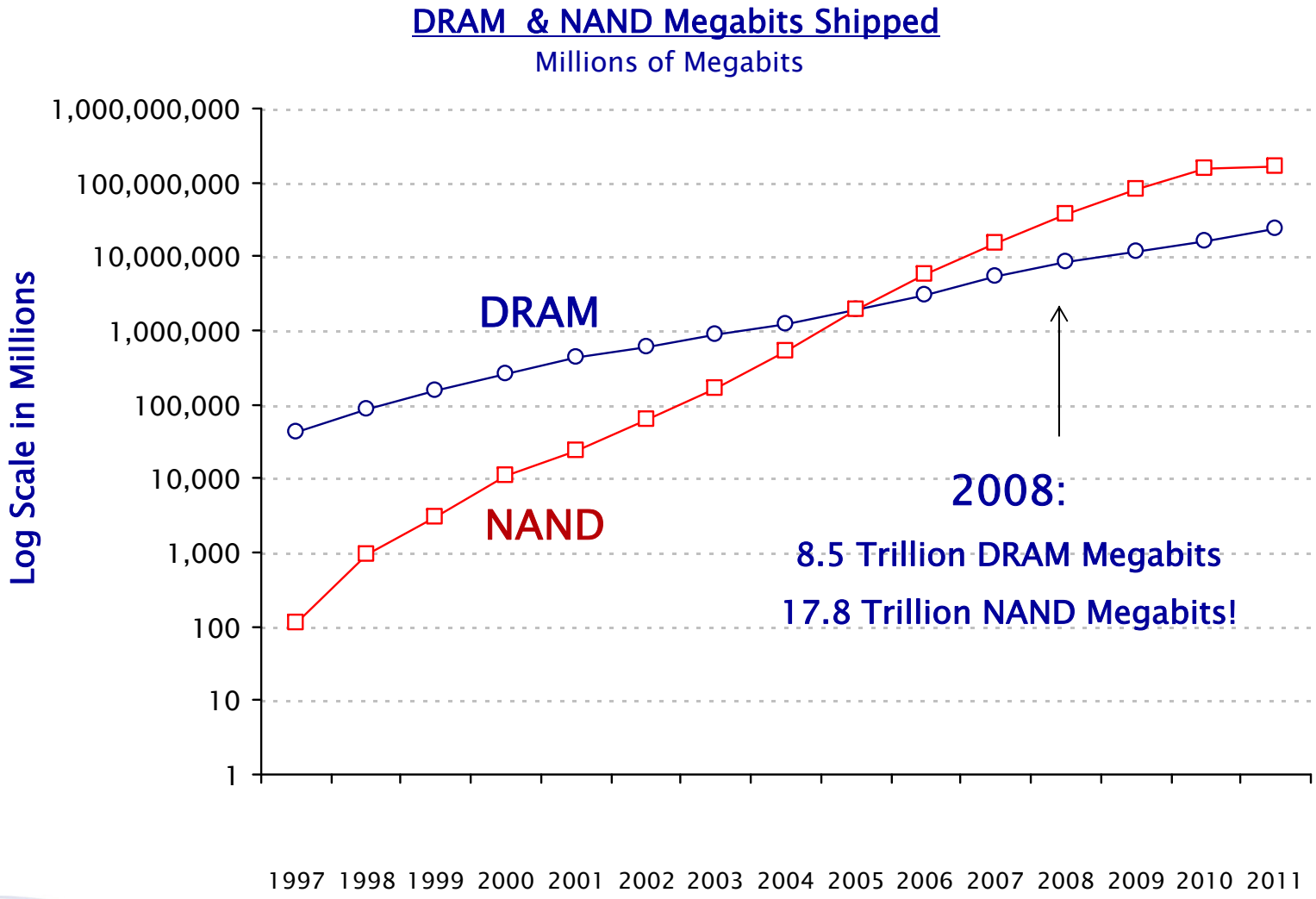
Devices not counting Afuse/Capacitors/diodes/Resistors

Source: KPAREKH

The Role of NAND

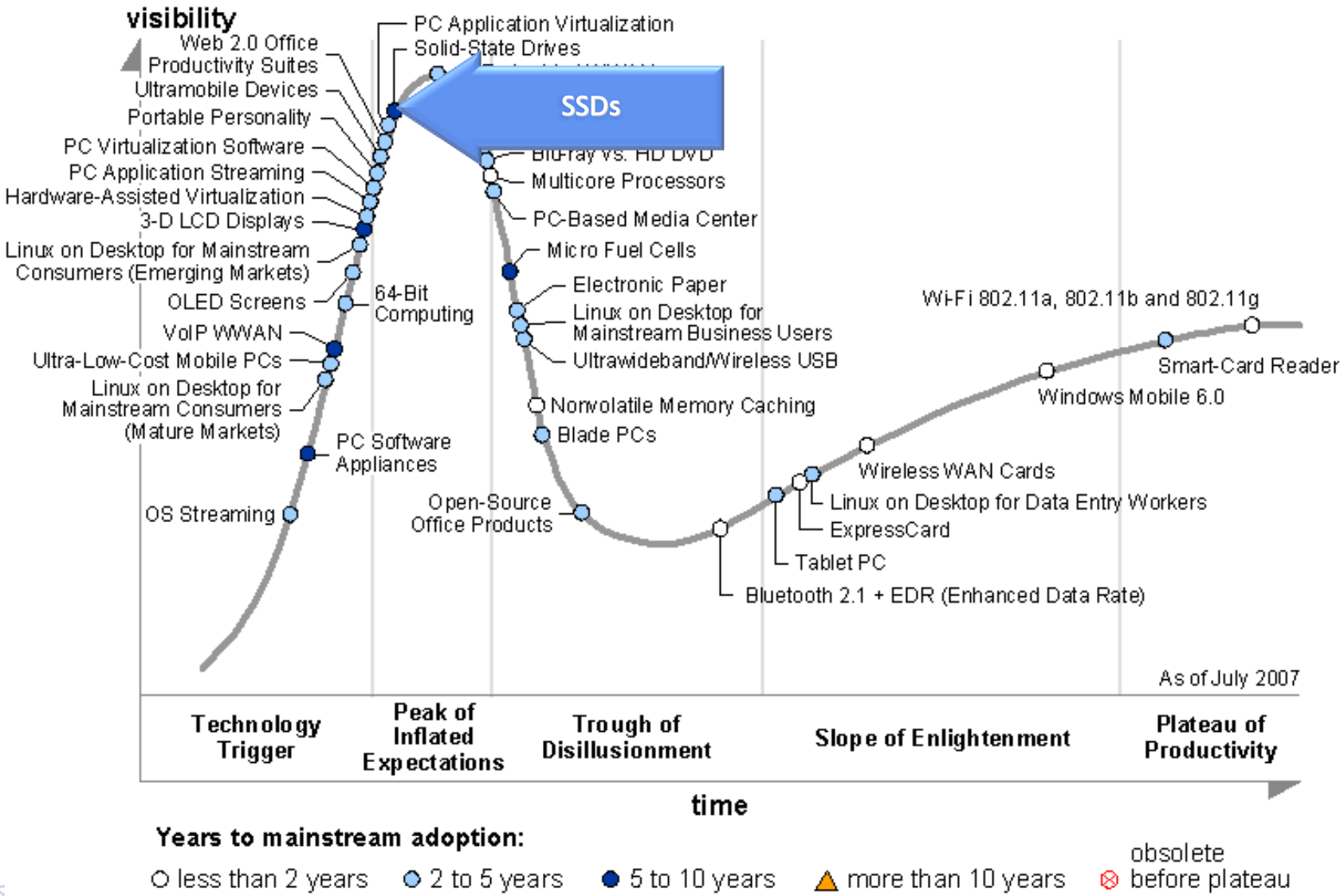
- Low cost bits
- Can we live with the warts?
  - Endurance
  - Speed (Lack of)
  - Block Architecture
- Will it stick around?

NAND Overtook DRAM in 2005 for Total Bits Shipped

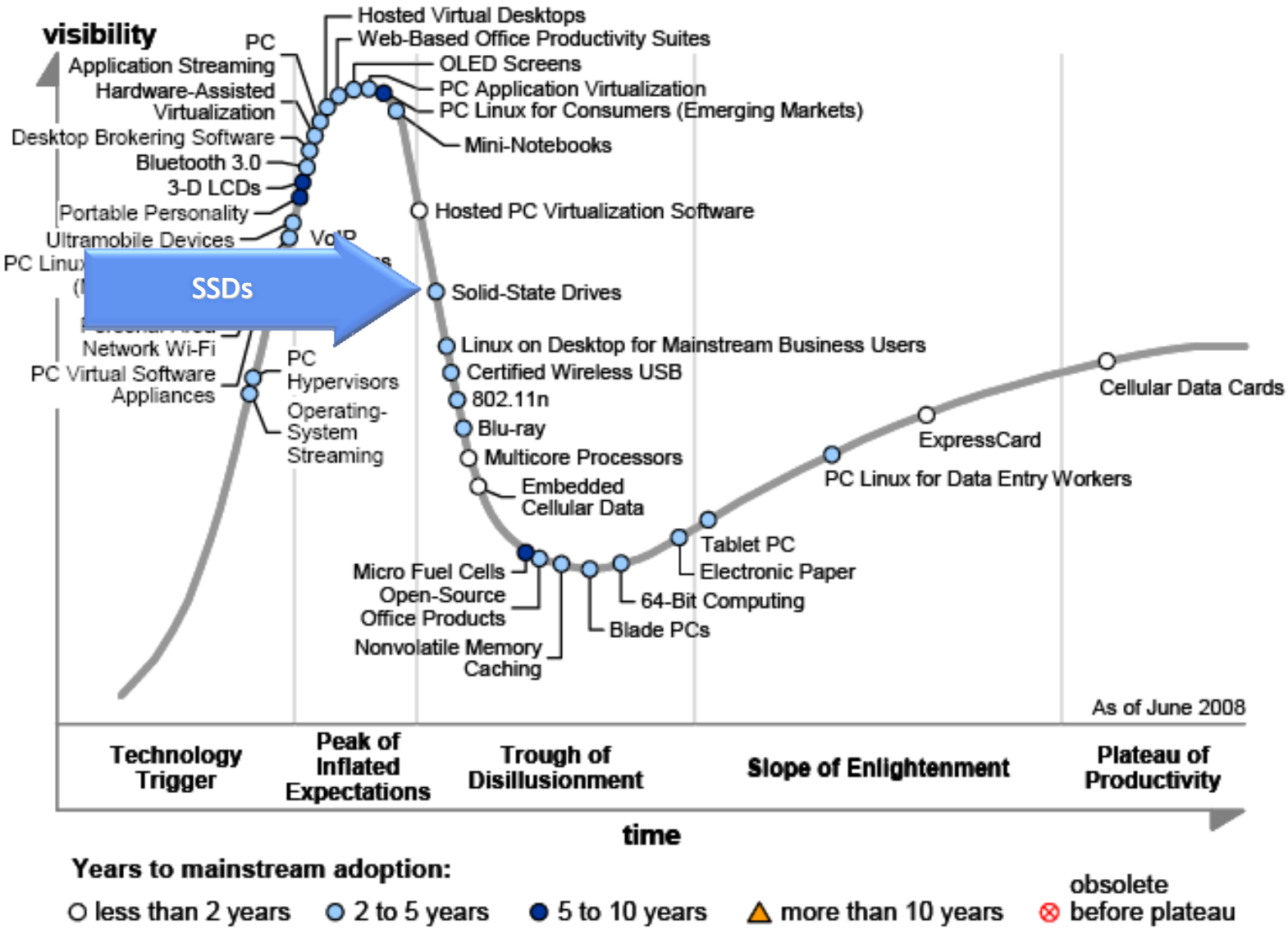


Source: Gartner

Gartner's Hype Cycle for PC Technologies 2007

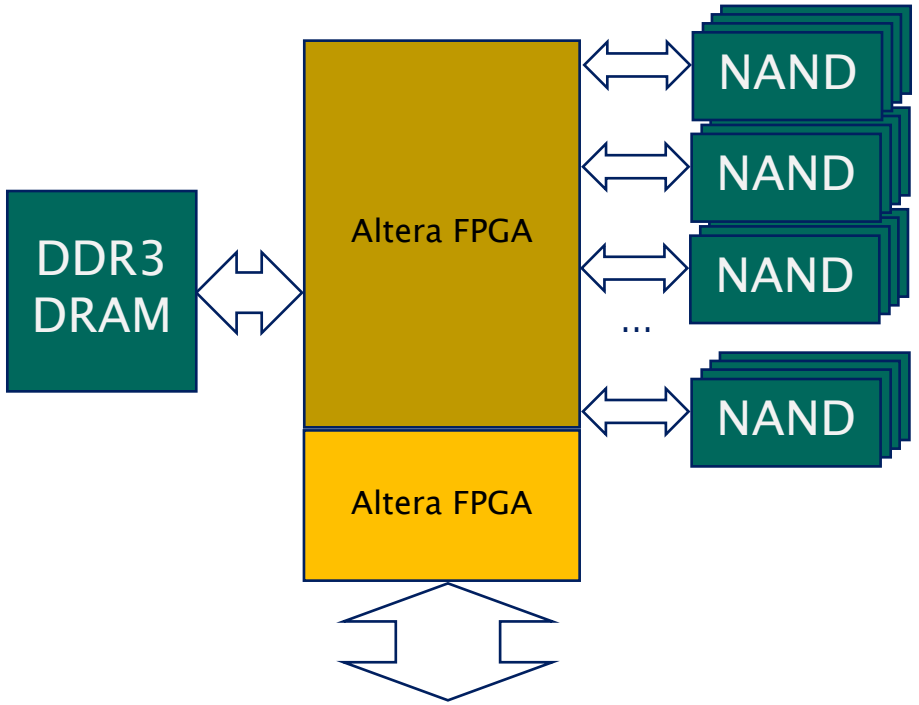


Gartner's Hype Cycle for PC Technologies 2008



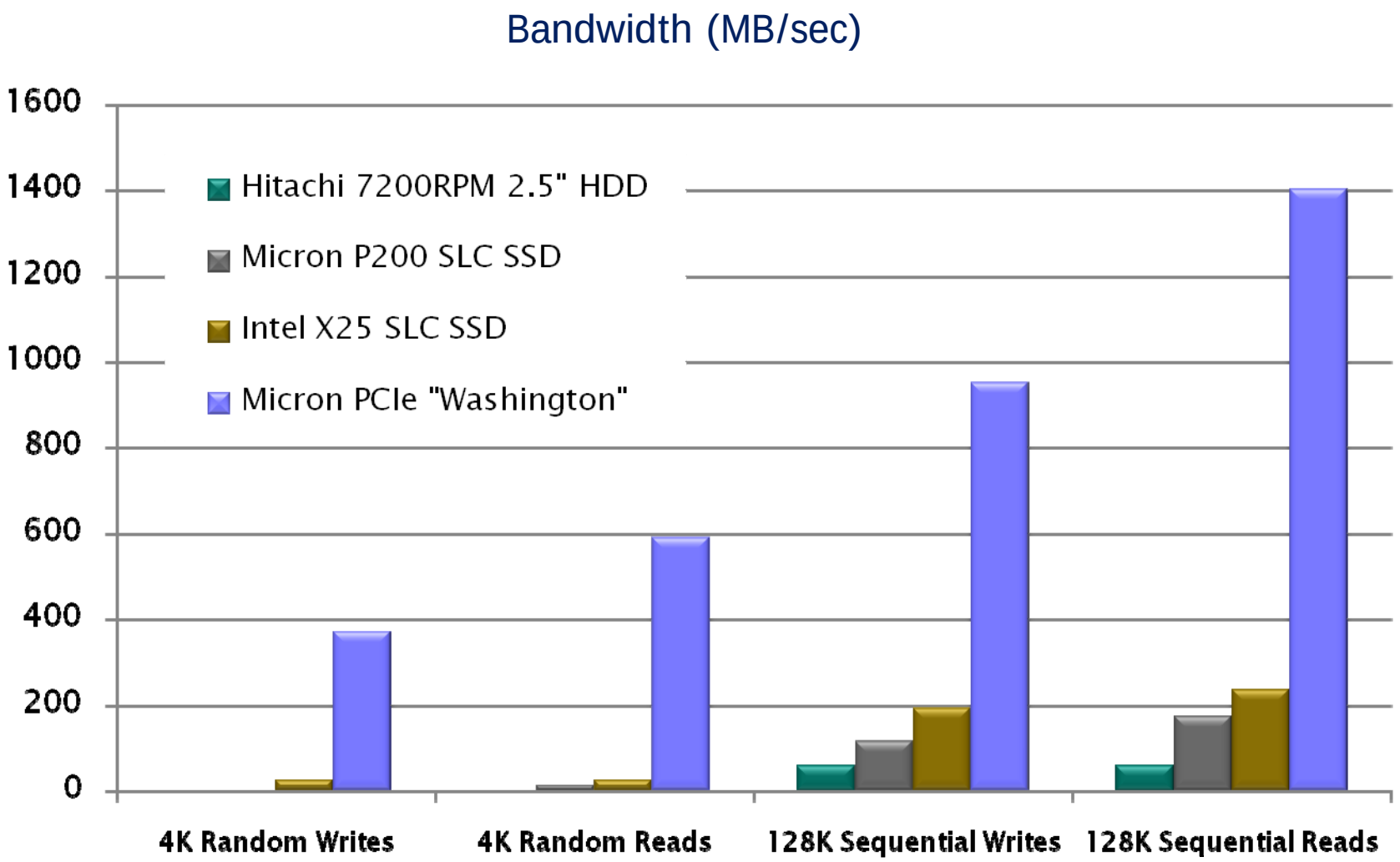
“Washington” Architecture Demo

- PCIe X8 Gen 1
- 16 channels ONFI2.1 NAND, 128GB total
- 1GB DDR3 DRAM
- Two big FPGAs



- 1.4GB/sec Read
- 960MB/sec Write
- >250K IOPS

Washington vs. SSD/HDD



Summary

Sell it at a loss, but make it up in volume…

Summary

- Staying in the memory business requires huge amounts of capital.
- Success is never assured, due to supply/demand imbalance.
- Processes are getting more complex and expensive, as are the designs and the fabs.
- JEDEC serves memory customers.
- The memory hierarchy is expanding. NAND is the disruptor.

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Questions?
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