Getting Results: eCache on a PC Platform

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V.P. Integrated Products

Micron Technology, Inc.

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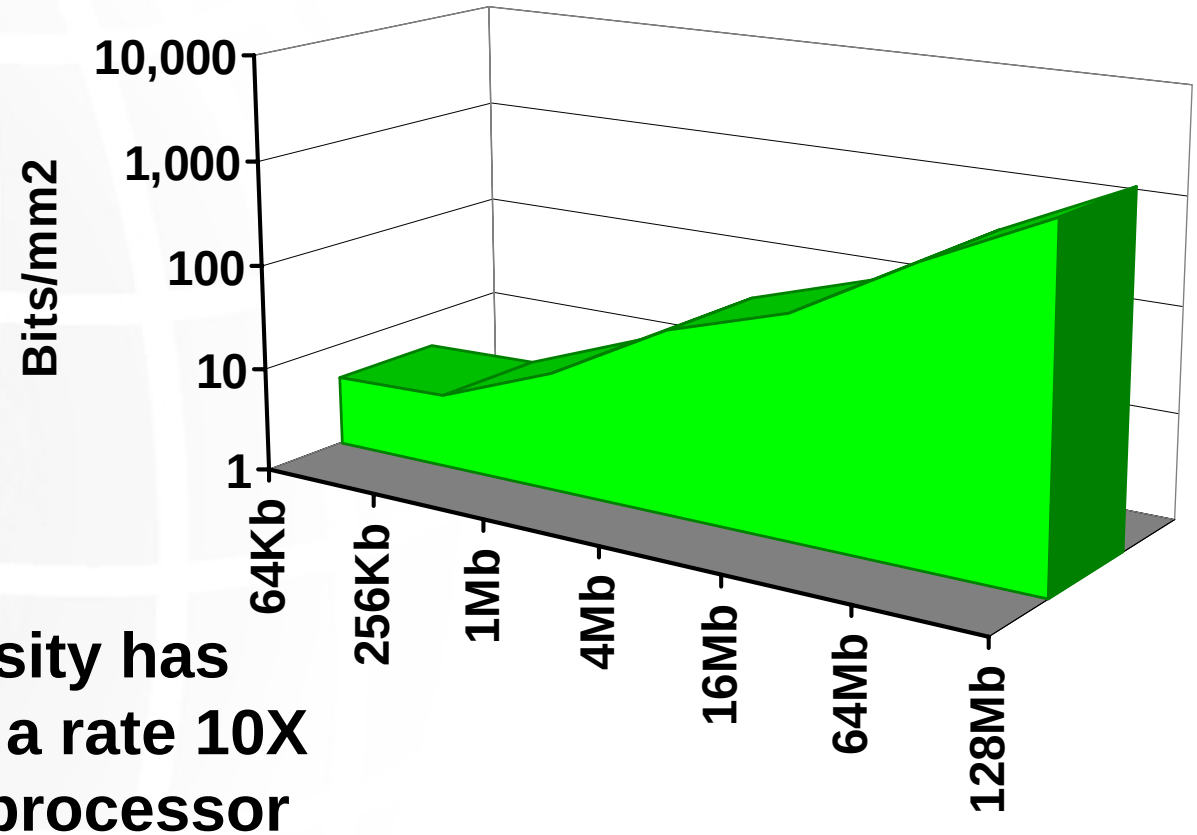
Memory Directions

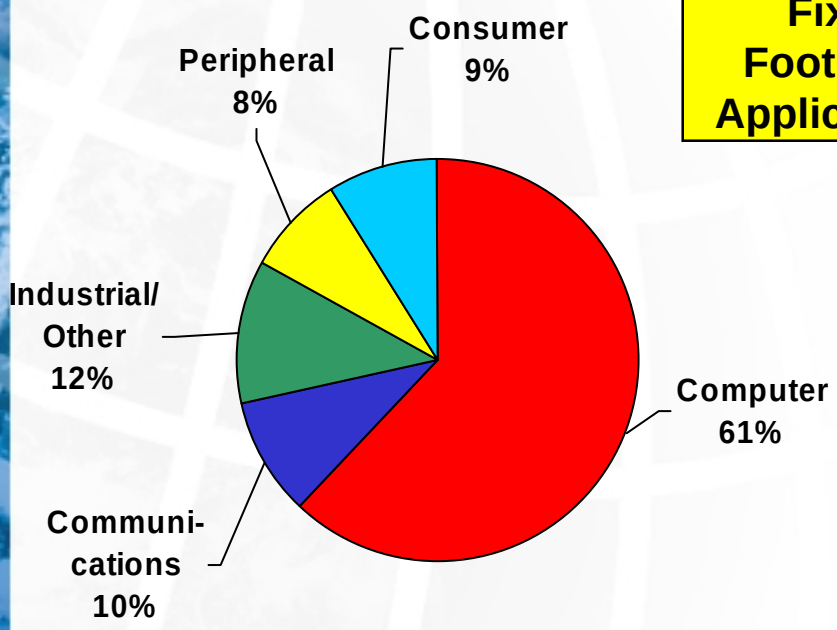


Memory density has increased at a rate 10X over that of processor performance in the past 20 years

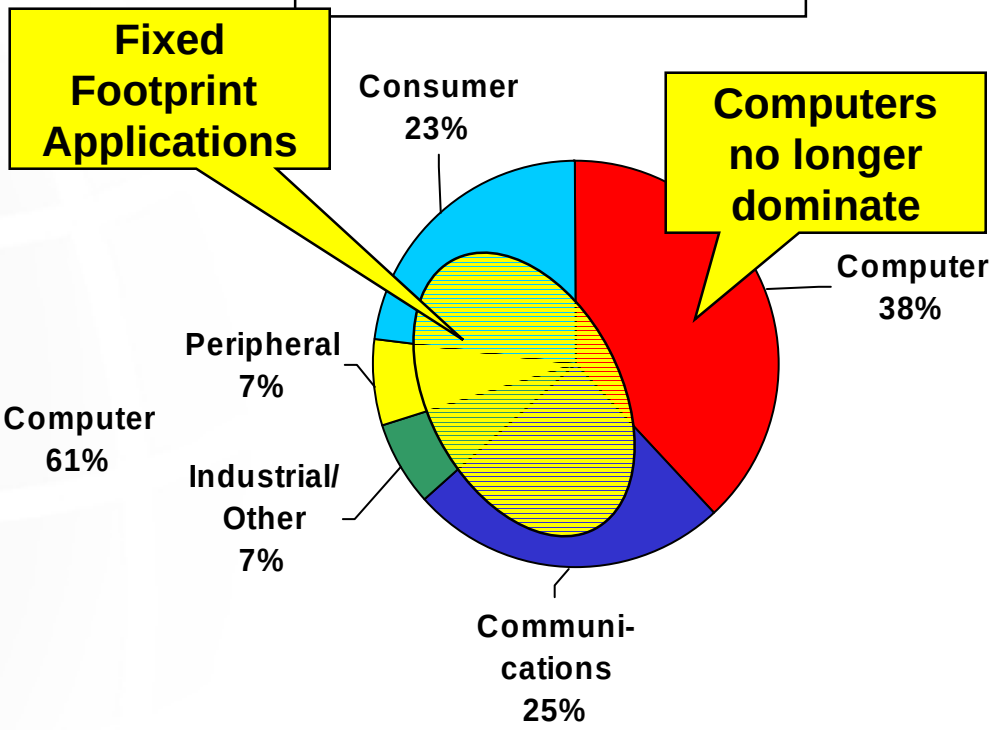
Source: Micron Technology, Inc.

Memory Directions

1999 – $20.7 Billion



2004F – $77.9 Billion



Computer – Desktop PCs, workstations, laptops, servers, etc.

Peripherals – Printers, copiers, monitors

Consumer – Camcorders, digital cameras, DVDs, set-top boxes, TVs, etc.

Communications – Switches, routers, LAN, hubs, cellular phones, modems, etc.

Industrial/Other – Robots, test equipment, medical equipment, automotive equipment (diagnostic equipment), GPS, and military equipment

Source: Semico Research, 1/00

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Micron eDRAM Approach

Logic + Memory
vs.
Memory + Logic

- **Memory-Centric Approach**
  - Greater density
  - Lower cost
  - Reasonable performance
  - Lower power
- **Logic-Centric Approach**
  - Lower density
  - Higher cost
  - Logic-type performance

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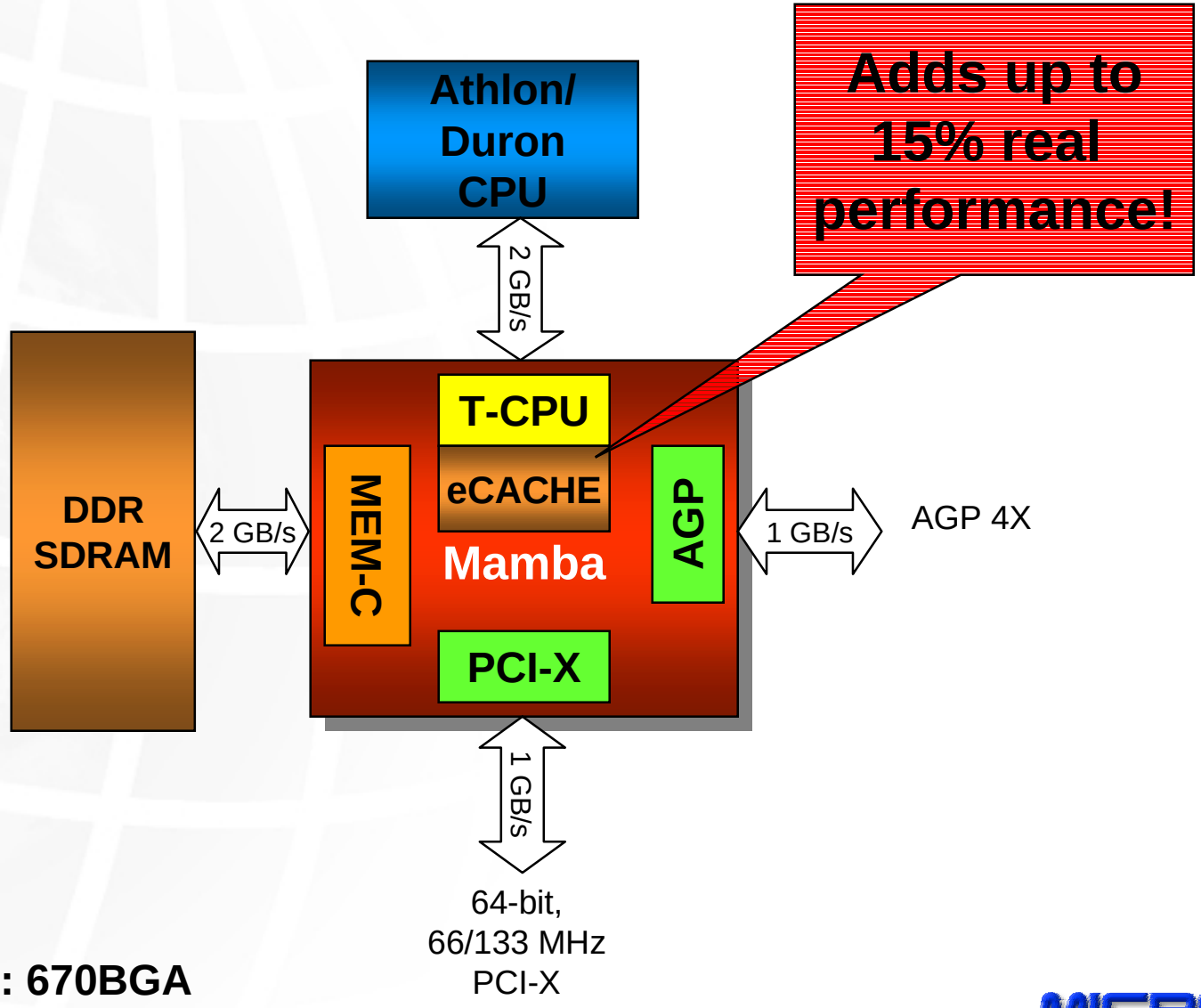
Current North Bridge Component

Wasted silicon wastes money!

What can we do?

eCACHE!

Mamba



Package: 670BGA

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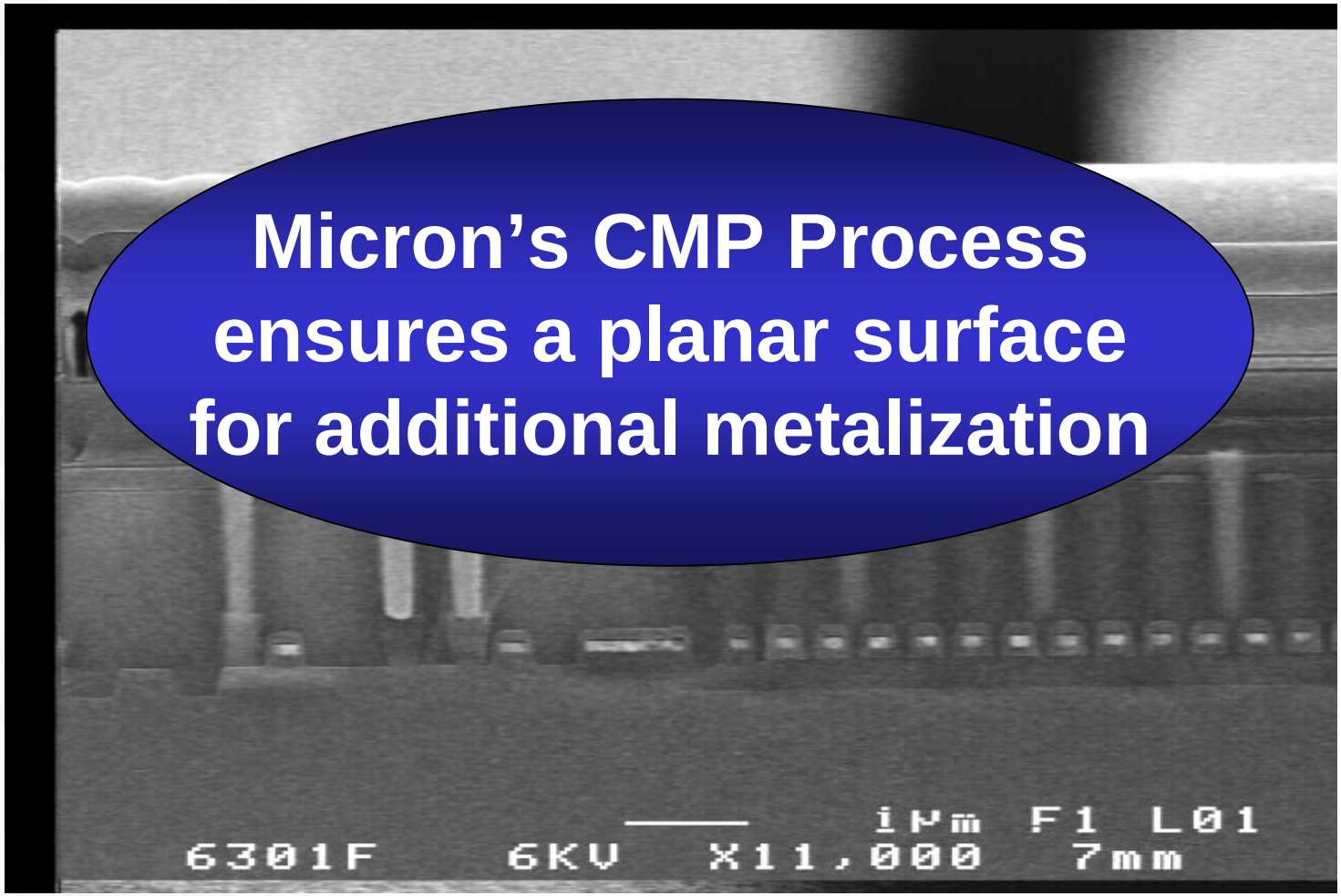
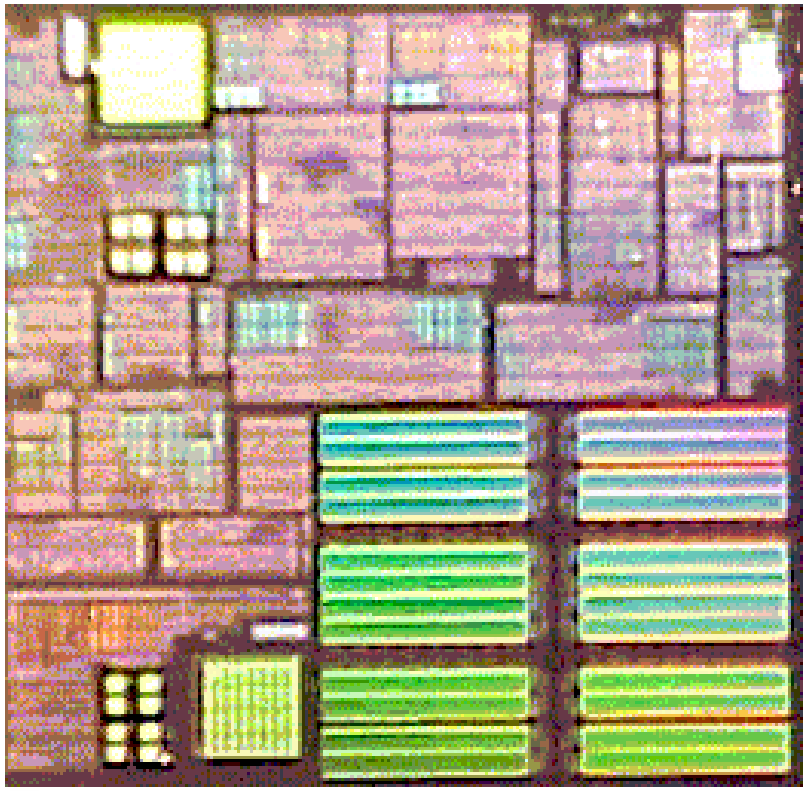
Micron Array Edge

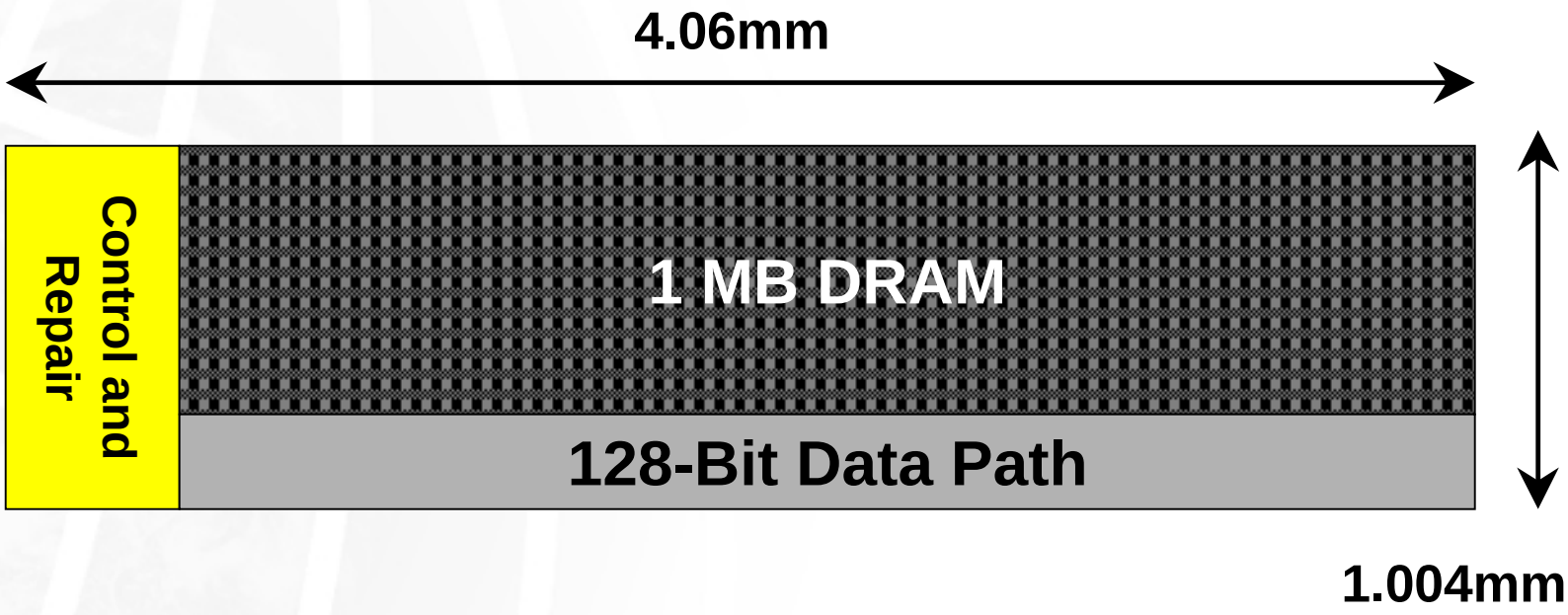


Micron eDRAM: V4400e Statistics

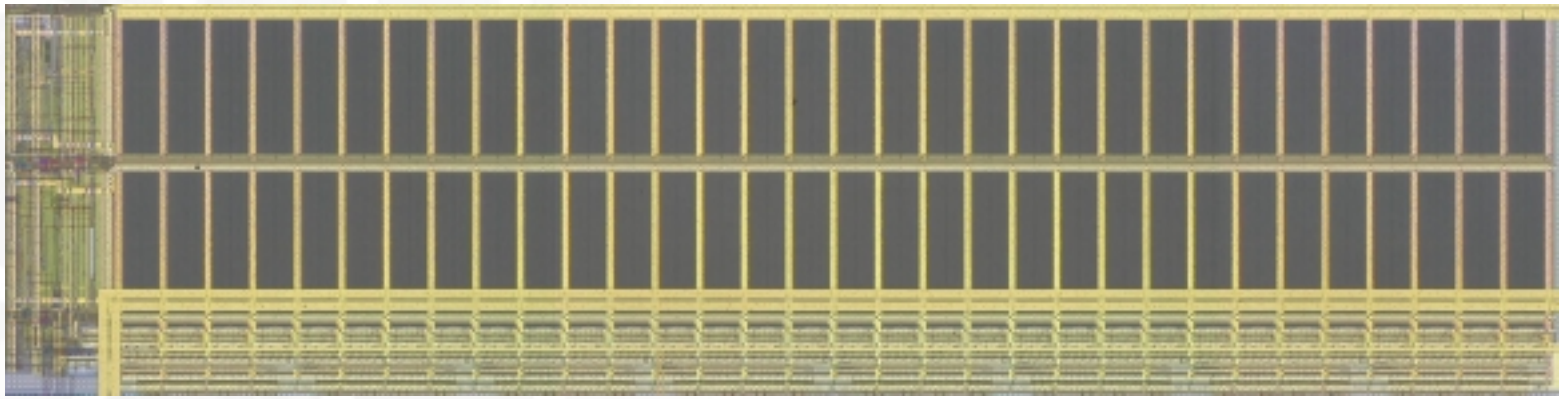
- The NVIDIA GeForce has 23M transistors
- The Intel P-III has 28M transistors
- The Intel P-4 has 42M transistors
- V4400: Over 125M transistors!



Micron's 1MB Core

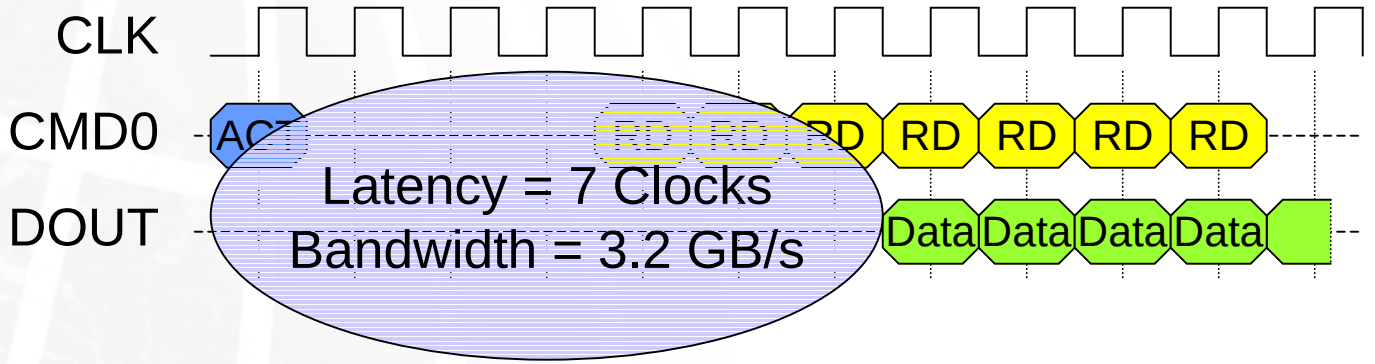


Micron's 1MB eDRAM Core

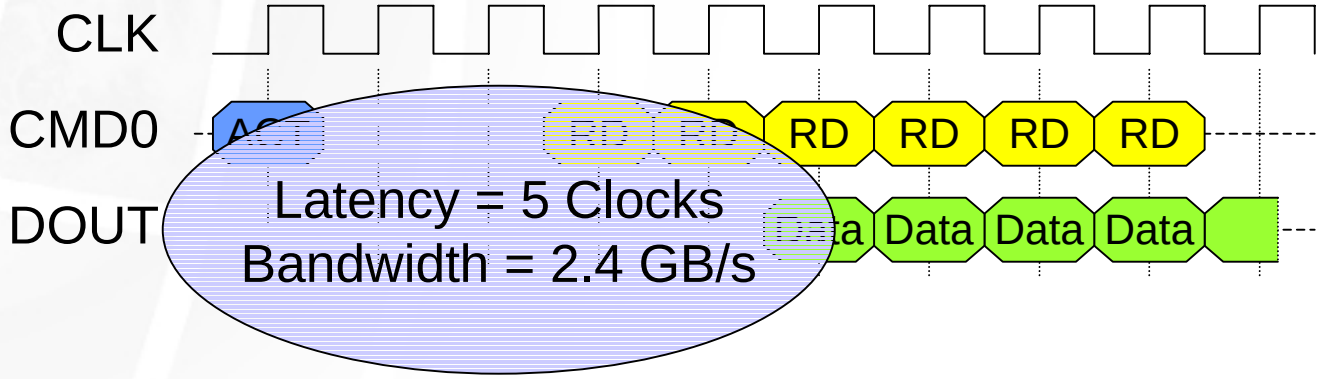


eDRAM Access

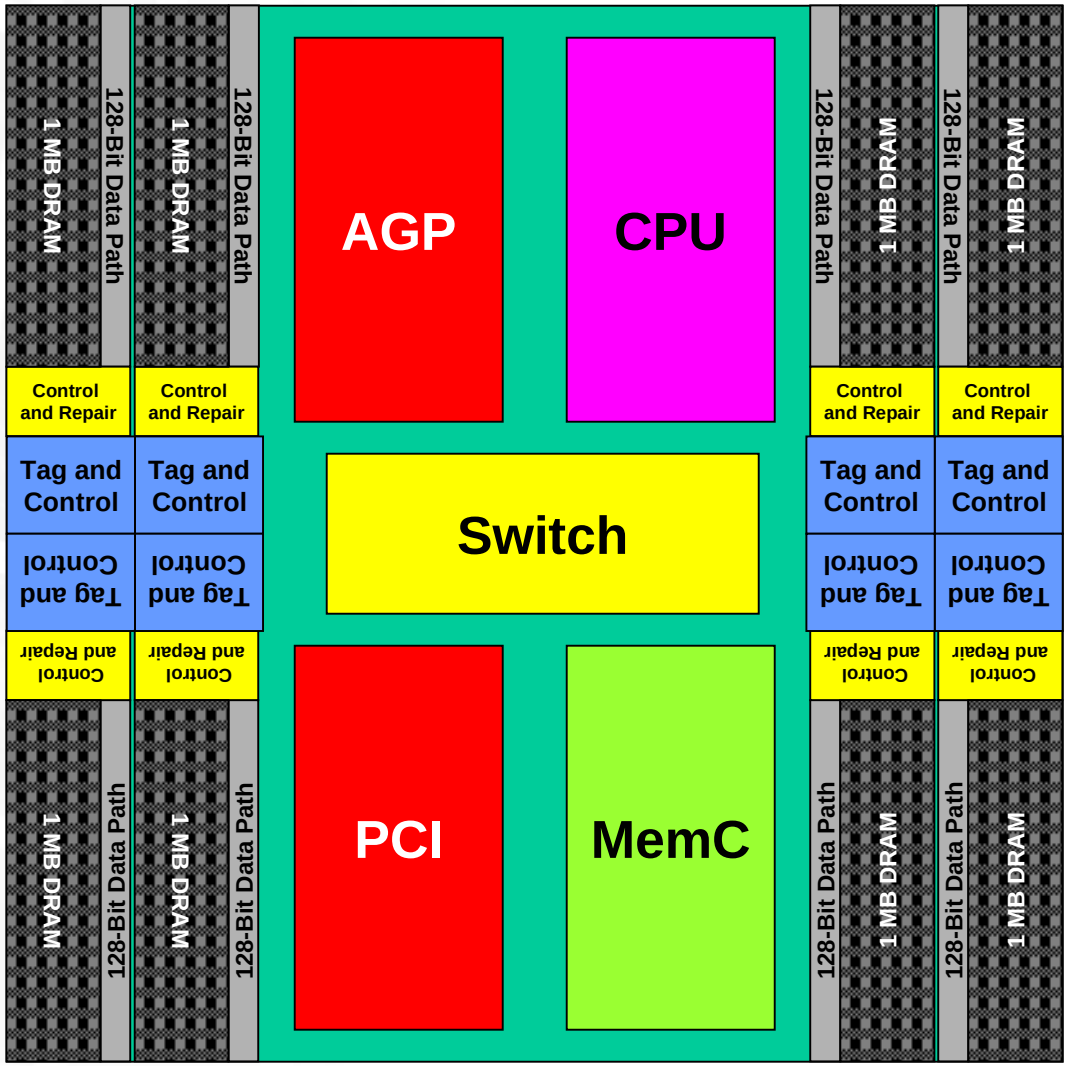
- **Standard eDRAM core**



- **Mamba-enhanced eDRAM core**



Mamba eCache



eCache Bandwidths

- eDRAM aggregate bandwidth is limited only by die size
- eCache aggregate eDRAM burst bandwidth is over 19 GB/s
- As implemented, allows simultaneous access to four arrays and four device ports, with a sustainable bandwidth from memory of 9.6 GB/s
- Command, access, refresh and precharge times can be overlapped, allowing sustained 9.6 GB/s

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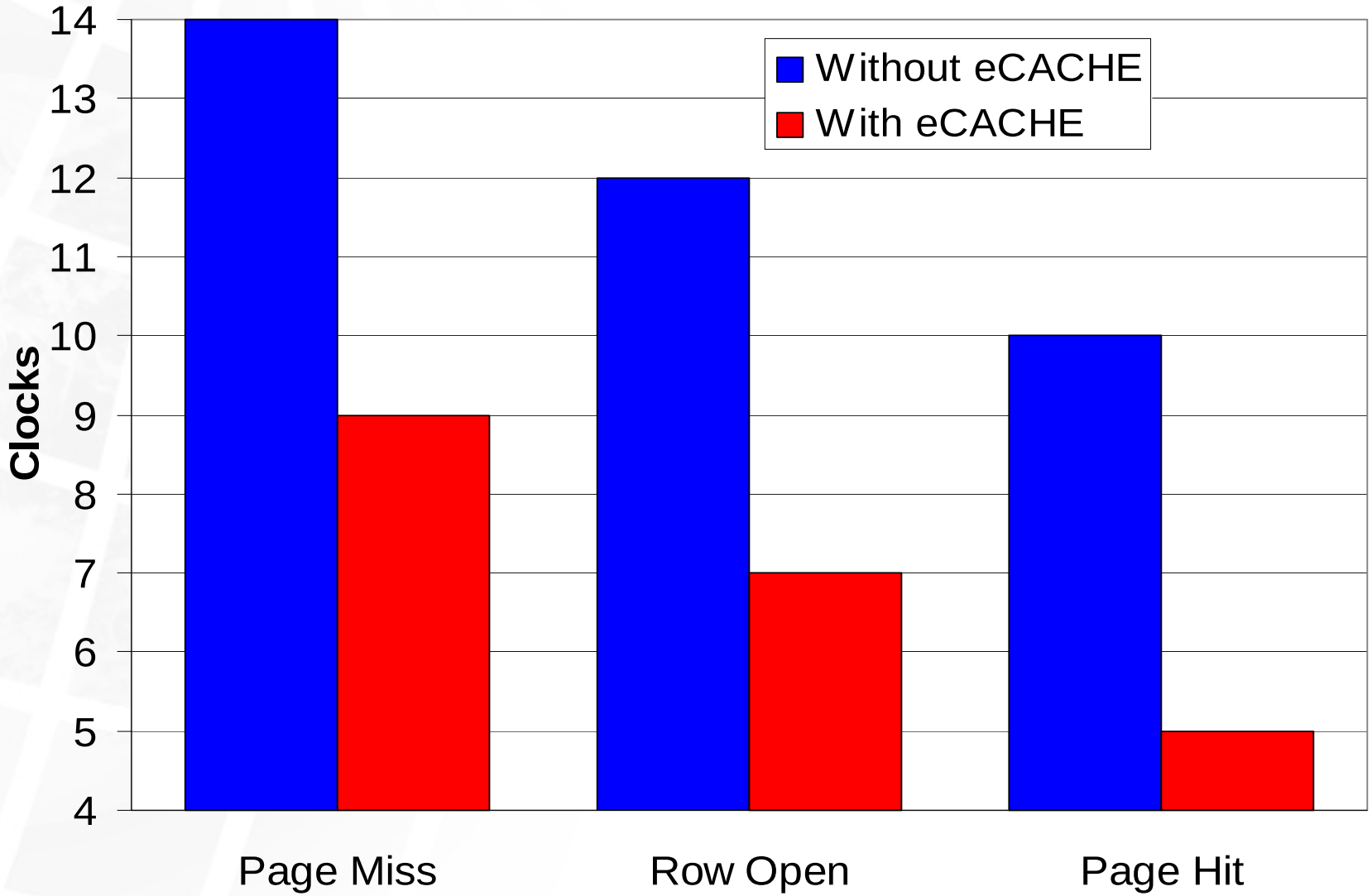
eCache Latency



(DRAM shown with 2-2-2 timing, 3-3-3 is worse)

Micron eDRAM eCache

- Embedded DRAM can be built cost effectively
- Embedded DRAM can improve performance both on-chip and off chip
- Embedded DRAM granularity allows size to be tailored to fit application
- Architectural decisions made with eCache allow low latency and high bandwidth
- Core logic architecture allows maximum utilization of eCache

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