IBM Deep Computing – Systems & Technology Group

petaScale Computing Outlook

Falls Creek 2006

Global Technology Outlook 2006

Global Technology Outlook

"I think there is a world market for maybe five computers."

Thomas Watson, chairman of IBM, 1943

"Computers in the future may weigh no more than 1.5 tons. "

Popular Mechanics, 1949

"There is no reason anyone would want a computer in their home. "

Ken Olsen, founder of DEC, 1977

"640K ought to be enough for anybody. "

Bill Gates, 1981

"Prediction is difficult, especially about the future"

Yogi Berra

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Technology Update

CMOS technology will continue to evolve for at least 10 more years but in fundamentally new ways

- The explosion of leakage currents and increasing variability in device characteristics are the critical challenges for the semiconductor industry
- In the near term CMOS will evolve through the infusion of new materials, process integration, device structures, and tailored layouts
- In the long term ultra-low voltage devices and circuits will emerge to mitigate the CMOS power crisis, enabling 3D Si integration and the concomitant density scaling
  - New packaging approaches will be crucial for the evolution of the industry
- Random variability is limiting SRAM scaling now and becoming an increasingly important factor in logic
  - On-chip monitoring and control will result in higher yield but will require accommodation of clock frequency variation

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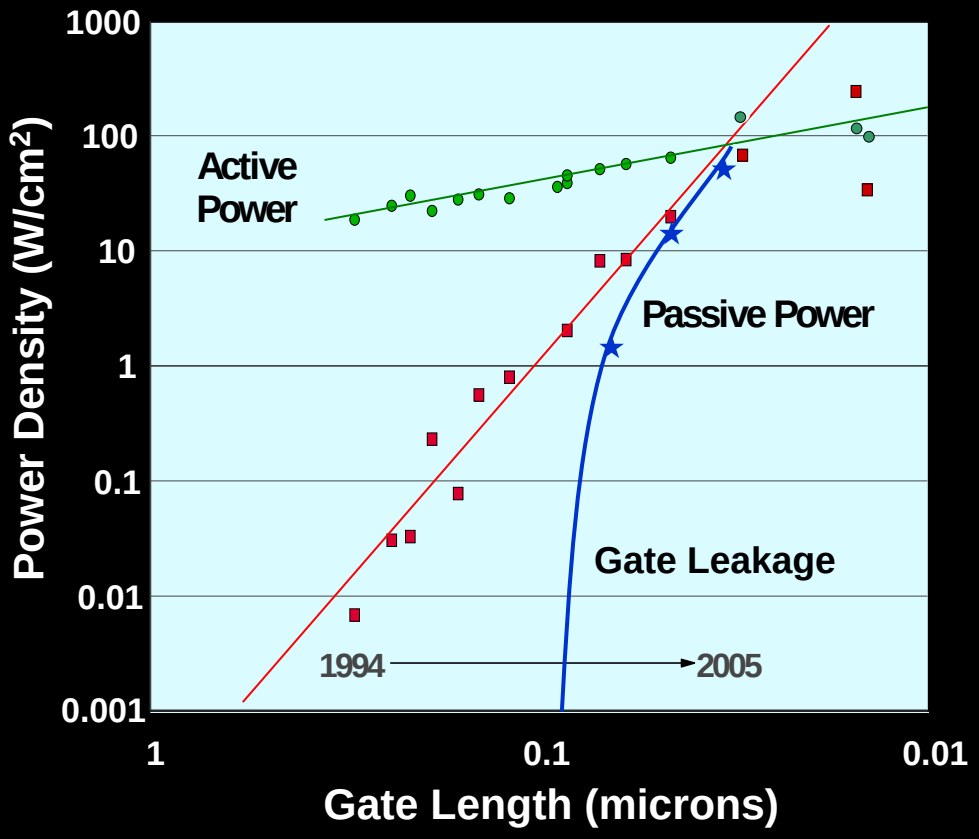
Passive Power Continues to Explode

- Power components:
  - Active power
  - Passive power
    - Sub-threshold leakage (source-drain leakage)
  - Gate leakage



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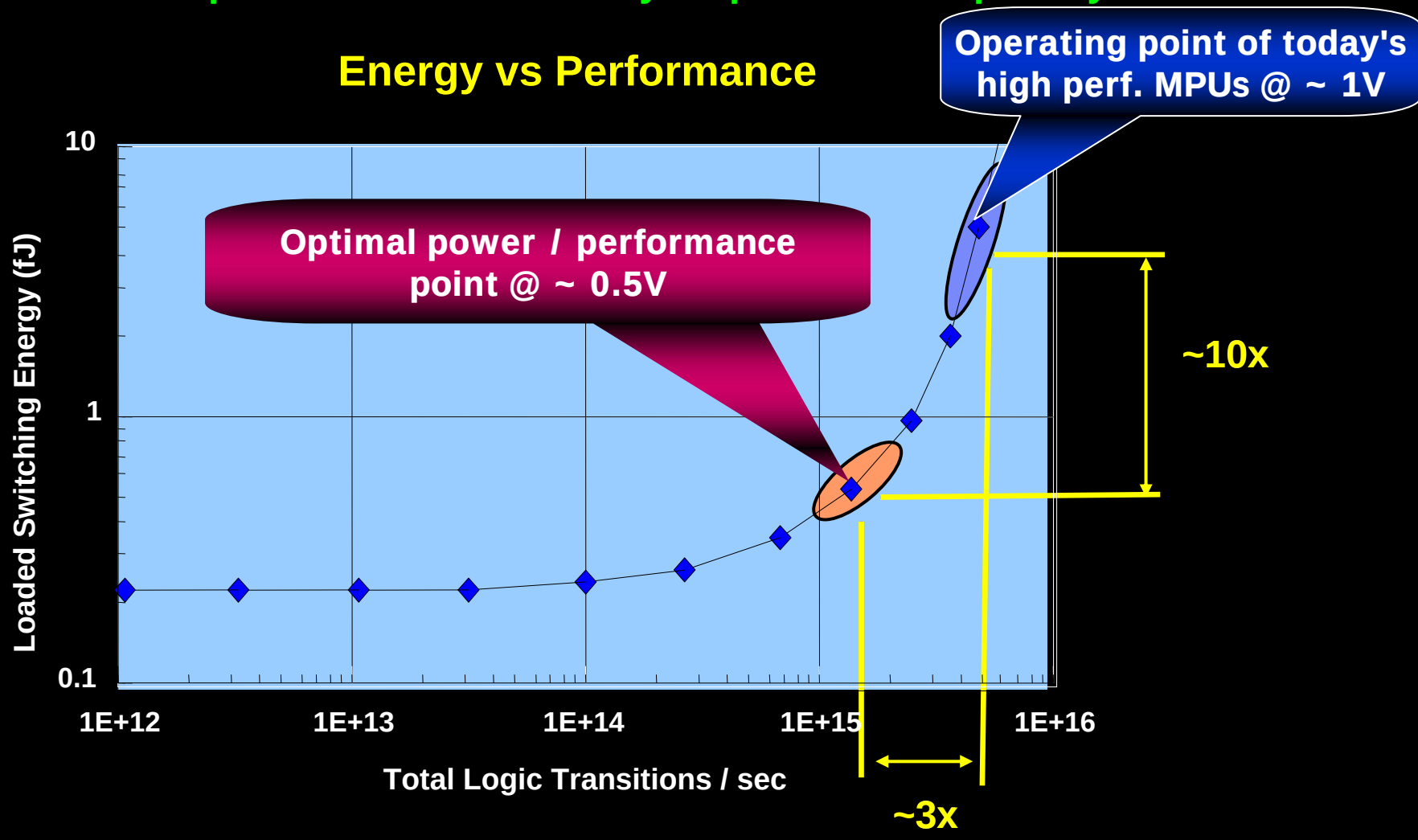
Moving to an Ultra-Low Voltage Operating Point

10X power reduction for only 3X performance penalty



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petaScale computing challenges

- Architecture affinity differs with problems/algorithms
- FLOPs are not equal
  - Bluegene
  - Cell
  - Power7
  - EM64T
- Extracting parallelism from software is difficult
  - FPGA – 96 way SIMD
  - Multi-core chips with limited increase in memory transactions
- Plan to develop multiple petaScale systems
  - Varying attributes
  - Hybrid combinations
- Major focus on software scalability
  - Middleware, OS, compilers, interconnects

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petaScale computing challenges

- 1 PetaFlop/s sustained over a wide range of applications suggests peak performance targets of 3-10 PetaFlops
- Assuming ASCI ratios, 5 PetaFlop/s peak performance implies:
  - 2.5PB of DRAM memory
  - 100PB of Disk Storage
  - 5TB/s Bandwidth to Disk
- DRAM price estimates for 2010 range from 44 to 124 per MegaByte
  - @44/MB, 2.5PB of DRAM costs $100M
  - Form factor and quality affect price
- 5TB/s Storage bandwidth in 2010 is estimated to require ~150,000 drives.
  - Bandwidth requirement dominates the capacity requirement (100PB)
  - Costs could be in the $60-$100M range
  - Floor space and power implications

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