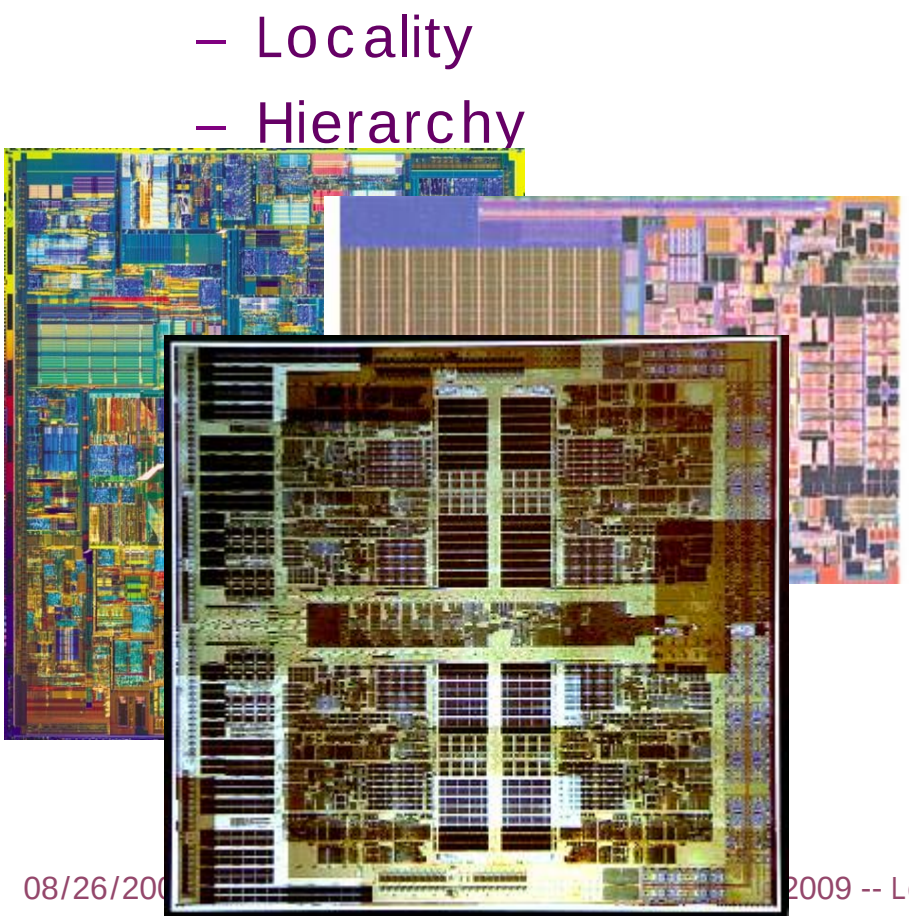
EE382N-22 (17208): Computer Architecture
Parallelism and Locality
Fall 2009

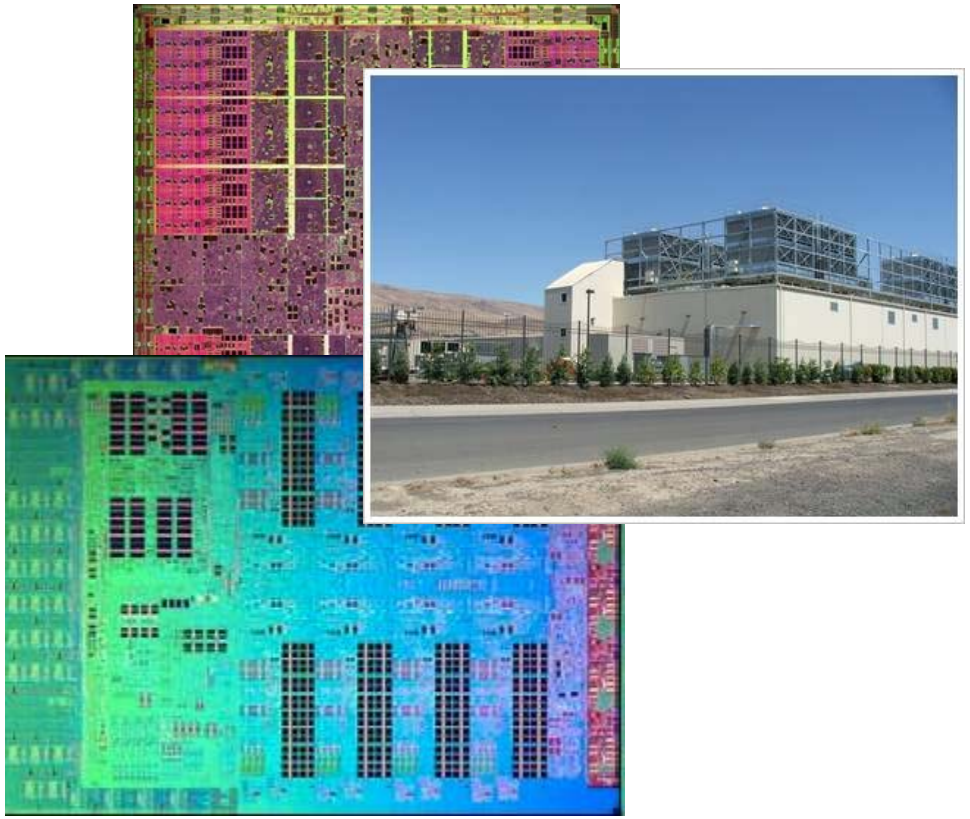
Mattan Erez

The University of Texas at Austin

What is this class about?

- Computer architecture
- Principles in computer architecture
  - Parallelism
  - Locality
  - Hierarchy





What is this class about?

- Computer architecture
- Principles in computer architecture
  - Parallelism
  - Locality
  - Hierarchy
- Advanced class computer architecture
  - Problems
  - Principles
  - Solutions
- Get some original research started

Outline (for today)

- Why you may want to listen to me
- Quick intro to computer architecture
  - What is it
  - What are the main challenges today
- What are parallelism, locality, and hierarchy
  - Why are they principles
  - How do they address the challenges
- Topics we'll cover in class
- Class procedures and expectations
- Other technicalities

About myself

- Education
  - B.Sc. Electrical Engineering, Technion, Israel
    - **Communications, signal processing, electro-optics**
  - B.A. Physics, Technion, Israel
  - M.S. & Ph.D. Electrical Engineering, Stanford, CA
- Experience
  - Intel microarchitecture research:
    - **Speculative execution, branch prediction, prefetching, …**
  - Stanford SmartMemories project
    - **Multicore**
  - Stanford Merrimac Streaming Supercomputer
    - **Streaming hardware, compilers, and applications**
  - Stanford Sequoia Programming Model
    - **Hierarchical, bulk, and asynchronous programming system**

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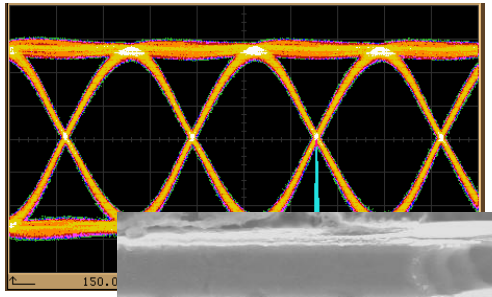
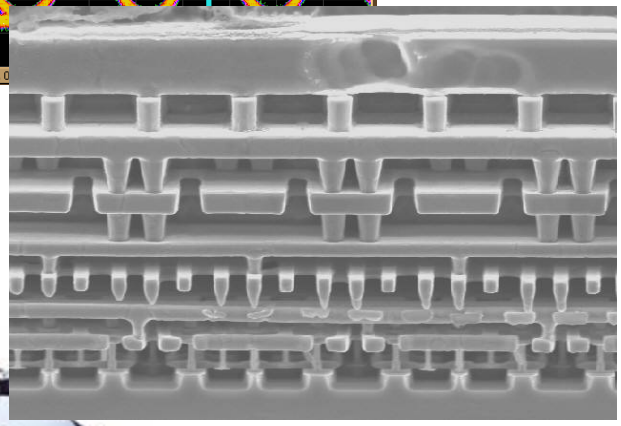
What is Architecture?

Form follows function **Louis Sullivan**

Computer Architects Match Hardware Technology with User Requirements





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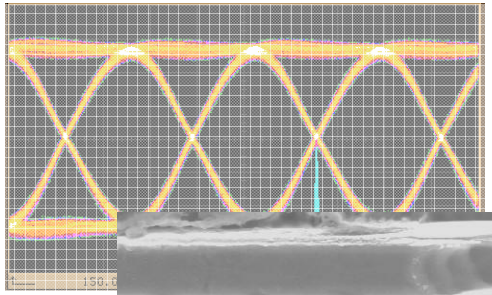

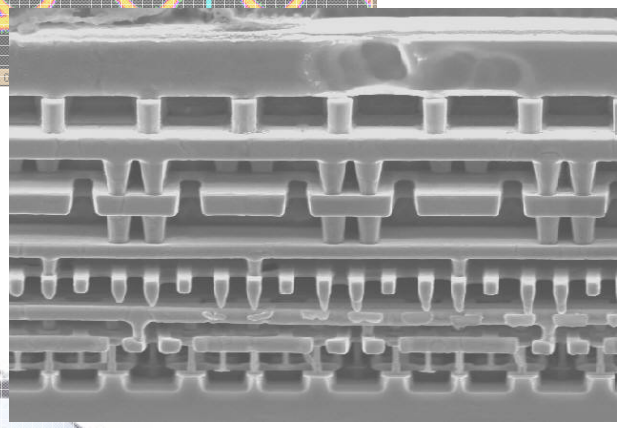

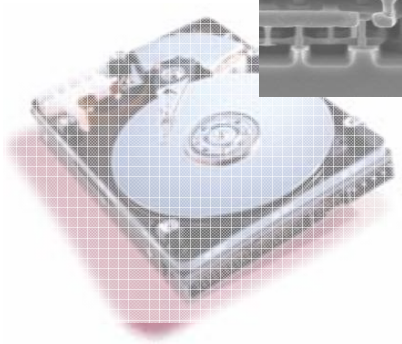

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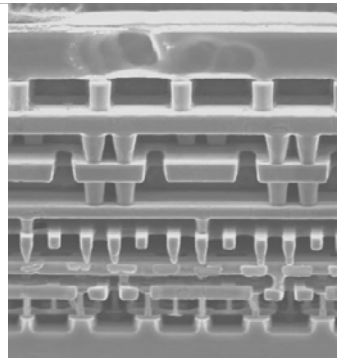

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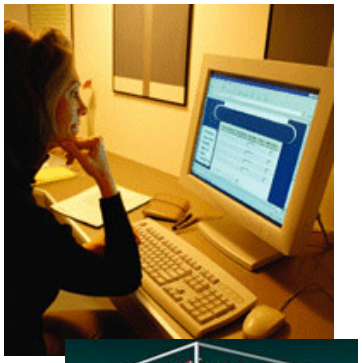

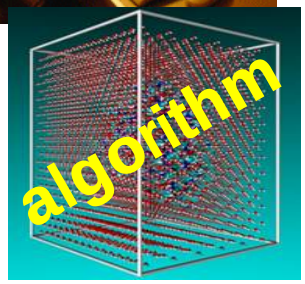

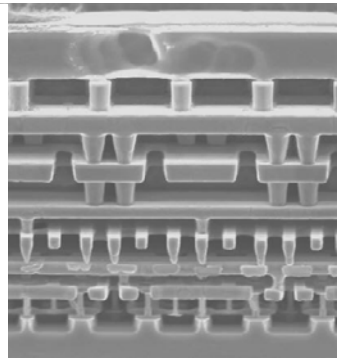

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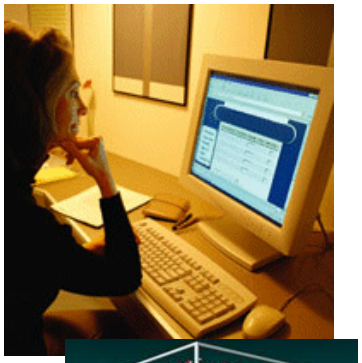

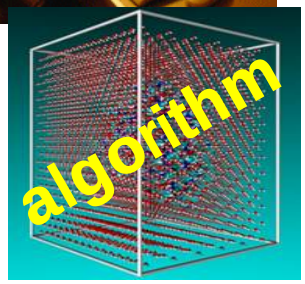

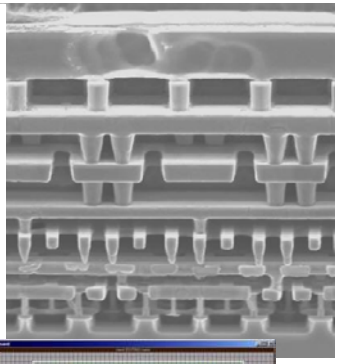

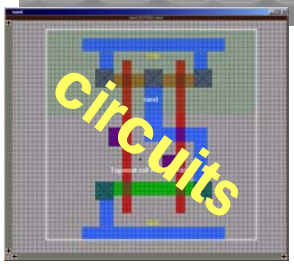

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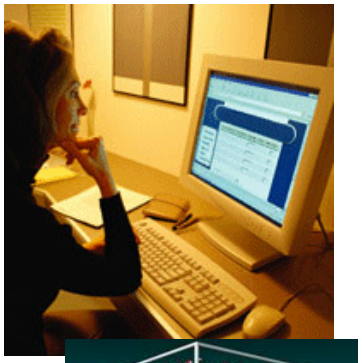

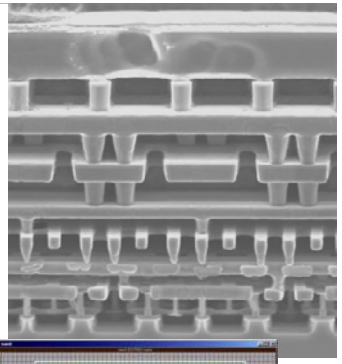

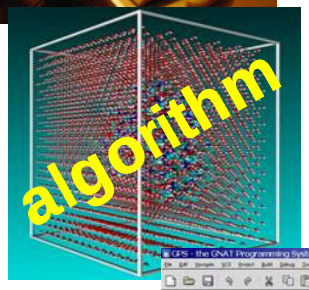

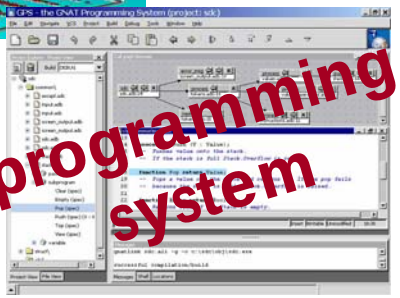

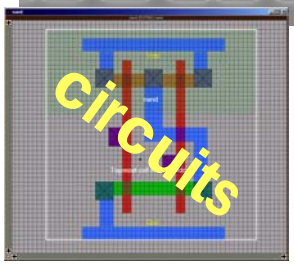

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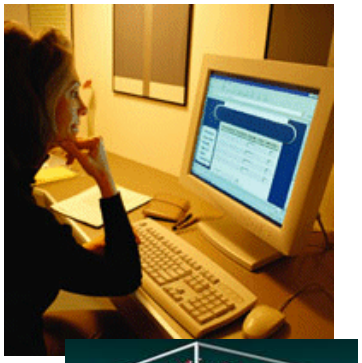

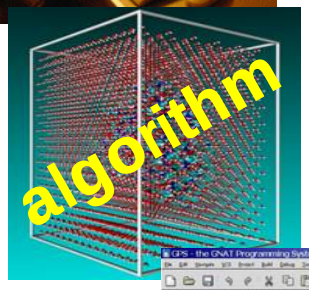

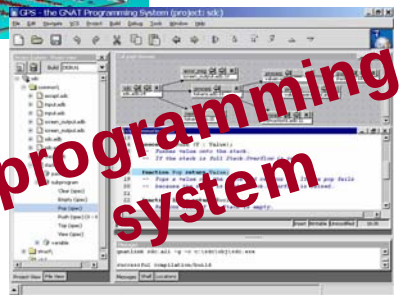

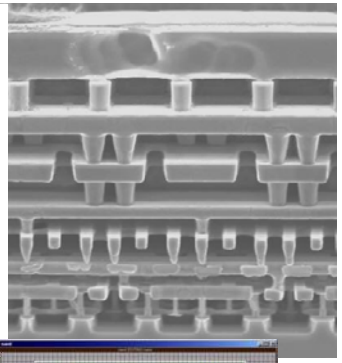

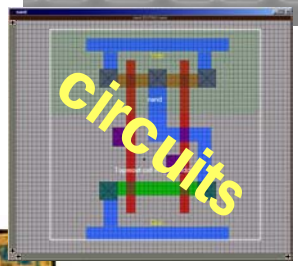

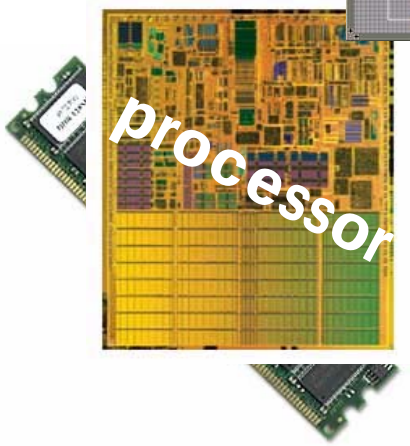

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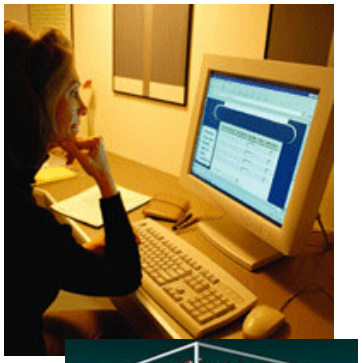

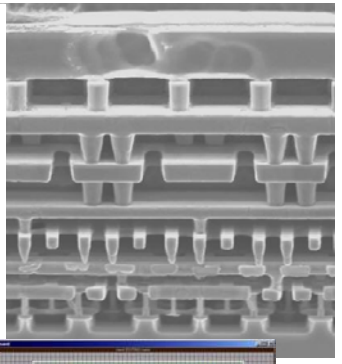

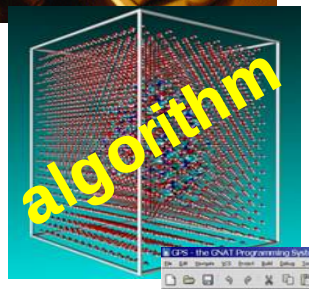

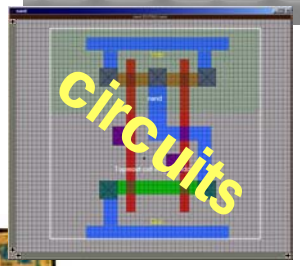

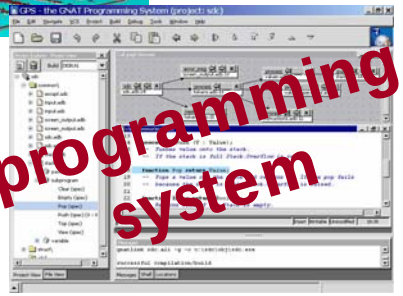

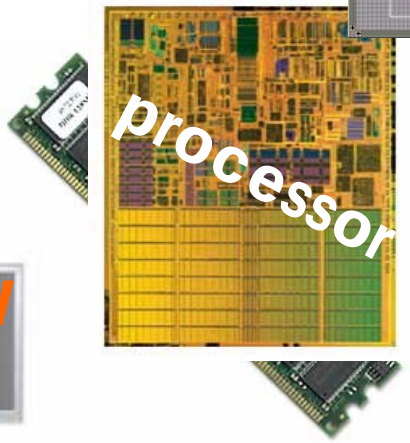

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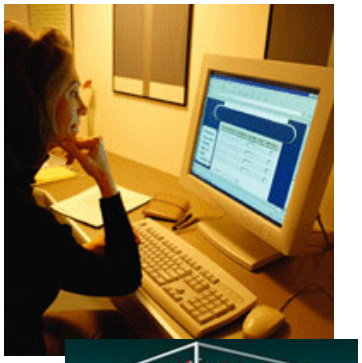

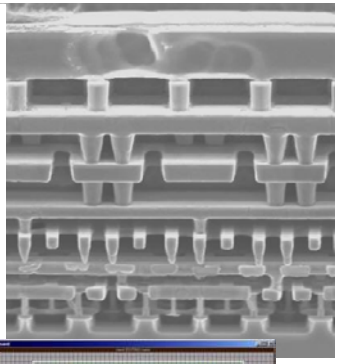

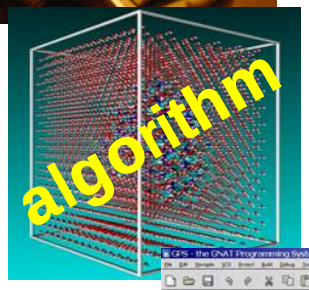

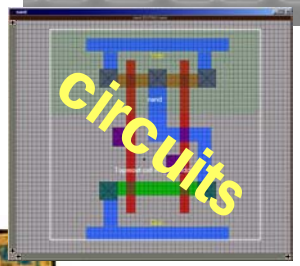

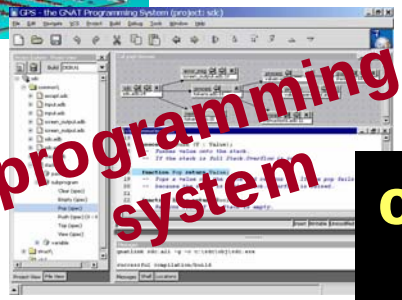

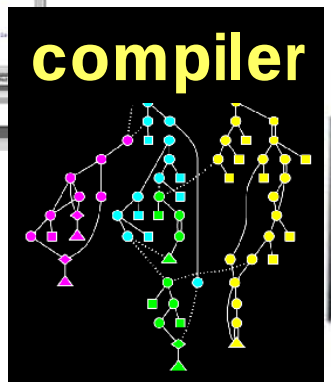

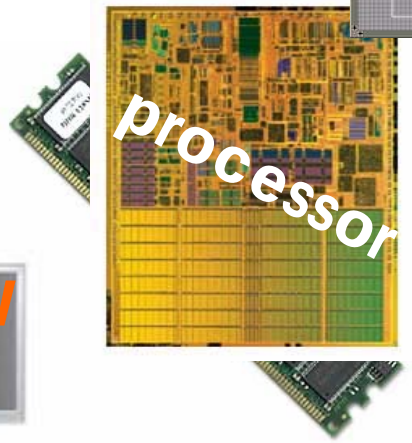

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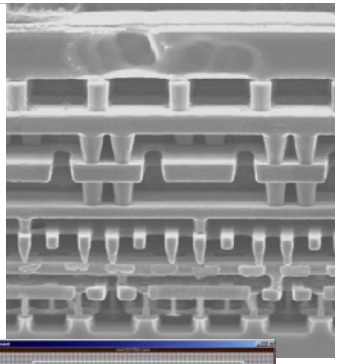
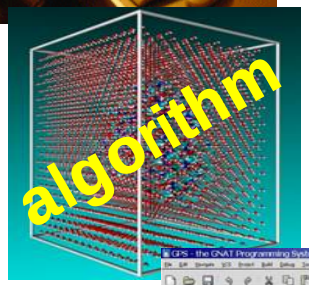
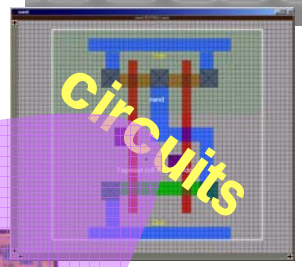
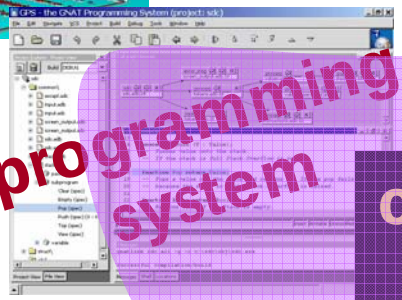
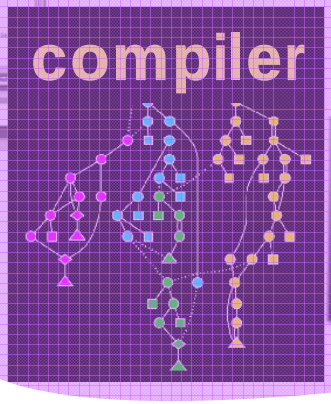
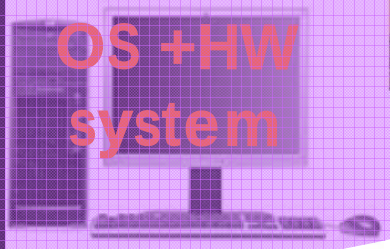


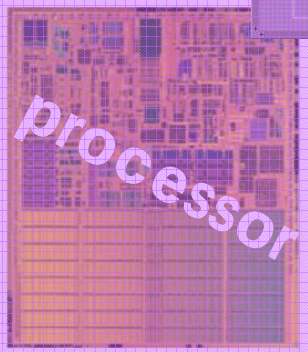












Five “major” Challenges for Computer Architects

“The number of people saying
Moore’s Law is dead
doubles every 18 months”

The Performance Challenge

Wireless communications
(3G, UWB, …)

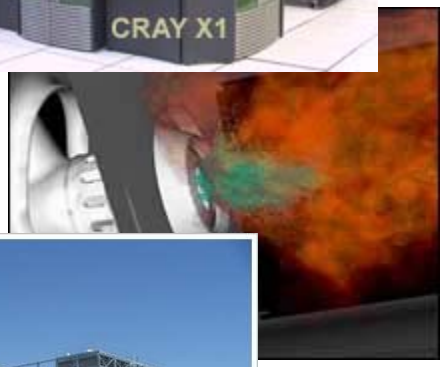
- Higher data rates
- More complex air interfaces

Workstations
(Games, CAD)

- Higher resolution
- Realism
- Accuracy

Supercomputers
(Scientific simulations)

- Fidelity
- Time scales



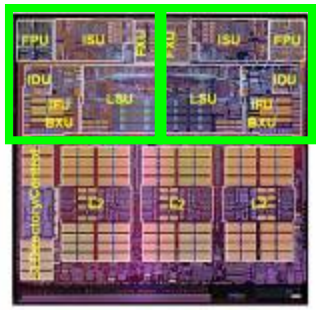
No limit to performance needs from embedded to supercomputing (FLOPS and GB/s)

The Efficiency Challenge

Embedded

- Battery life and heat
- Commodity and volume

Mainstream "CPUs"



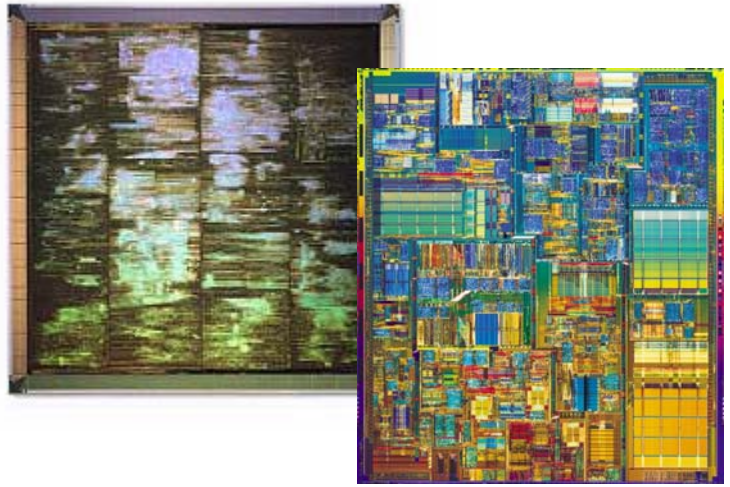
- Peak power
- Cooling

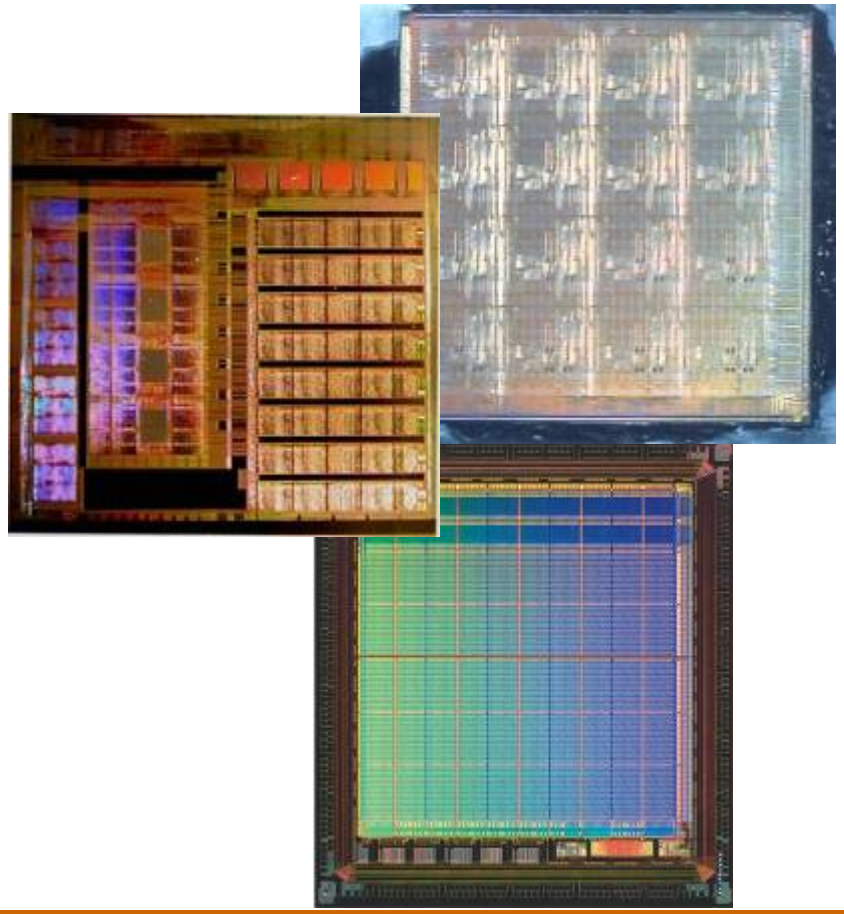
Supercomputers

- Energy bill (10 MW)
- Price/performance

Energy consumption, power dissipation, and cost are critical

The Designability Challenge



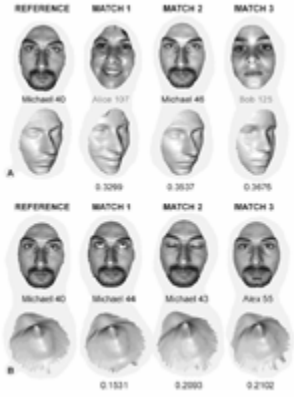


- Place & Rout billions of device?
- Verification?

Modular design is necessary

The Programmability Challenge

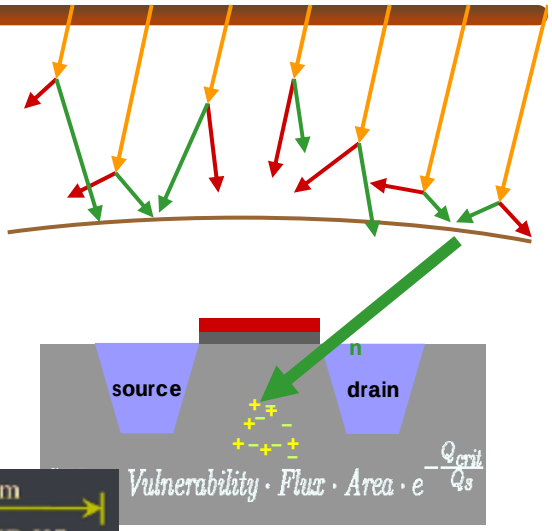
- Multiple modes
- Evolving standards
- Evolving features, differentiation
- Design/tooling costs

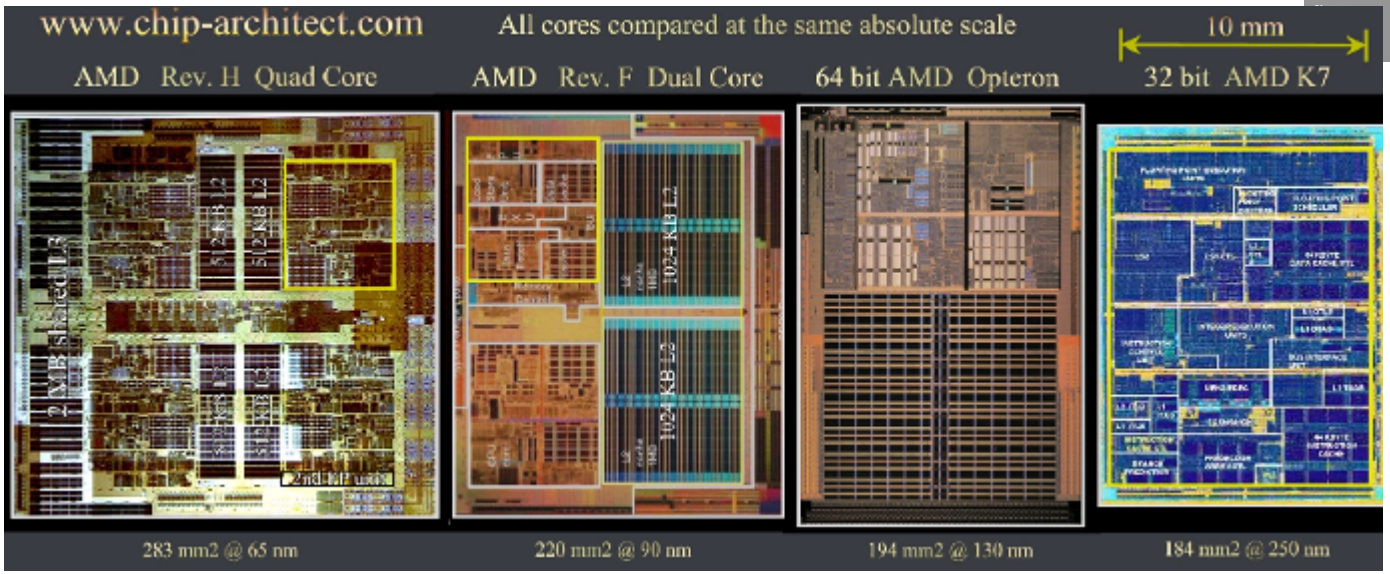


Programmability reduces cost, enables adaptation, and improves time-to-market

The Reliability Challenge

- More devices
- Smaller devices
- Greater variability





Reliability (soft-, hard-, and transient-errors) span all markets

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Rest of class was on the whiteboard