EEL 4709C
Computer Design

Dr. Gang Quan
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Florida International University
Fall, 2009

Syllabus highlight

- Instructor
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  - Office Hour:
    - MW 10:30am-12:00pm or by appointment
  - Web page
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Syllabus highlight

- Text:
  - Williams Stallings, *Computer Organization & Architecture: Design for Performance*, 7th Edition, Prentice Hall, 2006

Syllabus highlight

- Exams:
  - midterm and a comprehensive final exam
  - Closed book
- Grading:
  - 25% midterm, 35% final exam
  - 45% hw/assignment

Prerequisite

- EEL 3712, EEL 3712L
- Things you should have learned now
  - Boolean algebra
  - Number representation
    - 2's complement
    - Binary, octal, hex decimal
    - Conversion
  - Combinational logic
    - And, or, xor, nand, nor, mux, etc
  - Sequential logic
    - Flip-flops
    - Timing diagram, schematic

Academic Dishonesty

- You are responsible for your conduct
- Unless otherwise specified you must do your own work on all assignments and exams.
- Those found cheating will be referred to the university committee on academic dishonesty and will receive an F in this class.
- If you are unsure as to what constitutes cheating see student's handbook, ask instructor

Other Policies

- Attendance requirements
  - On-time and be prepared
  - Unexcused absences will result in the loss of points from your final grade
- Late assignment submission will receive half credit
  - Zero credit for submission three days later than due time
  - Please do not submit assignments by email
- I encourage questions provided:
  - You are respectful of others (raise hand, don't interrupt classmates, be polite)

What's in this course

- Introduction
- Performance assessment
- Processor structure, instruction cycle, pipelining, and bus interconnection
- Cache and memory hierarchy
- Internal/external memory
- I/O devices, interrupt, DMA
- Floating point arithmetic
- Instruction set architecture and assembly programming
- Multiprocessor/parallel architecture

After taking this course, you should be able to …

- Assess the performance of a computer
- Describe major components of a computer system, their organization, and their functions
- Understanding the execution of computer instructions
- Assembly language programming
- Describe the organization and operation of the parallel computer architecture

Questions?

The oldest computer

(http://www.wmallory.com/images/abacus.jpg)

Pros: cheap, portable, reliable, low power consumption, …
Cons: slooooooow, limited accuracy, no character processing, no multimedia …

Modern Computing Systems

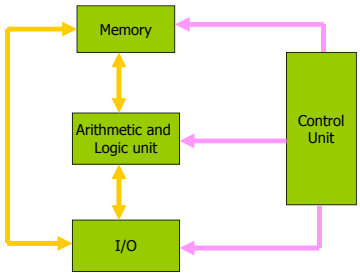
- Desktops
- Laptops
- Servers
- And ?

Embedded System !

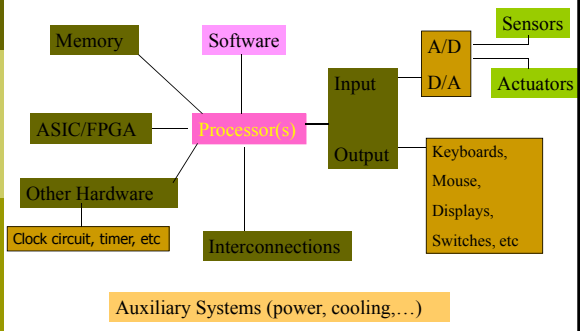
Modern Computer Architecture

- Dated back to 1940s
  - Electronic Numerical Integrator and Computer (ENIAC)
- Von Neumann Model
  - *Memory*
    - containing both data and instructions
  - *Calculating unit*
    - *capable of performing both arithmetic and logical operations on the data.*
  - *Control unit*
  - *I/O devices*
  - *Buses*

Von Newman Model



Major Components in a Computer System



A little bit of history

- Pre 1970's
  - 1945-1956
    - Vacuum tube
    - ENIAC
      - 18000 vacuum tubes, 6000 switches, 10 feet high, 30 tons, 1000 s.q. feet
  - 1956-1963
    - Transistor technology, software industry
  - 1964-1971
    - IC technology, operating system

Both the IC technology and the architecture improvement made major contribution to the development of computers at this stage…

A little bit of history (cont'd)

- During 1970s
  - Large scale integration (LSI) technology
  - Mainframe and minicomputer dominate the industry

… the IC technology becomes the dominating factors …

A little bit of history (cont'd)

- From 1980s on …
  - very large scale integration (VLSI), ultra-large scale integration (ULSI) technology
  - Personal computer
  - RISC architecture
    - Instruction level parallelism (ILP)
    - Cache
  - Network technology

… dramatic growth in performance (50% annually) due to the combination of the architectural and technology enhancements …

Processor Performance

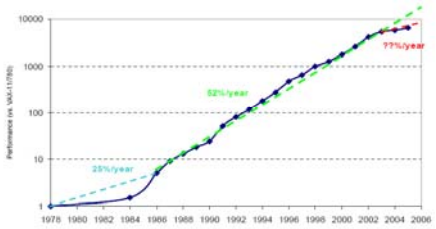


Figure 2. Processor performance improvement between 1978 and 2006 using integer SPEC [SPEC 2006] programs. RISCs helped inspire performance to improve by 52% per year between 1986 and 2002, which was much faster than the VAX minicomputer improved between 1978 and 1986. Since 2002, performance has improved less than 20% per year. By 2006, processors will be a factor of three slower than if progress had continued at 52% per year. This figure is Figure 1.1 in [Hennessy and Patterson 2007].

Computer Development

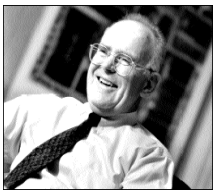
- Fact
  - In 1975, an IBM mainframe computer that could perform 10,000,000 instructions per second cost around $10,000,000.
  - 33mhz Intel 80486 can perform better than 11mips
  - How much money you would like to pay for a computer with Intel 80486 processor today?

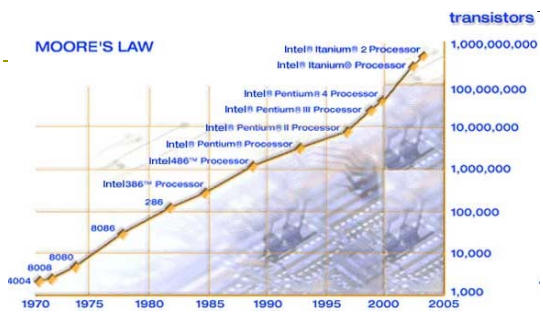
IC technology

- Moore's Law

  The transistor density of semiconductor chips would double roughly every 18 months.

  --by Gordon Moore,1965 (co-founder of Intel)

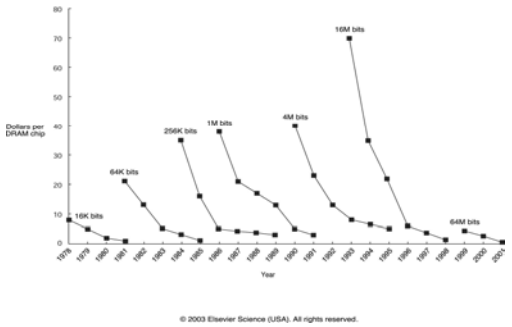




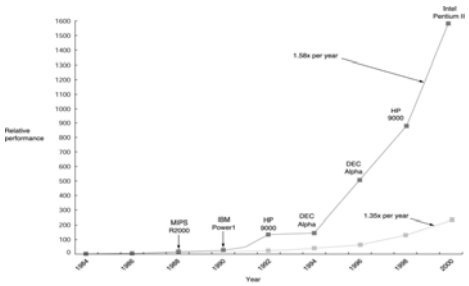
Memory (DRAM)

- Density increases by 40%-60% per year
- Cycle time decrease 1/3 every 10 years
- Bandwidth increases around 2 times as delay decreases
- Cost

DRAM Cost



Processor/Memory Performance Gap



Disk Storage

- Improve 100% per year
- Access time 1.3 per 10 years

Power Consumption

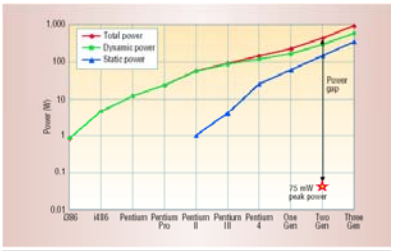


Figure 2. Power trends for desktop processors. The star indicates the mobile supercomputer's requirement.

Computer Architecture vs. Organization

- Architecture is those attributes visible to the programmer
  - Instruction set, I/O mechanisms, addressing techniques. etc
  - e.g. Is there a multiply instruction?
- Organization is how features are implemented
  - Control signals, interfaces, memory technology.
  - e.g. Is there a hardware multiply unit or is it done by repeated addition?
- Ex: the Intel x86 family share the same basic architecture but different organizations

Summary

- Key points
  - Von Newman Model
  - Major components in a computer system
  - Moore's law
  - Processor/memory performance gap
  - Computer architecture vs. organization