IC220
Computer Architecture and Organization

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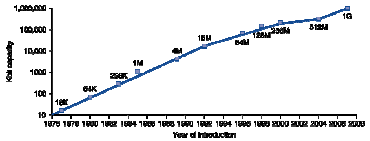
http://www.cs.usna.edu/~lmcdowel/courses/ic220/S09/

Outline

- Class Survey / Role Call
- What is:
  - a computer?
  - computer architecture?
  - this class?
- Course Admin
  - Policy Letter
  - Syllabus

Technology Trends

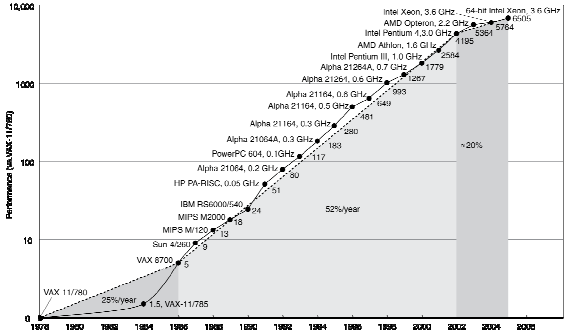
- Electronics technology continues to evolve
  - Increased capacity and performance
  - Reduced cost



DRAM capacity

Year	Technology	Relative performance/cost
1951	Vacuum tube	1
1965	Transistor	35
1975	Integrated circuit (IC)	900
1995	Very large scale IC (VLSI)	2,400,000
2005	Ultra large scale IC	6,200,000,000

Uniprocessor Performance



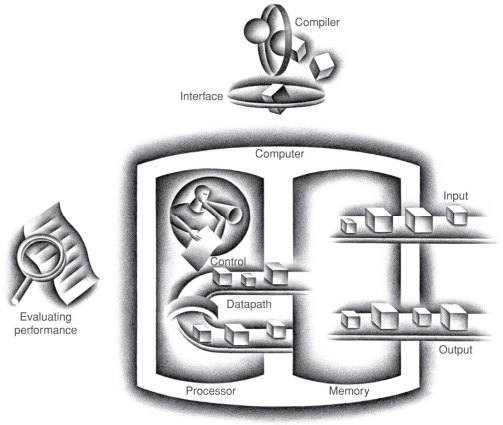
What We'll Learn

- How do computers really work?
- How to analyze performance (and not to!)
- Issues affecting modern processors (caches, pipelines, wire delay, parallelism, power…)
- Constant tradeoffs:
  - Speed vs. Capacity vs. Cost
- Insight into complexity of easy/hard operations
- Comment from prior student on "how much learned":
  "*A great deal. One of those classes where you don't realize how much you learned- you just come out understanding a lot of things that nobody else does.*"

Why learn this stuff?

- You want to call yourself a "computer scientist" or "information technologist"
- You want to build software people use (need performance)
- You need to make a purchasing decision or offer "expert" advice

What is a computer?

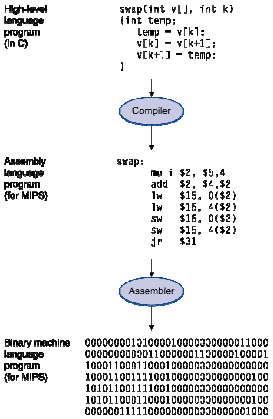


What is a computer, continued

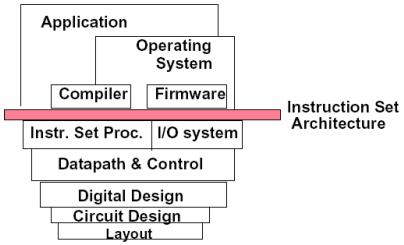
- Our primary focus:
  - implemented using millions of transistors
  - Impossible to understand by looking at each transistor
  - We need...

Abstraction

- An abstraction helps us cope with complexity by:
- Delving into the depths reveals more information



What is Computer Architecture?



Computer Architecture =

Instruction Set Architecture

- A very important abstraction
  - interface between hardware and low-level software
  - defines how a program interacts with the machine
  - standardizes instructions, machine language bit patterns, etc.
  - advantage:
  - disadvantage:
- Modern instruction set architectures:
  - 80x86, PowerPC, MIPS, SPARC, ARM

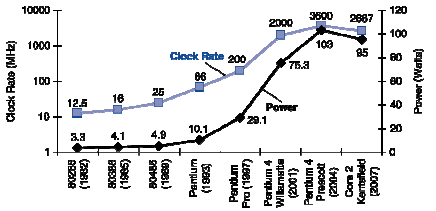
Example of Abstractions

1. Instruction set architecture (ISA)
   - The hardware/software interface
2. Application binary interface (ABI)
   - The ISA plus system software interface
3. “Virtual Memory”
   - Will see later

Multiprocessors

- Big new trend: Multicore microprocessors
  - More than one processor per chip
- Requires explicitly parallel programming
  - Compare with instruction level parallelism (ILP)
    - Hardware executes multiple instructions at once
    - Hidden from the programmer
  - Hard to do
    - Programming for performance
    - Load balancing
    - Optimizing communication and synchronization
- So why not just make faster single-core processors?

Power Trends



- In CMOS IC technology

$$\text{Power} = \text{Capacitive load} \times \text{Voltage}^2 \times \text{Frequency}$$

×30 | 5V → 1V | ×1000

Where we are headed

- Computer Abstractions & Technology (Chapter 1)
- A specific instruction set architecture (Chapter 2)
- Logic Design (Appendix C)
- Arithmetic and how to build an ALU (Chapter 3)
- Performance issues (back to Chapter 1)
- Constructing a processor to execute our instructions (Chapter 4)
- Memory: caches and virtual memory (Chapter 5)
- I/O (Chapter 6)
- Pipelining to improve performance (more Chapter 4)
- Multiprocessors and advanced topics (Chapter 7)

Admin

- Pet Peeves
- Class break?
- Policy
- Collaboration
- Syllabus
- Homeworks
  - *Some* exercises completed in class
  - *All* exercises must be completed & turned in
  - Expect less points for exercises done in class
- All assignments must be turned in to possibly earn a passing grade

Assignments

- Get the textbook
  - Lots of chapter 1 & 2 reading – see calendar
- Get a binder to keep track of notes
- Homework #1 due next Thursday

Success in IC220

- In Class – Participate
  - You **must** bring relevant slides/homework
  - Ask & answer questions
  - Be prepared to interact
  - Take notes – provided slides are not enough!
- On your own – Keep Up
  - Review/finish exercises after class
  - Read the book – lecture won't cover everything
  - See me for help and/or talk to friends