COMPUTER ORGANIZATION AND DESIGN
The Hardware/Software Interface

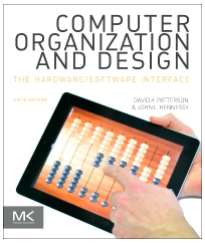
EECS2021

Computer Organization
Fall 2014

The slides are based on the publisher slides and contribution from Profs Amir Asif and Peter Lian

EECS2021 Computer Organization

- Computer Organization and Design– The hardware/Software approach
- Patterson and John Hennessy
- Morgan kaufmann
- Assessment:
  - Assignments/Quizzes 20%
  - Lab 20%
  - Midterm 25%
  - Final 35%



EECS2021 Computer Organization

- Monday and Wednesday 5:30-7:00pm
- LSB 106
- 2 Lab sections
  - Monday 7-10pm LAS 1006
  - Tuesday 7-10pm LAS 1006/2
- Labs start The week of Sept. 15
- Labs are posted on the course web page

Topics

- Computer abstraction and technology – Ch 1
- Instruction language of the computer – Ch 2
- Verilog -- Notes
- Arithmetic for computers – Ch 3
- The processor – Ch 4

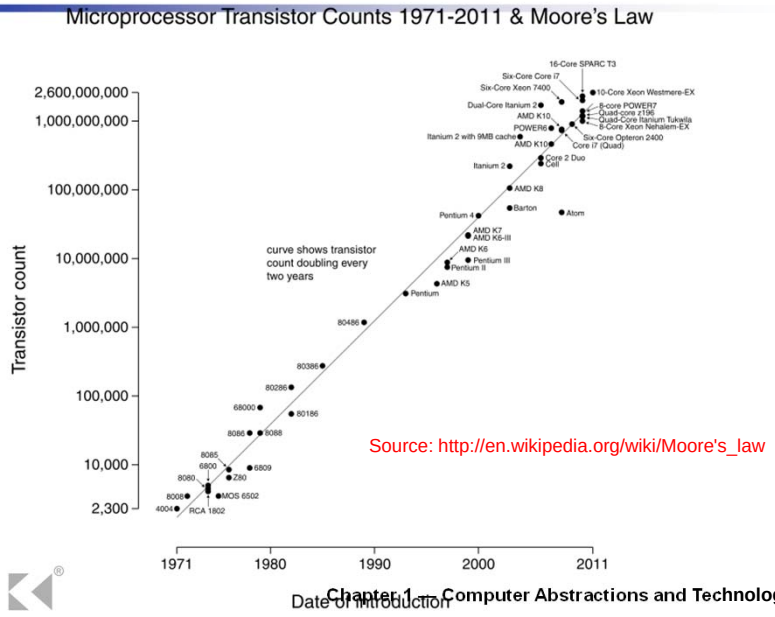
What You Will Learn

- How programs are translated into the machine language
  - And how the hardware executes them
- The hardware/software interface
- What determines program performance
  - And how it can be improved
- How the CPU works and how to improve its perfromance.

The Computer Revolution

- Progress in computer technology
  - Underpinned by Moore's Law
- Makes novel applications feasible
  - Computers in automobiles
  - Cell phones
  - Human genome project
  - World Wide Web
  - Search Engines
- Computers are pervasive

Moore's law

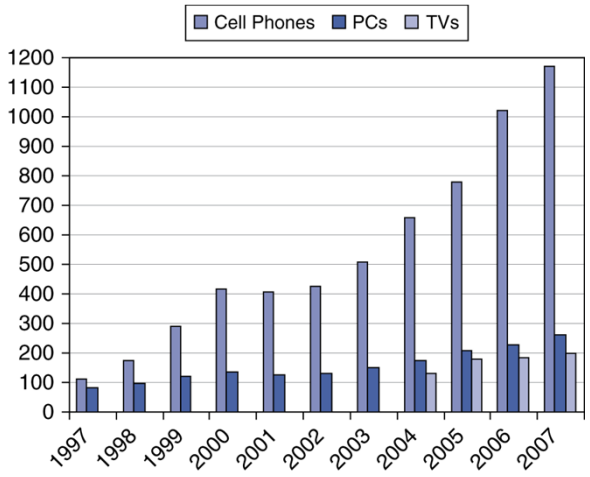


Source: http://en.wikipedia.org/wiki/Moore's_law

Classes of Computers

- Desktop computers
  - General purpose, variety of software
  - Subject to cost/performance tradeoff
- Server computers
  - Network based
  - High capacity, performance, reliability
  - Range from small servers to building sized
- Embedded computers
  - Hidden as components of systems
  - Stringent power/performance/cost constraints

The Processor Market



How computers work?

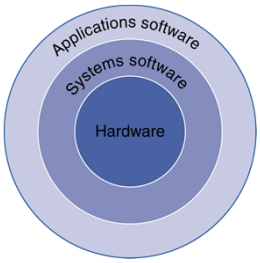
- In your first year, you studies programming (java)
- Sequence of instructions
- Translated to machine language
- Instructions are fetched from the memory one after the other and executed

Eight Great Ideas

1. Design for Moore's Law
2. Use Abstraction to Simplify Design
3. Make the Common case fast
4. Performance via Parallelism
5. Performance via Pipelining
6. Performance via Prediction
7. Hierarchy of Memories
8. Dependability via Redundancy

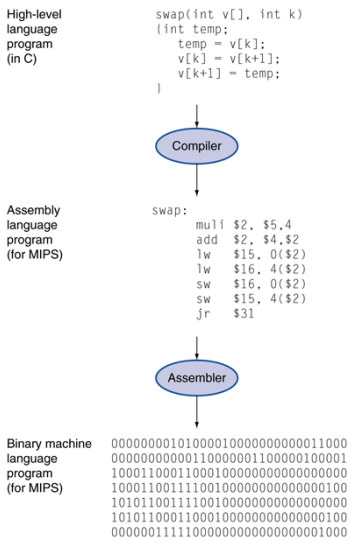
Below Your Program

- Application software
  - Written in high-level language
- System software
  - Compiler: translates HLL code to machine code
  - Operating System: service code
    - Handling input/output
    - Managing memory and storage
    - Scheduling tasks & sharing resources
- Hardware
  - Processor, memory, I/O controllers



Levels of Program Code

- High-level language
  - Level of abstraction closer to problem domain
  - Provides for productivity and portability
- Assembly language
  - Textual representation of instructions
- Hardware representation
  - Binary digits (bits)
  - Encoded instructions and data

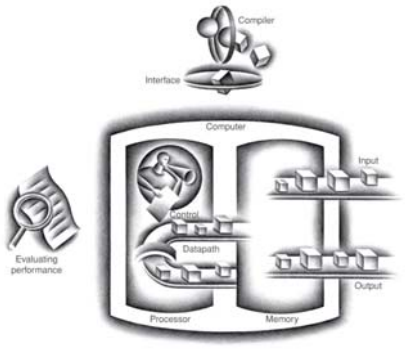


Understanding Performance

- Algorithm
  - Determines number of operations executed
- Programming language, compiler, architecture
  - Determine number of machine instructions executed per operation
- Processor and memory system
  - Determine how fast instructions are executed
- I/O system (including OS)
  - Determines how fast I/O operations are executed

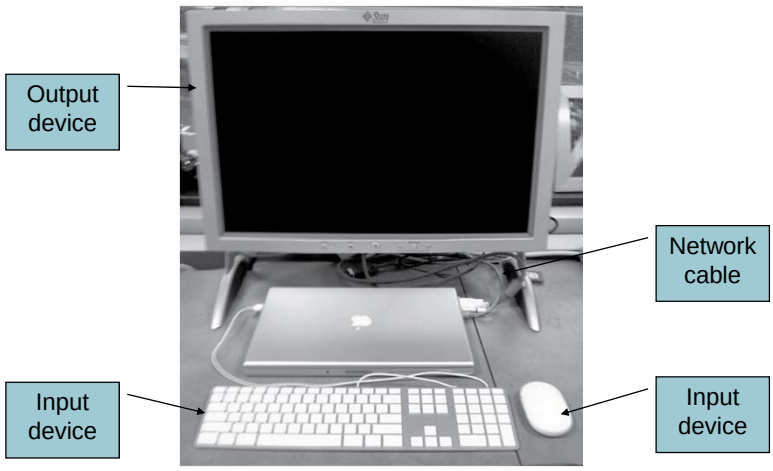
Components of a Computer

The BIG Picture



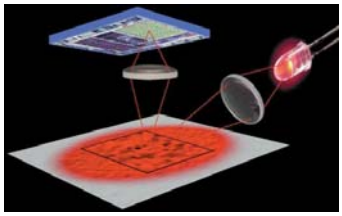
- Same components for all kinds of computer
  - Desktop, server, embedded
- Input/output includes
  - User-interface devices
    - Display, keyboard, mouse
  - Storage devices
    - Hard disk, CD/DVD, flash
  - Network adapters
    - For communicating with other computers

Anatomy of a Computer



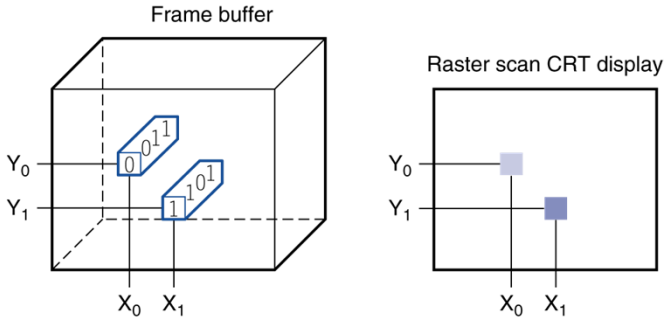
Anatomy of a Mouse

- Optical mouse
  - LED illuminates desktop
  - Small low-res camera
  - Basic image processor
    - Looks for x, y movement
  - Buttons & wheel
- Supersedes roller-ball mechanical mouse

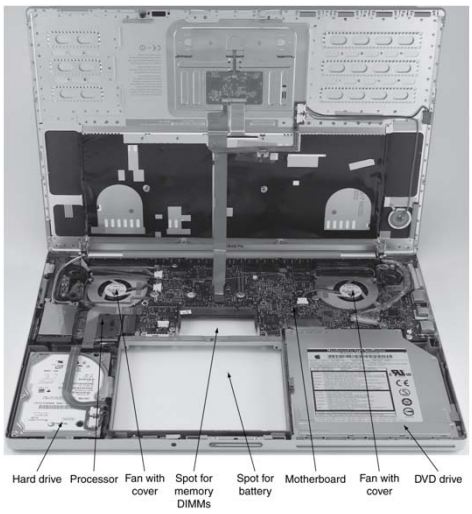


Through the Looking Glass

- LCD screen: picture elements (pixels)
  - Mirrors content of frame buffer memory



Opening the Box

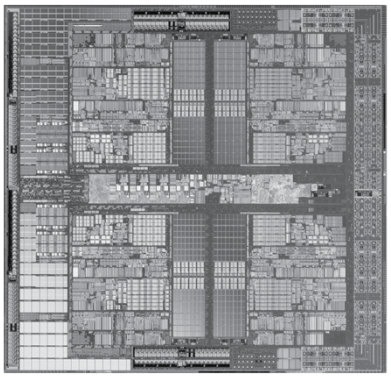


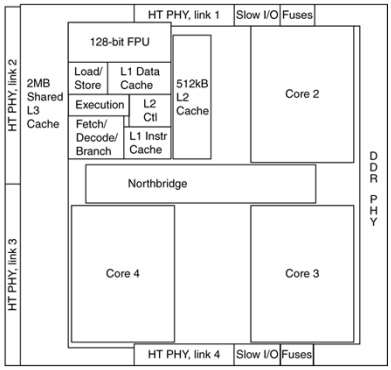
Inside the Processor (CPU)

- Datapath: performs operations on data
- Control: sequences datapath, memory, ...
- Cache memory
  - Small fast SRAM memory for immediate access to data

Inside the Processor

- AMD Barcelona: 4 processor cores





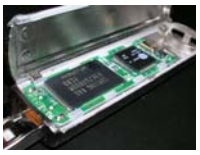
Abstractions

The BIG Picture

- Abstraction helps us deal with complexity
  - Hide lower-level detail
- Instruction set architecture (ISA)
  - The hardware/software interface
- Application binary interface
  - The ISA plus system software interface
- Implementation
  - The details underlying and interface

A Safe Place for Data

- Volatile main memory
  - Loses instructions and data when power off
- Non-volatile secondary memory
  - Magnetic disk
  - Flash memory
  - Optical disk (CDROM, DVD)

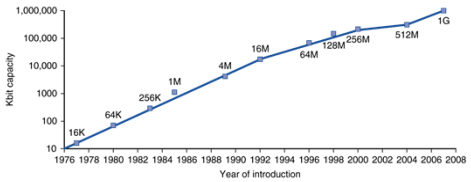


Networks

- Communication and resource sharing
- Local area network (LAN): Ethernet
  - Within a building
- Wide area network (WAN: the Internet
- Wireless network: WiFi, Bluetooth

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