Introduction

CSE 410, Spring 2004
Computer Systems

http://www.cs.washington.edu/education/courses/410/04sp/

Reading and References

• Reading
  » Chapter 1, Computer Organization and Design, Patterson and Hennessy

• Other References
  » The Rope and Pulley Wonder, in The Tinkertoy Computer, A. K. Dewdney

Class Overview

• Provide an introduction to the inner workings of computer systems
• Levels of abstraction
  » bits, bytes, assembly language
  » operating system concepts
  » higher level languages - C, C++, Java, …
  » application programs

Administrative

• Instructor:
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• All class info is on the web site
  » http://www.cs.washington.edu/410
  » also known as
    • http://www.cs.washington.edu/education/courses/cse410/04sp/
Goal

- You will understand
  - what is actually happening when a computer system is running application programs
- So that you will be able to
  - make good design choices as a developer, project manager, or system customer
  - calibrate your hype-o-meter with facts

The structure of this class

- The hardware / software interface
  - the elements of a computer system
  - what parts are visible to the software
  - instruction set architecture (ISA)
- Operating systems
  - services an OS performs for an application
  - design of various OS components

Elements of a computer system

- Start with a point of view
  - purchase a CD on the Web
  - get class schedule from MyUW
  - write a resume using Word
  - write a Java program to do image processing
  - write a C program to read real time data
  - write assembly language for matrix operations
  - write microcode for instruction emulation

“Top Level” elements

- At any level of abstraction, there are
  - elements at that level
  - the building blocks for those elements
- Rope analogy in the book
  - a cable: three hawsers twisted together
  - a hawser: three strands of many yarns
  - down to the molecular level and beyond
Purchase a CD on the Web

- the “top level” system includes
  - your browser, your desktop computer
  - connection to the internet (ISP)
  - server - http://www.amazon.com/
  - server application code
    - method="POST"
    - action="/exec/obidos/handle-buy-box=B00005NFZB/…"
    - ...

Write a resume using Word

- the “top level” system includes
  - winword.exe - the application program
  - Contemporary Resume.dot - document template
  - resume.doc - the file containing the text
  - Windows Explorer - file manager
  - network file and printer sharing

assembly language for matrix operations

- the “top level” system includes
  - programmer’s editor (eg, Context)
  - assembler - convert source to machine language
  - linker, loader - build and run executable
  - Instruction Set Architecture (ISA) that you are writing the code for
    - defines the programmer-visible face of the CPU
    - in this class, we will be writing for MIPS 1 ISA

Layers of abstraction

- Abstraction
  - isolates a layer from changes in the layer below
  - improves developer productivity by reducing detail needed to accomplish a task
  - helps define a single architecture that can be implemented with more than one organization
Architecture and Organization

- **Architecture**
  - defines elements and interfaces between layers
  - ISA: instructions, registers, addressing
- **Organization**
  - components and connections
  - how instructions are implemented in hardware
  - many different organizations can implement a single architecture

Computer Architecture

- Specification of how to program a specific computer family
  - what instructions are available?
  - how are the instructions formatted into bits?
  - how many registers and what is their function?
  - how is memory addressed?
- The MIPS 1 architecture is the basis for the first half of this course

Architecture Families

- IBM 360, 370, …
- PowerPC 601, 603, …
- DEC PDP-11
- Intel x86 286, 386, 486, Pentium, …
- Motorola 680x0
- MIPS R2000, R3000, R4000, R5000, …

Computer Organization

- **Processor**
  - datapath (functional units) manipulate the bits
  - control controls the manipulation
- **Memory**
  - cache memory - smaller, higher speed
  - main memory - larger, slower speed
- **Input / Output**
  - interface to the rest of the world
Organizations and Architectures

- Architecture is another abstraction layer
- One architecture can be implemented with many organizations
- One organization can support multiple architectures
- Different manufacturing technologies
  » TTL, ECL, PMOS, NMOS, CMOS
  » ropes and pulleys - see Dewdney reference

Many possible implementations

A typical organization

Change Organization or Architecture?

- Theory
  » Organization changes provide incremental changes in speed and cost for same software
  » Architecture changes enable breakthrough changes in speed and cost for new software
- Real life
  » incremental changes are very rapid
  » breakthrough changes are very costly
A quick hardware tour

- System board
  » CPU, memory, I/O bus
- Hard disk
  » 3600+ RPM, 8ms latency, 3-15 ms seek
- Monitor
  » CRT, LCD
- Mouse, keyboard
  » embedded processors