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*

Administrative

- Instructor:
  - » Doug Johnson
  - » djohnson@cs.washington.edu

- 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/

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

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

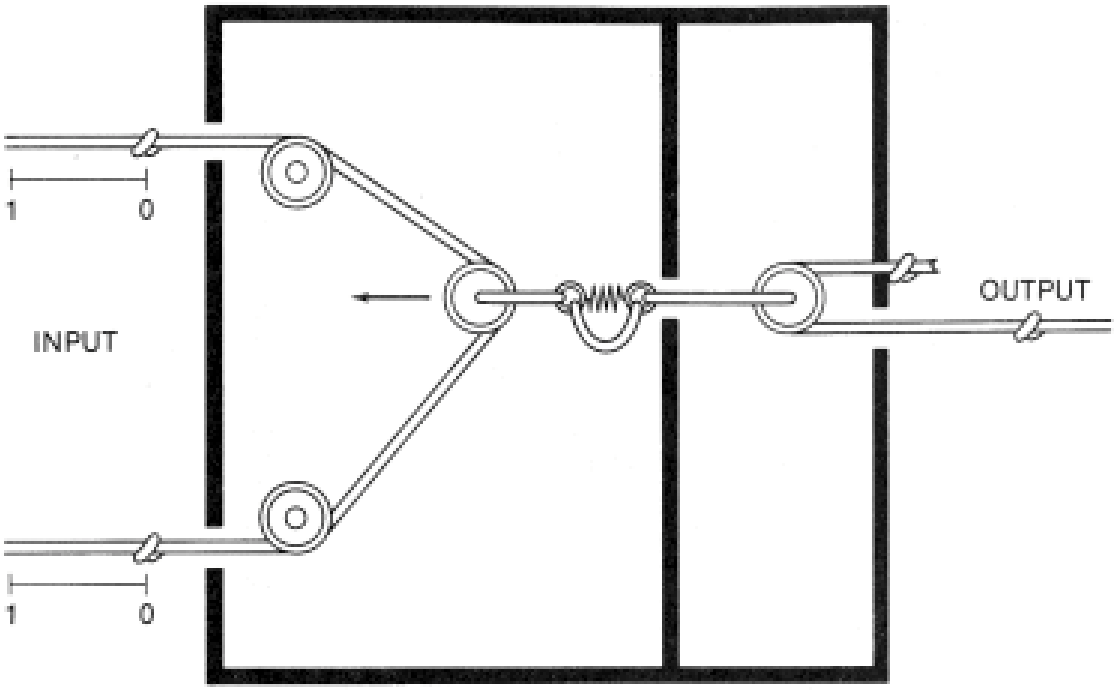
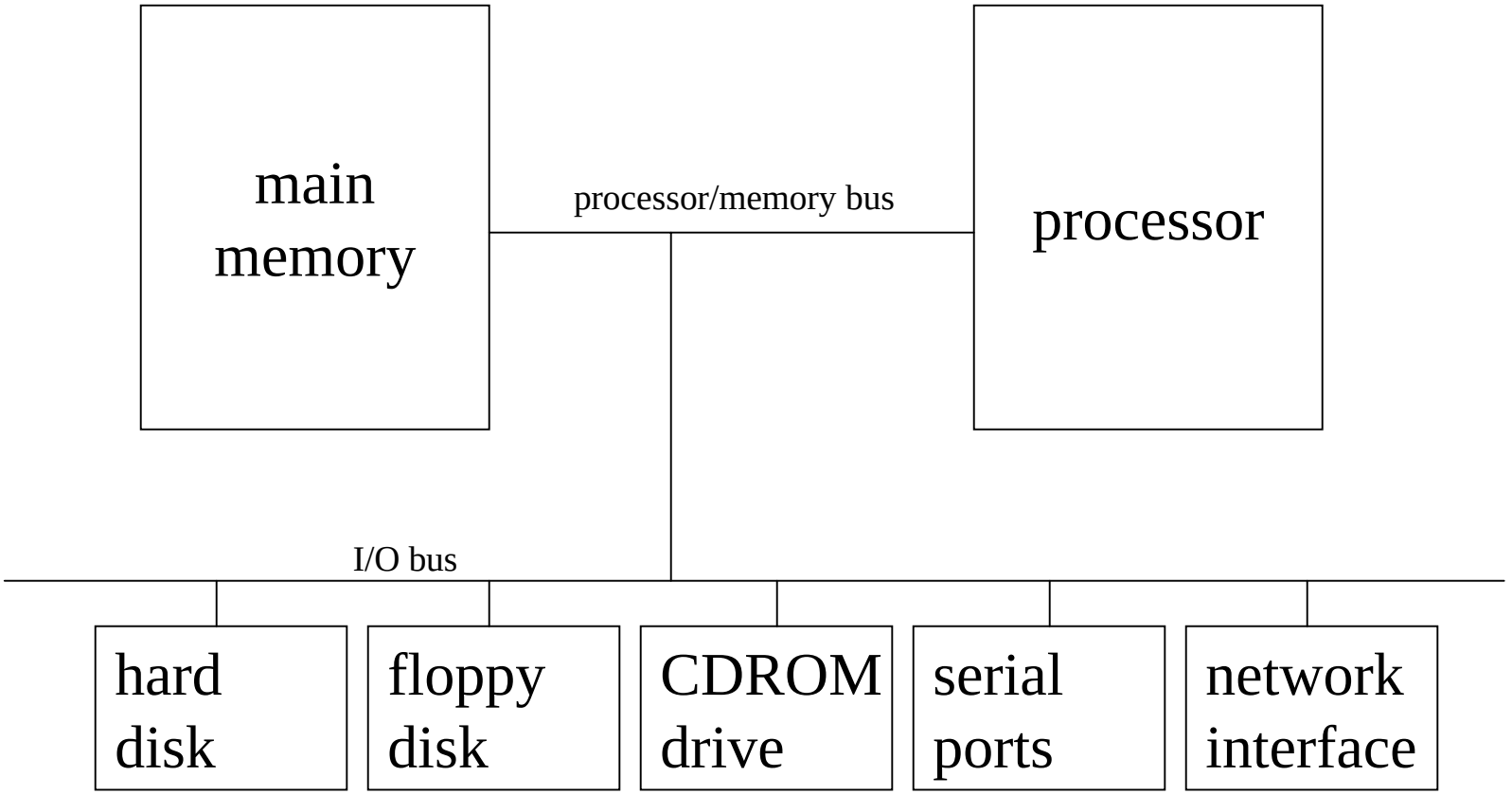


Figure 2.4 The Apraphulian AND gate.

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