How Computers Represent Data

- Number systems
  - A manner of counting
  - Several different number systems exist
- Decimal number system
  - Used by humans to count
  - Contains ten distinct digits
  - Digits combine to make larger numbers

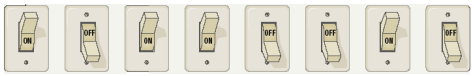
How Computers Represent Data

- Binary number system
  - Used by computers to count
  - Two distinct digits, 0 and 1
  - 0 and 1 combine to make numbers
- Think of binary numbers in terms of switches. With two switches you can represent up to four different numbers.
- * 0 0 (OFF OFF) = Decimal 0
- * 0 1 (OFF ON) = Decimal 1
- * 1 0 (ON OFF) = Decimal 2
- * 1 1 (ON ON) = Decimal 3

Decimal	Binary Representation
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111

How Computers Represent Data

- Bits and bytes
  - Binary numbers are made of bits
  - Bit represents a switch
  - A byte is 8 bits
  - Byte represents one character



How Computers Represent Data

- Text codes
  - Converts letters into binary
  - Standard codes necessary for data transfer
  - ASCII
    - American English symbols
  - Extended ASCII
    - Graphics and other symbols
  - Unicode
    - All languages on the planet

How Computers Process Data

- The CPU
  - Central Processing Unit
  - Brain of the computer
  - Control unit
    - Controls resources in computer
    - Instruction set
  - Arithmetic logic unit
    - Simple math operations
    - Registers

How Computers Process Data

- Machine cycles
  - Steps by CPU to process data
  - Instruction cycle
    - CPU gets the instruction
  - Execution cycle
    - CPU performs the instruction
  - Billions of cycles per second
  - Pipelining processes more data
  - Multitasking allows multiple instructions

How Computers Process Data

- Memory
  - Stores open programs and data
  - Small chips on the motherboard
  - More memory makes a computer faster

How Computers Process Data

- Nonvolatile memory
  - Holds data when power is off
  - Read Only Memory (ROM)
  - Basic Input Output System (BIOS)
  - Power On Self Test (POST)

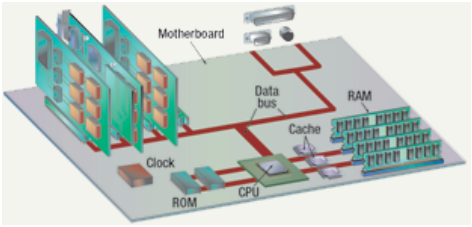
How Computers Process Data

- Flash memory
  - Data is stored using physical switches
  - Special form of nonvolatile memory
  - Camera cards, USB key chains

How Computers Process Data

- Volatile memory
  - Requires power to hold data
  - Random Access Memory (RAM)
  - Data in RAM has an address
  - CPU reads data using the address
  - CPU can read any address

Components affecting Speed



Affecting Processing Speed

- Registers
  - Number of bits processor can handle
  - Word size
  - Larger indicates more powerful computer
  - Increase by purchasing new CPU

Affecting Processing Speed

- Virtual RAM
  - When the Computer is out of actual RAM
  - This is a file that emulates RAM
  - Computer swaps data to virtual RAM
    - Least recently used data is moved

Affecting Processing Speed

- The computer's internal clock
  - Quartz crystal
  - Every tick causes a cycle
  - Speeds measured in Hertz (Hz)
    - Modern machines use Giga Hertz (GHz)

Affecting Processing Speed

- The bus
  - Electronic pathway between components
  - Expansion bus connects to peripherals
  - System bus connects CPU and RAM
  - Bus width is measured in bits
  - Speed is tied to the clock

Affecting Processing Speed

- External bus standards
  - Industry Standard Architecture (ISA)
  - Local bus
  - Peripheral control interface
  - Accelerated graphics port
  - Universal serial bus
  - IEEE 1394 (FireWire)
  - PC Card

Affecting Processing Speed

- Peripheral control interface (PCI)
  - Connects modems and sound cards
  - Found in most modern computers

Affecting Processing Speed

- Accelerated Graphics Port (AGP)
  - Connects video card to motherboard
  - Extremely fast bus
  - Found in all modern computers

Affecting Processing Speed

- Universal Serial Bus (USB)
  - Connects external devices
  - Hot swappable
  - Allows up to 127 devices to be connected (through hubs)
  - Cameras, printers, and scanners

Affecting Processing Speed

- PC Card
  - Used on laptops
  - Hot swappable
  - Devices are the size of a credit card

Affecting Processing Speed

- Cache memory
  - Very fast memory
  - Holds common or recently used data
  - Speeds up computer processing
  - Most computers have several caches
  - L1 holds recently used data
  - L2 holds upcoming data
  - L3 holds possible upcoming data

Chapter 5B

Modern CPUs

A Look Inside The Processor

- Architecture
  - Determines
    - Location of CPU parts
    - Bit size
    - Number of registers
    - Pipelines
  - Main difference between CPUs

Microcomputer Processors

- Intel
  - Leading manufacturer of processors
  - Intel 4004 was worlds first microprocessor
  - IBM PC powered by Intel 8086
  - Current processors
    - Centrino
    - Itanium
    - Pentium IV
    - Xeon

Microcomputer Processors

- Advanced Micro Devices (AMD)
  - Main competitor to Intel
  - Originally produced budget products
  - Current products outperform Intel
  - Current processors
    - Sempron
    - Athlon FX 64
    - Athlon XP

Microcomputer Processors

- Freescale
  - A subsidiary of Motorola
  - Co-developed the Apple G4 PowerPC
  - Currently focuses on the Linux market

Microcomputer Processors

- IBM
  - Historically manufactured mainframes
  - Partnered with Apple to develop G5
    - First consumer 64 bit chip

The Apple Intel Chip

- The Intel Core microarchitecture allows for high performance, speed and energy efficiency
- Two processors engineered on a single chip
- The Chip allows the Windows OS to run natively in addition to OSX
- So - two systems for the price of one!
- Intel information on the Core Duo http://www.intel.com/products/processor/coreduo/

Comparing Processors

- Speed of processor
- Size of cache
- Number of registers
- Bit size
- Speed of Front side bus

Advanced Processor Topics

- RISC processors
  - Reduced Instruction Set Computing
  - Smaller instruction sets
  - May process data faster
  - PowerPC and G5

Advanced Processor Topics

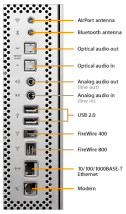
- Parallel Processing
  - Multiple processors in a system
  - Symmetric Multiple Processing
    - Number of processors is a power of 2
  - Massively Parallel Processing
    - Thousands of processors
    - Mainframes and super computers

Extending The Processors Power

- Standard computer ports
  - Keyboard and mouse ports
  - USB ports
  - Parallel
  - Network
  - Modem
  - Audio
  - Serial
  - Video

Standard PC Computer Ports

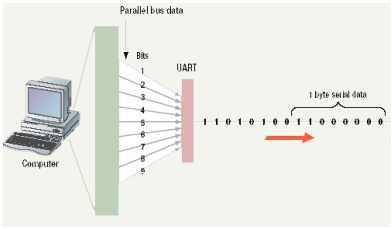
Mac Computer Ports



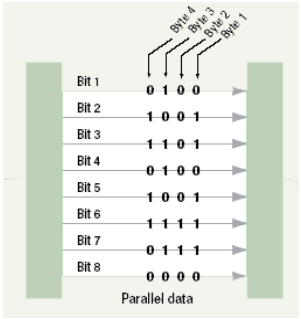
Extending The Processors Power

- Serial and parallel ports
  - Connect to printers or modems
  - Parallel ports move bits simultaneously
    - Made of 8 – 32 wires
    - Internal busses are parallel
  - Serial ports move one bit
    - Lower data flow than parallel
    - Requires control wires
    - UART converts from serial to parallel

Serial Communications



Parallel Communications



Extending The Processors Power

- SCSI
  - Small Computer System Interface
  - Supports dozens of devices
  - External devices daisy chain
  - Fast hard drives and CD-ROMs

Extending The Processors Power

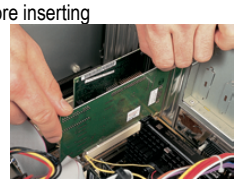
- USB
  - Universal Serial Bus
  - Most popular external bus
  - Supports up to 127 devices
  - Hot swappable

Extending the Processors Power

- FireWire
  - IEEE 1384
  - Cameras and video equipment
  - Hot swappable
  - Port is very expensive

Extending the Processors Power

- Expansion slots and boards
  - Allows users to configure the machine
  - Slots allow the addition of new devices
  - Devices are stored on cards
  - Computer must be off before inserting



Extending the Processors Power

- PC Cards
  - Expansion bus for laptops
  - PCMCIA
  - Hot swappable
  - Small card size
  - Three types, I, II and III
  - Type II is most common

Extending the Processors Power

- Plug and play
  - New hardware detected automatically
  - Prompts to install drivers
  - Non-technical users can install devices