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
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 world's first microprocessor
  - IBM PC powered by Intel 8086
  - Current processors
    - Centrino
    - Itanium
    - Pentium IV
    - Xeon

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

- **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

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