

# Computer Science

## Supplement Material

### The Computer Defined

- Electronic device
- Converts data into information
- Modern computers are digital
  - Two digits combine to make data
- Older computers were analog
  - A range of values made data

# Introducing Computer Systems

### Computers For Individual Use

- Desktop computers
  - The most common type of computer
  - Sits on the desk or floor
  - Performs a variety of tasks
- Workstations
  - Specialized computers
  - Optimized for science or graphics
  - More powerful than a desktop

## Computers For Individual Use

- Notebook computers
  - Small portable computers
  - Weighs between 3 and 8 pounds
  - About 8 ½ by 11 inches
  - Typically as powerful as a desktop
  - Can include a docking station

## Computers For Individual Use

- Handheld computers
  - Very small computers
  - Personal Digital Assistants (PDA)
  - Note taking or contact management
  - Data can synchronize with a desktop
- Smart phones
  - Hybrid of cell phone and PDA
  - Web surfing, e-mail access

## Computers For Individual Use

- Tablet computers
  - Newest development in portable computers
  - Input is through a pen
  - Run specialized versions of office products



## Computers For Organizations

- Network servers
  - Centralized computer
  - All other computers connect
  - Provides access to network resources
  - Multiple servers are called server farms
  - Often simply a powerful desktop

## Computers For Organizations

- Mainframes
  - Used in large organizations
  - Handle thousands of users
  - Users access through a terminal



## Computers For Organizations

- Supercomputers
  - The most powerful computers made
  - Handle large and complex calculations
  - Process trillions of operations per second
  - Found in research organizations



## Computers For Organizations

- Minicomputers
  - Called midrange computers
  - Power between mainframe and desktop
  - Handle hundreds of users
  - Used in smaller organizations
  - Users access through a terminal

## Computers In Society

- More impact than any other invention
  - Changed work and leisure activities
  - Used by all demographic groups
- Computers are important because:
  - Provide information to users
  - Information is critical to our society
  - Managing information is difficult

## Computers In Society

- Computers at home
  - Many homes have multiple computers
  - Most American homes have Internet
  - Computers are used for
    - Business
    - Entertainment
    - Communication
    - Education

## Computers In Society

- Computers in government
  - Necessary to track data for population
    - Police officers
    - Tax calculation and collection
  - Governments were the first computer users

## Computers In Society

- Computers in education
  - Computer literacy required at all levels
- Computers in small business
  - Makes businesses more profitable
  - Allows owners to manage
- Computers in industry
  - Computers are used to design products
  - Assembly lines are automated

## Computers In Society

- Computers in health care
  - Revolutionized health care
  - New treatments possible
  - Scheduling of patients has improved
  - Delivery of medicine is safer

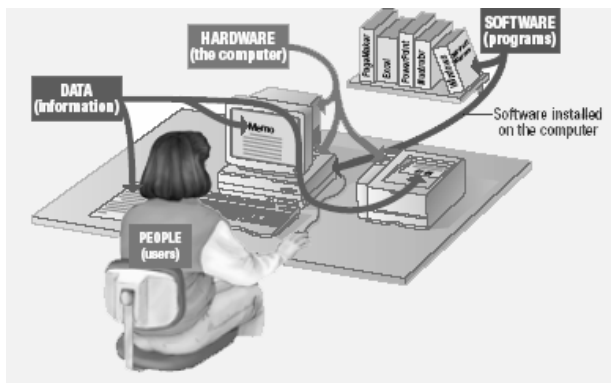
# Looking Inside the Computer System

## Parts of the Computer System

- Hardware
  - Mechanical devices in the computer
  - Anything that can be touched
- Software
  - Tell the computer what to do
  - Also called a program
  - Thousands of programs exist

## Parts of the Computer System

- Computer systems have four parts
  - Hardware
  - Software
  - Data
  - User

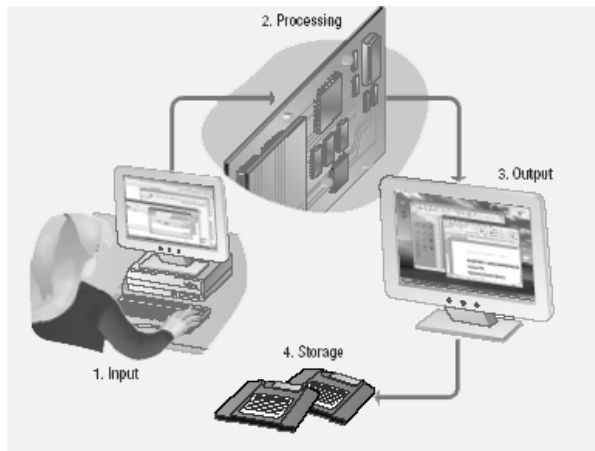


## Parts of the Computer System

- Data
  - Pieces of information
  - Computer organize and present data
- Users
  - People operating the computer
  - Most important part
  - Tell the computer what to do

# Information Processing Cycle

- Steps followed to process data
- Input
- Processing
- Output
- Storage

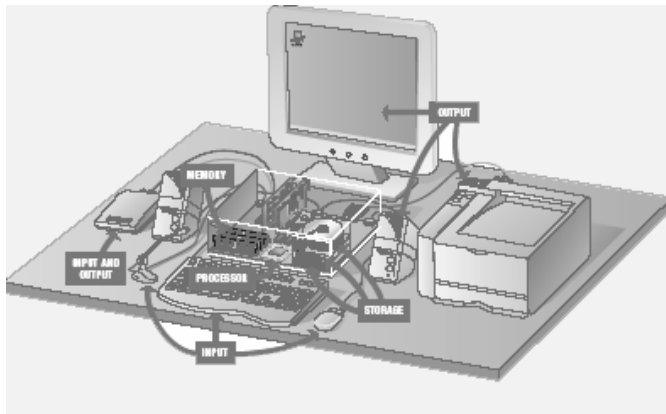


# Essential Computer Hardware

- Processing devices
  - Brains of the computer
  - Carries out instructions from the program
  - Manipulate the data
  - Most computers have several processors
  - Central Processing Unit (CPU)
  - Secondary processors
  - Processors made of silicon and copper

# Essential Computer Hardware

- Computers use the same basic hardware
- Hardware categorized into four types



# Essential Computer Hardware

- Memory devices
  - Stores data or programs
  - Random Access Memory (RAM)
    - Volatile
    - Stores current data and programs
    - More RAM results in a faster system
  - Read Only Memory (ROM)
    - Permanent storage of programs
    - Holds the computer boot directions

## Essential Computer Hardware

- Input and output devices
  - Allows the user to interact
  - Input devices accept data
    - Keyboard, mouse
  - Output devices deliver data
    - Monitor, printer, speaker
  - Some devices are input and output
    - Touch screens

## Software Runs The Machine

- Tells the computer what to do
- Reason people purchase computers
- Two types
  - System software
  - Application software

## Essential Computer Hardware

- Storage devices
  - Hold data and programs permanently
  - Different from RAM
  - Magnetic storage
    - Floppy and hard drive
    - Uses a magnet to access data
  - Optical storage
    - CD and DVD drives
    - Uses a laser to access data

## Software Runs The Machine

- System software
  - Most important software
  - Operating system
    - Windows XP
  - Network operating system (OS)
    - Windows Server 2003
  - Utility
    - Symantec AntiVirus

## Software Runs The Machine

- Application software
  - Accomplishes a specific task
  - Most common type of software
    - MS Word
  - Covers most common uses of computers

## Computer users

- Role depends on ability
  - Setup the system
  - Install software
  - Manage files
  - Maintain the system
- “Userless” computers
  - Run with no user input
  - Automated systems

## Computer data

- Fact with no meaning on its own
- Stored using the binary number system
- Data can be organized into files

## Using the Keyboard And Mouse



## The Keyboard

- The most common input device
  - Must be proficient with keyboard
  - Skill is called keyboarding

## The Mouse

- All modern computers have a variant
- Allows users to select objects
  - Pointer moved by the mouse
- Mechanical mouse
  - Rubber ball determines direction and speed
  - The ball often requires cleaning

## The Keyboard

- How keyboard works
  - Keyboard controller detects a key press
  - Controller sends a code to the CPU
    - Code represents the key pressed
  - Controller notifies the operating system
  - Operating system responds
  - Controller repeats the letter if held

## The Mouse

- Optical mouse
  - Light shown onto mouse pad
  - Reflection determines speed and direction
  - Requires little maintenance

## The Mouse

- Interacting with a mouse
  - Actions involve pointing to an object
  - Clicking selects the object
  - Clicking and holding drags the object
  - Releasing an object is a drop
  - Right clicking activates the shortcut menu
  - Modern mice include a scroll wheel

## The Mouse

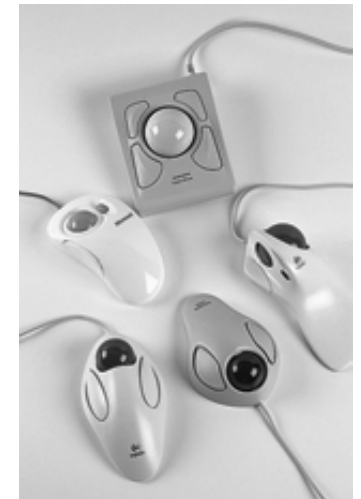
- Mouse button configuration
  - Configured for a right-handed user
    - Can be reconfigured
  - Between 1 and 6 buttons
  - Extra buttons are configurable

## The Mouse

- Benefits
  - Pointer positioning is fast
  - Menu interaction is easy
  - Users can draw electronically

## Variants of the Mouse

- Trackballs
  - Upside down mouse
  - Hand rests on the ball
  - User moves the ball
  - Uses little desk space



## Variants of the Mouse

- Track pads
  - Stationary pointing device
  - Small plastic rectangle
  - Finger moves across the pad
  - Pointer moves with the pointer
  - Popular on laptops



## Ergonomics and Input Devices

- Ergonomics
  - Study of human and tool interaction
  - Concerned with physical interaction
  - Attempts to improve safety and comfort

## Variants of the Mouse

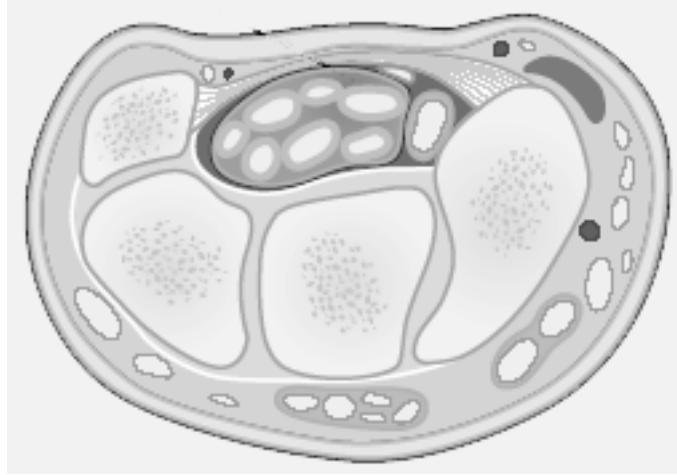
- Track point
  - Little joystick on the keyboard
  - Move pointer by moving the joystick



## Ergonomics and Input Devices

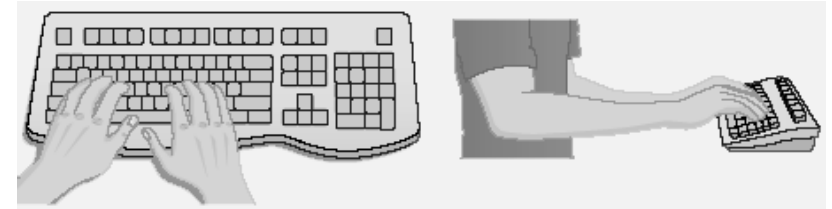
- Repetitive Strain Injury (RSI)
  - Caused by continuous misuse of the body
  - Many professions suffer from RSI
- Carpal Tunnel Syndrome
  - Carpal tunnel is a passage in the wrist
  - Holds nerves and tendons
  - Prolonged keyboarding swells tendons

## Carpal Tunnel Syndrome



## Ergonomics and Input Devices

- Techniques to avoid RSI
  - Sit up straight
  - Have a padded wrist support
  - Keep your arms straight
  - Keyboard properly
  - Take frequent breaks



## Ergonomics and Input Devices

- Office hardware suggestions
  - Office chairs should have
    - Adjustable armrests and height
    - Armrests
    - Lower back support
  - Desks should have
    - Have a keyboard tray
    - Keep hands at keyboard height
    - Place the monitor at eye level

## Inputting Data In Other Ways

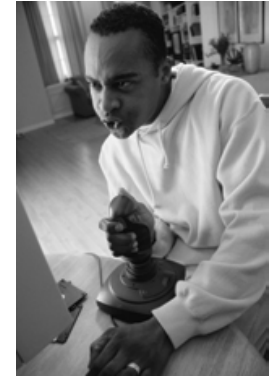
## Devices for the Hand

- Pen based input
  - Tablet PCs, PDA
  - Pen used to write data
  - Pen used as a pointer
  - Handwriting recognition
  - On screen keyboard



## Devices for the hand

- Game controllers
  - Enhances gaming experience
  - Provide custom input to the game
  - Modern controllers offer feedback
  - Joystick
  - Game pad



## Devices for the hand

- Touch screens
  - Sensors determine where finger points
  - Sensors create an X,Y coordinate
  - Usually presents a menu to users
  - Found in cramped or dirty environments



## Optical Input Devices

- Allows the computer to see input
- Bar code readers
  - Converts bar codes to numbers
    - UPC code
  - Computer find number in a database
  - Works by reflecting light
    - Amount of reflected light indicates number

## Optical Input Devices

- Image scanners
  - Converts printed media into electronic
  - Reflects light off of the image
  - Sensors read the intensity
  - Filters determine color depths

## Audiovisual Input Devices

- Microphones
  - Used to record speech
  - Speech recognition
    - “Understands” human speech
    - Allows dictation or control of computer
    - Matches spoken sound to known phonemes
    - Enters best match into document

## Optical input devices

- Optical character recognition (OCR)
  - Converts scanned text into editable text
  - Each letter is scanned
  - Letters are compared to known letters
  - Best match is entered into document
  - Rarely 100% accurate

## Audiovisual Input Devices

- Musical Instrument Digital Interface
  - MIDI
  - Connects musical instruments to computer
  - Digital recording or playback of music
  - Musicians can produce professional results



## Audiovisual Input Devices

- Digital cameras
  - Captures images electronically
  - No film is needed
  - Image is stored as a JPG file
  - Memory cards store the images
  - Used in a variety of professions



## Monitors

- Most common output device
- Connects to the video card
- Categorized by color output
  - Monochrome
    - One color with black background
  - Grayscale
    - Varying degrees of gray
  - Color
    - Display 4 to 16 million colors

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## Video and Sound

## Monitors

- Cathode Ray Tube (CRT)
  - Most common type of monitor
  - Electrons fired from the back
  - Electrons excite phosphor to glow
  - Phosphor is arranged in dots called pixels
  - Dot mask ensures proper pixel is lit

## Monitors

- CRT color
  - Phosphor dots arranged in triads
  - Red, green, and blue dots
  - Three colors blend to make colors
  - Varying the intensity creates new colors

## Monitors

- Liquid Crystal Display (LCD)
  - Commonly found on laptops
  - Desktop versions exist
  - Solve the problems of CRT
  - Fluorescent lights provide illumination

## Monitors

- CRT drawbacks
  - Very large
  - Very heavy
  - Use a lot of electricity

## Monitors

- Passive matrix LCD
  - Pixels arranged in a grid
  - Pixels are activated indirectly
    - Row and column are activated
  - Animation can be blurry



## Monitors

- Active matrix LCD
  - Each pixel is activated directly
  - Pixels have 4 transistors
    - One each for red, green, blue
    - One for opaqueness
  - Transistors arranged in a thin film
  - Animation is crisp and clean

## Monitors

- Paper-white displays
  - High contrast between fore and background
- Electro-luminescent displays (ELD)
  - Similar to LCD
  - Uses phosphor to produce light
- Plasma monitor
  - Gas is excited to produce light

## Monitors

- Drawbacks to LCD
  - More expensive than CRT
  - Must sit directly in front of screen
  - Can be more fragile than CRT

## Monitors and Video Cards

- Monitors impacts user effectiveness
- Monitors should have
  - Crisp text
  - Clear graphics
  - Adjustable controls
  - Clear edges

## Monitors and Video Cards

- Size of monitor
  - Measured in inches
  - Measured diagonally
  - Actual size
    - Distance from corner to corner
  - Viewable size
    - Useable portion of the screen

## Monitors and Video Cards

- Refresh rate
  - Number of time the screen is redrawn
  - Modern equipment sets this automatically
  - Improper settings can cause eyestrain

## Monitors and Video Cards

- Resolution
  - Number of pixels on the screen
  - Higher number creates sharper images
  - Higher number creates smaller images

## Monitors and Video Cards

- Dot pitch
  - Distance between the same color dots
  - Ranges between .15 mm and .40 mm
  - Smaller creates a finer picture
  - Should be less than .22

## Video Cards

- Device between the CPU and monitor
- Better cards result in better output
- Removes burden of drawing from CPU
- Have their own processor and RAM
- Modern cards have up to 512 MB RAM
- Capable of rendering 3D images

## Ergonomics and Monitors

- Electronic magnetic fields (EMF)
  - Generated by all electronic devices
  - EMF may be detrimental to health
  - Steps to avoid
    - Keep the computer at arms length
    - Take frequent breaks
    - Use an LCD monitor

## Ergonomics and Monitors

- Eyestrain
  - Fatigue of the eyes
  - Steps to avoid
    - Choose a good monitor
    - Place the monitor 2 – 3 feet away
    - Center of screen below eye level
    - Avoid reflected light

## Data Projectors

- Replaced overhead and slide projectors
- Project image onto wall or screen
- LCD projectors
  - Most common type of projector
  - Small LCD screen
  - Very bright light
  - Require a darkened room

## Data Projectors

- Digital Light Projectors
  - A series of mirrors control the display
  - May be used in a lighted room

## Sound Systems

- Sound card
  - Device between the CPU and speakers
  - Converts digital sounds to analog
  - Can be connected to several devices
  - Modern cards support Dolby Surround Sound

## Sound Systems

- Integral part of the computer experience
- Capable of recording and playback

## Sound Systems

- Headphones and headsets
  - Replacement for speakers and microphones
  - Offer privacy
  - Does not annoy other people
  - Outside noise is not a factor
  - Headsets have speakers and a microphone

# Modern 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

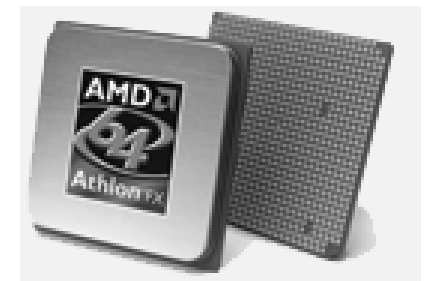


## A Look Inside The Processor

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

## 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

## Comparing Processors

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

## Microcomputer Processors

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

## 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

## Standard Computer Ports



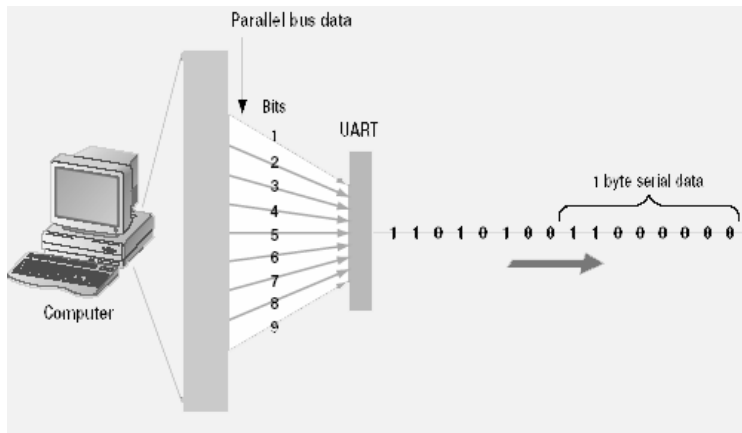
## Extending The Processors Power

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

## 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

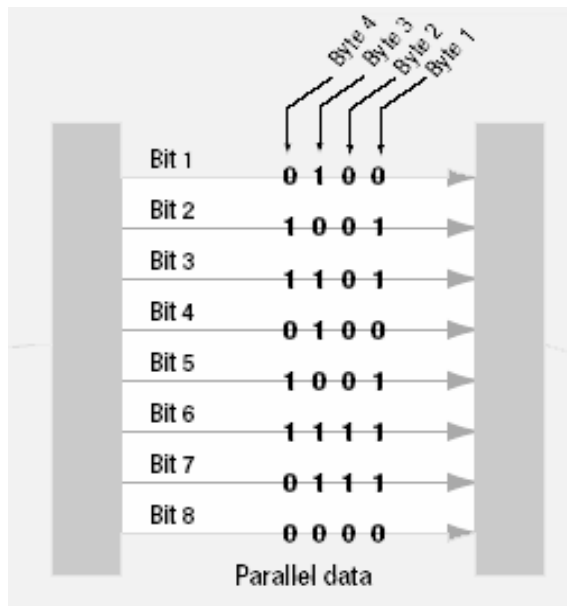
## Serial Communications



## Extending The Processors Power

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

## Parallel Communications



## 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

- 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

- 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

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

# Types of Storage Devices

## Describing Storage Devices

- Storage terms
  - Media is the material storing data
  - Storage devices manage the media
  - Magnetic devices use a magnet
  - Optical devices use lasers
  - Solid-state devices have physical switches

## Describing Storage Devices

- Store data when computer is off
- Two processes
  - Writing data
  - Reading data

## Magnetic Storage Devices

- Most common form of storage
- Hard drives, floppy drives, tape
- All magnetic drives work the same

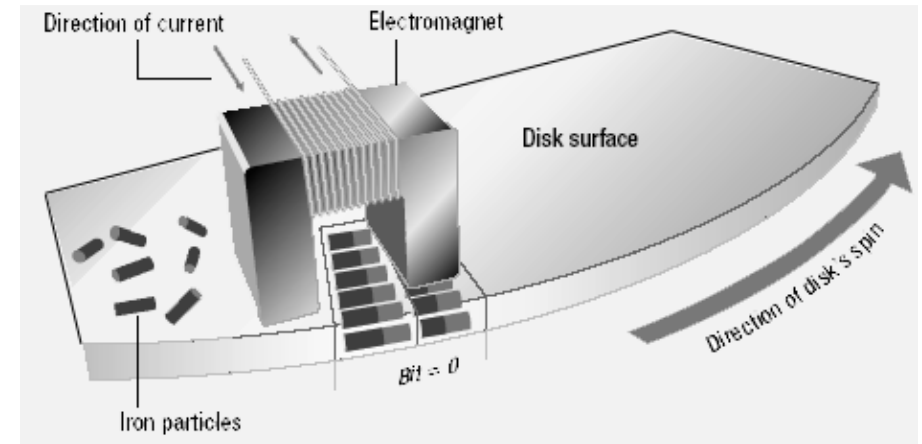
# Magnetic Storage Devices

Floppy Disk



Tape

# Data Retrieval



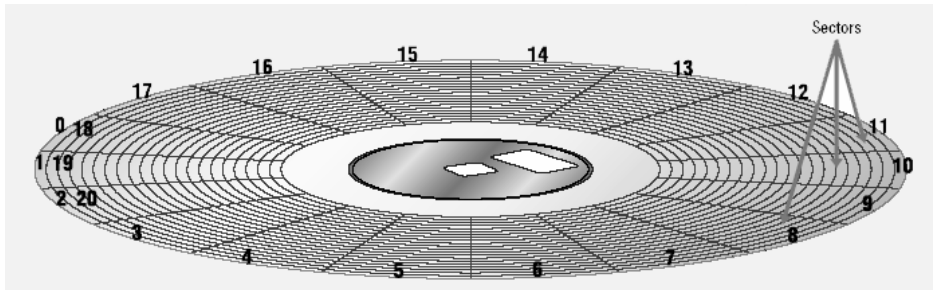
# Magnetic Storage Devices

- Data storage and retrieval
  - Media is covered with iron oxide
  - Read/write head is a magnet
  - Magnet writes charges on the media
    - Positive charge is a 1
    - Negative charge is a 0
  - Magnet reads charges
  - Drive converts charges into binary

# Magnetic Storage Devices

- Data organization
  - Disks must be formatted before use
  - Format draws tracks on the disk
  - Tracks is divided into sectors
    - Amount of data a drive can read

## Tracks and Sectors



## Magnetic Storage Devices

- Diskettes
  - Also known as floppy disks
  - Read with a disk drive
  - Mylar disk
  - Spin at 300 RPM
  - Takes .2 second to find data
  - 3 ½ floppy disk holds 1.44 MB

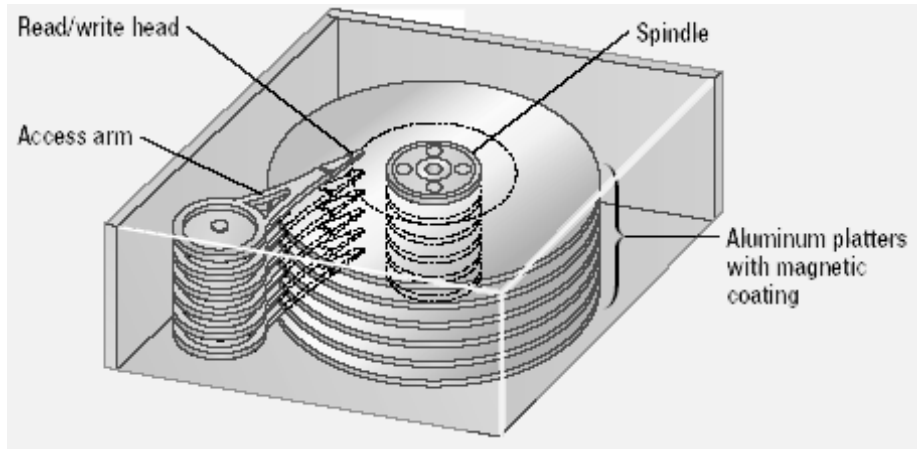
## Magnetic Storage Devices

- Finding data on disk
  - Each track and sector is labeled
    - Some are reserved
  - Listing of where files are stored
    - File Allocation Table (FAT)
    - FAT32
    - NTFS
  - Data is organized in clusters
    - Size of data the OS handles

## Magnetic Storage Devices

- Hard disks
  - Primary storage device in a computer
  - 2 or more aluminum platters
  - Each platter has 2 sides
  - Spin between 5,400 to 15,000 RPM
  - Data found in 9.5 ms or less
  - Drive capacity greater than 40 GB

## Illustrated Hard Disk



## Magnetic Storage Devices

- Tape drives
  - Best used for
    - Infrequently accessed data
    - Back-up solutions
  - Slow sequential access
  - Capacity exceeds 200 GB



## Magnetic Storage Devices

- Removable high capacity disks
  - Speed of hard disk
  - Portability of floppy disk
  - Several variants have emerged
  - High capacity floppy disk
    - Stores up to 750 MB of data
  - Hot swappable hard disks
    - Provide GB of data
    - Connect via USB

## Optical Storage Devices

- CD-ROM
  - Most software ships on a CD
  - Read using a laser
    - Lands, binary 1, reflect data
    - Pits scatter data
  - Written from the inside out
  - CD speed is based on the original
    - Original CD read 150 Kbps
    - A 10 X will read 1,500 Kbps
  - Standard CD holds 650 MB

## Optical Storage Devices

- DVD-ROM
  - Digital Video Disk
  - Use both sides of the disk
  - Capacities can reach 18 GB
  - DVD players can read CDs

## Recordable Optical Technologies

- CD Regrettable (CD-RW)
  - Create a reusable CD
  - Cannot be read in all CD players
  - Can reuse about 100 times

## Recordable Optical Technologies

- CD Recordable (CD-R)
  - Create a data or audio CD
  - Data cannot be changed
  - Can continue adding until full

## Recordable Optical Technologies

- Photo CD
  - Developed by Kodak
  - Provides for photo storage
  - Photos added to CD until full
  - Original pictures cannot be changed

## **Recordable Optical Technologies**

- DVD Recordable
  - Several different formats exist
  - None are standardized
  - Allows home users to create DVDs
  - Cannot be read in all players

## **Solid State Devices**

- Data is stored physically
- No magnets or laser
- Very fast

## **Recordable Optical Technologies**

- DVD-RAM
  - Allow reusing of DVD media
  - Not standardized
  - Cannot be read in all players

## **Solid State Devices**

- Flash memory
  - Found in cameras and USB drives
  - Combination of RAM and ROM
  - Long term updateable storage

## Solid State Devices

- Smart cards
  - Credit cards with a chip
  - Chip stores data
  - Eventually may be used for cash
  - Hotels use for electronic keys

## Graphics and Multimedia

## Solid State Devices

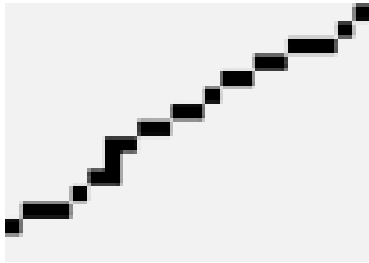
- Solid-state disks
  - Large amount of SDRAM
  - Extremely fast
  - Volatile storage
  - Require battery backups
  - Most have hard disks copying data

## Graphic File Formats

- Bitmapped images
  - Most common image type
  - Also called raster images
  - Image is drawn using a pixel grid
  - Each grid contains a color
  - Color depth
    - Number of usable colors
  - Used to store drawings or photographs
  - Resizing image can reduce quality



## Bitmap Resized



This image was drawn as a straight line.

## Graphic File Formats

- File formats and compatibility
  - Method for storing an image
  - Each method has pros and cons
  - Some formats are proprietary
  - Graphic software can handle all formats

## Graphic File Formats

- Vector images
  - Drawn using mathematical formulas
  - Formulas describe the line properties
  - CAD and animation software
  - Resizing image will not reduce quality

## Graphic File Formats

- Common bitmapped file formats
  - BMP
  - EMF
  - GIF
  - JPG
  - PICT
  - PNG
  - TIFF

## Graphic File Formats

- Vector file formats
  - Most vector formats are proprietary
  - Two universal formats exist
    - DXF
    - IGES

## Acquiring Images

- Digital cameras
  - Stores digitized images
  - Uses long term storage
  - Image is usually a JPG file

## Acquiring Images

- Scanners
  - Like a photocopier
  - Image is saved onto disk
  - Scanners import a variety of formats



## Acquiring Images

- Digital video cameras
  - Stores full motion video
  - Uses long term storage
  - Movie can be transferred to DVD

## Acquiring Images

- Clip art
  - Originally a book with images
  - Now a CD with images
  - Most office suites include a selection
  - Additional clip art is online



## Graphics Software

- Draw programs
  - Create vector based images
  - Used when accuracy is critical
  - Objects have an outline and fill
    - Both have line style and color
    - Can fill using pictures
  - Adobe Illustrator

## Graphics Software

- Paint programs
  - Create bitmap images
  - Includes sophisticated tools
  - Artists draw with several brushes
  - Objects drawn become permanent
  - Windows Paint

## Graphics Software

- Photo-editing software
  - Modify and manipulate digital images
  - Work at the pixel level
  - Images can be enhanced
  - Picture flaws can be repaired
  - Pictures can be completely changed
  - Photoshop and GIMP

## Enhancing a Photo



## Graphics Software

- 3D modeling software
  - Generates three dimensional images
  - Image can be shaped on screen
  - Image is animated frame by frame



## Graphics Software

- Computer Aided Drafting (CAD)
  - Generates vector files
  - Engineering and design fields
  - Drawings accurate to the millimeter
  - AutoCAD



## Graphics Software

- Computer generated imaging
  - Generates photo realistic images
  - Used for movies and television
  - Software eliminates tedious parts



## Multimedia Basics

- Medium
  - Way of sharing information
  - Voice, pictures, text
  - More effective with multiple mediums
  - Multimedia presents information with one medium

## Printing

## Multimedia Basics

- Interactivity
  - Users and program respond
  - Users can control the content
  - Main difference between TV and computer

## Commonly Used Printers

- Impact printers
  - Generate output by striking the paper
  - Uses an inked ribbon
- Non-impact printers
  - Use methods other than force
  - Tend to be quiet and fast

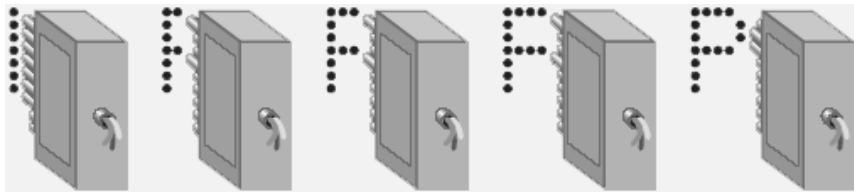
## Commonly Used Printers

- Dot matrix printers
  - Impact printer
  - Used to print to multi-sheet pages
  - Print head strikes inked ribbon
  - Line printers
  - Band printers
  - Speed measured in characters per second

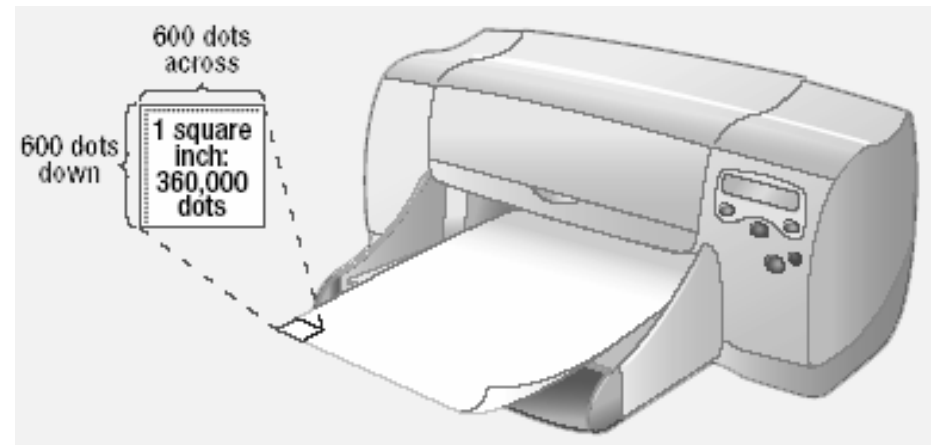
## Commonly Used Printers

- Ink-jet printers
  - Non-impact printer
  - Inexpensive home printer
  - Color output common using CMYK
    - Cyan, magenta, yellow, black
  - Sprays ink onto paper
  - Speed measured in pages per minute
  - Quality expressed as dots per inch

## Dot Matrix Print Head



## Dots Per Inch



## Commonly Used Printers

- Laser printer
  - Non-impact printer
  - Produces high quality documents
  - Color or black and white
  - Print process
    - Laser draws text on page
    - Toner sticks to text
    - Toner melted to page
  - Speed measured in pages per minute
  - Quality expressed as dots per inch

## Comparing Printers

- Determine what you need
- Determine what you can spend
- Initial cost
- Cost of operating
- Image quality
- Speed

## Commonly Used Printers

- All-in-one peripherals
  - Scanner, copier, printer and fax
  - Popular in home offices
  - Prices are very reasonable

## High-Quality Printers

- Special purpose printers
  - Used by a print shop
  - Output is professional grade
  - Prints to a variety of surfaces

## High-Quality Printers

- Photo printers
  - Produces film quality pictures
  - Prints very slow
  - Prints a variety of sizes



## High-Quality Printers

- Dye sublimation printers
  - Produces realistic output
  - Very high quality
  - Color is produced by evaporating ink
  - Operation costs are high
  - Output is very slow

## High-Quality Printers

- Thermal wax printers
  - Produces bold color output
  - Color generated by melting wax
  - Colors do not bleed
  - Operation costs are low
  - Output is slow

## High-Quality Printers

- Plotters
  - Large high quality blueprints
  - Older models draw with pens
  - Operational costs are low
  - Output is very slow

