



# Chapter 6: Operating Systems: The Genie in the Computer

What do you have left on your computer after you strip away all of the games and application programs you bought and installed?

# Operating Systems: The Genie in the Computer

- In this chapter:

- What is an operating system and what does it do?
- Where can the operating system be found before, during and after a computer has been turned on?
- What are some major interface differences in operating systems?
- What are some memory constraints dealing with the amount of RAM memory and the size of programs to be stored there?
- How does an operating system control information over a network?
- What do operating systems have in common?

# What is an operating system?

- **The operating system:** A collection of programs that manages and controls applications and other software, and coordinates the various hardware components to perform tasks requested by the user.
  - Allows use of (partial list!)
    - the keyboard
    - the mouse
    - printing to a printer of your choice
    - viewing information on a monitor
    - saving or retrieving files
    - formatting a disk
    - running programs
    - controlling any external device attached to the computer

# What is an operating system?

- Altair 8800: One of the first microcomputers (1975)
  - Had NO operating system
  - Switches had to be “fat fingered” - manually switched by hand - to enter instructions into RAM to start up the computer.
  - The first program “fat-fingered”: allowed the computer to recognize a paper-tape reader:
    - Keyboard
    - BASIC program



# What is an operating system?

- BIOS (Basic Input Output System)
  - Small unchangeable part of the operating system in the ROM.
  - **BIOS:**
    - A collection of programs that have the capability of communicating with peripheral devices.
      - Keyboards, Disk drives, printers, display/monitors, and other devices.
    - BIOS most important task: Loads the operating system into RAM and turns control of the computer over to it.

# Booting the Computer

- “Booting up”(Starting) the computer:
  - The computer invokes a stripped-down version of the operating system found in ROM. (Makes the computer recognize the keyboard, floppy and the hard disk drives.)
  - Diagnostics are run on RAM and any cards residing in the computer.
  - The programs in ROM make the computer look for the rest of the operating system on the floppy disk.
    - If it can’t find the floppy disk, it will look for rest of the operating system on the hard disk.
  - The operating system (found on the floppy or hard disk drive) is loaded into RAM.
  - The programs residing in RAM now control the computer.

# Booting the Computer

- Cold boot:
  - Starting up the computer by turning the power on.
  - Operating system in ROM looks for and loads the remaining operating system into RAM.
- Warm boot:
  - Reloads the operating system into RAM without disrupting the power to the disk drives or power supply.

# Booting the Computer

## ■ Booting with Multiple Operating Systems

- Common when you need to run programs recognized by older operating systems.
  - Example: MS DOS and Windows
- Common when you need two different operating systems and have only one machine.
  - Example: Macintosh X and Windows
- **Partitioning:** Dividing a hard drive so that it appears to the computer to be two (or more) separate disk drives.

# User Interface

- User interface: The part of the operating system that the user sees and communicates with.
  - Two basic ways the operating system is presented to the user:
    - **Command line** - Commands are typed in using the keyboard.
      - Example: `>copy c:paper.txt a:*.*`
    - **GUI (Graphical User Interface)** - Icons (graphical representation of command choices) are selected using an input device, usually a mouse.
      - Takes advantage of drag and drop.

# User Interface

- Version number: The number given to a program that is used for identification.
  - Indicates the variant of the program being considered.
  - Release and modification numbers give even more specific information about the program variant.
- Why is knowing the version number of the operating system important?
  - Programs such as word processors, spreadsheets and others are written for a particular version of the operating system.
  - They use parts of the operating system to function.

# User Interface

- UNIX:
  - Used by professional high-powered computer users in business, science, engineering and networking.
    - Flexible in doing computing jobs.
    - Doesn't fail or crash very often.
  - Some versions are free. Example: Linux.
    - **Open-source software:** The original program is available. Changes can be made to suit computing needs.
  - Can use either command line or GUI type user interface.
    - Popular command line: Korn shell, C shell, Bourne shell.
    - Example of GUI to UNIX: X Window.
    - Examples of GUI to Linux: Gnome and KDE

# Files and File Management

- **File:** the name given to any program or chunk of data that is stored on floppy, hard disk, CD ROM, or other storage.
  - Naming files:
    - Early operating systems allowed 8-letter names.
    - Modern operating systems allow as many as 256 letters.
  - Extensions:
    - A 3-letter extension is added to the file name separated by a period.
      - Helps the operating system identify the type of file.
      - Example: `index.htm` identifies a document called `index` that is made up of HTML code.

# Files and File Management

- Two types of file systems:
  - **Flat File** system: stores the files in a single list.
  - **Hierarchical File** system organizes files in a treelike structure or hierarchy.
    - Organizes files into groupings.
      - **Folders:** A grouping of files or other folders under a single name.

# Input & Output of Information - Device Control

- What makes binary information of these types different to the computer?
  - Numbers
  - Text or Characters
  - Visual information
  - Audio information
  - Instruction
- The computer has no way of “knowing” which of the five types of information are in a file unless the person or application supplies its type in the proper form.

# Input & Output of Information - Device Control

- Compatibility problem:
  - Files created by the same type of program are not always interchangeable.
    - Example: Can't always interchange files created by one word processor to another. Also, same word processors with different versions are not always compatible.

# Input & Output of Information - Device Control

- Installing a new device:
  - A physical connection must be made to the peripheral.
  - The proper software drivers must be added to the operating system's collection of programs.
    - **Device Driver:** A program that will allow communication between the operating system and another part of the computer, usually a peripheral device like a printer or scanner. It is an addition to the operating system.

# Memory Concerns: Cache and Virtual Memory

- If the primary memory were as large as ever needed, the following ideas would not be necessary.
- **Cache memory:** Used when the speed of memory access is too slow - can't keep up with the CPU's needs (two types).
  1. **Disk cache** - Saves the most frequently used parts of the program being run or executed in the RAM memory - Saving it from repeatedly retrieving it from the hard disk.
  2. **RAM disk** - Fools the program into thinking it is accessing the disk, but instead the needed information has been transferred to RAM (RAM is much faster than disk access).

# Memory Concerns: Cache and Virtual Memory

- RAM Cache Memory: Very fast memory that is used by the operating system to house the data and instructions that are currently being used.
  - The interaction is between ordinary RAM and a special type of very fast and expensive RAM.
    - Program and data are taken from disk and placed in RAM.
    - Cache controller loads instructions and data into cache.
    - CPU takes program instructions from cache RAM. (fast!)
    - Data needed by the program is also taken from RAM. (fast!)
    - CPU performs the instructions of the program.
    - The results of the computation are placed back into cache RAM.
    - Results are placed back into ordinary RAM.
    - When complete, the final results are placed back on the disk.

# Memory Concerns: Cache and Virtual Memory

- VRAM or Video RAM: Very fast memory that is used by the operating system to house video display data that allows quicker, better video display.
  - RAM isn't fast enough to make quick changes in the display.
  - By putting the image data into this faster video RAM, delays can be made minimal.

# Memory Concerns: Cache and Virtual Memory

- **Virtual Memory** - addresses the problem of a program being too big to fit into the available RAM.
  - The operating system divides the program into pieces.
  - The pieces are stored on the hard disk as if it were additional RAM memory needed by the program.
  - The pieces are retrieved into RAM as needed.
  - Disadvantage: This slows the system down, because retrieval of information from the disk is time consuming.

# Context Switching and Multitasking

- **Context Switching:** Allows several application programs to be in RAM memory at one time.
  - Allows switching from one program to another such as from a word processor to a spreadsheet and back again (both reside in RAM).
  - Limitation: The only active program is the one just switched to, the others are inactive.

# Context Switching and Multitasking

- **Multitasking:** Allows several application programs to be in RAM memory at one time.
  - Allows the operating system to control more than one program simultaneously.
  - Each program “stealing” CPU time.
    - Such as playing a game while a large document is being printed.
  - **(von Neumann) Bottleneck:** Microcomputers having only one program counter can run only one program at a time.
    - The CPU can only process a single instruction at any one time, no matter how many tasks there are.

# Operating Systems for the Networked World

- **Two categories of operating systems:**
  - The single CPU.
  - The multiprocessor system that has many CPUs (such as a supercomputer).
- **Parallel processing (Multiprocessing):**
  - Programs are divided into pieces.
  - Each of the pieces get processed by one of many processors.
  - Several processors or CPUs are simultaneously computing a program.

# Operating Systems for the Networked World

- **Distributive processing:**
  - Makes use of a network.
  - Decentralizes and distributes the computing needs over several interconnected computers.
- **Operating Systems designed for networks:**
  - Handles all of the single-computer chores.
  - Communicates with other computers in the network.
  - One computer on the network can act as a shared storage unit.
    - **Server:** A computer that provides data and programs on request from multiple clients.

# Operating Systems for the Networked World

- **Real-time processing:**

- Involves human interaction with the computer.
- Requires quick or timely return of results.
- Referred to in the engineering and manufacturing world as Controlling processes.
  - ATM: Customer wants cash now, not tomorrow! Bank wants to know how much money you have (even if after hours) before you are able to make a withdrawal from your account.
  - Airline ticket reservation system: Travel agent needs to know how many seats are still available. (Immediately)

# Operating Systems for the Networked World

## ■ **Process Control:**

- Refers to the control of some process by a computer in real time.
- Computer needs to accept information, then manage the process on the basis of these calculations.
  - Robotics: Maneuvering a robot's arm.
  - Automobiles: Computerized traffic signals at intersections control traffic flow through a city.

# Three Cutting Edge Operating Systems

- Comparing:
  - Windows 2000
  - Macintosh X
  - Linux
- Computer Start-up Requirements
  - The majority of all operating systems reside on the hard drive of the computer.
    - Operating system must be loaded into RAM.
    - Time to boot up:
      - Depends on how many features have been added to the operating system.
      - All three boot up in less than one minute.

# Three Cutting Edge Operating Systems

## ■ Running Applications

- **Compatibility:** Before you purchase software, examine the box. It will tell you which operating system and which version of the operating system is required.
- Compatibility problems may arise if an operating system is updated. One of two things might happen after updating:
  1. The operating system may be compatible with older software so that more users will purchase it.
  2. The operating system was optimized with the latest software technology. Many applications won't run. The hope is that manufacturers will rewrite the software so that it will become compatible with the new operating system.

# Three Cutting Edge Operating Systems

- Access to Previously Stored Information
  - Operating systems
    - Assist in creating new documents with various applications.
    - Allow the retrieval of files already created by some application.

# Three Cutting Edge Operating Systems

- Controlling and Communicating with Peripheral Devices
  - One major responsibility of the operating system is communicating and controlling peripheral devices.
  - Modern operating systems have a feature called: **plug & play**.
    - Just attach a new peripheral to your computer and start using it.
    - Problem: A new peripheral needs a device driver installed in the operating system. (An older peripheral's technology may have already been included as a part of the operating system.)

# Three Cutting Edge Operating Systems

- Connecting a computer to a network
  - Computers connected on a network need to be able to share files and communicate with other computers.
  - Operating system must be configured to network specifications.

# Three Cutting Edge Operating Systems

- Manage and Add to Capability
  - All operating systems are built to be extended.
    - By adding software to the operating system, new features can be added.
  - Operating system: Managing “housekeeping chores”:
    - A **fragmented** disk: As files become scattered on the hard disk, small chunks of space not large enough to hold an entire file develop.
      - A single file stored on such a disk can take up several of these chunks.
    - **Defragmenting** a hard drive is the process of moving the scattered files together. (Performed by software.)