Computers: Tools for an Information Age

Chapter 3
Operating Systems: Software in the Background
Objectives of Chapter 3

- Describe the functions of an Operating System
- Explain the basics of a personal computer operating system
- Describe the advantages of a graphical operating system
- Differentiate among different operating systems
- Explain the need for network operating systems
- Describe the methods of resource allocation on large computers
- Be able to describe the differences among multiprocessing, multiprogramming, and timesharing
- Explain the principles of memory management
- List several functions typically performed by utility programs
Systems Software

- Definition:
  - All programs related to coordinating computer operations

- Components
  - Operating System
  - Utility programs
  - Program language translators
Operating Systems: Hidden Software

- Serves as intermediary between hardware and applications software
- User interested in application software to make the PC useful
- Application software is platform specific
- User must be aware of the type of OS
- User should be aware of the functions of OS
Operating System

- The set of programs that lies between applications software and the hardware and:
  - Manages computer’s resources (CPU, memory, peripheral devices)
  - Establishes a user interface
    - Determines how user interacts with operating system
  - Provides and executes services for applications software
Kernel

- Manages the operating system
  - Loaded from hard drive into memory when computer is booted
    - **Boot**ing refers to starting the computer
  - Loads other operating system programs from disk storage as needed
    - Other programs referred to as *nonresident*
User Interface

- Facilitates communication between the user and the operating system

- Two forms
  - Command line
    - Text-based
    - Key commands
    - Examples: MS-DOS, Unix
  - Graphical user interface (GUI) (pronounced “gooey”)
    - Visual images
    - Menus
    - Examples: X Windows (UNIX), MS Windows, Mac OS
Platform

- **Definition:**
  Computer hardware and operating system software that dictate what other software can run

- **Wintel (Windows/Intel)**
  Intel-based PC running MS Windows

- **SPARC (Sun Microsystems)**
  Sun based architecture running Solaris (UNIX)
Types of Operating Systems

- Interface
  - Command Line, GUI

- Single User
  - PC, MAC

- Multi-user
  - UNIX, Linux, Mainframe (Proprietary)

- Network(ed) Operating System (NOS)
Operating Systems for Personal Computers

- Platform: combination of computer hardware and operating system software
  - **Wintel** (Microsoft Windows running on an Intel-based PC) is most common

- Common Platforms
  - MS-DOS
  - Windows
  - MAC OS
  - Unix
  - Linux
MS-DOS

- Uses a command-line interface
  - Screen provides prompts for user
  - User types commands
- Largely replaced by graphical user interfaces
- Not user-friendly

Sample MS-DOS Commands

- `C:\> FORMAT A:  Prepar... diskette on drive A: for use.
- `C:\> DIR A:DIR  Lists the files on the diskette in drive A: (DIR stands for directory)
- `C:\> COPY MRKTDATA.SUM A:  Copies file MRKTDATA.SUM on drive C to Drive A.
- `C:\> DEL A:SALESRPT.TXT  Deletes file SALESRPT.TXT from drive A:
- `C:\> RENAME MRKTDATA.SUM SSDATA.CHT  Renames the file MRKTDATA.SUM on drive C to SSDATA.CHT`
Microsoft Windows

- Began as an operating environment for MS-DOS
  - Not a full-blown operating system; required MS-DOS
- Uses a graphical user interface
  - Users can use DOS commands and interface
- Now a complete family of operating systems
MS-DOS Operating Environment

- Windows 3.1
- A layer added “on top” of DOS
  - Separates operating system from user
  - Makes operating system easier to use
- Called a *shell*
Graphical User Interface

- Eases access to the OS
- Most new computers come with Windows already installed
GUI (Graphical User Interface)

- Aka WIMP interface
  - Windows, Icons, Menus, Pointer
- On-screen pictures
  - Icons
  - Menus
    - Pull down
    - Pop up
  - Click to activate a command or function
- Fast and Easy
- Intuitive (usually)
Windows Features

- Long file names (up to 255 characters)
- Plug and Play
  - Makes installing hardware components easier
- Object Linking and Embedding (OLE)
  - Allows user to embed or link one document to another
The Windows Family

- Windows 9x
  - Windows 95
  - Windows 98
  - Windows Millennium Edition (ME)

- Corporate Market
  - Windows NT
  - Windows 2000

- Windows XP
- Windows CE
Windows 9x

- Serves home/consumer market
- No longer a shell, but a self-contained operating system
- Began with Windows 95
  - Next Generation:
    - Windows 98
    - Windows ME
- Many improvements over Windows 3.1
Windows 98 Enhancements

- Internet/intranet browsing capabilities
- Support for state-of-the-art hardware, including DVD and multimedia
- Support for larger disk drives
- Wizards: step-by-step software for installing, configuring, and using software
Windows ME Enhancements

- Multimedia support: Media Player, video editing
- Enhanced reliability features
- Home network support
Corporate Market

- Windows NT
  - NT stands for “new technology”
- Windows 2000
Windows NT

- Desktop looks and acts like Windows 98
- Meant for corporate, networked environments
  - Engineered for scalability (the ability to handle many users)
  - Stronger security
Windows 2000

- The latest generation of Windows NT
- One computer “serves” many users
  - You identify yourself and the system knows your preferences
  - You get “your” desktop and files, regardless of which PC you use to log into the network
Windows XP

- Brings consumer and corporate versions of Windows together into a single product
  - Has Home and Professional Editions
Windows XP Enhancements

- Improved user interface
  - Much clearer and uncluttered desktop
  - More icons on redesigned Start Menu
- Improved multimedia support
- More personalization
- Multiple user support
  - User can log off, leaving programs running, and allow another user to log on
  - Set up limited accounts for children to use; i.e., no inappropriate games or no Internet access
- Internet support and protection
Windows CE

- Scaled-back version of Windows 9x
  - Designed to work on machines with small screens and little, if any, storage
- Used in Pocket PCs
- Used in embedded systems
  - Computer devices integrated into other products; i.e., robots
- CE.NET supports .NET platform
MAC OS

- Designed for the Macintosh computer
- First commercially successful GUI
  - Has served as the model for Windows and other GUI products developed since then
UNIX

- Developed in 1971 for use on the DEC minicomputer
- Character-based system with command-line interface
- Not tied to any family of processors
  - Runs on just about every type of system (PC, mainframe, workstation) from any manufacturer
- Primary operating system in use on Internet servers
  - Handles many simultaneous users easily
Free BSD

- A Free, public domain version of Berkeley UNIX
- Open source software
  - GNU General Public License
  - Download it free
    - www.freebsd.org
  - Make changes and use freely
- XFree86 GUI included
- PC Setup
  - PC comes with Windows installed
  - Install FreeBSD in a dual-boot configuration
    - (or reformat drives and use only FreeBSD)
Linux

- Uses command-line interface
  - Many companies have created a GUI to work with Linux
- Open-source concept
  - Source code is free
  - Users can download, change, and distribute the software
- More stable than Windows
- Applications relatively scarce
- PC Setup
  - PC comes with Windows installed
  - Install LINUX in a dual-boot configuration
UNIX (FreeBSD, LINUX, etc)

- Advantages over Windows
  - Extremely stable
  - Internet support designed in from the beginning
    - UC Berkeley had early TCP/IP Unix distribution
  - Reinstallation is simpler

- Disadvantage
  - Scarcity of applications for new toys
Networked Operating Systems (NOS)

- Designed to permit computers on a network to share resources
- Examples
  - Windows 2000 Server
  - Novell Net Ware
  - UNIX – NFS...
- Provides
  - Data security
  - Troubleshooting
  - Administrative control
NOS Functions

- Split between client and server computers
- Server
  - File management
- Client
  - Requests to the server
  - Messaging
  - Has own local OS
- Makes the resources appear as if they are local to the client’s computer
Network Operating Systems

- Windows NT Server
- Windows 2000 Server
- Windows .NET Server
- Novell Netware
- Unix
- Linux
Operating Systems for Large Computers

- Resource allocation: assigning and computer resources to certain programs and processes for their use

- Main issues related to resource allocation
  - Sharing the Central Processing Unit
  - Sharing memory
  - Sharing storage resources
  - Sharing printing resources
Large Computer OS

- Used by many people at once
- OS works “behind the scenes” so users can share
- OS must control
  - Who gets access to resources
  - What keeps the programs from different users from getting mixed up with one another
Sharing the CPU

- Multiprocessing
- Multiprogramming
- Time-Sharing
Multiprocessing

- The use of a powerful computer with multiple CPUs
- Multiple programs run simultaneously
  - Each runs on its own processor
Multiprogramming (Multi-Tasking)

- Two or more programs executed concurrently
  - Programs take turns using the CPU
  - Event-driven
    - An interrupt suspends processing to allow another program to run
    - After the second program runs, the operating system returns the CPU to another program

- Used for real-time embedded processors and for batch programs that do not require user input
Event-driven *Multiprogramming Example*

- Two programs are running – Payroll and Inventory Management
- Payroll needs to read an employee record
- Payroll generates an interrupt to read from the disk
- Normal processing is temporarily suspended
- The CPU looks at the interrupt and initiates the read operation on the disk drive
- While waiting for the read to complete, the CPU begins processing the Inventory Management program
Event-driven *Multiprogramming Example*

- When the disk read operation is complete, another interrupt is generated.
- Normal processing is temporarily suspended.
- The CPU looks at the interrupt and determines its cause (read the data in from the disk drive for the Payroll program).
- The CPU will either continue processing the Inventory Management program or return to the Payroll program depending upon their priority.
Time-Sharing

- Programs take turns using the CPU
- Time-driven
  - Each user is given a slice of time (fraction of a second)
  - CPU works only on that user’s tasks during its time slice
  - Response time: the time between typed request and computer’s reply
- Typically used in applications with many users
Time-sharing *Multiprogramming*

- One program receives the attention of the CPU
- A small fraction of CPU time is allocated to the program
- The time slice ends
- The CPU begins processing a different program
- Response time can vary based upon the number of users on the system
Sharing Memory

- Program must be in memory to be executed

Problems
- Programs compete for space
- May have a very large program
- Memory space for each program must not overlap
Memory Management

- Divides memory into separate partitions
- Allocates memory to programs
- Keeps programs separate from one another
Partitions or Regions

- Divide memory into sections (i.e., partitions)
- The partition must accommodate the largest possible program
- Problem
  - May cause wasted memory space
Foreground and Background

- **Foreground**: for programs with high priority that will receive more CPU time.
  - For example: While performing read / write operations for the Foreground program, the CPU gives time to a program in Background

- **Background**: for programs with lower priority that will receive less CPU time
  - Programs waiting to run are kept in queues based on their priority
Virtual Storage

- Programs currently executed are stored on disk
  - Portions of program brought into memory as needed
  - Minimizes the amount of memory needed

- Can be implemented by *paging*
  - Divide memory into small, fixed-size pages
  - Page table keeps track of memory locations
Virtual Storage: Virtual Memory

- **Problem -- Thrashing**
  - A large portion of CPU time is spent swapping the correct page and bringing it into memory

- **Solution**
  - Run fewer programs concurrently
  - Add memory
  - Program design
    - “working set” size – number of pages required in memory for program to run
Memory Protection

- Keeps one program from straying into another

- Confines each program to certain defined limits in memory

Why needed
- Possible for one program to destroy or modify another by transferring to the wrong memory location
- May cause destruction of data

Action if assigned memory space is violated
- Termination of executing program
Sharing Storage Resources

- Keeps track of location of files
- Responds to commands to manipulate files
- Keeps track of input and output requests for files
  - Processes them in the order received
Sharing Printing Resources

- Print resources are shared between active programs
- Printouts are generated in pieces as the CPU gives each concurrent program some time

**Problem**
- The current program may generate a few print lines
- The CPU moves to the next program
- The second program may generate a few print lines, etc.

**Result**
- Printout is worthless as it contains a few lines from several programs
Sharing Printing Resources

Solution: Spooling

- Program writes a line to a disk file rather than sending directly to a printer
- When file is completed, placed in queue
- File printed when printer becomes available

- Allows program to complete execution much more quickly
  - Writing to disk much quicker than writing to printer
Utility Programs

- Are considered part of System Software
- Handle special needs
- Perform secondary chores
- Do not need to be memory resident
File Manager

- Stores files in a hierarchical directory structure
- Windows uses Windows Explorer
File Compression

- Reduces amount of space a file requires
  - Makes file take up less space on disk
  - Takes less time to transmit across communication lines
Other Utility Programs

- **Backup and Restore**
  - Backup: make copies of disks and store in a safe place
  - Restore: restore files from backups
- **Disk defragmenter**: reorganizes disk so all files are stored in contiguous locations
- **Device driver**: handles commands for devices, such as printers and storage devices