Chapter 3: Operating Systems

• 3.1 The History of Operating Systems
• 3.2 Operating System Architecture
• 3.3 Coordinating the Machine’s Activities
• 3.4 Handling Competition Among Processes
• 3.5 Security

Functions of Operating Systems

• Oversee operation of computer
• Store and retrieve files
• Schedule programs for execution
• Coordinate the execution of programs

Evolution of Shared Computing

• Batch processing
• Interactive processing – Requires real-time processing
• Time-sharing/Multitasking – Implemented by Multiprogramming
• Multiprocessor machines
Types of Software

- Application software
  - Performs specific tasks for users
- System software
  - Provides infrastructure for application software
  - Consists of operating system and utility software

Figure 3.1 Batch processing

Figure 3.2 Interactive processing

Figure 3.3 Software classification
Operating System Components

- **User Interface**: Communicates with users
  - Text based (Shell)
  - Graphical user interface (GUI)
- **Kernel**: Performs basic required functions
  - File manager
  - Device drivers
  - Memory manager
  - Scheduler and dispatcher

File Manager

- **Directory** (or **Folder**): A user-created bundle of files and other directories (subdirectories)
- **Directory Path**: A sequence of directories within directories

Memory Manager

- Allocates space in main memory
- May create the illusion that the machine has more memory than it actually does (**virtual memory**) by playing a “shell game” in which blocks of data (**pages**) are shifted back and forth between main memory and mass storage
Getting it Started (Bootstrapping)

- **Boot loader**: Program in ROM (example of firmware)
  - Run by the CPU when power is turned on
  - Transfers operating system from mass storage to main memory
  - Executes jump to operating system

Processes

- **Process**: The activity of executing a program
- **Process State**: Current status of the activity
  - Program counter
  - General purpose registers
  - Related portion of main memory

Process Administration

- **Scheduler**: Adds new processes to the process table and removes completed processes from the process table
- **Dispatcher**: Controls the allocation of time slices to the processes in the process table
  - The end of a time slice is signaled by an interrupt.

Figure 3.5 The booting process
Figure 3.6  Time-sharing between process A and process B

Handling Competition for Resources

- **Semaphore**: A “control flag”
- **Critical Region**: A group of instructions that should be executed by only one process at a time
- **Mutual exclusion**: Requirement for proper implementation of a critical region

Deadlock

- Processes block each other from continuing
- Conditions required for deadlock
  1. Competition for non-sharable resources
  2. Resources requested on a partial basis
  3. An allocated resource can not be forcibly retrieved

Figure 3.7  A deadlock resulting from competition for nonshareable railroad intersections
Security

• Attacks from outside
  – Problems
    • Insecure passwords
    • Sniffing software
  – Counter measures
    • Auditing software

Security (continued)

• Attacks from within
  – Problem: Unruly processes
  – Counter measures: Control process activities via privileged modes and privileged instructions