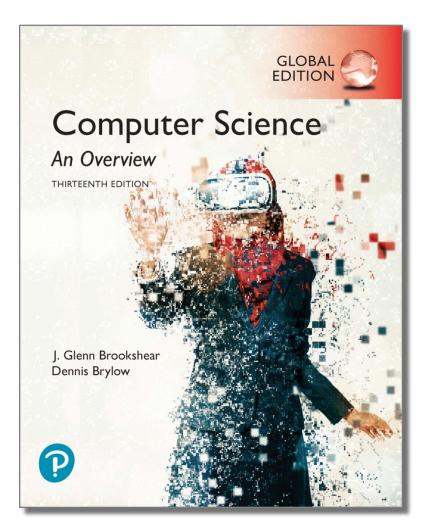
#### **Computer Science An Overview**

13th Edition, Global Edition



Chapter 3
Operating Systems



#### **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



#### **Examples of Operating Systems**

- Windows
- UNIX
- Mac OS
- Solaris (Sun/Oracle machines)
- Linux



#### **Smartphone Operating Systems**

- Apple iOS
- Windows Phone
- BlackBerry OS
- Nokia Symbian OS
- Google Android



#### **Functions of Operating Systems**

- Oversee operation of computer
- Store and retrieve files
- Provide the user interface to request execution of programs
- Coordinate the execution of programs



#### 3.1 History of Operating Systems

- Each program is called a "job"
- Early computers required significant setup time
- Each "job" required its own setup
- Operating Systems began as systems for simplifying setup and transitions between jobs

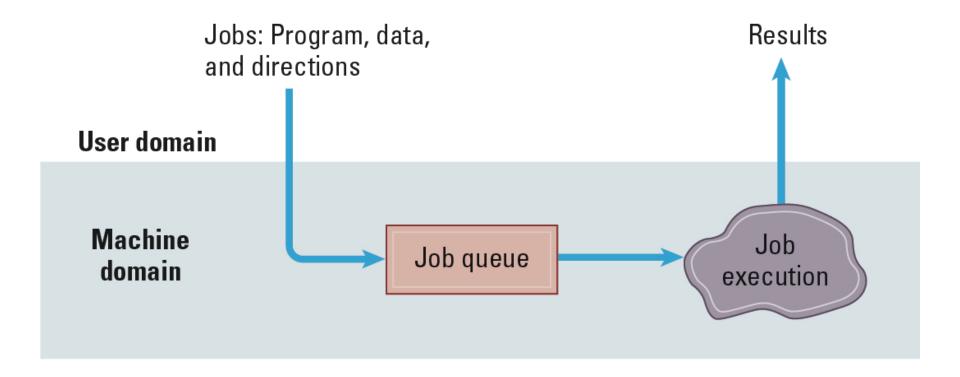


#### 3.1 History of Operating Systems

- Batch processing (job queue)
- Interactive processing (real time)
- Time-sharing (one machine, many users)
- Multitasking (one user, many tasks)
- Multiprocessor machines (load balancing)
- Embedded Systems (specific devices)

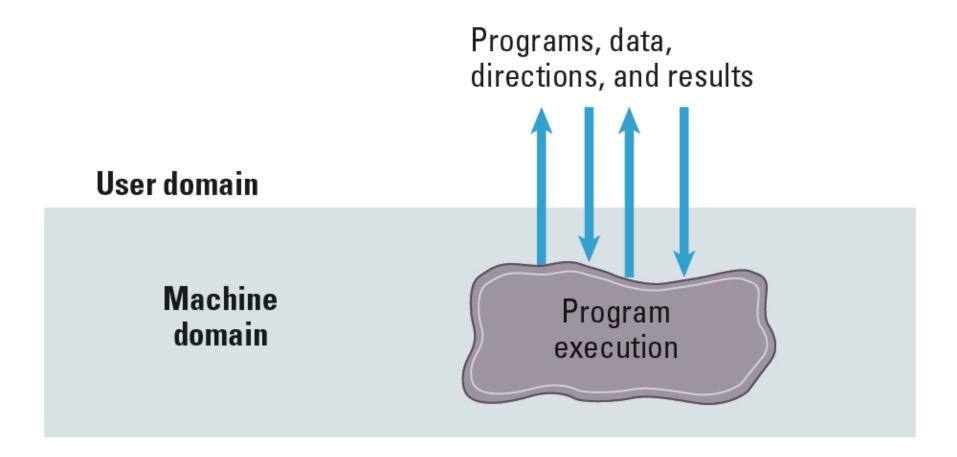


#### Figure 3.1 Batch processing





#### Figure 3.2 Interactive processing



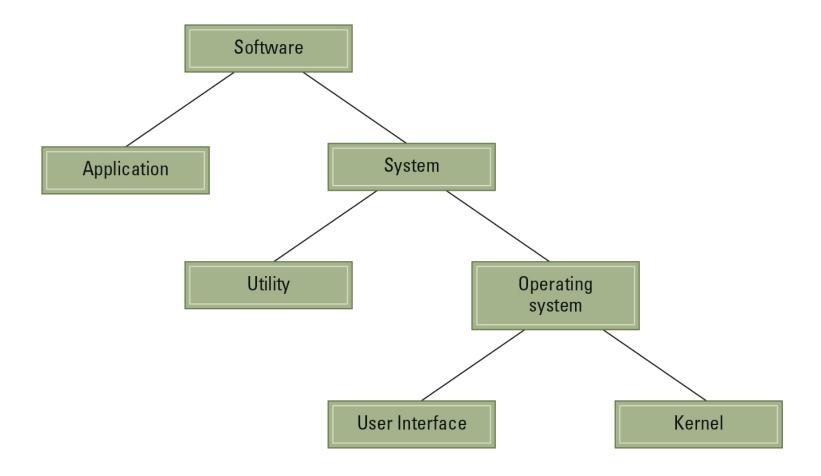


#### 3.2 Operating System Architecture

- Application software
  - Performs specific tasks for users (productivity, games, software development)
- System software
  - Provides infrastructure for application software
  - Consists of operating system and utility software



#### Figure 3.3 Software classification



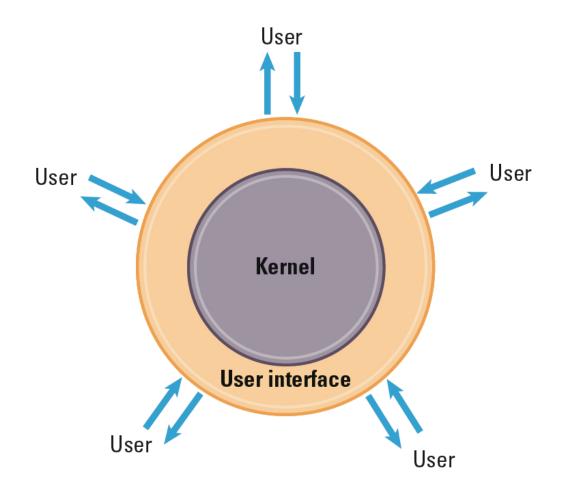


#### **Operating System Components**

- 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



# Figure 3.4 The user interface acts as an intermediary between users and the operating system's kernel





#### 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

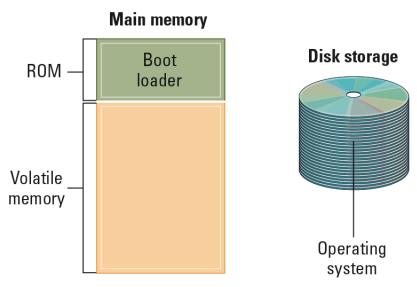


#### Getting it Started (Bootstrapping)

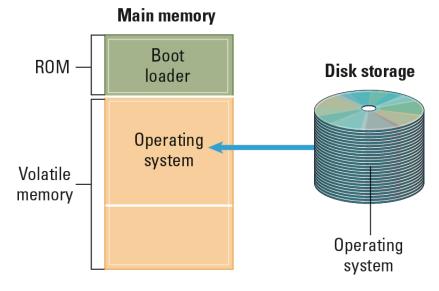
- Boot loader: Program in ROM (example of firmware)
  - Run by the CPU when power is turned on
  - Transfers operating system from mass storage to main memory
  - Executes jump to operating system



#### Figure 3.5 The booting process



**Step 1:** Machine starts by executing the boot loader program already in memory. Operating system is stored in mass storage.



Step 2: Boot loader program directs the transfer of the operating system into main memory and then transfers control to it.



#### 3.3 Coordinating the Machine's Activities

An operating system coordinates the execution of application software, utility software, and units within the operating system itself.



#### The Concept of a Process

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

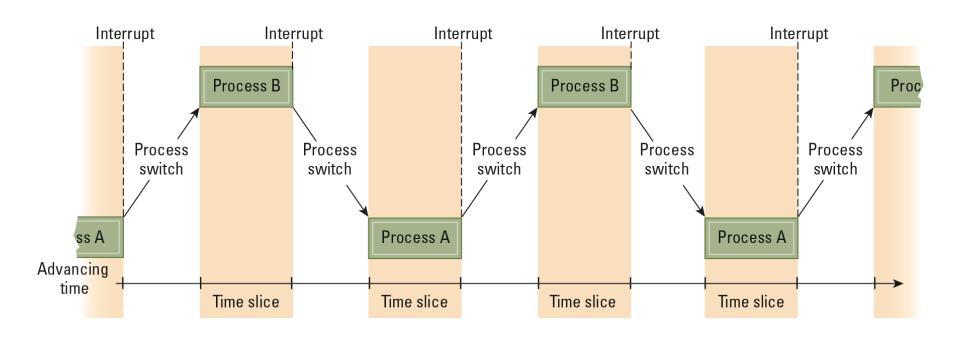


#### **Process Administration**

- 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 3.6 Multiprogramming between process A and process B





### 3.4 Handling Competition Among Processes

- Semaphore: A "control flag"
- Critical Region: A group of instructions that should be executed by only one process at a time
- Mutual exclusion: Requirement that only one process at a time be allowed to execute a Critical Region

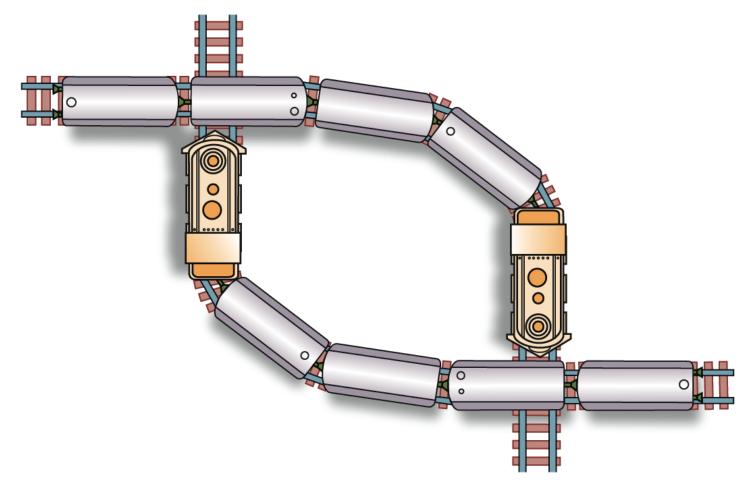


#### **Deadlock**

- Processes block each other from continuing because each is waiting for a resource that is allocated to another
- 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





#### 3.5 Security

- Attacks from outside
  - Problems
    - Insecure passwords
    - Sniffing software
  - Counter measures
    - Auditing software



#### **Security (continued)**

- Attacks from within
  - Problem: A process that gains access to memory outside its designated area
  - Counter measures: Control process activities via privilege levels and privileged instructions

