Chapter 3:
Operating Systems

**Computer Science: An Overview
Twelfth Edition**

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Chapter 3: Operating Systems

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
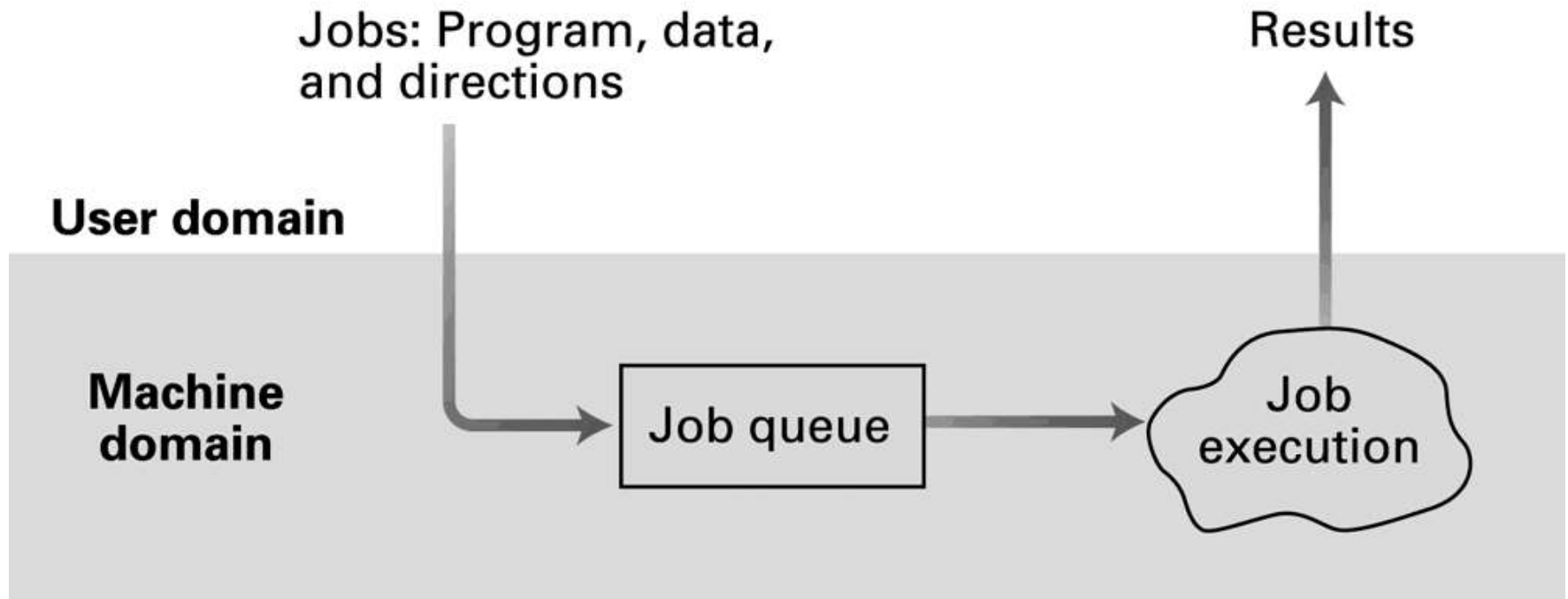
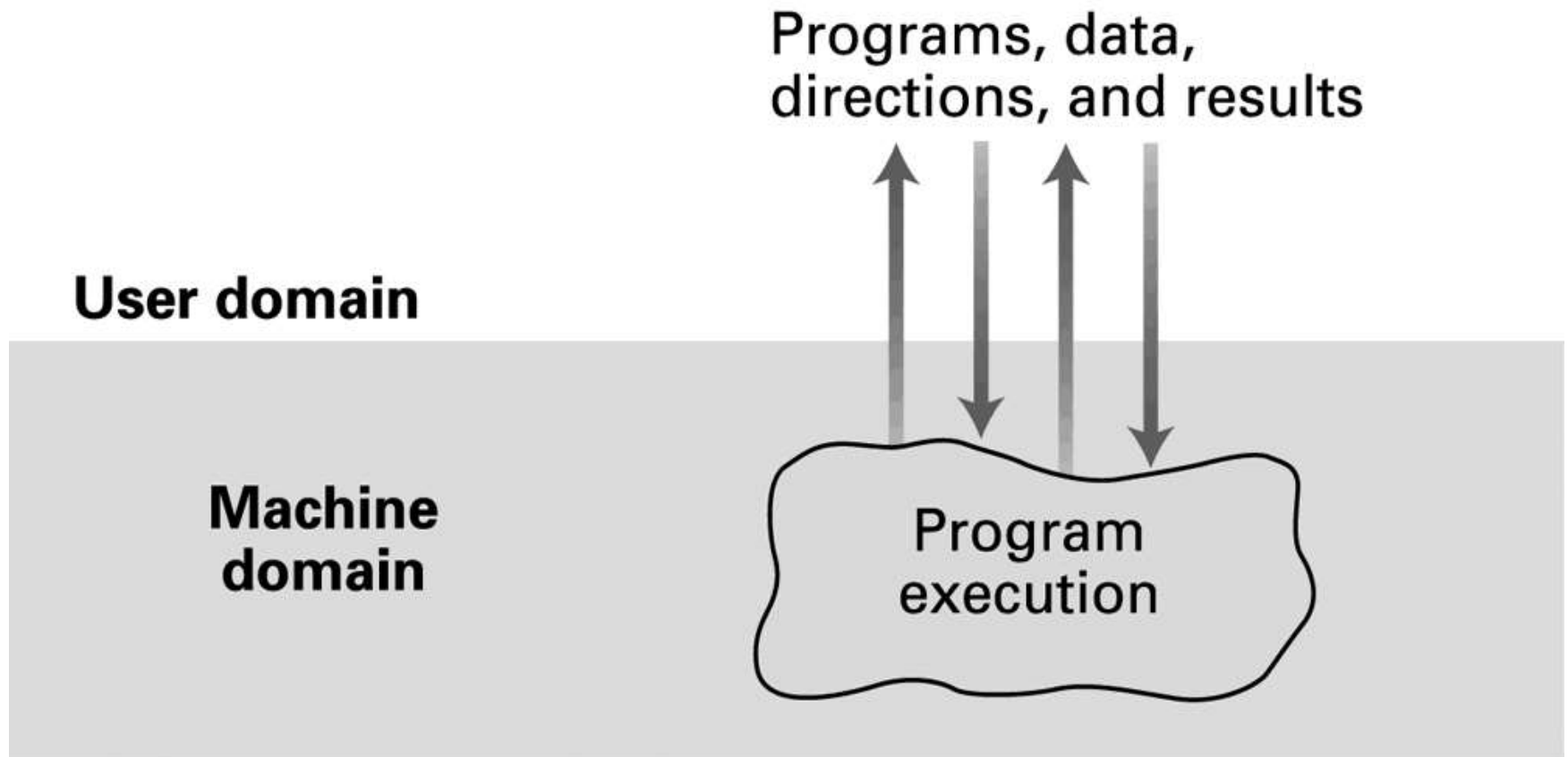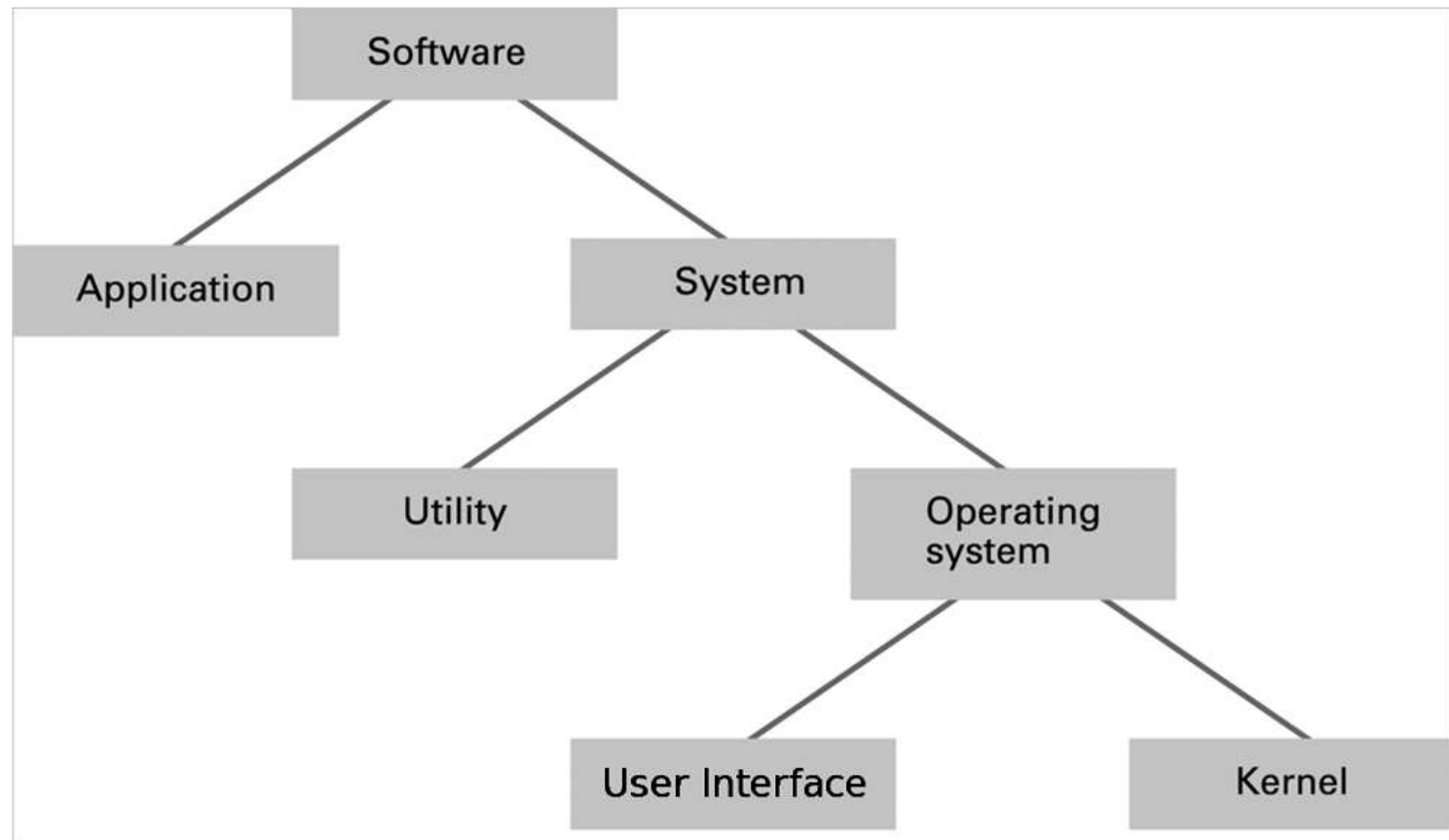# Figure 3.1 **Batch processing**

Figure 3.2 Interactive processing

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 3.3 **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 act as an intermediary between users and the operating system kernel
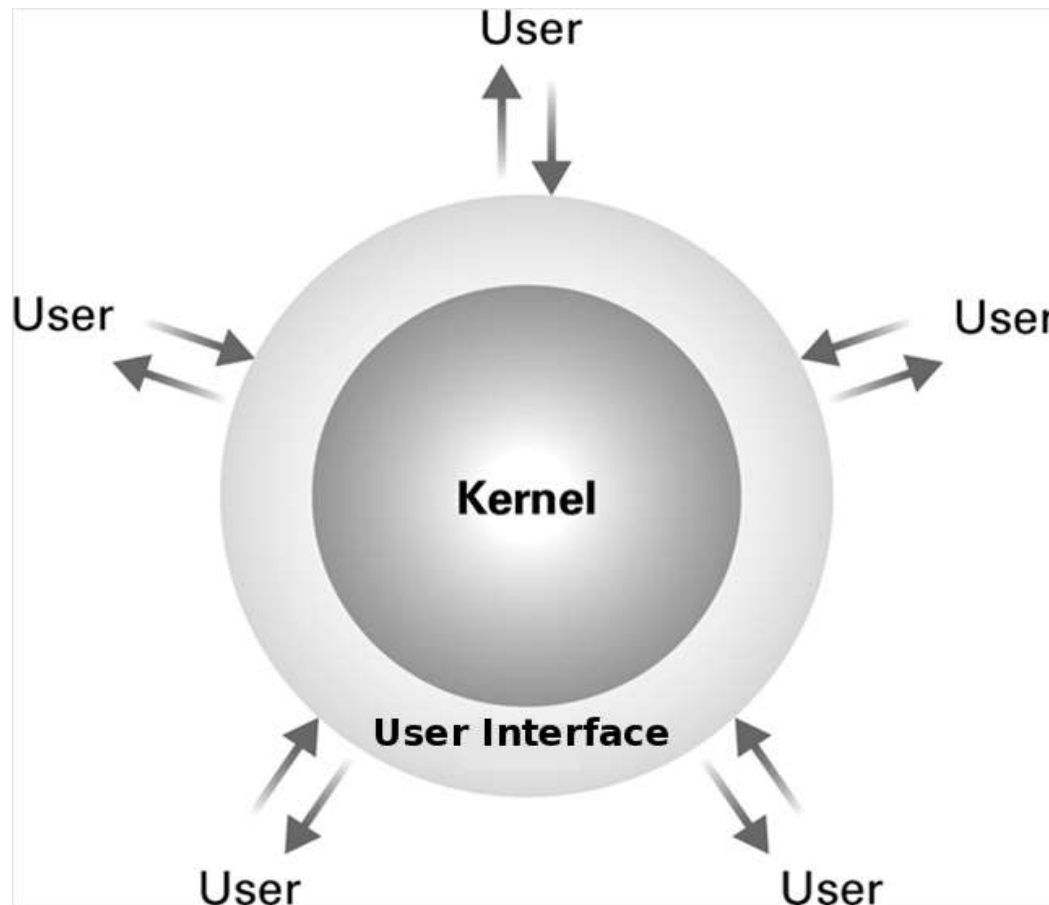
File Manager

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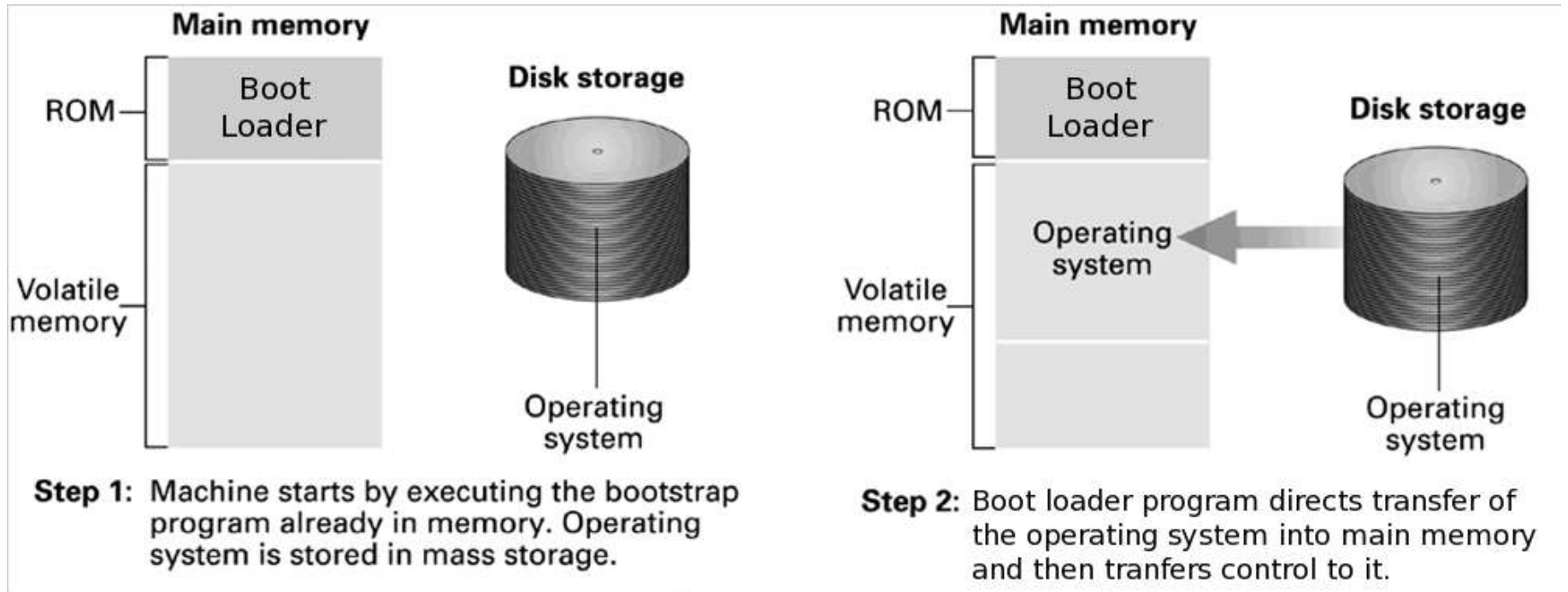
Memory Manager

- 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

Main memory

ROM — Boot Loader

Volatile memory

Disk storage

Operating system

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

Main memory

ROM — Boot Loader

Operating system

Volatile memory

Disk storage

Operating system

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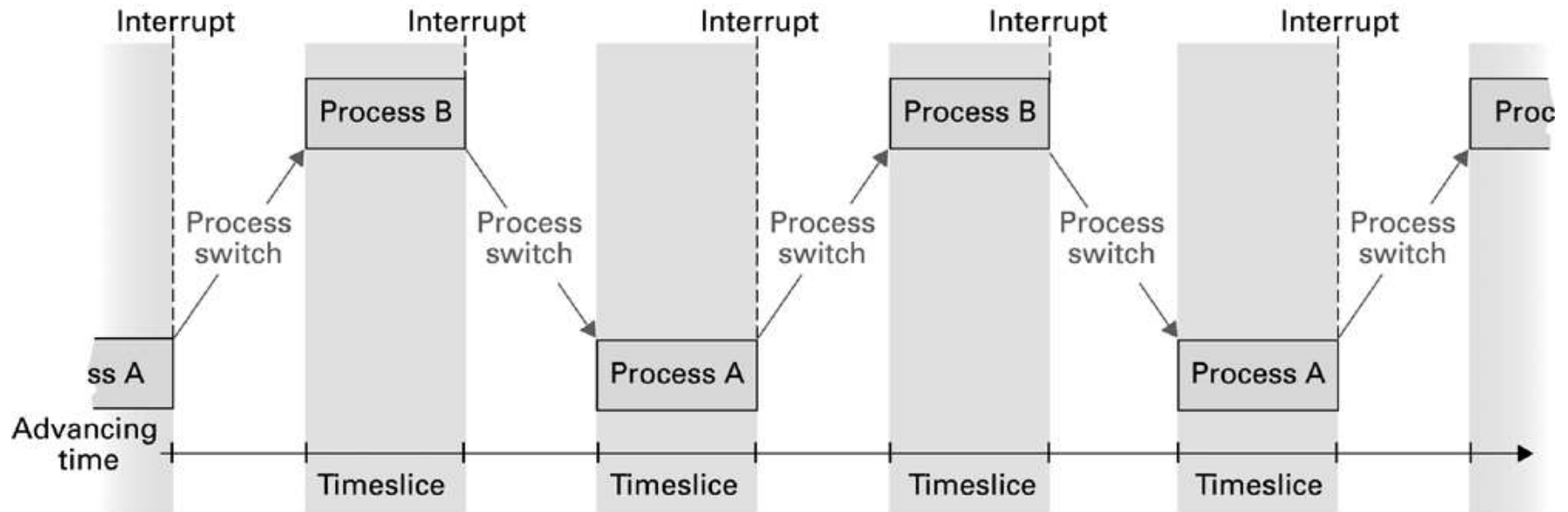
Processes

- **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 3.6 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
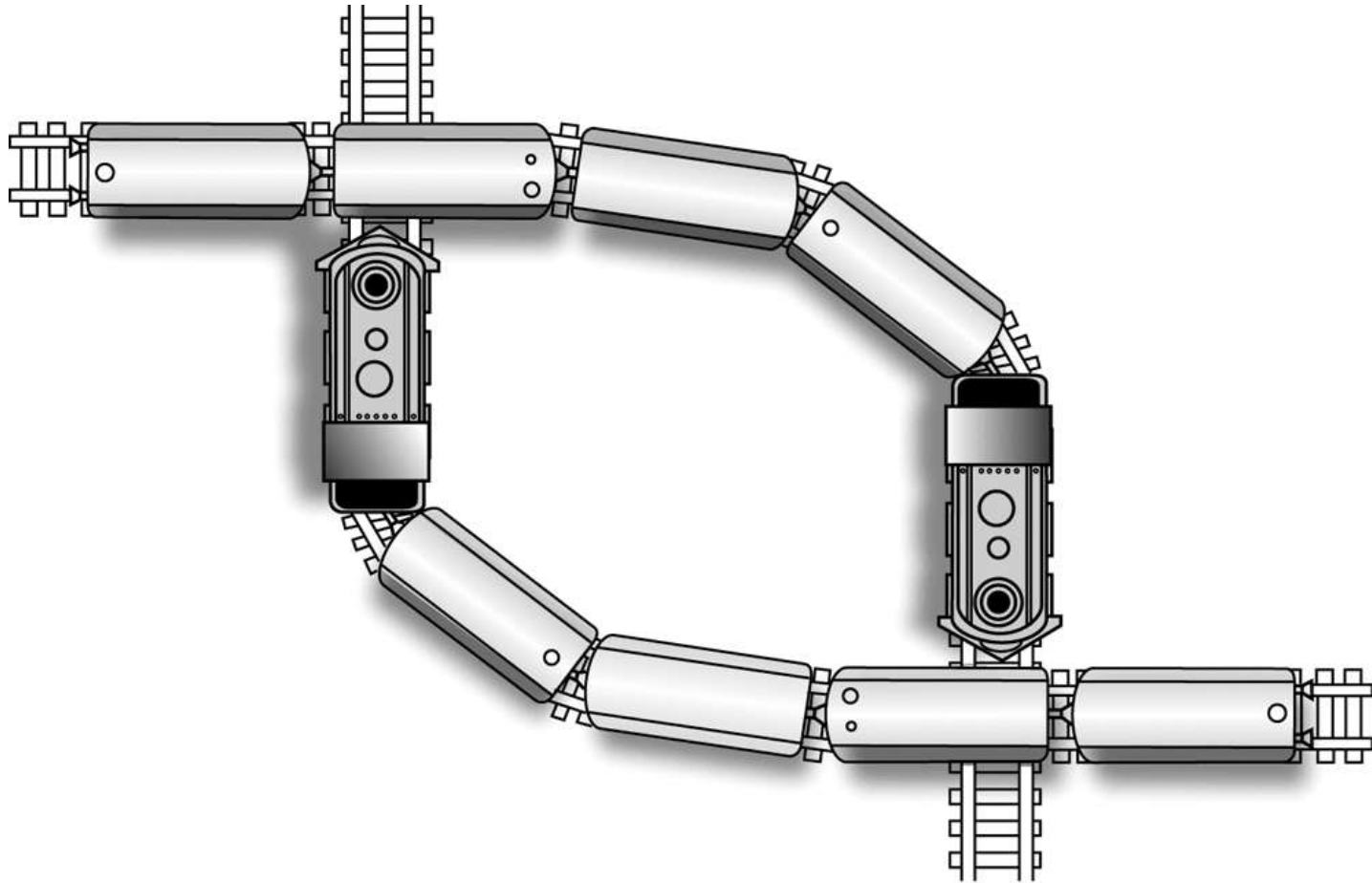
Security

- 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