OPERATING SYSTEMS

LECTURE SLIDES ARE ADAPTED/MODIFIED FROM SLIDES PROVIDED BY THE TEXTBOOK, **COMPUTER SCIENCE: AN OVERVIEW** BY J. GLENN BROOKSHEAR AND DENNIS BRYLOW

PUBLISHER PEARSON

Contents

- The History of Operating Systems

- Operating System Architecture

- Coordinating the Machine's Activities

- Handling Competition Among Processes

- Security
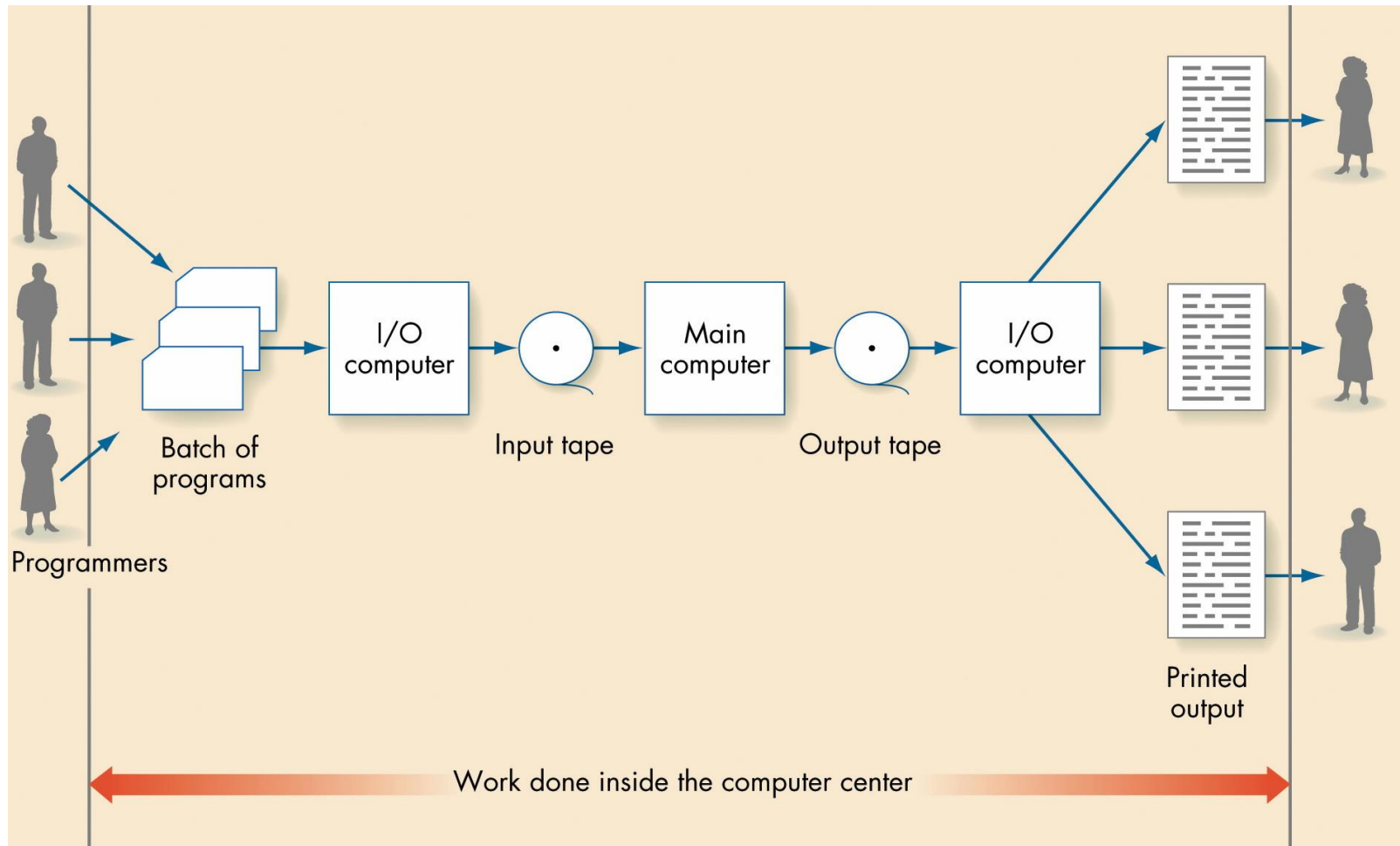
Evolution of Shared Computing

- Batch processing

- Interactive processing
  ◦ Requires real-time processing

- Time-sharing/Multitasking
  ◦ Implemented by Multiprogramming

- Multiprocessor machines
  ◦ Load balancing
  ◦ Scaling

- Embedded OS

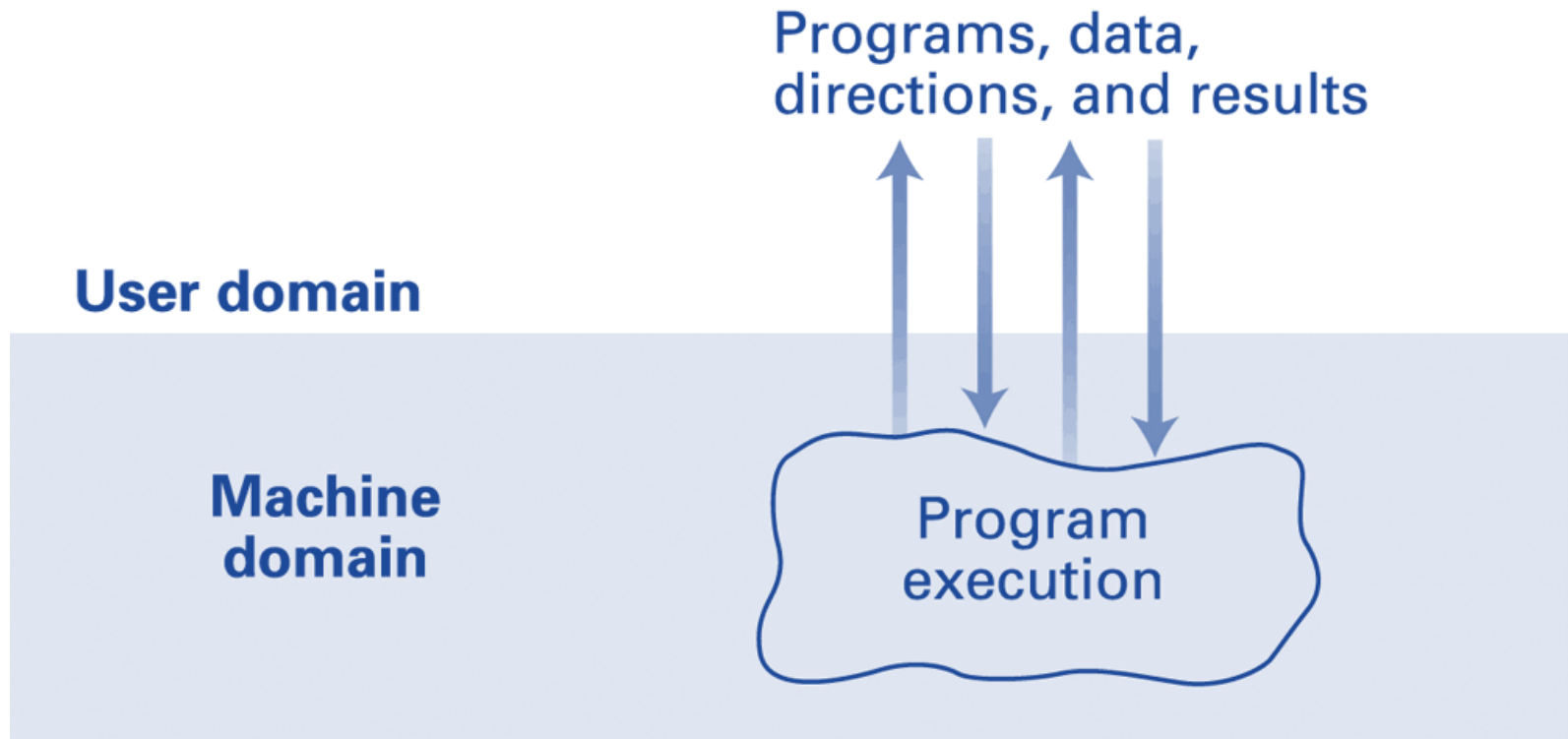| GENERATION	APPROXIMATE DATES	MAJOR ADVANCES
First	1945–1955	No operating system available Programmers operated the machine themselves
Second	1955–1965	Batch operating systems Improved system utilization Development of the first command language
Third	1965–1985	Multiprogrammed operating systems Time-sharing operating systems Increasing concern for protecting programs from damage by other programs Creation of privileged instructions and user instructions Interactive use of computers Increasing concern for security and access control First personal computer operating systems
Fourth	1985–present	Network operating systems Client-server computing Remote access to resources Graphical user interfaces Real-time operating systems Embedded systems
Fifth	??	Multimedia user interfaces Massively parallel operating systems Distributed computing environments

Batch processing

Jobs: Program, data, and directions

Results

User domain
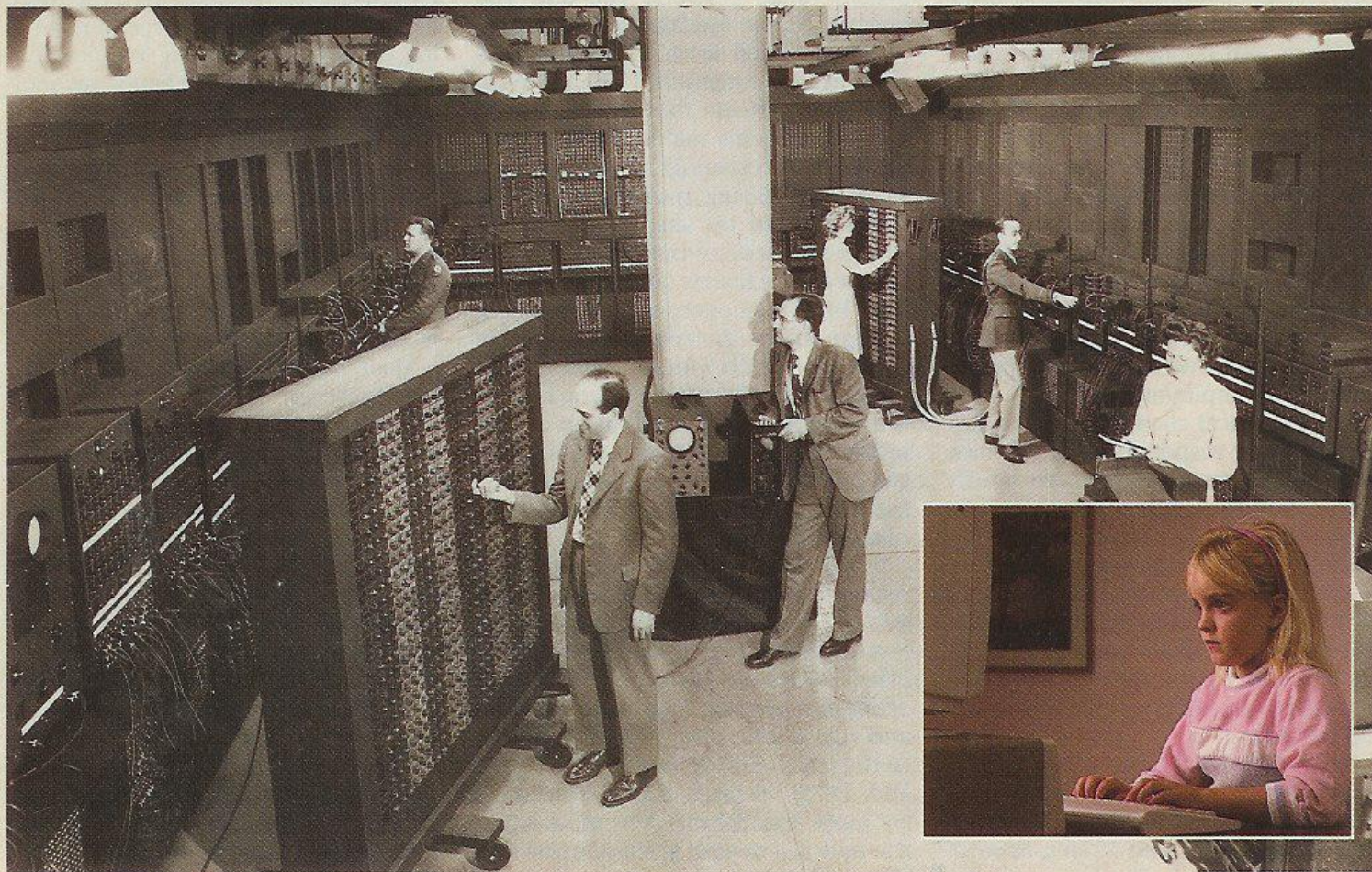
Machine domain

Job queue → Job execution

Batch processing

Interactive processing

TRAINING necessary to operate a computer has been drastically reduced as a result of advances in both hardware and software. Only highly trained operators could run the first computers, which were developed some 40 years ago. Today's personal computers (which surpass those first machines in both memory and computing power) can be operated by a child.

9

Multi tasking processing
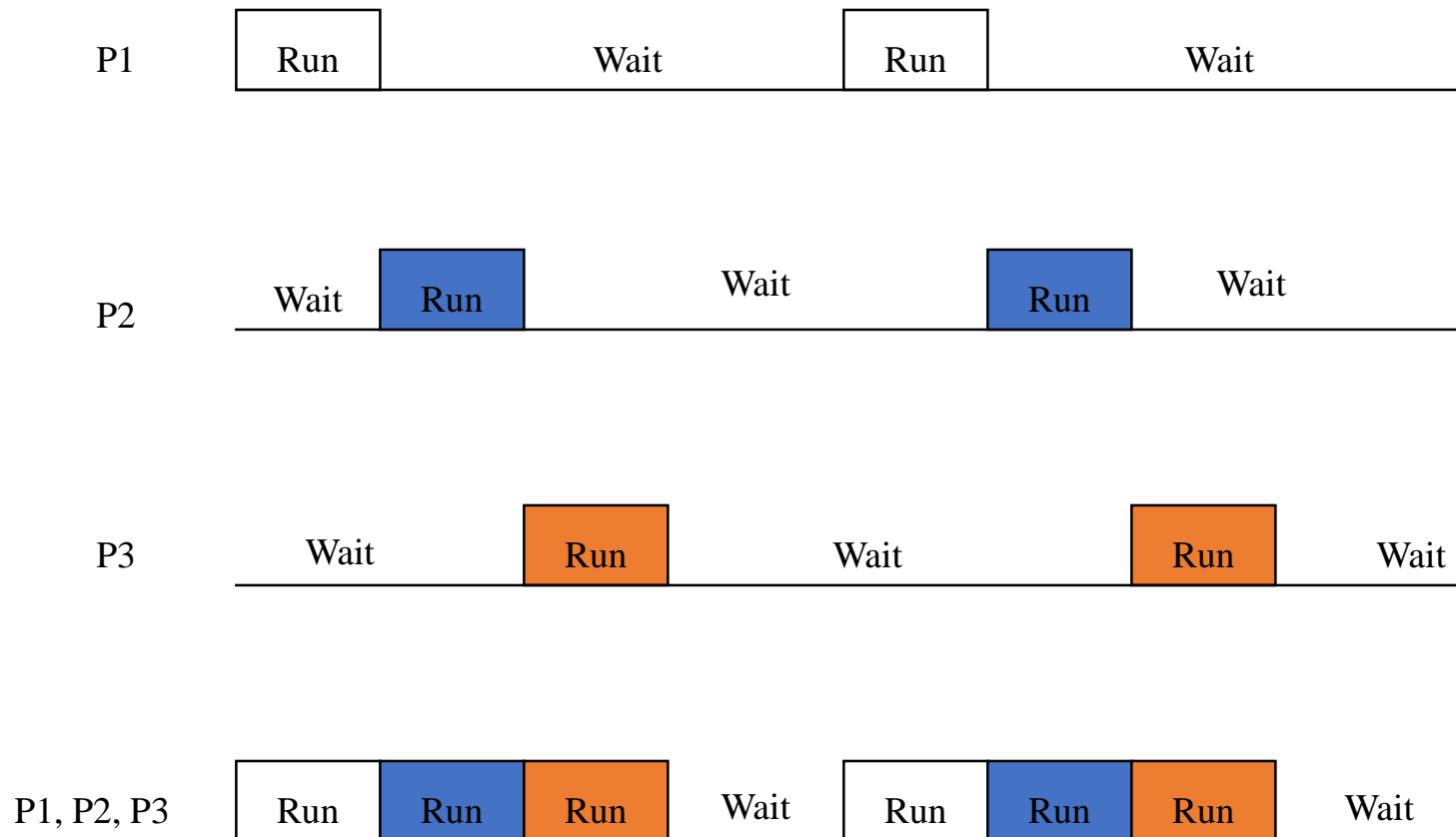
Evolution of CPU Utilization

(a) serial uniprogramming

(b) batch uniprogramming
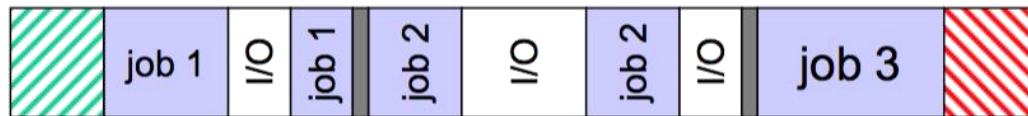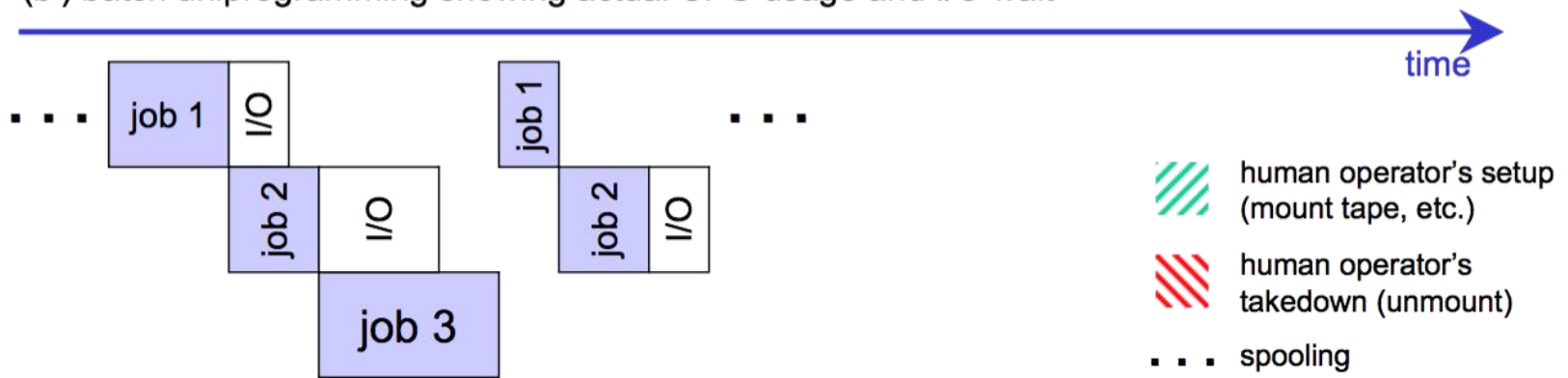
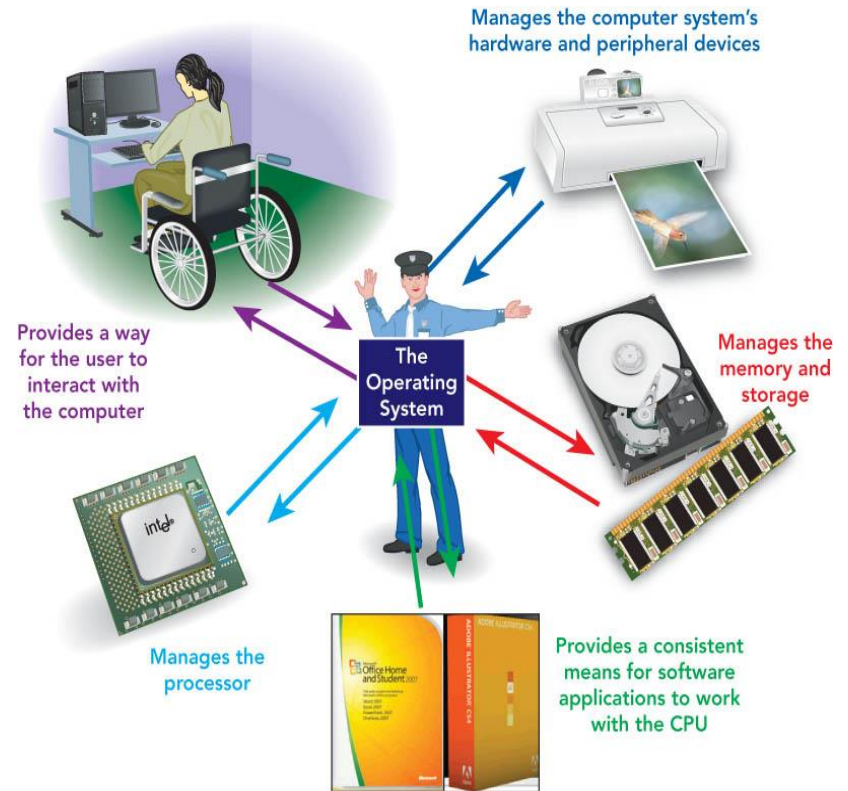(b') batch uniprogramming showing actual CPU usage and I/O wait

(c) multiprogramming

human overhead

time

human operator's setup (mount tape, etc.)

human operator's takedown (unmount)

... spooling

Evolution of CPU utilization

Basic functions of operating systems

- Five basic functions
  - Starts the computer
  - Manages applications
  - Manages memory
  - Handles input and output device messages
  - Provides a user interface for communication

Manages the computer system's hardware and peripheral devices

Provides a way for the user to interact with the computer

The Operating System

Manages the memory and storage

Manages the processor

Provides a consistent means for software applications to work with the CPU

Types of Software

- Application software
  ◦ Performs specific tasks for users

- System software
  ◦ Provides infrastructure for application software
  ◦ Consists of operating system and utility software

# Software classification
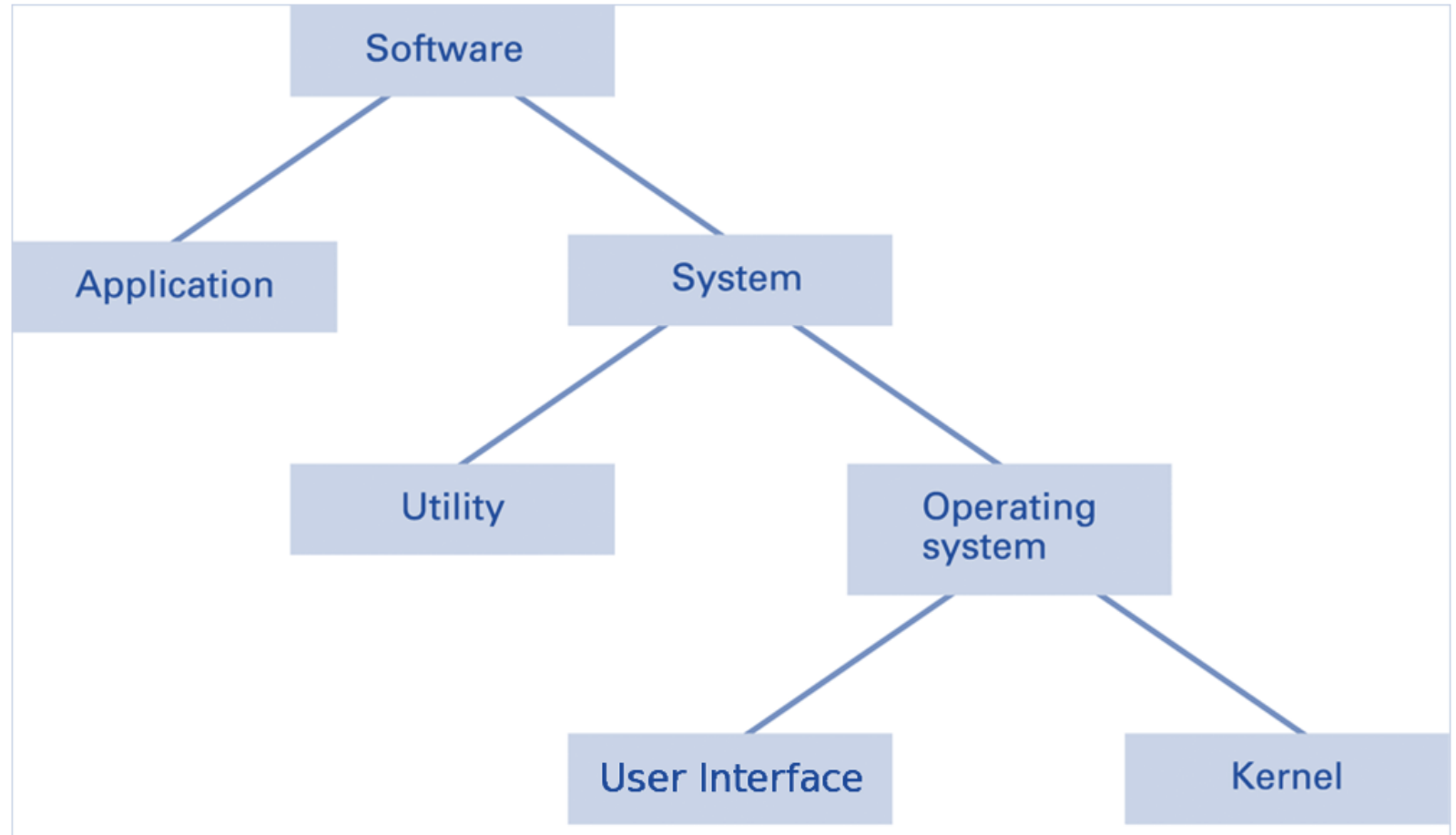
System Software

- Consists of all the programs that enable the computer and its peripheral devices to function smoothly

- Divided into two main categories:
  ◦ The operating system
  ◦ System utilities (utility programs)

Operating System Components

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

User - User interface - Kernel
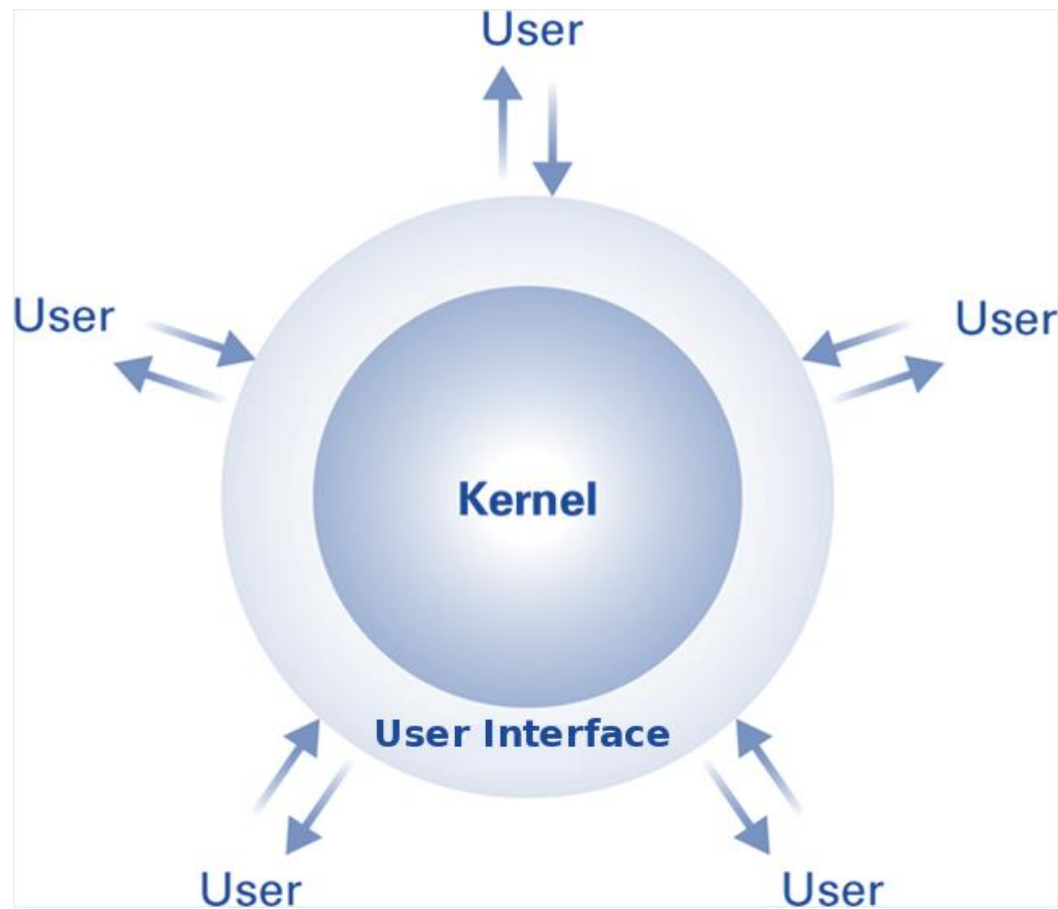
User interface

- Types of user interfaces
  - ◦ Graphical user interface (GUI)
  - ◦ Menu-driven user interface
  - ◦ Command-line user interface

Graphical interface

Menu-driven interface

Command-line-driven interface
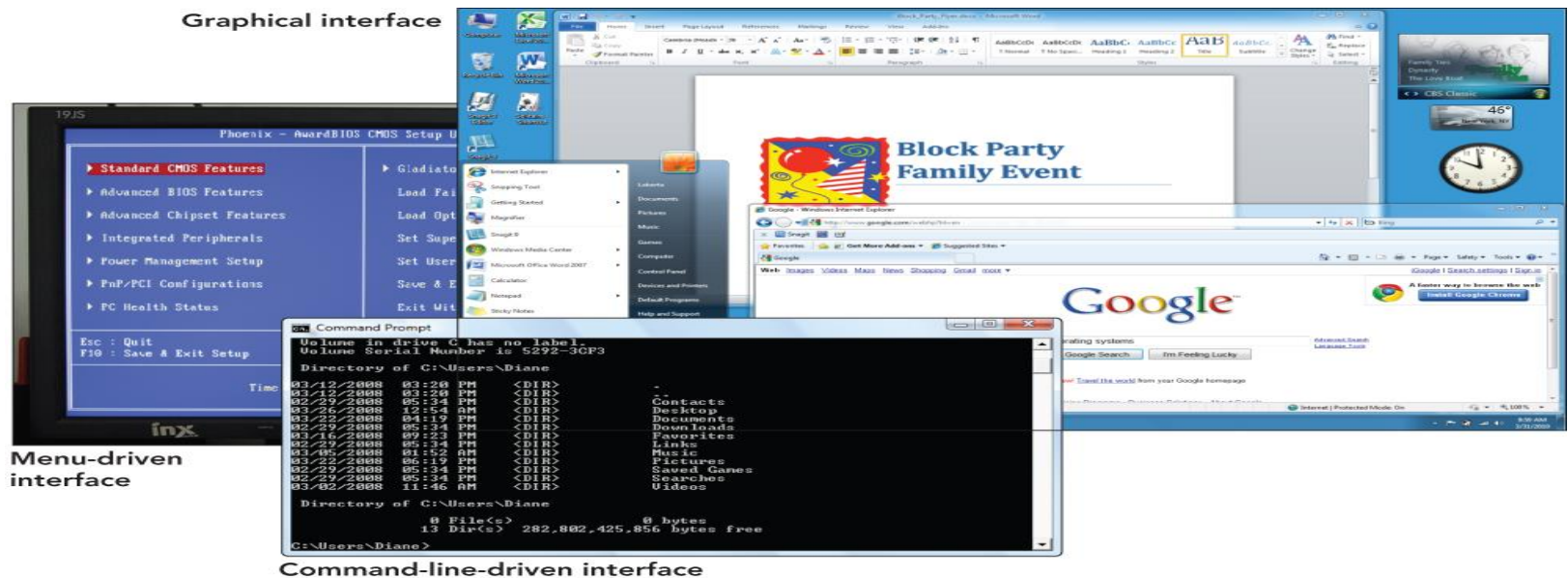
Kernel - File Manager

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

- **Directory Path:** A sequence of directories within directories

Kernel - File Manager

- Searching for and managing files
  - File manager—utility software that organizes and manages data
    - Copy files
    - Determine how and where files are stored
    - Delete files
  - Search utility—enables you to locate files

Kernel - 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

Kernel - Memory Manager

- Virtual memory—uses portion of hard disk to extend RAM
  - ◦ Pages—units of fixed size, contain program instructions and data
  - ◦ When RAM is full, copies of pages are temporarily stored in a swap file, a special hard disk file.
  - ◦ Transferring files between RAM and the hard disk—paging
  - ◦ Excessive paging—thrashing

- Adding more RAM—best way to improve computer performance:
  - ◦ Paging slows computer.
  - ◦ Accessing data from hard disk is slower than accessing from RAM.
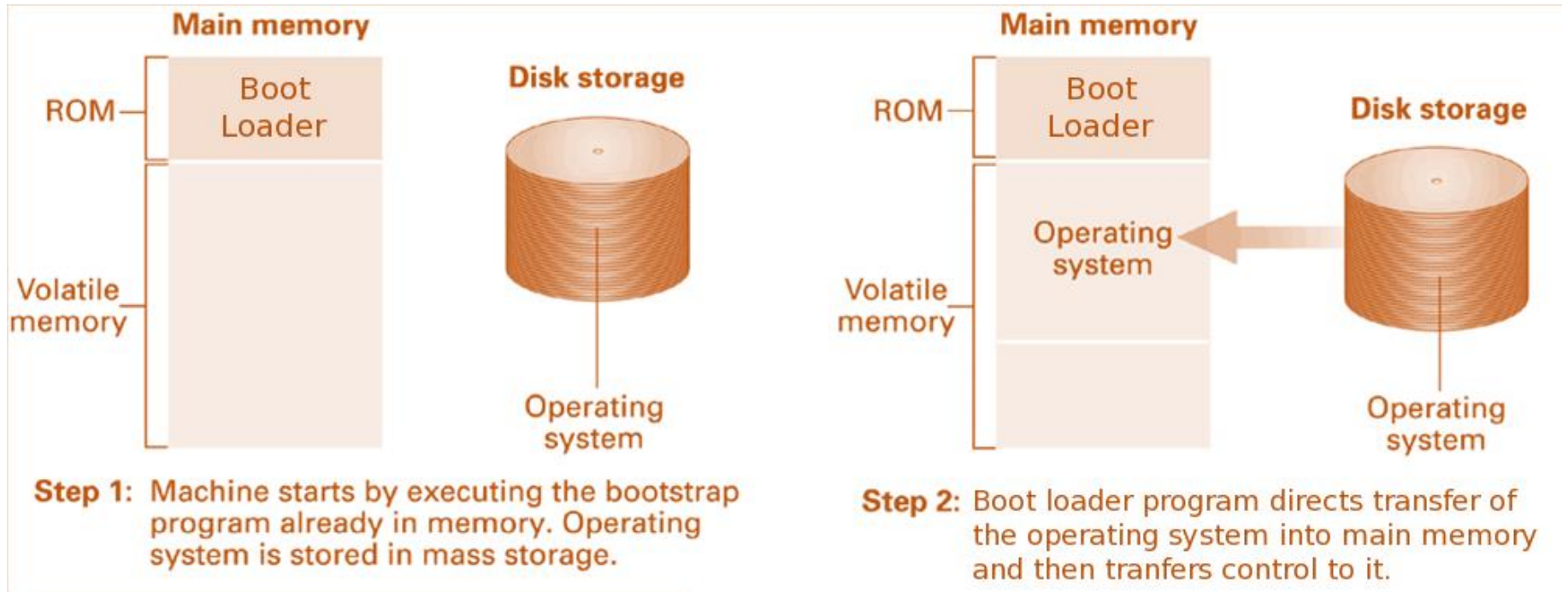
Kernel - Memory Manager
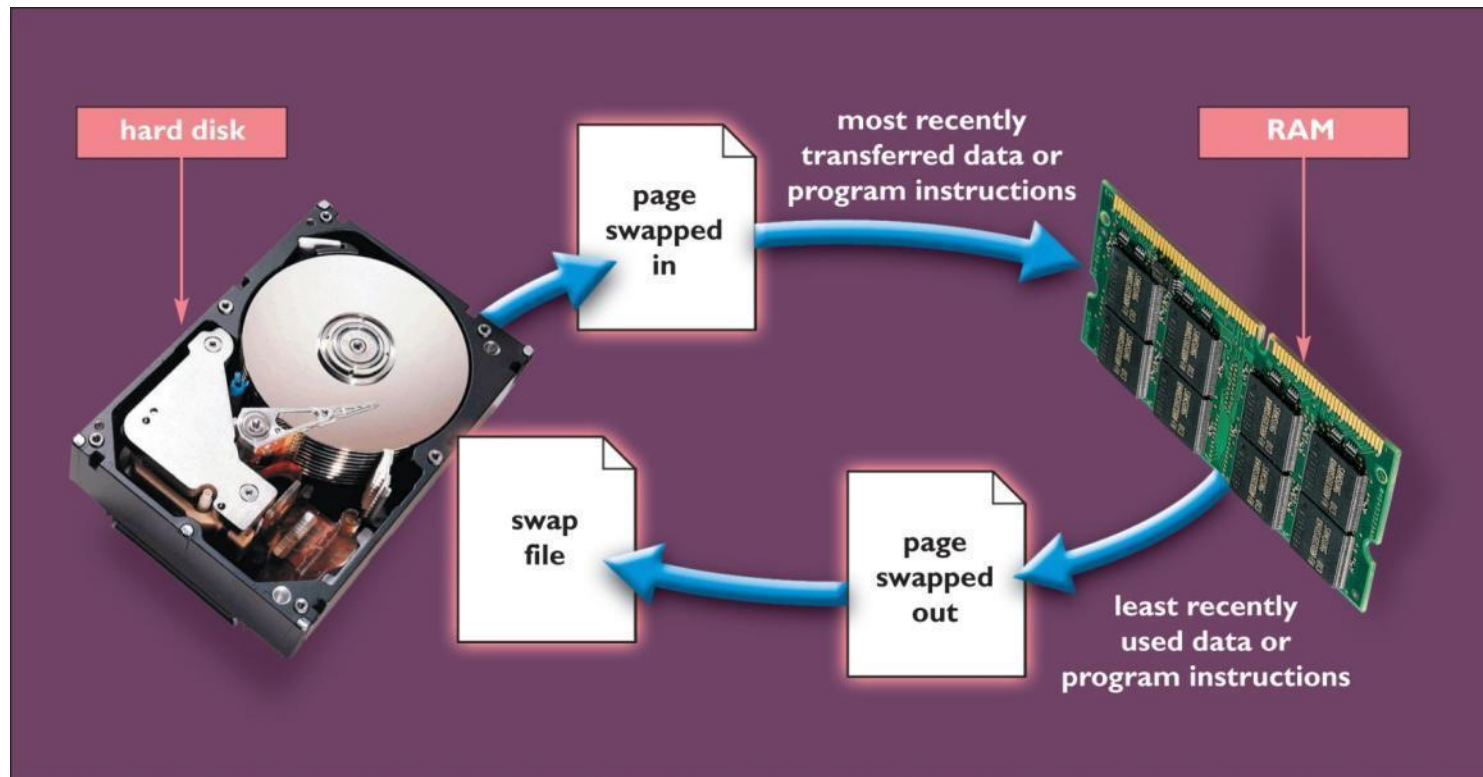
Getting It Started

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

  - Cold boot: Starting computer when it has not yet been turned on
  - Warm boot: Restarting a computer that is already on

The booting process

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

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

The booting process

The Six Steps of Booting a System
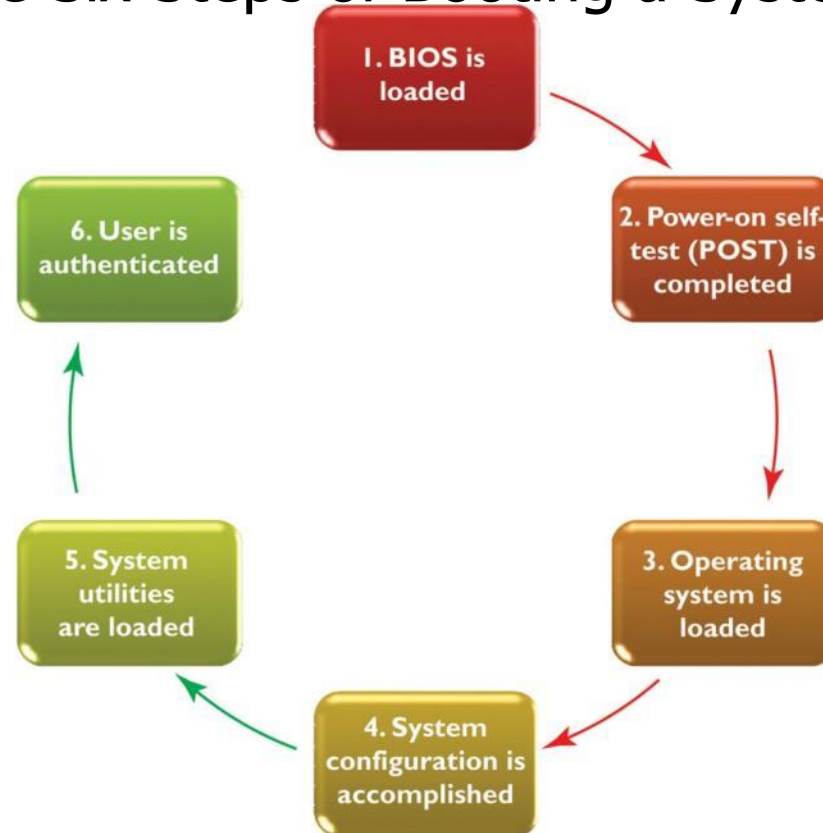
The booting process

- Step 1: Activate the BIOS and Setup Program
  - BIOS (Basic Input Output System) instructions provide the computer with descriptions of the internal equipment
    - BIOS is encoded on ROM (read-only memory)
    - Does not control external devices

  - Adjustable energy settings

  - Setup program
    - Includes settings that control computer hardware
    - Do not alter—making incorrect changes to a BIOS device will cause the system not to boot

The booting process

- BIOS Settings
  - Change the Boot Order
  - Load BIOS Setup Defaults
  - Remove a BIOS Password
  - Create a BIOS Password
  - Change the Date and Time
  - Change Floppy Drive Settings
  - Change Hard Drive Settings
  - Change CD/DVD/BD Drive Settings
  - View Amount of Memory Installed
  - Change the Boot Up NumLock Status
  - Enable or Disable the Computer Logo
  - Enable or Disable the Quick Power On Self Test (POST)

The booting process

- Step 2: Initiate the Power-On Self-Test
  - Power-on self-test (POST)—to confirm that both the computer and its peripheral devices are working properly

  - If the POST fails:
    - A beep will sound.
    - An error message will appear on the monitor.
    - The computer will stop.

The booting process

- Step 3: Load the Operating System
  - BIOS
    - Looks for the operating system
    - Loads the kernel into memory—the central part of the operating system

  - The operating system loads the system configuration information.

The booting process

- Step 4: Configure the System
  - Operating system
    - Checks the registry
      - Database that stores information about software and peripherals choices, for configuration information
    - Checks the configuration for drivers
      - Utility programs containing instructions for the proper functioning of peripheral devices.
    - Automatically detects plug-and-play (PnP) devices
    - Checks for conflicts between devices
    - Installs and loads needed drivers

The booting process

- Step 5: Load System Utilities
  - Antivirus software
  - Speaker volume control
  - Power management options

The booting process

- Step 6: Authenticate a User
  - Verifies authorized users
    - Enter an authentication/login user name and password
  - Profile—a record of a specific user's preferences for the desktop theme, icons, and menu styles
  - Account—for multiuser computer systems each user has an account
    - Consists of user name, password, and storage space
    - Created by server/computer administrator

Coordinating machine's activities

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.

Time-sharing
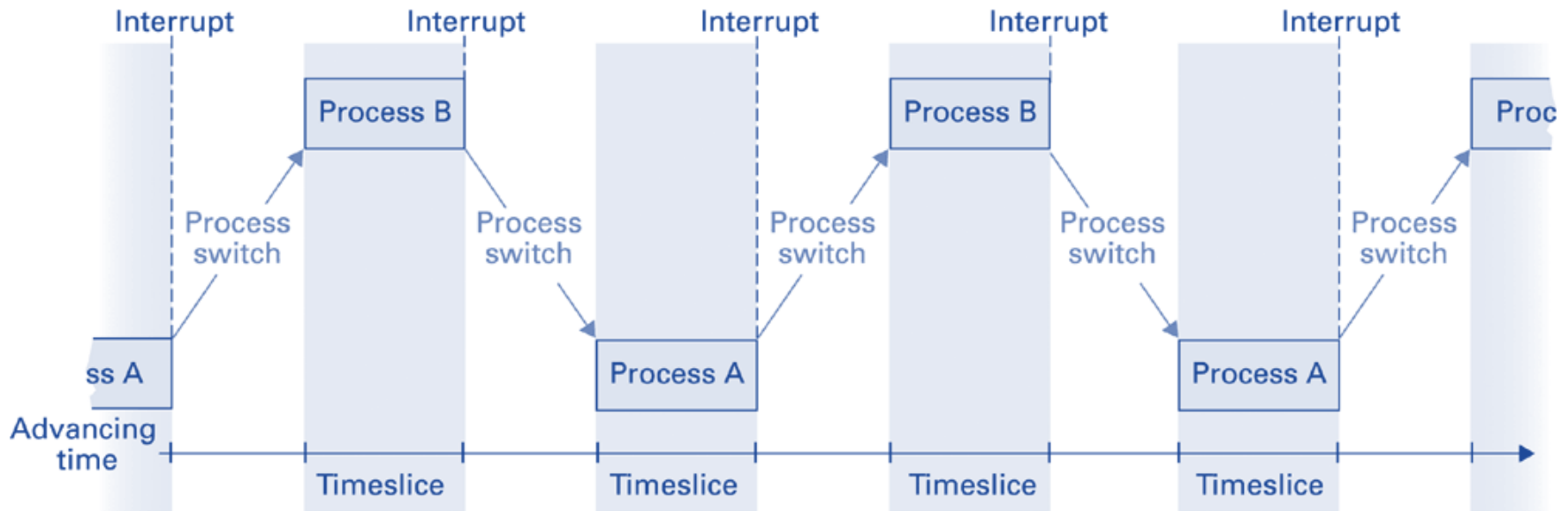
Handling Competition for Resources

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

A deadlock resulting from competition for nonshareable railroad intersections
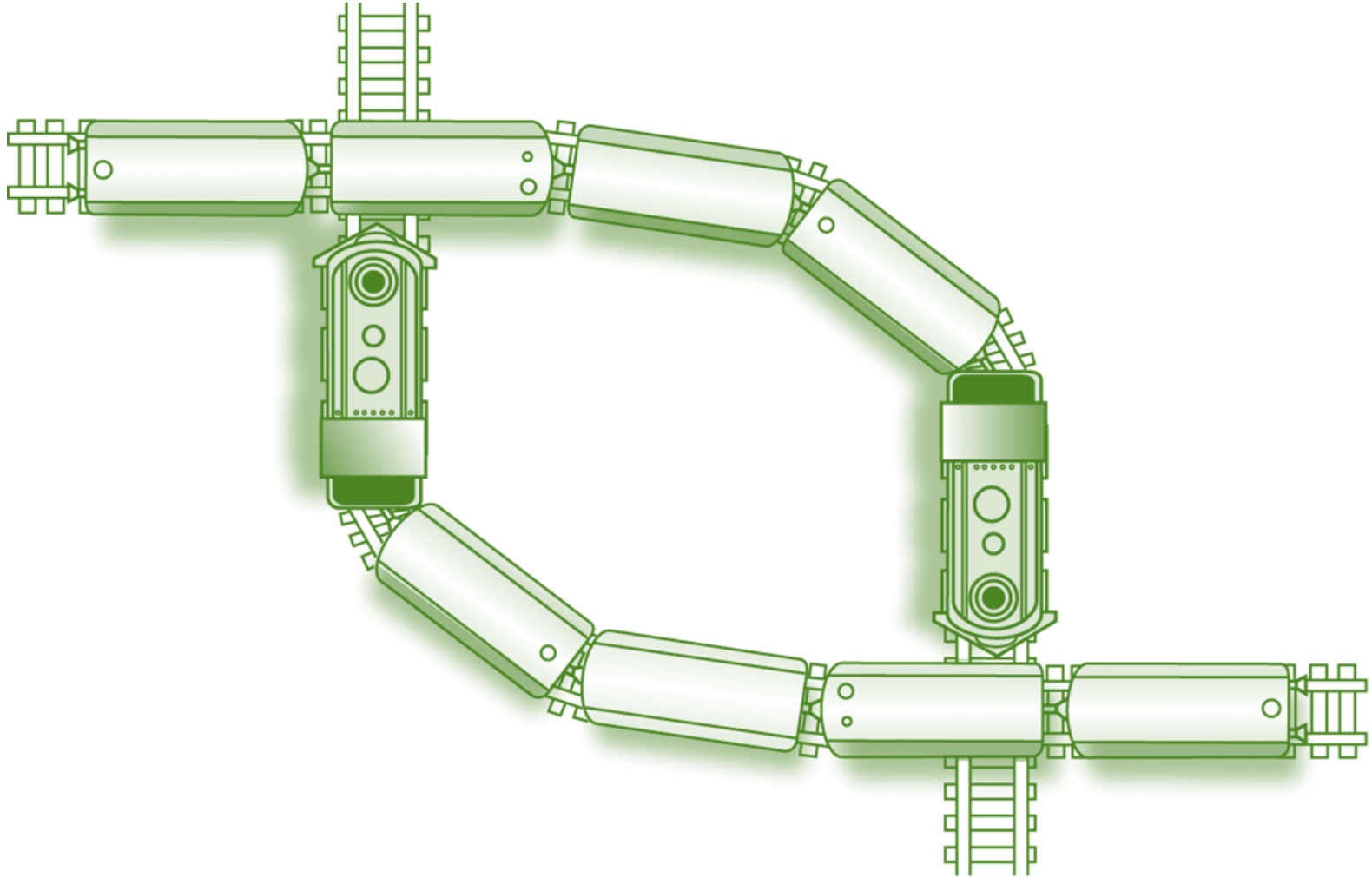
Security

- Attacks from outside
  - Problems
    - Insecure passwords
      - password cracker, network sniffer, Trojan horse login
    - Sniffing software
      - spyware, sniffing software
  - Counter measures
  - Auditing software

Security

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

Ring 3

Ring 2

Ring 1

Ring 0

Kernel

Device drivers

Device drivers

Applications

Least privileged

Most privileged