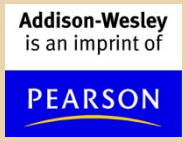
Operating Systems

Slides derived from those available on the web site of the book:

Computer Science: An Overview, 11th Edition, by J. Glenn Brookshear

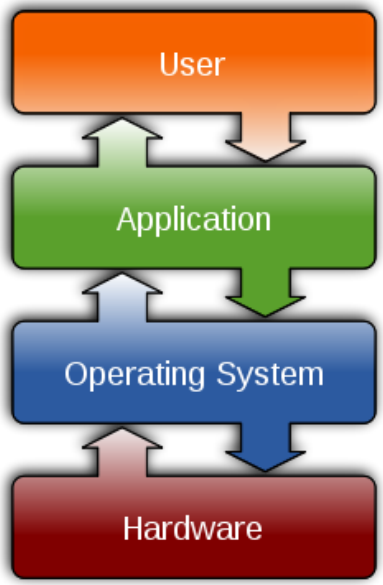


Operating Systems

- The History of Operating Systems
- Operating System Architecture
- Coordinating the Machine's Activities
- Handling Competition Among Processes
- Security

Operating System

An operating system (OS) is a set of programs that manage computer hardware resources and provide common services for application software.



Common features

- Process management
- Interrupts
- Memory management
- File system
- Device drivers
- Networking (TCP/IP, UDP)
- Security (Process/Memory protection)
- I/O

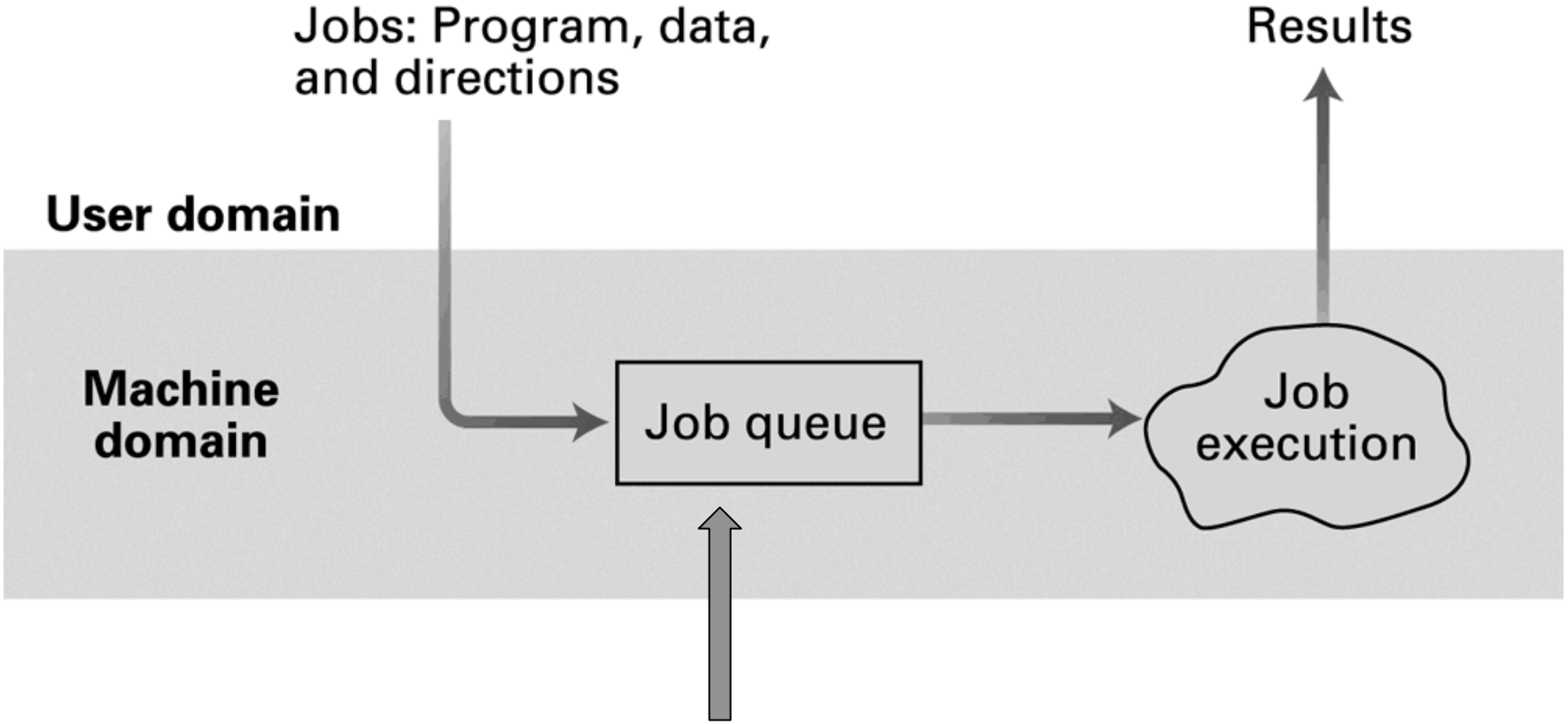
Functions of Operating Systems

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

Evolution of Shared Computing

- Batch processing
  - Execution of jobs by collecting them in a single batch
- Interactive processing
  - Requires real-time processing
- Time-sharing/Multitasking
  - Implemented by Multiprogramming
- Multiprocessor machines

Batch processing



FIFO vs Job Priorities

Evolution of Shared Computing

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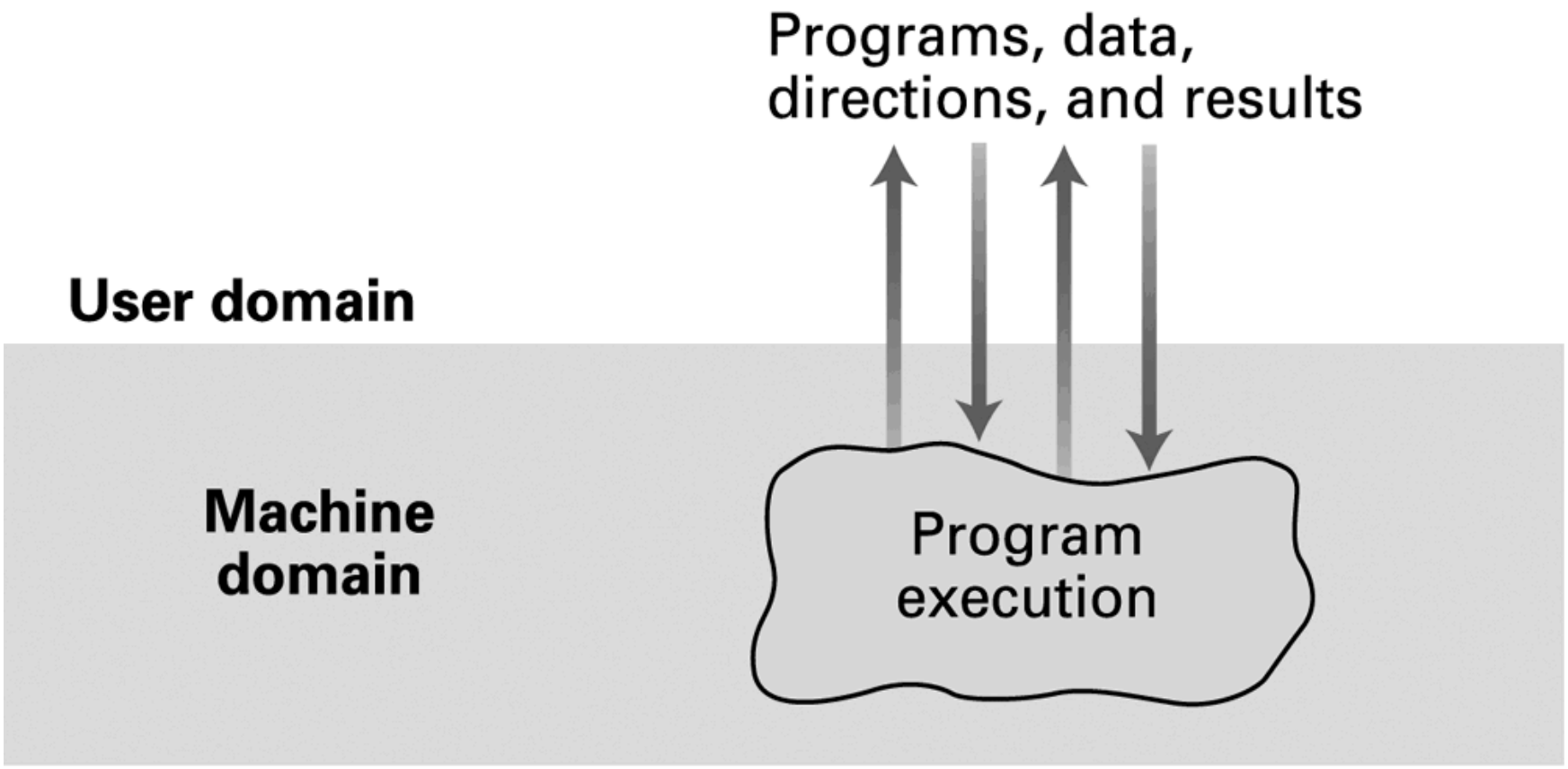
Interactive processing



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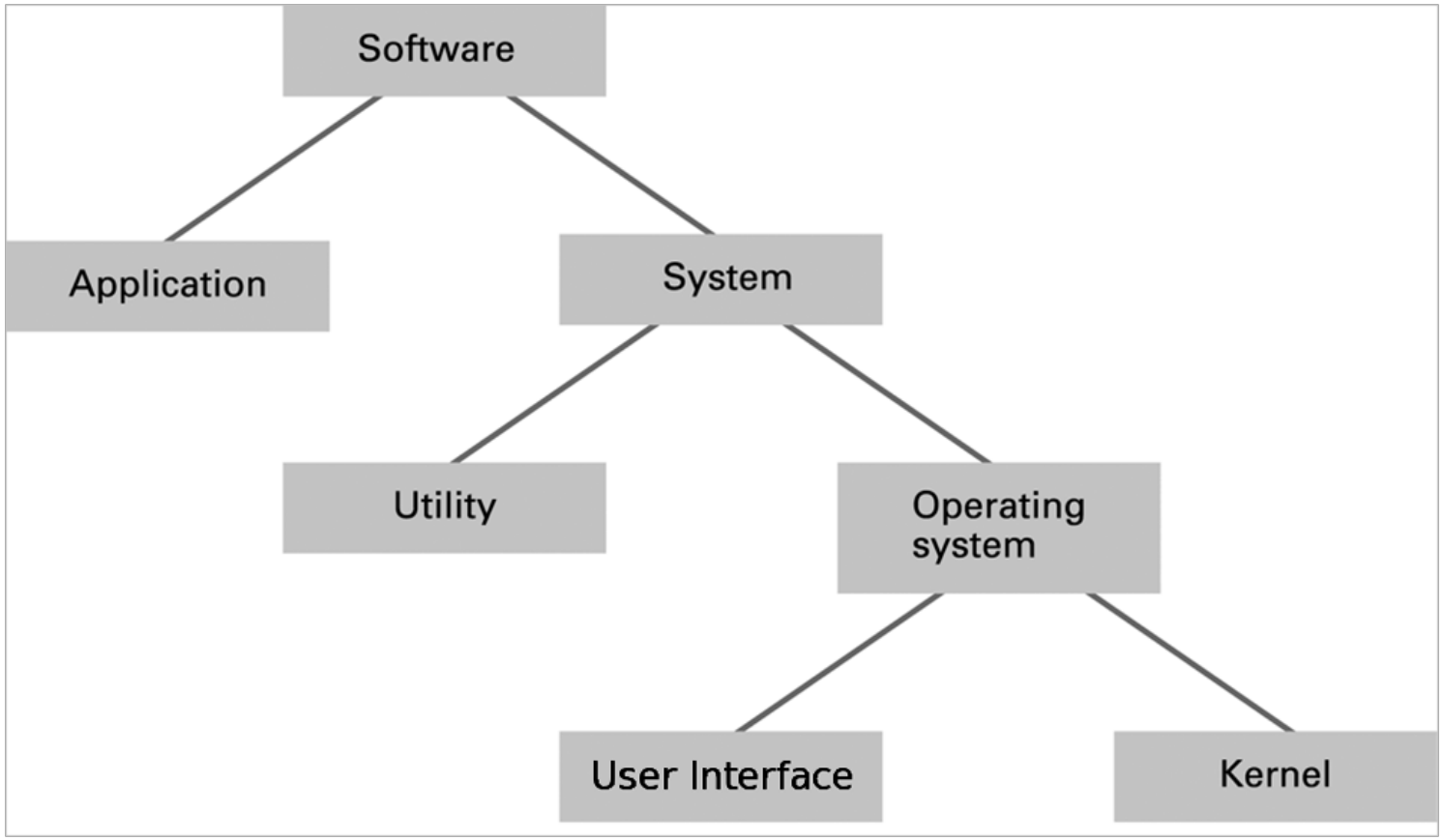
Types of Software

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

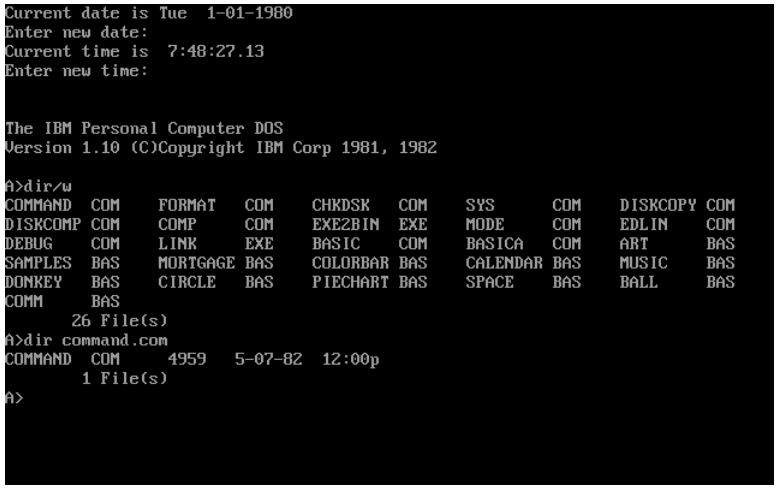
Software classification



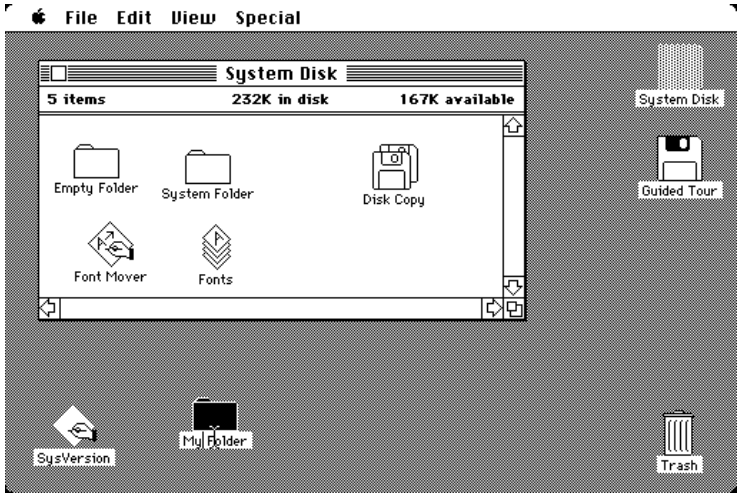
Operating System Components

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

PC DOS and MAC OS

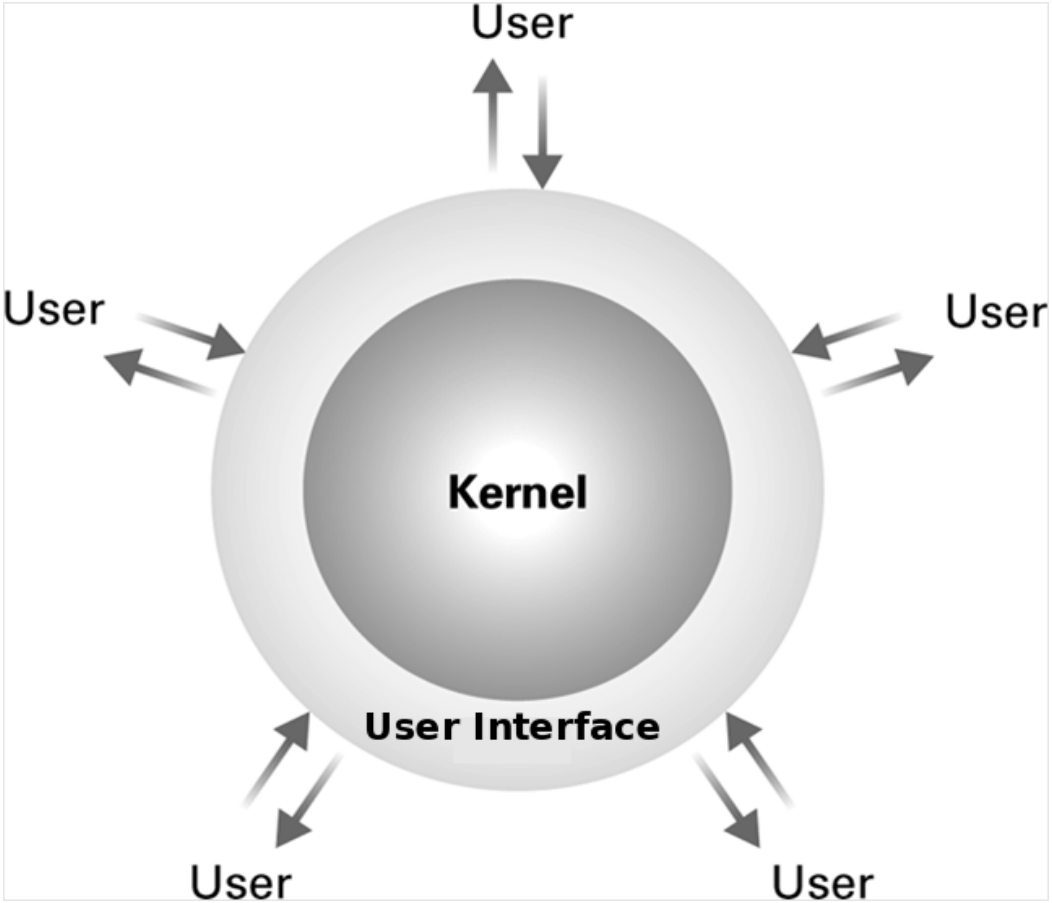


PC DOS (Command Line)



MAC OS with the first Graphical User Interface (GUI)

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

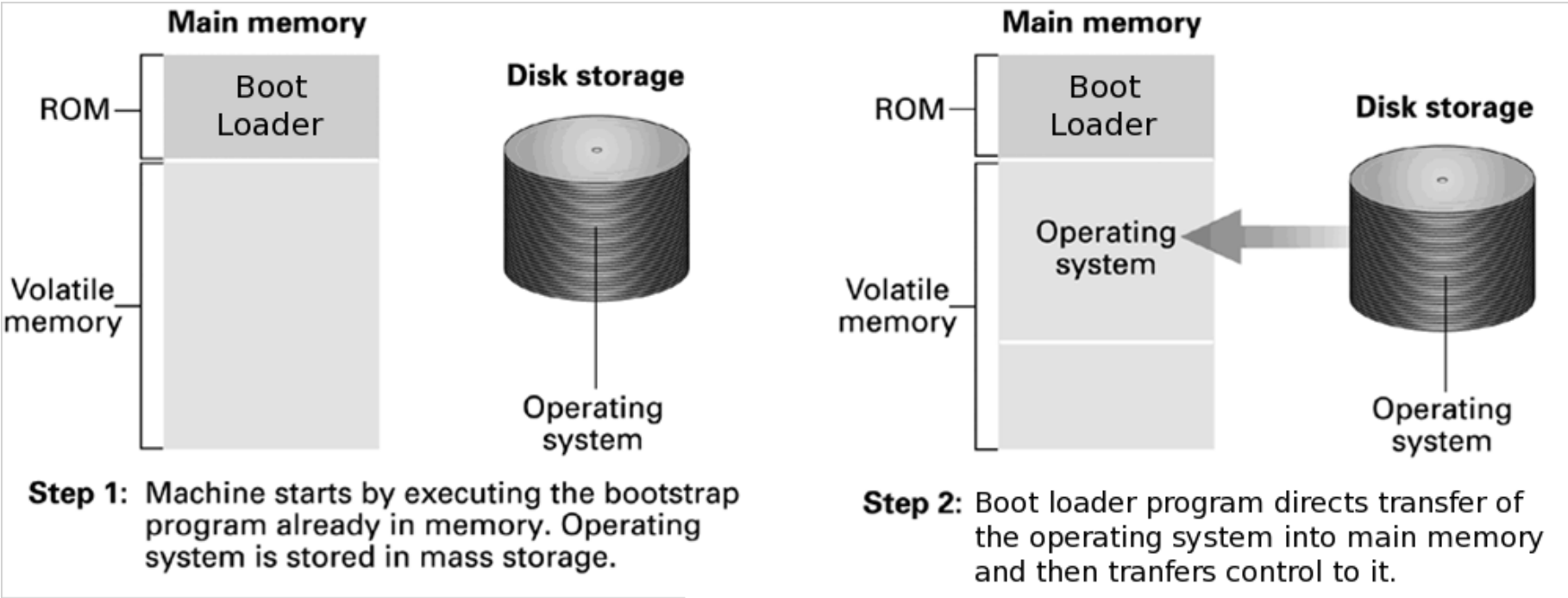
- Allocates space in main memory
- May create the illusion that the machine has more memory than it actually does (**virtual memory**) by playing a "shell game" in which blocks of data (**pages**) are shifted back and forth between main memory and mass storage

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

ROM also contains BIOS (Basic Input/Output System)

The booting process



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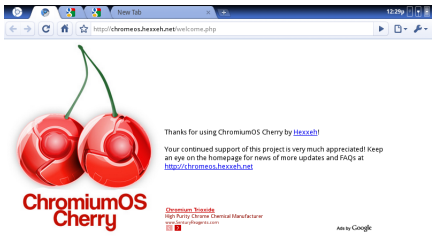

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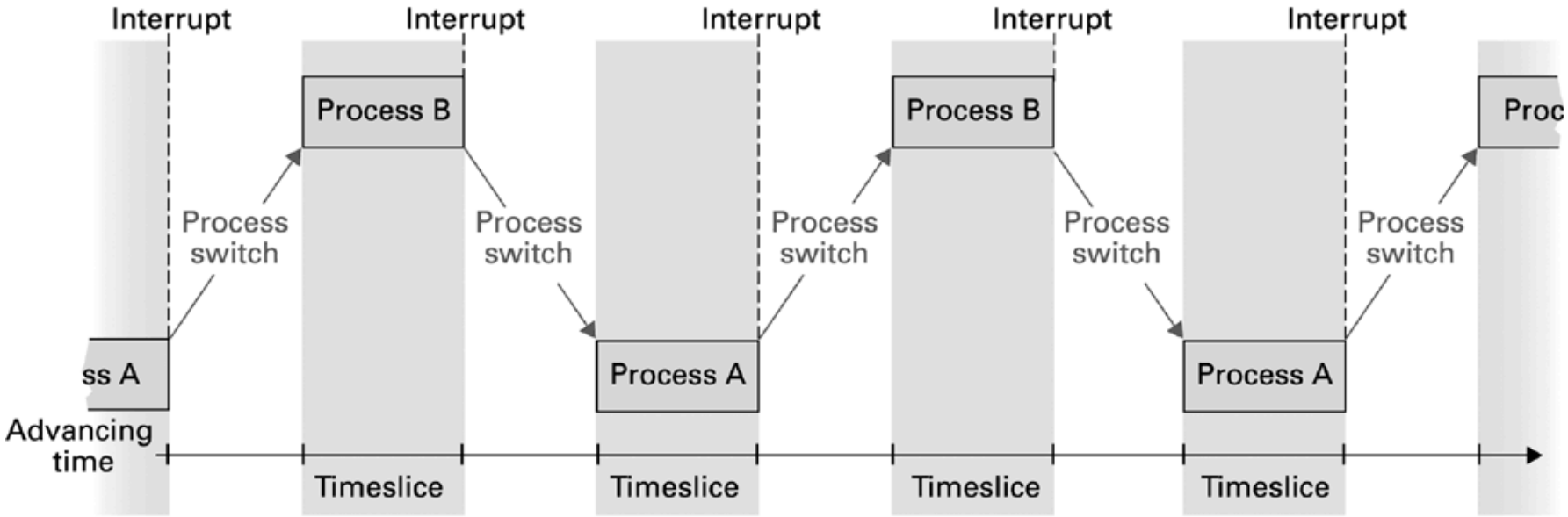
Processes

- **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
  - Make Process Table:
    - Memory, Priority, State (Ready/Wait)
- **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 between process A and process B



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Handling Competition for Resources

- There is a shared printer
- Use of flag to avoid conflict (in the main memory)
- Problems of conflict where there is interrupt
- Solutions:
  - Interrupt disable/enable
  - Test and set

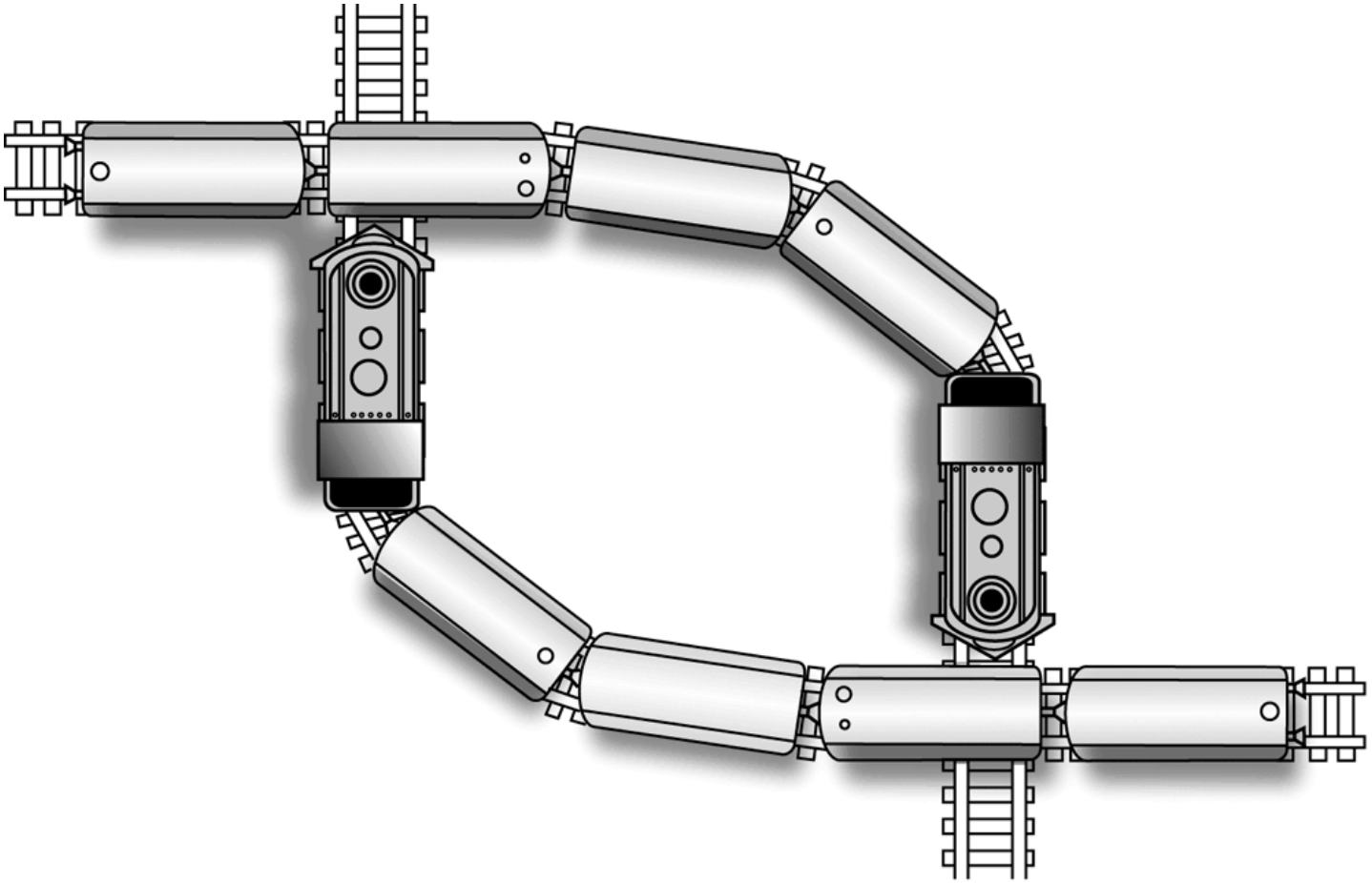
Handling Competition for Resources

- **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

- Examples of Deadlock
  - One process needs to print and then write on CD, another process needs to write on CD and then Print
  - Make process by process to complete a process, if there is no space in the processing table

A deadlock resulting from competition for non-shareable railroad intersections



Deadlock

- Processes block each other from continuing
- Conditions required for deadlock
  1. Competition for non-sharable resources
     (Solution: Make it shareable, e.g., Spooling)
  2. Resources requested on a partial basis
     (Solution: Ask for all required resources)
  3. An allocated resource can not be forcibly retrieved (e.g., processes make new process to complete the job)

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Security

- Attacks from outside
  - Problems
    - Insecure passwords
    - Sniffing software
  - Counter measures
    - Auditing software
      1. New activities by user
      2. Try different passwords by one user
      3. Find sniffing software

Security (continued)

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