

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

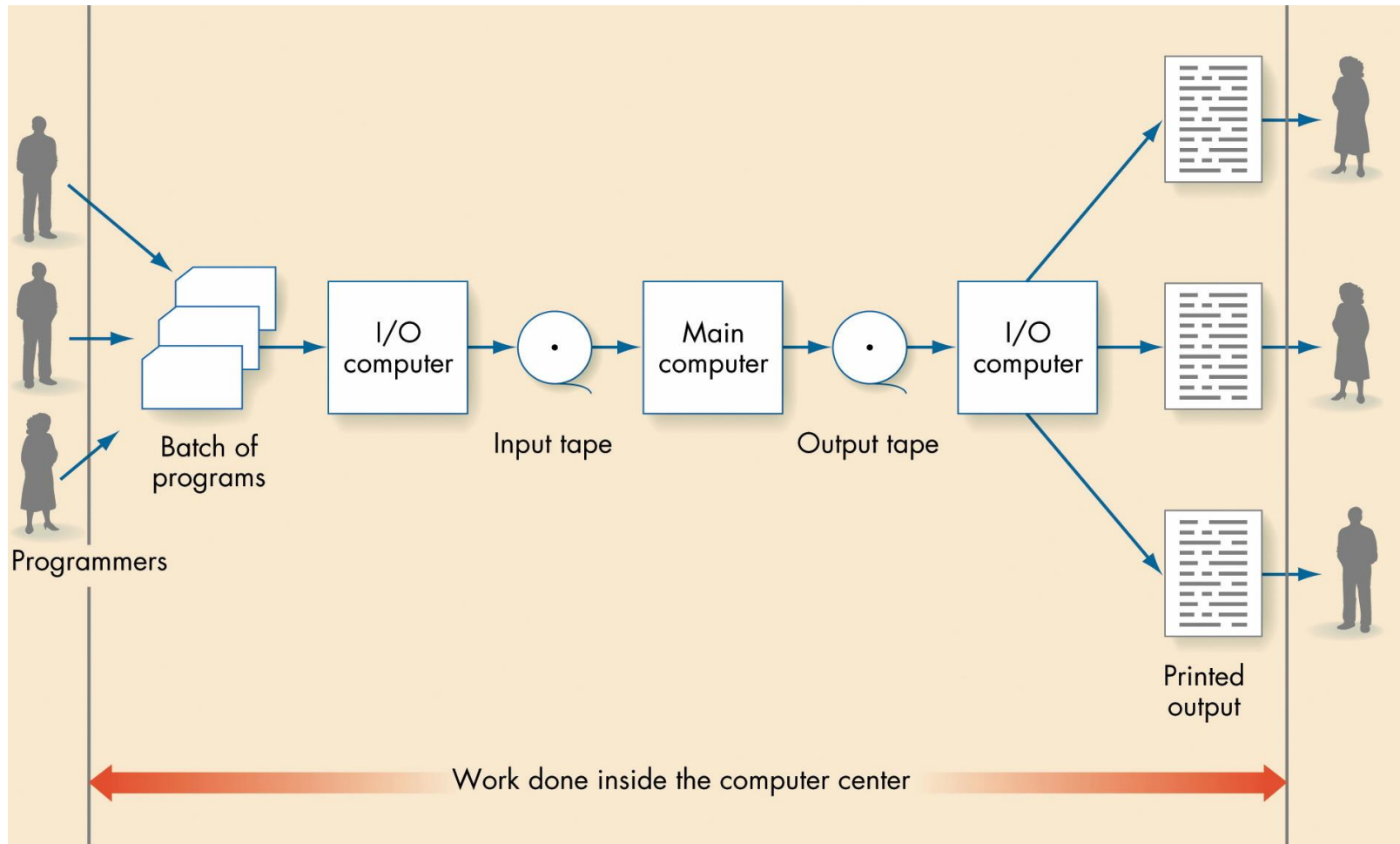
- Batch processing
- Interactive processing
 - Requires real-time processing
- Time-sharing/Multitasking
 - Implemented by Multiprogramming
- Multiprocessor machines
 - Load balancing
 - Scaling
- Embedded OS

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

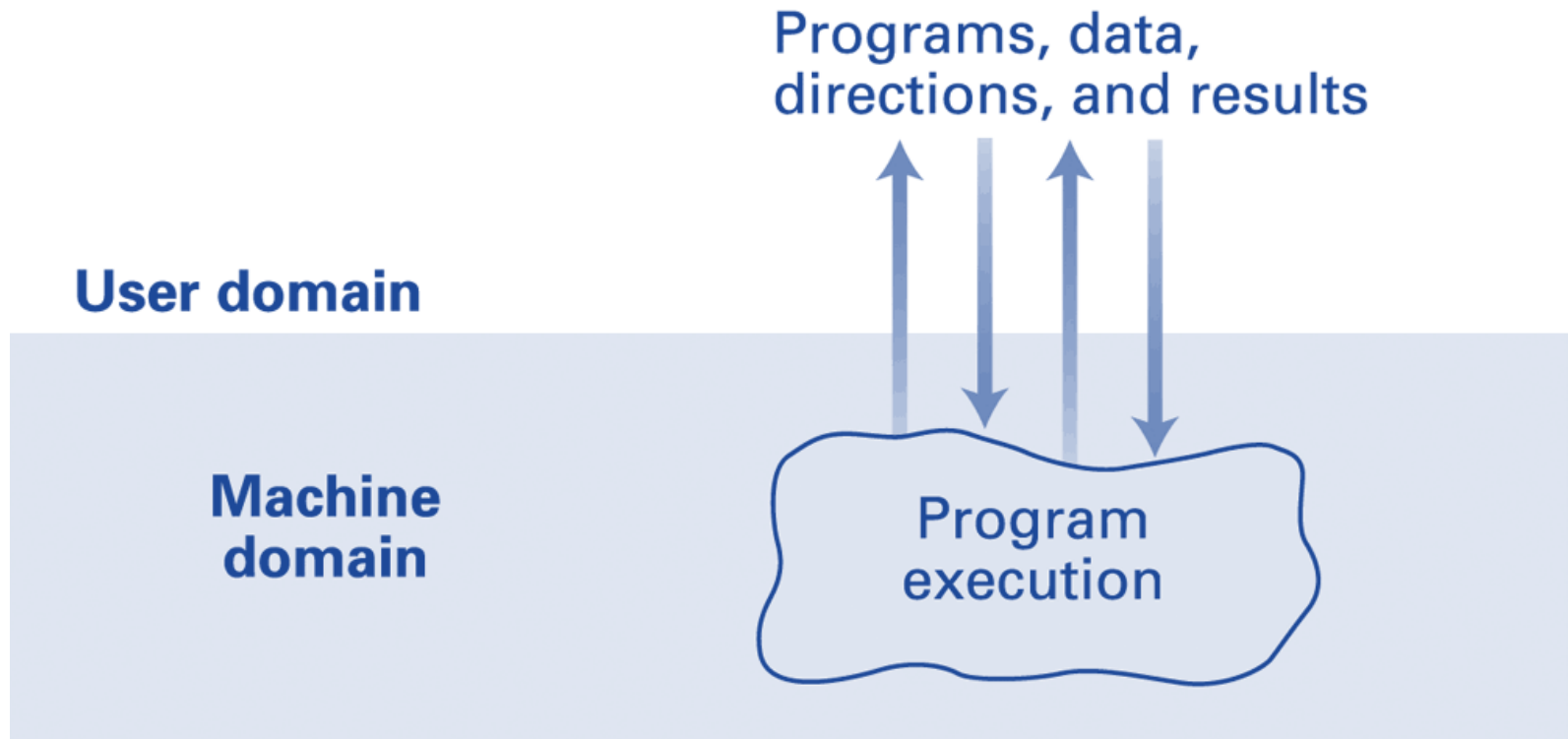
Batch processing

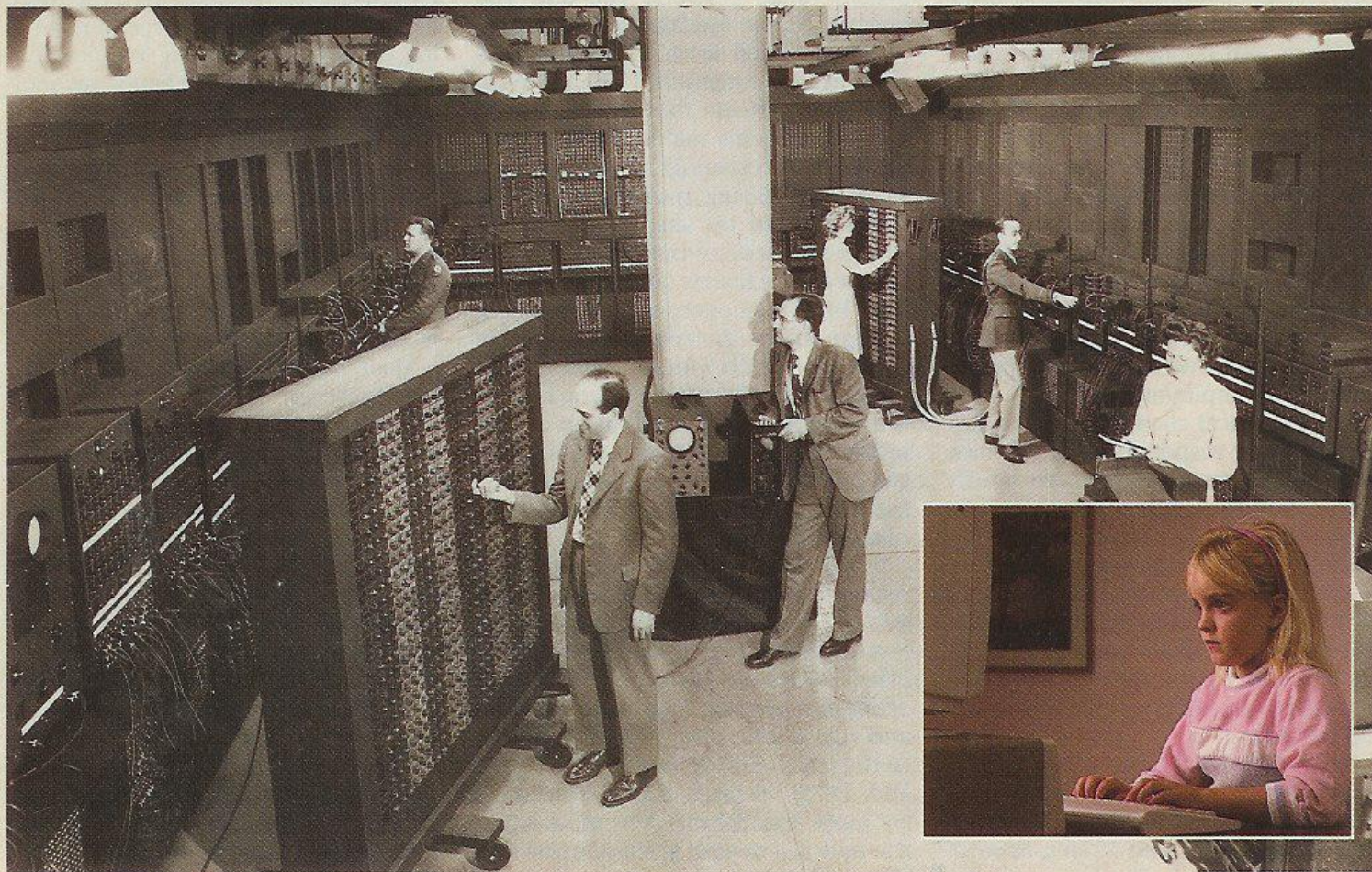


Batch processing



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.

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CS Education Week

Recognizing the
Transformative Role
of Computing

Certified Software

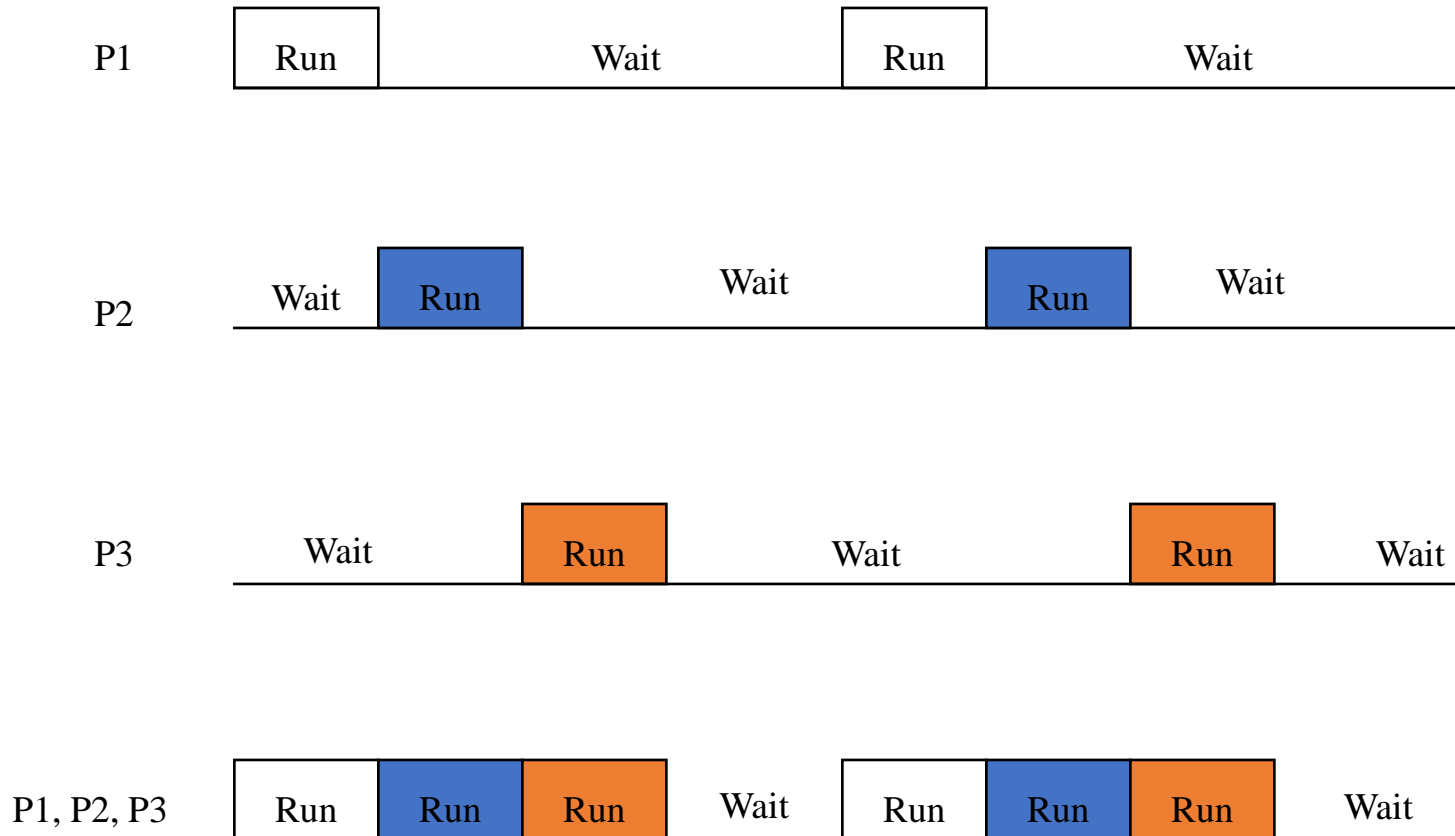
A Conversation with
Pixar's Ed Catmull

Bayesian Networks

The Theft of
Business Innovation



Multi tasking processing



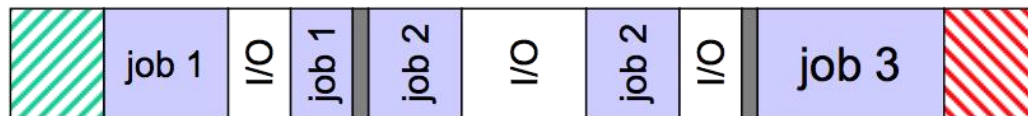
Evolution of CPU Utilization



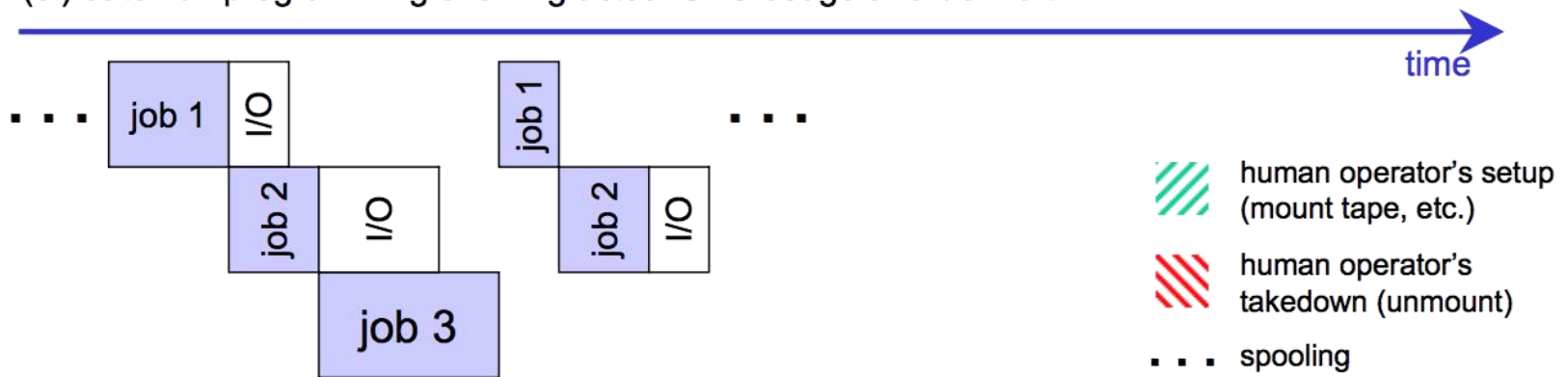
(a) serial uniprogramming



(b) batch uniprogramming



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

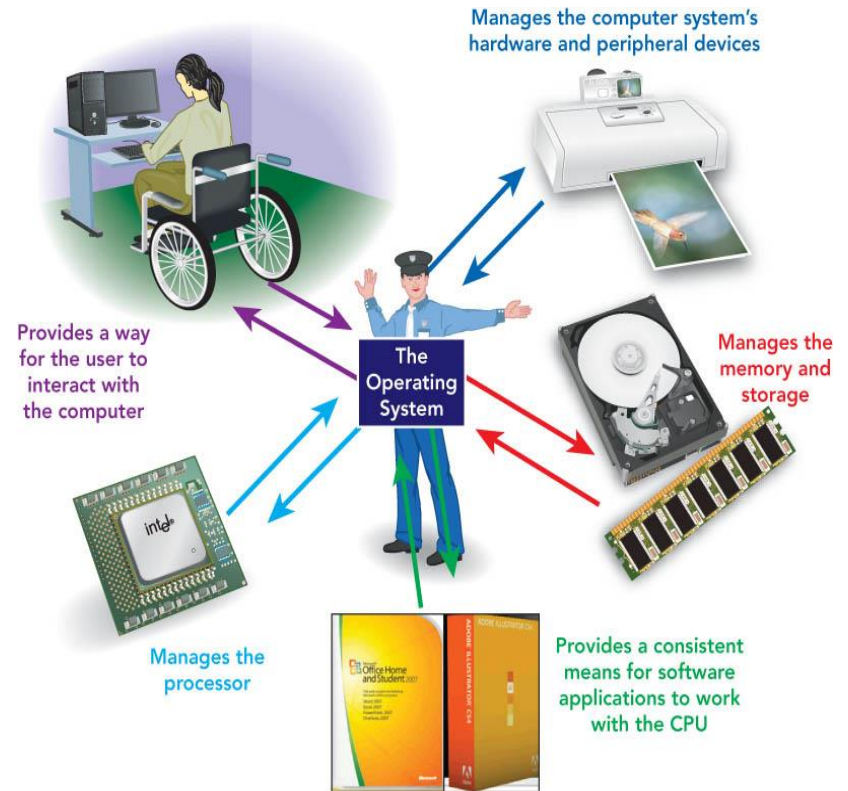


(c) multiprogramming

Evolution of CPU utilization

Basic functions of operating systems

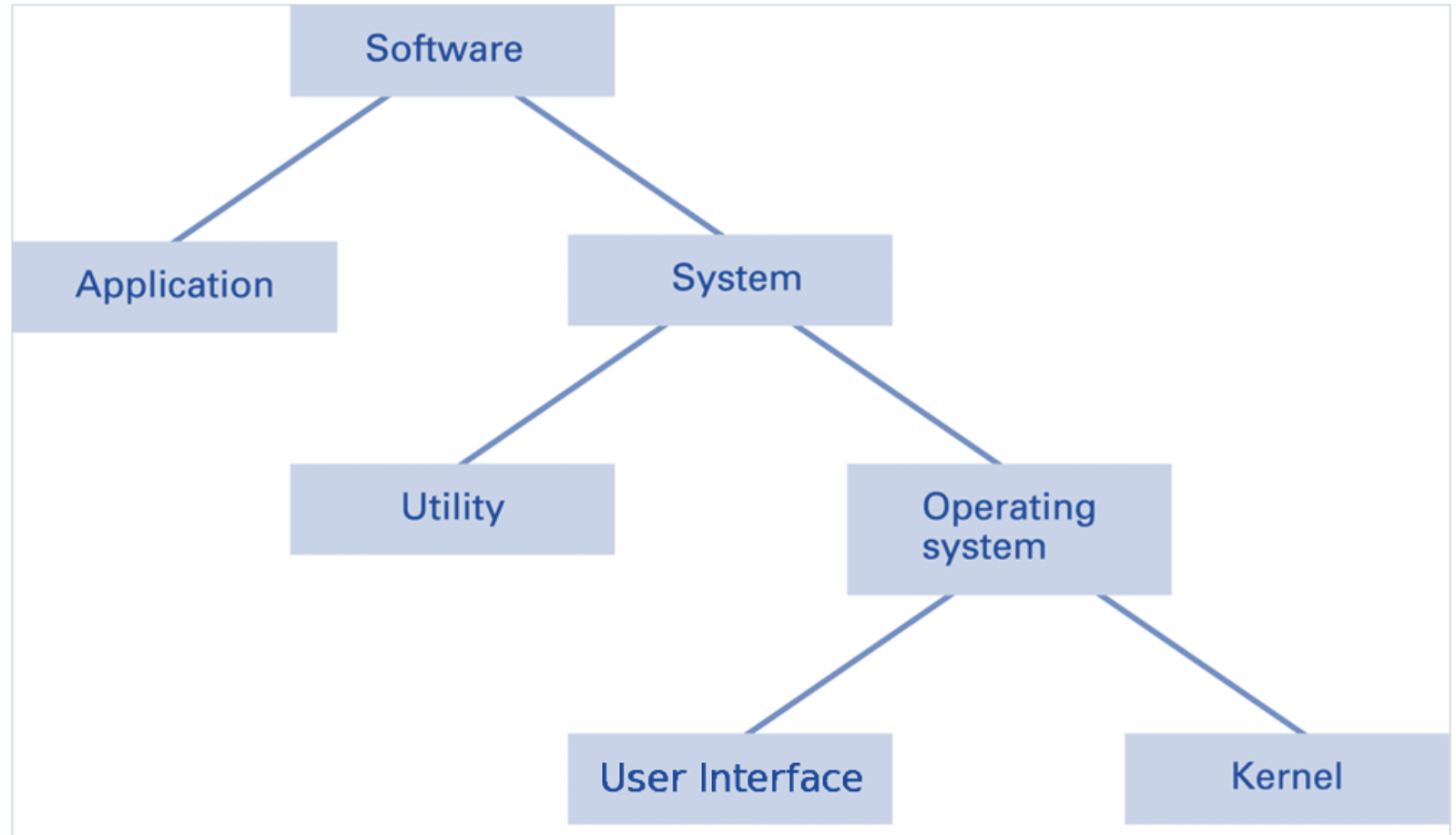
- Five basic functions
 - Starts the computer
 - Manages applications
 - Manages memory
 - Handles input and output device messages
 - Provides a user interface for communication



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

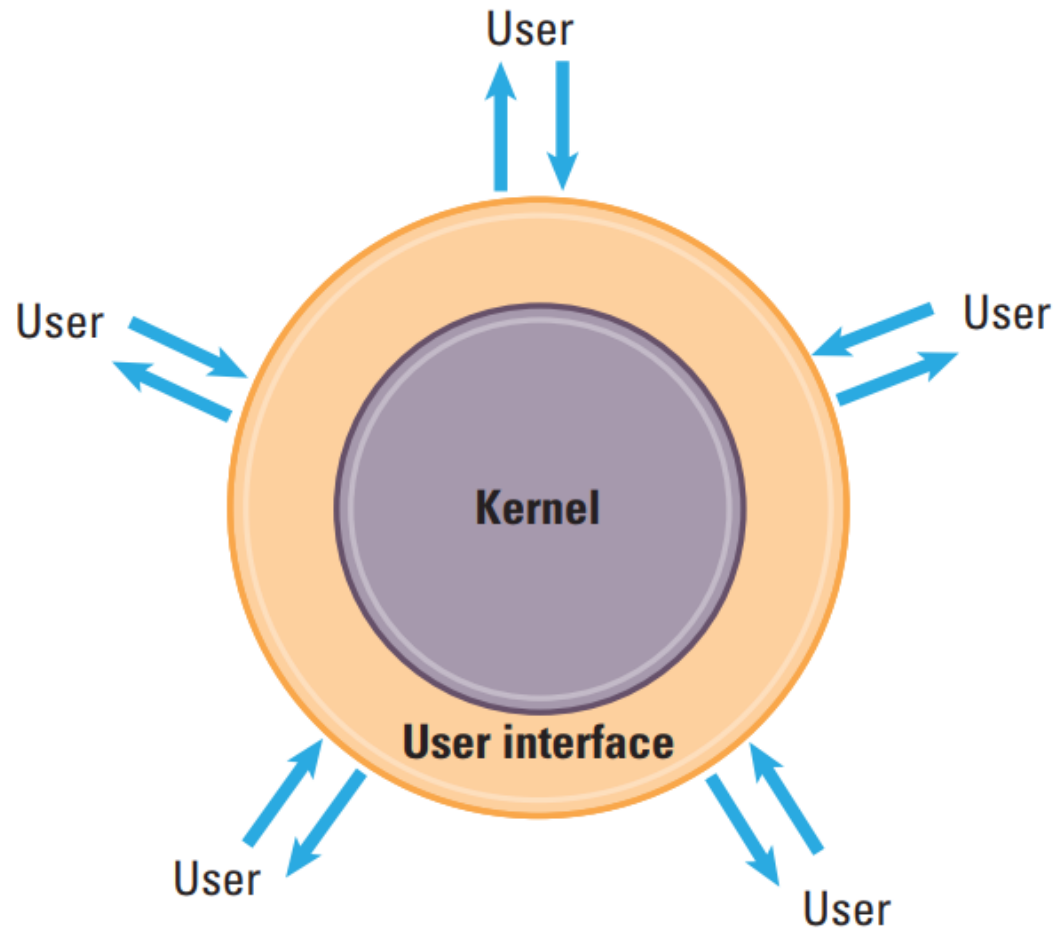
- Consists of all the programs that enable the computer and its peripheral devices to function smoothly
- Divided into two main categories:
 - The operating system
 - System utilities (utility programs)

Operating System Components

Operating System Components

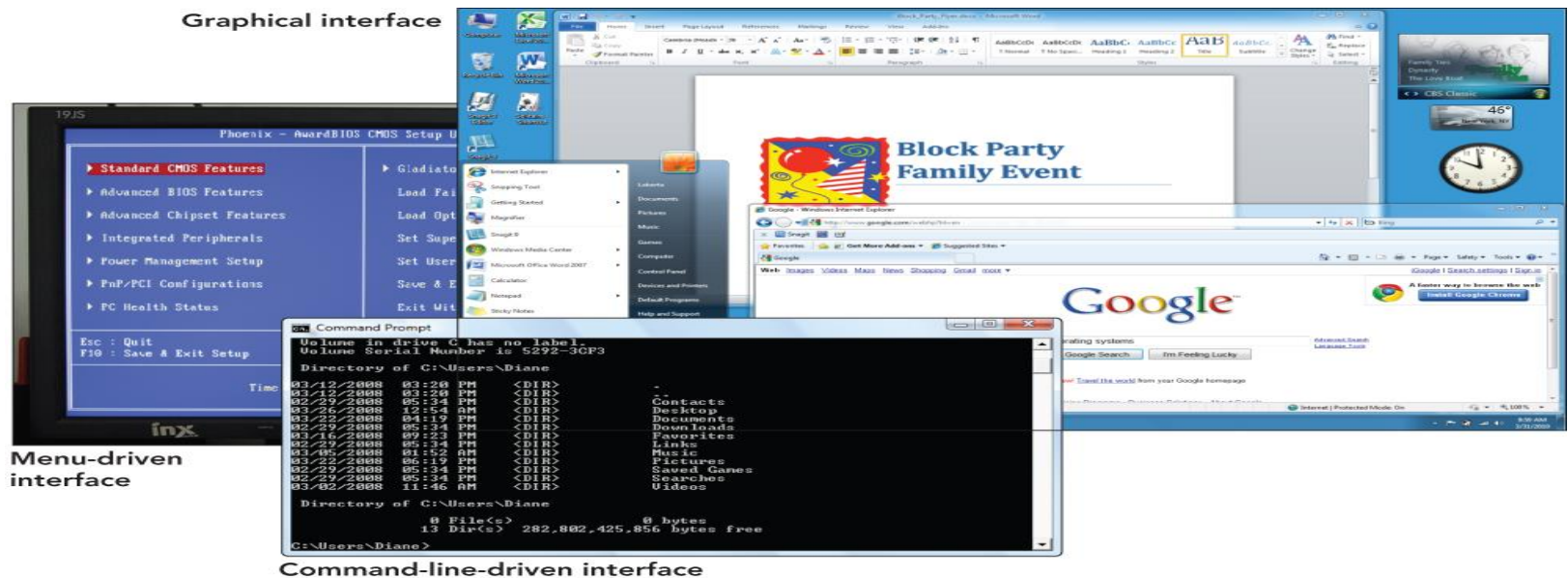
- **User Interface:** Communicates with users
 - Text based (Shell)
 - Graphical user interface (GUI)
- **Kernel:** Performs basic required functions
 - File manager
 - Device drivers
 - Memory manager
 - Scheduler and dispatcher

User - User interface - Kernel



User interface

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



User interface

Left			File			Command			Options			Right		
/software												/etc		
Name	Size	MTime				Name	Size	MTime				Name	Size	MTime
/..	4096	Oct 2 04:02				/..	4096	Oct 2 04:02				/..	4096	Oct 2 04:02
/ICAClient-3.0	2048	Jan 6 2003				/..	4096	Oct 2 04:02				/.java	30	May 13 2004
/aida-2.1.1	2048	Apr 28 2003				/.java	30	May 13 2004				/ada	4096	Aug 9 2001
/amber-6.0	2048	Feb 27 2004				/ada	4096	Aug 9 2001				/conf	151	Jul 19 2000
/amber-7.0	2048	Mar 5 2004				/conf	151	Jul 19 2000				/config	4096	Dec 13 2004
/amber-7.0p	2048	Apr 16 2004				/config	4096	Dec 13 2004				/cron.d	133	Sep 29 20:23
/amber-8	2048	Dec 22 2004				/cron.d	133	Sep 29 20:23				/default	75	Aug 12 2004
~ansys61	34	Jan 7 2003				/default	75	Aug 12 2004				/dt	27	Apr 5 2003
~ansys71	34	Nov 28 2003				/dt	27	Apr 5 2003				/fscklogs	39	Aug 3 2000
/ant-1.6	2048	Aug 10 13:26				/fscklogs	39	Aug 3 2000				~fstyp.d	15	Apr 25 2000
/apache-1.3.27	2048	Dec 16 2002				~fstyp.d	15	Apr 25 2000				~httpd	20	Jul 19 2000
/apache-1.3.28	2048	Jan 6 2004				~httpd	20	Jul 19 2000				/init.d	4096	Sep 21 15:45
/apache-1.3.33	2048	Feb 7 2005				/init.d	4096	Sep 21 15:45				/js	4096	Aug 9 2001
/autoconf-2.57	2048	May 27 2004				/js	4096	Aug 9 2001				/lost+found	4096	Oct 8 2004
/autodock-305	2048	Jan 5 2001				/lost+found	4096	Oct 8 2004				/mail	4096	May 2 10:04
/ICAClient-3.0												/cron.d		

Hint: Keys not working in xterms? Use our xterm.ad, .ti and .tcap files.

aisa:/software>\$

1Help 2Menu 3View 4Edit 5Copy 6RenMov 7Mkdir 8Delete 9PullDn 10Quit

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

- **Memory management** refers to management of Main Memory (RAM)
- Main memory provides a fast storage that can be accessed by the CPU. For a program to be executed, it must in the main memory.
- An Operating System does the following activities for memory management:
 - **Keeps tracks** of main memory: what part of it are in use by whom, what part are not in use.
 - In **multiprogramming**, the OS decides which process will get memory when and how much.
 - **Allocates** the memory when a process requests it to do so.
 - **De-allocates** the memory when a process no longer needs it or has been terminated.

Kernel - Memory Manager

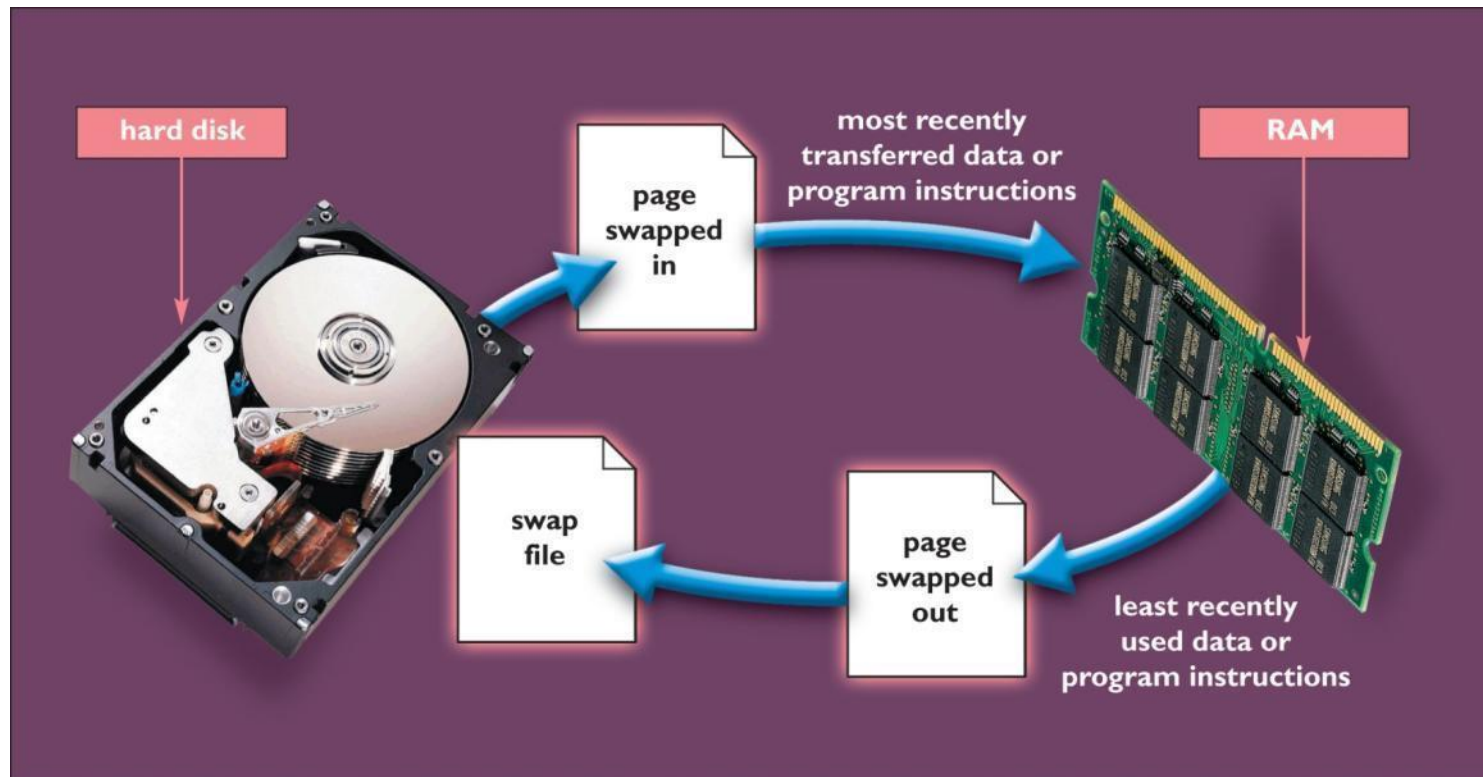
- Allocates space in main memory
- May create the illusion that the machine has more memory than it actually does (**virtual memory**) by playing a “shell game” in which blocks of data (**pages**) are shifted back and forth between main memory and mass storage

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

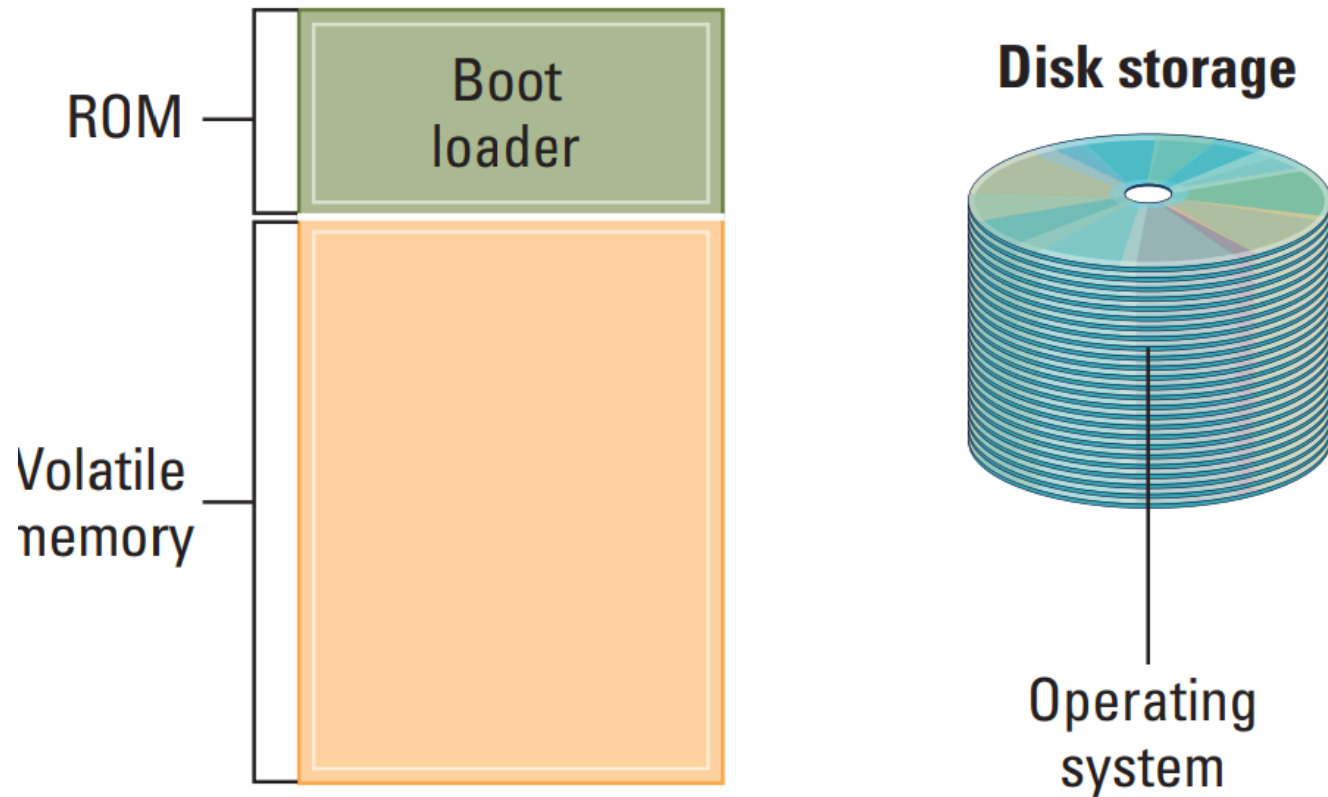


Getting It Started

Bootstrapping

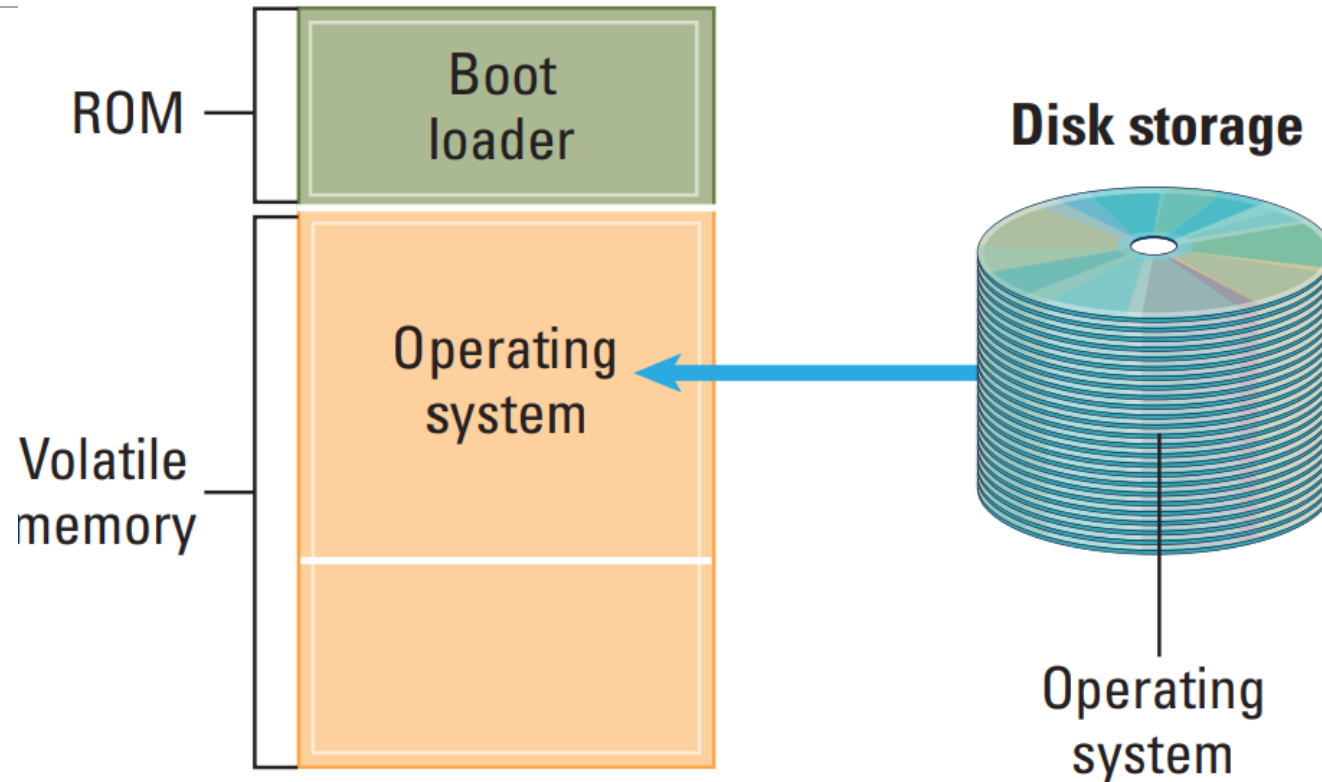
- **Boot loader:** Program in ROM (example of firmware)
 - Run by the CPU when power is turned on
 - Transfers operating system from mass storage to main memory
 - Executes jump to operating system
- Cold boot: Starting computer when it has not yet been turned on
- Warm boot: Restarting a computer that is already on

The booting process



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

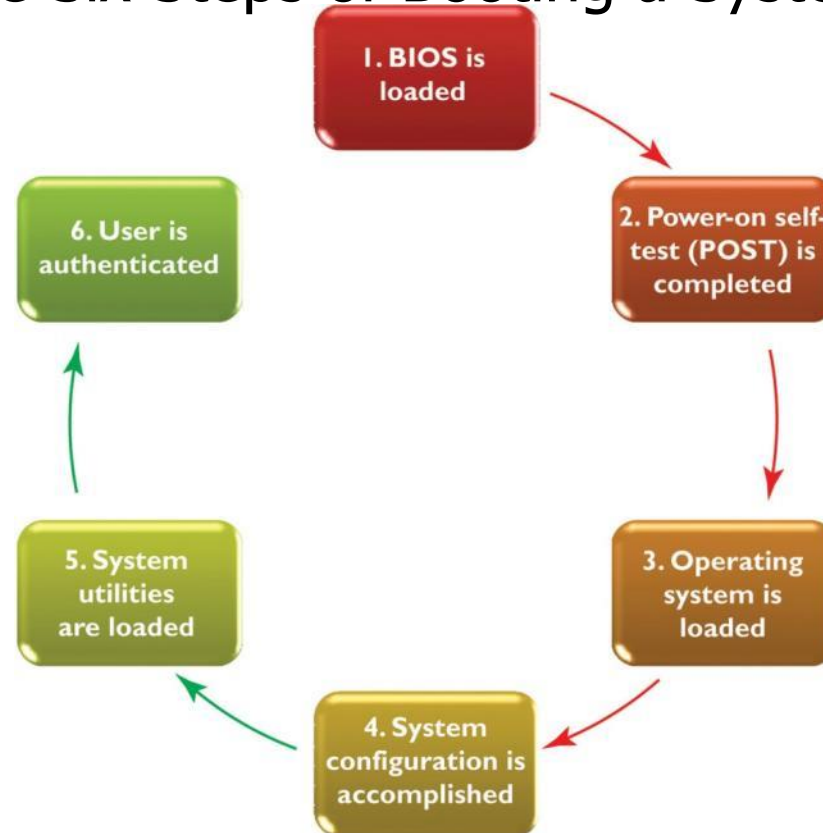
The booting process



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

The booting process

The Six Steps of Booting a System



BIOS SETUP UTILITY

Advanced

Manufacturer: Intel
 Brand String: Intel(R) Core(TM) i7 CPU 870
 Frequency : 2.93GHz
 BCLK Speed : 133MHz
 Cache L1 : 256 KB
 Cache L2 : 1024 KB
 Cache L3 : 8192 KB
 Ratio Status: Unlocked (Min:09, Max:22)
 Ratio Actual Value: 22
 CPUID : 106E5

CPU Ratio Setting [22.0]
 C1E Support [Enabled]
 Hardware Prefetcher [Enabled]
 Adjacent Cache Line Prefetch [Enabled]
 Max CPUID Value Limit [Disabled]
 Intel(R) Virtualization Tech [Enabled]
 CPU TM Function [Enabled]
 Execute-Disable Bit Capability [Enabled]

When disabled, force the XD feature flag to always return 0.

↔ Select Screen
 ↑↓ Select Item
 +- Change Option
 F1 General Help
 F10 Save and Exit
 ESC Exit

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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

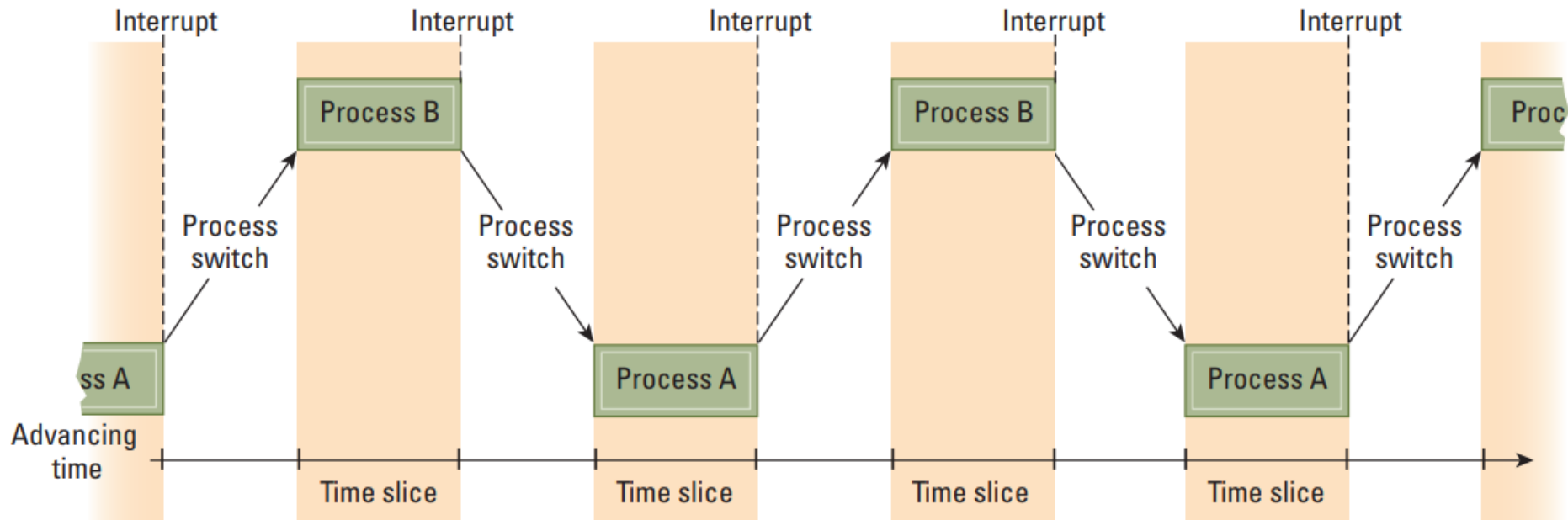
Processes

- **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

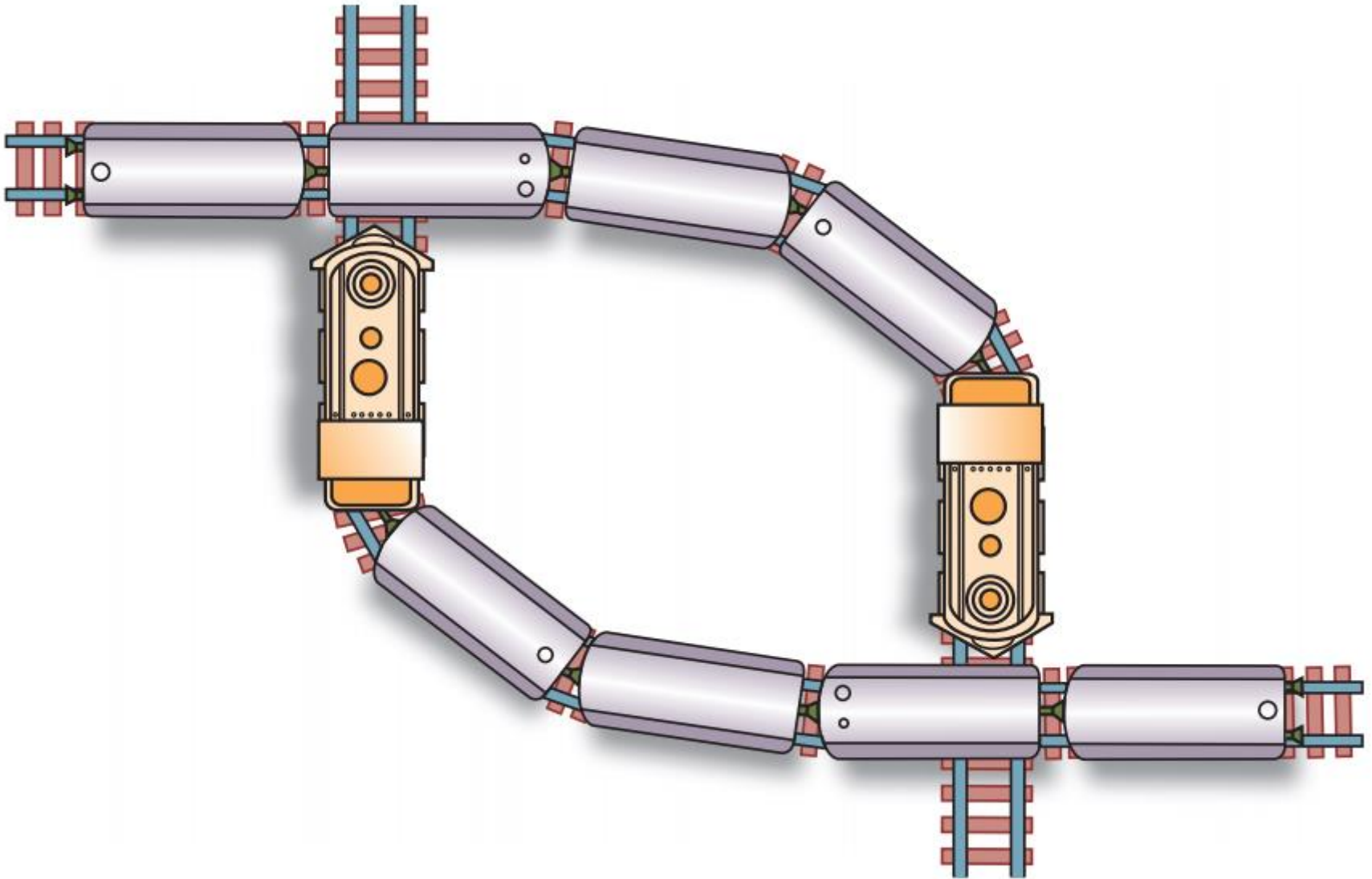
Handling Competition for Resources

- **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

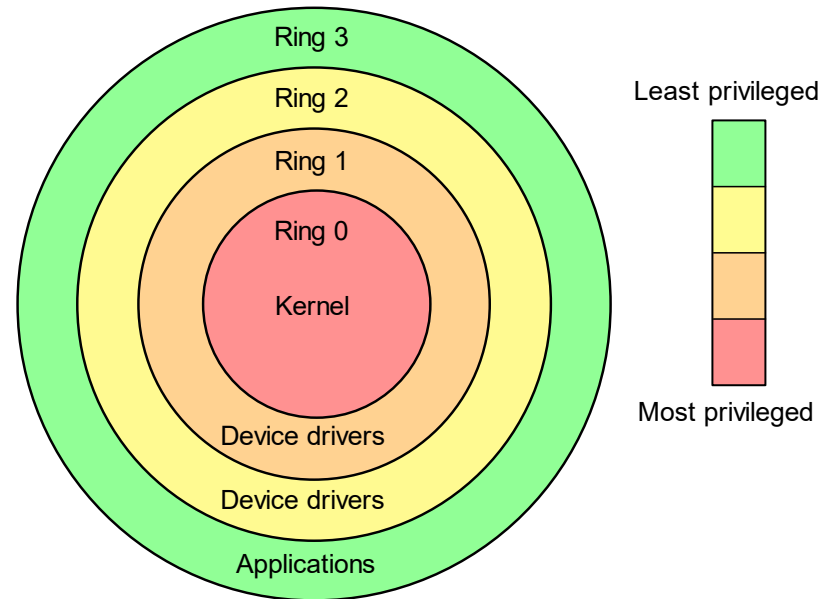


Security

- 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



Questions and Answers

Quiz

Which OS is not designed for smartphones and PDAs?

- A. Android
- B. Mac OS
- C. Symbian
- D. Windows Mobile

Quiz

What utility program reduces a file size by as much as 80 percent by substituting short codes for lengthy data patterns?

- A. Defragmentation
- B. Compression
- C. Interrupt
- D. Cleanup

Quiz

Which of the following is an OS function?

- A. Creating letters
- B. Defragmenting a disk
- C. Managing memory
- D. Writing an e-mail

Quiz

Virtual memory is used when:

- A. booting fails.
- B. an IRQ conflict occurs.
- C. RAM is full.
- D. a power-on-self-test fails.

Quiz

Which test makes sure the computer and its peripherals are working correctly during the start-up process?

- A. BIOS
- B. Upgrade
- C. ReadyBoost
- D. POST

Quiz

Which of following are functions of the operating system?

- A. File management
- B. CPU management
- C. Task management
- D. Booting
- E. All of these

Quiz

Which of the following refers are specialized software programs that allow input and output devices to communicate with the rest of the computer system?

- A. Multitasking
- B. Boot-disks
- C. Utility programs
- D. Device drivers
- E. Service packs

Quiz

Which is the common consumer computer interface used today?

- A. command-line interface
- B. graphical user interface
- C. menu-driven interface
- D. electronic user interface
- E. biometric user interface