Introduction

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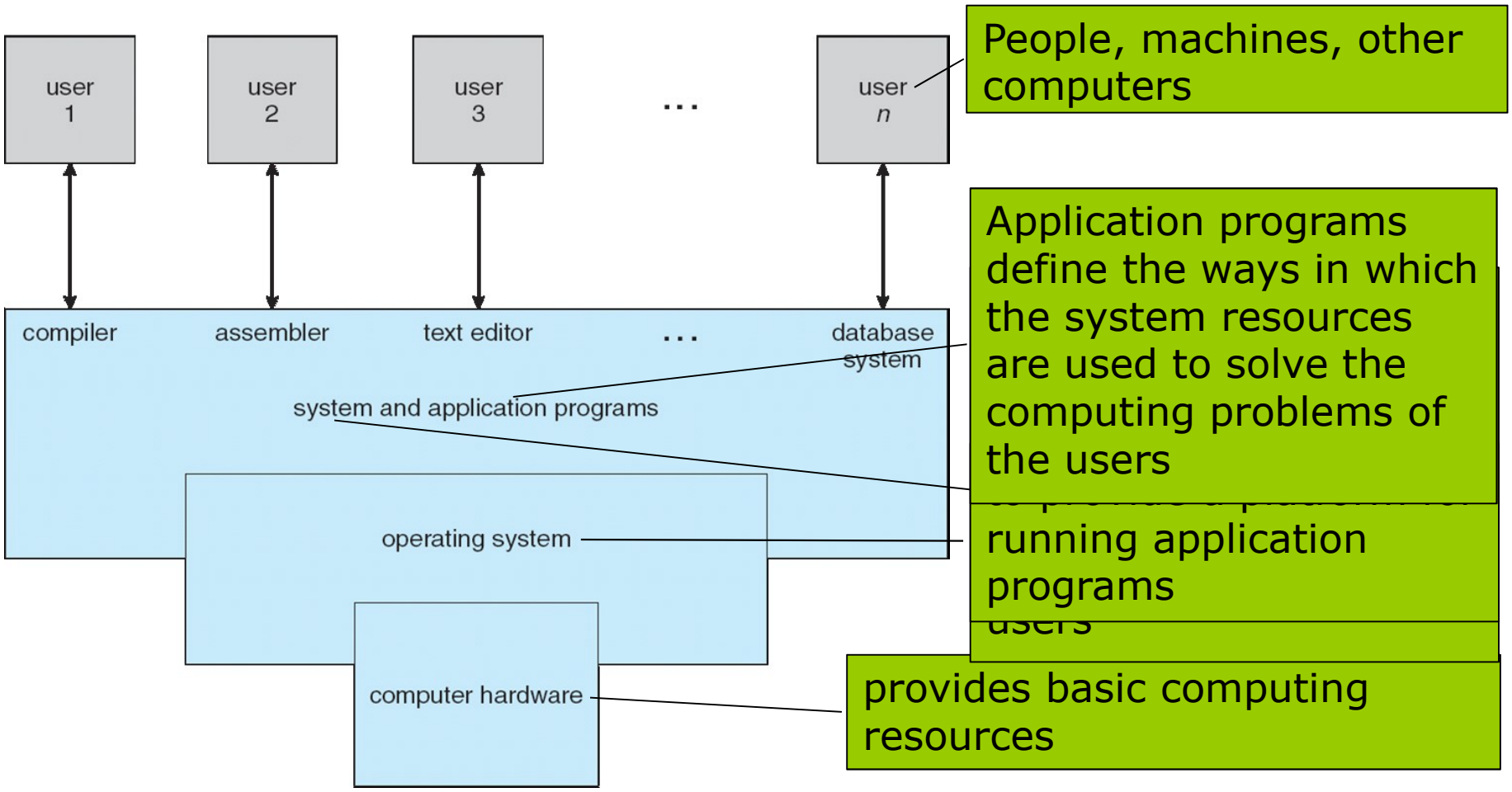
Operating Systems

Operating Systems

- UNIX-family: BSD(Berkeley Software Distribution), System-V, GNU/Linux, MINIX, Nachos, OS X, iOS
- BSD-family: FreeBSD, NetBSD, OpenBSD
- System-V-family: AIX, HP-UX, IRIX, Solaris
- Linux-family: Red Hat, Debian, Ubuntu, Fedora, openSUSE, Linux Mint, Google's Android, WebOS, Meego
- MS-DOS, Microsoft Windows, Windows Mobile, Win-CE, WP8
- AmigaOS
- Symbian, MeeGo
- Google Chrome OS
- OS/2
- XrossMediaBar(XMB) for PS3, Orbis OS for PS4
- Input Output System for Wii
- Tiny-OS, LynxOS, QNX, VxWorks

Four Components of a Computer System



Computer System Structure

- **Hardware** – provides basic computing resources
  - CPU, memory, I/O devices
- **Operating system** – Controls and coordinates use of hardware among various applications and users
- **System programs** – are computer software designed to operate the computer hardware and to provide a platform for running application programs
  - BIOS and device drivers
- **Application programs** – define the ways in which the system resources are used to solve the computing problems of the users
  - Word processors, compilers, web browsers, database systems, video games
- **Users**
  - People, machines, other computers

What is an Operating System?

- An operating system is a program that manages the computer hardware
- A program that acts as an intermediary between the computer user and the computer hardware

- Operating system goals:
  - Execute user programs and make solving user problems easier
  - Make the computer system convenient to use
  - Use the computer hardware in an efficient manner

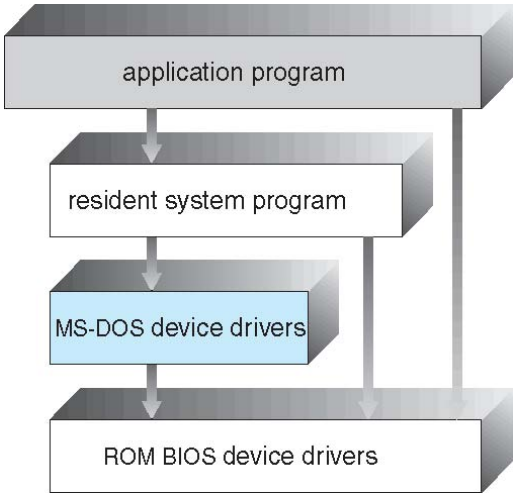
Operating System Definition

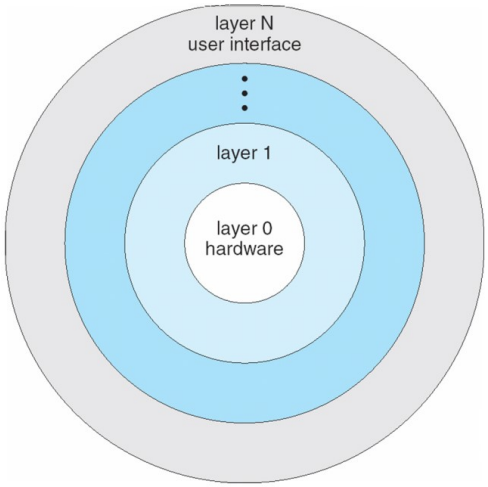
- OS is a **resource allocator**
  - Manages all resources
  - Decides between conflicting requests for efficient and fair resource use
- OS is a **control program**
  - Controls execution of programs to prevent errors and improper use of the computer

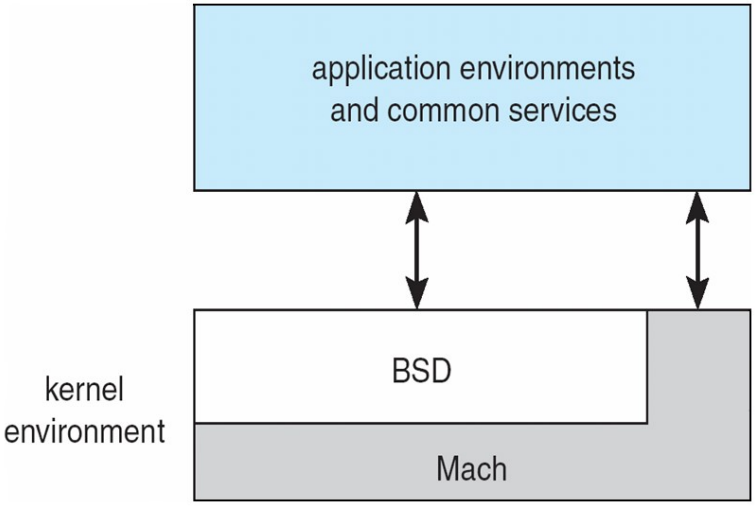
Operating System Definition (Cont.)

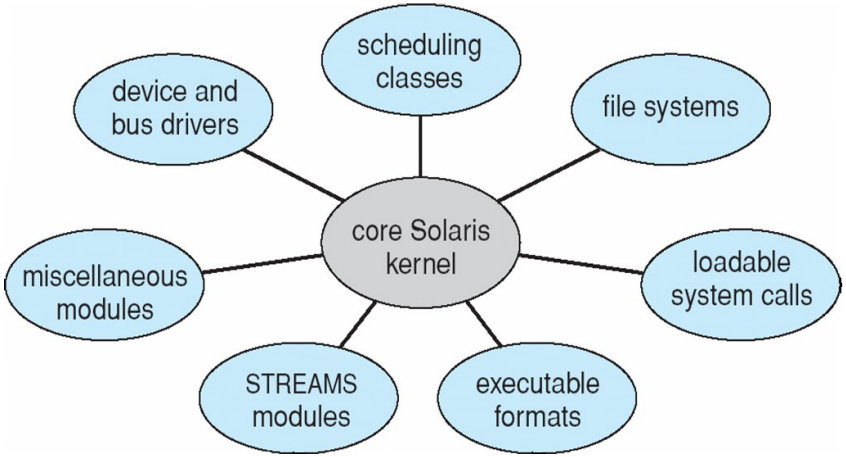
- No universally accepted definition
- "Everything a vendor ships when you order an operating system" is good approximation
  - But varies wildly
- "The one program running at all times on the computer" is the **kernel**. Everything else is either a system program (ships with the operating system) or an application program.
- "An operating system (OS) is **software**, consisting of programs and data, that **runs on computers, manages computer hardware resources, and provides common services for execution of various application software**." --- From Wikipedia

Operating System Structures

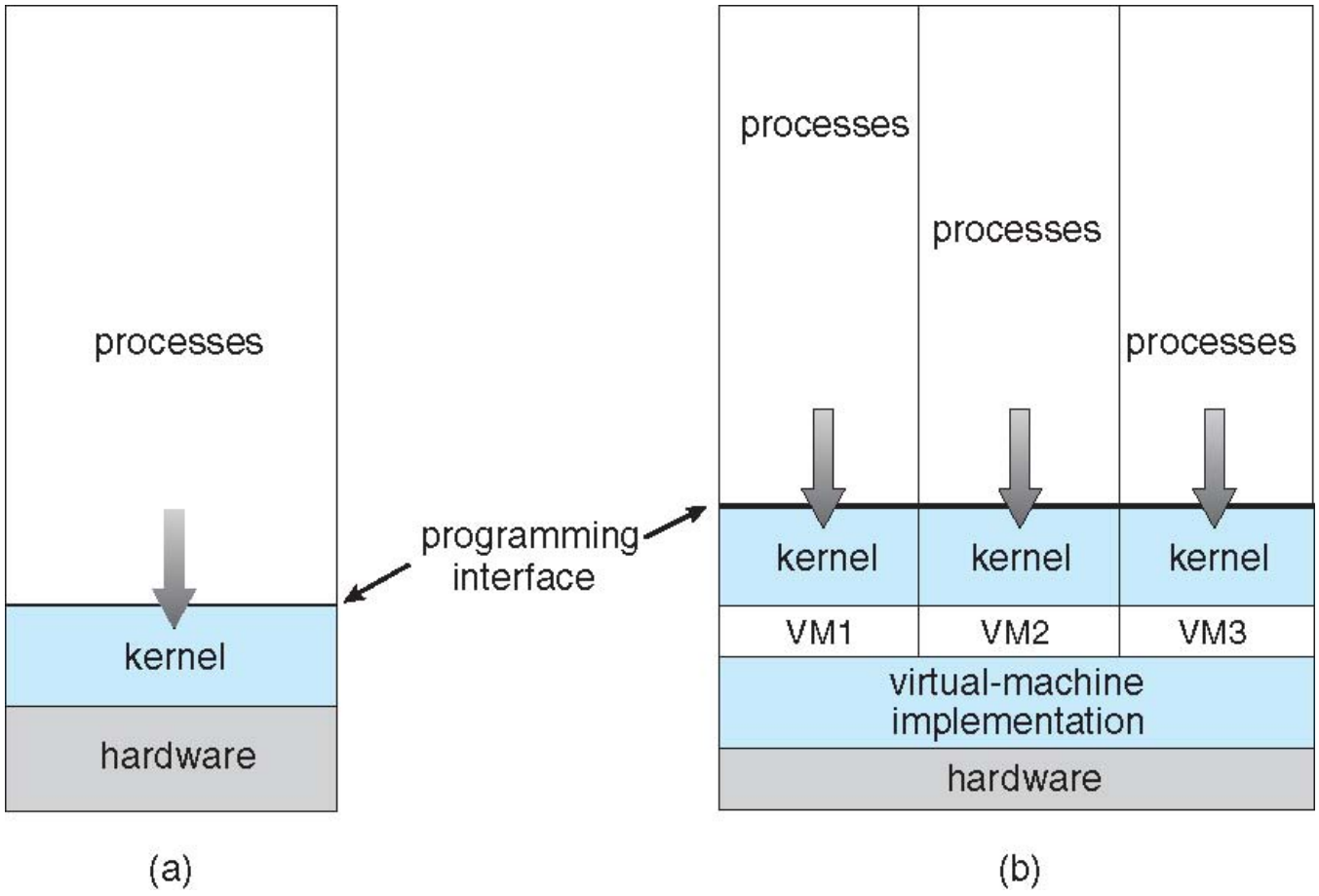






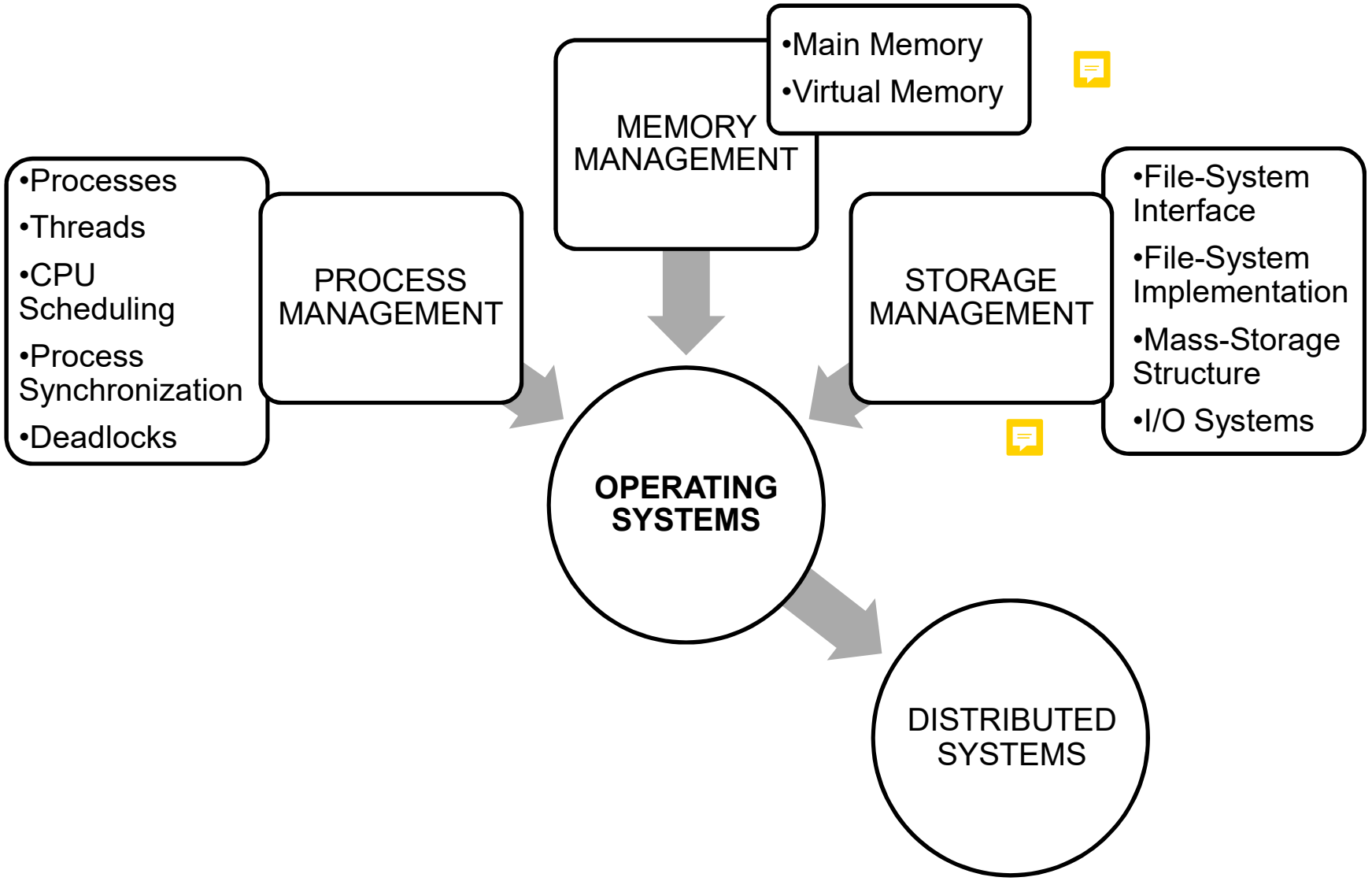


Virtual Machines

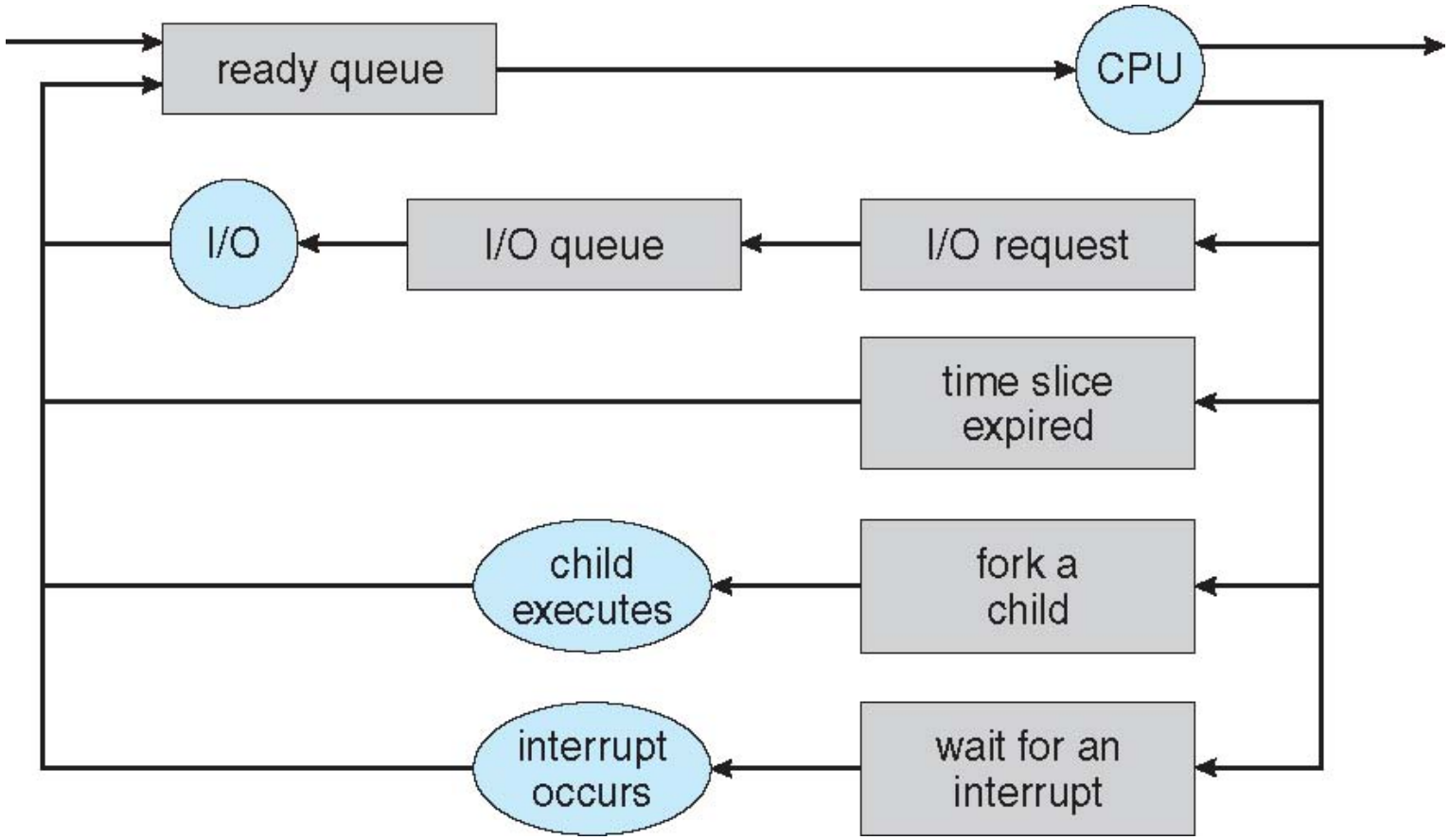


(a) Bare Machine (b) Virtual Machine

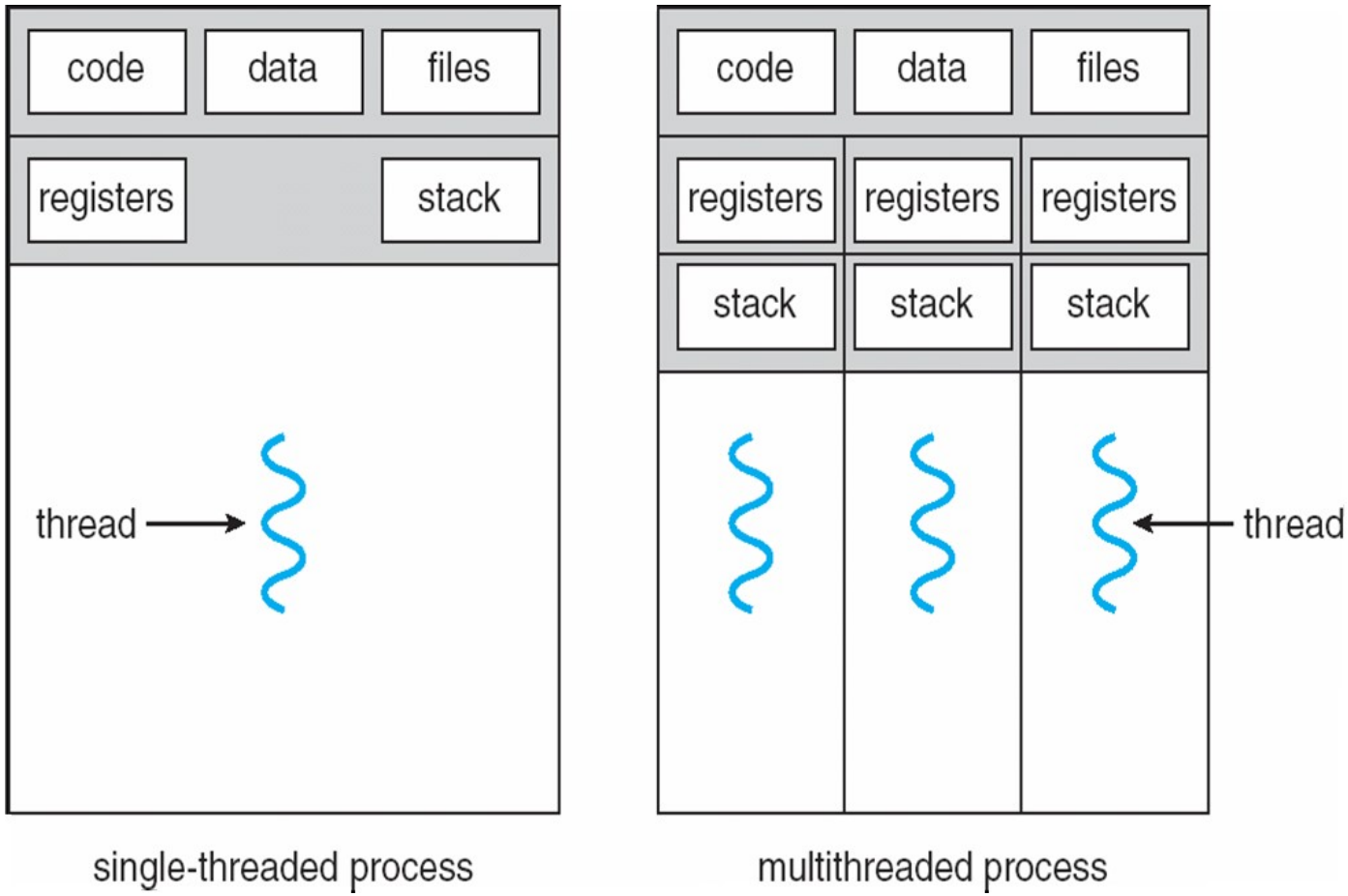
Course Outline



Process Scheduling



Single and Multithreaded Processes

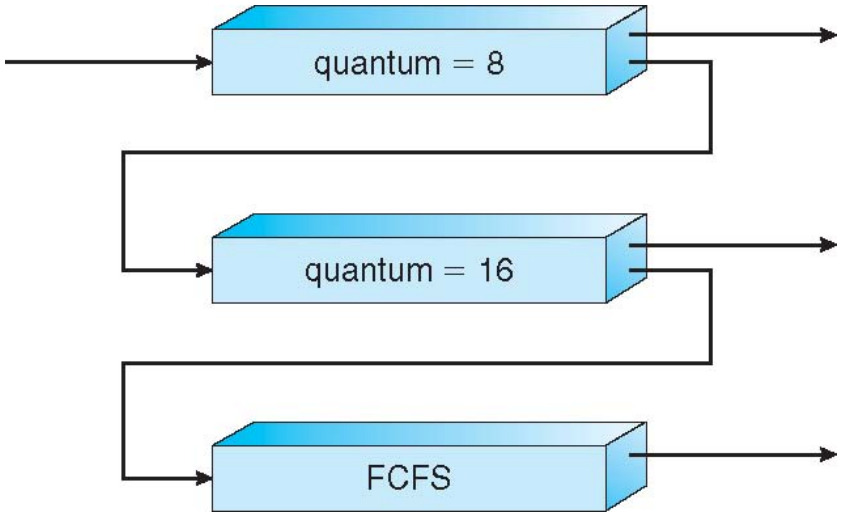


single-threaded process

multithreaded process

CPU Scheduling

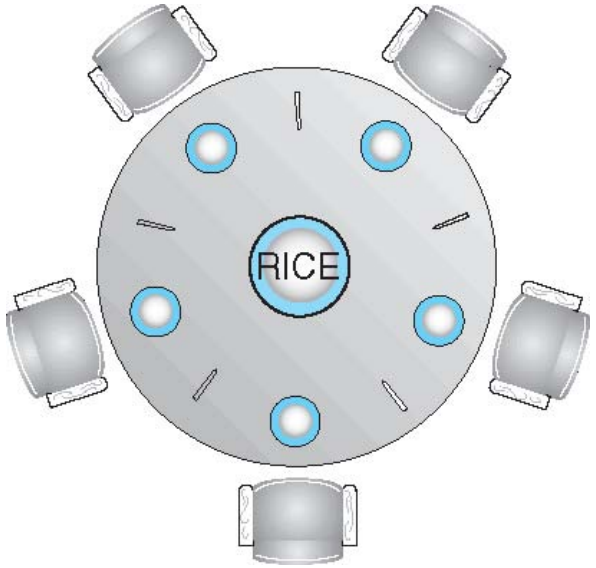
- First-Come, First-Served (FCFS) Scheduling
- Shortest-Job-First (SJF) Scheduling
- Priority Scheduling
- Round-Robin Scheduling
- Multilevel Queue Scheduling
- Multilevel Feedback Queue Scheduling



Process Synchronization

Dining-Philosophers Problem

- Philosophers spend their lives thinking and eating
- Don't interact with their neighbors, occasionally try to pick up 2 chopsticks (one at a time) to eat from bowl
  - Need both to eat, then release both when done
- In the case of 5 philosophers
  - Shared data
    - Bowl of rice (data set)
    - Semaphore chopstick [5] initialized to 1



Deadlock Avoidance

Example of Banker's Algorithm

- 5 processes P_0 through P_4;

  3 resource types:

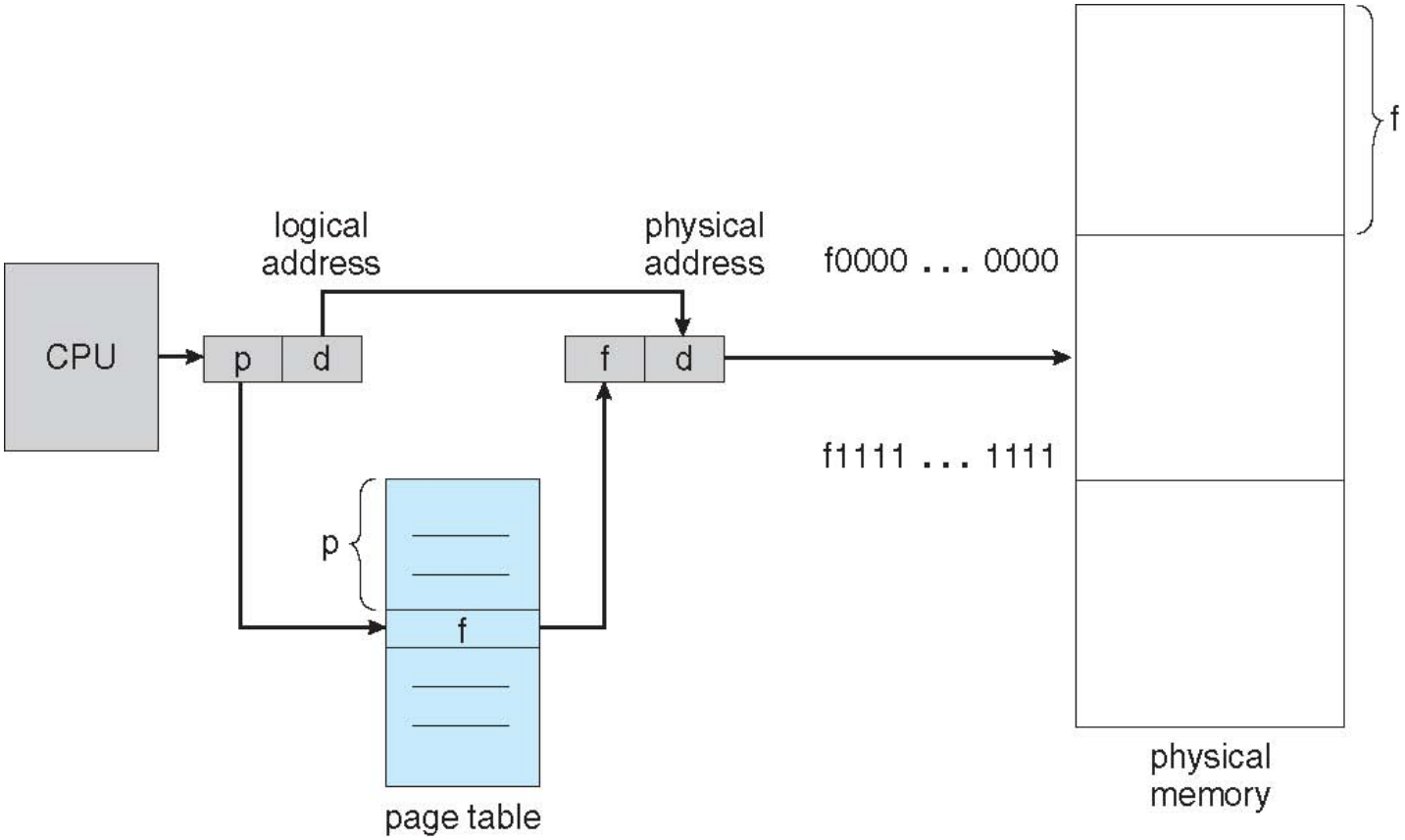
  A (10 instances), B (5 instances), and C (7 instances)

Snapshot at time T_0:

	Max	Allocation	Need	Available
	A B C	*A B C*	*A B C*	*A B C*
P_0	7 5 3	0 1 0	7 4 3	3 3 2
P_1	3 2 2	2 0 0	1 2 2	
P_2	9 0 2	3 0 2	6 0 0	
P_3	2 2 2	2 1 1	0 1 1	
P_4	4 3 3	0 0 2	4 3 1	

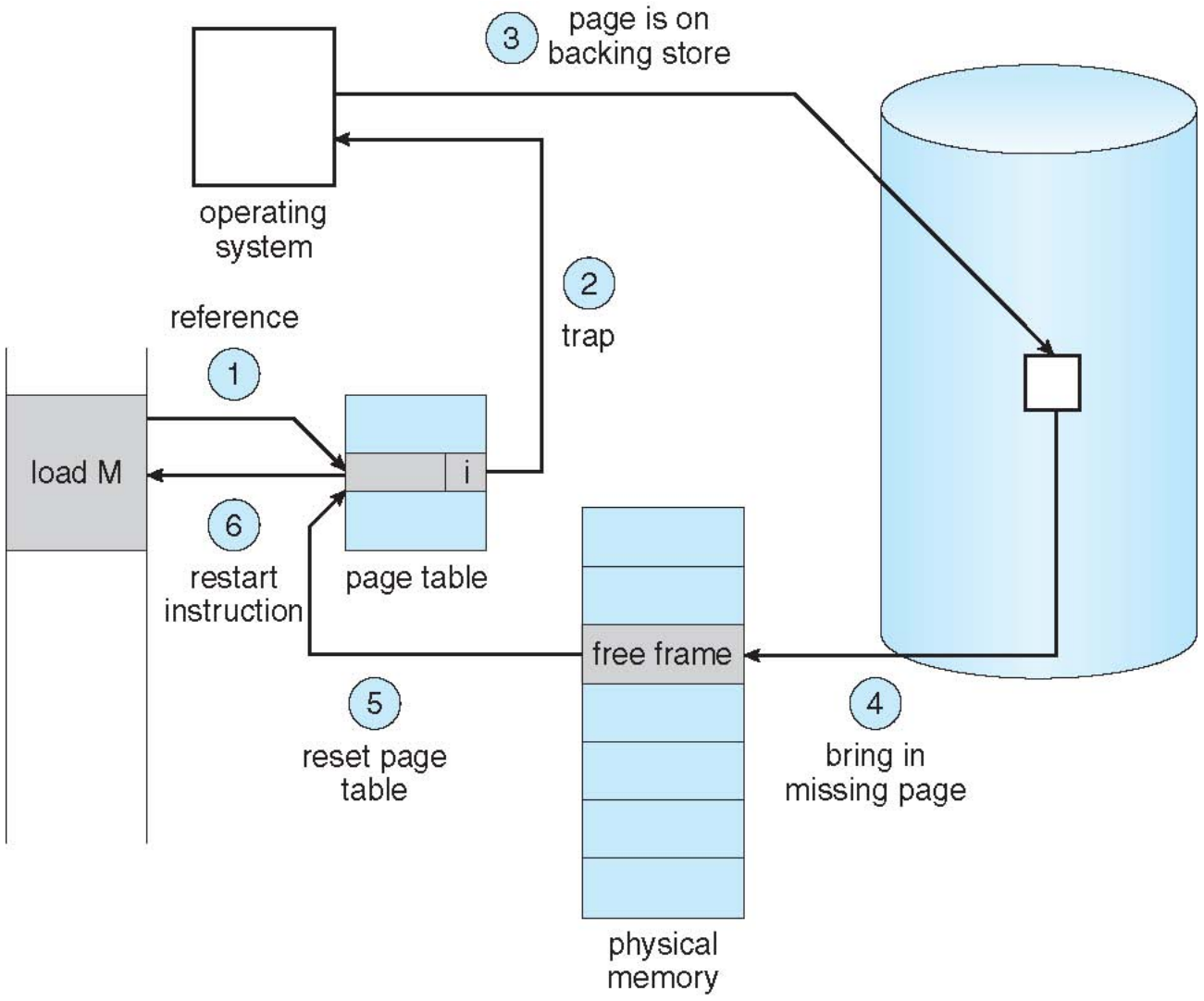
- The system is in a safe state since the sequence $< P_1, P_3, P_0, P_2, P_4 >$ satisfies safety criteria

Memory Management

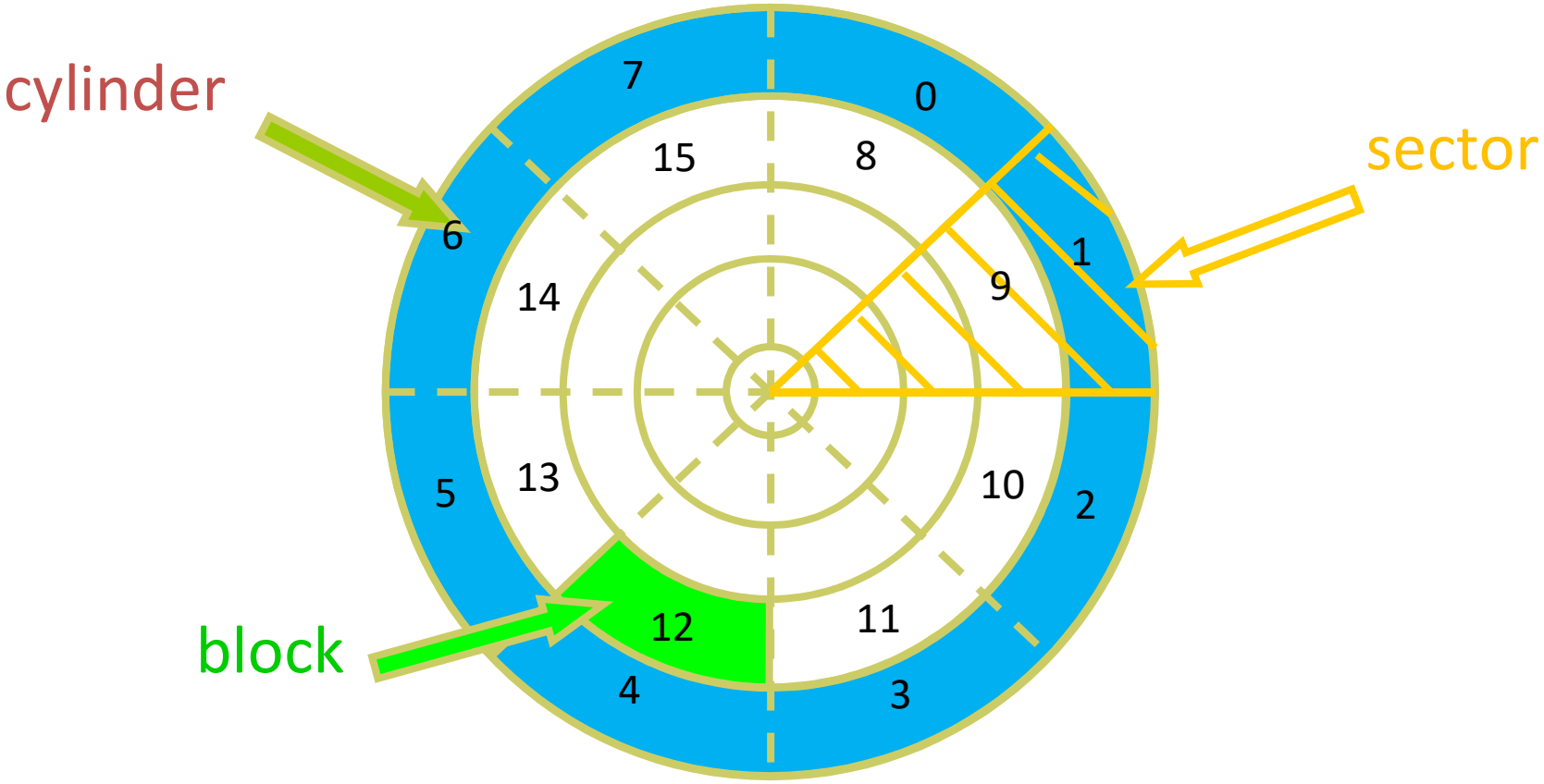


Paging Hardware

Virtual Memory Management

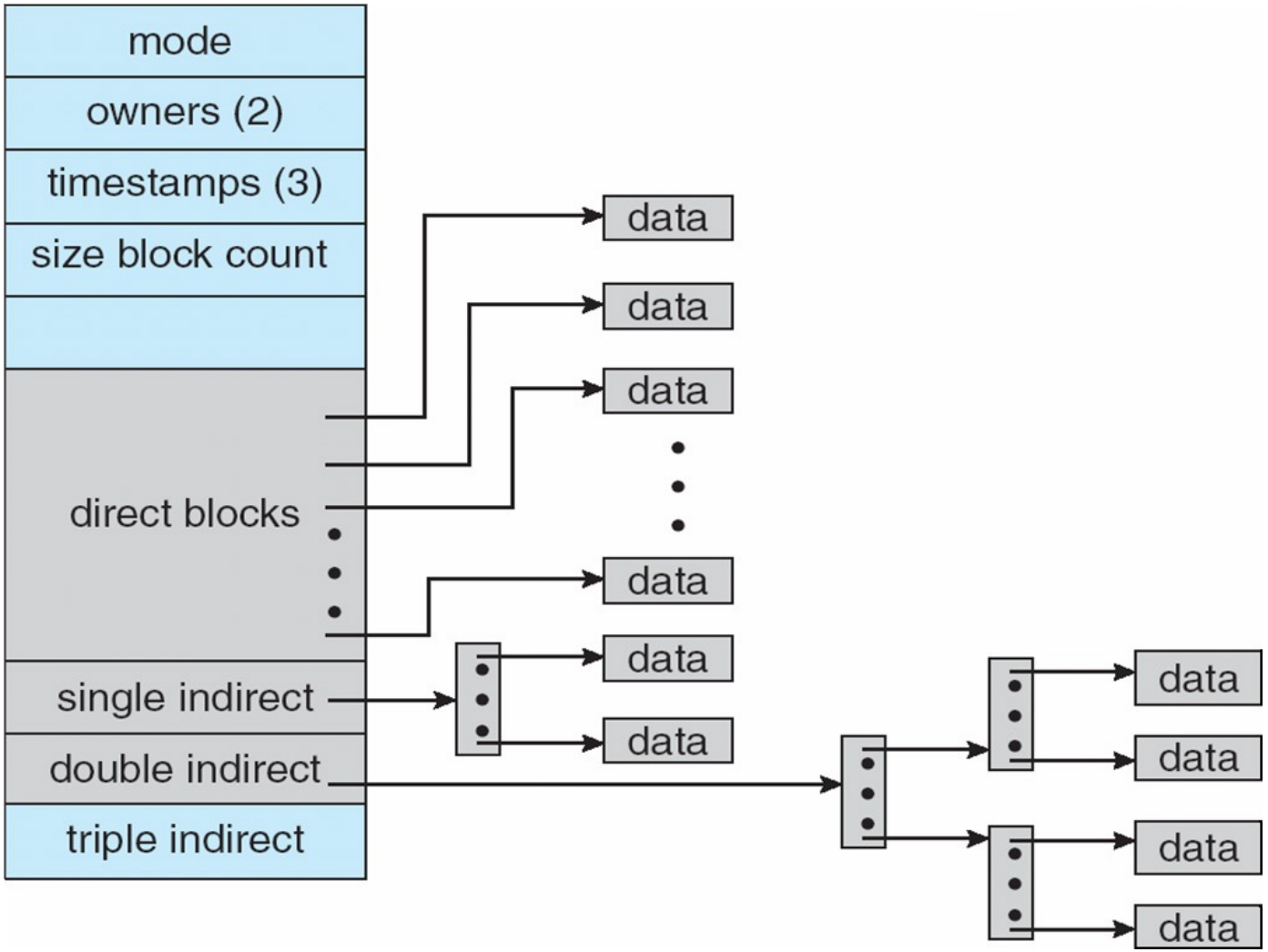


Mass-Storage Systems



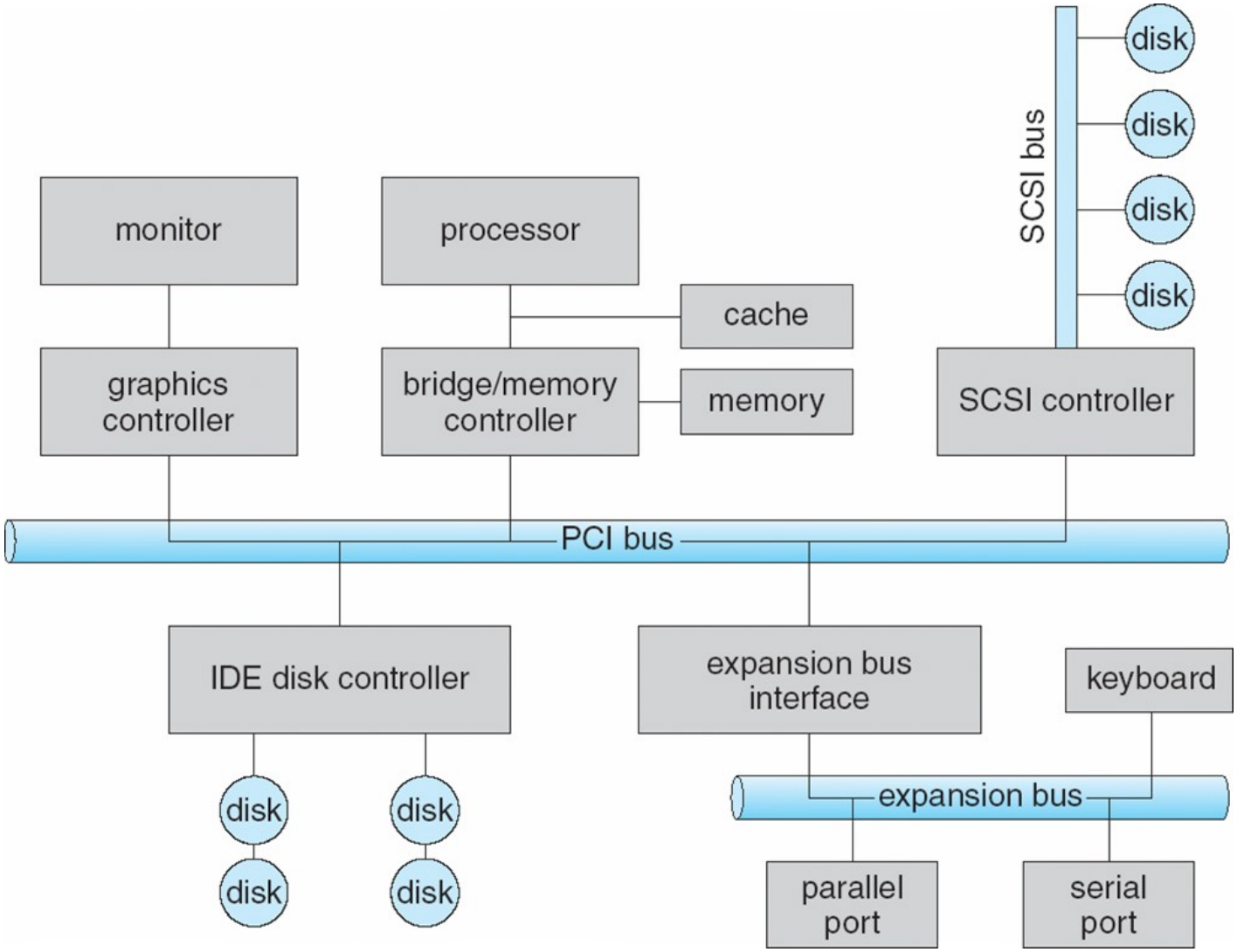
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	.....

File-System

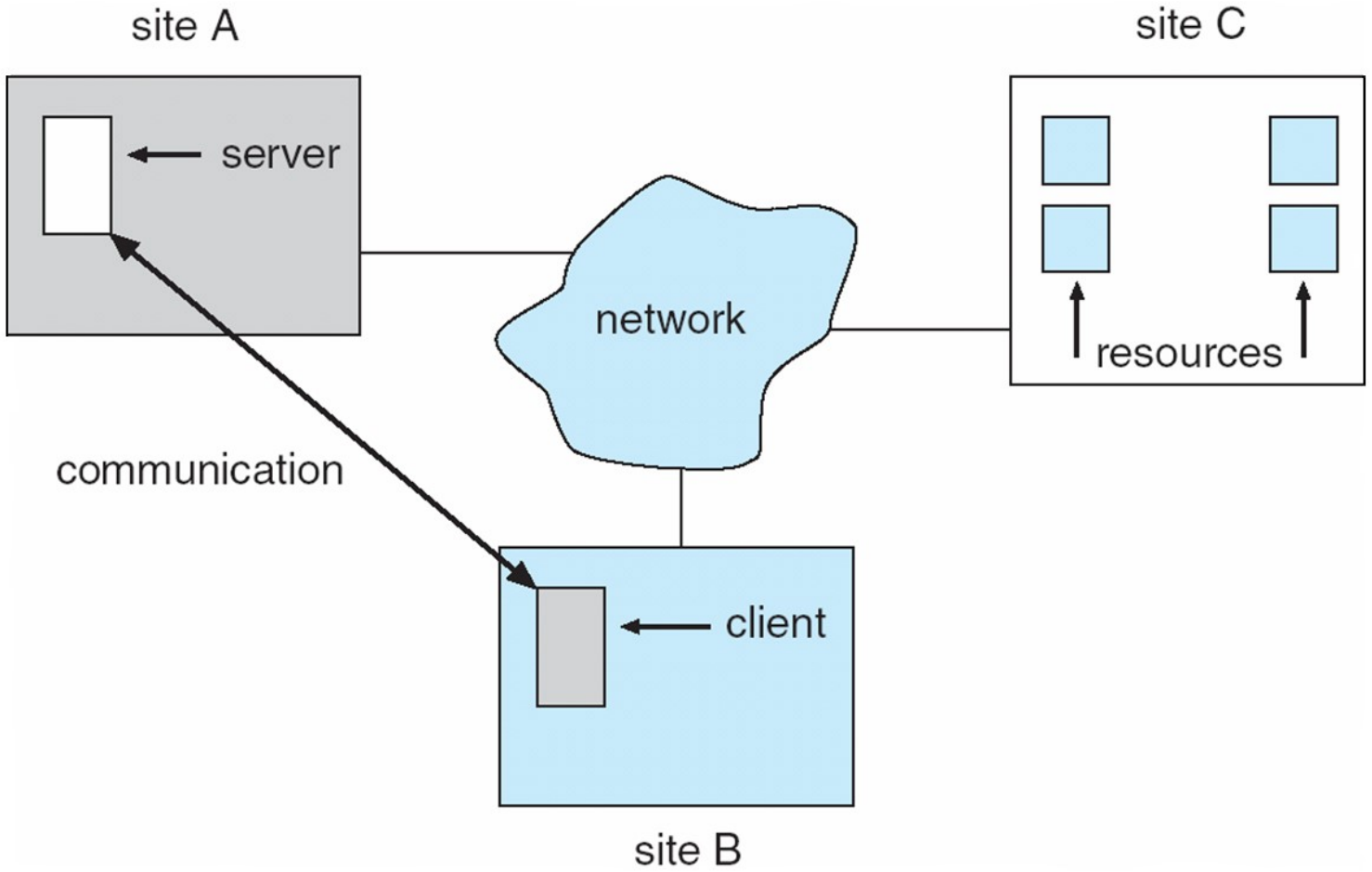


Combined Scheme with **UNIX I-node**

I/O Systems


monitor
processor
cache
graphics controller
bridge/memory controller
memory
SCSI bus
disk
disk
disk
disk
SCSI controller
PCI bus
IDE disk controller
expansion bus interface
keyboard
disk
disk
disk
disk
expansion bus
parallel port
serial port

Distributed System Structure



Homework

- Reading
  - Chapter 1: Introduction