Introduction

What is an Operating System?

- A program that acts as an intermediary between a user of a computer 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

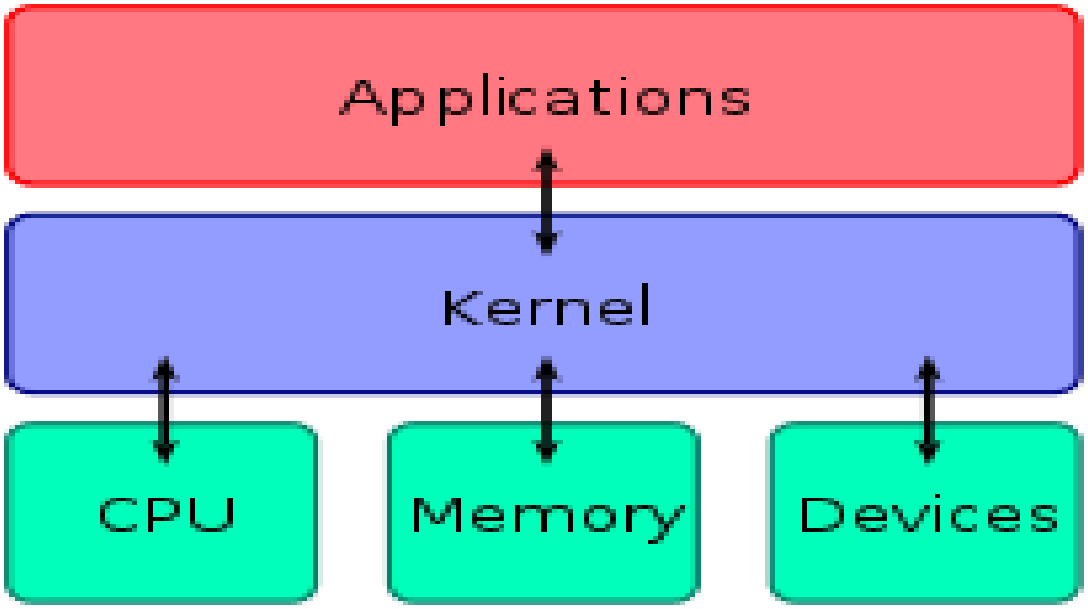
Operating System Definition (Cont.)

- No universally accepted definition
- "Everything a vendor ships when you order an operating system" is a 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.

Computer Startup

- **bootstrap program** is loaded at power-up or reboot
  - Typically stored in ROM or EPROM(erasable programmable read-only memory) , generally known as **firmware**
  - Initializes all aspects of system
  - Loads operating system kernel and starts execution

Kernel



A kernel connects the application software to the hardware of a computer.

Computer System Structure

- Computer system can be divided into four components:
  - Hardware – provides basic computing resources
    - CPU, memory, I/O devices
  - Operating system
    - Controls and coordinates use of hardware among various applications and users

Computer System Structure

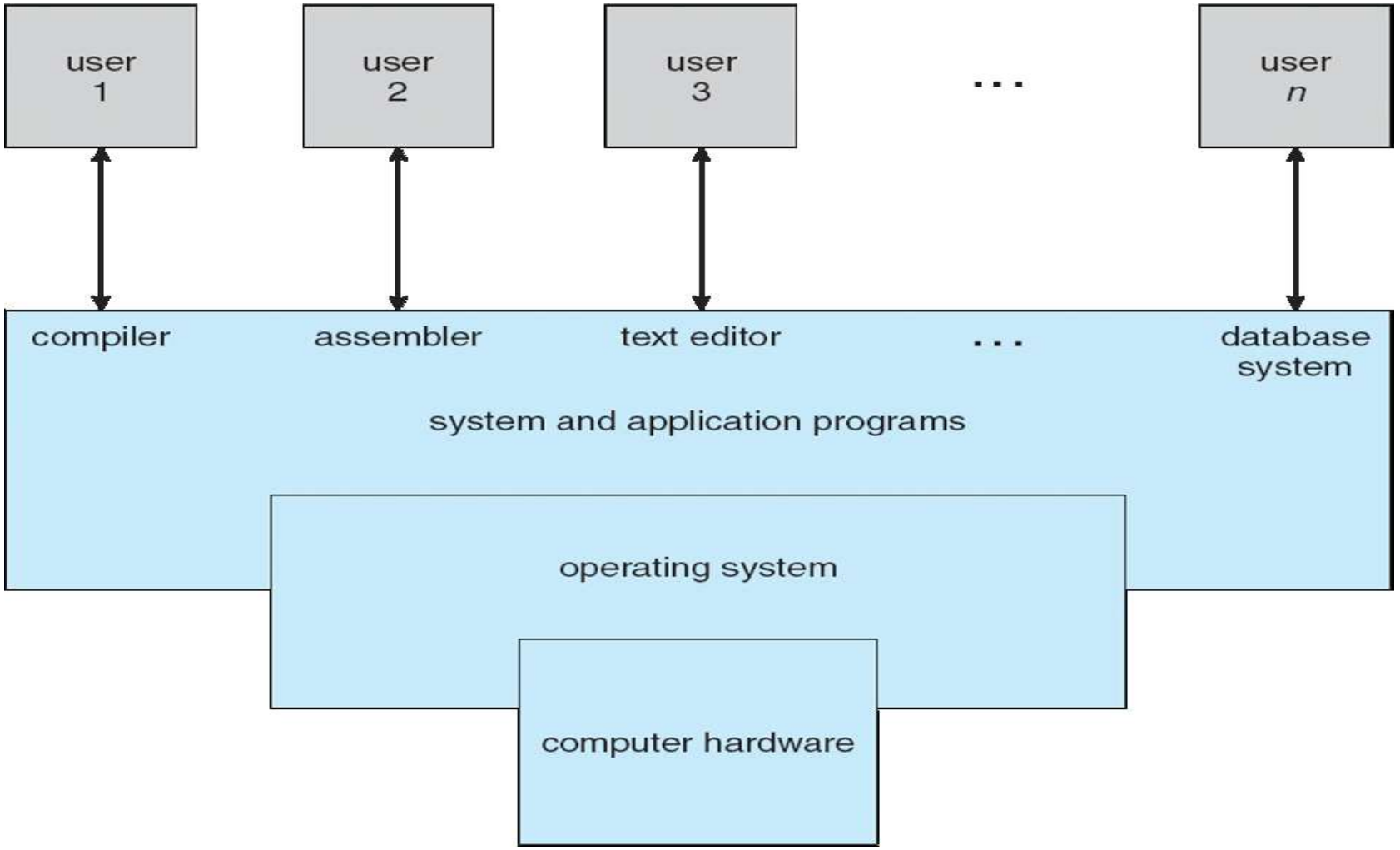
– Application programs – define the ways in which the system resources are used to solve the computing problems of the users

  - Word processors, compilers, web browsers, database systems, video games

-Users

  - People, machines, other computers

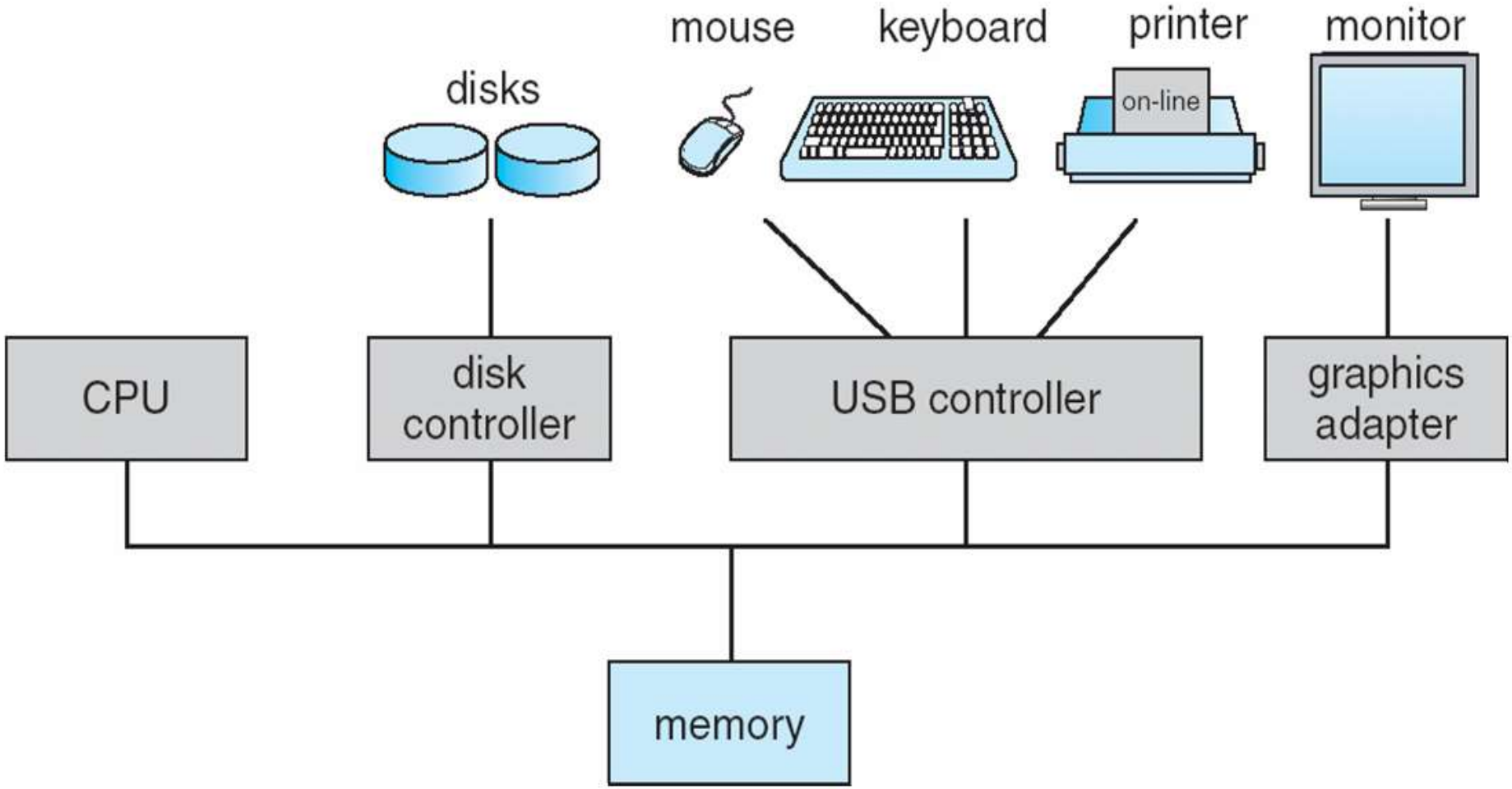
Four Components of a Computer System



Computer System Organization

- Computer-system operation
  - One or more CPUs, device controllers connect through common bus providing access to shared memory
  - Concurrent execution of CPUs and devices competing for memory cycles

Computer System Organization



Computer-System Operation

- I/O devices and the CPU can execute concurrently
- Each device controller is in charge of a particular device type
- Each device controller has a local buffer
- CPU moves data from/to main memory to/from local buffers
- I/O is from the device to local buffer of controller
- Device controller informs CPU that it has finished its operation by causing an interrupt

Common Functions of Interrupts

- Interrupt transfers control to the interrupt service routine generally, through the **interrupt vector**, which contains the addresses of all the service routines
- Interrupt architecture must save the address of the interrupted instruction
- A **trap** or **exception** is a software-generated interrupt caused either by an error or a user request
- An operating system is **interrupt driven**

Interrupt Handling

- The operating system preserves the state of the CPU by storing registers and the program counter
- Separate segments of code determine what action should be taken for each type of interrupt

Types of an Operating System

Batch operating system

- The users of a batch operating system do not interact with the computer directly.
- Each user prepares his job on an off-line device like punch cards and submits it to the computer operator.
- To speed up processing, jobs with similar needs are batched together and run as a group.
- The programmers leave their programs with the operator and the operator then sorts the programs with similar requirements into batches.

Time-sharing operating systems

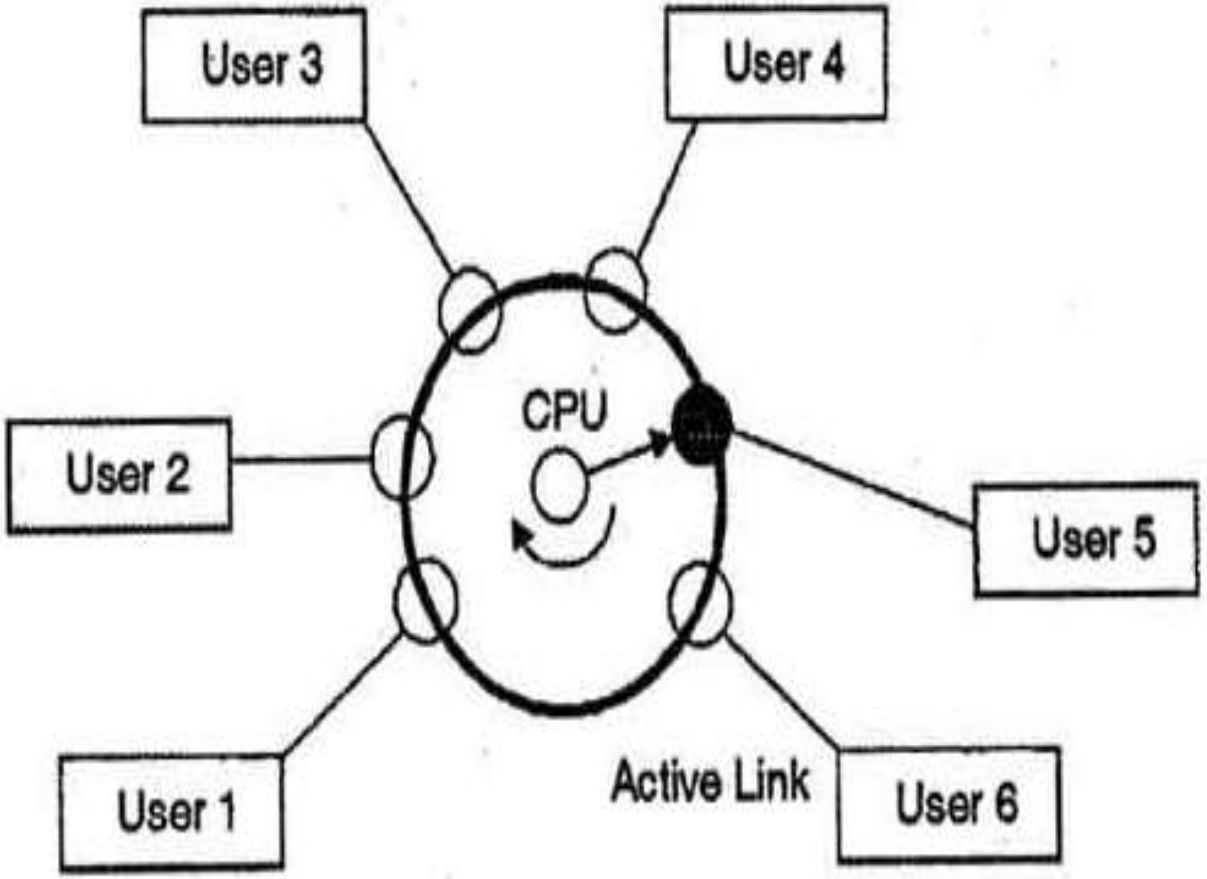
- Time-sharing is a technique which enables many people, located at various terminals, to use a particular computer system at the same time.
- Time-sharing or multitasking is a logical extension of multiprogramming.
- Processor's time which is shared among multiple users simultaneously is termed as time-sharing.

Time-sharing operating systems

- The main difference between Multi programmed Batch Systems and Time-Sharing Systems is that in case of Multi programmed batch systems,
- The objective is to maximize processor use, whereas in Time-Sharing Systems, the objective is to minimize response time.

Time-sharing operating systems

- The time sharing system provides the direct access to a large number of users where CPU time is divided among all the users on scheduled basis.
- The OS allocates a set of time to each user. When this time is expired, it passes control to the next user on the system.
- The time allowed is extremely small and the users are given the impression that they each have their own CPU and they are the sole owner of the CPU.
- This short period of time during that a user gets attention of the CPU; is known as a *time slice or a quantum.* The concept of time sharing system is shown in figure.

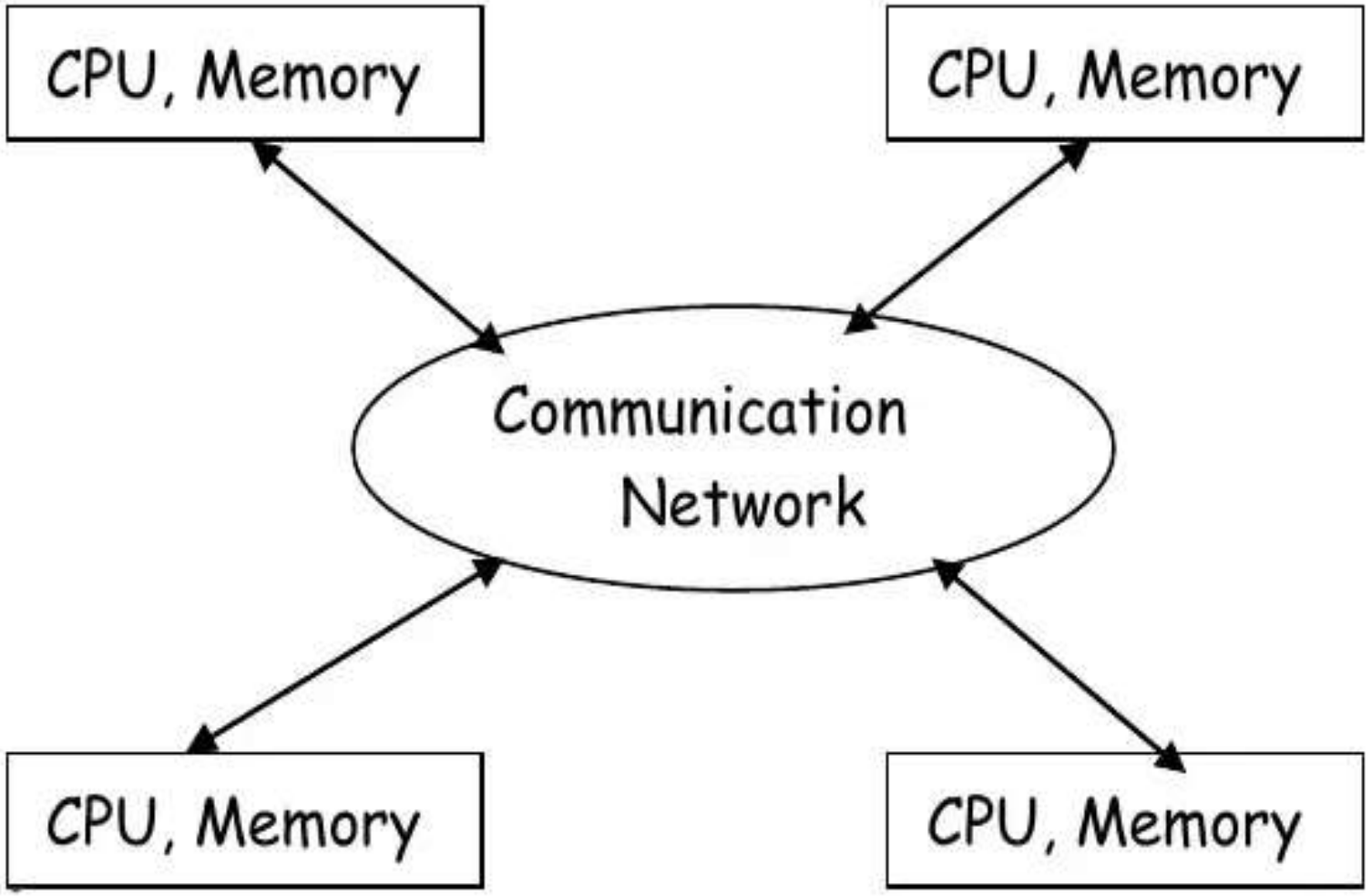

User 3
User 4
CPU
User 2
User 5
User 1
Active Link
User 6

Distributed operating System

- Distributed systems use multiple central processors to serve multiple real-time applications and multiple users.
- Data processing jobs are distributed among the processors accordingly.
- The processors communicate with one another through various communication lines (such as high-speed buses or telephone lines). These are referred as **loosely coupled systems** or distributed systems.
- Processors in a distributed system may vary in size and function

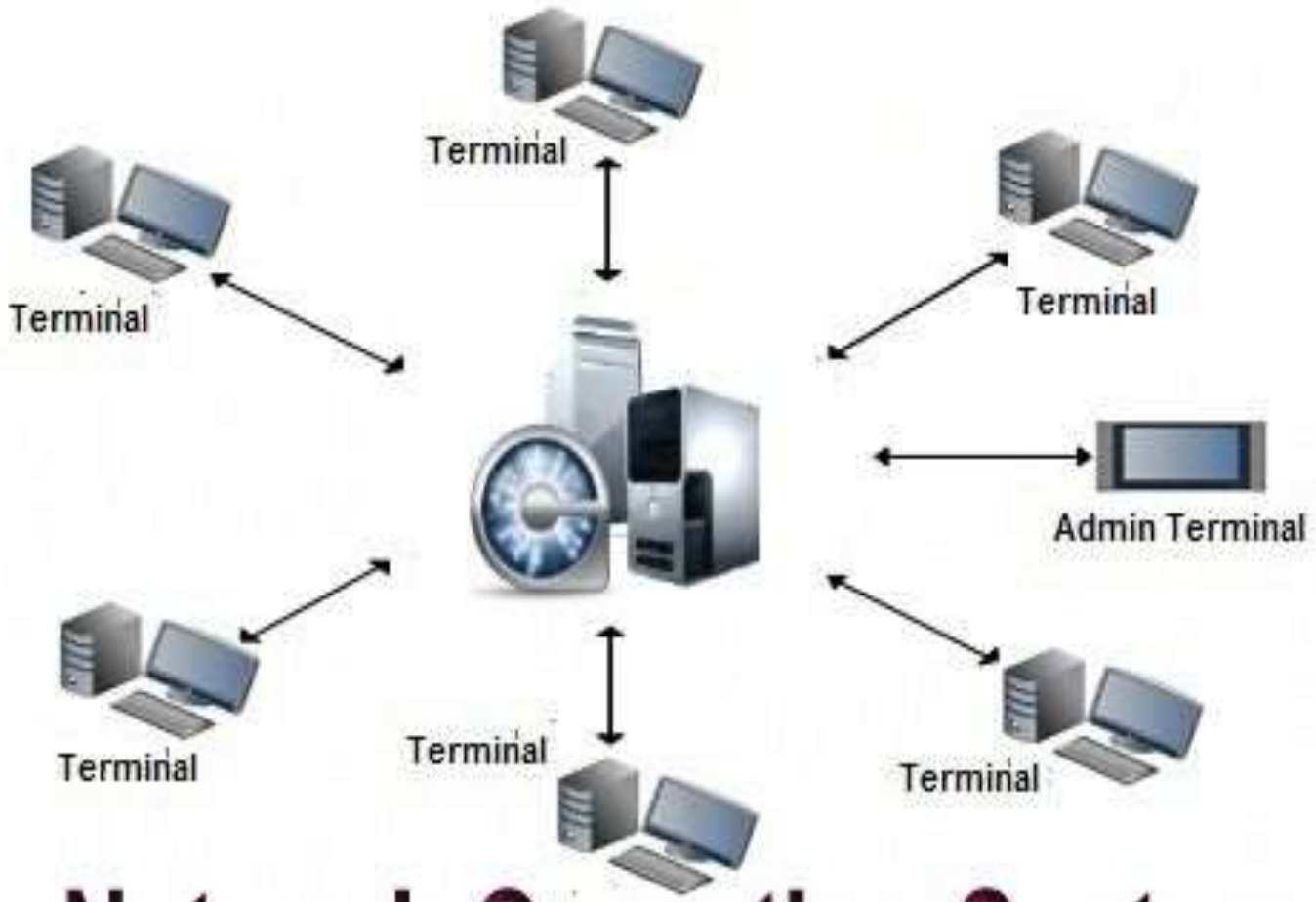
Distributed operating System

- These systems are referred as loosely coupled systems where each processor has its own local memory and processors communicate with one another through various communication lines, such as high speed buses or telephone lines.
- By loosely coupled systems, we mean that such computers possess no hardware connections at the CPU - memory bus level, but are connected by external interfaces that run under the control of software


CPU, Memory
CPU, Memory
Communication
Network
CPU, Memory
CPU, Memory

Network operating System

- **Network Operating System** is an operating system that includes special functions for connecting computers and devices into a local-area network (LAN) or Inter-network.
- A Network Operating System runs on a server and provides the server the capability to manage data, users, groups, security, applications, and other networking functions.
- The primary purpose of the network operating system is to allow shared file and printer access among multiple computers in a network, typically a local area network (LAN), a private network or to other networks.



Network Operating System

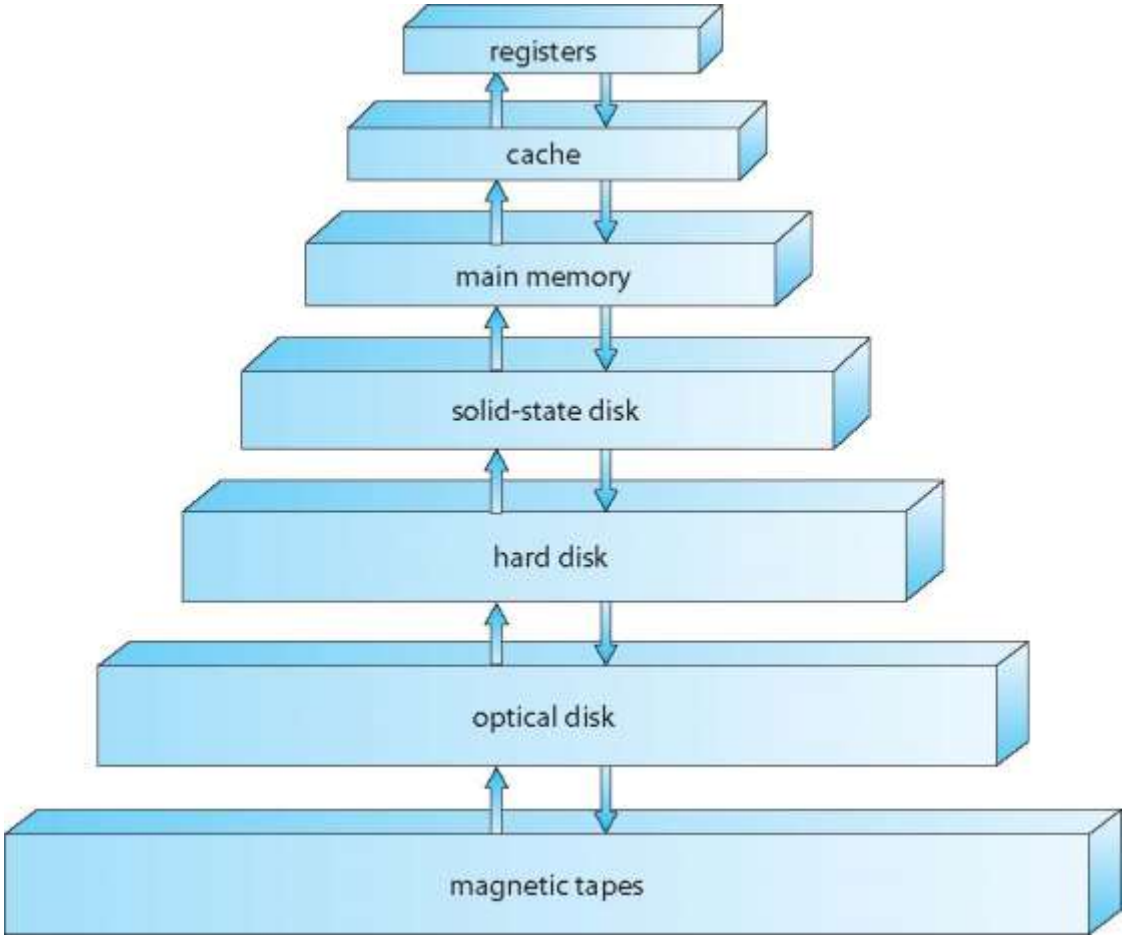
Storage Structure

- Main memory – only large storage media that the CPU can access directly(RAM)
  - **Random access**
  - Typically **volatile**
- Secondary storage – extension of main memory that provides large **nonvolatile** storage capacity
- Hard disks – rigid metal or glass platters covered with magnetic recording material
  - Disk surface is logically divided into **tracks**, which are subdivided into **sectors**
  - The **disk controller** determines the logical interaction between the device and the computer
- **Solid-state disks** – faster than hard disks, nonvolatile
  - Various technologies
  - Becoming more popular

Storage Hierarchy

- Storage systems organized in hierarchy
  - Speed
  - Cost
  - Volatility
- **Caching** – copying information into faster storage system; main memory can be viewed as a cache for secondary storage
- **Device Driver** for each device controller to manage I/O
  - Provides uniform interface between controller and kernel

Storage-Device Hierarchy



Caching

- Important principle, performed at many levels in a computer (in hardware, operating system, software)
- Information in use copied from slower to faster storage temporarily
- Faster storage (cache) checked first to determine if information is there
  - If it is, information used directly from the cache (fast)
  - If not, data copied to cache and used there
- Cache smaller than storage being cached
  - Cache management important design problem
  - Cache size and replacement policy

Direct Memory Access Structure

- Used for high-speed I/O devices able to transmit information at close to memory speeds
- Device controller transfers blocks of data from buffer storage directly to main memory without CPU intervention
- Only one interrupt is generated per block, rather than the one interrupt per byte