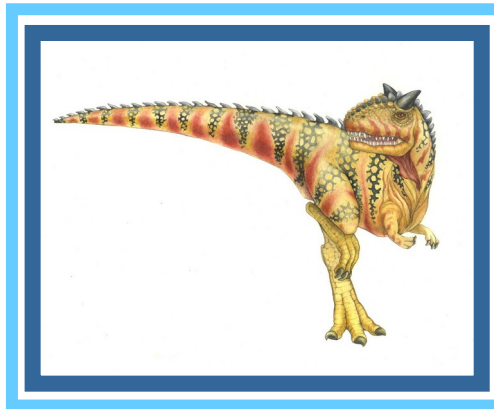


Chapter 1: Introduction





Chapter 1: Introduction

- What Operating Systems Do
- Computer-System Organization
- Computer-System Architecture
- Operating-System Structure
- Operating-System Operations
- Process Management
- Memory Management
- Storage Management
- Protection and Security
- Kernel Data Structures
- Computing Environments
- Open-Source Operating Systems





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





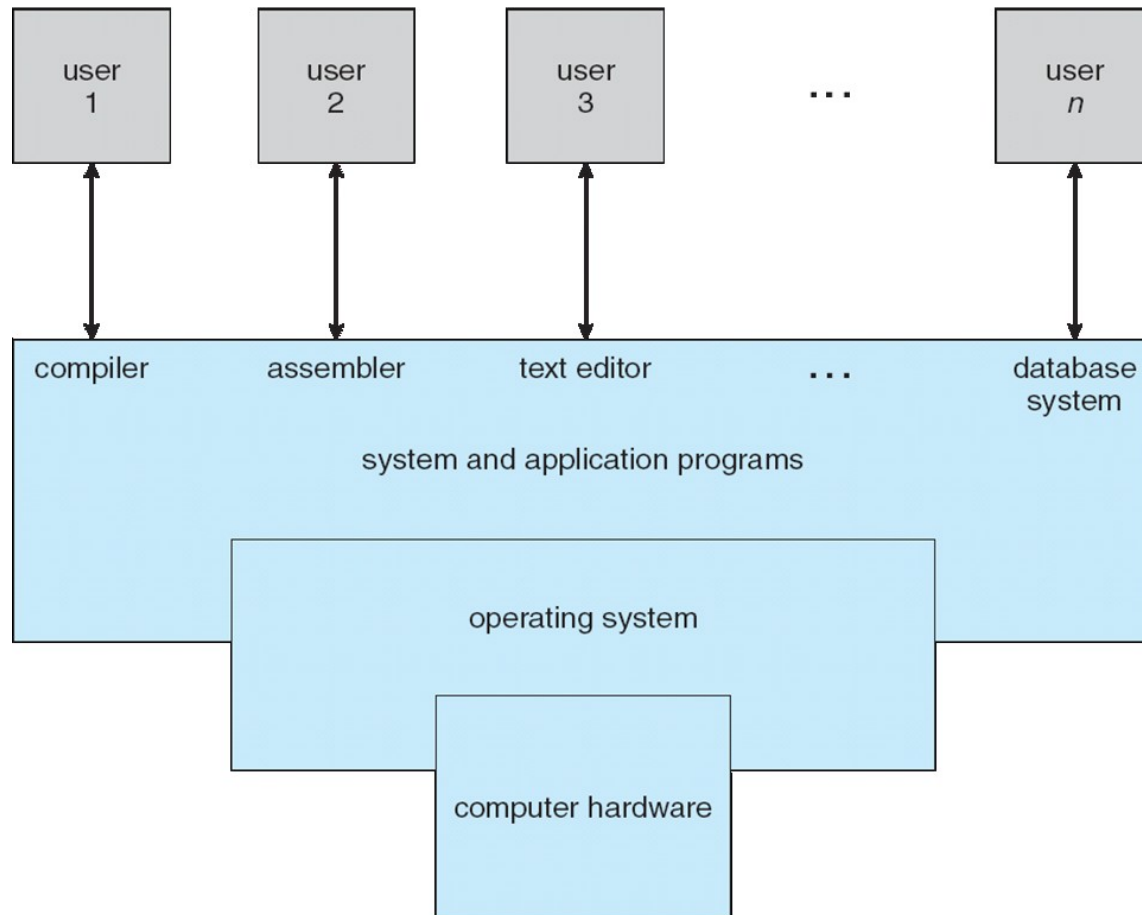
Computer System Structure

- 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
 - 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





What Operating Systems Do

- Depends on the point of view
- Users want convenience, **ease of use** and **good performance**
 - Don't care about **resource utilization**
- But shared computer such as **mainframe** or **minicomputer** must keep all users happy
- Users of dedicate systems such as **workstations** have dedicated resources but frequently use shared resources from **servers**
- Handheld computers are resource poor, optimized for usability and battery life
- Some computers have little or no user interface, such as embedded computers in devices and automobiles





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
- “The one program running at all times on the computer” is the **kernel**.
- Everything else is either
 - a system, or
 - an application program.





Computer Startup

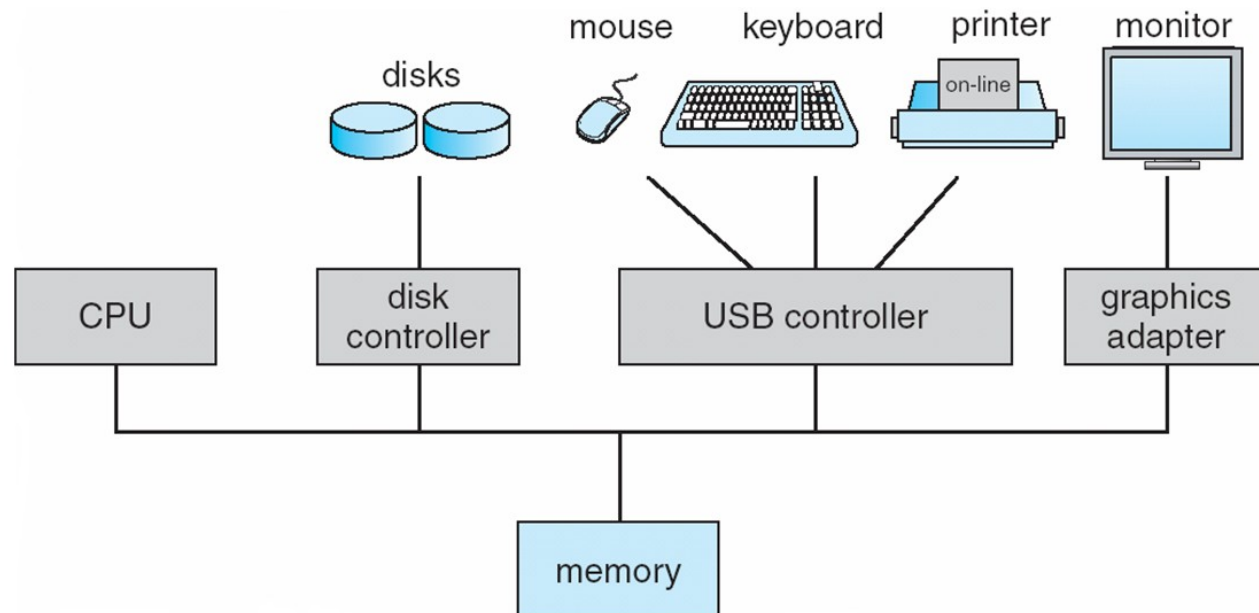
- **bootstrap program** is loaded at power-up or reboot
 - Typically stored in ROM or EPROM, generally known as **firmware**
 - Initializes all aspects of system
 - Loads operating system kernel and starts execution





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 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 (ISR) generally, through the **interrupt vector**, which contains the addresses of 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**





Storage Definitions and Notation Review

The basic unit of computer storage is the **bit**. A bit can contain one of two values, 0 and 1. All other storage in a computer is based on collections of bits. Given enough bits, it is amazing how many things a computer can represent: numbers, letters, images, movies, sounds, documents, and programs, to name a few. A **byte** is 8 bits, and on most computers it is the smallest convenient chunk of storage. For example, most computers don't have an instruction to move a bit but do have one to move a byte. A less common term is **word**, which is a given computer architecture's native unit of data. A word is made up of one or more bytes. For example, a computer that has 64-bit registers and 64-bit memory addressing typically has 64-bit (8-byte) words. A computer executes many operations in its native word size rather than a byte at a time.

Computer storage, along with most computer throughput, is generally measured and manipulated in bytes and collections of bytes.

A **kilobyte**, or **KB**, is $1,024$ bytes

a **megabyte**, or **MB**, is $1,024^2$ bytes

a **gigabyte**, or **GB**, is $1,024^3$ bytes

a **terabyte**, or **TB**, is $1,024^4$ bytes

a **petabyte**, or **PB**, is $1,024^5$ bytes

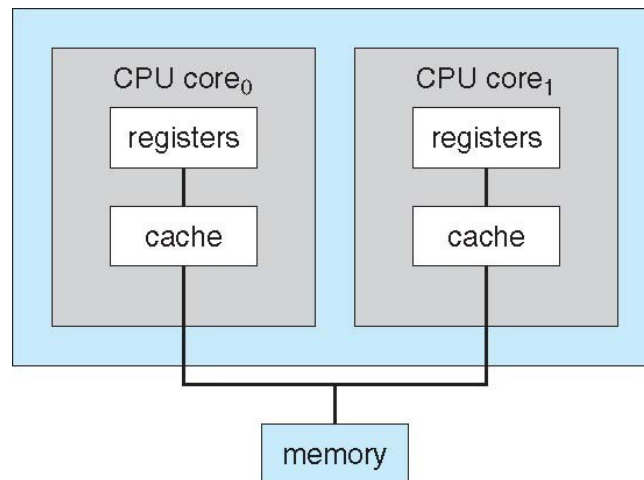
Computer manufacturers often round off these numbers and say that a megabyte is 1 million bytes and a gigabyte is 1 billion bytes. Networking measurements are an exception to this general rule; they are given in bits (because networks move data a bit at a time).





A Dual-Core Design

- Multi-chip and **multicore**
- Systems containing all chips
 - Chassis containing multiple separate systems





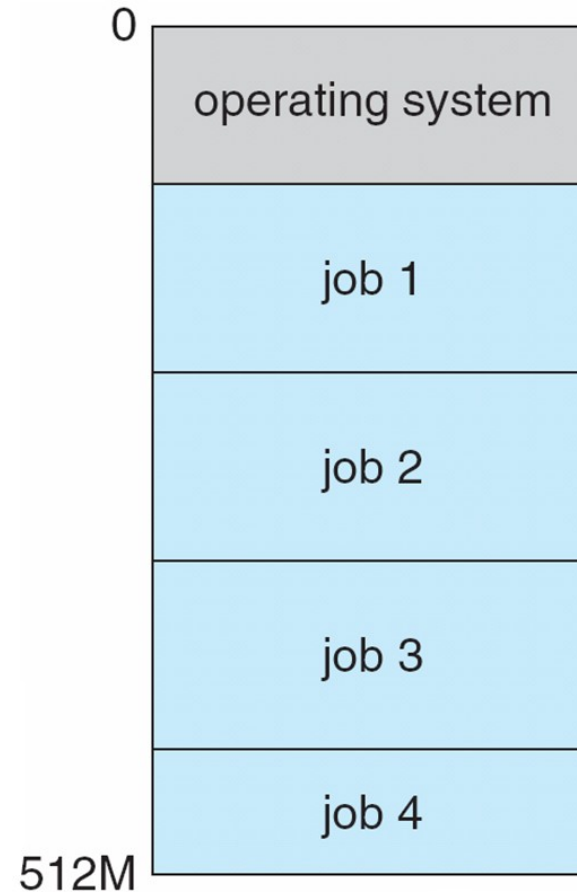
Operating System Structure

- **Multiprogramming (Batch system)** needed for efficiency
 - Single user cannot keep CPU and I/O devices busy at all times
 - Multiprogramming organizes jobs (code and data) so CPU always has one to execute
 - A subset of total jobs in system is kept in memory
 - One job is selected and run via **job scheduling**
 - When it has to wait (say, for I/O), OS switches to another job
- **Timesharing (multitasking)** is logical extension in which CPU switches jobs so frequently that users can interact with each job while it is running, creating **interactive** computing
 - **Response time** should be < 1 second
 - Each user has at least one program executing in memory □ **process**
 - If several jobs are ready to run at the same time □ **CPU scheduling**
 - If processes don't fit in memory, **swapping** moves them in and out to run
 - **Virtual memory** allows execution of processes not completely in memory





Memory Layout for Multiprogrammed System





Operating-System Operations

- **Interrupt driven** (hardware and software)
 - Hardware interrupt by one of the devices
 - Software interrupt (**exception** or **trap**):
 - ▶ Software error (e.g., division by zero)
 - ▶ Request for operating system service
 - ▶ Other process problems include infinite loop, processes modifying each other or the operating system





Operating-System Operations (cont.)

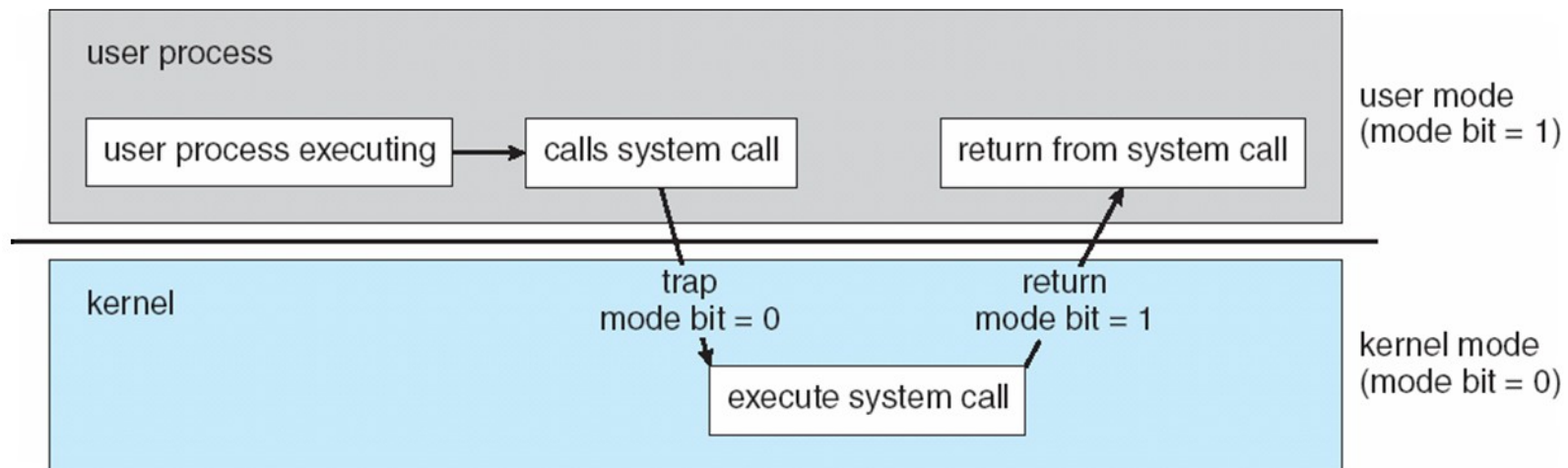
- **Dual-mode** operation allows OS to protect itself and other system components
 - **User mode** and **kernel mode**
 - **Mode bit** provided by hardware
 - ▶ Provides ability to distinguish when system is running user code or kernel code
 - ▶ Some instructions designated as **privileged**, are only executable in kernel mode
 - ▶ System call changes mode to kernel, return from call resets it to user
- Increasingly CPUs support multi-mode operations
 - i.e. **virtual machine manager (VMM)** mode for guest **VMs**





Transition from User to Kernel Mode

- Timer to prevent infinite loop / process hogging resources
 - Timer is set to interrupt the computer after some time period
 - Keep a counter that is decremented by the physical clock.
 - Operating system set the counter (privileged instruction)
 - When counter zero generate an interrupt
 - Set up before scheduling process to regain control or terminate program that exceeds allotted time



End of Chapter 1

