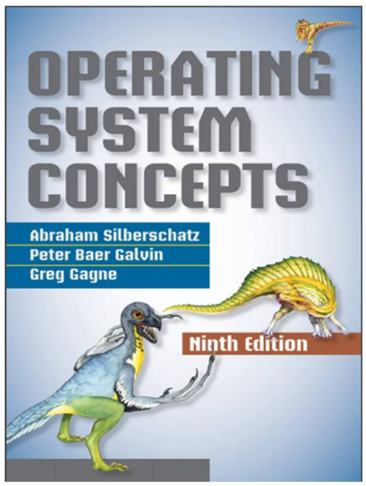
Introduction to Operating System

Contents of Lecture:

- What is an Operating System?
- Operating-System components
- What Operating Systems Do
- Computer-System Organization
- Computer-System Structure
- Operating-System Operations
- Process Management
- Memory Management
- Storage Management

References for course:

- ✓ *Abraham Silberschatz, Peter Bear Galvin and Greg Gagne,* ***Operating System Concepts****, 9th Edition*



References for This Lecture:

- ✓ *Abraham Silberschatz, Peter Bear Galvin and Greg Gagne, Operating System Concepts, 9th Edition,* ***Chapter 1***

What is an Operating System?

- An operating system is a program that manages a computer's hardware. It also provides a basis for application programs and 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

Computer System components

- A computer system can be divided into four components: the ***hardware***, the ***operating system***, the ***application programs***, and the ***users*** (next figure (Figure 1.1)).

  - ✓ **The hardware**:
    The central processing unit (CPU), the memory, and the input/output (I/O) devices provides the basic computing resources for the system.
  - ✓ The **application programs**:
    Such as word processors, spreadsheets, compilers, and Web browsers define the ways in which these resources are used to solve users' computing problems.
  - ✓ The **operating system:**
    Controls the hardware and coordinates its use among the various application programs for the various users.
  - ✓ **Users**
    People, machines, other computers

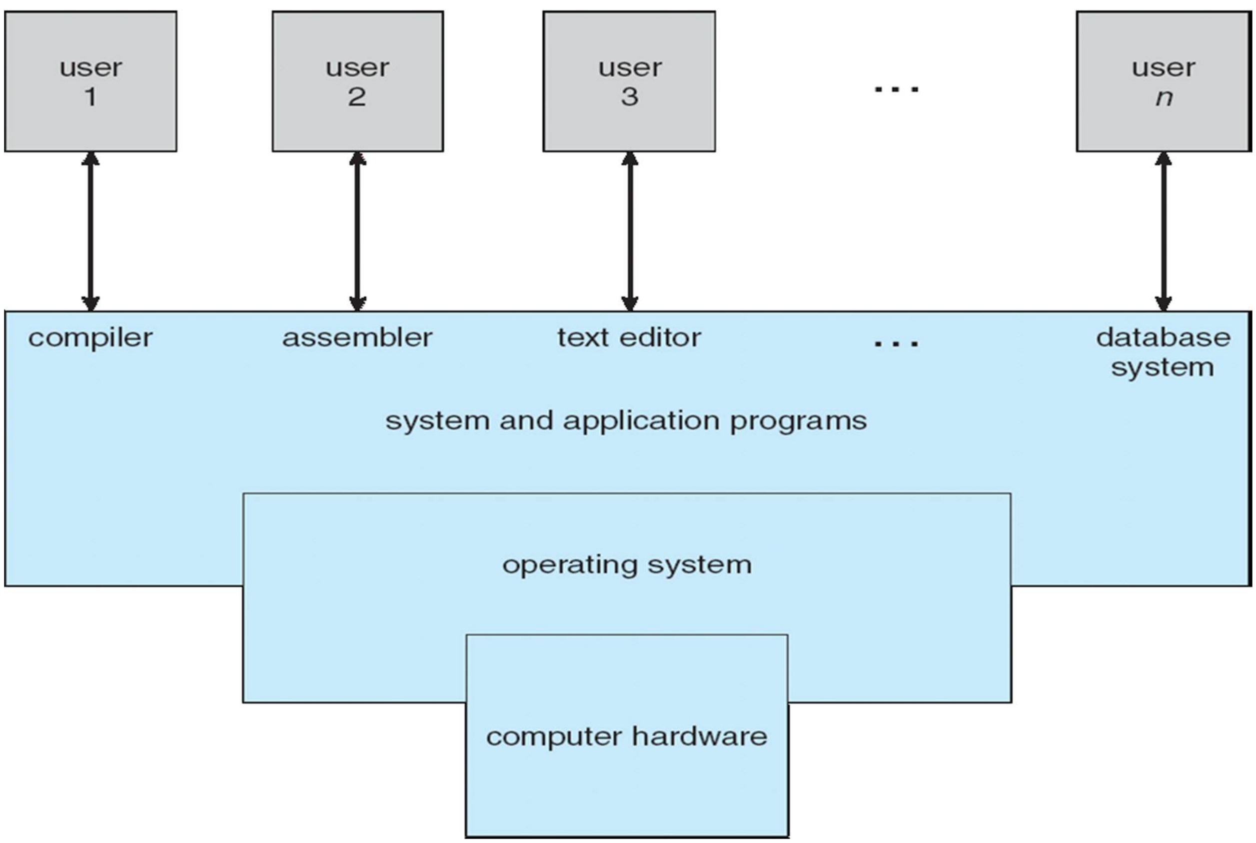


Figure 1.1 Abstract view of the components of a computer system.

What Operating Systems Do

Depends on the point of view

- **User 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
- **System view:**
  - ✓ 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

Computer-System Organization

Computer-system operation

- A general-purpose computer system consists of one or more CPUs and a number of device controllers connected through a common bus that provides access to shared memory (next figure(Figure 1.2)).

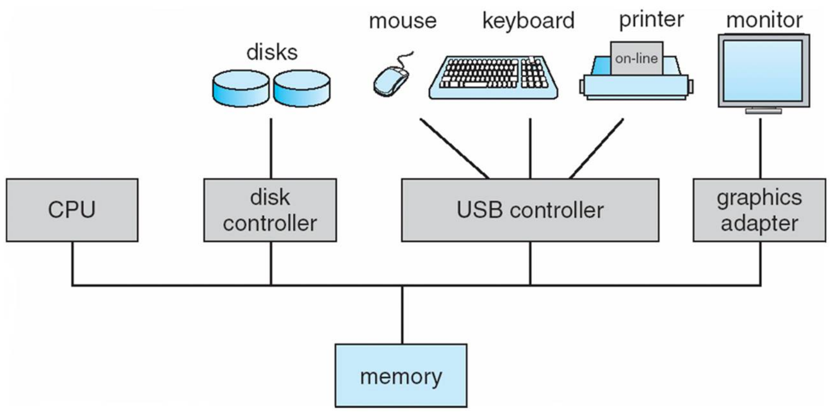


Figure 1.2 A modern computer system.

- Each device controller is in charge of a specific type of device (for example, disk drives, audio devices, or video displays), and 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
- Concurrent execution of CPUs and devices competing for memory cycles

Computer-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 selected and run via **job scheduling**
- ✓ When it has to wait (for I/O for example), OS switches to another job

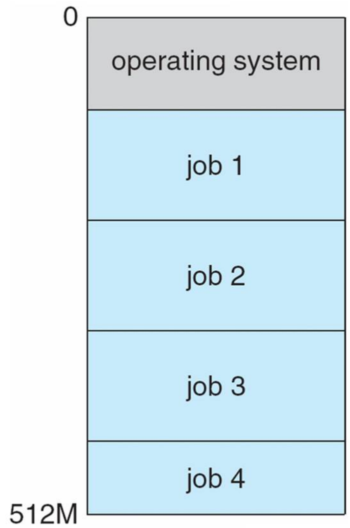


Figure 1.9 Memory layout for a multiprogramming system.

❖ **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 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

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

- **Dual-mode** operation allows OS to protect itself and other system components
    - ✓ **User mode** and **kernel mode** (also called supervisor mode, system mode or privileged mode)
    - ✓ **Mode bit** provided by hardware
        - Provides ability to distinguish when system is running user code or kernel code
        - Some instructions designated as **privileged**, 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

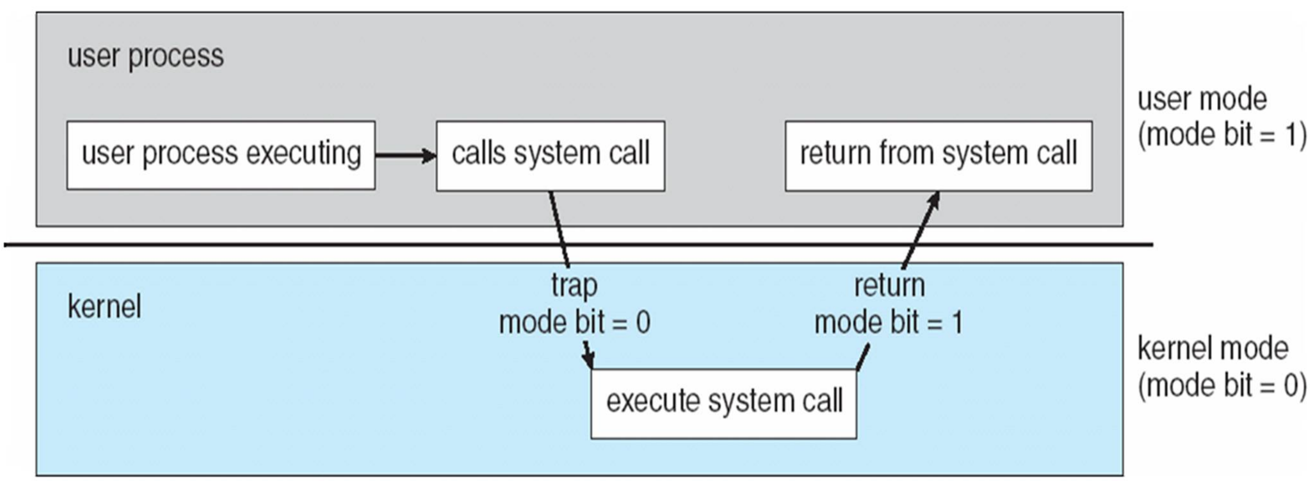


Figure 1.10 Transition from user to kernel mode

Process Management

- ❖ A process is a program in execution. It is a unit of work within the system. Program is a ***passive entity***, process is an ***active entity***.

- ❖ Process needs resources to accomplish its task
  - ✓ CPU, memory, I/O, files
  - ✓ Initialization data

- ❖ Process termination requires reclaim of any reusable resources
- ❖ Single-threaded process has one **program counter** specifying location of next instruction to execute
  - ✓ Process executes instructions sequentially, one at a time, until completion

- ❖ Multi-threaded process has one program counter per thread
- ❖ Typically system has many processes, some user, some operating system running concurrently on one or more CPUs
  - ✓ Concurrency by multiplexing the CPUs among the processes / threads

Process Management Activities

- ❖ The operating system is responsible for the following activities in connection with process management:
  - ✓ Creating and deleting both user and system processes
  - ✓ Suspending and resuming processes
  - ✓ Providing mechanisms for process synchronization
  - ✓ Providing mechanisms for process communication
  - ✓ Providing mechanisms for deadlock handling
  - ✓ Memory Management

Memory Management

- ❖ To execute a program all (or part) of the instructions must be in memory
- ❖ All (or part) of the data that is needed by the program must be in memory.
- ❖ Memory management determines what is in memory and when
  - ✓ Optimizing CPU utilization and computer response to users
- ❖ Memory management activities
  - ✓ Keeping track of which parts of memory are currently being used and by whom
  - ✓ Deciding which processes (or parts thereof) and data to move into and out of memory
  - ✓ Allocating and deallocating memory space as needed

Storage Management

- OS provides uniform, logical view of information storage
    - Abstracts physical properties to logical storage unit - **file**
    - Each medium is controlled by device (i.e., disk drive, tape drive)
        - Varying properties include access speed, capacity, data-transfer rate, access method (sequential or random)

- File-System management
    - Files usually organized into directories
    - Access control on most systems to determine who can access what
    - OS activities include
        - Creating and deleting files and directories
        - Primitives to manipulate files and directories
        - Mapping files onto secondary storage
        - Backup files onto stable (non-volatile) storage media

Mass-Storage Management

- Usually disks used to store data that does not fit in main memory or data that must be kept for a "long" period of time
- Proper management is of central importance
- Entire speed of computer operation depend on disk subsystem and its algorithms

- OS activities
    - Free-space management
    - Storage allocation
    - Disk scheduling

- Some storage need not be fast
    - Tertiary storage includes optical storage, magnetic tape
    - Still must be managed – by OS or applications
    - Varies between WORM (write-once, read-many-times) and RW (read-write)

I/O Subsystem

- One purpose of OS is to hide properties of hardware devices from the user
- I/O subsystem responsible for
    - Memory management of I/O including buffering (storing data temporarily while it is being transferred), caching (storing parts of data in faster storage for performance), spooling (the overlapping of output of one job with input of other jobs)
    - General device-driver interface
    - Drivers for specific hardware devices