BASICS OF OPERATING SYSTEMS

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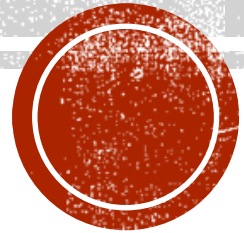
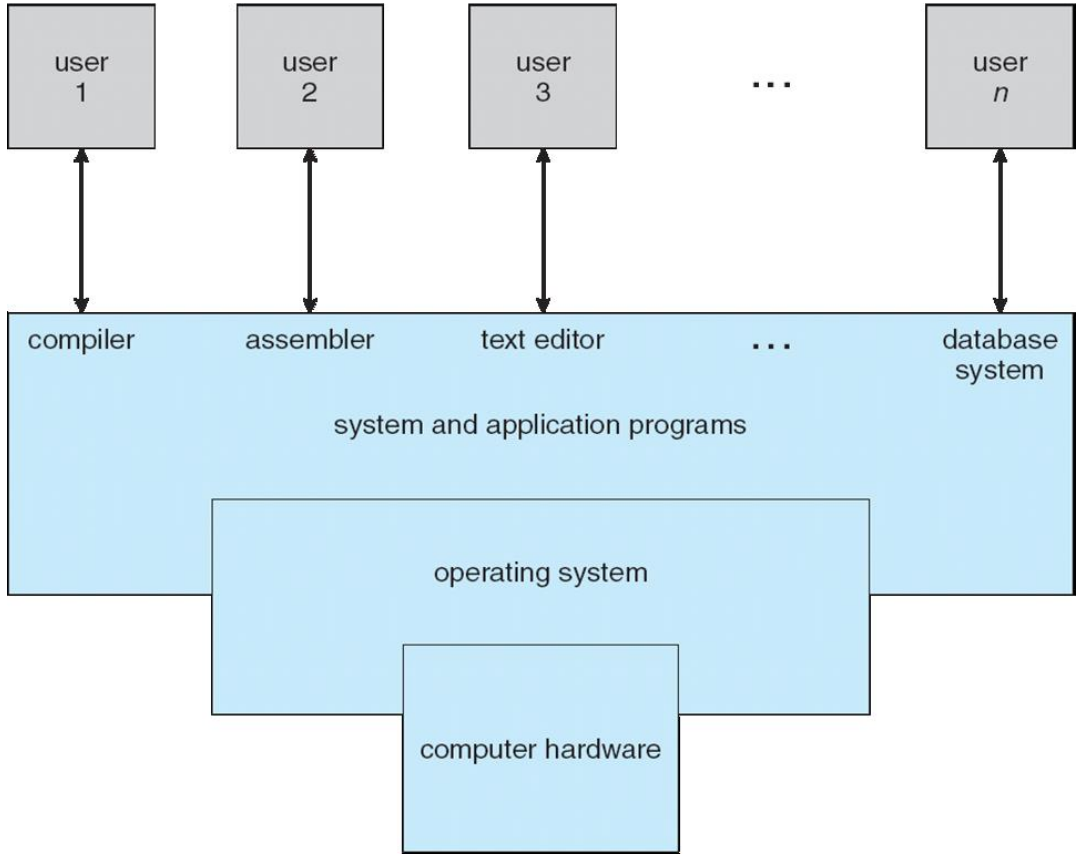


COMPUTER SYSTEM STRUCTURE

- 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

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**
- Users of dedicate systems such as **workstations** have dedicated resources but frequently use shared resources from **servers**
- Some computers have little or no user interface, such as embedded computers in devices and automobiles

WHAT IS AN OPERATING SYSTEM?

- **most important software** that runs on a computer.
- manages the computer's **memory** and **processes**, as well as all of its **software** and **hardware**.
- allows you to **communicate** with the computer.
- ***"Without an operating system, a computer is useless."***

CONTD..

- 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 STARTUP

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

PS: A **kernel** is the central part of an operating system. It manages the operations of the computer and the hardware, most notably memory and CPU time. There are five types of **kernels**: A micro **kernel**, which only contains basic functionality; A monolithic **kernel**, which contains many device drivers.

OPERATING SYSTEM'S JOB

- Computer's **operating system** (**OS**) manages all of the **software** and **hardware** on the computer. Most of the time, there are several different computer programs running at the same time, and they all need to access your computer's **central processing unit (CPU)**, **memory**, and **storage**. The operating system coordinates all of this to make sure each program gets what it needs.

TYPES OF PRE-LOADED OPERATING SYSTEMS

- usually come **pre-loaded,** but possible to upgrade or even change operating systems.
- three most common operating systems for personal computers are:
  - **Microsoft Windows**,
  - **macOS**, and
  - **Linux**.

PS: Modern operating systems use a **graphical user interface**. A GUI lets you use your mouse to click **icons**, **buttons**, and **menus**, and everything is clearly displayed on the screen using a combination of **graphics** and **text**.

THE THREE ELEMENTS OF AN OS

- User Interface – The part of the OS that you interface with.
- Kernel – The core of the OS. Interacts with the BIOS (at one end), and the UI (at the other end).
- File Management System – Organizes and manages files.

OPERATING SYSTEM FUNCTIONS

- File Management
- Application Management
- Built-in Utility Programs
- Control of Computer Hardware

OPERATING SYSTEM TYPES

- Multiuser – Two or more users work with the computer at the same time
  - A multi-user operating system (OS) is a **computer** system that allows multiple users that are on different computers to access a single system's OS resources simultaneously.
- Multitasking – Two or more processes running at the same time.
  - also known as Time-sharing **systems**.
  - uses the concept of CPU scheduling and multiprogramming to provide each user with a small portion of a time-shared CPU.
- Multithreading – Two or more parts of the same process running at the same time.
  - similar to multitasking, but enables the processing of **multiple threads** at one time, rather than multiple processes.
  - A multithreaded program contains two or more parts that can run concurrently. Each such part of a program called **thread** (consisting of a program counter, a stack, and a set of registers).

FILE SYSTEM

- A *file* is a collection of bytes of information treated as a single unit.
- It is given a *name* to make it easy to find and use later.
- The *file system* keeps track of where a file is actually resident on a disk.
- A disk (hard disk, floppy, optical disk) is subdivided into *directories* or *folders*.

CONTD..

- The top level folder on a disk is known as the *root*.
- The root is generally subdivided into *subfolders*.
- Any folder or subfolder can contain files and other folders.
- The *fully-qualified filename* includes the name of the file and the *path* to the folder in which it resides:

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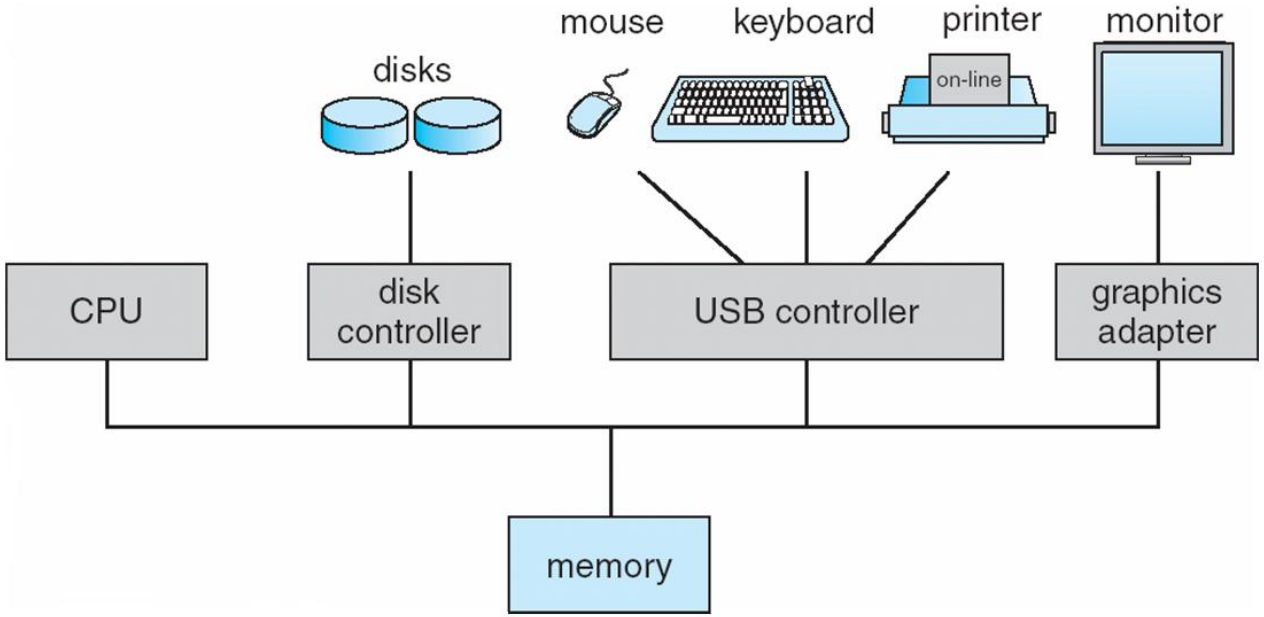
COMPUTER SYSTEM ORGANIZATION

- 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 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**

STORAGE STRUCTURE

- Main memory – only large storage media that the CPU can access directly
  - **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

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

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

- 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