OPERATING SYSTEM

Mr. MLELI

What is operating system?

- An operating system is the most important software that runs on a computer. It manages the computer's memory and processes, as well as all of its software and hardware. It also allows you to communicate with the computer without knowing how to speak the computer's language. Without an operating system, a computer is useless.
- Your 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.
- It acts as an intermediary between a user and computer hardware and provides an environment required to execute different programs efficiently.

Operating System cont.....

- Operating systems usually come pre-loaded on any computer you buy. Most people use the operating system that comes with their computer, but it's possible to upgrade or even change operating systems. The three most common operating systems for personal computers are Microsoft Windows, macOS, and Linux.
- Modern operating systems use a graphical user interface (GUI) . 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.

Functions of Operating System

I. Processor Management: In a multi-programming environment, the OS decides the order in which processes have access to the processor, and how much processing time each process has. This function of OS is called Process Scheduling. An Operating System performs the following activities for Processor Management.

An operating system manages the processor's work by allocating various jobs to it and ensuring that each process receives enough time from the processor to function properly.

Keeps track of the status of processes. The program which performs this task is known as a traffic controller. Allocates the CPU that is a processor to a process. De-allocates processor when a process is no longer required.

II. Memory Management: The operating system manages the Primary Memory or Main Memory. Main memory is made up of a large array of bytes or words where each byte or word is assigned a certain address. Main memory is fast storage and it can be accessed directly by the CPU. For a program to be executed, it should be first loaded in the main memory. An operating system manages the allocation and deallocation of memory to various processes and ensures that the other process does not consume the memory allocated to one process. An Operating System performs the following activities for Memory Management.

- It keeps track of primary memory, i.e., which bytes of memory are used by which user program
- In multiprogramming, the OS decides the order in which processes are granted memory access, and for how long.
- It Allocates the memory to a process when the process requests it and deallocates the memory when the process has terminated.

III. Device Management: An OS manages device communication via its respective drivers. It performs the following activities for device management. Keeps track of all devices connected to the system. designates a program responsible for every device known as the Input/Output controller. Decide which process gets access to a certain device and for how long. Allocates devices effectively and efficiently. Deallocates devices when they are no longer required. There are various input and output devices. an OS controls the working of these input-output devices. It receives the requests from these devices, performs a specific task, and communicates back to the requesting process.

- **File Management:** A file system is organized into directories for efficient or easy navigation and usage. These directories may contain other directories and other files. An Operating System carries out the following file management activities. It keeps track of where information is stored, user access settings, the status of every file, and more. These facilities are collectively known as the file system. An OS keeps track of information regarding the creation, deletion, transfer, copy, and storage of files in an organized way. It also maintains the integrity of the data stored in these files, including the file directory structure, by protecting against unauthorized access.

Functions of Operating System Cont……

V. **Security:** The operating system uses password protection to protect user data and similar other techniques. it also prevents unauthorized access to programs and user data. The operating system provides various techniques which assure the integrity and confidentiality of user data. Following security measures are used to protect user data;

- Protection against unauthorized access through login.
- Protection against intrusion by keeping Firefall active.
- Protecting the system memory against malicious access.
- Displaying messages related to system vulnerabilities

Functions of Operating System Cont……

VI. **Error Detection:** The operating system constantly monitors the system to detect errors and avoid malfunctioning computer systems. From time to time, the operating system checks the system for any external threat or malicious software activity. It also checks the hardware for any type of damage. This process displays several alerts to the user so that the appropriate action can be taken against any damage caused to the system.

VII. **Job Scheduling:** In a multitasking operating system where multiple programs run simultaneously, the operating system determines which applications should run in which order and how time should be allocated to each application.

Components of Operating System

In order for the operating system to perform the functions mentioned above, the operating system needs two core components:

I. Shell
II. Kernel

Shell

Shell handles user interactions. It is the outermost layer of the operating system and manages the interaction between user and operating system. It also serves as the user interface, allowing the user to interact with the operating system by interpreting their commands and facilitating communication with the kernel.

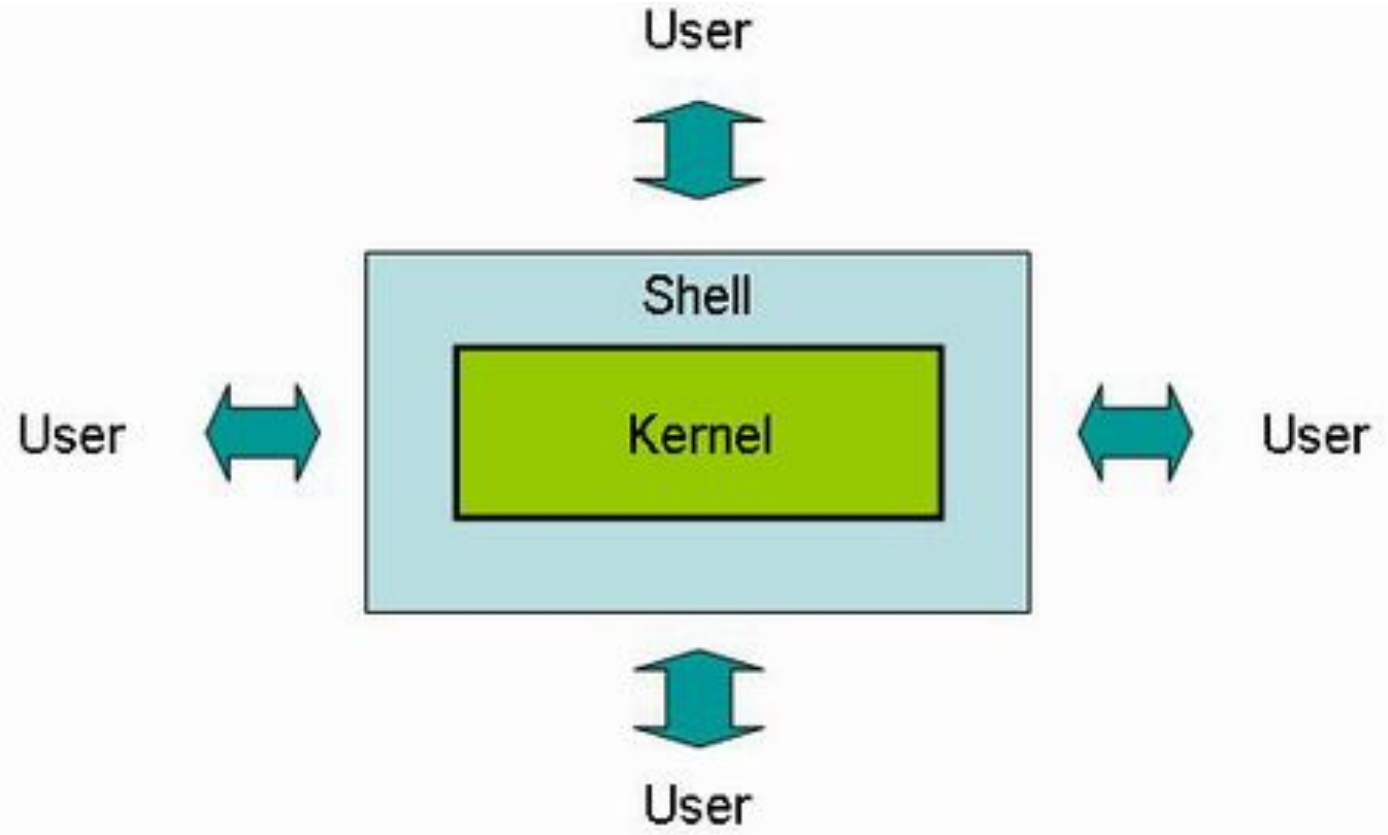
It allowing the user to interact with OS by;

Components of Operating System Cont.…

I. Prompting the user to give input
II. Interpreting the input for the operating system
III. Handling the output from the operating system

Shell provides a way to communicate with the operating system by either taking the input from the user or the shell script. A shell script is a sequence of system commands that are stored in a file.

Components of Operating System Cont.…



Components of Operating System Cont.…

Kernel

- The kernel is the core component of an operating system which acts as an interface between applications, and the data is processed at the hardware level.
- The kernel is the central component that manages system resources and provides essential services
- When an OS is loaded into memory, the kernel is loaded first and remains in memory until the OS is shut down. After that, the kernel provides and manages the computer resources and allows other programs to run and use these resources. The kernel also sets up the memory address space for applications, loads the files with application code into memory, and sets up the execution stack for programs.

Components of Operating System Cont.…

The kernel is responsible for performing the following tasks:

I. Input-Output management
II. Memory Management
III. Process Management for application execution.
IV. Device Management
V. System calls control

NB: Shell and Kernel together they form the foundation of an operating system's functionality

Components of Operating System Cont.…

There are various components of an Operating System to perform well defined tasks. Though most of the Operating Systems differ in structure but logically they have similar components. Each component must be a well-defined portion of a system that appropriately describes the functions, inputs, and outputs.

Components of Operating System Cont.…

Process Management

A process is program or a fraction of a program that is loaded in main memory. A process needs certain resources including CPU time, Memory, Files, and I/O devices to accomplish its task. The process management component manages the multiple processes running simultaneously on the Operating System.

Components of Operating System Cont.…

I/O Device Management

One of the purposes of an operating system is to hide the peculiarities of specific hardware devices from the user. I/O Device Management provides an abstract level of H/W devices and keep the details from applications to ensure proper use of devices, to prevent errors, and to provide users with convenient and efficient programming environment.

Components of Operating System Cont.…

File Management

File management is one of the most visible services of an operating system. Computers can store information in several different physical forms; magnetic tape, disk, and drum are the most common forms.

A file is defined as a set of correlated information and it is defined by the creator of the file. Mostly files represent data, source and object forms, and programs. Data files can be of any type like alphabetic, numeric, and alphanumeric.

Components of Operating System Cont.…

Network Management

The definition of network management is often broad, as network management involves several different components. Network management is the process of managing and administering a computer network. A computer network is a collection of various types of computers connected with each other.

Network management comprises fault analysis, maintaining the quality of service, provisioning of networks, and performance management. Some activities are;

i. Network administration
ii. Network maintenance
iii. Network operation
iv. Network provisioning
v. Network security

Components of Operating System Cont.…

Main Memory Management

Memory is a large array of words or bytes, each with its own address. It is a repository of quickly accessible data shared by the CPU and I/O devices.

Main memory is a volatile storage device which means it loses its contents in the case of system failure or as soon as system power goes down.

The operating system is responsible for the following activities in connections with memory management:

i. Keep track of which parts of memory are currently being used and by whom.
ii. Decide which processes to load when memory space becomes available.
iii. Allocate and deallocate memory space as needed.

Components of Operating System Cont.…

Secondary Storage Management

The main purpose of a computer system is to execute programs. These programs, together with the data they access, must be in main memory during execution. Since the main memory is too small to permanently accommodate all data and program, the computer system must provide secondary storage to backup main memory.

Most modern computer systems use disks as the principle on-line storage medium, for both programs and data. Most programs, like compilers, assemblers, sort routines, editors, formatters, and so on, are stored on the disk until loaded into memory, and then use the disk as both the source and destination of their processing.

The operating system is responsible for the following activities in connection with disk management:

i. Free space management
ii. Storage allocation
iii. Disk scheduling

Components of Operating System Cont.…

Security Management

The operating system is primarily responsible for all task and activities happen in the computer system. The various processes in an operating system must be protected from each other's activities. For that purpose, various mechanisms which can be used to ensure that the files, memory segment, cpu and other resources can be operated on only by those processes that have gained proper authorization from the operating system.

Components of Operating System Cont.…

Command Interpreter System

One of the most important component of an operating system is its command interpreter. The command interpreter is the primary interface between the user and the rest of the system.

Command Interpreter System executes a user command by calling one or more number of underlying system programs or system calls.

Types of Operating System

Basically we have six types of operating systems,

I. Batch OS
II. Distributed OS
III. Multitasking OS
IV. Network OS
V. Real-OS
VI. Mobile OS

Types of Operating System Cont……

Batch OS

- Batch operating systems are designed to process large volumes of data with minimal user interaction. They operate in a batch mode, where tasks are executed in predefined sequences without requiring immediate user input,and then these batches are executed one by one based on the first-come, first, serve principle.
- The users who using a batch operating system do not interact with the computer directly. Each user prepares its job on an off-line device like punch cards and submits it to the computer operator. To speed up the processing, jobs with similar needs are batched together and run as a group. The programmers exit their programs with the operator and the operator then sorts the programs with similar requirements into batches.

Advantages of Batch OS

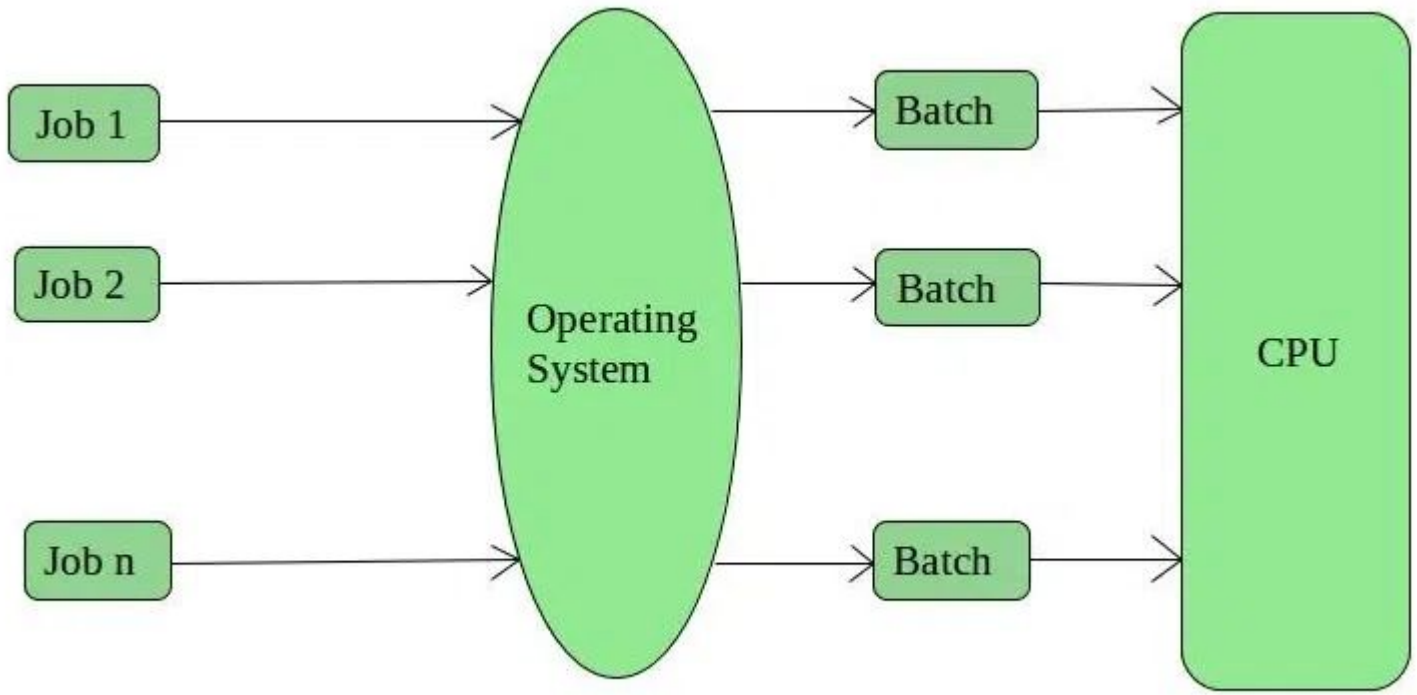
I. Execution time taken for similar jobs is higher.
II. Multiple users can share batch systems.
III. Managing large works becomes easy in batch systems.
IV. The idle time for a single batch is very less.

Types of Operating System Cont……

Disadvantages of Batch OS

I. It is hard to debug batch systems.
II. There is a lack of interaction between the user and the job
III. If a job fails, then the other jobs have to wait for an unknown time till the issue is resolved.
IV. Batch systems are sometimes costly.
V. The other jobs will have to wait for an unknown time if any job fails

Examples of Batch OS: IBM OS/360, IBM OS/370, IBM OS/390, UNIVAC EXEC I, BESYS (Batch Environment System), Multics (Multiplexed Information and Computing Service)etc.


Job 1
Job 2
Job n
Operating System
Batch
Batch
Batch
CPU

Types of Operating System Cont……

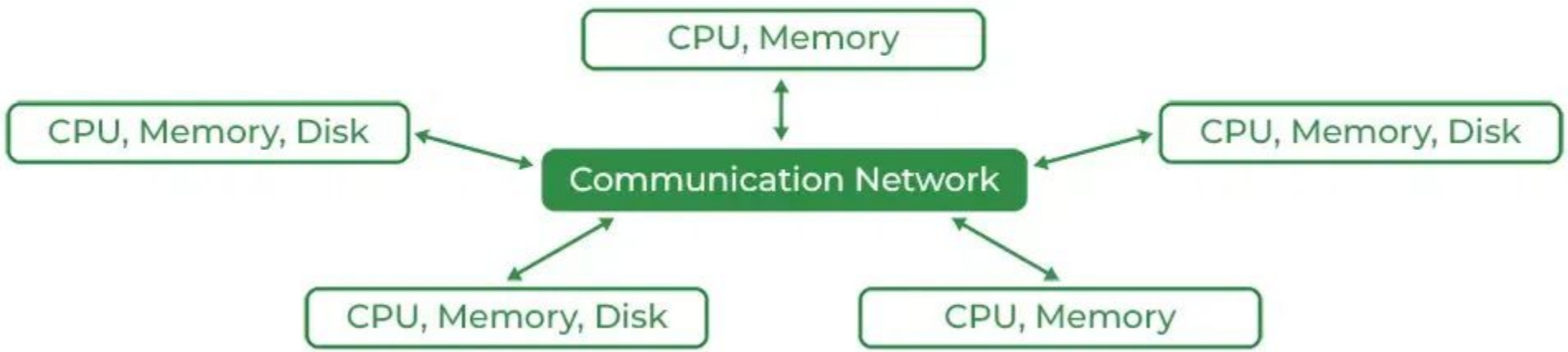
Distributed OS

- A distributed operating system is a recent advancement in the field of computer technology and is utilized all over the world that too with great pace. In a distributed OS, various computers are connected through a single communication channel.
- Various autonomous interconnected computers communicate with each other using a shared communication network. Independent systems possess their own memory unit and CPU. These are referred to as loosely coupled systems or distributed systems.
- These independent computers have their memory unit and CPU and are known as loosely coupled systems. The system processes can be of different sizes and can perform different functions. The major benefit of such a type of operating system is that a user can access files that are not present on his system but another connected system. In addition, remote access is available to the systems connected to this network.

Distributed OS Cont.…

- A distributed operating system is an operating system that runs on multiple machines and allows them to work together as a single, integrated system. The primary goal of a distributed operating system is to provide a transparent and efficient environment for users and applications, despite the underlying complexity of multiple interconnected machines.
- Unlike traditional operating systems that run on a single machine, distributed operating systems extend their functionality to a network of interconnected computers. The primary goal is to provide a unified and transparent environment for users and applications, despite the physical distribution of computing resources.

Architecture of Distributed OS



Types of Operating System Cont……

Advantages of Distributed OS

I. Failure of one system will not affect the other systems because all the computers are independent of each other.

II. The load on the host system is reduced.

III. The size of the network is easily scalable as many computers can be added to the network.

IV. As the workload and resources are shared therefore the calculations are performed at a higher speed.

V. Data exchange speed is increased with the help of electronic mail.

Types of Operating System Cont……

Disadvantages of Distributed OS

I. The setup cost is high.
II. Software used for such systems is highly complex.
III. Failure of the main network will lead to the failure of the whole system.

Examples of Distributed OS: LOCUS, Plan 9 from Bell Labs, MINIX 3 etc.

Types of Operating System Cont……

Multitasking OS

A multitasking operating system is an operating system that allows multiple tasks or processes to run concurrently on a computer, providing the illusion that they are executing simultaneously. Multitasking enables users to perform several tasks concurrently without waiting for one task to complete before starting another. There are two main types of multitasking: preemptive multitasking and cooperative multitasking.

Preemptive Multitasking

- Preemptive multitasking is a type of multitasking in which the operating system can interrupt or preempt currently running tasks to give time to another task. The decision to switch between tasks is typically based on priorities assigned to different processes or time-slicing mechanisms, where each process is given a certain amount of time to execute before being interrupted. This type of multitasking allows the operating system to efficiently manage multiple tasks and provide the illusion of parallel execution.
- In preemptive multitasking, the operating system can interrupt or preempt a currently running task to give time to another task. The scheduler decides when to switch between tasks based on priorities and time-slicing. This type of multitasking is commonly found in modern operating systems. Examples include;

Preemptive Multitasking Cont.…

1. **Microsoft Windows:**

   Windows operating systems, such as Windows 10, support preemptive multitasking. The operating system dynamically allocates CPU time to different processes based on their priority levels. Use preemptive multitasking to manage multiple processes concurrently.

2. **Linux:**

   Description: Linux is a multitasking operating system that uses a preemptive scheduler. It efficiently manages multiple processes running concurrently on a system.

3. **macOS:**

   Description: macOS, the operating system for Apple Mac computers, utilizes preemptive multitasking to manage and switch between running applications.

Cooperative Multitasking

- Cooperative multitasking is a type of multitasking in which multiple tasks or processes run concurrently, but they voluntarily yield control to the operating system or other tasks. Unlike preemptive multitasking, where the operating system can forcefully interrupt a running task to switch to another, cooperative multitasking relies on the cooperation of tasks to yield control.
- In cooperative multitasking, each task voluntarily gives up control to allow other tasks to run. This type of multitasking relies on the cooperation of processes to yield control to the operating system. If a task fails to yield, it can adversely affect the overall system performance. Cooperative multitasking was more common in early operating systems but is less prevalent in modern systems. Examples include;

Cooperative Multitasking Cont.…

1. **Classic Mac OS (pre-Mac OS X):**

   Classic Mac OS used cooperative multitasking. Applications were expected to yield control back to the operating system to allow other tasks to execute.

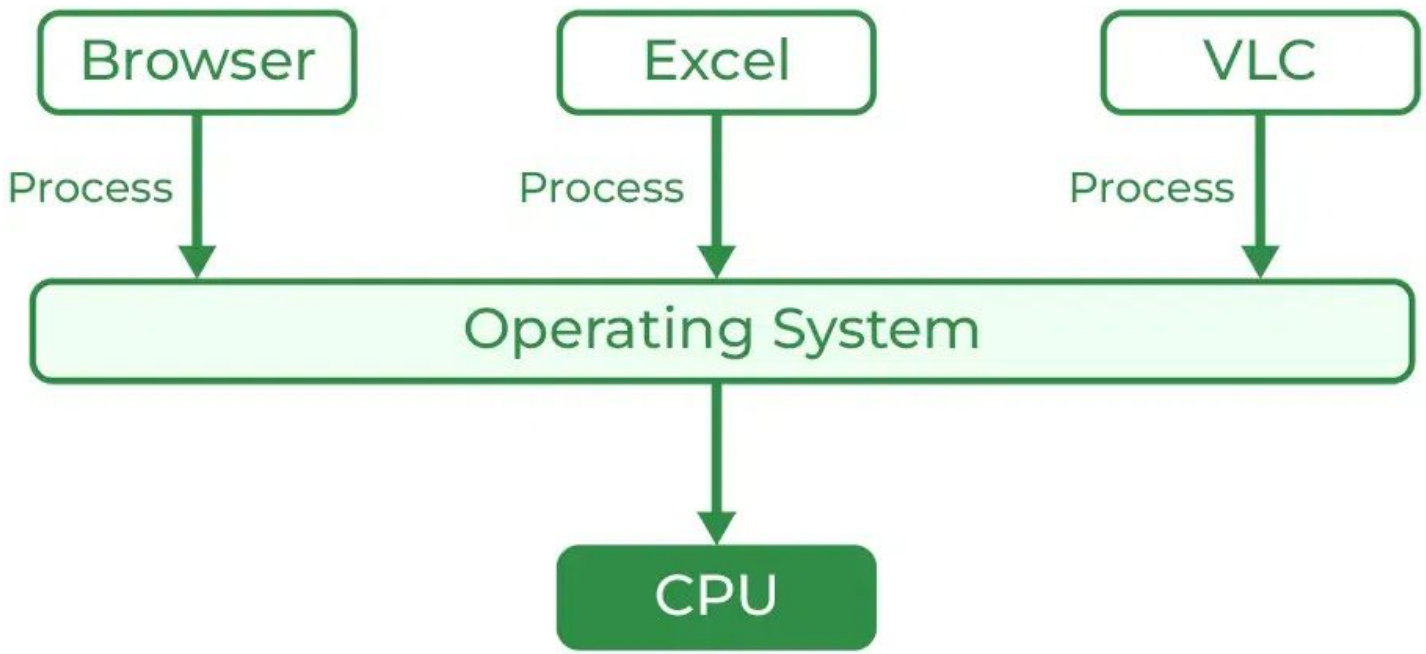
2. **MS-DOS:**

   MS-DOS, the operating system for early IBM-compatible personal computers, relied on cooperative multitasking. Applications had to cooperate to ensure fair access to system resources.

Cooperative Multitasking Cont.…

- Despite its simplicity, cooperative multitasking has limitations, especially in terms of system stability and responsiveness. If one task fails to cooperate, the entire system may be affected. As a result, modern operating systems, particularly those designed for multitasking in complex environments, tend to favor preemptive multitasking for better control and system stability.
- While both types of multitasking are still relevant, preemptive multitasking is more common in modern operating systems due to its ability to provide better system stability and responsiveness. It ensures that no single task can monopolize the CPU for an extended period, leading to a smoother user experience in a multitasking environment.

Multitasking



Types of Operating System Cont……

Advantages of Multitasking OS

I. Each task gets equal time for execution.
II. The idle time for the CPU will be the lowest.
III. There are very few chances for the duplication of the software.

Disadvantages of Multitasking OS

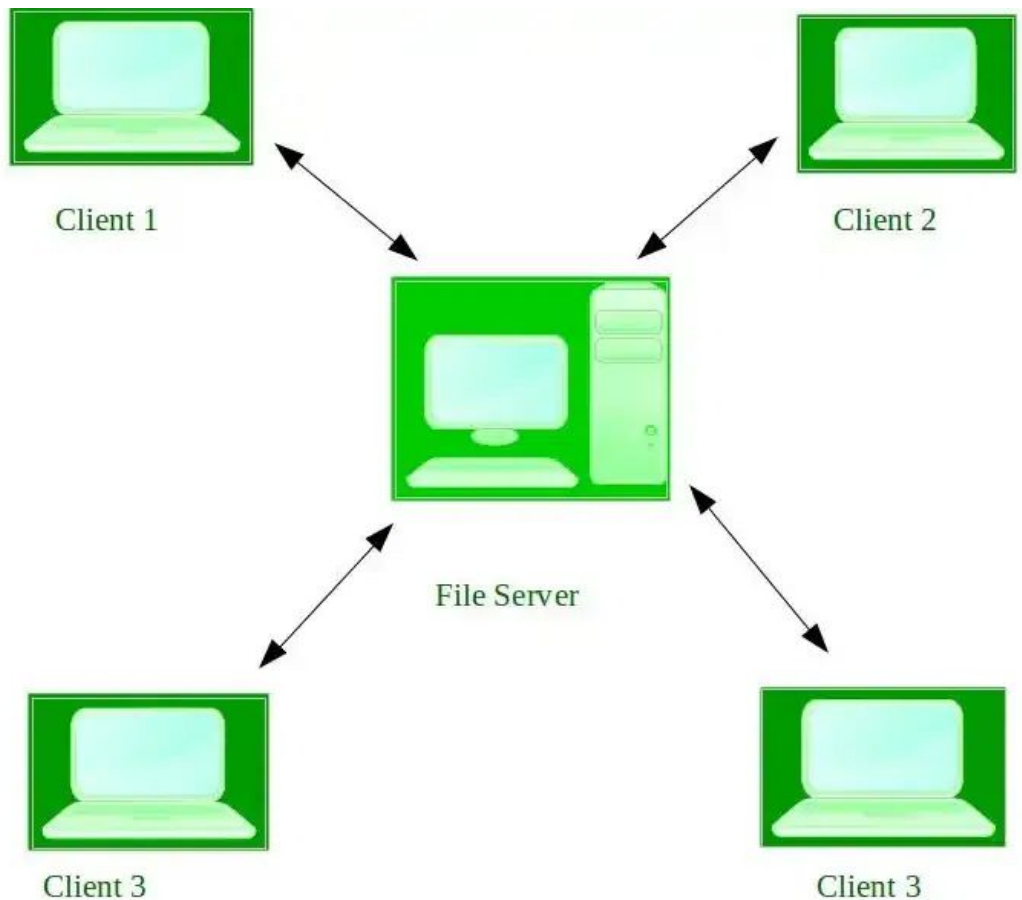
I. Processes with higher priority cannot be executed first as equal priority is given to each process or task.
II. Various user data is needed to be taken care of from unauthorized access.
III. Sometimes there is a data communication problem.

Examples of Multitasking OS: UNIX, etc.

Types of Operating System Cont……

Network OS

Network operating systems are the systems that run on a server and manage all the networking functions. They allow sharing of various files, applications, printers, security, and other networking functions over a small network of computers like LAN or any other private network. In the network OS, all the users are aware of the configurations of every other user within the network, which is why network operating systems are also known as tightly coupled systems.


Client 1
Client 2
File Server
Client 3
Client 3

Types of Operating System Cont……

Advantages of Network OS

I. New technologies and hardware can easily upgrade the systems.
II. Security of the system is managed over servers.
III. Servers can be accessed remotely from different locations and systems.
IV. The centralized servers are stable.

Types of Operating System Cont……

Disadvantages of Network OS

I. Server costs are high.
II. Regular updates and maintenance are required.
III. Users are dependent on the central location for the maximum number of operations.

Examples of Network OS: Microsoft Windows server 2008, LINUX, etc.

Types of Operating System Cont……

Real-Time OS

Real-Time operating systems serve real-time systems. These operating systems are useful where many events occur in a short time or certain deadlines, such as real-time simulations.

Types of the real-time operating system are:

I. Hard real-time OS

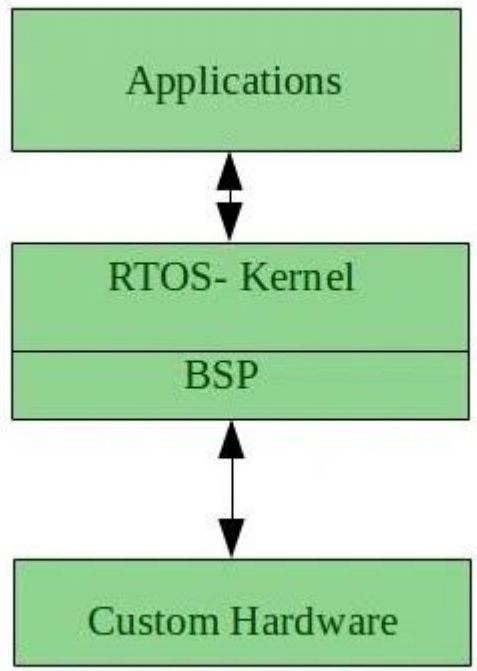
The hard real-time OS is the operating system for mainly the applications in which the slightest delay is also unacceptable. The time constraints of such applications are very strict. Such systems are built for life-saving equipment like parachutes and airbags, which immediately need to be in action if an accident happens.

Types of Operating System Cont……

II. Soft real-time OS

The soft real-time OS is the operating system for applications where time constraint is not very strict.

In a soft real-time system, an important task is prioritized over less important tasks, and this priority remains active until the completion of the task. Furthermore, a time limit is always set for a specific job, enabling short time delays for future tasks, which is acceptable. For Example, virtual reality, reservation systems, etc.


Applications
RTOS- Kernel
BSP
Custom Hardware

Types of Operating System Cont……

Advantages of Real-Time OS

I. It provides more output from all the resources as there is maximum utilization of systems.
II. It provides the best management of memory allocation.
III. These systems are always error-free.
IV. These operating systems focus more on running applications than those in the queue.
V. Shifting from one task to another takes very little time.

Types of Operating System Cont……

Disadvantages of Real-Time OS

I. System resources are extremely expensive and are not so good.
II. The algorithms used are very complex.
III. Only limited tasks can run at a single time.
IV. In such systems, we cannot set thread priority as these systems cannot switch tasks easily.

Examples of Real-Time OS: Medical imaging systems, robots, etc.

Types of Operating System Cont……

Mobile OS

A mobile OS is an operating system for smartphones, tablets, and PDA's. It is a platform on which other applications can run on mobile devices.

Advantages of Mobile OS

I. It provides an ease to users.

Disadvantages of Mobile OS

I. Some of the mobile operating systems give poor battery quality to users.

II. Some of the mobile operating systems are not user-friendly

Examples of the Mobile OS: Android OS, ios, Symbian OS, and Windows mobile OS.

Characteristics of Operating System

I. **Virtualization:** Operating systems can provide Virtualization capabilities, allowing multiple operating systems or instances of an operating system to run on a single physical machine. This can improve resource utilization and provide isolation between different operating systems or applications.

II. **Networking:** Operating systems provide networking capabilities, allowing the computer system to connect to other systems and devices over a network. This can include features such as network protocols, network interfaces, and network security.

III. **Scheduling:** Operating systems provide scheduling algorithms that determine the order in which tasks are executed on the system. These algorithms prioritize tasks based on their resource requirements and other factors to optimize system performance.

Characteristics of Operating System Cont...

IV. **Interprocess Communication:** Operating systems provide mechanisms for applications to communicate with each other, allowing them to share data and coordinate their activities.

V. **Performance Monitoring:** Operating systems provide tools for monitoring system performance, including CPU usage, memory usage, disk usage, and network activity. This can help identify performance bottlenecks and optimize system performance.

VI. **Backup and Recovery:** Operating systems provide backup and recovery mechanisms to protect data in the event of system failure or data loss.

VII. **Debugging:** Operating systems provide debugging tools that allow developers to identify and fix software bugs and other issues in the system.

THE END

ANY QUESTION