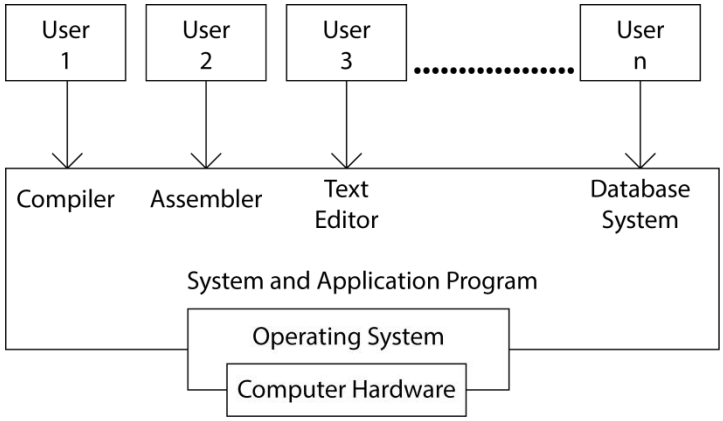
Overview of Operating System

1. Introduction to Operating System

Concept -

An OS is a program that manages the computer hardware. It also provides a basis for application programs and acts as an intermediary between a user of a computer and the computer hardware.

Components of Computer System -



- The Hardware like CPU, the Memory and the I/O devices provides the basic computing resources.
- The application programs such as word processor, Spreadsheets, Compilers and Web browsers define the ways in which these resources are used to solve the computing problems of the users.

- The OS controls and coordinates the use of the hardware among the various application programs for the various users.

- The components of a computer system are its hardware, software and data. The OS provides the means for the proper use of these resources in the operation of the computer system.

- An OS in similar to a government. Like a government within which other programs can do useful work.

2. Role of the Operating System

I. **Security :** The OS uses password protection to protect user data and similar other techniques. It also prevents unauthorized access to programs and user data.

II. **Control over System Performance :** Monitors overall system health to help improve performance. Records the response time between service requests and system response to have a complete view of the system health. This can help improve performance by providing important information needed to troubleshoot problems.

III. **Job accounting :** Operating System keeps track of time and resources used by various tasks and users, this information can be used to track resources usage for a particular user or group of users.

IV. **Error detection aids :** OS constantly monitors the system to detect errors and avoid the malfunctioning of computer system.

V. **Coordination between the other software and users :** OS also coordinate and assign interpreters, compilers, assemblers and other software's to the various users of the computer system.

VI. **Memory management :** The OS manages the primary memory or main memory. It keeps tracks of primary memory I.e., which bytes of memory addresses that have already been allocated and the memory addresses of the memory that has not yet been used. In multi-programming, the OS decides the order in which process are granted access to memory and for how long it allocated the memory to a process when the process requests it and deallocates the memory when the process has terminated or is performing an I/O operation.

VII. **Processor management :** In multi-programming environment the OS decides the order in which processor have access to the processor and how much processing time each process has. This form of OS is called process scheduling.

An OS performs the following activities for processor management -

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

VIII. **Device management :** An OS manages device communication via their respective drivers. OS keeps tracks of all devices connected to system designates a program responsible for every device known as the I/O controller. Decides which process gets access to a certain device and for how long. Allocated devices in an effective and efficient way. Deallocated devices when they are no longer required.

IX. **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 OS keeps tracks of where information is stored, user access settings and status of every file and more. These facilities are collectively known as the file system.

3. Different types of OS

1) Batch OS

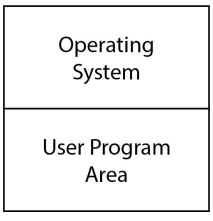


Fig. Memory layout for a simple batch system

- Early computers were physically enormous machines run from a console.
- The common input devices were card readers and tape drives. The common output devices were line printers, tape drivers and card punches
- The user did not interact directly with the computer systems. Rather, the user prepared a job which consisted of the program, the data, and some control information about the nature of the job and submitted it to the computer operator.

- The job was usually in the form of punch cards. At some later time (after minutes, hours or days), the output appeared.
- The major task of OS was to transfer control automatically from one job to the next.
- To speed up processing, operators batched together jobs with similar needs and ran them through the computer as a group. Thus, the programmers would leave their programs with the operator.
- The operator would sort programs into batches with similar requirements and as the computer became available, would run each batch.
- The output from each job would be sent back to the appropriate programmers.
- In this execution environment the CPU is often idle, because the speeds of the mechanical I/O devices are intrinsically slower than are those of electronic devices.
- The difference in speed between the CPU and its I/O devices may be three orders of magnitude or more.
- Over time, improvements in technology and the introduction of disks resulted in faster I/O devices.
- However, CPU speed increased to an even greater extent, so the problem was not only unresolved but exacerbated.

2) Multi-programming System

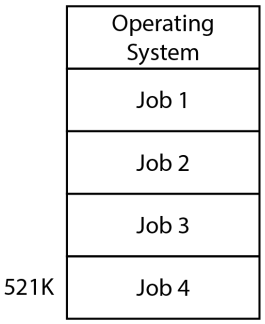


Fig. Memory layout for multi-programming system

- The most important aspect of job scheduling is the ability to multi-program. A single user can not in general keep either the CPU or the I/O devices busy at all times.
- Multi-programming increases CPU utilization by organizing jobs so that the CPU always has one to executes.

The idea is as follows -

- The OS keeps several jobs in memory simultaneously. This set of jobs is a subset of the jobs kept in the job pool since the number of jobs that can be kept simultaneously in memory is usually much smaller than the number of jobs that can be in the job pool.
- The OS picks and begins to execute one of the jobs in the memory. Eventually, the job may have to wait for some tasks such as an I/O operation to complete.
- In multi-programming system, the OS simply switches to and executes another job. When that job needs to wait the CPU is switches to another job, and so on.
- Eventually the first job finishes waiting and gets the CPU back as long as at least one job needs to execute, the CPU is never idle.
- Multi-programming is the first instance where the OS must make decisions for the users.

- In multi-programming OS all the jobs that enter the system are kept in the job pool. This pool consists of all process residing on disk awaiting allocation of main memory of several jobs are not ready to be bought into the memory and if there is not enough room for all of them then the system must choose among them. (Job scheduling)

- When the OS selects a job from the job pool it loads that job into memory for execution. Having several programs in memory at the same time requires some form of memory management.

- In addition, if several jobs are ready to run at the same time, the system must choose among them. Making this decision is CPU scheduling.

- Finally multiple jobs running concurrently require that their ability to affect one another be limited in all phases of the OS, including process scheduling, disk storage, and memory management.

3) Multitasking OS

- Multitasking is a logical extension of multi-programming system that supports multiple programs to run concurrently.
- In multitasking more than one task are executed at the same time. In this technique the multiple tasks, also known as processes share common processing resources such as a CPU.
- In the case of a computer with single CPU only one job can be processed at a time. Multitasking solves the problem by scheduling and deciding which task should be the running task and when a waiting task should get turn.
- The multitasking systems were developed to provide interactive use of a computer system.
- This system uses the CPU scheduling and multi-programming to provide each user with a small portion of a time-shared computer.
- Thus, multitasking makes the best possible use of available hardware at any given instance of time and improves the overall efficiency of computer system.
- Multitasking is achieved by simultaneous management of several processes in the main memory at the same time and by availing I/O resources amongst the active tasks. The multitasking OS monitors the state of all the tasks and of the system resources.

4) Multiprocessor System

- Most systems to date are single processor system, that is, they have only one main CPU.
- However, multiprocessor systems (also known as parallel system or tightly coupled system) are growing in importance.
- Such systems have more than one processor in close common sharing the computer bus, the clock and sometimes memory and peripheral devices.

Multiprocessor systems have three main advantages -

i) **Increased throughput -** By increasing the number of processors, we hope to get more work done in less time. The speed-up ratio with N processors is not N, rather, it is less than N.

ii) **Economy of scale -** Multiprocessor system can save more money than multiple single processor system, because they aim can share peripherals, manage storage and power supplies.

iii) **Increase reliability -** If functions can be distributed properly among several processors, then the failure of one processor will not halt the system only slow it down.

- The most common multiple processor systems now use symmetric multiprocessing (SMP), in which each processor runs an identical copy of the OS and these copies communicate with one another as needed.

- Some systems use asymmetric multiprocessing, in which each processor is assigned a specific task. A master processor controls the system the other processor either look to the master for instruction or have predefined tasks. This scheme defines a master slave relationship. The master processor schedules and allocates work to the slave processors.

- SMP means that all processors are peers; no master - slave relationship exists between processors. Each processor concurrently runs a copy of the OS.

5) Time sharing OS

- In time sharing OS each task is given some time to execute, so that all the tasks work smoothly.
- Each user gets time of CPU as they use single system. These systems are also known as Multitasking systems.
- The task can be from single user or from different users also.
- The time that each task gets to execute is called quantum.
- After this time interval is over OS switches over to next task.

Advantages -

i) Each task gets an equal opportunity.
ii) Less chances of duplication of software.
iii) CPU idle time can be reduced.

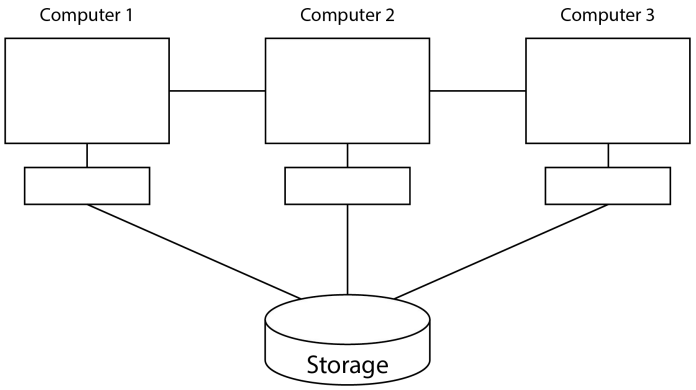
Disadvantages -

i) Reliability problem.
ii) One must have to take care of security and integrity of user programs and data.
iii) Data communication problem.

Example of time-sharing OS are Multics, Unix, etc.

6) Cluster system

- Like parallel systems, clustered system gathers together multiple CPUs to accomplish computational work.
- Clustered system differ from parallel system, however, in that they are composed of two or more individual systems coupled together.
- Clustered computers share storage and are closely linked via LAN networking.
- Clustering is usually performed to provide high availability.



- The clustered systems are a combination of hardware clusters and software clusters.
- The hardware clusters help in sharing of high-performance disks between the system. The software clusters make all the systems work together.
- Each node in the clustered system contains the cluster software.
- This software monitors the cluster system and make sure it is working as required.
- If any one of the nodes in the clustered system fail, then the rest of the nodes take control of its storage and resources and try to restart.

Types of clustered system -

i. Asymmetric clustering system
ii. Symmetric clustering system

1. Asymmetric clustering system

- In this system, one of the nodes in the clustered system is in how standby mode and all the others run the required applications.
- The hot standby mode is a fail-safe in which a hot standby node is part of the system.
- The hot standby mode continuously monitors the server and if it fails the hot standby node takes its place.

2. Symmetric clustering system

- In symmetric clustering system two or more nodes all run application as well as monitor each other.
- This is more efficient than asymmetric system as it uses all the hardware and doesn't keep a node merely as a hot standby.

Advantages -

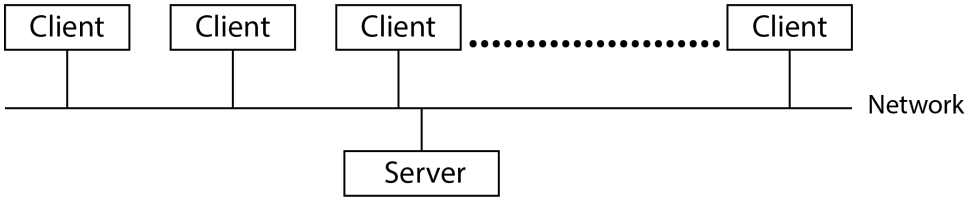
1) Performance – It is high performance system as they contain two or more individual computer systems merged together.
2) Fault tolerance – These systems are quite fault tolerant and the loss of one node does not result in the loss of the system.
3) Scalability – They are quite scalable as it is easy to add a new node to the system. There is no need to take the entire cluster down to add a new node.

7) Distributed Systems

- Distributed systems depend on networking for their functionality.
- A network, in the simplest terms, is a common patch between two or more systems.
- By being able to communicate, distributed systems are able to share computational tasks, and provide a rich set of features to users.

i. Client - Server system

As PCs have become faster, more powerful, and cheaper designers have shifted away from the centralized system architecture.
Terminals connected to centralized systems are now being planted by PCs.
Centralized systems today act as server systems to satisfy requests generated by client systems.
Server systems can be broadly categorized as computer servers and file servers.
Computer server systems provide an input to which client can send requests to perform an action, in response to which they execute the action and send back results to the client.
File server systems provide a file system input where client can create, update, read and delete files.



General structure of client – server system

ii. Peer to Peer system

In this system peers are the computer systems which are connected to each other via the internet. Files can be shared directly between systems on the hardware without the need of a central server.
The distributed OS are referred as loosely coupled systems. These systems processors differ in size and function.
The major benefit of working with these types of OS is that it is always possible that one user can access the files or software which are not actually present on his system but on some other system connected this hardware. I.e., remote access is enabled within the devices connected in that hardware. E.g., LOCUS etc.

Advantages -

1. Failure of one will not affect the other hardware communication, as all systems are independent from each other.
2. Electronic mail increases the data exchange speed.
3. Since resources are being shared computation in highly fast and durable.
4. Load on host computer reduces.
5. These systems are easily scalable as many systems can be easily added to the hardware.
6. Delay in data processing reduces.

Disadvantages -

1. Failure of the main hardware will stop the entire communication.
2. To establish distributed systems the languages that are used are not well defined yet.
3. These types of systems are not readily available as they are very expensive.

8) Real time system

- These types of OS serve the real time systems. The time interval required to process and respond to input is very small. This time interval is called as response time.
- Real time system means that the system us subjected to real time, I.e., response should be guaranteed within a specified timing constraint or system should meet the specified deadline. E.g., flight control system, real time monitors, etc.
- Real time systems are used when there are time requirements are very strict like missile system, air traffic control systems, robots etc.

There are two types of Real time OS -

i. Hard real time system
ii. Soft real time system

I. Hard real time system -

- These OS are means for the application where time constraints are very strict and even the shortest possible delay is not acceptable.
- These systems are built for saving life like automatic parachutes or air bags which are required to be readily available in case of any accident. Virtual memory is almost never found in these systems.

II. Soft real time system -

- These OS are for applications where for time constraint is less strict. In this OS a critical real time task gets priority over other tasks, and retains that priority until it completes.

- Soft real time system is an achievable goal that can be mixed with other types of systems. Soft real time systems, however, have more limited utility than hard real time system.
- They are useful, however in several areas including multimedia, virtual reality and advanced scientific projects such as undersea exploration and planetary rovers.

9) Open-Source OS

- Open-source OS are released under a license where the copyright holder allows others to study, change as well as distribute the software to other people. This can be done for any reason.
- The different open-source OS available in the market are – Cosmos, FreeDOS, Genode, GhostOS, ITS, OSV, PhantomOS

i. Cosmos :

This is an open-source OS written mostly in programming language C# full is C# open-source managed operating system. Till 2016, Cosmos did not intend to be a fully sledged OS but a system that allowed other developers to easily build their own OS. It also hides the inner working of the hardware from the developers thus providing data abstraction.

ii. FreeDOS :

This was a free OS developed for systems compatible with IBM PC computers. Free DOS provides a complete environment to run legacy software and other embedded systems. It can be booted from a floppy disk or USB flash drive as required.

iii. Genode :

It contains a micro kernel layer and different user components. It is one of the few open-source OS not derived from a licensed OS such as UNIX. Genode can be used as an OS for computers, tablets, etc. as required. It is also used as a base for virtualization, inter processors communication, software development etc. as it has small code system.

iv. Ghost OS :

This OS developed for personal computers. It started as a research project and developed to contain various features like GUI, C library, etc. It features multiprocessing and multitasking and is based on the Ghost kernel. Most of the programming in Ghost OS is done in C++.

v. ITS :

The incompatible time-sharing system was developed by the MIT Artificial Intelligence library. There is a remote login facility which allowed guest users to informally try out the OS and its features using ARPANET. ITS also gave out many new features that were unique at that time such as device independent graphics terminal, virtual devices, inter m/c file system access etc.

vi. OSV :

This was an OS released in 2013. It was mainly focused on cloud computing and was built to run on top of a virtual m/c as a guest. This is the reason it doesn't include drivers for bare hardware. In the OSV OS, everything runs in the kernel address space and there is no concept of multi-user system.

vii. Phantom OS :

This is an OS that is based on the concepts on persistent virtual memory and is code oriented. It was mostly developed by Russian developers. Phantom OS is not based on concept of famous OS such as UNIX. Its main goal is simplicity and effectiveness in process management.

10) Mobile Operating system

- A mobile OS is an OS built exclusively for a mobile device, such as a smart-phone, personal digital assistant (PDA), tablet or other embedded mobile OS.
- Popular mobile OS are Android, Symbian, iOS, BlackBerryOS and Windows Mobile.
- A mobile OS is responsible for identifying and defining mobile device features and functions, including keypads, application synchronization, email, thumbnails and text managing.
- A mobile OS is similar to a standard OS (like Windows, Linux and Mac) but is relatively simple and light and primarily manages the wireless variations of local and broadband connections, mobile multimedia and various input methods.