Operating System-Introduction, Structures-Simple Batch, Multi-programmed, Time-shared, Personal Computer,Parallel, Distributed Systems, Real-Time Systems , System components, Operating System services.

**Introduction to Linux** operating system, linux file system, Linux Utilities

A computer system has many resources (hardware and software), which may be required to complete a task. The commonly required resources are input/output devices, memory, file storage space, CPU, etc. The operating system acts as a manager of the above resources and allocates them to specific programs and users, whenever necessary to perform a particular task. Therefore the operating system is the resource manager i.e. it can manage the resource of a computer system internally. The resources are processor, memory, files, and I/O devices.

In simple terms, an operating system is an interface between the computer user and the machine.

It is very important for you that every computer must have an operating system in order to run other programs. The operating system mainly coordinates the use of the hardware among the various system programs and application programs for various users.

An operating system acts similarly like government means an operating system performs no useful function by itself; though it provides an environment within which other programs can do useful work. Below we have an abstract view of the components of the computer

Four Components of a Computer System
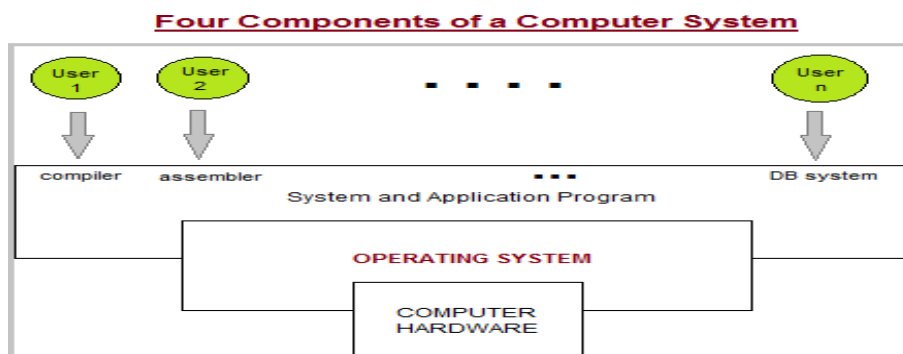
system:

In the above picture:

- The **Computer Hardware** contains a central processing unit(CPU), the memory, and the input/output (I/O) devices and it provides the basic computing resources for the system.

- The **Application programs like spreadsheets, Web browsers, word processors, etc.** are used to define the ways in which these resources are used to solve the computing problems of the users. And the System program mainly consists of compilers, loaders, editors, OS, etc.
- The Operating System is mainly used to control the hardware and coordinate its use among the

various application programs for the different users.

- Basically, Computer System mainly consists of hardware, software, and data.

OS is mainly designed in order to serve two basic purposes:

1. The operating system mainly controls the allocation and use of the computing System's resources among the various user and tasks.

2. It mainly provides an interface between the computer hardware and the programmer that simplifies and makes feasible for coding, creation of application programs and debugging

Two Views of Operating System

1. User's View
2. System View

Operating System: User View

The user view of the computer refers to the interface being used. Such systems are designed for one user to monopolize its resources, to maximize the work that the user is performing. In these cases, the operating system is designed mostly for ease of use, with some attention paid to performance, and none paid to resource utilization.

Operating System: System View

The operating system can be viewed as a resource allocator also. A computer system consists of many resources like - hardware and software - that must be managed efficiently. The operating system acts as the manager of the resources, decides between conflicting requests, controls the execution of programs, etc.
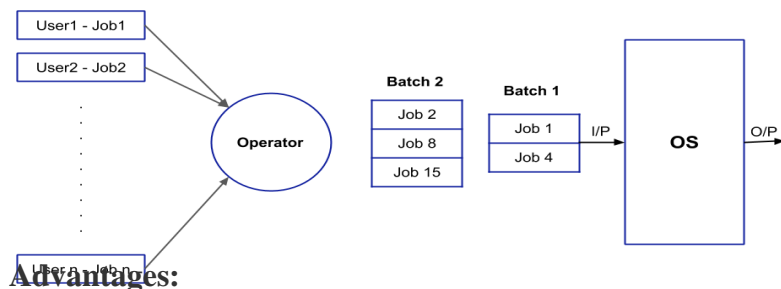
Types of Operating System

Given below are different types of Operating System:

1. Simple Batch System
2. Multiprogrammed
3. Time-Shared
4. Personal Computer
5. Parallel
6. Distributed Systems
7. Real Time Systems

1. Simple Batch System

In a Batch Operating System, the similar jobs are grouped together into batches with the help of some operator and these batches are executed one by one. For example, let us assume that we have 10 programs that need to be executed. Some programs are written in C++, some in C and rest in Java. Now, every time when we run these programmes individually then we will have to load the compiler of that particular language and then execute the code. But what if we make a batch of these 10 programmes. The benefit with this approach is that, for the C++ batch, you need to load the compiler only once. Similarly, for Java and C, the compiler needs to be loaded only once and the whole batch gets executed. The following image describes the working of a Batch Operating System.

Advantages:

1. The overall time taken by the system to execute all the programmes will be reduced.

2. The Batch Operating System can be shared between multiple users.

Disadvantages:

1. Manual interventions are required between two batches.

2. The CPU utilization is low because the time taken in loading and unloading of batches is very high as compared to execution time.

Multiprogramming

Sharing the processor, when two or more programs reside in memory at the same time, is referred as **multiprogramming**. Multiprogramming assumes a single shared processor. Multiprogramming increases CPU utilization by organizing jobs so that the CPU always has one to execute.

The following figure shows the memory layout for a multiprogramming
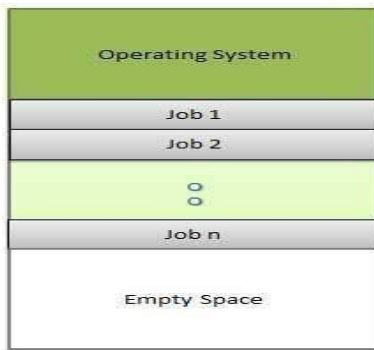
system.

An OS does the following activities related to multiprogramming.

- The operating system keeps several jobs in memory at a time.

- This set of jobs is a subset of the jobs kept in the job pool.

- The operating system picks and begins to execute one of the jobs in the memory.

- Multiprogramming operating systems monitor the state of all active programs and system resources using memory management programs to ensures that the CPU is never idle, unless thereare no jobs to process.

Advantages

- High and efficient CPU utilization.

- User feels that many programs are allotted CPU almost simultaneously.

Disadvantages

- CPU scheduling is required.

- To accommodate many jobs in memory, memory management is required.

Time-Sharing Operating System

In a Multi-tasking Operating System, more than one processes are being executed at a particular time with the help of the time-sharing concept. So, in the time-sharing environment, we decide a time that is called time quantum and when the process starts its execution then the execution continues for only that amount of time and after that, other processes will be given chance for that amount of time only. In the next cycle, the first process will again come for its execution and it will be executed for that time quantum only and again next process will come. This process will continue. The following image describes the working of a Time-Sharing Operating System.

Advantages:

1. Since equal time quantum is given to each process, so each process gets equal opportunity to execute.

2. The CPU will be busy in most of the cases and this is good to have case.

Disadvantages:

1. Process having higher priority will not get the chance to be executed first because the equal opportunity is given to each process.

Personal Computers

Personal computer operating system provides a good interface to a single user.

Personal computer operating systems are widely used for word processing, spreadsheets and Internet access.

Personal computer operating system are made only for personal. You can say that your laptops, computer systems, tablets etc. are your personal computers and the operating system such as windows 7, windows 10, android, etc. are your personal computer operating system.

And you can use your personal computer operating system for your personal purposes, for example, to chatting with your friends using some social media sites, reading some articles from internet, making some projects through microsoft powerpoint or any other, designing your website, programming something, watching some videos and movies, listening to some songs and many more.

Parallel Processing

Parallel processing **requires multiple processors and all the processor works simultaneously in the system. Here, the task is divided into subparts and these subparts are then distributed among the available processors in the system. Parallel processing completes the job on the shortest possible time.**

All the processors in the parallel processing environment should run on the **same operating system**. All processors here are **tightly coupled** and are packed in one casing. All the processors in the system share the common **secondary storage** like the hard disk. As this is the first place where the programs are to be placed.

There is one more thing that all the processors in the system share i.e. the **user terminal** (from where the user interact with the system). The user need not to be aware of the inner architecture of the machine. He should feel that he is dealing with the single processor only and his interaction with the system would be the same as in a single processor,
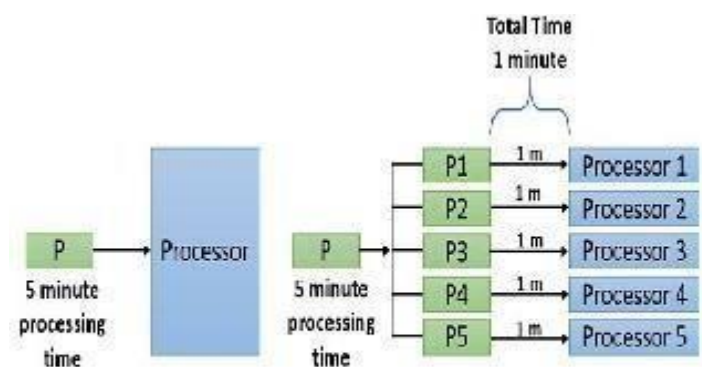
Single Processor Vs Multiprocessor in Parallel processing

Advantages

1. It saves time and money as many resources working together will reduce the time and cut potential costs.

2. It can be impractical to solve larger problems on Serial Computing.

3. It can take advantage of non-local resources when the local resources are finite.

4. Serial Computing 'wastes' the potential computing power, thus Parallel Computing makes better work of the hardware.
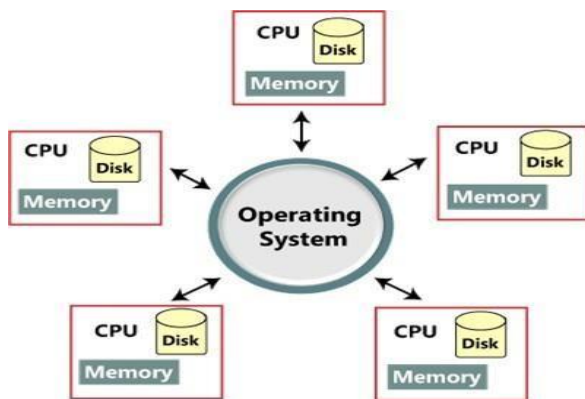
Disadvantages

1. It addresses such as communication and synchronization between multiple sub-tasks and processes which is difficult to achieve.

2. The algorithms must be managed in such a way that they can be handled in a parallel mechanism.

3. The algorithms or programs must have low coupling and high cohesion. But it's difficult to

create such programs.

4. More technically skilled and expert programmers can code a parallelism-based program well.

Distributed Operating System

These types of the operating system is a recent advancement in the world of computer technology and are being widely accepted all over the world and, that too, with a great pace. 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 system's processors differ in size and function. The major benefit of working with these types of the operating system is that it is always possible that one user can access the files or software which are not actually present on his system but some other system connected within this network i.e., remote access is enabled within the devices connected in that network.


Advantages of Distributed Operating System:

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

Disadvantages of Distributed Operating System:

*   Failure of the main network will stop the entire communication
*   To establish distributed systems the language which is used are not well defined yet
*   These types of systems are not readily available as they are very expensive.

Real-Time Operating System:
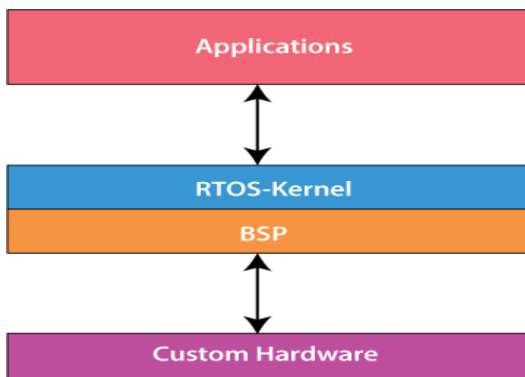
It is developed for real-time applications where data should be processed in a fixed, small duration of time. It is used in an environment where multiple processes are supposed to be accepted and processed in a short time. RTOS requires quick input and immediate response, e.g., in a petroleum refinery, if the temperate gets too high and crosses the threshold value, there should be an immediateresponse to this situation to avoid the explosion. Similarly, this system is used to control scientific instruments, missile launch systems, traffic lights control systems, air traffic control systems, etc.

This system is further divided into two types based on the time constraints:

Hard Real-Time Systems:

These are used for the applications where timing is critical or response time is a major factor; even a delay of a fraction of the second can result in a disaster. For example, airbags and automatic parachutes that open instantly in case of an accident. Besides this, these systems lack virtual memory.

Soft Real-Time Systems:

These are used for application where timing or response time is less critical. Here, the failure to meet the deadline may result in a degraded performance instead of a disaster. For example, video surveillance (cctv), video player, virtual reality, etc. Here, the deadlines are not critical for every task every time.

Advantages of real-time operating system:

o The output is more and quick owing to the maximum utilization of devices and system
o Task shifting is very quick, e.g., 3 microseconds, due to which it seems that several tasks are executed simultaneously
o Gives more importance to the currently running applications than the queued application
o It can be used in embedded systems like in transport and others.
o It is free of errors.
o is allocated appropriately.

Disadvantages of real-time operating system:

o A fewer number of tasks can run simultaneously to avoid errors.

o It is not easy for a designer to write complex and difficult algorithms or proficient programs required to get the desired output.

o Specific drivers and interrupt signals are required to respond to interrupts quickly.

o It may be very expensive due to the involvement of the resources required to work.

An operating system is an interface which provides services to both the user and to the programs. It provides an environment for the program to execute. It also provides users with the services of how to execute programs in a convenient manner. The operating system provides some services to program and also to the users of those programs. The specific services provided by the OS are off course different.

Following are the common services provided by an operating system:

1. Program execution
2. I/O operations
3. File system manipulation
4. Communication
5. Error detection
6. Resource allocation
7. Protection

1) Program Execution

• An operating system must be able to load many kinds of activities into the memory and to run it. The program must be able to end its execution, either normally or abnormally.

• A process includes the complete execution of the written program or code. There are some of the activities which are performed by the operating system:

o   The operating system Loads program into memory
o   It also Executes the program
o   It Handles the program's execution

o   It Provides a mechanism for process synchronization

o   It Provides a mechanism for process communication

2) *I/O Operations*

- The communication between the user and devices drivers are managed by the operating system.

- I/O devices are required for any running process. In I/O a file or an I/O devices can be involved.

- I/O operations are the read or write operations which are done with the help of input-output devices.

- Operating system give the access to the I/O devices when it required.

3) *File system manipulation*

- The collection of related information which represent some content is known as a file. The computer can store files on the secondary storage devices. For long-term storage purpose. examples of storage media include magnetic tape, magnetic disk and optical disk drives like CD, DVD.

- A file system is a collection of directories for easy understand and usage. These directories contain some files. There are some major activities which are performed by an operating system with respect to file management.

o   The operating system gives an access to the program for performing an operation on the file.

o   Programs need to read and write a file.

o   The user can create/delete a file by using an interface provided by the operating system.

o   The operating system provides an interface to the user creates/ delete directories.

o   The backup of the file system can be created by using an interface provided by the operating system.

4) *Communication*

In the computer system, there is a collection of processors which do not share memory peripherals devices or a clock, the operating system manages communication between all the processes. Multiple processes can communicate with every process through communication lines in the network. There are some major activities that are carried by an operating system with respect to communication.

- Two processes may require data to be transferred between the process.

- Both the processes can be on one computer or a different computer, but are connected through a computer network.

5) *Error handling*

An error is one part of the system that may cause malfunctioning of the complete system. The operating system constantly monitors the system for detecting errors to avoid some situations. This

give relives to the user of the worry of getting an error in the various parts of the system causing malfunctioning.

The error can occur anytime and anywhere. The error may occur anywhere in the computer system like in CPU, in I/O devices or in the memory hardware. There are some activities that are performed by an operating system:

- The OS continuously checks for the possible errors.
- The OS takes an appropriate action to correct errors and consistent computing.

6) Resource management

When there are multiple users or multiple jobs running at the same time resources must be allocated to each of them. There are some major activities that are performed by an operating system:

- The OS manages all kinds of resources using schedulers.
- CPU scheduling algorithm is used for better utilization of CPU.

7) Protection

The owners of information stored in a multi-user computer system want to control its use. When several disjoints processes execute concurrently it should not be possible for any process to interfere with another process. Every process in the computer system must be secured and controlled.

Operating system can be implemented with the help of various structures. The structure of the OS depends mainly on how the various common components of the operating system are interconnected and melded into the kernel. Depending on this we have following structures of the operating system:

Simple structure:

Such operating systems do not have well defined structure and are small, simple and limited systems. The interfaces and levels of functionality are not well separated. MS-DOS is an example of such operating system. In MS-DOS application programs are able to access the basic I/O routines. These types of operating system cause the entire system to crash if one of the user programs fails. Diagram of the structure of MS-DOS is shown below.
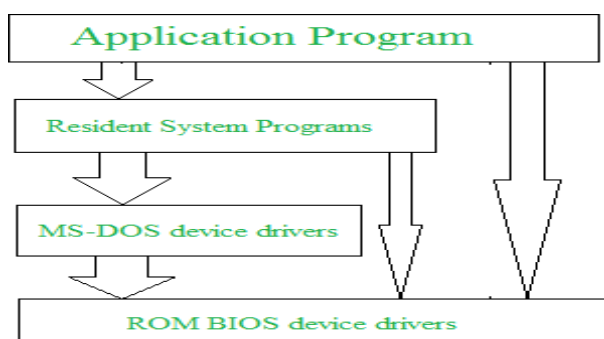
Advantages of Simple structure:

- It delivers better application performance because of the few interfaces between the application

program and the hardware.

- Easy for kernel developers to develop such an operating system.

Disadvantages of Simple structure:

- The structure is very complicated as no clear boundaries exists between modules.
- It does not enforce data hiding in the operating system.

Layered structure:

An OS can be broken into pieces and retain much more control on system. In this structure the OS is broken into number of layers (levels). The bottom layer (layer 0) is the hardware and the topmost layer (layer N) is the user interface. These layers are so designed that each layer uses the functions of the lower level layers only. This simplifies the debugging process as if lower level layers are debugged and an error occurs during debugging then the error must be on that layer only as the lower level layers have already been debugged.

The main disadvantage of this structure is that at each layer, the data needs to be modified and passed on which adds overhead to the system. Moreover careful planning of the layers is necessary as a layer can use only lower level layers. UNIX is an example of this structure.

```
           Layer N
        User Interface
           ......
           Layer 1
          Layer 0
          Hardware
```
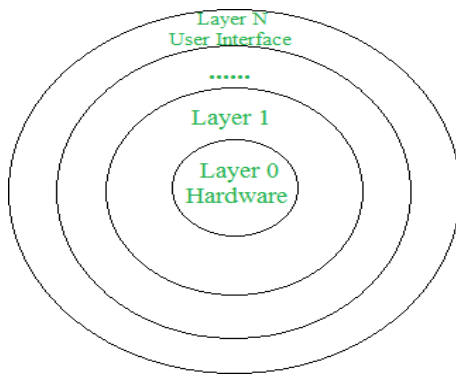
Advantages of Layered structure:

- Layering makes it easier to enhance the operating system as implementation of a layer can be changed easily without affecting the other layers.
- It is very easy to perform debugging and system verification.

Disadvantages of Layered structure:

- In this structure the application performance is degraded as compared to simple structure.

- It requires careful planning for designing the layers as higher layers use the functionalities of only the lower layers.