# UNIT-3

Operating System (OS)

An Operating System (OS) is an interface between a computer user and computer hardware. An operating system is a software which performs all the basic tasks like file management, memory management, process management, handling input and output, and controlling peripheral devices such as disk drives and printers.

Some popular Operating Systems include Linux Operating System, Windows Operating System, VMS, OS/400, AIX, z/OS, etc.

An operating system is a program that acts as an interface between the user and the computer hardware and controls the execution of all kinds of programs.

An **Operating System (OS)** is a software that acts as an interface between computer hardware components and the user. Every computer system must have at least one operating system to run other programs. Applications like Browsers, MS Office, Notepad Games, etc., need some environment to run and perform its tasks.

The OS helps you to communicate with the computer without knowing how to speak the computer's language. It is not possible for the user to use any computer or mobile device without having an operating system.
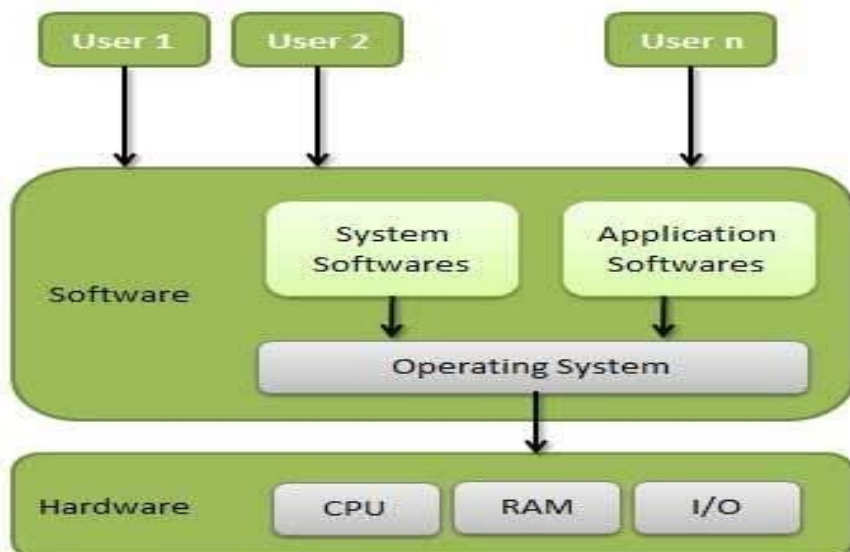
History of Operating System

- Operating systems were first developed in the late 1950s to manage tape storage
- The General Motors Research Lab implemented the first OS in the early 1950s for their IBM 701
- In the mid-1960s, operating systems started to use disks
- In the late 1960s, the first version of the Unix OS was developed
- The first OS built by Microsoft was DOS. It was built in 1981 by purchasing the 86-DOS software from a Seattle company
- The present-day popular OS Windows first came to existence in 1985 when a GUI was created and paired with MS-DOS.
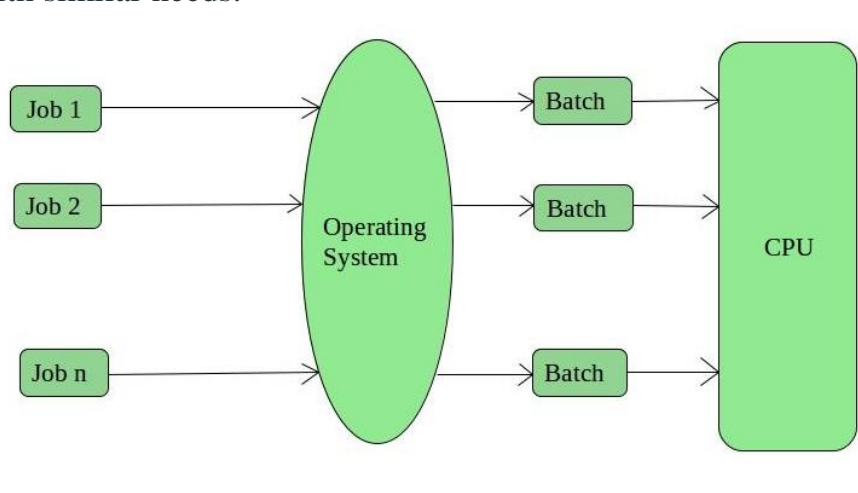
Types of Operating Systems

An Operating System performs all the basic tasks like managing files, processes, and memory. Thus operating system acts as the manager of all the resources, i.e. **resource manager**. Thus, the operating system becomes an interface between user and machine.

Types of Operating Systems: Some widely used operating systems are as follows-

1. Batch Operating System –
This type of operating system does not interact with the computer directly. There is an operator which takes similar jobs having the same requirement and group them into batches. It is the responsibility of the operator to sort jobs with similar needs.

Advantages of Batch Operating System:
- It is very difficult to guess or know the time required for any job to complete. Processors of the batch systems know how long the job would be when it is in queue

- Multiple users can share the batch systems
- The idle time for the batch system is very less
- It is easy to manage large work repeatedly in batch system

Disadvantages of Batch Operating System:
- The computer operators should be well known with batch systems
- Batch systems are hard to debug
- It is sometimes costly
- The other jobs will have to wait for an unknown time if any job fails

Examples of Batch based Operating System: Payroll System, Bank Statements, etc.

2. Time-Sharing Operating Systems –
Each task is given some time to execute so that all the tasks work smoothly. Each user gets the time of CPU as they use a single system. These systems are also known as Multitasking Systems. The task can be from a single user or different users also. The time that each task gets to execute is called quantum. After this time interval is over OS switches over to the next task.
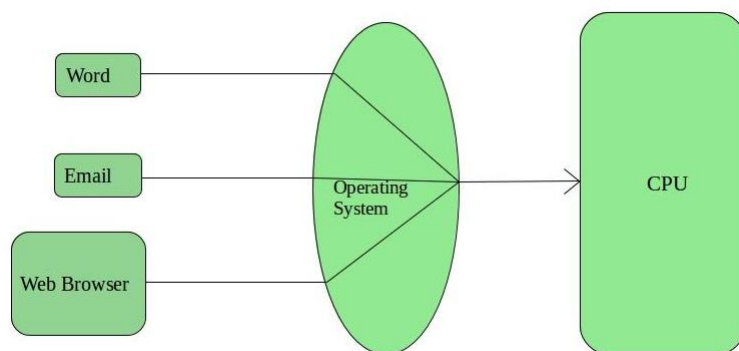
Advantages of Time-Sharing OS:
- Each task gets an equal opportunity
- Fewer chances of duplication of software
- CPU idle time can be reduced

Disadvantages of Time-Sharing OS:
- Reliability problem
- One must have to take care of the security and integrity of user programs and data
- Data communication problem

- **Examples of Time-Sharing OSs are:** Multics, Unix, etc.

3. 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.
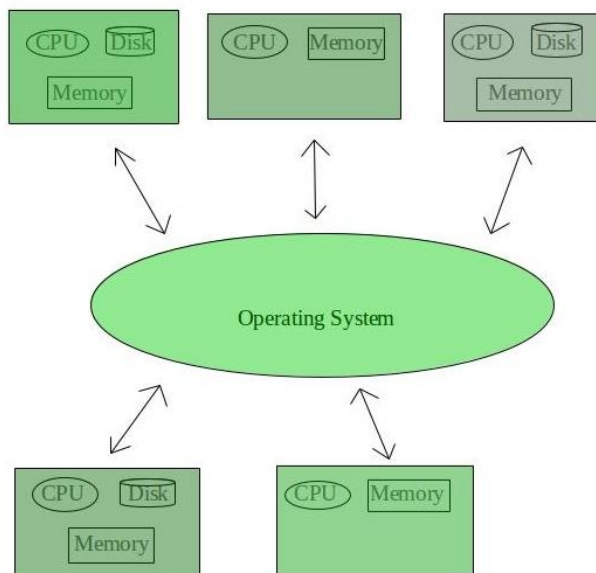
Advantages of Distributed Operating System:
- Failure of one will not affect the other network communication, as all systems are independent from each other
- Electronic mail increases the data exchange speed
- Since resources are being shared, computation is highly fast and durable
- Load on host computer 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. Not only that the underlying software is highly complex and not understood well yet

Examples of Distributed Operating System are- LOCUS, etc.

4. Network Operating System –
These systems run on a server and provide the capability to manage data, users, groups, security, applications, and other networking functions. These types of operating systems allow shared access of files, printers, security, applications, and other networking functions over a small private network. One more important aspect of Network Operating Systems is that all the users are well aware of the underlying configuration, of all other users within the network, their individual connections, etc. and that's why these computers are popularly known as **tightly coupled systems**.
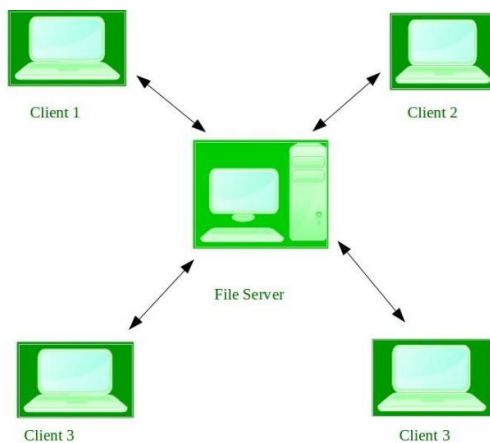
Advantages of Network Operating System:

- Highly stable centralized servers
- Security concerns are handled through servers
- New technologies and hardware up-gradation are easily integrated into the system
- Server access is possible remotely from different locations and types of systems

Disadvantages of Network Operating System:

- Servers are costly

- User has to depend on a central location for most operations
- Maintenance and updates are required regularly

Examples of Network Operating System are: Microsoft Windows Server 2003, Microsoft Windows Server 2008, UNIX, Linux, Mac OS X, Novell NetWare, and BSD, etc.

5. Real-Time Operating System –
These types of OSs serve real-time systems. The time interval required to process and respond to inputs is very small. This time interval is called **response time**.
Real-time systems are used when there are time requirements that are very strict like missile systems, air traffic control systems, robots, etc.

Two types of Real-Time Operating System which are as follows:
- **Hard Real-Time Systems:**
  These OSs are meant for applications 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 airbags which are required to be readily available in case of any accident. Virtual memory is rarely found in these systems.
- **Soft Real-Time Systems:**
  These OSs are for applications where for time-constraint is less strict.
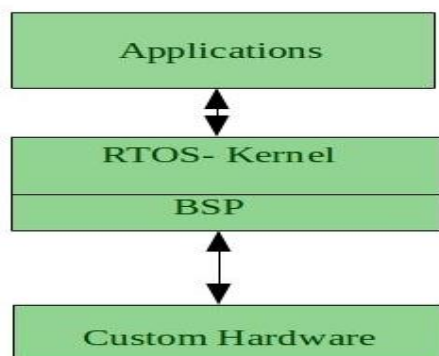
Advantages of RTOS:
- **Maximum Consumption:** Maximum utilization of devices and system, thus more output from all the resources
- **Task Shifting:** The time assigned for shifting tasks in these systems are very less. For example, in older systems, it takes about 10 microseconds in

shifting one task to another, and in the latest systems, it takes 3 microseconds.

- **Focus on Application:** Focus on running applications and less importance to applications which are in the queue.
- Real-time **operating system in** the **embedded system:** Since the size of programs are small, RTOS can also be used in embedded systems like in transport and others.
- **Error Free:** These types of systems are error-free.
- **Memory Allocation:** Memory allocation is best managed in these types of systems.

Disadvantages of RTOS:
- **Limited Tasks:** Very few tasks run at the same time and their concentration is very less on few applications to avoid errors.
- **Use heavy system resources:** Sometimes the system resources are not so good and they are expensive as well.
- **Complex Algorithms:** The algorithms are very complex and difficult for the designer to write on.
- **Device driver and interrupt signals:** It needs specific device drivers and interrupts signals to respond earliest to interrupts.
- **Thread Priority:** It is not good to set thread priority as these systems are very less prone to switching tasks.

Examples of Real-Time Operating Systems are: Scientific experiments, medical imaging systems, industrial control systems, weapon systems, robots, air traffic control systems, etc.

Functions of Operating System

1. Memory Management

It is the management of the main or primary memory. Whatever program is executed, it has to be present in the main memory. Therefore, there can be more than one program present at a time. Hence, it is required to manage the memory.

The operating system:

- Allocates and deallocates the memory.

- Keeps a record of which part of primary memory is used by whom and how much.

- Distributes the memory while multiprocessing.

2. Processor Management/Scheduling

When more than one process runs on the system the OS decides how and when a process will use the CPU. Hence, the name is also **CPU Scheduling**. The OS:

- Allocates and deallocates processor to the processes.

- Keeps record of CPU status.

Certain algorithms used for CPU scheduling are as follows:

- First Come First Serve (FCFS)

- Shortest Job First (SJF)

- Round-Robin Scheduling

- Priority-based scheduling etc.

Purpose of CPU scheduling

The purpose of CPU scheduling is as follows:

- Proper utilization of CPU. Since the proper utilization of CPU is necessary. Therefore, the OS makes sure that the CPU should be as busy as possible.

- Since every device should get a chance to use the processor. Hence, the OS makes sure that the devices get fair processor time.

- Increasing the efficiency of the system.

3. Device Management

The processes may require devices for their use. This management is done by the OS. The OS:

- Allocates and deallocates devices to different processes.

- keep records of the devices.

- Decides which process can use which device for how much time.

4. File Management

The files on a system are stored in different directories. The OS:

- keeps records of the status and locations of files.

- Allocates and deallocates resources.

5. Security

The OS keeps the system and programs safe and secure through authentication. A user id and password decide the authenticity of the user.

7. Accounting

As the operating system keeps track of all the functions of a computer system. Hence, it makes a record of all the activities taking place on the system. It has an account of all the information about the memory, resources, errors, etc. Therefore, this information can be used as and when required.

8. Other Functions

Some other functions of the OS can be:

- **Control over system performance** –
  Monitors overall system health to help improve performance. records the response time between service requests and system response to having a complete view of the system health. This can help improve performance by providing important information needed to troubleshoot problems.
- **Error detecting aids** –
  The operating system constantly monitors the system to detect errors and avoid the malfunctioning of a computer system.

- **Coordination between other software and users** –
  Operating systems also coordinate and assign interpreters, compilers, assemblers, and other software to the various users of the computer systems.

Operating System services

The Operating System provides certain services to the users which can be listed in the following manner:

1. **Program Execution**: The Operating System is responsible for the execution of all types of programs whether it be user programs or system programs. The Operating System utilizes various resources available for the efficient running of all types of functionalities.
2. **Handling Input/Output Operations**: The Operating System is responsible for handling all sorts of inputs, i.e, from the keyboard, mouse, desktop, etc. The Operating System does all interfacing in the most appropriate manner regarding all kinds of Inputs and Outputs.

For example, there is a difference in the nature of all types of peripheral devices such as mice or keyboards, the Operating System is responsible for handling data between them.

3. **Manipulation of File System**: The Operating System is responsible for making decisions regarding the storage of all types of data or files, i.e, floppy disk/hard disk/pen drive, etc. The Operating System decides how the data should be manipulated and stored.

4. **Error Detection and Handling**: The Operating System is responsible for the detection of any type of error or bugs that can occur while any task. The well-secured OS sometimes also acts as a countermeasure for preventing any sort of breach to the Computer System from any external source and probably handling them.

5. **Resource Allocation:** The Operating System ensures the proper use of all the resources available by deciding which resource to be used by whom for how much time. All the decisions are taken by the Operating System.

6. **Accounting:** The Operating System tracks an account of all the functionalities taking place in the computer system at a time. All the details such as the types of errors that occurred are recorded by the Operating System.

7. **Information and Resource Protection:** The Operating System is responsible for using all the information and resources available on the machine in the most protected way. The Operating System must foil an attempt from any external resource to hamper any sort of data or information.

Features of Operating System (OS)

Here is a list important features of OS:

- Protected and supervisor mode
- Allows disk access and file systems Device drivers Networking Security
- Program Execution
- Memory management Virtual Memory Multitasking
- Handling I/O operations
- Manipulation of the file system
- Error Detection and handling
- Resource allocation
- Information and Resource Protection
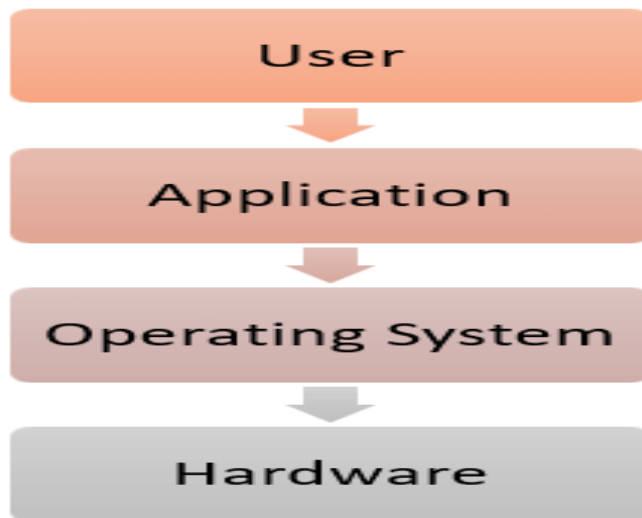
Advantage of Operating System

- Allows you to hide details of hardware by creating an abstraction
- Easy to use with a GUI
- Offers an environment in which a user may execute programs/applications
- The operating system must make sure that the computer system convenient to use
- Operating System acts as an intermediary among applications and the hardware components
- It provides the computer system resources with easy to use format
- Acts as an intermediator between all hardware's and software's of the system

Disadvantages of Operating System

- If any issue occurs in OS, you may lose all the contents which have been stored in your system
- Operating system's software is quite expensive for small size organization which adds burden on them. Example Windows
- It is never entirely secure as a threat can occur at any time

What is Kernel in Operating System?

The kernel is the central component of a computer operating systems. The only job performed by the kernel is to the manage the communication between the software and the hardware. A Kernel is at the nucleus of a computer. It makes the communication between the hardware and software possible. While the Kernel is the innermost part of an operating system, a shell is the outermost one.
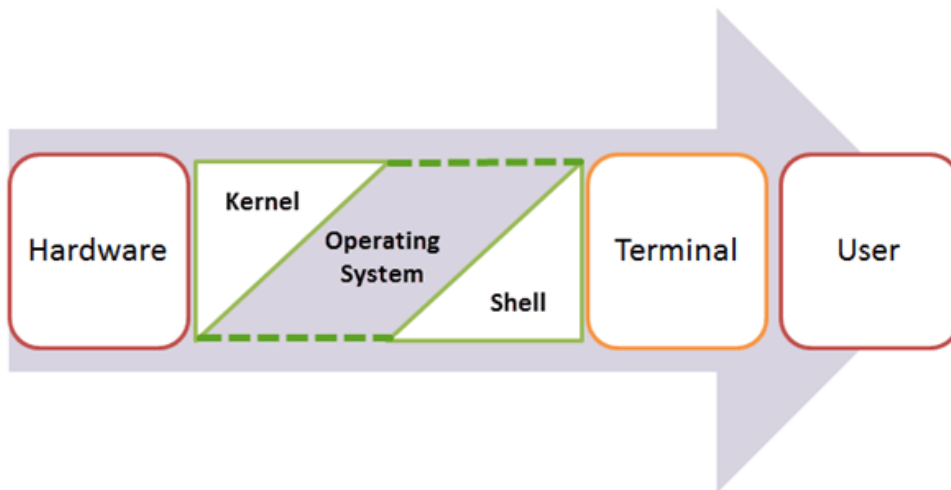
Introduction to Kernel

Features of Kernel

- Low-level scheduling of processes
- Inter-process communication
- Process synchronization
- Context switching

Types of Kernel

There are many types of kernels that exists, but among them, the two most popular kernels are:

1. Monolithic

A monolithic kernel is a single code or block of the program. It provides all the required services offered by the operating system. It is a simplistic design which creates a distinct communication layer between the hardware and software.

2. Microkernels

Microkernel manages all system resources. In this type of kernel, services are implemented in different address space. The user services are stored in user address space, and kernel services are stored under kernel address space. So, it helps to reduce the size of both the kernel and operating system.

Difference between Firmware and Operating System

Below are the Key Differences between Firmware and Operating System:

Firmware	Operating System
Define Firmware: Firmware is one kind of programming that is embedded on a chip in the device which controls that specific device.	Define Operating System: OS provides functionality over and above that which is provided by the firmware.
Firmware is programs that been encoded by the manufacture of the IC or something and cannot be changed.	OS is a program that can be installed by the user and can be changed.
It is stored on non-volatile memory.	OS is stored on the hard drive.

Difference between 32-Bit and 64-Bit Operating System

Parameters	32. Bit	64. Bit
Architecture and Software	Allow 32 bit of data processing simultaneously	Allow 64 bit of data processing simultaneously
Compatibility	32-bit applications require 32-bit OS and CPUs.	64-bit applications require a 64-bit OS and CPU.
Systems Available	All versions of Windows 8, Windows 7, Windows Vista, and Windows XP, Linux, etc.	Windows XP Professional, Vista, 7, Mac OS X and Linux.
Memory Limits	32-bit systems are limited to 3.2 GB of RAM.	64-bit systems allow a maximum 17 Billion GB of RAM.

What is Windows?

Windows is a **graphical operating system** developed by Microsoft. It allows users to view and store files, run the software, play games, watch videos, and provides a way to connect to the internet. It was released for both home computing and professional works.

Microsoft introduced the first version as 1.0

It was released for both home computing and professional functions of Windows on **10 November 1983**. Later, it was released on many versions of Windows as well as the current version, Windows 10.

In 1993, the first business-oriented version of Windows was released, which is known as **Windows NT 3.1**. Then it introduced the next versions, **Windows 3.5**, **4/0**, and **Windows 2000**. When the XP Windows was released by Microsoft in 2001, the company designed its various versions for a personal and business environment. It was designed based on standard x86 hardware, like **Intel** and **AMD processor**. Accordingly, it can run on different brands of hardware, such as HP, Dell, and Sony computers, including home-built PCs.

Editions of Windows

Microsoft has produced several editions of Windows, starting with Windows XP. These versions have the same core operating system, but some versions included advance features with an additional cost. There are two most common editions of Windows:

- Windows Home
- Windows Professional

Windows Home

Windows Home is basic edition of Windows. It offers all the fundamental functions of Windows, such as browsing the web, connecting to the Internet, playing video games, using office software, watching videos. Furthermore, it is less expensive and comes pre-installed with many new computers.

Windows Professional

Windows Professional is also known as Window Pro or win Pro. It is an enhanced edition of Windows, which is beneficial for power users and small to medium-size businesses. It contains all features of Windows Home as well as the following:

- **Remote Desktop:** Windows Professional editions allow users to create a remote desktop connection. It provides users the option to connect with another computer remotely, including share the control of its mouse, keyboard, and view display. It is mainly accessed with the help of port 3389. Additionally, we can also use the TeamViewer or VNC application to create a remote desktop connection.

- **Trusted Boot:** It provides security as encrypting to the boot loader and protects the computer from **rootkits** (Collection of software tools that allow users to enter another computer through an unauthorized way known as rootkits).
- **Bitlocker:** It allows users to encrypt a storage drive by using AES (Advanced Encryption Standard) algorithm. This feature is present in Windows 7, and Windows Vista (Only ultimate and Enterprise versions), including Windows Server 2008.

Business laptops or computers mainly use the Bitlocker feature to protect their data on the computer. As if your computer has been stolen, it is very difficult to break the Bitlocker password. It can be unlocked by entering the correct password only. Furthermore, if you forget your Bitlocker password, it cannot be retrieved.

- **Windows Sandbox:** A sandbox is located on a computer, network, or an online service enables users to experiment or test computer security without interrupting the system.
- **Hyper-V:** It stands for a hypervisor, and developed by Microsoft Corporation on 26 June 2008. It is also called Windows Server Virtualization. Hyper-V is used for virtualization of x86-64 servers, running virtual machines and third party software like VirtualBox.
- **Group policy management:** An admin can specify group policies in an organization to manage different Windows users.
- It provides support for the systems that have more than 128 GB of RAM.
- Furthermore, it also offers more Windows update installation options as well as flexible scheduling and postponement around 34 days.

Why Microsoft Windows is called Windows?

When Microsoft Windows was not introduced, all of the Microsoft users were used MS-DOS operating system. Microsoft gave one word to most of its products; it required a new Word that can represent its new GUI

Operating system. Microsoft decided to call it Windows because it has the ability to perform several tasks and run applications simultaneously.

Another reason behind calling it Windows was that you could not trademark a common name like Windows. Its official name was Microsoft Windows, the first version 1.0 of Windows was introduced in 1995.

In this Introduction to Windows, we will also clear you about the latest OS release of Windows is "Windows 10" which was launched in the year 2015.

In a nutshell, below is how Microsoft windows evolved over time:

- Windows 1.0 – Nov 1985
- Windows 2.0 – Dec 1987
- Windows 3.0 – May 1990
- Windows 95 – Aug 1995
- Windows 98 – June 1998
- Windows ME – Sep 2000
- Windows XP – Oct 2001
- Windows Vista – Nov 2006
- Windows 7 – July 2009
- Windows 8.0 – Oct 2012
- Windows 8.1 – Oct 2013
- Windows 10 – July 2015

Main Components of Windows

After learning about the Introduction to Windows, we are now going to study about the main components of Windows. The main components of the Windows Operating System are the following:

- Configuration and maintenance
- User interface
- Applications and utilities
- Windows Server components
- File systems
- Core components
- Services
- DirectX
- Networking
- Scripting and command-line
- Kernel
- NET Framework
- Security
- Deprecated components and apps
- APIs

Features of Windows

As we learned about Introduction to Windows in the above section, so let's explore the main Features of Windows:

- **Windows Search:** We can have numerous files and contents located on our system and sometimes we may run out of memory about the exact

location of our file. Windows Search is a search function included with Windows that allows the user to search their entire computer

- **Windows File Transfer:** We may have the need to transfer in or transfer out the files and contents from our machine to other devices such as other computers or mobiles and tablets. We can do this by using an Easy Transfer Cable, CDs or DVDs, a USB flash drive, wireless Bluetooth, a network folder, or an external hard disk.

- **Windows Updates:** Windows includes an automatic update feature with the intended purpose of keeping its operating system safe and up-to-date.

- **Windows taskbar:** At the bottom most part of your windows, you will see a row which is known as the taskbar. It has the currently running applications, you can also pin applications that you frequently use by using an option Pin to Taskbar". The taskbar is the main navigation tool for Windows

- **Remote Desktop Connection:** This feature of windows allows you to connect to another system and work remotely on another system.

Advantages and Disadvantages of Windows

After going through all the components, Features and the wide Introduction to Windows, we are going to explore the advantages and disadvantages of Windows

Advantages

Let us see some advantages:

- Desktop as well as tablet-friendly OS
- Switch between applications is very easy
- Not much technical knowledge is required to operate windows
- Windows OS is the dominant OS and enjoys more than 90% of Market share
- MS OS have a great support community and it also has the largest number of applications
- Microsoft provides a powerful set of Enterprise focused Operating System, Applications and the services making it the most dominant player in the OS market.
- More gaming

Disadvantages

There are privacy and security concerns and incidents and they are widespread. Linux OS is by far most secure OS ever built.

- Cost for upgrade
- Windows OS attracts a large number of virus programs due to its largest market share and easy to breach paradigm
- Windows OS is not that much of touch-friendly

Difference between Linux and Windows OS

Topic	Windows	Linux
Command Line	Windows allows users to use the command line, but not as a Linux command line. To open the command line, click on the Run dialog box and type CMD in the run search bar and press Enter key.	Although the Linux command-line offers more features for administration and daily tasks, it does not offer much to end-users.
Reliability	Windows has improved its reliability in the past few years, but still it is less reliable as compared to Linux.	Linux is more reliable and secure then Windows OS. It mainly focuses on system security, process management, and up-time.
Usability	Windows is easier to use as it provides a simple user interface. But its installation process can take more time.	Although Linux has the ability to perform complex tasks easier, its installation process is complicated.
Security	Microsoft has enhanced the security features in Windows over recent years. As it has a huge user base, mostly for new computer users, it can be easily targeted for malicious coders. Furthermore, among all of the operating systems, Microsoft Windows can be part of developing malware and viruses.	Linux is a more secure operating system as compared to Microsoft Windows. Even attackers found difficulty in breaking the security with the help of Linux.

Support	It provides users the online and integrated help systems, as well as a large number of informative books, are available to provide help for people at all skill levels.	A wide number of books are available to offer help about Linux, including online support.
Updates	Regular Windows update makes users frustrated by alerting the Windows update for inconvenient times. Additionally, it takes more time to get an update.	Linux provides users full control over updates. They can update it accordingly, and it takes less time to get an update as well as without any reboot the system.
Licensing	Microsoft Windows with license does not allow to modify the software (don't have access to the source code). It can be installed only on the systems with a Windows license key.	Linux operating system with a license offers users the benefit to re-use the source code on any number of systems. It is also allowed the users to modify the software and sell its modified version.