Week 1 – Operating System

1.1 OVERVIEW OF OPERATING SYSTEM

Computer system can be divided into **four** components:

1. **Hardware:** provides basic computing resources for the system.
   Example: CPU, memory, I/O devices
2. **Operating system:** Controls and coordinates use of hardware among various applications and users.
   Example: UNIX, Mach, MS-DOS, MS-Windows, Windows/NT, Chicago, OS/2, MacOS, VMS, MVS, and VM
3. **Application programs:** define the ways in which the system resources are used to solve the computing problems of the users.
   Example: Word processors, compilers, web browsers, database systems, video games
4. **Users: Example:** People, machines, other computers

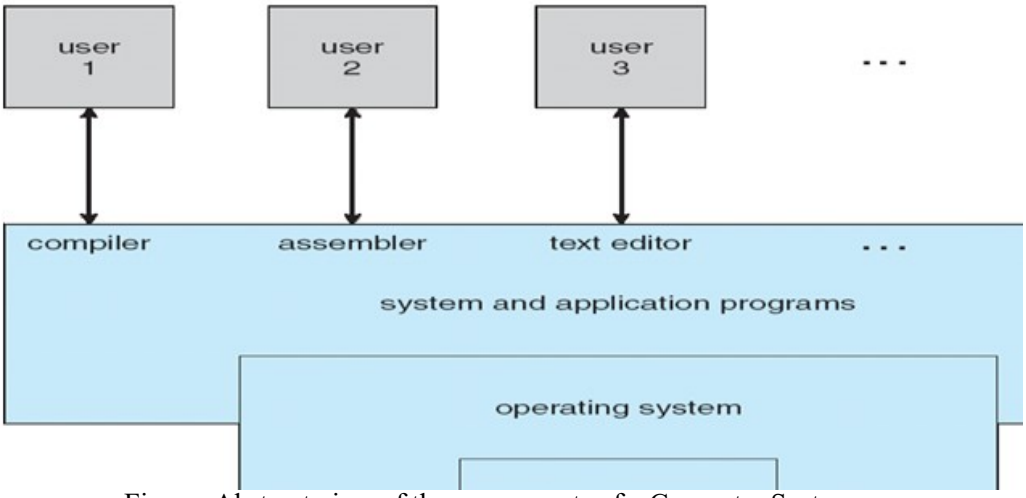


Figure: Abstract view of the components of a Computer System.

Overview of Operating System

Operating System is a program that acts as an intermediary between a user of a computer and the computer hardware

OS is a **Resource Allocator**

- ✓ Manages all resources
- ✓ Decides between conflicting requests for efficient and fair resource use

OS is a C**ontrol Program**

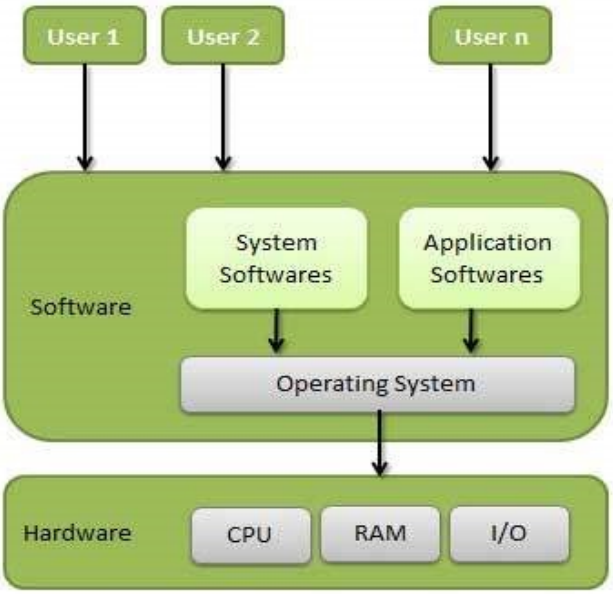
- ✓ Controls execution of programs to prevent errors and improper use of the computer

Operating system goals:

- ✓ Execute user programs and make solving user problems easier
- ✓ Make the computer system convenient to use
- ✓ Use the computer hardware in an efficient manner.

Definition:

- ✓ An **Operating System (OS)** is an interface between computer user and computer hardware.
- ✓ An operating system is 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.



Following are some of important functions of an operating System.

1. Memory Management
2. Processor Management
3. Device Management
4. File Management
5. Security
6. Control over system performance
7. Job accounting
8. Error detecting aids
9. Coordination between other software and users

1.2 Need for Operating System

We need an operating system for the following functions:

1. The interface between the user and the computer
2. Booting
3. Managing the input/output devices
4. Multitasking
5. The platform for other application programs
6. Manages the memory
7. Manages the system files
8. Provides Security
9. The interface between hardware and software

1. Interface between the user and the computer

An OS provides a very easy way to interact with the computer. It provides different features and GUI so that we can easily work on a computer. We have to interact just by clicking the mouse or through the keyboard. Thus, we can say that an OS makes working very easy and efficient.

2. Booting

Booting is a process of starting the computer operating system starts the computer to work. It checks the computer and makes it ready to work.

When the CPU is first switched ON it has nothing inside the memory. So, to start the computer, we load the **operating system** into the main memory. Therefore, loading the OS to the main memory to start the computer is booting. Hence, the Os helps to start the computer when the power is switched ON.

3. Managing the input/output devices

The OS helps to operate the different input/output devices. The OS decides which program or process can use which device. Moreover, it decides the time for usage. In addition to this, it controls the allocation and deallocation of devices.

4. Multitasking

The OS helps to run more than one application at a time on the computer. It plays an important role while multitasking. Since it manages memory and other devices during multitasking. Therefore, it provides smooth multitasking on the system.

5. Platform for other application software

Users require different application programs to perform specific tasks on the system. The OS manages and controls these applications so that they can work efficiently. In other words, it acts as an interface between the user and the applications.

Some other uses/need for operating system are:

6. Manages the memory

It helps in managing the main memory of the computer. Moreover, It allocates and deallocates memory to all the applications/tasks.

7. Manages the system files

It helps to manage files on the system. As we know, all the data on the system is in the form of files. It makes interaction with the files easy.

8. Provides Security

It keeps the system and applications safe through authorization. Thus, the OS provides security to the system.

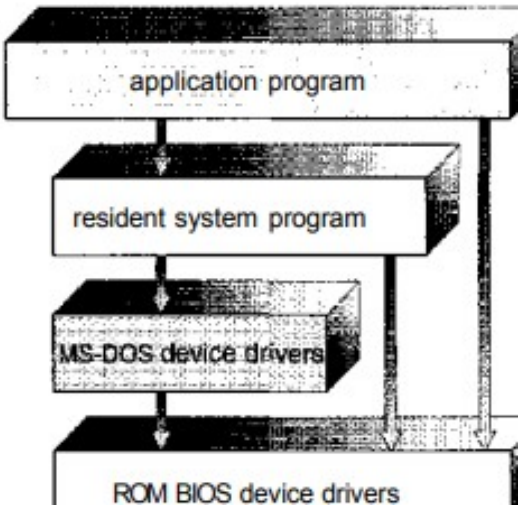
9. Acts as an Interface

It is an interface between computer hardware and software. Moreover, it is an interface between the user and the computer.

1.3 Operating-System Structure

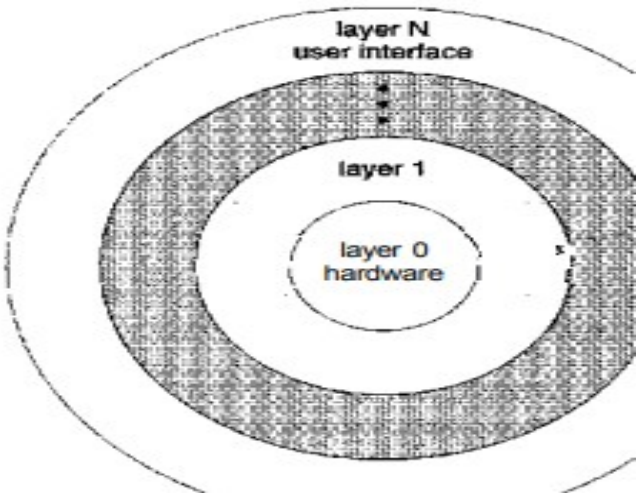
1.3.1 Simple Structure:

- ✓ Many commercial systems do not have well-defined structures. Frequently, such operating systems started as small, simple, and limited systems and then grew beyond their original scope.
- ✓ MS-DOS is an example of such a system. It was originally designed and implemented by a few people who had no idea that it would become so popular. It was written to provide the most functionality in the least space, so it was not divided into modules carefully.
- ✓ Figure 2.10 shows its structure. In MS-DOS, the interfaces and levels of functionality are not well separated



1.3.2 Layered Approach

- ✓ A system can be made modular in many ways. One method is the layered approach, in which the operating system is broken up into a number of layers (levels). The bottom layer (layer 0) is the hardware; the highest (layer N) is the user interface. This layering structure is depicted in Figure 2.12.
- ✓ The main advantage of the layered approach is simplicity of construction and debugging
- ✓ Each layer is implemented with only those operations provided by lower level layers. A layer does not need to know how these operations are implemented;
- ✓ The major difficulty with the layered approach involves appropriately defining the various layers. Because a layer can use only lower-level layers, careful planning is necessary.



Operating System structure

Operating System structure is the basic model which is needed to implement Operating Systems.

Components of OS: OS has two parts.

(1) Kernel.

(2) Shell.

(1) Kernel is an active part of an OS i.e., it is the part of OS running at all times. It is a programs which can interact with the hardware.

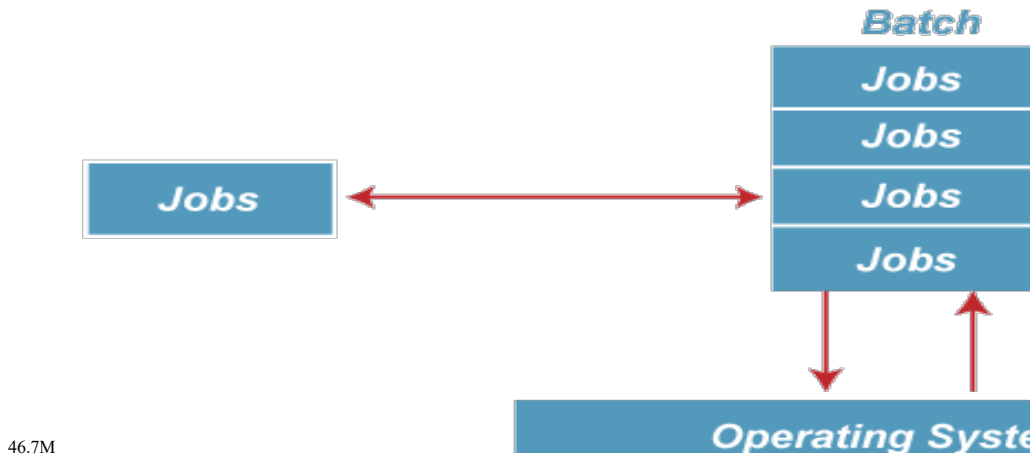
Ex: Device driver, dll files, system files etc.

(2) Shell is called as the command interpreter. It is a set of programs used to interact with the application programs. It is responsible for execution of instructions given to OS (called commands).

1.4 Types of Operating Systems

1.4.1 Batch Operating System

- ✓ Batch Operating System accepts more than one job and these jobs are batched/ grouped together according to their similar requirements. This is done by computer operator. Whenever the computer becomes available, the batched jobs are sent for execution and gradually the output is sent back to the user.
- ✓ It allowed only one program at a time.
- ✓ This OS is responsible for scheduling the jobs according to priority and the resource required



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Advantages of Batch OS

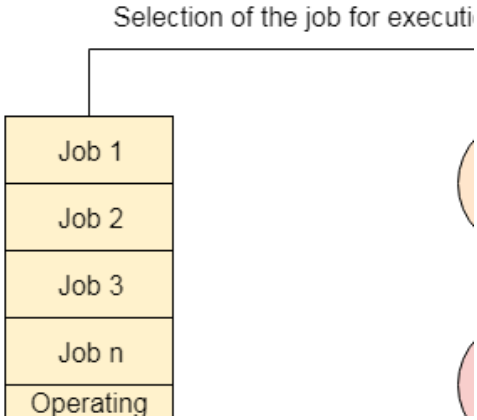
1. The use of a resident monitor improves computer efficiency as it eliminates CPU time between two jobs.

Disadvantages of Batch OS

1. Starvation

Batch processing suffers from starvation.

For Example:



There are five jobs J1, J2, J3, J4, and J5, present in the batch. If the execution time of J1 is very high, then the other four jobs will never be executed, or they will have to wait for a very long time. Hence the other processes get starved.

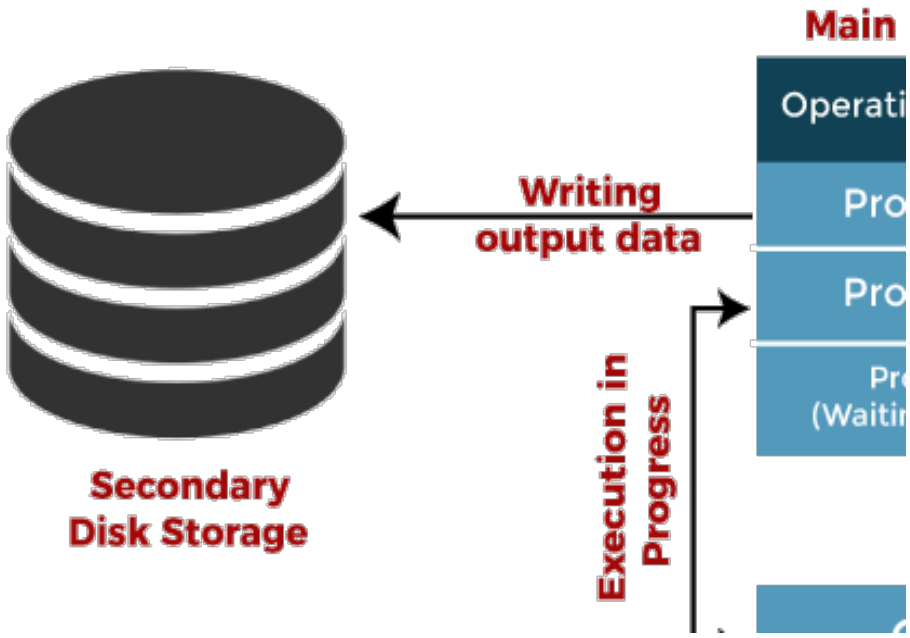
2. Not Interactive

Batch Processing is not suitable for jobs that are dependent on the user's input. If a job requires the input of two numbers from the console, then it will never get it in the batch processing scenario since the user is not present at the time of execution.

Examples are the payroll system, bank statement, etc.

1.4.2 Multiprogramming Operating System

- ✓ Multiprogramming OS is used to execute more than one job simultaneously by a single processor. It increases CPU utilization by organizing jobs so that the CPU always has one job to execute.
- ✓ The concept of multiprogramming is described as follows:
  - ➢ All the jobs that enter the system are stored in the job pool (in disc). The operating system loads a set of jobs from job pool into main memory and begins to execute.
  - ➢ During execution, the job may have to wait for some task, such as an I/O operation, to complete. In a multiprogramming system, the operating system simply switches to another job and executes. When that job needs to wait, the CPU is switched to another job, and so on.
  - ➢ When the first job finishes waiting and it gets the CPU back.
  - ➢ As long as at least one job needs to execute, the CPU is never idle.
- ✓ Multiprogramming operating systems use the mechanism of job scheduling and CPU scheduling.



Advantages of Multiprogramming OS

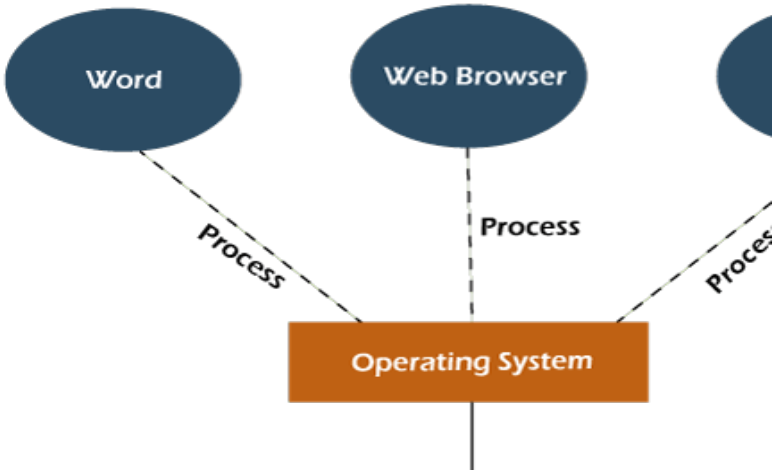
1. Throughout the system, it increased as the CPU always had one program to execute.
2. Response time can also be reduced.

Disadvantages of Multiprogramming OS

1. Multiprogramming systems provide an environment in which various systems resources are used efficiently, but they do not provide any user interaction with the computer system.

1.4.3 Multitasking/ Time-Sharing Operating System

- ✓ **Time sharing (or multitasking) Operating System** is a logical extension of multiprogramming system that enables multiple programs simultaneously. It allows a user to perform more than one computer task at the same time.
- ✓ **Time sharing OS** allows the user to perform more than one task at a time, each task getting the same amount of time to execute.
- ✓ It provides extra facilities such as:
  - ➢ Faster switching between multiple jobs to make processing faster.
  - ➢ Allows multiple users to share computer system simultaneously.
  - ➢ The users can interact with each job while it is running.
- ✓ These systems use a concept of virtual memory for effective utilization of memory space. Hence, in this OS, no jobs are discarded. Each one is executed using virtual memory concept.
- ✓ It uses CPU scheduling, memory management, disc management and security management.
- ✓ Examples: UNIX, CTSS, MULTICS, CAL etc.



Advantages of Multitasking operating system

1. Response time of CPU reduces.
2. Idle time of CPU reduces.
3. Each task/process gets an equal time slot to execute.

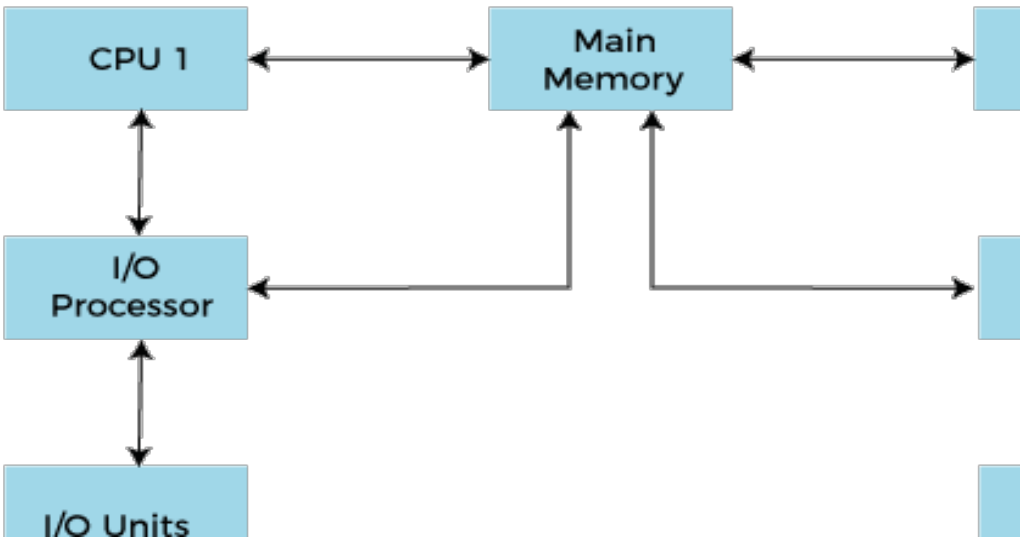
Disadvantages of Multitasking operating system

1. The multiple processors are busier at the same time to complete any task in a multitasking environment, so the CPU generates more heat.

1.4.4 Multiprocessor Operating System

- ✓ Multiprocessor operating systems are also known as parallel OS or tightly coupled OS. Such operating systems have more than one processor in close communication that sharing the computer bus, the clock and sometimes memory and peripheral devices. It executes multiple jobs at same time and makes the processing faster.
- ✓ Multiprocessor systems have three main advantages:

1. **Increased throughput:** By increasing the number of processors, the system performs more work in less time. The speed-up ratio with N processors is less than N.
2. **Economy of scale:** Multiprocessor systems can save more money than multiple single-processor systems, because they can share peripherals, mass storage, and power supplies.
3. **Increased reliability:** If one processor fails to done its task, then each of the remaining processors must pick up a share of the work of the failed processor. The failure of one processor will not halt the system, only slow it down.



Advantages of Multiprocessing operating system:

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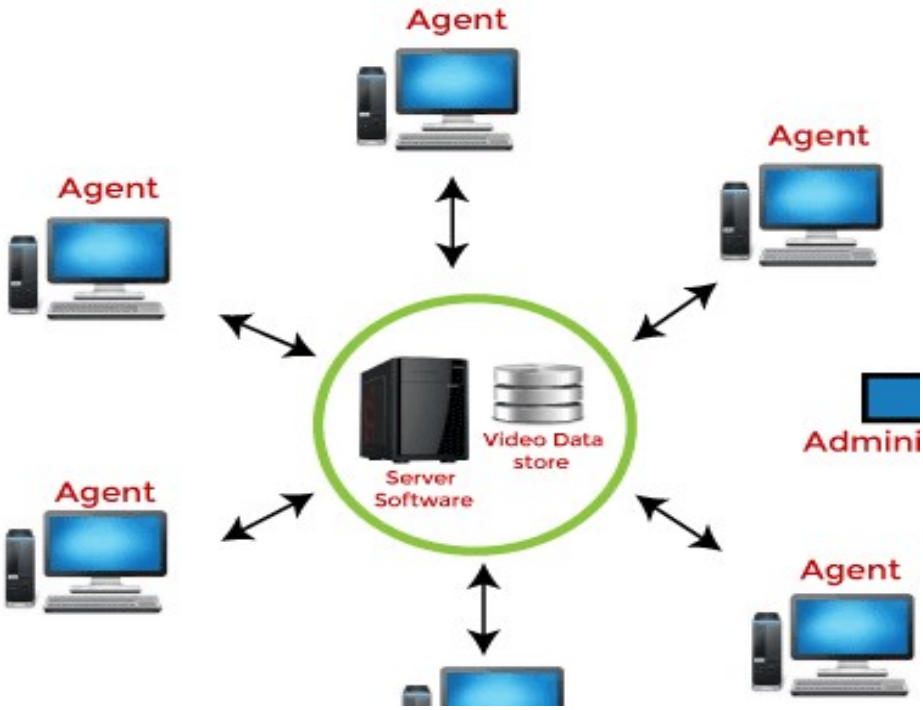
Disadvantages of Multiprocessing operating System

1. Multiprocessing operating system is more complex and sophisticated as it takes care of multiple CPUs simultaneously.

1.4.5 Network Operating System

In Network Operating System various systems are connected to a server. It allows the system to share resources such as files, printers, applications, etc. Moreover, it gives the capability to serve to manage these resources.

Examples are UNIX, LINUX, Microsoft Windows Server 2008, etc.



An Operating system, which includes software and associated protocols to communicate with other computers via a network conveniently and cost-effectively, is called **Network Operating System**.

Advantages of Network Operating System

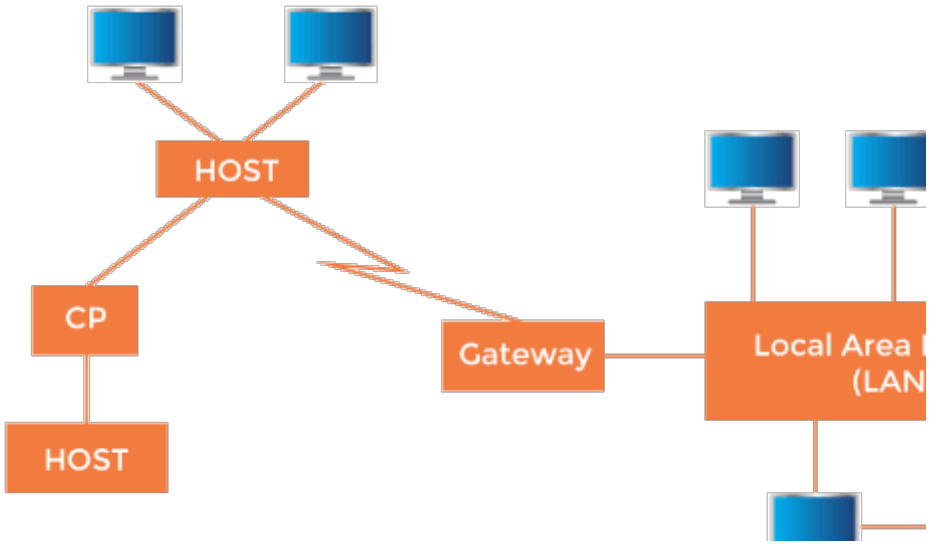
1. In this type of operating system, network traffic reduces due to the division between clients and the server.
2. This type of system is less expensive to set up and maintain.

Disadvantages of Network Operating System

1. In this type of operating system, the failure of any node in a system affects the whole system.
2. Security and performance are important issues. So trained network administrators are required for network administration.

1.4.6 Distributed Operating System

- ✓ In distributed operating system, the different machines are connected in a network and each machine has its own processor and own local memory.
- ✓ In this system, the operating systems on all the machines work together to manage the collective network resource.
- ✓ The Distributed Operating system is not installed on a single machine, it is divided into parts, and these parts are loaded on different machines. A part of the distributed Operating system is installed on each machine to make their communication possible. Distributed Operating systems are much more complex, large, and sophisticated than Network operating systems because they also have to take care of varying networking protocols.



✓

- ✓ It can be classified into two categories:
  1. Client-Server systems
  2. Peer-to-Peer systems
- ✓ Advantages of distributed systems:
  1. Resources Sharing
  2. Computation speed up – load sharing
  3. Reliability
  4. Communications
  5. Requires networking infrastructure.
  6. Local area networks (LAN) or Wide area networks (WAN)
- ✓ Examples are LOCUS etc.

Advantages of Distributed Operating System

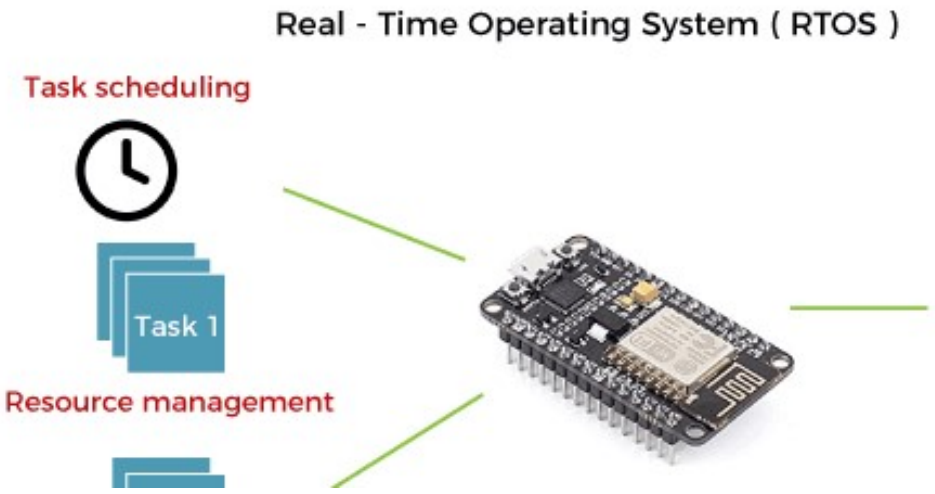
1. The distributed operating system provides sharing of resources.
2. This type of system is fault-tolerant.

Disadvantages of Distributed Operating System

1. Protocol overhead can dominate computation cost.

1.4.7 Real Time Operating System

A real-time operating system (RTOS) is a multitasking operating system intended for applications with fixed deadlines (real-time computing). Such applications include some small embedded systems, automobile engine controllers, industrial robots, spacecraft, industrial control, and some large-scale computing systems.



The Application of a Real-Time system exists in the case of military applications, if you want to drop a missile, then the missile is supposed to be dropped with a certain precision.

The real time operating system can be classified into three categories:

1. Hard real time system
2. Firm real time system. And
3. Soft real time systems

1. Hard Real-Time Systems

In this, the time constraint is very short and strict. Even seconds of delay is not acceptable. Therefore, it is compulsory to complete the task within the given time only.

Examples are Airplanes systems, Medical treatment systems, etc.

2. Firm Real-Time Systems

In these systems, although the deadline is given but, missing them does not result in great loss. There can be some unwanted side effects in the system if the deadline is not followed.

Examples are multimedia systems.

3. Soft Real-Time Systems

As the name suggests, the system handles the deadlines softly. This means that if there are small delays in the system, it is acceptable.

Examples are Online Transaction systems, Livestock price quotation systems, Computer games, etc.

Advantages of Real-time operating system:

- They have no errors.
- Due to their small size, they can be easily added to other systems.

Disadvantages of Real-time operating system:

- Algorithms are complex.
- System resources are expensive.

The differences between hard real-time systems and soft real-time systems are as follows:

Hard Real-Time System	Soft Real-Time System
These systems have to follow the deadline very strictly.	These systems do not have fewer restrictions on the deadline.
The size of the data file is either small or medium.	On the other hand, soft real-time systems have large data files.
The response time is in milliseconds.	Comparatively, the response time is higher.

These systems strictly emphasize safety.	Safety is not so strict in these systems.
Examples are satellite launch systems, missile launch systems, Railway systems, etc	Examples are computer games, online transaction systems, etc.

Difference between Firm and Soft Real-Time Systems

The differences between firm real-time systems and soft real-time systems are as follows:

Firm Real-Time System	**Soft Real-Time System**
The system should complete the task before the deadline.	It also has to complete the task within the deadline but, not strictly.
In case, it gives the results after the deadline it has zero importance.	If it gives the results after the deadline, the importance decreases and slowly goes to zero value.
If the results are given after the deadline, they are considered as incorrect.	On the other hand, even if the system gives the results after the deadline they are not considered incorrect.
Multimedia applications use such systems. Practical systems make less use of them.	It is mostly used in practical applications.
Examples are multimedia systems etc.	Examples are computer games, online transaction systems, etc.

1.5 Examples of Operating System

1. MS Windows

MS Windows is a personal computer operating system. It was created by Microsoft. MS Windows is an operating system that manages the resources of the computer and provides an interface for the user to interact with different parts of the computer.
MS Windows has three main versions that are used in PCs, laptops, tablets, and other devices (Windows 10, 8.1, 7).

2. MS DOS

MS-DOS is an operating system made by Microsoft that is the predecessor to Windows.
It used to be the most popular operating system in the world, but nowadays it's rare for people to use MS-DOS.
But what exactly does it do? MS-DOS stands for "Microsoft Disk Operating System."
It's a computer program that was designed to provide basic file management and text output functions.

3. Ubuntu OS

Ubuntu is an open-source Linux-based operating system.
It can be installed on desktops, servers, and smart phones.
Ubuntu is the most popular operating system in use on supercomputers and can also be found on many of the world's fastest machines.

4. Mac OS

Mac OS is a desktop operating system created by Apple Inc. that has been designed to work on Macintosh computers. The original version of Mac OS was introduced in 1984.
It is the predecessor of macOS, which is the current Apple's desktop and laptop operating system.
Mac OS provides a number of different features, such as a graphical user interface, pre-emptive multitasking, and memory protection that had never been seen before on personal computers when it was introduced with the original Macintosh 128K in 1984.

5. Apple IOS

Apple IOS is a mobile operating system that was created in 2007 and released in 2008.
It was the successor of Apple’s other operating system, known as OS X.
The IOS has been developed by Apple Inc., which is headquartered in Cupertino, California.
There are two versions of this software: iOS 12 and iOS 11.

The IOS is designed for use on Apple devices, such as the iPhone, iPad Pro, and iPod Touch.

It can also be downloaded onto computers to allow them to run the same features available on the devices.

6. Linux OS

Linux is a free and open-source operating system.

You can use it for any device, including your computer, laptop, smartphone, tablet, and even a smartwatch.

Linux has been around since 1991 and was created by a Finnish student named Linus Torvalds.

It was made specifically to have the benefits of being an open-source software which makes it possible for anyone to contribute or make changes to the code without paying royalties or using patents.

7. UNIX OS

UNIX is a computer operating system originally developed in 1969 and was built with the intention of being an open and free operating system.

It is a multi-user, multitasking, and multithreaded computer system that is capable of running different applications at the same time.

UNIX operating systems are most commonly used in enterprise servers, college networks, and high-performance computing clusters.

8. Android OS

Android is a popular mobile operating system.

Unlike Apple's iOS, Android is an open-source platform, which means it can be used for free by any manufacturer.

So now you have people from all over the world making phones and tablets with Android on them.

Android is designed to be flexible and adaptable to a wide variety of devices, from smartphones to digital cameras, watches, TVs, and cars.

9. Chrome OS

Chrome OS is a Google operating system that focuses on the web browser.

It was created at the end of 2009 to be a lightweight and efficient operating system that would work on low-end machines.

This operating system has been designed to integrate seamlessly with Google’s cloud computing software.

10. Fedora OS

Fedora is a Linux-based operating system that is distributed free of charge and includes a number of features that make it stand out from the rest.

Fedora provides open-source software and other features that you would expect to find in an operating

system like Ubuntu or Mint, but it also comes with additional perks such as community support and training as well as updates on a release schedule

Examples of Operating System

Following are some examples of Operating Systems:

1. Microsoft Windows

It is a series of graphical operating systems developed, marketed, and sold by Microsoft. The first version of Windows was released in 1985 as a GUI add-on to MS-DOS. The first version of Windows sold as a standalone operating system was Windows 95.

2. macOS

It is a series of graphical operating systems developed by Apple Inc. It is the successor to Mac OS X, and it is the operating system that powers Apple's Mac family of computers.

3. Linux

Linux is built around the Linux kernel and is a free and open-source software operating system. It is one of the most popular operating systems for servers and embedded devices. It is also used by millions of desktop users around the world.

4. Android

It is a mobile operating system developed by Google. It is based on the Linux kernel and designed primarily for touchscreen mobile devices such as smartphones and tablets.

5. iOS

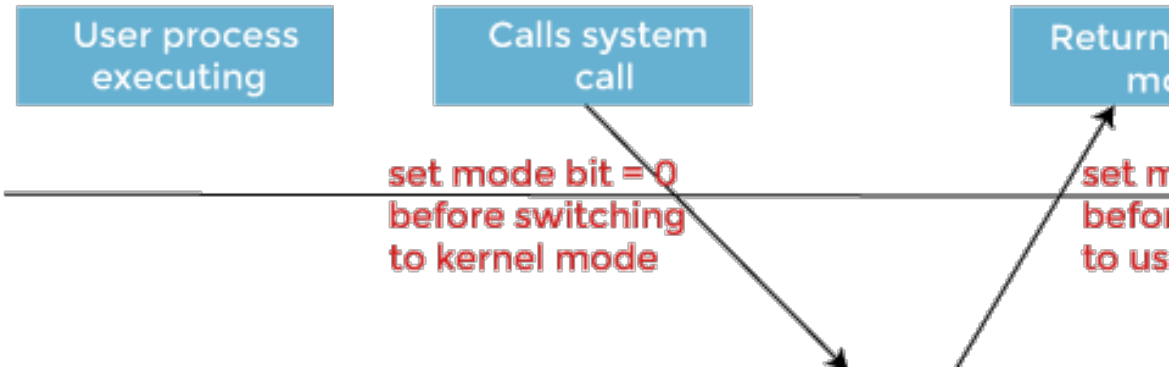
Another example of a mobile operating system developed by Apple Inc. iOS is the successor to iPhone OS. It is an operating system that powers the iPhone, iPad, and iPod Touch products.

1.6 Dual-Mode Operation

- ✓ Dual-mode operation allows OS to protect itself and other system components.
- ✓ Two separate modes of operation: user mode and kernel mode (also called supervisor mode, system mode, or privileged mode).
- ✓ A bit, called the mode bit, is added to the hardware of the computer to indicate the current mode: kernel (0) or user (1). With the mode bit, we are able to distinguish between a task that is executed on behalf of the operating system and one that is executed on behalf of the user. When the computer system is executing on behalf of a user application, the system is in user mode. However, when a user application

requests a service from the operating system (via a system call), it must transition from user to kernel mode to fulfill the request

- ✓ At system boot time, the hardware starts in kernel mode. The operating system is then loaded and starts user applications in user mode. Whenever a trap or interrupt occurs, the hardware switches from user mode to kernel mode
- ✓ The dual mode of operation provides us with the means for protecting the operating system from errant users—and errant users from one another.



Kernel

Kernel is the core part of an OS (Operating system); hence it has full control over everything in the system. Each operation of hardware and software is managed and administrated by the kernel.

- ✓ It is the part of the OS that always resides in computer memory and enables the communication between software and hardware components.
- ✓ It is the computer program that first loaded on start-up the system (After the bootloader). Once it is loaded, it manages the remaining start-ups. It also manages memory, peripheral, and I/O requests from software. Moreover, it translates all I/O requests into data processing instructions for the CPU. It manages other tasks also such **as memory management, task management, and disk management**.
- ✓ A kernel is kept and usually loaded into separate memory space, known as **protected Kernel space.** It is protected from being accessed by application programs or less important parts of OS.

Microkernels

This method structures the operating system by removing all nonessential components from the kernel and implementing them as system and user-level programs. The result is a smaller kernel.

The main function of the microkernel is to provide a communication facility between the client program and the various services that are also running in user space.

For example, if the client program wishes to access a file, it must interact with the file server. The client program and service never interact directly. Rather, they communicate indirectly by exchanging messages with the microkernel. One benefit of the microkernel approach is ease of extending the operating system. All new services are added to user space and consequently do not require modification of the kernel. When the kernel does have to be modified, the changes tend to be fewer, because the microkernel is a smaller kernel. The resulting operating system is easier to port from one hardware design to another. The microkernel also provides more security and reliability, since most services are running as user—rather than kernel—processes. If a service fails, the rest of the operating system remains untouched

1.7 Functions of Operation System

Given below are the various functions of an Operating System:

- ✓ It helps with memory management. It keeps a track of the files being saved in the Main memory and the primary memory of the computer device
- ✓ Whenever a computer is turned on, the Operating system automatically starts to work. Thus, the booting and rebooting process of a computer device is also an important function of the OS
- ✓ It provides a user interface
- ✓ Managing of basic peripheral devices is done by the operating system
- ✓ Using the password protection option of an operating system, the data in the device can be kept secure
- ✓ It coordinates with the software and the user
- ✓ Easy navigation and organization of files and programs are managed by the OS
- ✓ Any kind of program which needs to be run through the system is done by the operating system
- ✓ If any kind of error or bug is found during the program is detected using the operating system.

1.8 User Interface

A User interface (UI) facilitates communication between an application and its user by acting as an intermediary between them. The two basic function of a user interface of an application is to take the inputs from the user and to provide the output to the users.

A user interface of any operating system can be classified into one of the following types:

1. Graphical user interface (GUI)
2. Command line user interface (CLI)

1. **Graphical User Interface (GUI):** The modern operating systems such as Windows, Linux, and Mac all use GUI. GUI is easy to operate and user-friendly. GUI provides the ability to use the mouse or fingertips to navigate the commands. It becomes easy to interact with the computers. The operating system with GUI uses four components to interact with the system. These are abbreviated as WIMP (windows, icons, menus, and pointer).

2 .Command Line Interface (CLI): The CLI has a command prompt from where you can issue a command. The CLI accepts the text based commands on the command line or terminal and executes them. In CLI, the correct syntax of commands has to be used, hence the commands need to be remembered by the user. CLI was used by the operating system of the early days. Operating systems—DOS and Unix are the examples of CLI. In using command line interface, the correct syntax has to be used.

1.9 Types of OS installation

i) Windows 10 Upgrade

It is possible to upgrade Windows 10 on the existing computers or you can choose the clean installation. If you have the licensed copy of Windows 7, then it is possible to upgrade it to Windows 10.

In place upgrade: The existing operating system can be updated to Windows 10 without destroying the user data and settings. It is the recommended and most preferred method for most of the users who wish to upgrade to Windows 10 in the existing hardware. In this method, Windows 10 setup program automatically retains the settings. It is important to backup user data files before starting the upgrade to avoid possible data loss.

ii) Clean installation

A clean installation of Windows 10 is the process of erasing the hardware and setting up a new fresh copy of the platform when a computer has a problem. For example, you can resolve performance, memory, startup, shut down, and apps issues using this method. Also, it's perhaps the best approach to remove viruses and other types of malware, and it can help to improve battery life.

In addition, it's an excellent solution to remove preloaded bloatware (unnecessary preloaded software) from Windows 10. You can use this method to decommission a computer without giving away your data. Or you can set up a new installation after replacing the hard drive.

iii) Dual Booting

Most computers ship with a single operating system, but you can have multiple operating systems installed on a single PC. Having two operating systems installed — and choosing between them at boot time — is known as "dual-booting."

A dual boot is when you run two operating systems on one computer at the same time. This can be any combination of operating systems, for example, Windows and Mac, Windows and Linux or Windows 7 and Windows 10.

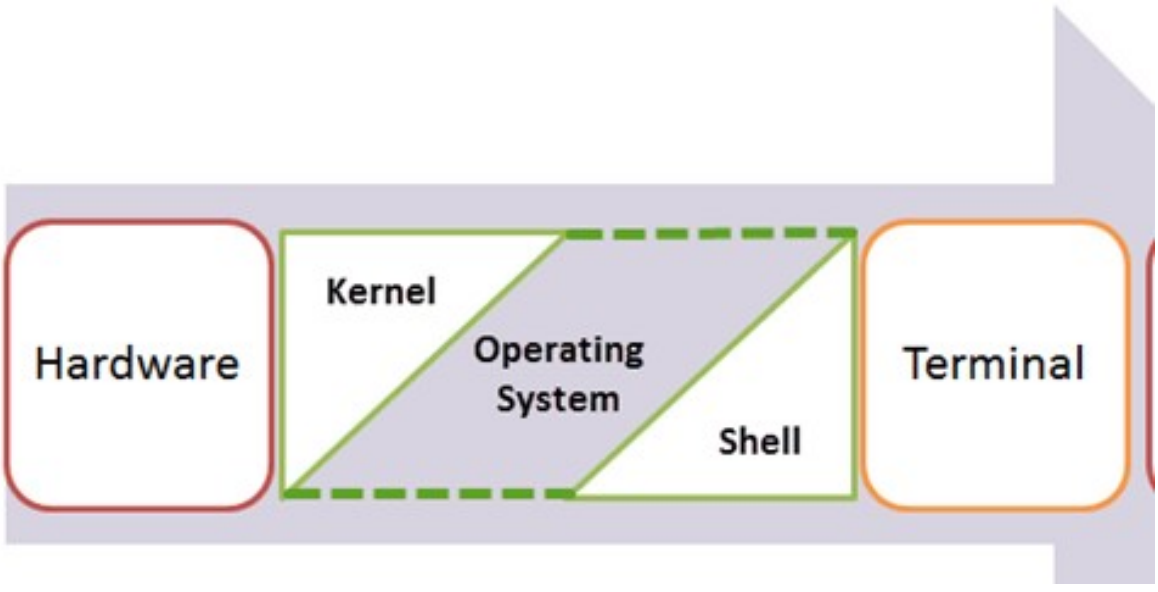
Comparison: Mobile Operating System vs Desktop Operating System

FUNCTIONS	MOBILE OPERATING SYSTEM	DESKTOP OPERATING SYSTEM
Definition	It allows smartphones, tablet PCs, and other devices to run applications and programs	Main control program or environment through which user controls a personal computer and it manages all applications and programs in a computer
Purpose	Manages cellular and wireless connectivity, and phone access	Manages hardware and software resources of the system
Boot time	Boots faster than desktop OS	It boots much slower
Storage	Uses flash drive to store data/information	Uses hard drives / flash drives to store data/information
Power requirements	Optimized to work under minimal power requirements and have feature to prevent energy loss	Desktop OS is not readily optimized for energy loss
Interface	Mobile Os operates with touchscreen or touch pad	PC operates via many input devices such as mouse, keyboard etc.
Memory usage	Optimized to work on minimum RAM	Requires good amount of memory to operate
Features	-Specialized for specific set of devices -Don't offer complete access to	-Full featured. Designed to take advantages of fast CPUs, large amount of disk space, and RAM

	system hardware (such as administrator or root) -Limited or no interoperability (Mobile apps are strictly hardware specific)	-Based on X86 majorly it is more flexible in terms of interoperability
OS flavours	Apple iOS, Google Android, Bada (Samsung electronics), Blackberry OS, iPhone OS / iOS, Symbian OS, Windows Mobile OS, Harmony OS, Palm OS, WebOS (Palm/HP) etc.	Windows 10, MacOS, Windows Vista etc.

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 Microkernel and Monolithic Kernel

Parameters	Monolithic kernel	MicroKernel
Basic	It is a large process running in a single address space	It can be broken down into separate processes called servers.
Code	In order to write a monolithic kernel, less code is required.	In order to write a microkernel, more code is required
Security	If a service crashes, the whole system collapses in a monolithic kernel.	If a service crashes, it never affects the working of a microkernel.
Communication	It is a single static binary file	Servers communicate through IPC.
Example	Linux, BSDs, Microsoft Windows (95,98, Me), Solaris, OS-9, AIX, DOS, XTS-400, etc.	L4Linux, QNX, SymbianK42, Mac OS X, Integrity, etc.

Advantages of Microkernel

Here, are the pros/benefits of using Microkernel

- Microkernel architecture is small and isolated therefore it can function better.
- Microkernels are secure because only those components are included that disrupt the functionality of the system otherwise.
- The expansion of the system is more accessible, so it can be added to the system application without disturbing the Kernel.
- Microkernels are modular, and the different modules can be replaced, reloaded, modified without even touching the Kernel.
- Fewer system crashes when compared with monolithic systems.
- Microkernel interface helps you to enforce a more modular system structure.
- Without recompiling, add new features
- Server malfunction is also isolated as any other user program's malfunction.
- Microkernel system is flexible, so different strategies and APIs, implemented by different servers, which can coexist in the system.
- Increased security and stability will result in a decreased amount of code which runs on kernel mode

Disadvantage of Microkernel

Here, are drawback/cons of using Microkernel:

- Providing services in a microkernel system are expensive compared to the normal monolithic system.
- Context switch or a function call needed when the drivers are implemented as procedures or processes, respectively.
- The performance of a microkernel system can be indifferent and may lead to some problems.

Summary:

- A kernel is an important part of an OS that manages system resources.
- A microkernel is a software or code which contains the required minimum amount of functions, data, and features to implement an operating system.
- In Monolithic Kernel approach, the entire operating system runs as a single program in kernel mode

- A Microkernel is the most important part for correct implementation of an operating system.
- A microkernel comprises only the core functionalities of the system.
- A monolithic kernel is a large process running in a single address space, whereas Microkernel can be broken down into separate processes called servers.
- Microkernel architecture is small and isolated therefore it can function better
- Providing services in a microkernel system are expensive compared to the normal monolithic system

User interfaces

Types of User Interface

Command Line Interface (CLI)

- A **command-line interface** is a mechanism for interacting with a computer operating system or software by typing commands to perform specific tasks.
- This method of instructing a computer to perform a given task is referred to as "entering" a command.
- Accept input via keyboard only.
- Not suitable for beginners.

- Examples of command:

Command	Description
DIR	To display list of files or folder
COPY	To copy file or folder
MD	To make new folder
CLS	To clear screen
Quit	To quit

Graphical User Interface (GUI)

- Is a type of user interface which allows people to interact with computer with images rather than text commands.
- Accept input via keyboard and pointing devices.
- Easy to learn.

Elements of Graphical User Interface

- Pointer
- Icons
- Desktop
- Windows
- Menus

Corporate vs. Personal Needs

Computers are being used everywhere - including at work and at home. Users can use Windows, Mac OS, or Linux in either of these environments. However, the manner in which computers are setup and configured differs in both environments. A computer in the office environment is likely to be part of a domain and will interact with the other computers. A computer at home is likely to be part of a workgroup and is considered to be a standalone computer.

Boot Methods

Booting is the process of powering on the computer and starting the operating system. An operating system is a program, which makes the application programs and the computer hardware work together. The most usual place where you will install an operating system is a hard drive. However, you can also boot a computer with an operating system that runs on a USB drive. You can install an operating system using a hard drive, optical disk, USB drive, or PXE. During the boot process, the device containing the operating system program is loaded in the RAM or computer's main memory and executed. After execution, the operating system becomes functional and takes over control of the machine.

Types of OS installation

An operating system can be installed using multiple methods. Some of these methods are listed below:

- Unattended installation
- In-place upgrade
- Clean install
- Repair installation
- Multiboot
- Remote network installation
- Image deployment
- Recovery partition
- Restore/Refresh

For all the methods listed above, the actual process of installation remains the same. Only the choice of boot device differs. In this

Types of OS installation:

An operating system can be installed using multiple methods. Some of these methods are listed below:

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- Remote network installation
- Image deployment
- Recovery partition
- Restore/Refresh

For all the methods listed above, the actual process of installation remains the same. Only the choice of boot device differs. In this

1. **Attended installation**: Here, someone is required to interact with the computer while executing the installation process.
2. **Silent installation**: This means once the installation starts, the user is not offered any options to change or edit the installation process.
3. **Unattended installation**: The installation of a program without requiring the user to select options or click next at the end of each step. It often uses a file of predefined answers so that after starting the installation, it runs to completion without further user intervention.
4. **Headless installation**: A headless server is simply an operating system installed on a computer without a monitor, mouse, keyboard, and other peripherals.
5. **Scheduled or automated installation**: An installation process that runs on a preset time or when a predefined condition transpires, as opposed to an installation process that starts explicitly on a user's command.
6. **Clean installation**: A clean install is a software installation in which any previous version is eradicated.
7. **Network installation**: Installing the NOS directly from the CD-ROM distribution discs on the server's CD-ROM drive and shared hard disk from sever.

Performing a Clean Installation of Windows 10

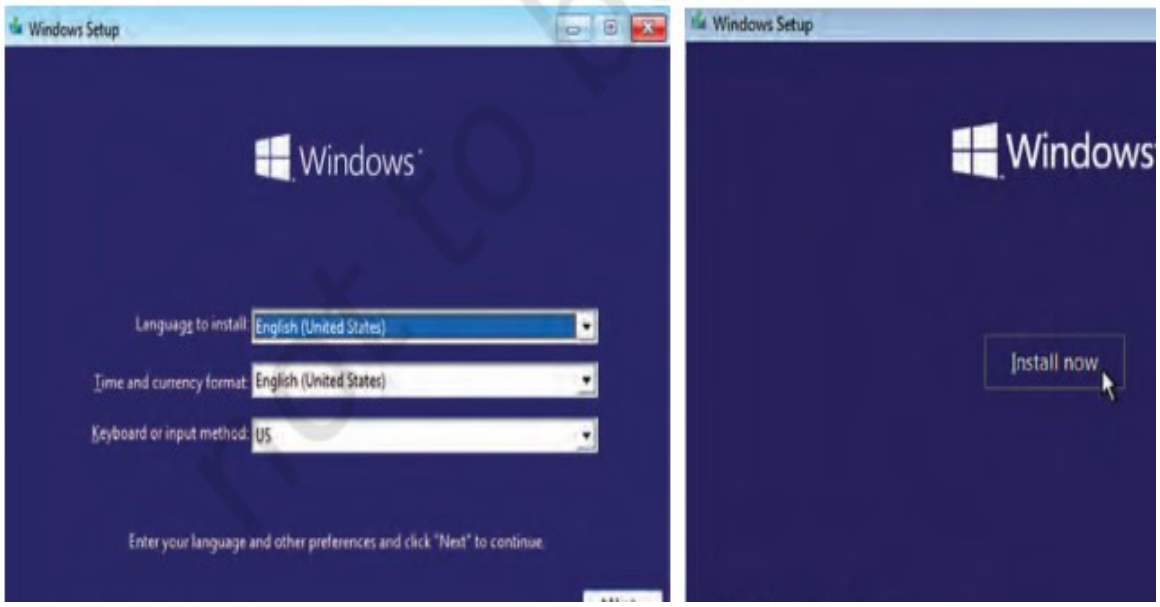
A clean installation of Windows 10 is the process of erasing the hardware and setting up a new fresh copy of the platform when a computer has a problem. For example, you can resolve performance, memory, startup, shut down, and apps issues using this method. Also, it's perhaps the best approach to remove viruses and other types of malware, and it can help to improve battery life

Follow the steps below for clean installation of Windows 10.

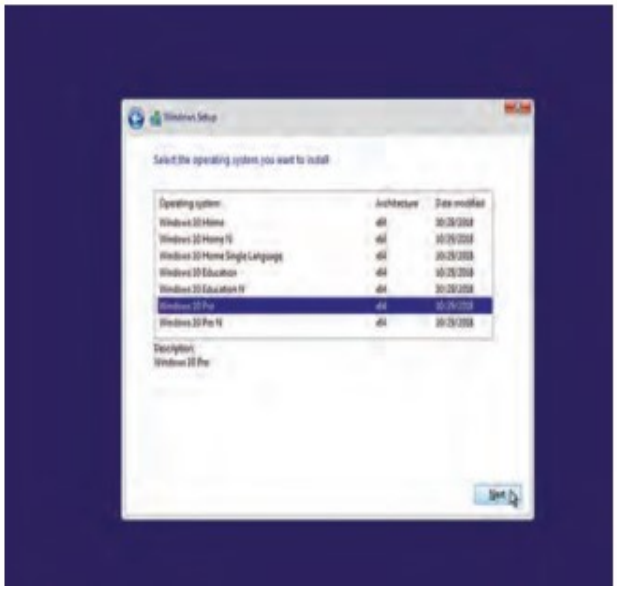
i) Insert a bootable media DVD or USB pen drive in your computer system. Provide the details of language, time zone, and keyboard layout as shown in Figure 5.4. Then click on the 'Next' button.

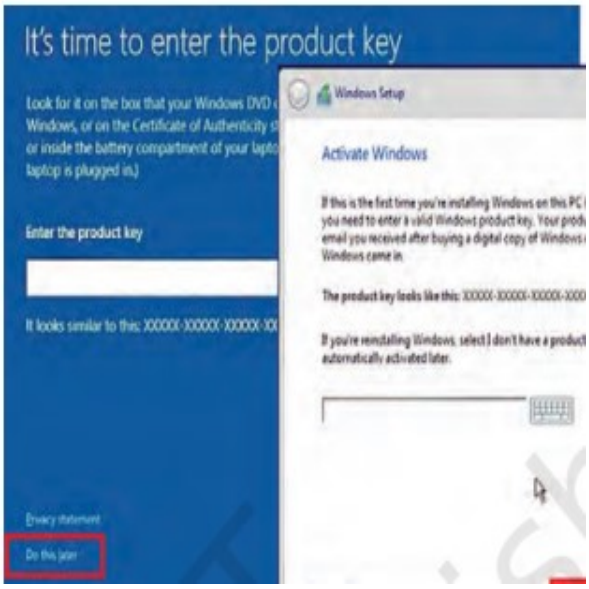
(ii) Click the 'Install now' button as shown in Figure 5.5.

Figure 5.5:



(iii) In the next window, you will be asked to enter the product key. Enter it and click on the 'Next' button to proceed. In case you don't have the product key currently, then you can skip to enter the product key by clicking on the option 'I don't have a product key' to continue the installation as shown in Figure 5.7 below.

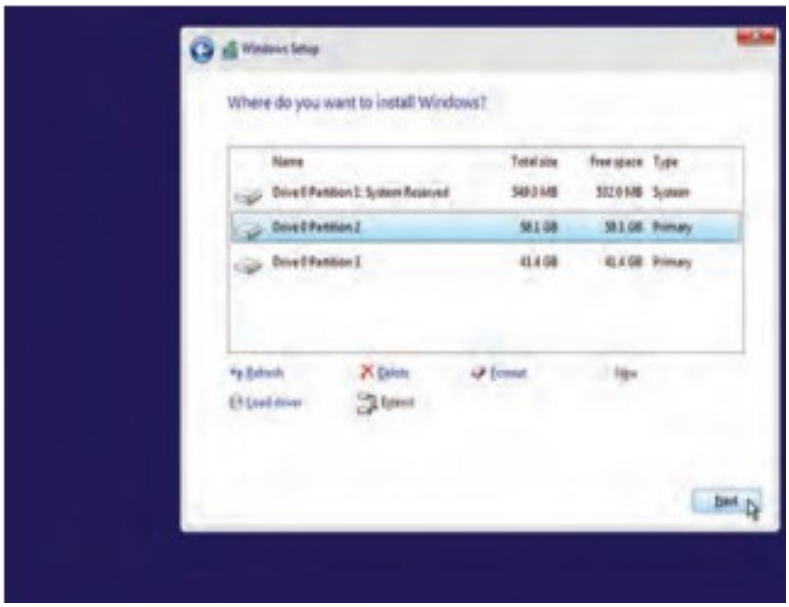




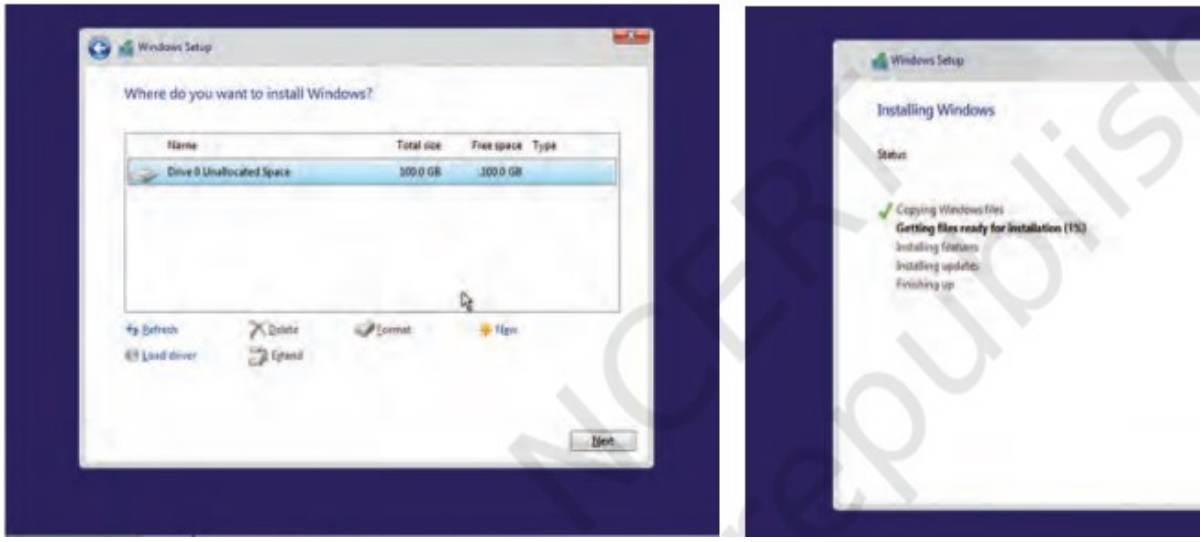
(iv) A new window as shown in Figure 5.8 will appear where you have to accept the licence terms by) on the checkbox 'I accept the⎦ putting the tick (license terms'.

(v) Click the 'Next' button as shown in Figure 5.8.

(vi)Click on the 'Custom: Install Windows only (advanced)' option as shown in Figure 5.9.



vii) Select the partition with the current installation of Windows (usually "Drive 0"), and click the 'Delete' button to remove it from the hard drive. (viii) Click the 'Yes' button to confirm the deletion. (ix) Select the empty drive ('Drive 0 Unallocated Space') and click on the 'Next' button as shown in Figure 5.11. (x) After completion of these steps, the set-up will proceed to install Windows 10 as shown in Figure 5.12.



xi) After complete installation, the initial, window will appear on the computer screen as shown in Figure 5.13.

Post Installation Tasks

After installation of Windows 10, you need to perform certain post installation tasks. (i) Check whether Windows is activated or not. To confirm that you're running an activated copy of Windows 10, Fig. 5.13: Home window of Windows 10 open 'Settings'. For this, press the windows key and type settings in the textbox. The Windows setting will be displayed as shown in Figure 5.14.

(ii) Click on 'Update & Security' as shown in Figure 5.15.

(iii) Click on 'Activation' as shown in Figure 5.16.

(iv) Under the 'Activation' head, Windows edition and activation status is displayed as 'Windows is activated with a digital license' as shown in Figure 5.16. This confirms that your Windows 10 is activated. Instead of this if it shows the message 'Windows is not activated', then you need to activate the Window by entering the product key

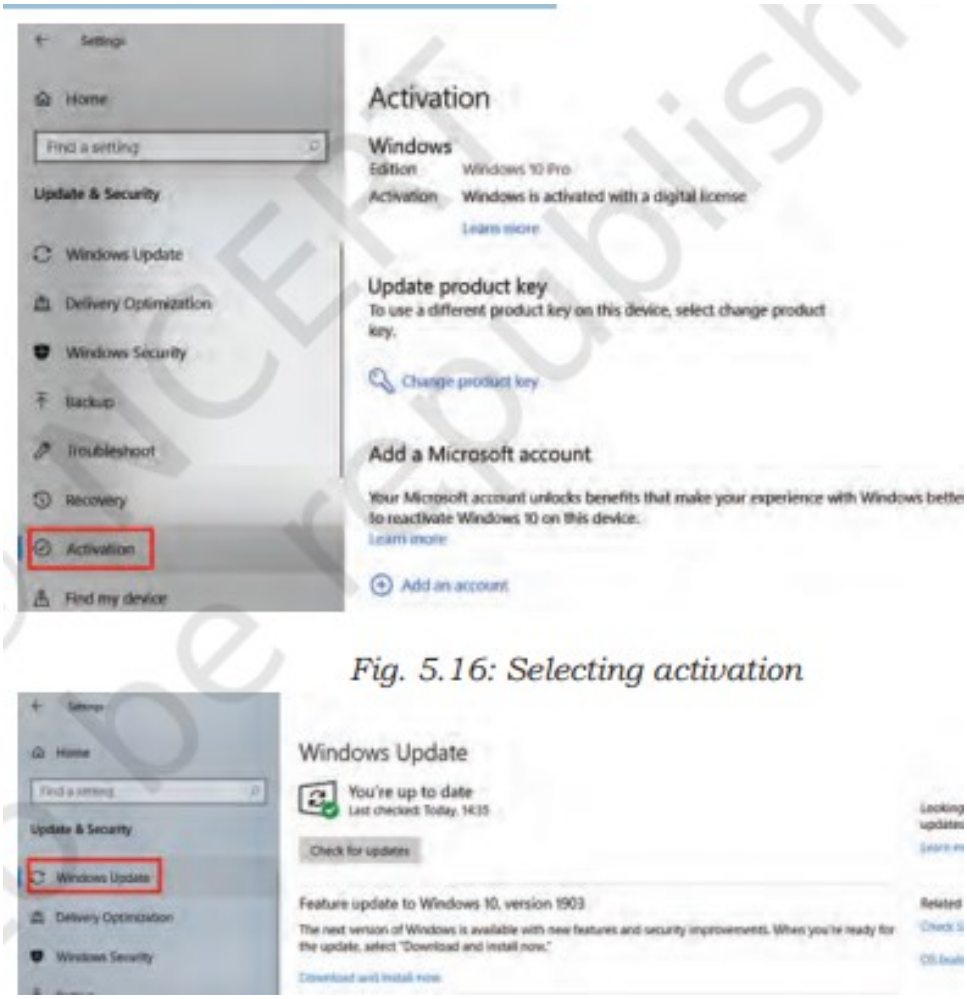
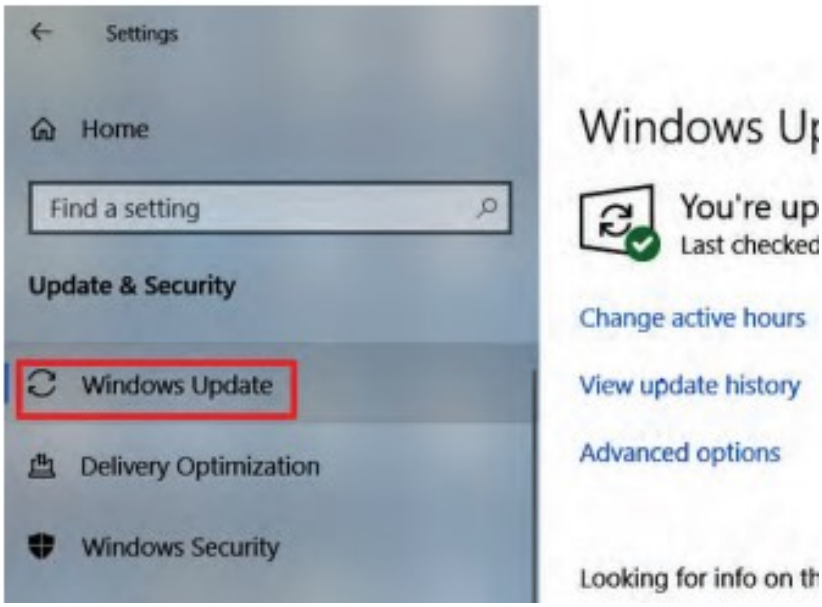


Fig. 5.16: Selecting activation

To install the latest updates: (i) Open 'Settings' as shown in Figure 5.14. (ii) Click on 'Update &' Security' as shown in Figure 5.15. (iii) Click on 'Windows Update' as shown in Figure 5.18



Post installation tasks:

Post Installation task is the set of steps to be carried out to ensure that the installation is complete and went smoothly.

1. Network Configuration,

2. Antivirus Installation,

3. Windows update,

4. Installing Application Software's.

Dual boot Ubuntu Linux with Windows 10

Dual Booting

- ✓ Most computers ship with a single operating system, but you can have multiple operating systems installed on a single PC. Having two operating systems installed — and choosing between them at boot time — is known as "dual-booting."
- ✓ A dual boot is when you run two operating systems on one computer at the same time. This can be any combination of operating systems, for example, Windows and Mac, Windows and Linux or Windows 7 and Windows 10.

Step 1: Download Ubuntu (or whichever Linux distribution you are using)

Head over to Ubuntu's website and download the ISO file.

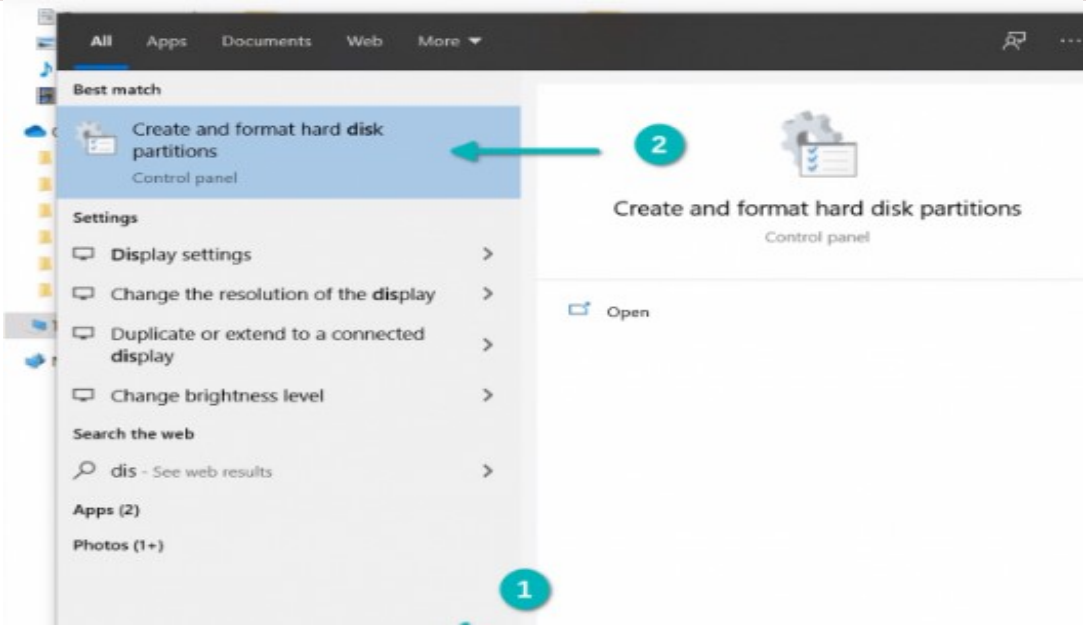
Step 2: Create a live USB/disk of Ubuntu

There are several free applications that allow you to create a live Ubuntu USB.

Example: Rufus, Power ISO etc.,

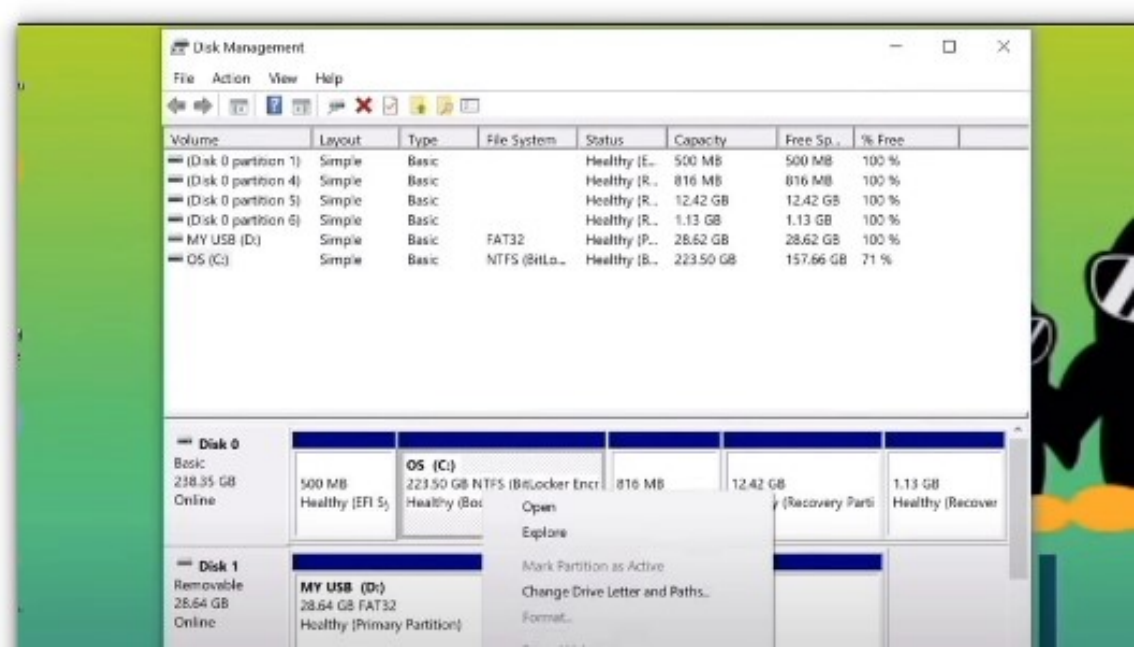
Step 3: Make some free space on your disk for Ubuntu installation

In the Windows menu, search for 'disk partitions' and go to 'Create and format hard disk partitions'.



In the Disk Management tool, right-click on the drive which you want to partition and select **shrink volume**.

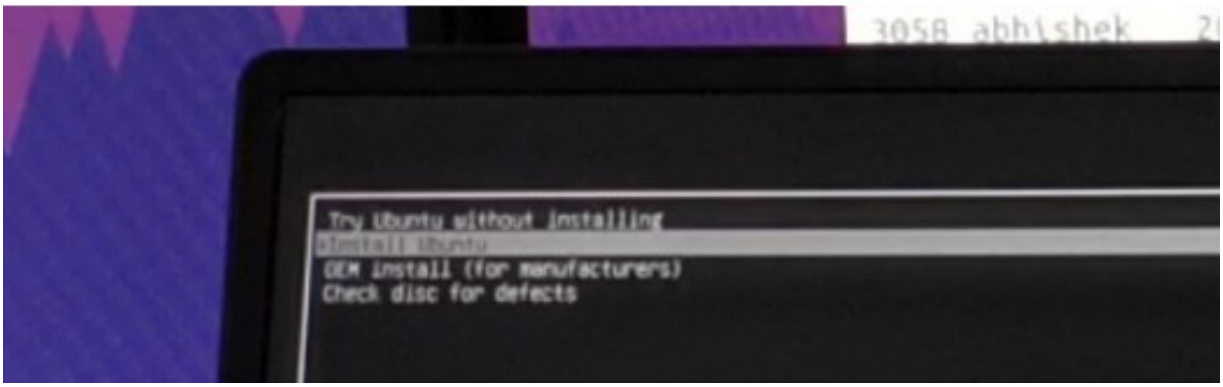
If you have just one partition like this, you need to make some free space out of it for Linux. If you have several partitions of considerable size, use any of them except C drive because it may erase the data.



Step 4: Boot from live Ubuntu USB

You created a live Ubuntu USB in the step 3. Plug it in the system

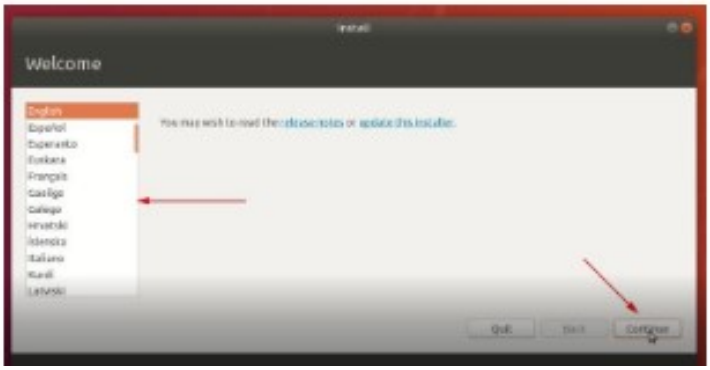
Now it will power off your system and reboot into the disk you chose which should be the live USB disk. You should see a screen like this after a few seconds:



The “Install Ubuntu” option will start the Ubuntu installation immediately.

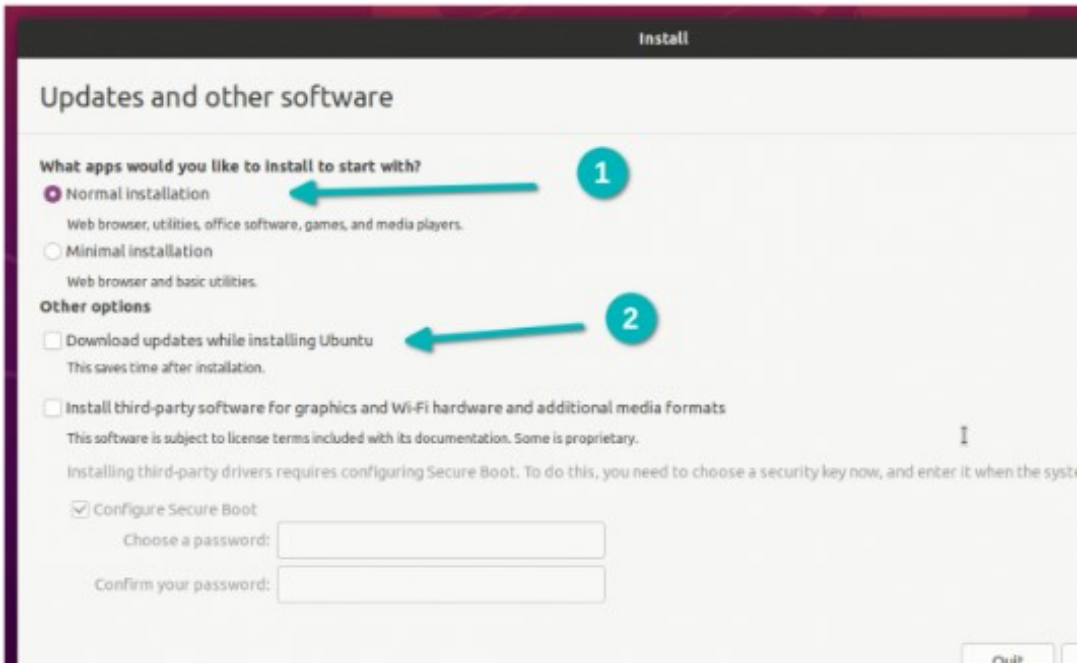
Step 6: Installing Ubuntu along with Windows 10

Start the installation procedure. The first few steps are simple. You choose the language and keyboard layout.



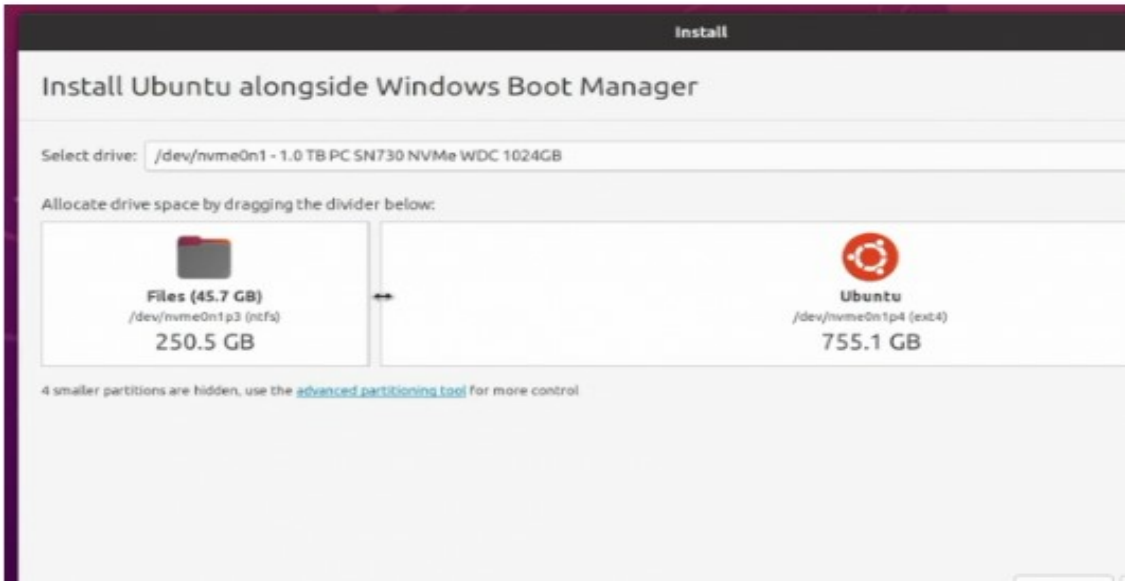
On the next screen, choose Normal installation. No need to download updates or install third-party software just yet. You may do it after installation completes.

Hit continue. It may take some time to go to the next step.

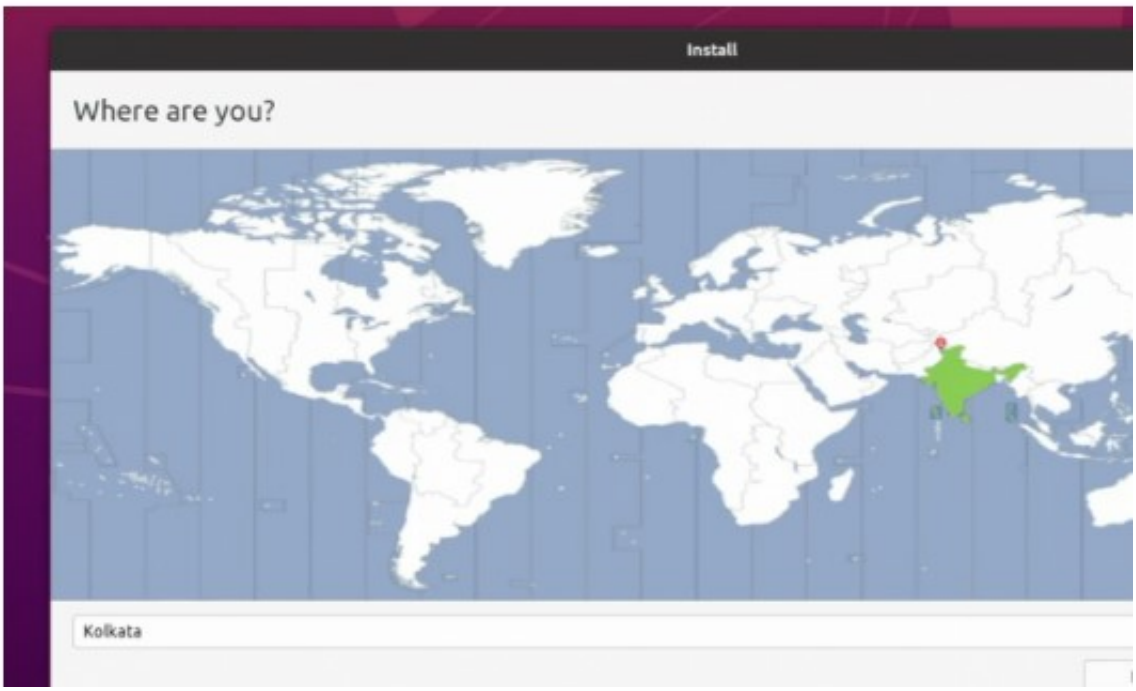


If you see the "Install Ubuntu alongside Windows Boot Manager" on the **Installation type** screen, you are in luck. You can select this method and hit continue.

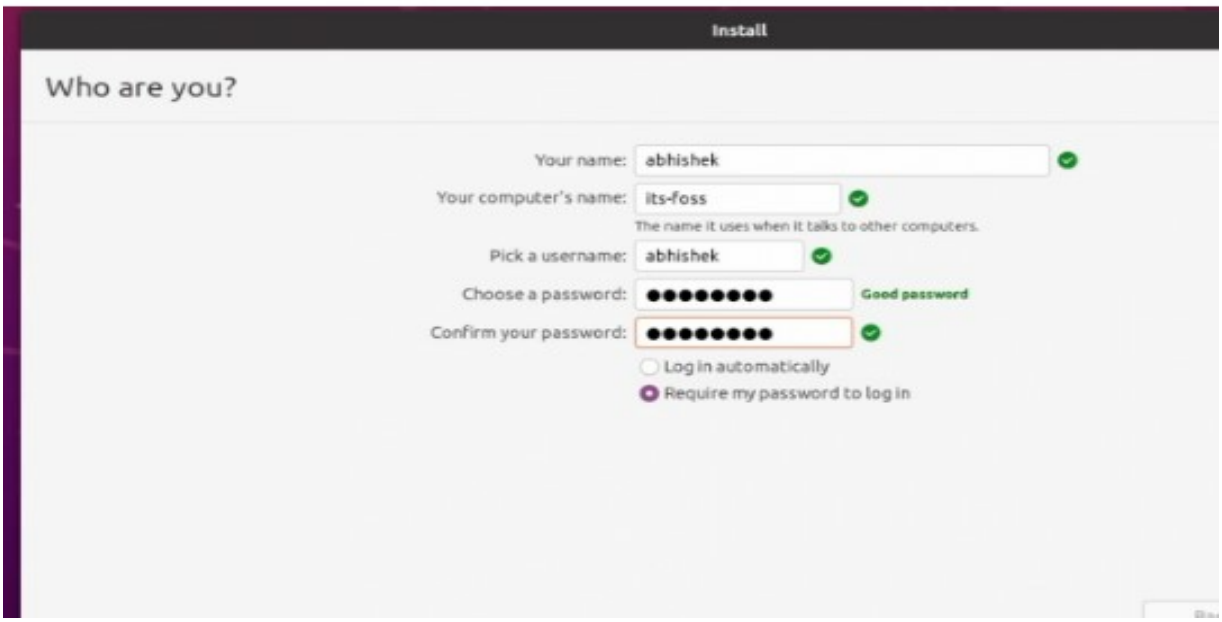
The next screen will give you the option to create a partition for Ubuntu by dragging the divider. You can allocate appropriate disk space to Linux here. Ubuntu will create one partition of the allocated disk space and it will have root with home and a swapfile of 2 GB in size under root itself.



Select a timezone when asked.

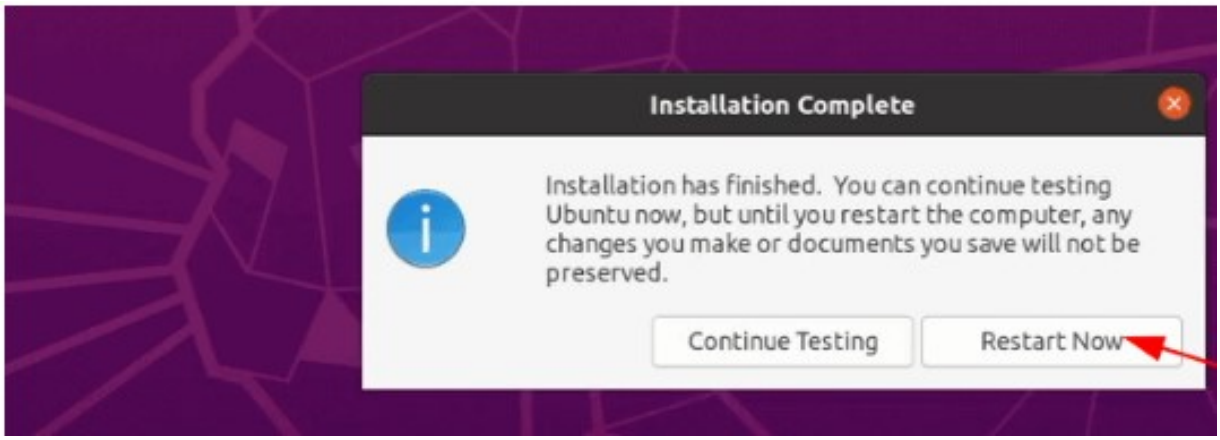


Next, you'll be asked to enter a username, hostname (computer's name) and a password.



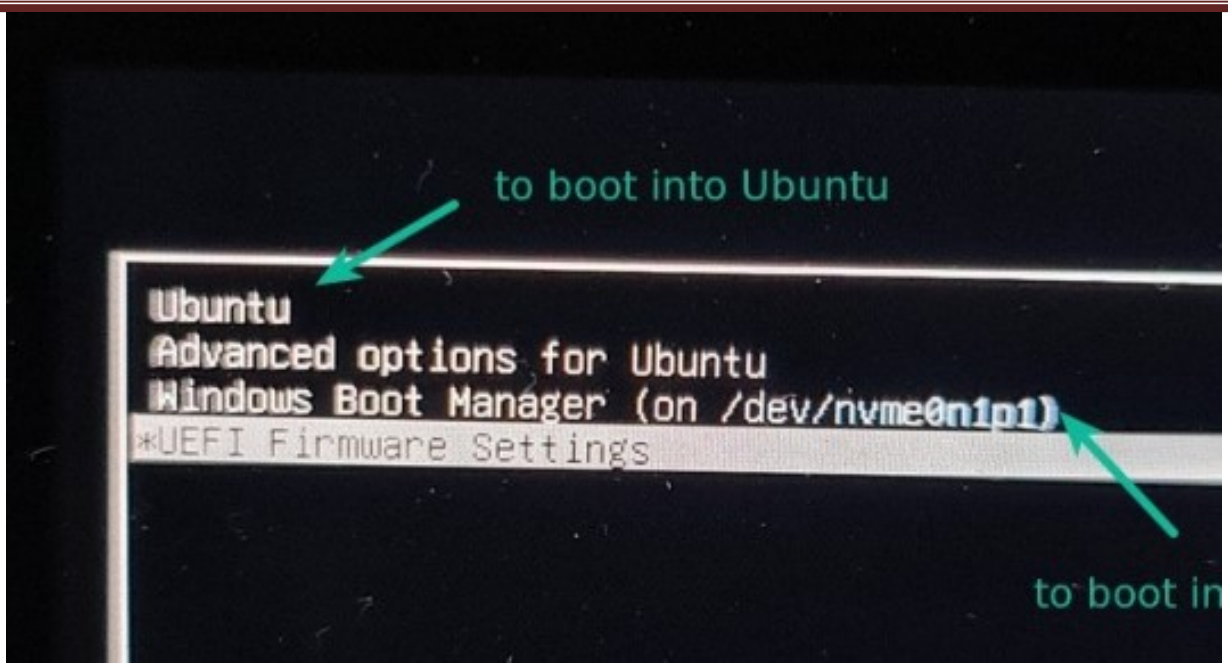
Now it's just the matter of waiting. It should take 8-10 minutes to complete the installation.

Once the installation finishes, restart the system.



You'll be asked to remove the USB disk. You can remove the disk at this stage without worrying. The system reboots after this.

If everything went smooth, you should see the grub screen once the system powers on. Here, you can choose Ubuntu to boot into Ubuntu and Windows boot manager to boot into Windows



Post Installation Tasks for Ubuntu Operating System:

- ✓ Online accounts

  The first step allows user to configure online accounts, in case user want to integrate the desktop with different services.

- ✓ **Livepatch**

  Livepatch is a service that allows the installation of some updates that would generally require a system reboot, such as those of the kernel.

- ✓ **Help improve Ubuntu**

  In this step user can choose whether or not to send data from his system to Ubuntu. The option is activated by default. The user can verify the secrecy of the data being sent beforehand. The results are used to improve Ubuntu.

- ✓ **Privacy**

  If required, a user can enable location services so that apps can determine user geographic location. All the applications installed by default on Ubuntu are free software.

- ✓ **You are ready to start!**

  The last screen shows some featured applications -some of which are not free software with the option to open the software center to install them.

2. Boot methods

- ✓ **Booting** is the process of powering on the computer and starting the operating system.
- ✓ When the CPU is first switched on it has nothing inside the Memory. In order to start the Computer, load the Operating System into the Main Memory and then Computer is ready to take commands from the User.

Types of Booting

There are two types of booting:

1. Cold Booting

A cold boot is also called **a hard boot.** It is the process when we first start the computer. In other words, when the computer is started from its initial state by pressing the power button it is called cold boot. The instructions are read from the ROM and the operating system is loaded in the main memory.

2. Warm Booting

Warm Boot is also called **soft boot**. It refers to when we restart the computer. Here, the computer does not start from the initial state. When the system gets stuck sometimes it is required to restart it while it is ON. Therefore, in this condition the warm boot takes place. Restart button or CTRL+ALT+DELETE keys are used for warm boot.

Booting is the process of powering on the computer and starting the operating system. An operating system is a program, which makes the application programs and the computer hardware work together. The most usual place where you will install an operating system is a hard drive. However, you can also boot a computer with an operating system that runs on a USB drive. You can install an operating system using a hard drive, optical disk, USB drive, or PXE. During the boot process, the device containing the operating system program is loaded in the RAM or computer's main memory and executed. After execution, the operating system becomes functional and takes over control of the machine.

3. File System and formatting:

- ✓ **File system** is the part of the operating system which is responsible for file management.
- ✓ A **files system** is the *method* used to organise data on a disk. It controls the allocation of disk space to files, and associates each file with a filename, directory, permissions, and other information.
- ✓ A **file system** is a structure used for storing and managing data. It includes a boot, file and directory structures. A file system also needs to.
  - ➢ track free and used space
  - ➢ maintain file and directory names
  - ➢ record where each file is located on disk
- ✓ Different OS's use different file systems, but all have similar features.
- ✓ The most commonly used file system with Windows is NTFS
- ✓ Without file management, it would be impossible for a file with the same name to exist and also impossible to remove installed programs and recover specific files.
- ✓ Many operating systems support more than one file system:
  1. Windows uses FAT32 (File Allocation Table), exFAT (Extensible File Allocation Table) and NTFS (New Technology File System)
  2. Linux uses ext2 (second extended file system), ext3(third extended file system), FAT32 and exFAT (Extensible File Allocation Table)
  3. UNIX systems use UFS (UNIX file system), ext2, ext3 and ZFS (Zettabyte file system).
  4. Macs use FAT32, exFAT, HFS+ (Hierarchical file system) and APFS (apple file system)

File System	***OS***	***Accessible by***
FAT 16	**DOS, Win3.1, Win95**	**Win98/NT/2000/ ME/XP/Linux**
FAT 32	**Win95 (2nd release), Win98, ME, 2000,**	**Win98/NT/2000/ ME/XP/Linux** *not DOS, Win3.1, Win95(1st release)*
NTFS	**WinNT, 2000, XP**	**WinNT, 2000, XP** *not DOS, Win3.1, Win95,*

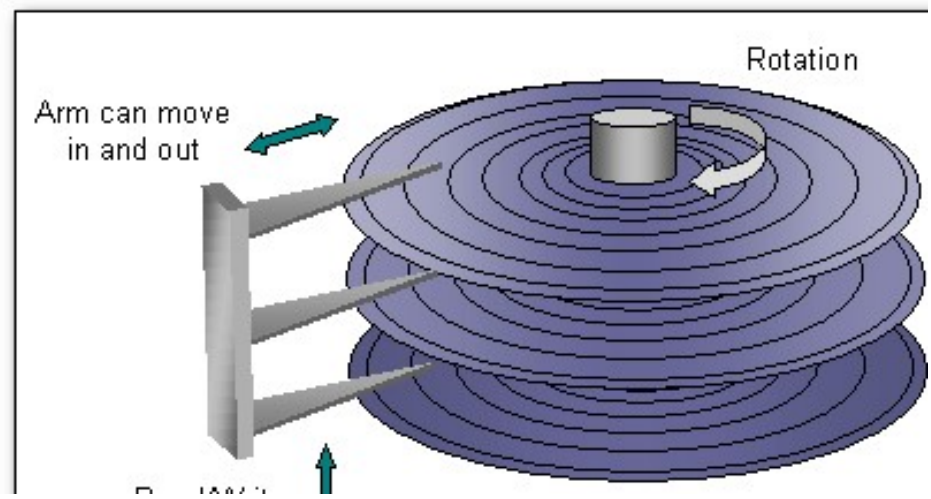
		Win98, read-only for Linux
EXT2 or EXT3	**Linux**	**Linux or Unix** *not DOS or Windows*
Netware	**Novell Netware**	**Netware** *not DOS, Windows, Linux or Unix*

Formatting:

- ✓ ***Formatting*** *is a process of preparing the storage device to store the data. Formatting storage device will erase the earlier contents of the device.*
- ✓ **Disk formatting** is the process of preparing a data storage device such as a hard disk drive, solid-state drive, floppy disk or USB flash drive for initial use. In some cases, the formatting operation may also create one or more new file systems.

Physical Formatting

A magnetic disk is physically **formatted** (also call a low-level format) into a **tracks**, **sectors** and **cylinders**, usually by the manufacturer. Physical formatting divides the disk into basic elements so that data can be read from the disk.



After formatting, the magnetic quality of the surface may gradually deteriorate. the read-write heads may find it difficult to read the magnetic properties of sectors. Any sector that becomes impossible to read is marked as a **bad sector** and is ignored by the computer.

Logical Formatting

After physical formatting, the disk must be logically formatted. This process places a **file system** on disk and allows an operating system to store and retrieve files. Different operating systems (Windows 9x, NT, Linux etc.) use different file systems. So a disk must be formatted using the correct file system for the operating system that you plan to install.

After a disk is formatted using a particular file system, you are usually limited to installing one operating system. However, it is possible to logically format a disk using more than one file system using a technique called partitioning.

Partitioning effectively divides up your hard disk into different parts, allowing you to logically format each part separately, using different file systems and installing *different* operating systems.