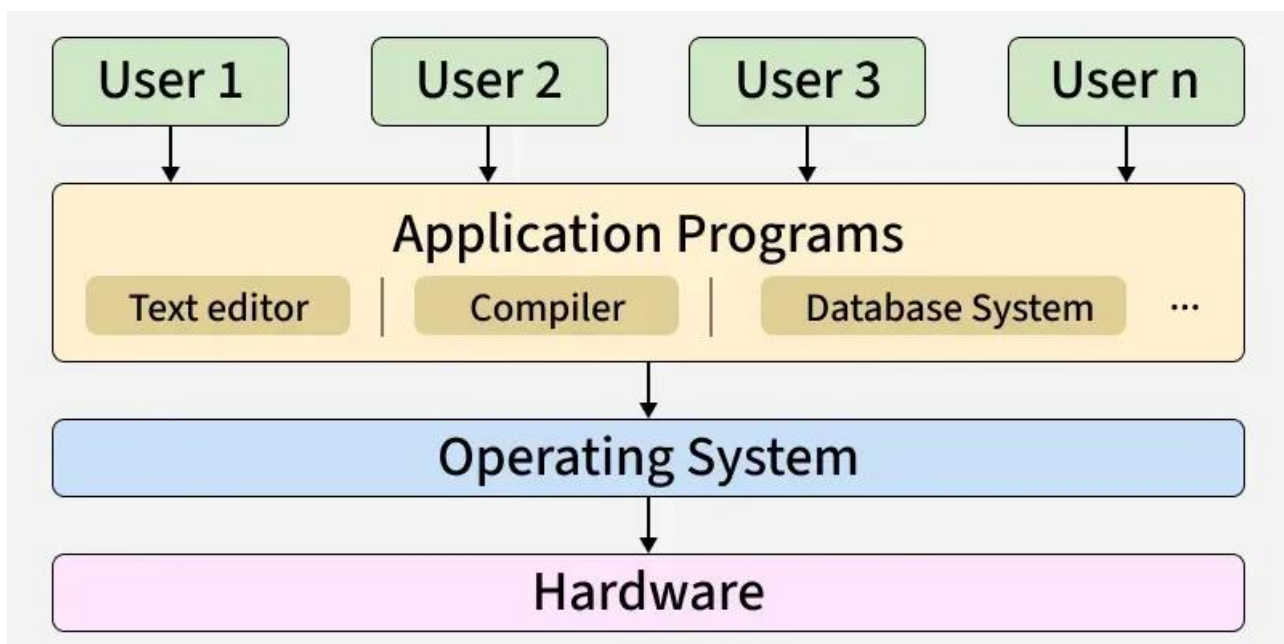# PCS Unit – II

## Operating System

An Operating System (OS) is system software that manages the hardware and software resources of a computer. It acts as an interface between the user and the machine, enabling smooth execution of programs and efficient use of system resources. The OS controls overall system operations and coordinates the sharing of resources among running applications.

**Key Features:**

- Manages computer resources such as CPU, memory, and files
- Acts as an interface between user and hardware
- Performs core functions like process, memory, and file management
- Organizes system resources similar to different departments in a government
- Examples include Linux, Unix, Windows 11, MS-DOS, Android, macOS, and iOS

**Why do we need an Operating System?**

- To manage hardware resources efficiently
- To run multiple programs simultaneously
- To provide a user-friendly environment
- To ensure system security and access control
- To improve system performance and reliability



## Functions of Operating System

An Operating System (OS) is software that acts as a bridge between the user and the computer hardware. It provides an environment where users can execute programs efficiently and conveniently.

- Manages and controls all computer resources.
- Provides services and resources to user programs.
- Coordinates and monitors program execution to prevent errors.
- Offers a user interface (virtual machine) and hides software complexity.
- Supports multiple execution modes for programs.

**Functions of an Operating System**

## 1. Process Management

Process management in operating system is about managing processes. A [Process](#) is a running program. The life cycle of process is from the moment program start until it finishes.

Core Functions in Process Management:

- **Scheduling:** Decides which process uses the CPU next (using algorithms like Round Robin or Priority Scheduling).
- **Synchronization:** Ensures orderly execution using locks, semaphores, or monitors to prevent race conditions.
- **Deadlock Handling:** Detects and prevents situations where processes wait forever for resources.
- **Inter-Process Communication (IPC):** Allows processes to exchange data via shared memory or message passing.
-

## 2. Memory Management

Memory management in an operating system controls how data is stored and organized in [main (primary) memory](#) and [secondary storage](#), ensuring programs get the memory they need and freeing it when no longer used. Key Activities in Memory Management:

- **Allocation & Deallocation:** Assigns and frees memory as needed.
- **Protection:** Prevents processes from interfering with each other's memory..
- **Virtual Memory:** Uses disk space as extra memory to run large programs.
- **Fragmentation Handling:** Reduces wasted space through compaction.
- **Disk Management:** Handles file storage, free space, disk scheduling, and backups.

## 3. File System Management

File management in an operating system organizes and controls how data is stored, named, and accessed on storage devices, making it easy for users to find and use their files.
File System Management includes managing of:

- **File Attributes:** Name, type, size, and permissions.
- **File Types:** Text, binary, and executable files.
- **Operations:** Create, read, write, and delete files.
- **Access Methods:** Sequential, direct, and indexed access for faster retrieval.

## 4. Device Management (I/O System)

Device management in an operating system controls how the computer communicates with hardware devices like printers or disks, using drivers and techniques to ensure smooth and efficient operation.
Major components in Device Management:

- **Device Drivers:** Interface between hardware and OS.
- **Buffering & Caching:** Temporarily store data to match device speeds and improve performance.

- **Spooling:** Spooling manages data waiting to be processed, particularly in devices like printers. The OS places print jobs in a spool (a temporary storage area), allowing the CPU to continue other tasks while the printer works through the queue.

## 5. Protection and Security

Protection and security mechanisms in an OS are designed to safeguard system resources from unauthorized access or misuse. These mechanisms control which processes or users can access specific resources (such as memory, files, and CPU time). It also ensures that only authorized users can perform specific actions.

The OS protects system resources and user data from unauthorized access and attacks.

- **Access Control:** Limits user and process permissions.
- **Authentication:** Verifies users through credentials (UIDs/SIDs).
- **Resource Protection:** Prevents misuse of files, memory, or devices.
- **Security:** Guards against malware, denial-of-service attacks, and data theft.


## Multi programming -

In a modern computing system, there are usually several concurrent application processes which want to execute. Now it is the responsibility of the Operating System to manage all the processes effectively and efficiently. One of the most important aspects of an Operating System is to multi program. In a computer system, there are multiple processes waiting to be executed, i.e. they are waiting when the CPU will be allocated to them and they begin their execution. These processes are also known as jobs. Now the main memory is too small to accommodate all of these processes or jobs into it. Thus, these processes are initially kept in an area called job pool. This job pool consists of all those processes awaiting allocation of main memory and CPU. CPU selects one job out of all these waiting jobs, brings it from the job pool to main memory and starts executing it. The processor executes one job until it is interrupted by some external factor or it goes for an I/O task. **Non-multi programmed system's working -**
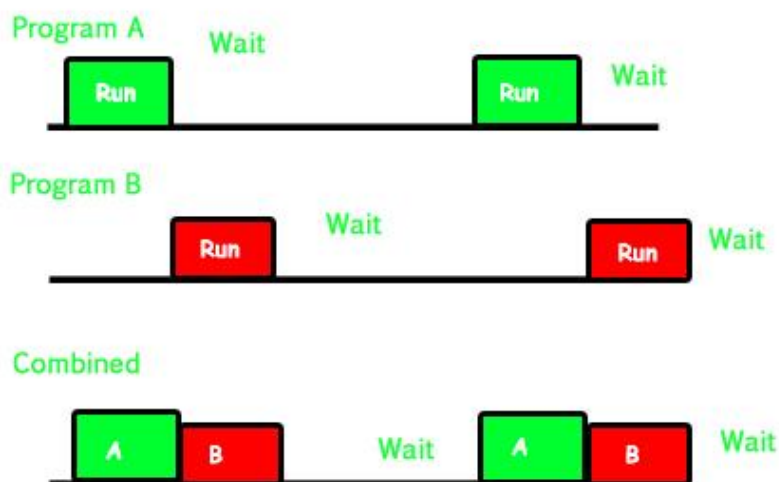
- In a non multi programmed system, As soon as one job leaves the CPU and goes for some other task (say I/O ), the CPU becomes idle. The CPU keeps waiting and waiting until this job (which was executing earlier) comes back and resumes its execution with the CPU. So CPU remains free for all this while.
- Now it has a drawback that the CPU remains idle for a very long period of time. Also, other jobs which are waiting to be executed might not get a chance to execute because the CPU is still allocated to the earlier job. This poses a very serious problem that even though other jobs are ready to execute, CPU is not allocated to them as the CPU is allocated to a job which is not even utilizing it (as it is busy in I/O tasks).
- It cannot happen that one job is using the CPU for say 1 hour while the others have been waiting in the queue for 5 hours. To avoid situations like this and come up with efficient utilization of CPU, the concept of multi programming came up.

The main idea of multi programming is to maximize the CPU time. **Multi programmed system's working -**

- In a multi-programmed system, as soon as one job goes for an I/O task, the Operating System interrupts that job, chooses another job from the job pool (waiting queue), gives CPU to this new job and starts its execution. The previous job keeps doing its I/O operation while this new job does CPU bound tasks. Now say the second job also goes for an I/O task, the CPU chooses a third job and starts executing it. As soon as a job completes its I/O operation and comes back for CPU tasks, the CPU is allocated to it.

- In this way, no CPU time is wasted by the system waiting for the I/O task to be completed. Therefore, the ultimate goal of multi programming is to keep the CPU busy as long as there are processes ready to execute. This way, multiple programs can be executed on a single processor by executing a part of a program at one time, a part of another program after this, then a part of another program and so on, hence executing multiple programs. Hence, the CPU never remains idle.

In the image below, program A runs for some time and then goes to waiting state. In the mean time program B begins its execution. So the CPU does not waste its resources and gives program B an opportunity to run.



## Multiprocessing -

In a uni-processor system, only one process executes at a time. Multiprocessing is the use of two or more CPUs (processors) within a single Computer system. The term also refers to the ability of a system to support more than one processor within a single computer system. Now since there are multiple processors available, multiple processes can be executed at a time. These multi-processors share the computer bus, sometimes the clock, memory and peripheral devices also. **Multi processing system's working -**
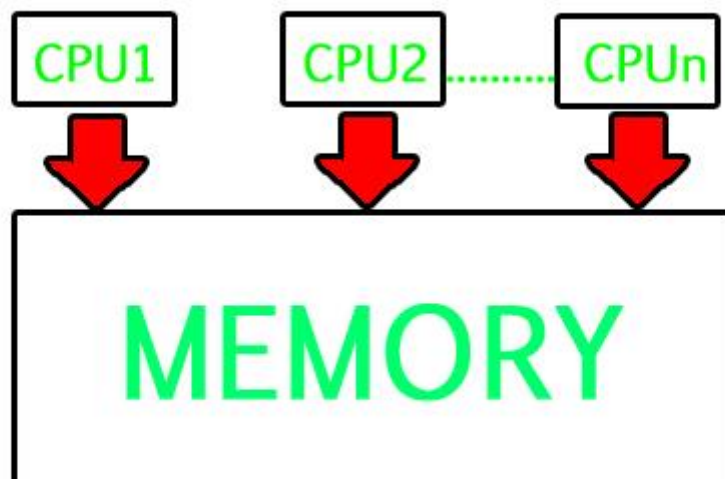
- With the help of multiprocessing, many processes can be executed simultaneously. Say processes P1, P2, P3 and P4 are waiting for

execution. Now in a single processor system, firstly one process will execute, then the other, then the other and so on.

- But with multiprocessing, each process can be assigned to a different processor for its execution. If its a dual-core processor (2 processors), two processes can be executed simultaneously and thus will be two times faster, similarly a quad core processor will be four times as fast as a single processor.

**Why use multi processing -**

- The main advantage of multiprocessor system is to get more work done in a shorter period of time. These types of systems are used when very high speed is required to process a large volume of data. Multi processing systems can save money in comparison to single processor systems because the processors can share peripherals and power supplies.
- It also provides increased reliability in the sense that if one processor fails, the work does not halt, it only slows down. e.g. if we have 10 processors and 1 fails, then the work does not halt, rather the remaining 9 processors can share the work of the 10th processor. Thus the whole system runs only 10 percent slower, rather than failing altogether.



Multiprocessing refers to the hardware (i.e., the CPU units) rather than the software (i.e., running processes). If the underlying hardware provides more than one processor then that is multiprocessing. It is the ability of the system to leverage multiple processors' computing power. **Difference between Multi programming and Multi processing -**
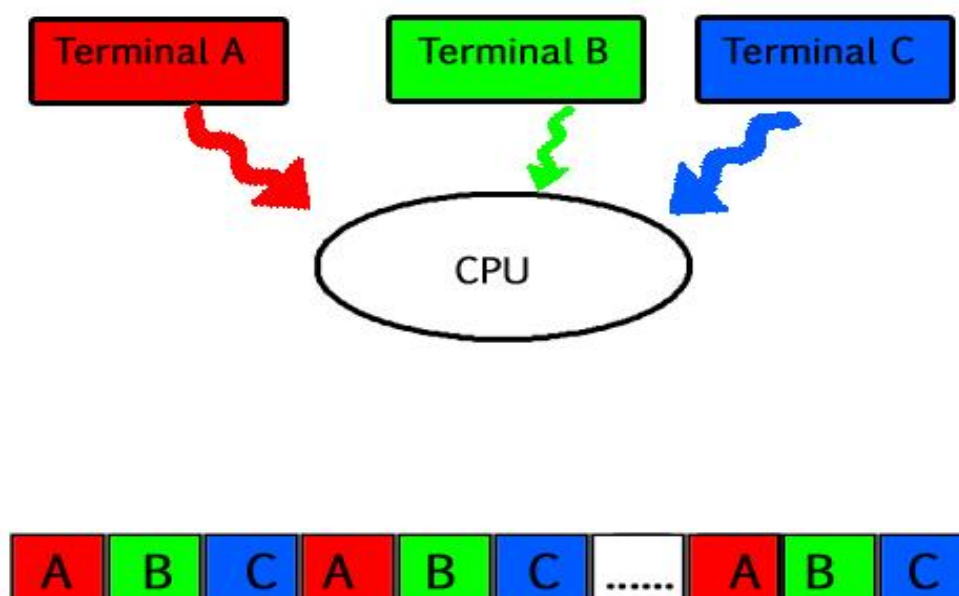
- A System can be both multi programmed by having multiple programs running at the same time and multiprocessing by having more than one physical processor. The difference between multiprocessing and multi programming is that Multiprocessing is basically executing multiple processes at the same time on multiple processors, whereas multi programming is keeping several programs in main memory and executing them concurrently using a single CPU only.
- Multiprocessing occurs by means of parallel processing whereas Multi programming occurs by switching from one process to other (phenomenon called as context switching).

**Multitasking -**

As the name itself suggests, multitasking refers to execution of multiple tasks (say processes, programs, threads etc.) at a time. In the modern operating systems, we are able to play MP3 music, edit documents in Microsoft Word, surf the Google Chrome all simultaneously, this is accomplished by means of multi tasking. Multitasking is a logical extension of multi programming. The major way in which multitasking differs from multi programming is that multi programming works solely on the concept of context switching whereas multitasking is based on time sharing alongside the concept of context switching. **Multi tasking system's working -**

- In a time sharing system, each process is assigned some specific quantum of time for which a process is meant to execute. Say there are 4 processes P1, P2, P3, P4 ready to execute. So each of them are assigned some time quantum for which they will execute e.g time quantum of 5 nanoseconds (5 ns). As one process begins execution (say P2), it executes for that quantum of time (5 ns). After 5 ns the CPU starts the execution of the other process (say P3) for the specified quantum of time.

- Thus the CPU makes the processes to share time slices between them and execute accordingly. As soon as time quantum of one process expires, another process begins its execution.

- Here also basically a context switch is occurring but it is occurring so fast that the user is able to interact with each program separately while it is running. This way, the user is given the illusion that multiple processes/ tasks are executing simultaneously. But actually only one process/ task is executing at a particular instant of time. In multitasking, time sharing is best manifested because each running process takes only a fair quantum of the CPU time.

In a more general sense, multitasking refers to having multiple programs, processes, tasks, threads running at the same time. This term is used in modern operating systems when multiple tasks share a common processing resource (e.g., CPU and Memory).

- As depicted in the above image, At any time the CPU is executing only one task while other tasks are waiting for their turn. The illusion of parallelism is achieved when the CPU is reassigned to another task. i.e all the three tasks A, B and C are appearing to occur simultaneously because of time sharing.
- So for multitasking to take place, firstly there should be multiprogramming i.e. presence of multiple programs ready for execution. And secondly the concept of time sharing.
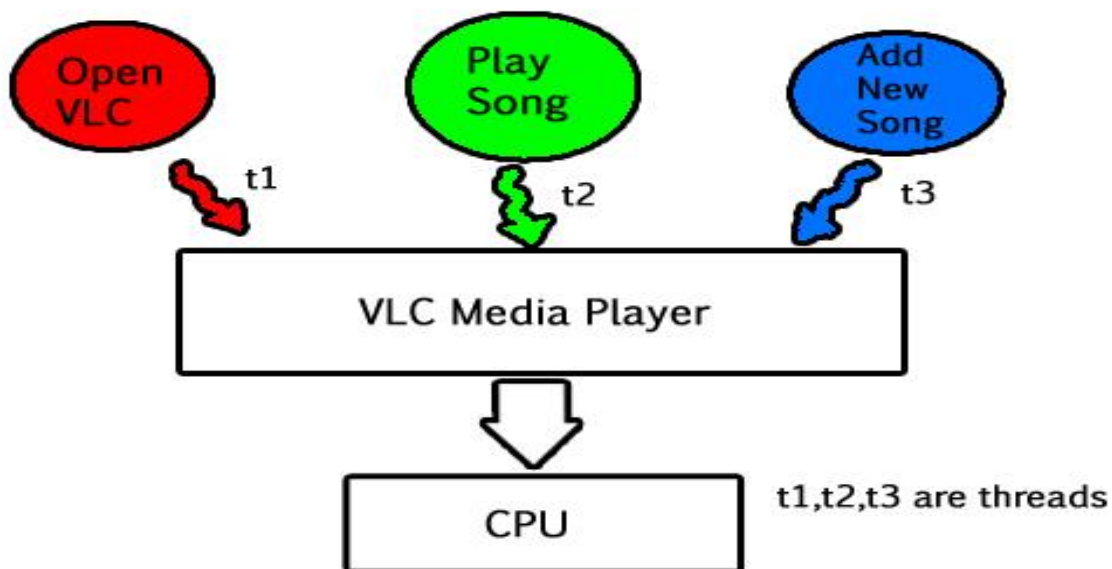

## Multi threading -

A thread is a basic unit of CPU utilization. Multi-threading is an execution model that allows a single process to have multiple code segments (i.e., threads) running concurrently within the "context" of that process. e.g. VLC media player, where one thread is used for opening the VLC media player, one thread for playing a particular song and another thread for adding new songs to the playlist. Multi threading is the ability of a process to manage its use by more than one user at a time and to manage multiple requests by the same user without having to have multiple copies of the program. **Multi threading system's working - Example 1 -**

- Say there is a web server which processes client requests. Now if it executes as a single threaded process, then it will not be able to process multiple requests at a time. Firstly one client will make its request and finish its execution and only then, the server will be able to process another client request. This is really costly, time consuming and tiring task. To avoid this, multi threading can be made use of.
- Now, whenever a new client request comes in, the web server simply creates a new thread for processing this request and resumes its execution to hear more client requests. So the web server has the task of listening to new client requests and creating threads for each individual request. Each newly created thread processes one client request, thus reducing the burden on web server.

**Example 2 -**

- We can think of threads as child processes that share the parent process resources but execute independently. Now take the case of a GUI. Say we are performing a calculation on the GUI (which is taking very long time to finish). Now we can not interact with the rest of the GUI until this command finishes its execution. To be able to interact with the rest of the GUI, this command of calculation should be assigned to a separate thread. So at this point of time, 2 threads will be executing i.e. one for calculation, and one for the rest of the GUI. Hence here in a single process, we used multiple threads for multiple functionality. The image below completely describes the VLC player example.

:

**Advantages of Multi threading -**
- Benefits of Multi threading include increased responsiveness. Since there are multiple threads in a program, so if one thread is taking too long to execute or if it gets blocked, the rest of the threads keep executing without any problem. Thus the whole program remains responsive to the user by means of remaining threads.
- Another advantage of multi threading is that it is less costly. Creating brand new processes and allocating resources is a time consuming task, but since threads share resources of the parent process, creating threads and switching between them is comparatively easy. Hence multi threading is the need of modern Operating Systems.

# Computer Virus

A computer virus is a type of harmful program. When it runs, it makes copies of itself and adds its code to other programs and files on your computer. These viruses come in different types, and each type can affect your device differently. Simply put, a computer virus changes how your computer works and aims to spread to other computers. It does this by attaching itself to normal programs or documents that can run code, known as macros.

A virus can harm or destroy data, slow down system resources, and log keystrokes, among other things. A virus can have unexpected or harmful outcomes during this procedure, such as destroying system software by corrupting data. Some viruses are made to mess things up by deleting files, messing up programs, or even wiping out your hard drive completely. Even if they're not super harmful, viruses can still slow down your computer a lot, using up memory and making it crash often. Others might just make copies of themselves or send so much stuff over the internet that it's hard to do anything online.

**Types of Computer Virus**

| Type of Virus | Description |
|---|---|
| **Boot Sector Virus** | Attacks the part of the computer that starts up when you turn it on. Boot Sector Virus can also spread through devices like **floppy disks**. Often called **a memory virus.** |
| **File Virus** | Attaches to the **end of a file** and **modifies** how a program starts to **run the virus's code first.** |
| **Email Virus** | Hides in email messages and activates by **clicking a link**, **opening an attachment**, or **interacting with the email.** |
| **Polymorphic Virus** | Changes its form every time it **installs to avoid detection** by antivirus software. |
| **Macro Virus** | Activates by running a program capable of executing macros, often found in documents like spreadsheets. |
| **Multipartite Virus** | Infects the **computer's boot sector**, **memory,** and **files,** making **it difficult to detect and remove.** |
| **Encrypted Virus** | Uses encryption to hide from **antivirus software**, includes a **decryption algorithm** to run before executing. |
| **Stealth Virus** | **Modifies detection code**, making it very difficult to detect. |
| **Resident Virus** | Saves itself in the computer's memory and can infect other files even after the original program stops. |
| **Direct Action Virus** | Tied to an executable file, it activates when the file is opened but does not **delete files** or **affect system speed**; **blocks file access.** |
| **Browser Hijacker Virus** | **Changes browser settings** without permission, can **redirect to malicious sites.** |

**Antivirus**

Antivirus software is a program that searches for, **detects**, **prevents**, and **removes software infections** that can harm your computer. Antivirus can also detect and remove other dangerous software such as **worms**, **adware**, and **other dangers**. This software is intended to be used as a **preventative measure** against **cyber dangers**, keeping them from entering your computer and **causing problems**. Antivirus is available for free as well. Anti-virus software that is available for free only

provides limited virus protection, whereas premium anti-virus software offers more effective security. For example **Avast**, **Kaspersky**, etc.

# MS-DOS Operating System

MS-DOS Operating System also called the Disk Operating system was Developed by Microsoft for x86 personal computers. It works on the phenomenon of doing less and getting more. It is a 16-bit operating system. A closed-source model was initially released on August 12, 1981, and the final release on September 14, 2000.

### MS-DOS layer Structure

```
        ┌─────────────────────────────────────┐
        │      Application Program            │──┐
        └──────────────┬──────────────────────┘  │
                       ▼                          │
        ┌───────────────────────────────┐        │
        │   Resident System Programs    │──┐     │
        └──────────┬────────────────────┘  │     │
                   ▼                        │     │
        ┌──────────────────────────┐       │     │
        │   MS-DOS Device Drivers   │       │     │
        └──────┬───────────────────┘       │     │
               ▼                            ▼     ▼
        ┌─────────────────────────────────────────┐
        │      ROM BIOS Device Drivers            │
        └─────────────────────────────────────────┘
```

It is used for many purposes:
- **Education and research**: It is used in the Education and research field to know how simple MS-DOS is and how it works. The source code is available from Microsoft in two versions.
- **Legacy systems**: Some organizations prefer using MS-DOS because it has been used reliably over decades whereas others don't have the budget to upgrade the application since this process is costly.
- **Embedded systems**: Embedded systems are dependent on MS-DOS especially new devices with x86 processor architecture. It is also used on legacy Embedded systems which have been used for decades.
- **Classic Computer Games**: There are still some games that were developed on MS-DOS and still support only MS-DOS.

**Features of MS-DOS Operating System**
- It is a minimalist OS which means it can boot a computer and run programs.
- Still usable for simple tasks like word processing and playing games.

- The mouse cannot be used to give inputs instead it uses basic system commands to perform the task.
- It is a 16-bit, free operating system.
- It is a single-user operating system.
- It is very lightweight due to fewer features available and no multitasking.

## File & Directory structure and naming rules

DOS uses a hierarchical, tree-like structure starting from a **Root Directory** (), organizing files in folders (directories) and subdirectories, following a strict **8.3 naming convention**: up to 8 characters for the name, a period, and up to 3 characters for the extension (e.g., `MYFILE.TXT`), with no spaces allowed in filenames, and case-insensitivity.

### Directory Structure

- **Root Directory ( `\` ):** The top level of every disk (e.g., `C:\`).

- **Directories/Folders:** Containers for files and other directories (subdirectories).

- **Subdirectories:** Directories inside other directories (e.g., `C:\DOS\UTILS`).

- **Hierarchical/Tree Structure:** Organizes files logically, with paths specifying locations (e.g., `C:\DOCS\REPORT.TXT`).

### File & Directory Naming Rules (8.3 Format)

- **Filename:** 1 to 8 characters.

- **Extension:** Optional, 1 to 3 characters (e.g., `.TXT`, `.COM`, `.EXE`).

- **Separator:** A single period ( `.` ) separates the name and extension.

- **Case Insensitive:** `File.TXT` is the same as `file.txt`.

- **Valid Characters:** Letters (A-Z), numbers (0-9), and some symbols like `!`, `$`, `#`, `&`, `_`, `-`.

- **Invalid Characters:** `< > : " / \ | ? *` and spaces (in filenames).

- **Reserved Words:** Words like `CON`, `PRN`, `NUL`, `COM1`, `LPT1` are reserved and can't be used as filenames alone.

- **Uniqueness:** Each file in the *same directory* must have a unique name.

### Examples

- **Valid:** `DOCUMENT.DOC`, `MY_DATA.TXT`, `PROG1.EXE`, `REPORT`.

- **Invalid:** `MY DOCUMENT.TXT` (space), `LONGNAME.TXT` (name too long), `FILE.HTML` (extension too long).

# Booting Process

**Booting** is a process of starting a computer or computer like device such as a smartphone, etc. Therefore, booting of a computing device start when we press the power button of the device, it makes the computer or the device ready for use.

Actually, when a computer or any computing device is switched off, its operating system remains in the secondary memory like hard disk of the system. But for execution of a software, it must be in the main memory of the system. Hence, booting may also be defined in other words as, the process of loading the operating system from secondary memory into main memory of the device is called **booting.**

When we press power button of the device, the BIOS of the system is activated which locates and loads the operating system into the main memory, this process of loading the operating system into main memory is called booting.

**Types of Booting**

Based on the current state of the computer or computing device, the booting is classified into the following two types ?

Types of Booting

Based on the current state of the computer or computing device, the booting is classified into the following two types ?

- Cold Booting ? When computer is in the powerless state, and is started by the user by pressing the power button of the system unit. In this case, the operating system is loaded from the disk to the main memory, this type of booting is referred to as cold booting.
- Warm Booting ? Sometimes situations arises when the system has stopped working and needs to be restarted. In other words, when system is already running and required to be restarted so that it will boot again, this type of booting is called warm booting.

**Booting Process in DOS Operating System**

In **DOS (Disc Operating System)**, the booting process begins when we press the power button of system unit and continues until the DOS command prompt is appeared on the computer screen. In DOS operating system, booting process primarily deals with the loading of the following three DOS system files into the main memory of the system ?

- IO.SYS
- MSDOS.SYS
- COMMAND.COM

We can understand the booting process in DOS operating system in the following steps ?

**Step 1**

When the computer system is started by pressing the power button, the BIOS (Basic Input-Output System) performs several important functionality tests on the programs in ROM (Read Only Memory). This is called **Power-On Self Test (POST).** POST checks the system for correct peripheral configurations, i.e. whether the peripherals are connected in perfect order or not.

**Step 2**

Once the BIOS is done with the basic functionality test, it finds the master boot record (MBR) in the first physical sector of the bootable disk as per the boot device sequence specified.
For example, if the boot device sequence is ?
- Hard Disk Drive
- Floppy Disk Drive
- CD-ROM

**Step 3**

Hence, the BIOS will search for the master boot record first in the hard disk drive. If it is not found, then search in the floppy disk drive. If not found in the floppy disk drive as well, the it will search in the CD-ROM. In case, when the system is unable to find the master boot record in all these resources, it shows a message **"No Boot Device Found"** on the screen and the system will stop.
If master boot record is found in any of the bootable disk drivers, the **operating system loader** (also called **Bootstrap Loader**) is loaded from the bootable drive into the main memory.

**Step 4**

The bootstrap loader first loads the DOS system **IO.SYS,** and after this it loads the **MSDOS.SYS** file that is the core file of the disk operating system.

**Step 5**

The MSDOS.SYS file finds the **command interpreter** in another system file named **CONFIG.SYS.** When it is found, it is to be loaded into the main memory. In case when no command interpreter is specified in the CONFIG.SYS, then the **COMMAND.COM** file is loaded into the main memory as the default command interpreter of the disk operating system.

**Step 6**

At last, the **AUTOEXEC.BAT** file is loaded and executed. This file contains the sequence of DOS commands. Once the AUTOEXEC.BAT is loaded, the DOS command prompt is displayed on the computer screen. We can see the letter of the bootable drive in the prompt screen. This indicates that the operating system is

successfully loaded from disk into the main memory. At this stage, the system is ready to use.

This is how the booting process takes place in the disk operating system.

**Types of MS-DOS Commands**

There are mainly two types of MS-DOS commands:

**1. Internal Commands**

Internal commands are those commands that are loaded automatically in the memory when DOS is loaded into memory during the booting process. These commands are easier to learn and use. They require no external files for their storage as in the case of external commands. These are for performing a basic operation on files and in directories. They do not need any external file support. These commands are used for common jobs such as copying and erasing files.

**2. External Commands**

These external commands are for performing advanced tasks and they do not need some external file support as they are not stored in COMMAND.com. The external commands are used less frequently and are stored in some external files which are stored in some secondary storage devices. Whenever an external command is to be executed then the external file in which that particular command is stored is transferred from the secondary storage disk to the main memory(RAM).

**How to open MS-DOS in windows?**

- **Step 1:** Click on Windows.
- **Step 2:** Search for 'Run' or directly use (Windows key+R) to open.
- **Step 3:** Type 'cmd' in run and press 'Enter'.
- **Step 4:** MS-DOS will open in many cases with default command prompt i.e. c:\>

**Basic MS-DOS Commands**

| Command | Description | Type |
|---------|-------------|------|
| mem | Display memory on the system. | External |
| mkdir | Command to create a new directory. | Internal |
| mklink | Creates a symbolic link. | Internal |
| md | Command to create a new directory. | Internal |
| chdir | Changes directories. | Internal |

| Command | Description | Type |
|---------|-------------|------|
| chkdsk | Check the hard drive running FAT for errors. | External |
| chkntfs | Check the hard drive running NTFS for errors. | External |
| choice | Specify a listing of multiple options within a batch file. | External |
| append | It Causes MS-DOS to look in other directories when editing a file or running a command. | External |
| arp | Displays, adds and removes arp information from network devices. | External |
| assign | Assign a drive letter to an alternate letter. | External |
| assoc | View the file associations. | Internal |
| at | Schedule a time to execute commands or programs. | External |
| batch | Recovery console command that executes several commands in a file. | Recovery Console |
| bcdedit | Modify the boot configuration data store. | External |

| Command | Description | Type |
|---------|-------------|------|
| bootcfg | Recovery console command that allows a user to view, modify, and rebuild the boot.ini file. | Recovery Console |
| break | Enable and disable the Ctrl+C feature. | Internal |
| del | Deletes one or more files. | Internal |
| delete | Recovery console command that deletes a file. | Internal |
| deltree | Deletes one or more files or directories. | External |
| disable | Recovery console command that disables Windows system services or drivers. | Recovery Console |
| lock | Lock the hard drive. | Internal |

**MS-DOS File and Filetypes**

A computer file created by an application running under the DOS operating system. is called an MS-DOS file. There are three main files of DOS. During the Booting process, the computer loads the operating system into its memory. DOS booting involves reading the following files into memory namely

- **IO. SYS:** A hidden executable binary file that processes instructions that tell the operating system (OS) how the computer is set up when it is booted or started. It contains the default MS-DOS device drivers (hardware interfacing routines) and the DOS initialization program.
- **MSDOS. SYS:** The MSDOS.SYS file is a hidden, system, read-only file created on the root of the boot drive. There are several configurations that can be changed using this file. Most values in the MSDOS.SYS are either 0 or 1, which is off or on.
- **COMMAND.COM:** COMMAND.COM is the default command-line interpreter for MS-DOS. It is the default user interface as well.COMMAND.COM is the

command shell on MS-DOS and PC-DOS, as well as versions of Windows that depend on DOS. Gives users a command line interface to DOS as well as a way to run scripts called "batch files" with the .BAT file extension.

# Windows

Windows is an Operating System developed by Microsoft. It is a graphical user interface (GUI) based system that allows users to interact with their computers and manage various tasks. It runs applications and provides a user-friendly interface that enables users to interact directly with the system to perform tasks.

Windows OS offers distinctive features such as:

- Users are allowed to run the software.
- Users interact with the OS through visual elements, such as icons, windows, menus, and a mouse-driven pointer.
- Users can view or store their files.
- Users can create, delete, rename, and move files using the GUI or the CLI.

**History and Evolution of Windows OS**

This OS was first introduced by Microsoft in 1985 and has since undergone many developments and evolutions:

**1. Windows 1.0 (1985):**

- It was the first graphical operating environment developed by Microsoft, marking the company's entry into user-friendly, visual interfaces.
- It was the first version of Windows released on 20 November 1985.

**2. Windows XP (2001):**

- Windows XP was launched on 25 October 2001.
- Windows XP became one of the most popular versions, known for its user-friendly interface and reliable performance.

**3. Windows 7 (2009):**

- Windows 7 was released on 22 October 2009.
- It offered better performance and a more user-friendly, visually appealing interface.

**4. Windows 10 (2015):**

- Windows 10 was established on 29 July 2015
- It blended the best features of Windows 7 and 8 to create a more balanced and user-friendly experience.
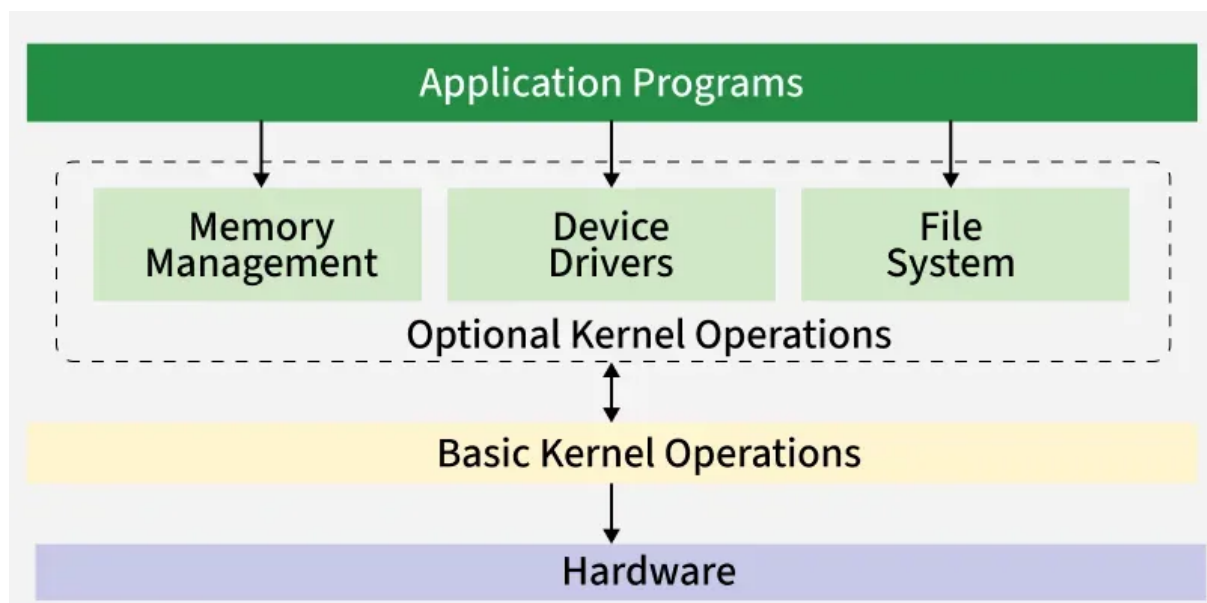
**5. Windows 11 (2021):**

- Windows 11 was officially launched on October 5, 2021.
- It featured a modernized user interface with sleek rounded corners and a redesigned Start Menu for a cleaner, more intuitive experience.

**Key Characteristics of Windows OS**

- **Graphical User Interface (GUI):** The primary user interface is graphical, i.e., instead of typing the commands you manipulate various graphical objects (such as icons) with a pointing device.
- **File Management:** File management refers to the process of organizing and controlling data files stored on the cloud or a device, such as a computer or smartphone.
- **Task Manager:** It is built-in system utility in Microsoft Windows that provides detailed information about the performance of your computer and the applications, processes, and services currently running.
- **Control Panel:** Allows users to view and change system settings. It serves as a centralized interface where you can manage the hardware, software, user accounts, and various system configurations.
- **Built-in security tools:** Built-in security tools designed to provide protection at various levels—ranging from antivirus to encryption and network safety. These tools work together to keep your system safe from both internal and external threats.
- **Virtual desktops:** It refers to a logical extension of a physical desktop interface that allows users to create and manage multiple desktop environments on a single computer.

**Architecture of Windows OS**



- **Application Programs:** An Application Program is a type of computer software designed to perform specific tasks for users. Application Program help users accomplish real-world activities such as creating documents, playing media, browsing the internet, or managing data. Application programs can be installed on various devices, including computers, smartphones, and tablets. They may be bundled with the device or installed separately
- **Memory Management:** Memory Management is a hardware component that stores data, instructions and information temporarily or permanently for processing. It consists of an array of bytes or words,

each has a unique address. Memory management in the Windows Operating System is the process through which the OS handles, allocates, and frees physical and virtual memory to ensure efficient performance and multitasking. Windows uses a virtual memory model, which gives applications the illusion of having a large, continuous block of memory, even if the actual physical memory (RAM) is limited.

- **Device drivers:** Device drivers are specialized software programs that act as a bridge between a computer's operating system and its hardware components**.** The main purpose of device drivers is to provide abstraction by acting as a translator between a hardware device and the applications or Operating System that use it. Programmers can write higher-level application code independently of whatever specific hardware the end-user is using.
- **File System:** A File System is defined as a medium used for saving and managing data in the computer system. The data stored in the computer system is completely in digital format, although there can be various types of files that help us to store the data. A file system is an essential component of any operating system. It ensures data integrity, security, and usability by managing how files are stored and accessed. Understanding the file system helps users and developers work more effectively with data, system resources, and storage media.
- **Kernel:** A kernel is the core part of an operating system. It acts as a bridge between software applications and the hardware of a computer. The kernel manages system resources, such as the CPU, memory, and devices, ensuring everything works together smoothly and efficiently. It acts as the main interface between the computer's hardware and the software applications that run on the system. The kernel is responsible for managing system resources, such as the CPU, memory, input/output devices, and system calls.
- **Hardware:** Hardware refers to the physical components of a computer system or any electronic device. These are the tangible parts you can touch and see — such as the keyboard, mouse, monitor, CPU, hard drive, and even internal circuits. Hardware is typically directed by the software to execute any command or instructions. A combination of hardware and software forms a usable computing system, although other systems exist with only hardware.
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**User Mode VS Kernel Mode**
Here is the key differences between User Mode and Kernel Mode in Windows OS.

| Aspect | User Mode | Kernel Mode |
|---|---|---|
| **Privilege Level** | Low-level privilege. | High-level (full) privilege. |
| **System Access** | Limited; cannot directly access hardware or kernel memory. | Full access to all hardware and memory. |

| Aspect | User Mode | Kernel Mode |
| --- | --- | --- |
| Who Runs Here? | User applications (e.g., MS Word, Chrome, games). | Operating System kernel, device drivers, and core system processes. |
| Memory Access | Can only access its own memory space. | Can access both user and kernel memory spaces. |
| System Call Requirement | Needs to make system calls to access system resources. | No need for system calls; can execute all instructions. |
| Error Impact | Errors affect only the application. | Errors may crash the entire system. |
| Security | More secure, as access is restricted. | Less secure if not well-protected, since it has total control. |
| Execution Speed | Slower for hardware-level tasks. | Faster for system-level operations. |
| Examples | Applications like browsers, media players, games. | OS components like memory manager, file system, hardware drivers. |

**File System and Management**
A Computer File System is defined as a medium used for saving and managing data in the computer system. The data stored in the computer system is completely in digital format, although there can be various types of files that help us to store the data.

- **File Explorer and Libraries:** File Manager, known as **File Explorer** in modern Windows versions, is a graphical user interface tool that allows users to browse, organize, manage, and access files and folders stored on the computer. It provides features such as creating, copying, moving, renaming, and deleting files and folders, as well as accessing connected drives, network locations, and cloud storage services. File Manager also displays file properties, previews, and navigation options like the address bar, ribbon menu, and navigation pane. **Libraries** in

Windows are virtual folders that aggregate content from multiple physical locations (folders) into a single view for easier access and organization. Instead of moving files from their original locations, libraries link to folders such as Documents, Pictures, Music, and Videos, allowing users to manage similar types of files from one unified place. Libraries enhance file organization without changing the file's actual storage path.

- **Drive Partitions and Disk management:** A **drive partition** is a logically divided section of a physical hard disk or solid-state drive (SSD). Each partition functions as an independent storage unit and is assigned a drive letter (like C:, D:). Partitions help in organizing data, separating system files from personal files, and allowing multiple operating systems to reside on a single physical disk.
- **There are typically three types of partitions**
    - **Primary Partition** – Can contain an operating system and is bootable.
    - **Extended Partition** – Can contain one or more logical drives.
    - **Logical Drive** – A section inside an extended partition used for storing data. **Disk Management** is a built-in Windows utility that allows users to view and manage disk drives and their partitions. It provides a graphical interface to perform tasks such as:
        - Creating and deleting partitions
        - Formatting drives
        - Changing drive letters

## Memory Management

Memory management is the process by which the operating system handles and coordinates computer memory (RAM) usage. It keeps track of every byte in a computer's memory and manages the allocation and deallocation of memory blocks to various applications.

- **How windows manages RAM and CPU:** Windows uses a combination of physical memory (RAM) and virtual memory (page file) to manage running applications. It allocates memory to processes, uses paging to swap data between RAM and disk, applies memory protection to isolate processes, and reclaims memory when applications close. Windows manages the CPU through preemptive multitasking, where the scheduler allocates time slices to each process based on priority. It supports multicore processing, balances CPU load across cores, and ensures efficient execution of threads while preventing any single task from monopolizing the processor.
- **Task Manager Overview:** Task Manager is a system utility in Microsoft Windows that provides detailed information about the computer's performance and running processes. It allows users to monitor, control, and manage active applications, background processes, CPU and memory usage, and overall system performance.
- **Background Process and Services:** Background process are programs or tasks that run behind the scenes without direct user interaction. They support system operations or applications by performing essential functions such as updates, syncing, notifications, and system monitoring. These processes are typically launched at

startup or by active applications and continue running silently in the background.

- **Services** are specialized background programs in Windows that perform specific functions required by the operating system or applications. They start automatically at boot or manually when needed, and run independently of user sessions. Windows services handle tasks like networking, printing, system updates, security, and hardware management, and are managed through the **Services Manager**.

### My computer
"My Computer" is the classic name for the Windows feature (now called This PC) that lets you view and manage your computer's drives, folders, and connected devices, accessible via File Explorer (Win + E) or by adding the icon to your desktop through Personalization settings for quick access to local disks, USB drives, and system tools.

## How to Open/Find "This PC" (My Computer)

1. **Keyboard Shortcut:**

   Press the Windows key + E to open File Explorer directly, where "This PC" is listed on the left.

2. **Start Menu (Windows 10/11):**

   Open the Start Menu, click the File Explorer icon, then select "This PC" from the left pane.

3. **Desktop Shortcut:**
- Right-click an empty space on your desktop and select Personalize.

- Go to Themes, then click Desktop icon settings.

- Check the box next to Computer (This PC) and click Apply and OK.

## What it Does

- **Shows Drives:** Lists your internal hard drives (C:, D:), external drives, and optical drives.

- **Accesses Files:** Provides a gateway to your Documents, Pictures, and other folders.

- **Manages Devices:** Shows connected devices like printers, USB drives, and network locations.

### Windows Explorer
Windows Explorer, known as File Explorer in modern Windows, is the built-in file management application for browsing, organizing, and managing files and folders on your PC, accessed via the taskbar icon or **Windows key + E** shortcut, providing a graphical interface to navigate your computer's storage.

**What it does:**

- **Browse Files:** View your drives, folders, and files in a tree-like structure.

- **Manage Files:** Perform actions like copying, moving, renaming, and deleting files.

- **Quick Access:** Pin frequently used folders and view recent files for easy access.

- **Search:** Find files and folders on your computer.

**How to open it:**

- **Keyboard Shortcut:** Press the **Windows key + E** (hold down the Windows key, then press E).

- **Taskbar Icon:** Click the yellow folder icon on your taskbar.

- **Start Menu:** Click the Start button and type "File Explorer," then select it.

**Key Features:**

- **Ribbon:** A toolbar with common commands (like Copy, Paste, New Folder).

- **Navigation Pane:** Left side shows drives, libraries, and quick access.

- **Tabs:** Switch between multiple folders in the same window (Ctrl+T for new tab).

## Windows Accessories

"Windows Accessories" refers to the collection of basic, pre-installed applications in Microsoft Windows for everyday tasks like Notepad (text editing), Paint (graphics), Calculator, Snipping Tool (screenshots), WordPad (formatted text), and system tools like Disk Cleanup, while "PC Accessories" are physical hardware like mice, keyboards, headphones, and webcams that enhance a Windows computer's functionality.

## Common Software Accessories (Built-in)

- **Notepad/WordPad**: Simple text editors for basic writing.

- **Paint**: Basic image creation and editing.

- **Calculator**: For simple and scientific math.

- **Snipping Tool/Snip & Sketch**: Capture screenshots of your screen.

- **Character Map**: Insert special symbols and characters.

- **On-Screen Keyboard**: A virtual keyboard for touch devices or accessibility.

- **System Tools**: Utilities like Disk Cleanup, Task Scheduler, and Performance Monitor for system maintenance.

- **Remote Desktop Connection**: Connect to other computers.

## Common Hardware Accessories (External)

- **Mice & Keyboards**: Ergonomic or compact options for better input.
- **Headphones/Speakers**: For audio output, often with noise-cancelling.
- **Webcams & Microphones**: For video calls and conferencing.
- **Docking Stations**: Expand connectivity for laptops.
- **Monitor Arms/Stands**: Improve desk ergonomics.

## How to Find Them

- In newer Windows versions (like 10/11), many are under "All apps" in the Start Menu, often in folders like "Windows Accessories," "Windows System," or "Ease of Access".

## Managing multiple windows

Managing multiple windows in Windows involves using features like **Task View** (Win + Tab) for virtual desktops, **Snap Layouts/Assist** (Win + Arrow keys) for split-screen, and **Alt + Tab** for quick switching, allowing you to organize apps across separate desktops or screen sections for better focus and productivity.

## Key Tools & Shortcuts

- **Task View (Windows key + Tab):** Shows all open apps and virtual desktops, letting you create new ones, switch, or move windows between them.

- **Snap Assist (Windows key + Arrow keys):**

  o `Win + Left/Right` : Docks a window to half the screen.

  o `Win + Up` : Maximizes the window.

  o `Win + Down` : Restores or minimizes the window.

- **Alt + Tab:** Cycles through your open applications.

- **Show Desktop (Win + D or click bottom-right corner):** Minimizes all windows to reveal the desktop.

## Arrange icons on the desktop

To arrange desktop icons in Windows, **right-click** a blank space, select **View**, and toggle **Auto arrange icons** to lock them or uncheck it for free placement; you can also use **Sort by** (Name, Size, Type, Date) for automatic sorting or adjust icon size via the **View** menu, letting you customize layout and appearance easily.

## Sorting & Automatic Arrangement (Grid)

1. **Right-click** an empty area on your desktop.

2. Hover over **View** to see options like Large, Medium, or Small Icons for size.

3. Hover over **Sort by** to choose Name, Size, Item Type, or Date Modified for automatic sorting.

4. To enable automatic grid alignment, right-click, go to **View**, and ensure **Auto arrange icons** has a checkmark.

## Creating and Managing folders

To create and manage folders in Windows, use **File Explorer (Win+E)**, right-click a blank space for **New > Folder**, name it, and press Enter; manage by **dragging/dropping, Cut/Copy/Paste (Ctrl+X/C/V)**, renaming (right-click > Rename), or deleting (right-click > Delete) files/folders, organizing them hierarchically for better access and storage.

### Creating Folders

1. **Open File Explorer:** Press `Win + E` or click the folder icon on the taskbar.

2. **Navigate:** Go to your Desktop, Documents, or any desired location.

3. **Right-Click Method:** Right-click a blank area, select **New**, then click **Folder**.

4. **Toolbar Method (Win 10/11):** In File Explorer, click the **New** button (or arrow next to it) and choose **Folder**.

5. **Keyboard Shortcut:** Navigate to the spot and press `Ctrl + Shift + N`.

6. **Name & Enter:** Type the folder's name (e.g., "My Photos") and press `Enter`.

### Managing Folders & Files

- **Moving/Copying:**

o **Drag & Drop:** Click and drag files/folders into another folder.

o **Cut/Copy/Paste:** Select item(s), press `Ctrl+X` (Cut) or `Ctrl+C` (Copy), go to destination, press `Ctrl+V` (Paste).

- **Renaming:** Right-click the folder/file, select **Rename**, type the new name, press `Enter`. (Or click once to select, then click again slowly/wait a second and type).

- **Deleting:** Right-click the item and select **Delete**, or select it and press the `Delete` key (moves to Recycle Bin).

- **Creating Subfolders (Folders Inside Folders):** Open a folder, then create another folder inside it using the same methods above to build a hierarchical structure (e.g., Photos > Vacation 2024).

## Managing files and drives

Managing files and drives in Windows involves using File Explorer for daily tasks like creating, moving, copying, and deleting files/folders, organizing with folders, and using shortcuts, while also leveraging tools like Disk Management (right-click Start > Disk Management) for advanced tasks like initializing new disks or managing partitions, plus Storage Sense for automatic cleanup, keeping your system efficient.

## File & Folder Management (File Explorer)

- **Create:** Right-click > New > Folder/Text Document, then name it.

- **Copy/Move (Cut & Paste):** Right-click file/folder > Copy/Cut > Right-click destination > Paste, or use **Ctrl+C/Ctrl+X & Ctrl+V**.

- **Drag & Drop:** Drag files between open windows (use right-click drag for options: Move/Copy/Shortcut). Hold **Ctrl** to copy, **Shift** to move when dragging to another drive.

- **Rename:** Click once to select, wait a second, click the name, or right-click > Rename.

- **Select Multiple:** Click, hold **Shift** (range) or **Ctrl** (specific files), or **Ctrl+A** (all).

- **Shortcuts:** Right-click file/folder > Send to > Desktop (create shortcut) or Pin to Quick Access.

## Drive Management (Disk Management)

- **Access:** Right-click Start button > **Disk Management**.

- **Initialize New Disk:** Right-click offline disk > Initialize Disk (choose GPT for modern systems).

- **Create Volume:** Right-click unallocated space > New Simple Volume.

- **Extend/Shrink:** Right-click a volume > Extend Volume or Shrink Volume.

## Storage Optimization

- **Storage Sense:** Go to **Start > Settings > System > Storage** to automatically free up space by deleting temporary files.

- **Storage Spaces:** Group multiple drives into a single pool to create larger virtual drives and protect against failure.

## Logging off and shutting down windows

Logging off closes your user session but keeps the PC on, while shutting down turns the entire computer off; you do both via the Start Menu (Power icon) or shortcuts like

Win+X or Ctrl+Alt+Del, choosing **Sign out** for log off or **Shut down** for power off, always saving work first.

## How to Log Off (Sign Out)

Logging off closes your apps and returns to the login screen, letting another user log in.

- **Start Menu:** Click Start > [User Icon/Arrow] > **Sign out**.

- **Ctrl+Alt+Del:** Press `Ctrl + Alt + Del` > Select **Sign out**.

- **Win+X Menu:** Press `Windows Key + X` > **Shut down or sign out** > **Sign out**.

## How to Shut Down (Turn Off)

Shutting down closes all programs and powers off the computer completely.

- **Start Menu:** Click Start > Power icon > **Shut down**.

- **Alt+F4:** On the desktop (click desktop first), press `Alt + F4` > Choose **Shut down** from the menu.

- **Win+X Menu:** Press `Windows Key + X` > **Shut down or sign out** > **Shut down**.

## Key Difference

- **Log Off:** You, the user, are signed out; the computer stays on (like ending a call but not hanging up).

- **Shut Down:** The entire system powers off (like hanging up the call and turning off the phone).

### Media Player

"Media Player Windows" refers to Microsoft's built-in application for playing audio/video, now called simply Media Player, a modern replacement for the classic Windows Media Player, both handling music/video libraries; you can find it via the Start menu or Microsoft Store, and other popular alternatives include VLC Media Player, PotPlayer, or GOM Player, offering broader format support.

### Microsoft's Media Players

- **Media Player (New):**

The current version for Windows 10/11, offering a fresh interface and focusing on music and video playback, often found in the Microsoft Store.

- **Windows Media Player (Legacy):**
The older, classic player still available on Windows 10/11, accessible through "Turn Windows features on or off" if missing, for familiar functionality.

### How to Find & Use Them

1. **Search:** Type "Media Player" or "Windows Media Player" in the Windows search bar.

2. **Start Menu:** Look under "Windows Accessories" for the legacy version.

3. **Microsoft Store:** Search for "Media Player" to download the modern app.

## Sound Recorder

Windows has a built-in Sound Recorder (also known as Voice Recorder) app for Windows 10 & 11, found by searching the Start Menu, used to capture audio with a simple click, trim recordings, and save them as files in your Documents folder. For more advanced needs, like editing or system audio recording, free alternatives like Audacity are available, but the default app offers basic, easy-to-use functions for lectures, notes, or interviews.

## How to Use the Built-In Sound Recorder

1. **Open the App**: Press the Windows key, type `Sound Recorder` or `Voice Recorder`, and open the app.

2. **Start Recording**: Click the large red Start button or press `Ctrl+R`.

3. **Pause/Resume**: Click the pause button to pause, then click it again to resume.

4. **Stop Recording**: Click the red stop button when done.

5. **Manage Recordings**:

o View your recordings on the left pane.

o **Rename**: Right-click a recording to rename it.

o **Trim**: Use the trim tool for basic edits (cut start/end).

o **Play**: Click to play back.

6. **Find Files**: Recordings are saved in your `Documents\Sound recordings` folder.

## Volume control

Windows volume control offers quick adjustments via the taskbar speaker icon (slider for overall volume, mixer for app-specific levels), dedicated keyboard keys (volume up/down/mute), or through Settings > System > Sound for detailed control over input/output devices and individual app volumes, letting you manage sound for everything from system-wide to specific apps like games or browsers.

## Quick Adjustments (Taskbar)

- **Overall Volume:** Click the speaker icon in the bottom-right taskbar and drag the slider.

- **Volume Mixer (Per App):** Click the speaker icon, then click the icon next to the volume slider to open Quick Settings and find the Volume Mixer link for app-specific controls (Windows 11) or right-click the speaker and select Open Volume Mixer (Windows 10/11).