

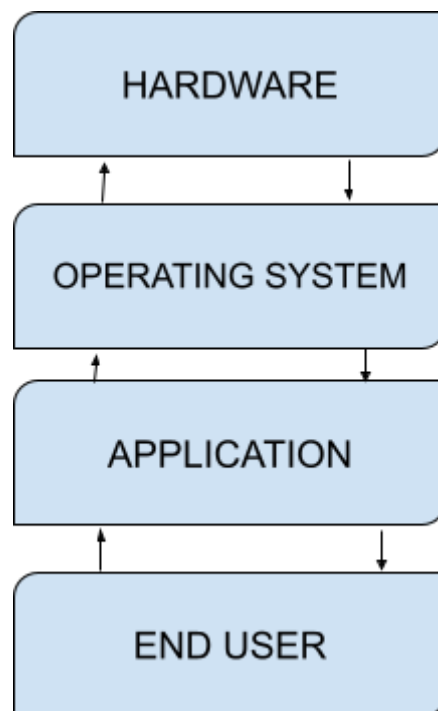
Linux Kernel

Operating System :

- OS is an interface that helps you to interact between hardware and software.
- Linux is a kind of operating system like Microsoft, MAC OS.
- OS enables the communication between computer hardware and software.

Kernel :

- Kernel is the heart of the OS which lets you communicate with the hardware.



Kernel vs OS

- Operating System is a software program that manages computer hardware resources while Kernel is the core part of the operating system that interacts directly with the computer hardware.
- In simpler words we can say OS is like a manager that controls all the resources of a computer whereas the kernel works as the worker who actually performs the task on computer hardware.
- OS is responsible for managing user level tasks like managing applications, it provides an interface to a user to compute, manage the system resources.

While the kernel is responsible for managing the system resources like CPU, Memory, I/O devices. Kernel is also responsible for handling system calls, interrupts and exceptions.

- OS is a large software program that includes kernel and other system level services which is responsible for managing the system resources while the kernel stays closer to hardware to handle system calls, interrupts.
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CPU

- The CPU is the brain of the computer that is responsible for executing and controlling the operation of any system.
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RAM

- It stores the data and program instructions temporarily.
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Input Devices

- These devices are used to enter data or command into the systems like keyboard, mouse, touchscreen, scanners, etc.

Output Devices

- These devices are used to display the output from the system like monitor, printer, speaker, etc.
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Kernel Module

- Kernel module is also known as device driver or loadable kernel.
- These are dynamic softwares or loadable components that can be loaded or unloaded into the kernel to add support to new hardware.
- Kernel module is basically written in C or assembly language.
- They are loaded into memory when needed and we can unload the resources when we don't need them.
- Eg. Graphic cards, network adapters

Kernel

- Kernel is a core component of an operating system that manages system resources like memory input output, CPU time.

- It provides essential services like process management, memory management, device driver and system calls.

System libraries

- System libraries are predefined or pre written codes that provide common functionality to programs and applications running on an operating system.
- System libraries are divided into two parts : -

Standard libraries: It is collection of language libraries that provides common functionalities for programming languages such as C,C++,Java

Platform specific libraries: These are designed to provide system level resources such as hardware devices, file system, networking.

User utility

- It is a set of tools and commands that are used to manage user accounts and their associated permissions.
- Eg. `adduser`, `userdel`, `chgrp`, `chown`, `chmod`, `su`, `passwd`, `chsh`

User processes

- They refer to programs or tasks that are initiated and managed by the user.
- When any user login into the system they are typically assigned user ID and when the user starts any processes that is typically associated with the user ID.
- Each user process is assigned with a process ID (pid) which is used to identify and manage the processes.
- User process typically runs in user mode which means that they have limited access to system resources and cannot directly access hardware devices/kernel functions.
- There are system processes also that are initiated and managed by the operating system, these are typically run in kernel mode. These kinds of processes are responsible for managing system resources, handling system level functions such as memory management, I/O operations, and process scheduling.

System Softwares

- There are large variety of applications that falls under this category

These are those software that is designed to manage and control the operation of a computer system.

- It includes programs like device driver, operating system, utility programs.

Types of kernel

→ Monolithic Kernel

- It is a type of kernel where all operating system services operate in kernel space.
- It is the oldest type of kernel where the entire operating system is composed of a single large binary executable file that runs in kernel mode.
- It has direct access to all hardware resources and provide services such as memory management, process scheduling and device drivers
- Eg. Linux, UNIX

Advantage: It is very fast because it operates from kernel space.

Disadvantage: It has million lines of code, so anything gets corrupted the whole system is affected/stopped.

→ Micro Kernel

- This is a type of kernel which provides essential services such as interprocess communication, basic memory management, and other services run as user mode processes.
- It is more stable than a monolithic kernel as any service gets affected/corrupted. We don't have to reinstall it/ it will not affect the whole system.

→ Hybrid Kernel

- It is a combination of monolithic kernel and micro kernel, it combines in such a way where it avoids the non essential services like device driver into user mode and it keeps the critical services in kernel mode.
- Eg. Windows, MAC OS

Monolithic Kernel	Micro Kernel
Both user and kernel services are kept in same space (kernel space)	User services and kernel services are in separate spaces
They are larger than micro kernels	They are smaller in size

It is difficult to add new functionalities	It is easier to add any new functionalities
Failure of one component will affect the whole system	Failure of one component does not affect the working of micro kernel
Their execution speed is faster	Their execution speed is slower
Eg. Linux, UNIX	Eg. Windows, MAC

Device Management :

- Device management refers to the management of hardware devices by the operating system kernel.
- It involves handling device driver, allocating and freeing resources such as memory, I/O
- There are few tasks performed in device management
 1. It loads and initializes device drivers at system boot time and unloads them when they are not required.
 2. The kernel detects and configures hardware devices that are connected to the system.
 3. It also allocates system resources such as memory, I/O port to each device.
 4. It also ensures that different devices and applications do not conflict with each other when accessing shared resources.
 5. It enforces security policies to prevent unauthorized access to sensitive data/devices.

Memory Management :

- Memory management in kernel refers to management of system memory by operating system kernel. It involves allocating and deallocating memories for different applications.
- Following are the task that are done under memory management:
 1. The kernel manages allocation and deallocation of memory.
 2. It keeps track of available memories and allocates the memories to process when requested.
 3. The kernel provides memory protection to ensure that processes don't interfere with each other's spaces.

4. It provides the mechanism of sharing memory between processes.
5. The kernel uses **paging, virtual memory** to manage the system memory more efficiently.

Process Management :

- Process management in kernel refers to management of processes, this include creating, scheduling and termination of any process.
- Following are the few tasks that are performed under process management:
 1. Kernel creates a process when a program is executed by user or another process.
 2. Each process has a unique process ID and are allocated resources such as memory and file descriptor.
 3. Kernel schedules processes for execution on the CPU using scheduling algorithms.
 4. Kernel provides a synchronization mechanism that multiple processes can access shared resources without interfering each other.
 5. Kernel terminates the processes when they have finished executing or when they are terminated by the users.

Handling System call:

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Shell :

- Shell is a command line interface that allows users to interact with the operating system.
- It is a program that interprets user input and execute the command.
- Following are the tasks that are performed by shell:
 1. We can execute the commands.

2. The shell provides I/O redirection which allows the users to redirect the input and output of the command to and fro from the file.
3. The shell manages system or environment variables (these are the variables that stores the variables about system environment)
4. User can modify the system variables using shell
5. The shell allows users to write a script which is collection of commands that can be executed as single unit.
6. Shells are divided into two type:
 - a. **Graphical** : This shell specifies the manipulation of a program using a graphical interface that provides operations like moving, closing, resizing, switching between different applications.
 - b. **Command line** : It is a program that provides a command line interface for interacting with the operating system. It allows users to enter any command on prompt and execute them.

Bash :

- Bourne again shell
- The extension for bash is .sh
- This is usually installed in /bin/sh

Root user default prompt is #

Non-root user default prompt is \$

Linux File System :

- In linux, files are ordered in tree structure where root is considered as the start of file system and root is denoted by /
- There are 3 different types of files :
 - **General**: They contain files like images, text, configuration files.

- **Directory:** They are special type of files that contain files and directories
 - **Device:** These are special files that represent physical and virtual devices in system such as printer, hard drive, CD ROM, etc
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Types of users in linux :

→ **Regular user:**

Regular user is created whenever you install ubuntu. In this, all files and folders are stored in the home directory.

These kinds of users don't have access to the directory or files of any other user.

→ **Root user/ admin:**

Root users are the super users that have access to all the restricted files and have all the administrative privileges.

→ **Service users:**

Linux is widely used as a server operating system and services like email and other applications have their own service account.

Linux File System:

In linux directories are created in /home

If you create any user in Linux their files and directories will be saved in /home/username

In windows all the program files are usually stored in C: drive while in linux the system and program files are stored in different directories like boot files are stored in /boot directory, all the program files can be stored in /bin and many more.

Windows	Linux
Windows use different data drives like C: , D:	While linux use tree like structure
In windows peripheral devices like CD ROM, printers, are considered as device	While in linux all the peripheral devices are considered as file
In windows there are 5 different kinds of users: <ul style="list-style-type: none"> • Admin • Child • Guest 	While in linux we have 3 different kinds of users: <ul style="list-style-type: none"> • Regular • Root • Service

: - this is separator

~ - home directory

\$- signs suggest that you are working as a regular user in Linux.

- this signs suggest that you are working as root user in Linux

/ - sign for root

Path: It is a location of any file or folder in the file system.

There are 2 different types of path:

- **Relative path:** These are the paths related to the present working directory. It starts at your current directory.
 - Eg. /directory_name(current)
- **Absolute path:** Absolute path defines the location of any file or directory from the root directory.
 - eg. /home/user/filename

In linux files are stored in tree structure or free format.

On the top we have root directory and under directory we have many other directory and subdirectories like bin, boot, etc, var.

/etc : It contains all the configuration files used by system services. This contains startup and shutdown shell scripts that are used to start and stop individual programs.

/boot : This contains all the files needed to start the boot process.

/usr : This contains all the shared libraries, installed softwares and read only program data

/home : This stores all the program files by the user. This contains all the user stored data, personal configuration, user documents, music, videos, etc.

/bin : This contains all the user commands in binary format like ls, cp, pwd and others.

/dev : This contains all the device files used to access hardware.