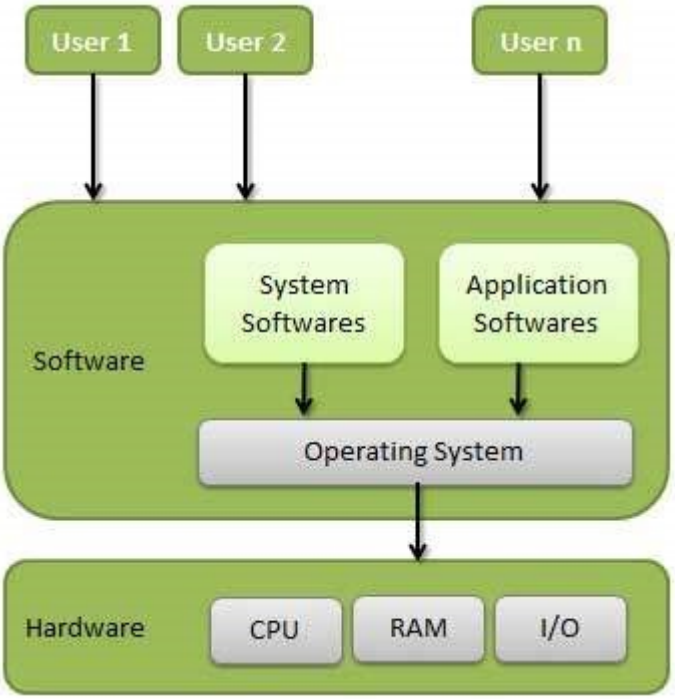
Operating Systems

1. Introduction to operating systems

Os is a system software that serves as an intermediary between computer hardware and user applications.



2. Major Role of an Operating System

a. Process Management

process is a program in execution. Each process has its own memory space, system resources, and a set of data structures. OS can

i. create
ii. schedule
iii. terminate a process.

b. Memory Management

The OS manages a computer's memory hierarchy, including RAM (Random Access Memory) and virtual memory. It allocates memory to processes and ensures efficient use of available resources.

i. File System Management

Operating systems provide file management services, organising data into files and directories. This includes file creation, deletion, reading, and writing operations.

c. Device Management

The OS controls and coordinates input and output devices such as keyboards, monitors, printers, and storage devices. It provides a uniform interface for different hardware components.

d. Security and Protection

Operating systems implement security mechanisms to protect data and resources from unauthorised access. This involves user authentication, access control, and encryption.

e. User Interface

Operating systems provide a user interface that allows users to interact with the computer. This can be a command-line interface (CLI) or a graphical user interface (GUI).

f. Network Management

In networked environments, the OS facilitates communication between computers. It manages network connections, protocols, and data transfer between systems.

g. Resource Allocation

The OS allocates system resources such as CPU time, memory, and I/O devices to different processes based on priorities and scheduling algorithms.

h. Bootstrapping

The OS is responsible for the system's startup process. It loads essential programs into memory during bootstrapping and initialises the hardware for operation.

3. Evolution of operating systems.

a. No Operating System (Pre-1950s):

Early computers had no operating systems; programming was done at the hardware level.

b. Single-User Batch Processing Systems (1950s):

Early operating systems were designed for single-user batch processing, where users submitted jobs and received results later.

c. IBM OS/360 (1960s):

IBM OS/360 was a significant milestone, introducing a family of compatible operating systems

for mainframes. It featured virtual memory and a range of utilities.

d. Time-Sharing Systems (1960s-1970s):

Time-sharing systems allowed multiple users to interact with a computer simultaneously, providing a more interactive experience.

e. UNIX (1970s):

Developed at Bell Labs, UNIX introduced the concept of a portable, multitasking, and multi-user operating system. It had a significant impact on subsequent systems.

f. Microcomputer Operating Systems (1970s-1980s):

With the rise of microcomputers, operating systems like CP/M and MS-DOS became prevalent. MS-DOS later evolved into Microsoft Windows.

g. Apple Macintosh System Software (1984):

The Macintosh System Software introduced a graphical user interface (GUI) for Apple computers, setting a standard for user-friendly interfaces.

h. Microsoft Windows (1985):

Microsoft Windows 1.0 was released, providing a graphical environment for MS-DOS. Subsequent versions improved GUI functionality and added features.

i. Networked Operating Systems (1980s-1990s):

Novell NetWare and Microsoft Windows NT introduced features for networked computing, paving the way for client-server architectures.

j. Linux (1991):

Linus Torvalds released the Linux kernel, an open-source Unix-like operating system kernel. The open-source movement gained momentum.

k. Windows 95/98/NT (1990s):

Microsoft Windows 95 brought significant improvements, including a more advanced GUI and preemptive multitasking. Subsequent versions added features and stability.

l. Mac OS X (2001):

Apple introduced Mac OS X, combining the stability of UNIX with a user-friendly interface. It later evolved into macOS.

m. Mobile Operating Systems (2000s):

iOS (Apple), Android (Google), and others emerged for mobile devices, transforming how people interact with computing devices.

n. Virtualization and Cloud Computing (2000s-2010s):

Virtualization technologies like VMware and cloud computing services revolutionised resource utilisation and scalability.

o. Containerization and Microservices (2010s):

Docker and Kubernetes popularised containerization and microservices, facilitating scalable and portable applications.

p. Security-Focused Operating Systems (2010s-2020s):

Operating systems have placed a greater emphasis on security features to address evolving cybersecurity threats.

q. Edge Computing (2020s):

The focus on edge computing has emerged, where processing is done closer to the data source, reducing latency.

r. Integration of AI (2020s):

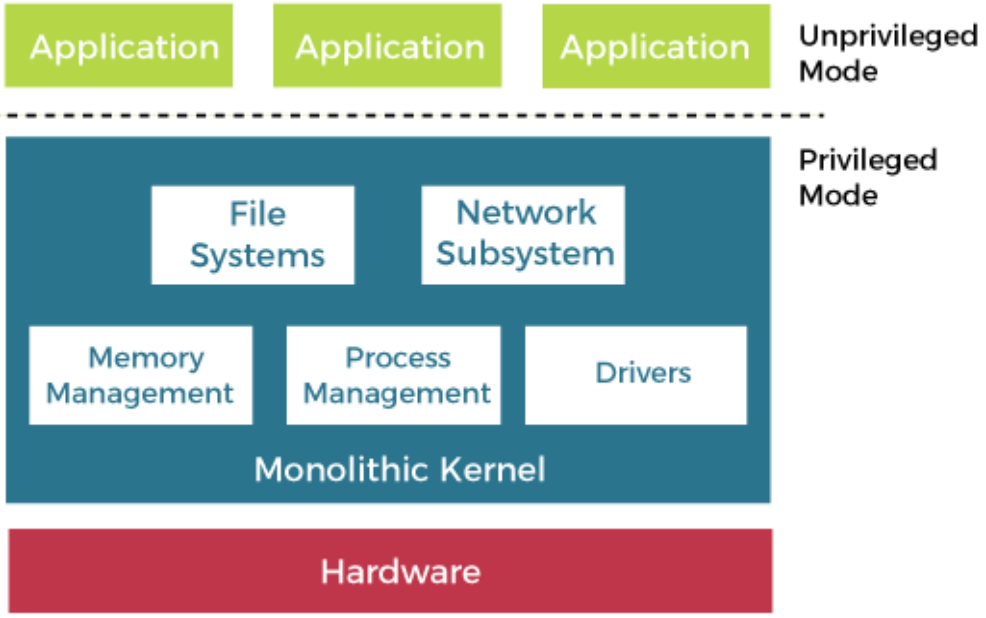
Operating systems are increasingly integrating artificial intelligence features for improved user experiences and security.

4. Operating System Structures:

a. Monolithic Architecture

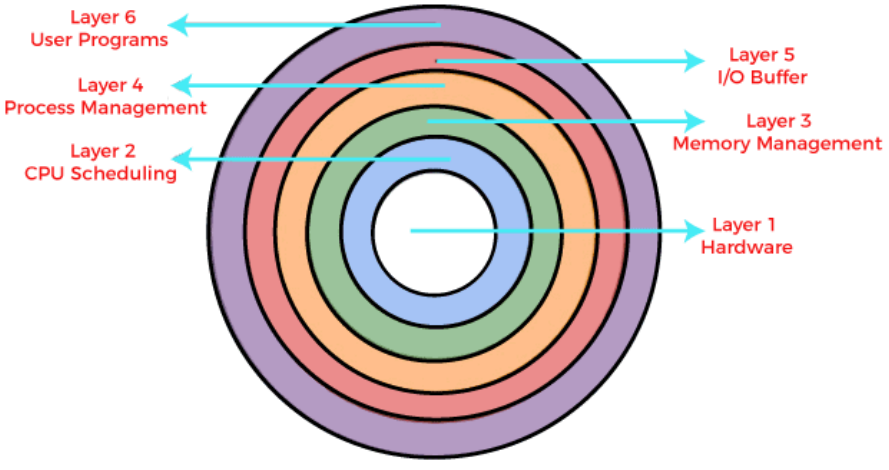
i. All modules are Implemented as a single program

ii. Runs in kernel mode. a single large program.



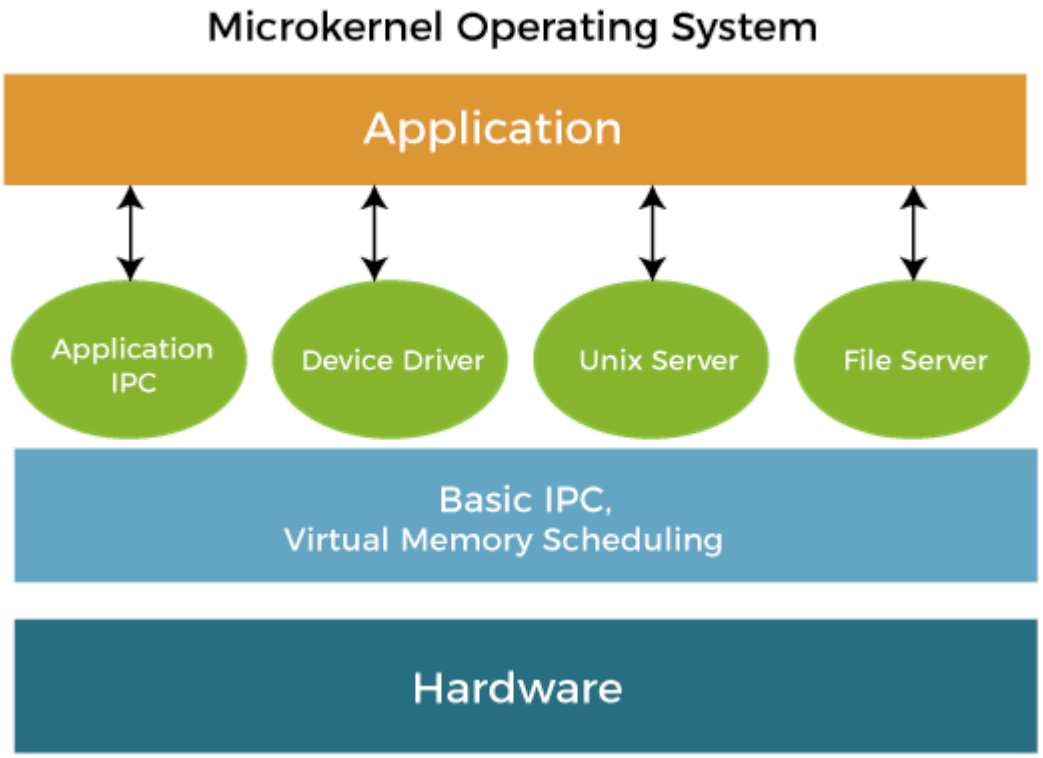
b. Layered Architecture

- Organised into distinct layers.
- Each layer provides a specific set of services
- Allow modularity and ease of maintenance
- use well-defined interfaces to Communicate between layers



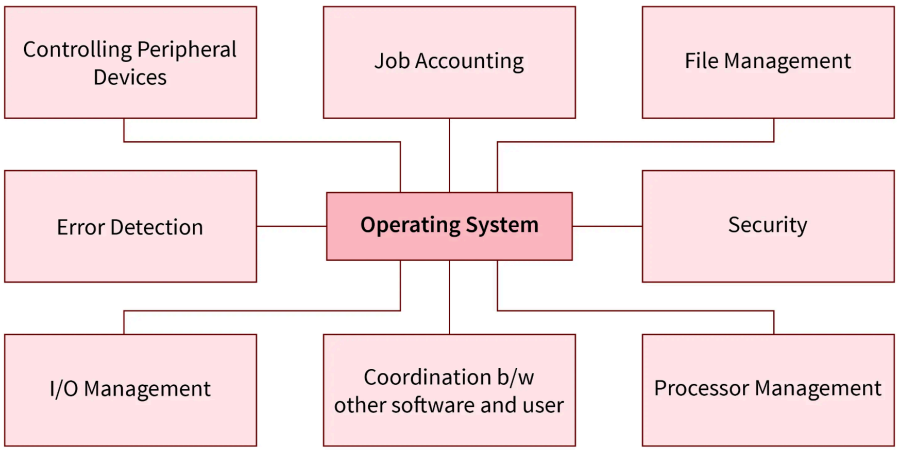
c. Microkernel

The microkernel is the core component of the operating system. It provides essential services such as inter-process communication (IPC), basic memory management, and possibly thread scheduling. Its goal is to remain as small and simple as possible.



d. Modular Architectures

In modular operating system architectures, the system is organised into well-defined and relatively independent modules or components, each responsible for specific functions or services. The modular approach aims to enhance flexibility, maintainability, and scalability by allowing the system to be built from interchangeable and composable parts.



i. independent modules, each responsible for a specific set of functions.
ii. Promotes maintainability
iii. Allows for customization
iv. Easier updates.
v. Dynamic Loading of Modules
    1. Definition: Allows for the addition or removal of modules during runtime without requiring a system reboot.
vi. Advantages: Enables flexibility, supports hot-swapping of functionalities, and simplifies updates.
vii. Modular Device Drivers:
    1. Definition: Device drivers are implemented as modular components, allowing users to add or remove

device support without affecting the entire system.

2. Advantages: Supports a wide range of hardware configurations, allows for easy customization, and simplifies maintenance.

viii. Modular File System enable support for different file system types

5. History of Linux

a. The Beginning (1991)

In 1991, Linus Torvalds, then a student at the University of Helsinki, created the Linux kernel as a hobby project. He announced the project on the Usenet newsgroup comp.os.minix, seeking feedback and collaboration.

b. The Linux Kernel (1991-1994)

Linus continued to develop the Linux kernel, refining and expanding its capabilities. The kernel, which serves as the core of the operating system, quickly attracted attention and contributions from developers worldwide.

c. The Birth of GNU/Linux (1992)

The combination of the Linux kernel and the GNU utilities led to the creation of a complete, free, and open-source operating system. This combination is often referred to as GNU/Linux, acknowledging the contributions of both projects.

d. Free Software Foundation's GNU Project (1983-1992)

Various individuals and groups began creating Linux distributions, which bundled the Linux kernel with other software to provide a complete operating system. Examples include Slackware (1993) and Debian (1993).

e. The Rise of Red Hat (1994)

Red Hat, founded in 1993, played a pivotal role in popularising Linux for business use. In 1994, Red Hat released its first distribution, and it later became a leading provider of enterprise Linux solutions.

f. Graphical Environments (late 1990s)

The late 1990s saw the development of graphical desktop environments for Linux, such as GNOME and KDE, enhancing the user experience and making Linux more accessible to a broader audience.

g. Linux on Servers (2000s)

Linux gained significant traction as a server operating system. Its stability, scalability, and open-source nature made it a popular choice for server deployments, particularly in data centres.

h. Android (2008)

Google released the Android operating system, a Linux-based platform for mobile devices. Android became the dominant operating system for smartphones and tablets.

i. Linux in Embedded Systems and IoT (2010s)

Linux found widespread adoption in embedded systems and Internet of Things (IoT) devices due to its flexibility and open-source nature.

j. Containerization and Cloud (2010s)

Technologies like Docker and Kubernetes, which leverage containerization, gained popularity on the Linux platform, facilitating scalable and portable applications in cloud environments.

k. Enterprise Adoption and Partnerships (2010s-2020s)

Linux became a standard in enterprise environments, with major corporations adopting it for servers, cloud infrastructure, and embedded systems. Partnerships and collaborations further strengthened Linux's position in the industry.

l. Continued Development and Community Involvement (Ongoing)

Linux development remains an open and collaborative effort involving thousands of contributors worldwide. The kernel and

associated software continue to evolve, with new releases and updates ensuring Linux's relevance in modern computing.

m. Popular Linux Distributions

i. Debian
   1. Ubuntu:
      a. Kubuntu (KDE desktop)
      b. Xubuntu (Xfce desktop)
      c. Lubuntu (LXQt desktop)
      d. Ubuntu MATE
      e. Ubuntu Budgie
      f. Linux Mint
   2. Knoppix
   3. Devuan (Debian without systemd)
   4. MX Linux.

ii. Fedora:
   1. Red Hat Enterprise Linux (RHEL), CentOS, Rocky Linux, Oracle Linux.

iii. Arch Linux:
   1. Manjaro, Antergos (discontinued), ArchBang.

iv. Kali Linux:
   1. BlackArch,
   2. Parrot Security OS.

6. A brief about Linux Mint

a. Cinnamon Desktop Environment (or Xfce/MATE):

Linux Mint primarily ships with the Cinnamon desktop environment, which offers a traditional desktop experience with a taskbar, system tray, and a customizable start menu. However, users can choose versions with the Xfce or MATE desktop environments for different preferences.

b. Nemo File Manager:

Nemo is the default file manager in Linux Mint. It includes features like a dual-pane view, easy navigation, and built-in search capabilities.

c. Software Manager:

Linux Mint includes a Software Manager that allows users to easily browse, install, and manage software applications. The Software Manager categorises applications, provides user reviews, and simplifies the installation process.

d. Update Manager:

The Update Manager is a tool that provides information about available updates, including security updates and system upgrades. Users can choose different update policies, such as applying updates automatically or manually selecting them.

e. Firefox Web Browser:

Linux Mint typically comes with the Mozilla Firefox web browser as the default. Firefox is known for its speed, security features, and extensive add-on ecosystem.

f. LibreOffice Suite

Linux Mint includes the LibreOffice office suite, which includes applications for word processing, spreadsheet editing, presentations, and more.

g. Multimedia Codecs

Linux Mint comes with built-in support for various multimedia codecs, allowing users to play popular audio and video formats without additional configuration.

h. System Settings

Linux Mint provides an intuitive System Settings panel that allows users to configure various aspects of their system, including display settings, sound, network connections, and more.

i. Terminal

While Linux Mint emphasises a user-friendly graphical interface, it also includes a terminal for users who prefer or need to use command-line interfaces.