Basics of operating system

Definitions

- A program that acts as an intermediary between a user of a computer and the computer hardware
- Resource allocator: Manages and allocates resources.
- Control program: Controls the execution of user programs and operation of I/O devices.
- Kernel: The one program running at all times (all else being application programs)

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

Computer System Components

- Hardware: Provides basic computing resources (CPU, memory, I/O devices).
- Operating system: Controls and coordinates the use of the hardware among the various application programs for the various users.
- Applications programs: Define the ways in which the system resources are used to solve the computing problems of the users (compilers, database systems, video games, business programs).
- Users (people, machines, other computers)

Functions of an Operating System

- Process Management: The OS manages processes by allocating resources, scheduling execution, and ensuring synchronization among multiple processes. It also handles process creation, termination, and state transitions.
- Memory Management: It allocates and deallocates memory space as needed by various applications and processes. The OS ensures efficient utilization of memory and prevents conflicts through techniques like paging and segmentation.
- File System Management: The OS organizes, stores, retrieves, and secures data on storage devices through a structured file system. It maintains directories, access permissions, and file handling operations.
- Device Management: It manages hardware devices such as printers, keyboards, and storage drives using device drivers. The OS ensures smooth communication between hardware and applications.

- Security and Access Control: Operating systems implement security measures, including user authentication, encryption, and access control, to protect data and prevent unauthorized access.
- User Interface: The OS provides interfaces such as Command-Line Interfaces (CLI) and Graphical User Interfaces (GUI) to enable users to interact with the system efficiently.

Main Concepts of an Operating System

- Processes and Threads: A process is an instance of a running program, including its code, data, and system resources. A thread is a smaller execution unit within a process, allowing parallel execution of tasks within the same application.
- Multitasking and Scheduling: Multitasking allows multiple processes to run simultaneously by efficiently managing CPU time. Process scheduling algorithms such as First-Come-First-Serve (FCFS), Shortest Job Next (SJN), and Round Robin (RR) determine how processes share CPU time.
- Memory Management Techniques
    1. Virtual Memory: Extends physical memory using disk storage.
    2. Paging: Divides memory into fixed-size pages to optimize allocation.
    3. Segmentation: Allocates memory based on logical units such as functions or objects.
- File Systems and Storage Management: Operating systems manage data storage using different file systems like FAT32, NTFS, and ext4. They ensure data integrity, access control, and efficient retrieval mechanisms.
- Security and Protection: Operating systems incorporate encryption, firewalls, access control lists (ACLs), and authentication methods to protect data and user privacy from threats like malware and unauthorized access.

Types of Operating Systems

- Batch Operating System: A Batch Operating System is a type of operating system that does not interact with the computer directly. There is an operator who takes similar jobs having the same requirements and groups them into batches.
- Time-sharing Operating System: Time-sharing Operating System is a type of operating system that allows many users to share computer resources (maximum utilization of the resources).

- Distributed Operating System: Distributed Operating System is a type of operating system that manages a group of different computers and makes appear to be a single computer. These operating systems are designed to operate on a network of computers. They allow multiple users to access shared resources and communicate with each other over the network. Examples include Microsoft Windows Server and various distributions of Linux designed for servers.
- Network Operating System: Network Operating System is a type of operating system that runs on a server and provides the capability to manage data, users, groups, security, applications, and other networking functions.
- Real-time Operating System: Real-time Operating System is a type of operating system that serves a real-time system and the time interval required to process and respond to inputs is very small. These operating systems are designed to respond to events in real time. They are used in applications that require quick and deterministic responses, such as embedded systems, industrial control systems, and robotics.
- Multiprocessing Operating System: Multiprocessor Operating Systems are used in operating systems to boost the performance of multiple CPUs within a single computer system. Multiple CPUs are linked together so that a job can be divided and executed more quickly.
- Single-User Operating Systems: Single-User Operating Systems are designed to support a single user at a time. Examples include Microsoft Windows for personal computers and Apple macOS.
- Multi-User Operating Systems: Multi-User Operating Systems are designed to support multiple users simultaneously. Examples include Linux and Unix.
- Embedded Operating Systems: Embedded Operating Systems are designed to run on devices with limited resources, such as smartphones, wearable devices, and household appliances. Examples include Google’s Android and Apple’s iOS.
- Cluster Operating Systems: Cluster Operating Systems are designed to run on a group of computers, or a cluster, to work together as a single system. They are used for high-performance computing and for applications that require high availability and reliability. Examples include Rocks Cluster Distribution and OpenMPI.