



An Introduction to Operating Systems

Core Concepts for the CDAC CCAT Exam

The OS is the Bridge Between User and Hardware



Key Definition

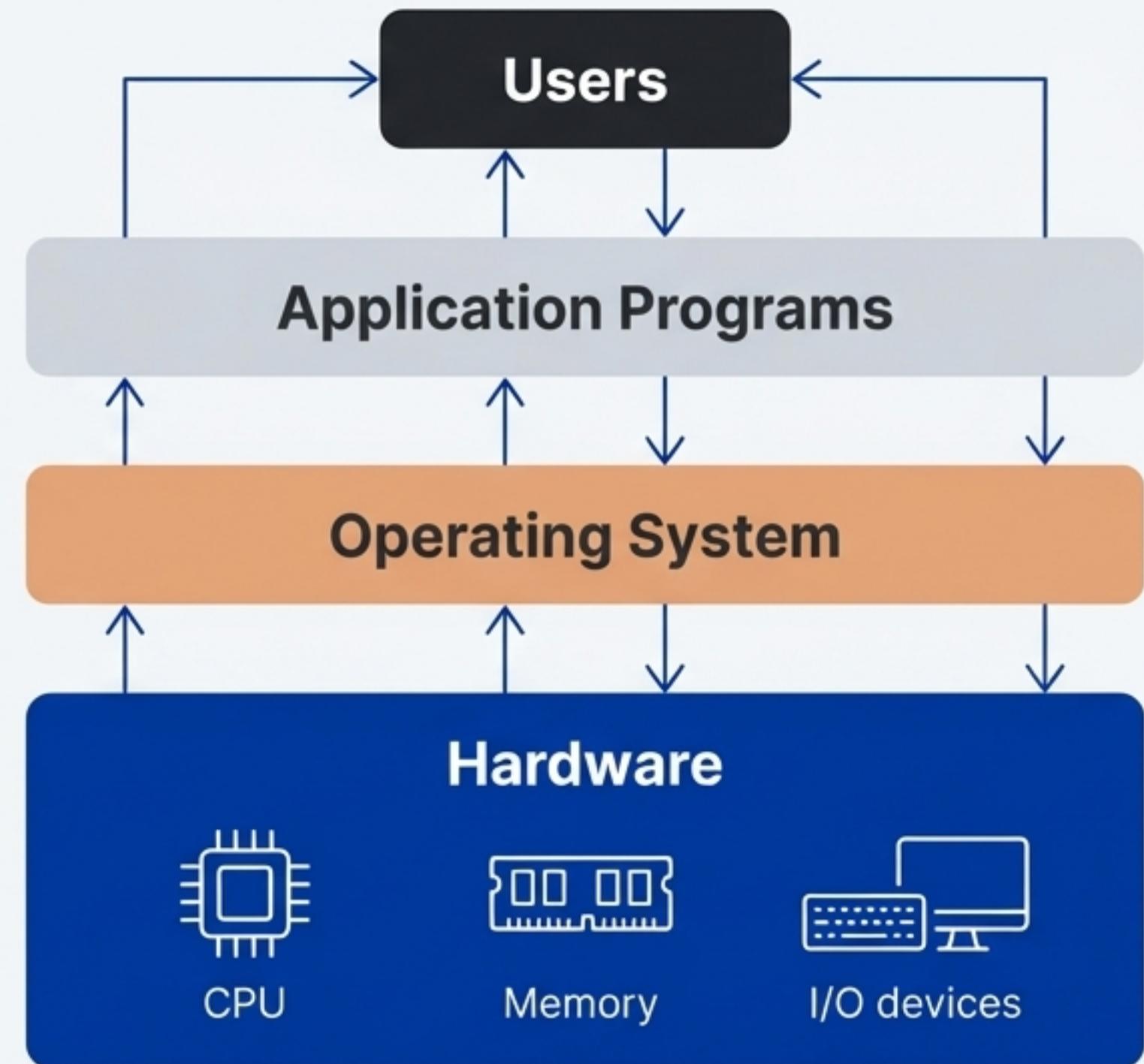
An operating system acts as an intermediary between the user of a computer and the computer hardware. Its purpose is to provide an environment in which a user can execute programs in a convenient and efficient manner.

Core Function

An operating system is software that manages the computer hardware. It provides the mechanisms to ensure the correct operation of the computer system and to prevent user programs from interfering with the system's proper operation.

Understanding the Four Components of a Computer System

- **Hardware:** Provides basic computing resources (CPU, memory, I/O devices).
- **Operating System:** Controls and coordinates the use of hardware among various application programs for various users.
- **Application Programs:** Define the ways resources are used to solve users' computing problems (e.g., word processors, web browsers).
- **Users:** The people interacting with the system.

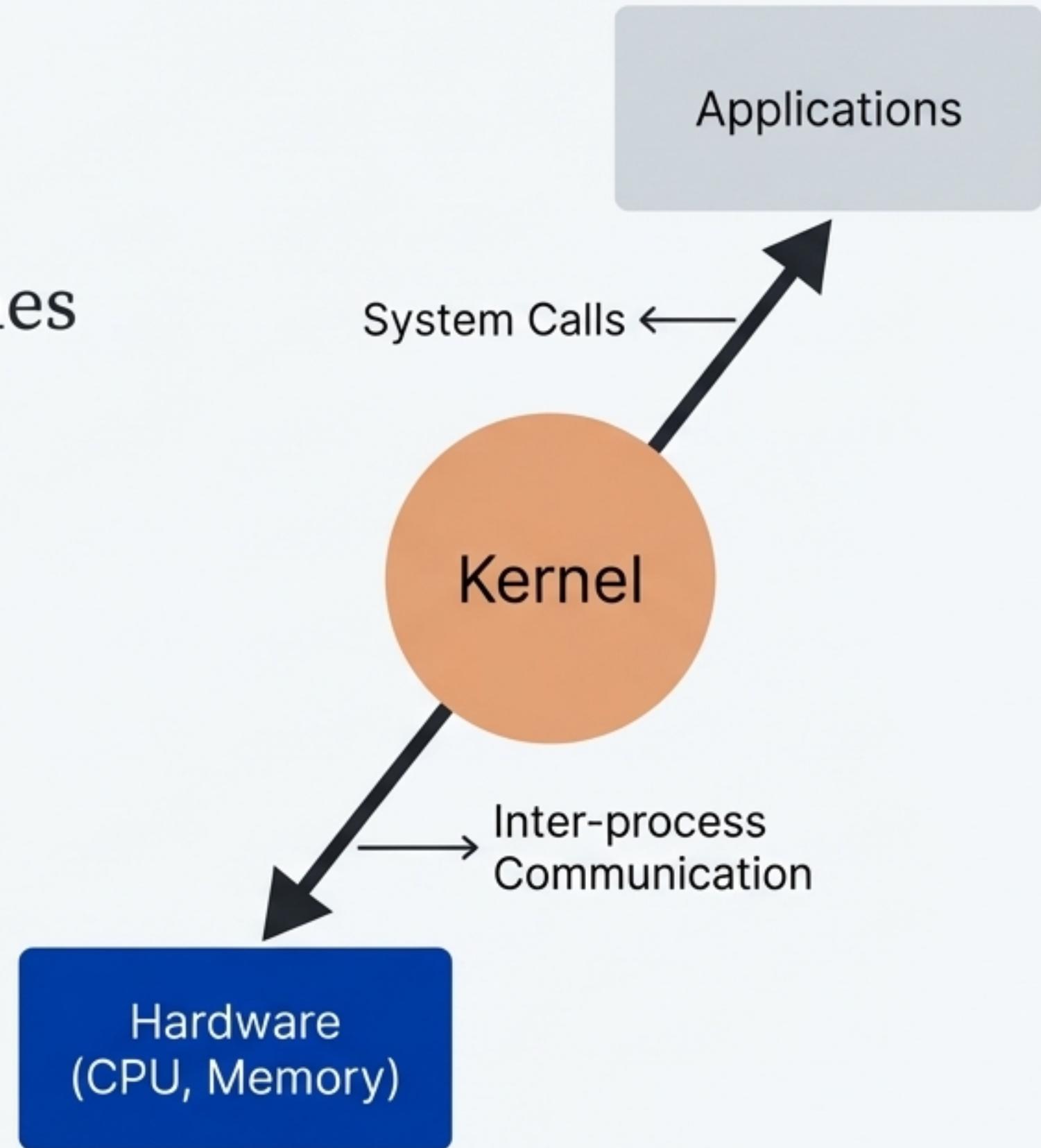


At the Heart of the System Lies the Kernel

“The one program running at all times on the computer is the kernel.”

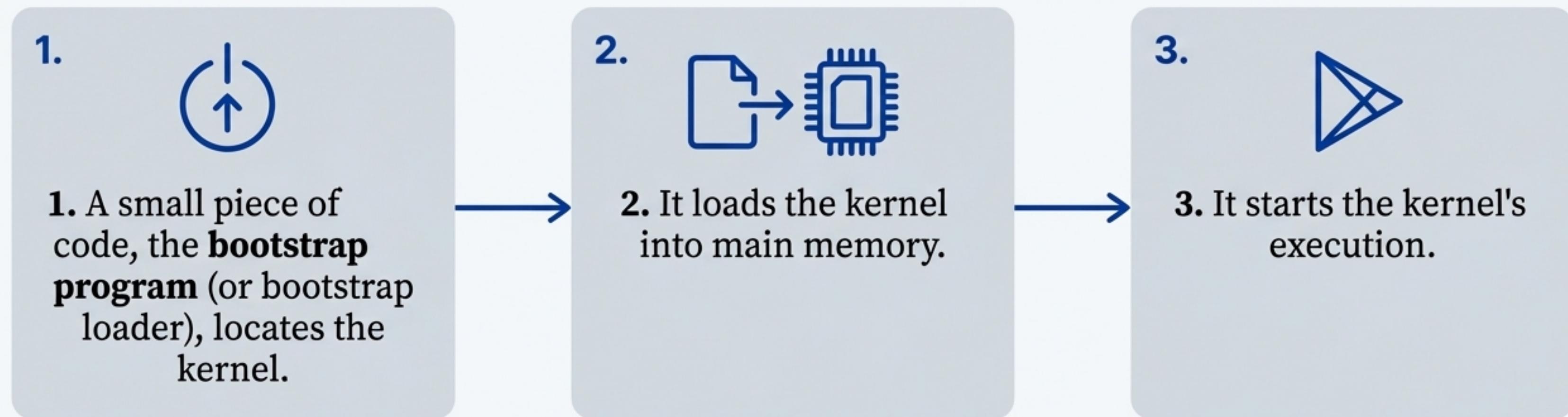
Definition: The kernel is the core component of the OS. It manages the fundamental operations of the computer system and hardware, specifically memory and CPU time.

Function: It acts as a bridge between applications and the data processing performed at the hardware level, using inter-process communication and system calls.



The Booting Process: Loading the Kernel

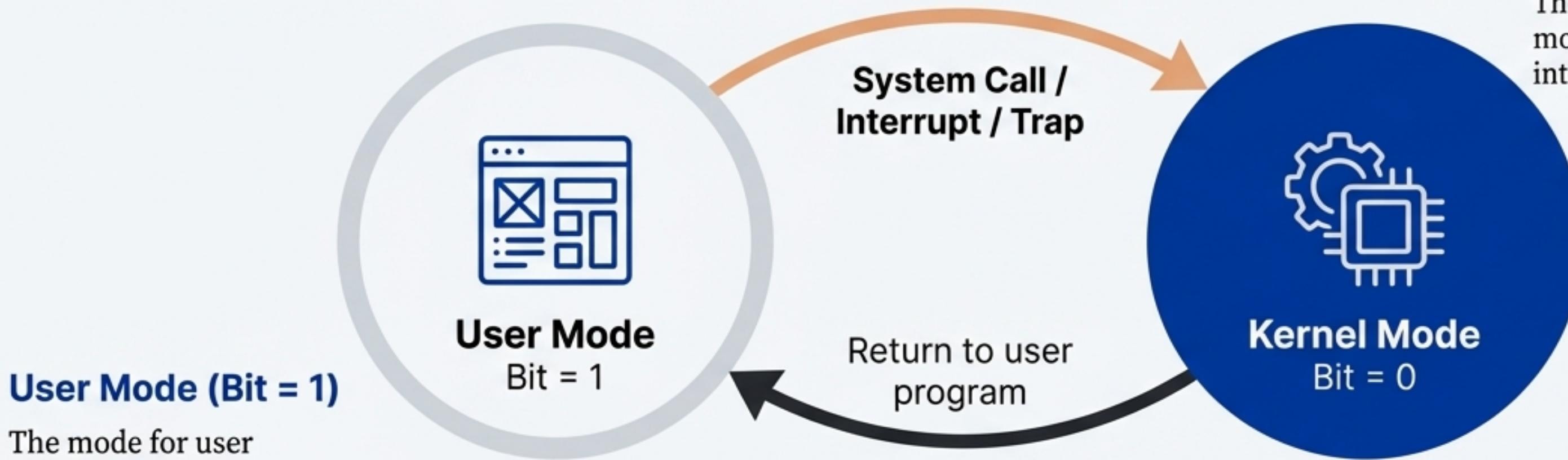
Definition: System Booting is the procedure of starting a computer by loading the kernel.



Note on PC Systems: Some systems, like PCs, use a two-step process where a simple bootstrap loader fetches a more complex boot program from the disk, which then loads the kernel.

Protecting the System with Dual-Mode Operation

To protect the OS from errant users (and users from one another), the hardware provides support to differentiate between modes of execution using a **mode bit**.



User Mode (Bit = 1)

The mode for user applications. The OS starts user applications in this mode.

Kernel Mode (Bit = 0)

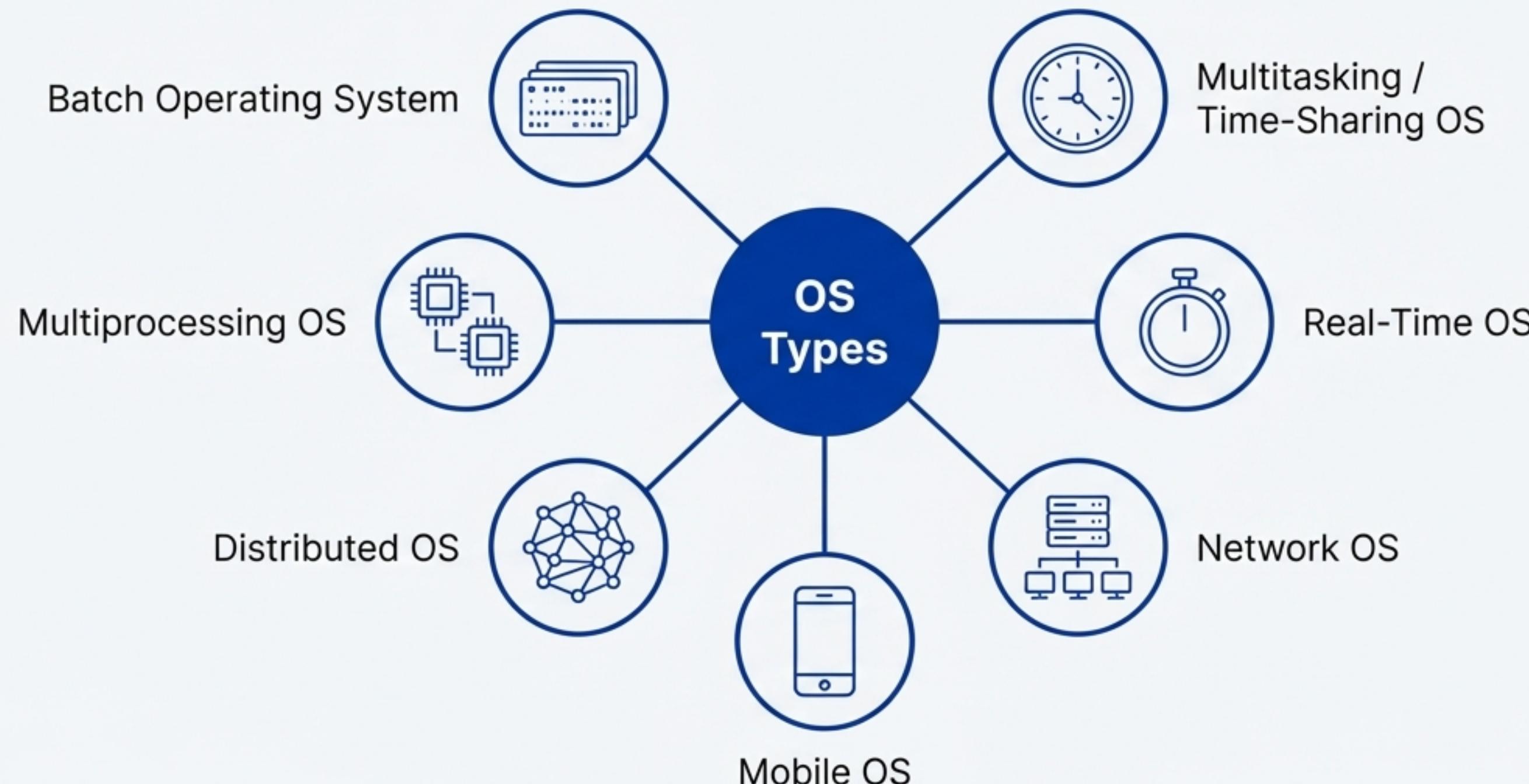
The mode for the operating system. The hardware starts in kernel mode at boot time. The system switches to this mode whenever a trap or interrupt occurs.

The Switch

When a user application needs a service from the OS (via a system call), it must transition from user mode to kernel mode to fulfil the request. The system always switches back to user mode before passing control to a user program.

A Survey of Operating System Types

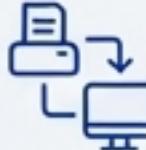
Operating systems are designed for different purposes and environments.
We will explore the most common types.



OS Types: Batch, Multitasking, and Multiprocessing

Batch Operating System

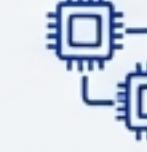
 **Concept:** Jobs with similar needs are batched together and run as a group to speed up processing.

 **Interaction:** The user does not interact directly with the computer; jobs are prepared on offline devices (like punch cards) and submitted to an operator.

Multitasking / Time-Sharing OS

 **Concept:** A logical extension of multiprogramming. The processor's time is shared among multiple users simultaneously, enabling many people to use a single computer system at the same time from various terminals.

Multiprocessing OS

 **Concept:** Two or more CPUs control the computer's functions. Each CPU holds a copy of the OS, and they communicate to coordinate operations.

 **Benefit:** Allows for faster calculations as tasks can be divided between processors.

OS Types: Real-Time, Distributed, and Networked

Real-Time OS (RTOS)



Concept: A software component that rapidly switches between tasks, creating the impression of simultaneous execution on a single processing core.

- **Examples:** Airline traffic control systems, command control systems, heart pacemakers, network multimedia systems.

Distributed OS



Concept: Uses multiple central processors to serve multiple real-time applications and users. Data processing jobs are distributed among the processors, which are known as loosely coupled systems.

Communication: Processors communicate via high-speed buses or telephone lines.

Network OS



Concept: Runs on a powerful server and facilitates the connection and communication of various autonomous computers over a network.

- **Function:** Manages security, data, users, groups, applications, and other network functionalities.

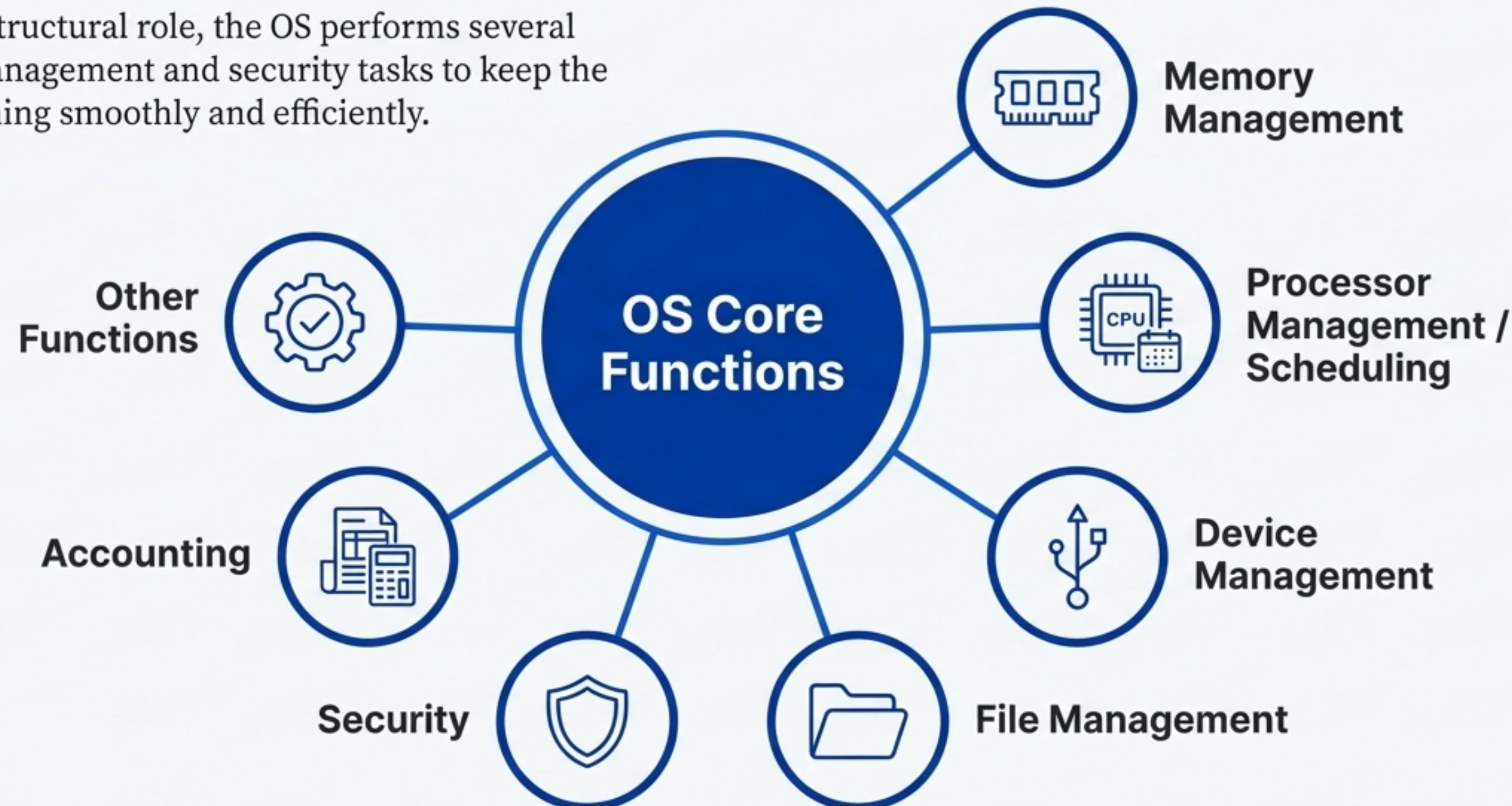
OS Types: The Modern Mobile OS

- **Definition:** An operating system designed for mobile phones, tablets, smartwatches, 2-in-1 PCs, and other mobile devices.
- **Key Features:** Mobile OSs combine features of a personal computer OS with others useful for mobile or handheld use.
- **Built-in Connectivity:** Usually includes a wireless inbuilt modem and SIM tray for telephony and data connection.



The Seven Core Functions of an Operating System

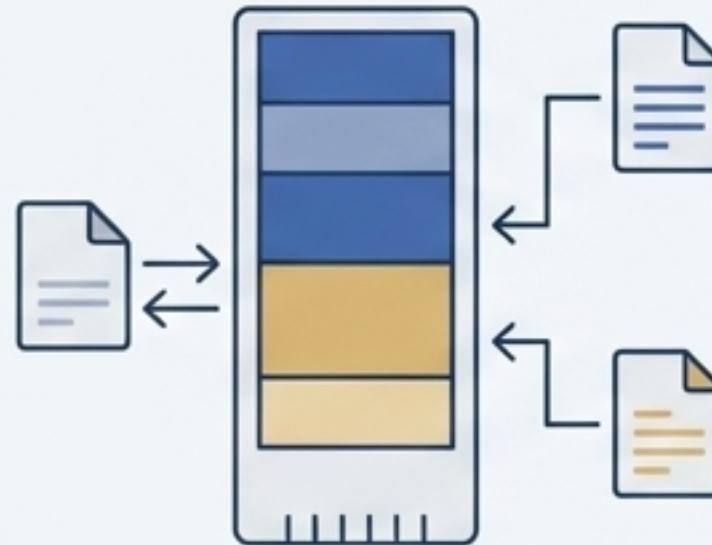
Beyond its structural role, the OS performs several essential management and security tasks to keep the system running smoothly and efficiently.



Core Functions: Managing System Resources

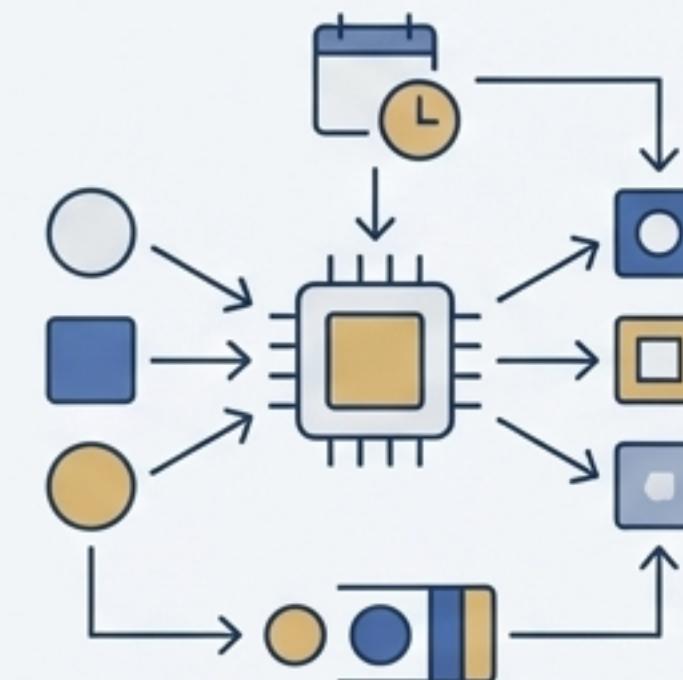
Memory Management

Manages the main or primary memory. Since multiple programs can be in memory at once, the OS must manage its allocation and use.



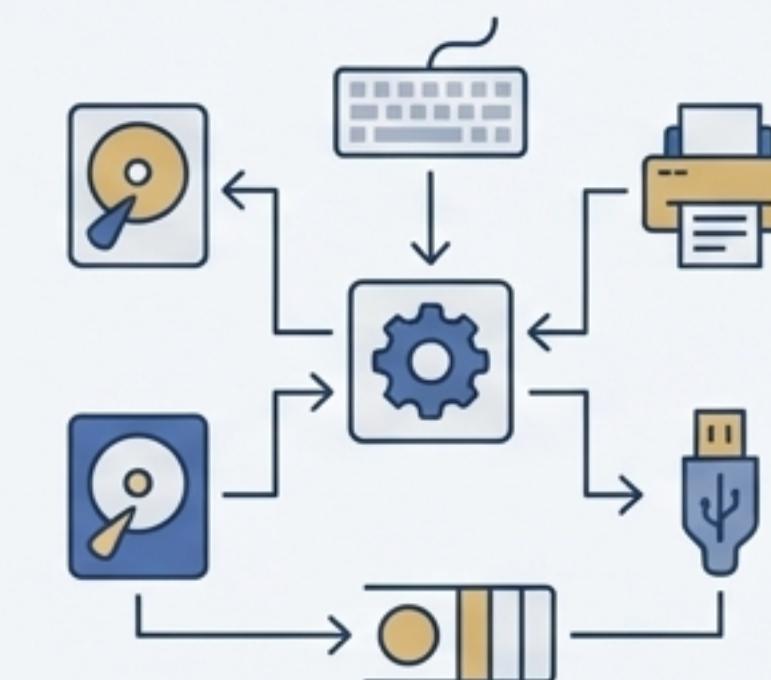
Processor Management/Scheduling

Also known as CPU Scheduling. When more than one process is running, the OS decides how and when a process will use the CPU.



Device Management

Controls all Input/Output devices (disk, keyboard, printer, USB ports). A process may require resources; if available, the OS allocates them. If not, the process must wait.



Core Functions: Organisation, Security, and Accounting



File Management

A system (also known as a file manager) used for file maintenance operations. It manages data files and may display details like owner, creation date, and status.



Security

Refers to practices that ensure the confidentiality, integrity, and availability (CIA) of the OS. The goal is to protect the OS from threats like malicious software, misconfigurations, and remote intrusions.



Accounting

The OS keeps track of all system activities. It records information about memory usage, resources, errors, etc. This information can be used as required.

How Applications Request Services: System Calls

A system call is a routine that allows a user application to request actions that require special privileges, extending the functions provided by the kernel.

Key Categories of System Calls:



Process Control

Stop program execution (normally or abnormally).



File Management

Create, delete, read, write, reposition, or close files.



Device Management

Request and release resources/devices (physical or abstract).



Information Management

Transfer information between the user program and the OS (e.g., time/date).



Communication

Manage interprocess communication via message-passing or shared memory models.

The Final Layer: The User Interface (UI)

A user interface (UI) is the part of an OS, program, or device that allows a user to enter and receive information.



Graphical User Interface (GUI)

Tactile input with visual output (e.g., keyboard and monitor). Functions are carried out by clicking buttons, icons, and menus.



Touch User Interface

Interaction through haptics or touch (e.g., smartphones, tablets).



Voice User Interface (VUI)

Interaction using auditory commands (e.g., virtual assistants, talk-to-text).



Menu-Driven User Interface

Uses a list of choices to navigate (e.g., ATMs).



Form-Based User Interface

Offers a limited selection of choices to enter data (e.g., a settings menu).