Operating System Structures

Operating System (OS) structure refers to the way an operating system is designed and organized to manage hardware and software resources, provide services to users and applications, and ensure efficient and secure operation of a computer system. There are several different approaches to operating system structure, each with its own advantages and disadvantages.

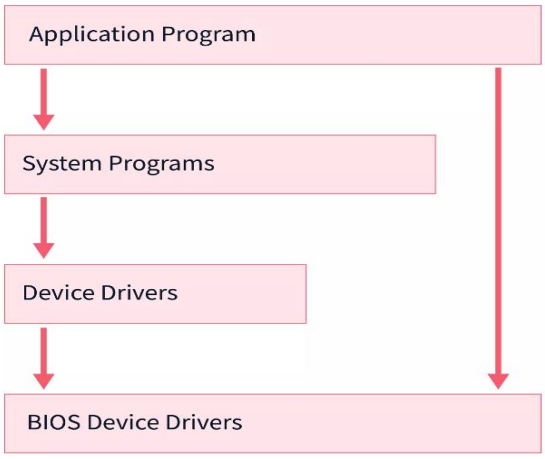
Different types of structures implementing Operating Systems as mentioned below.

1. Simple Structure
2. Layered Structure
3. Micro Kernel Structure
4. Modular Structure
5. Hybrid Structure

Simple Structure

It is the simplest Operating System Structure and is not well defined. It can only be used for small and limited systems. In this structure, the interfaces and levels of functionality are well separated,hence programs can access I/O routines which can cause unauthorized access to I/O routines.

This structure is implemented in MS-DOS operating system.The **MS-DOS operating System is made up of various layers, each with its own set of functions.**



Advantages of Simple Structure

- It is easy to develop because of the limited number of interfaces and layers.
- Offers good performance due to lesser layers between hardware and applications.

- Minimal overhead, suitable for resource-constrained environments.

Disadvantages of Simple Structure

- If one user program fails, the entire operating system crashes.
- Limited functionality.
- Abstraction or data hiding is not present as layers are connected and communicate with each other.
- Layers can access the processes going in the Operating System, which can lead to data modification and can cause Operating System to crash.

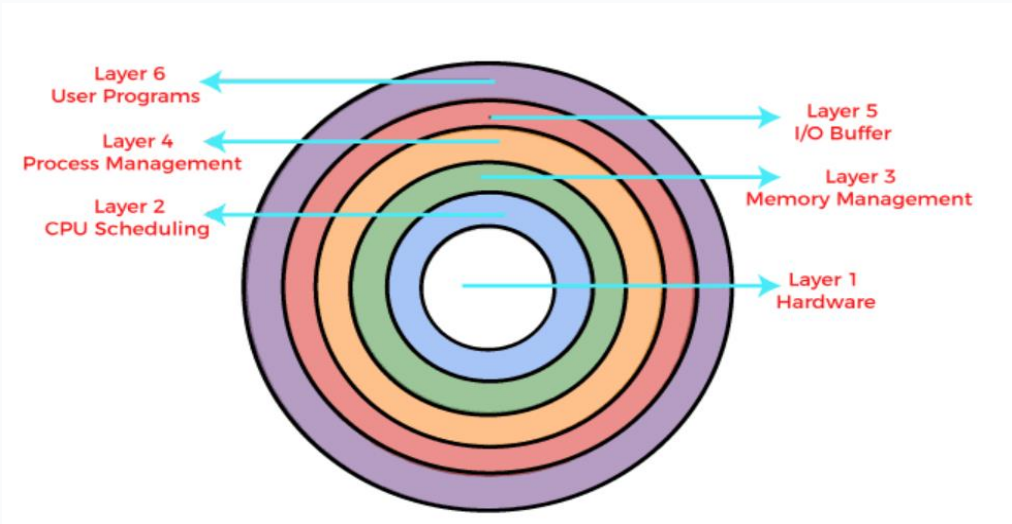
Layered Structure

In this type of structure, OS is divided into layers or levels. The hardware is on the bottom layer (layer 0), while the user interface is on the top layer (layer N). These layers are arranged in a hierarchical way in which the top-level layers use the functionalities of their lower-level levels. **Example:Linux**

The following are some of the key characteristics of a layered operating system structure:

- Each layer is responsible for a specific set of tasks. This makes it easier to understand, develop, and maintain the operating system.
- Layers are typically arranged in a hierarchy. This means that each layer can only use the services provided by the layers below it.
- Layers are independent of each other. This means that a change to one layer should not affect the other layers.

Below is the Image illustrating the Layered structure in OS:



Advantages of Layered Structure

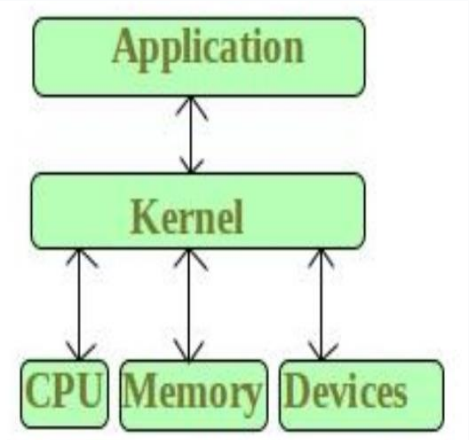
- A layered structure is highly modular, meaning that each layer is responsible for a specific set of tasks. This makes it easier to understand, develop, and maintain the operating system.
- Each layer has its functionalities, so work tasks are isolated, and abstraction is present up to some level.
- Debugging is easier as lower layers are debugged, and then upper layers are checked.

Disadvantages of Layered Structure

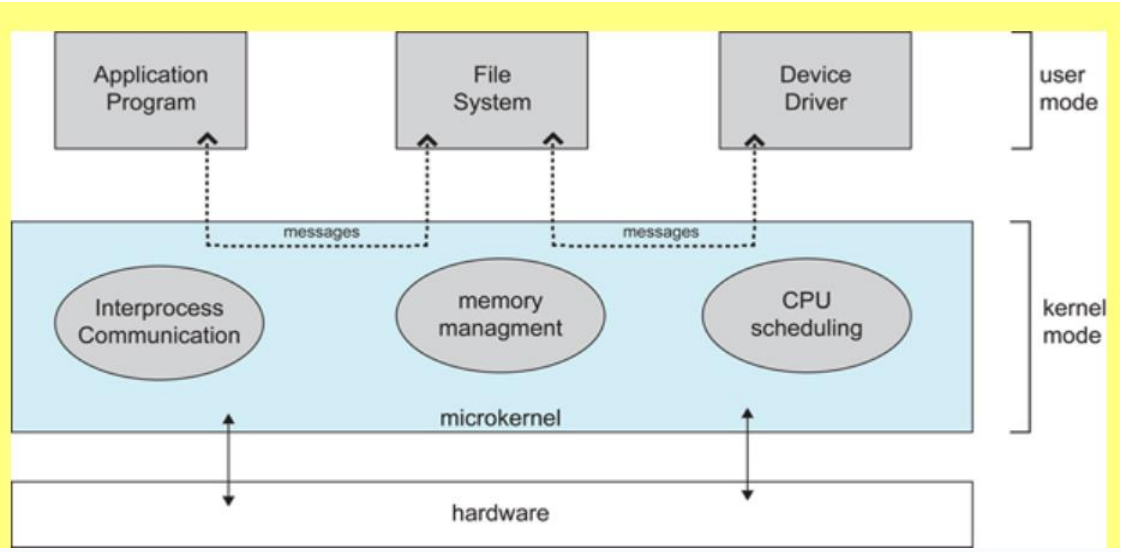
- In Layered Structure, layering causes degradation in performance.
- It takes careful planning to construct the layers since higher layers only utilize the functions of lower layers.
- There can be some performance overhead associated with the communication between layers. This is because each layer must pass data to the layer above it.

Micro-Kernel structure

Kernel is the core part of an operating system that manages system resources. It also acts as a bridge between the application and hardware of the computer. It is one of the first programs loaded on start-up (after the Bootloader).



A microkernel is a type of operating system kernel that is designed to provide only the most basic services required for an operating system to function, such as memory management and process scheduling. Other services, such as device drivers and file systems, are implemented as user-level processes that communicate with the microkernel via message passing. **Ex:Mac OS**



Advantages of Micro-kernel structure:

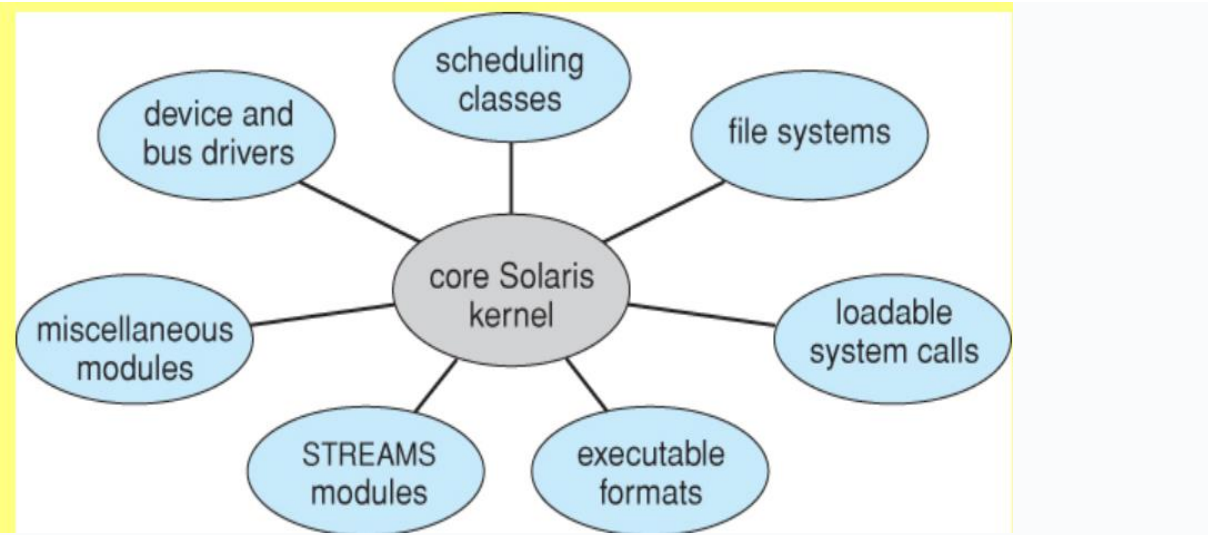
- It allows the operating system to be portable between platforms.
- Enhanced system stability and security.
- As each Micro-Kernel is isolated, it is safe and trustworthy.
- Because Micro-Kernels are smaller, they can be successfully tested.
- If any component or Micro-Kernel fails, the remaining operating System is unaffected and continues to function normally.

Disadvantages of Micro-kernel structure:

- Increased inter-module communication reduces system performance.
- System is complex to be constructed.
- Complexity in managing user-space components.

Modular Structure

In a modular operating system structure, the operating system is divided into a set of independent modules. Each module is responsible for a specific task, such as memory management, process scheduling, or device drivers. Modules can be loaded and unloaded dynamically, as needed**.EX:Solaris**



Advantages of Modular Structure

- A modular structure is highly modular, meaning that each module is independent of the others. This makes it easier to understand, develop, and maintain the operating system.
- A modular structure is very flexible. New modules can be added easily, and existing modules can be modified or removed without affecting the rest of the operating system.

Disadvantages of Modular Structure

- There can be some performance overhead associated with the communication between modules. This is because modules must communicate with each other through well-defined interfaces.
- A modular structure can be more complex than other types of operating system structures. This is because the modules must be carefully designed to ensure that they interact correctly

Hybrid Structure

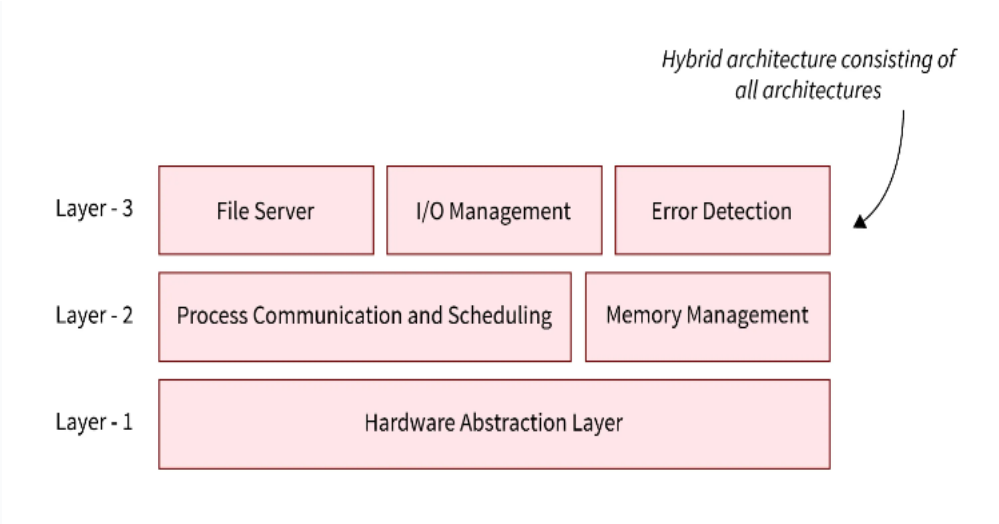
Hybrid Structure as the name suggests consists of a hybrid of all the Structure explained so far and hence it has properties of all of those architectures which makes it highly useful in present-day operating systems. The hybrid-Structure consists of three layers.

1) Hardware abstraction layer: It is the interface between the kernel and hardware and is present at the lowest level.

2) Microkernel Layer: This is the old microkernel that we know and it consists of CPU scheduling, memory management, and inter-process communication.

3) Application Layer: It acts as an interface between the user and the microkernel. It contains functionalities like a file server, error detection, I/O device management, etc.

Example: Microsoft Windows NT kernel implements a hybrid architecture of the operating system.



Advantages:

1. Since it is a hybrid of other structures it allows various structures to provide their services respectively.
2. It is easy to manage because it uses a layered approach.
3. The number of layers is relatively lesser.
4. Security and protection are relatively improved.

Disadvantage:

1. It increases overall complexity of system by implementing both structure (monolithic and micro) and making the system difficult to understand.