OPERATING SYSTEMS:

An Operating System (OS) acts as an interface connecting a computer user with the hardware of the computer. An operating system falls under the category of system software that performs all the fundamental tasks like file management, memory handling, process management, handling the input/output, and governing and managing the peripheral devices like disk drives, networking hardware, printers, etc.

Some well-liked Operating Systems are Linux, Windows, OS X, Solaris, OS/400, Chrome OS, etc.

FUNCTIONS OF OPERATING SYSTEM

Here is a list of some significant functions of an Operating System, which is found common, is almost all operating system:

- Memory Management
- Processor Managing
- Device Managing
- File handling
- Security Handling
- System performance controlling
- Job accounting and handling
- Error detecting and handling
- Synchronization with other software and users

OBJECTIVES OF OPERATING SYSTEM

An operating system consists of a special program that controls the execution of the application program. The OS acts as an intermediary between applications and hardware components. OS can be thought of as having three objectives. These are:

- **Convenience**: It makes a computer more suitable to use.
- **Efficiency**: It provides the computer system resources with efficiency and in easy to use format.
- **Ability to develop**: It should be built in such a way that it permits the efficient development, testing, and installation of new system functions without interfering with service.

COMPONENTS OF COMPUTER:
At an upper level of any computer architecture, a computer is supposed to have a processor, memory and some I/O components, with one or more quantities of each type. These components are interrelated and connected in a way to achieve the major function of the computer, which is to execute programs. So, there are four key structural elements of any computer. These are:

- **Processor**: It controls the processes within the computer and carries out its data processing functions. When there is only one processor available, it is in combination termed as the central processing unit (CPU), which you must be familiar with.
- **Main memory**: It stores data and programs within it. This memory is typically volatile and is also called primary memory. This is because when the computer is shut down, the contents that are within the memory gets lost. In contrast, the contents of disk memory are kept hold of even when the computer system is turned off which you call as shutting down of Operating system or computer. Main memory is also termed as real memory.
- **I/O modules**: This moves the data within the computer to its peripheral external environment. The external environment supposed to have a variety of devices, including secondary memory devices (e.g., pen drives, CDs, etc.), communications equipment (such as LAN cable), terminals, etc.
- **System bus**: It provides communication between processors, main memory, and I/O modules.

Operating System services:

An Operating System supplies different kinds of services to both the users and to the programs as well. It also provides application programs (that run within an Operating system) an environment to execute it freely. It provides users the services run various programs in a convenient manner.

Here is a list of common services offered by an almost all operating systems:

- User Interface
- Program Execution
- File system manipulation
- Input / Output Operations
- Communication
- Resource Allocation

- Error Detection
- Accounting
- Security and protection

User Interface of Operating System

Usually Operating system comes in three forms or types. Depending on the interface their types have been further subdivided. These are:

- Command line interface
- Batch based interface
- Graphical User Interface

The command line interface (CLI) usually deals with using text commands and a technique for entering those commands.

The batch interface (BI): commands and directives are used to manage those commands that are entered into files and those files get executed.

The graphical user interface (GUI): which is a window system with a pointing device (like mouse or trackball) to point to the I/O, choose from menus driven interface and to make choices viewing from a number of lists and a keyboard to entry the texts.

Program Execution in Operating System

The operating system must have the capability to load a program into memory and execute that program. Furthermore, the program must be able to end its execution, either normally or abnormally / forcefully.

File System Manipulation in Operating System

Programs need has to be read and then write them as files and directories. File handling portion of operating system also allows users to create and delete files by specific name along with extension, search for a given file and / or list file information. Some programs comprise of permissions management for allowing or denying access to files or directories based on file ownership.

I/O operations in Operating System

A program which is currently executing may require I/O, which may involve file or other I/O device. For efficiency and protection, users cannot directly govern the I/O devices. So, the OS provide a means to do I/O Input / Output operation which means read or write operation with any file.

Communication System of Operating System

Process needs to swap over information with other process. Processes executing on same computer system or on different computer systems can communicate using operating system support. Communication between two processes can be done using shared memory or via message passing.

Resource Allocation of Operating System

When multiple jobs running concurrently, resources must need to be allocated to each of them. Resources can be CPU cycles, main memory storage, file storage and I/O devices. CPU scheduling routines are used here to establish how best the CPU can be used.

Error Detection

Errors may occur within CPU, memory hardware, I/O devices and in the user program. For each type of error, the OS takes adequate action for ensuring correct and consistent computing.

Accounting

This service of the operating system keeps track of which users are using how much and what kinds of computer resources have been used for accounting or simply to accumulate usage statistics.

Protection and Security

Protection includes in ensuring all access to system resources in a controlled manner. For making a system secure, the user needs to authenticate him or her to the system before using (usually via login ID and password).

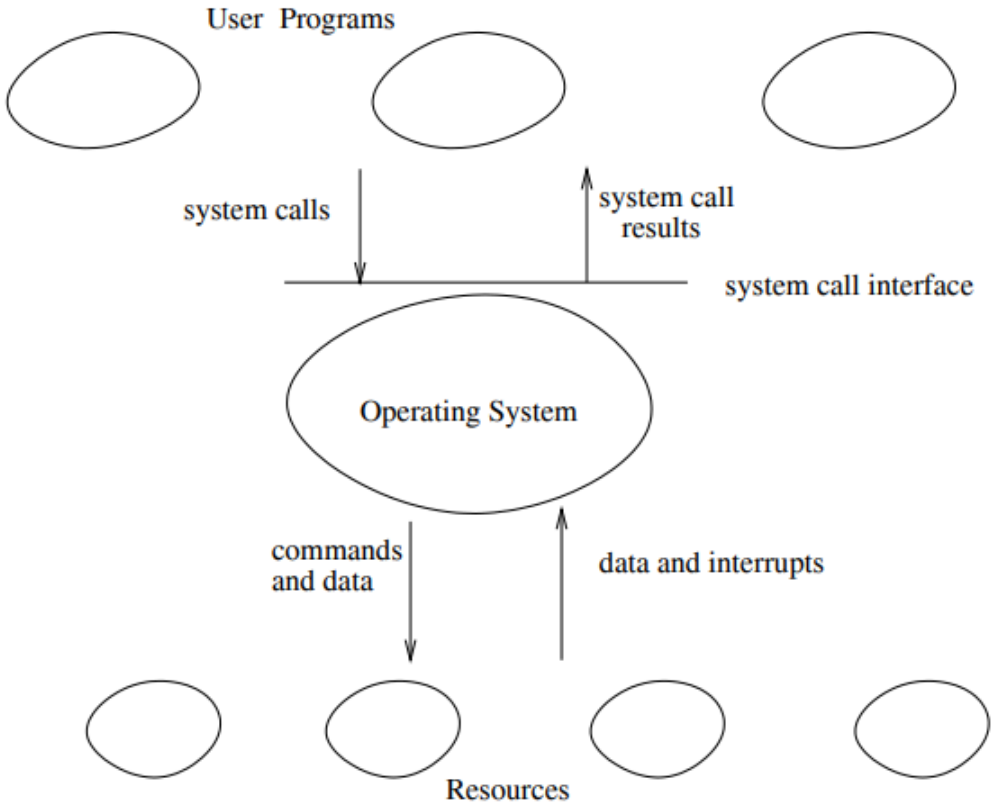
USER VIEW AND SYSTEM VIEW IN OPERATING SYSTEM

The operating system provides a proper means to utilize the resources of the computer system. It provides an environment within which other programs can do useful work. To understand the operating system clearly, it is explored with two viewpoints.

User View – The goal of the operating system in this viewpoint is to maximize the work (or play) that the user is performing. Therefore in this viewpoint, the operating system is designed for ease of use of the system for the user. And less attention is paid to the performance of the operating system.

System View – The goal of the operating system in this viewpoint is to maximize the performance. In this viewpoint, the operating system is more involved with hardware services – CPU time, memory space, I/O operation, and so on. The operating system is involved in managing the hardware resources and allocation them to programs and users for maximum performance.

Schematic View of an Operating System

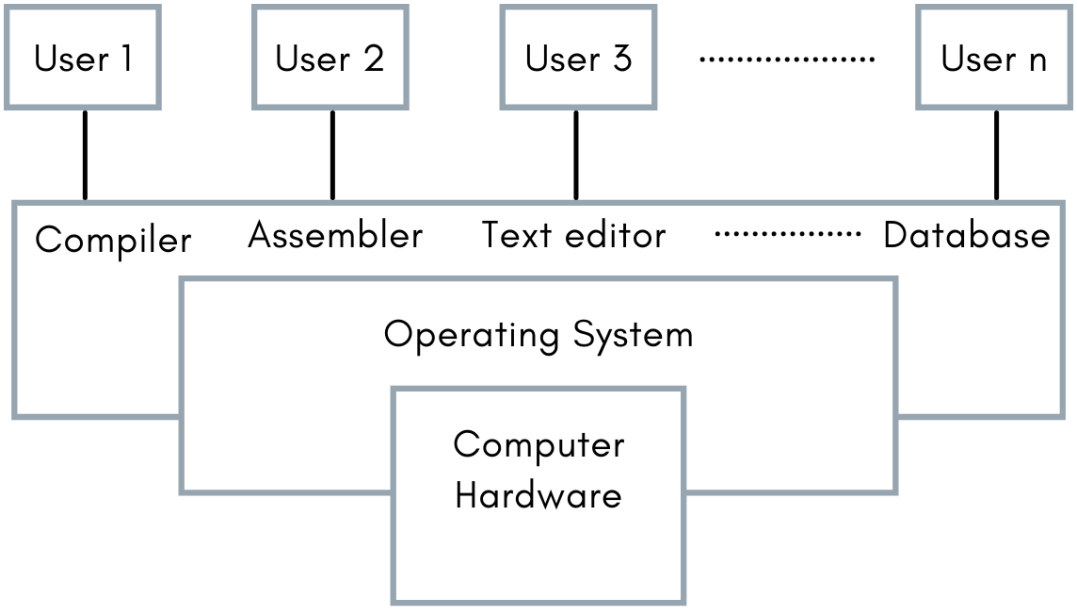


The computer system can be categorized mainly in four components – hardware, operating system, application program, and the user. The hardware is responsible for providing various resources such as memory and register or processing whenever the operating system demands and the operating system will only demand when the application programs that are developed by the software engineer are running on the operating system asking the operating system to demand more memory from the hardware.

The hardware and software consist of more of the system point of view where there is more stress on how the system is performing and if the system can allocate the desired resources efficiently and effectively. The application and user interface are more for the user's point of view, where the user experience and user interface are given more importance. The look and feel of the application programs influence the user greatly. If we had not focused on the user's point of view when the computer was improving from the system point of view, then there's a possibility that might not have been an era of personal computing.

Personal computers are existent because they are more dedicated to providing a better user view and making a computer system for the masses.

Abstract View of Operating System



Example – We can all understand the user view and the system view of the computer system by comparing it to any devices we use today such as smartphones, the smartphone is made for easy and simple to use, and that what's make the device to reach the hands of common people functionality such as web browsing and smooth scrolling or the top-down menu charts are all made for providing value to the user and create more user satisfaction. Now the same example can be considered from the system point of view, here more value is provided to the system than user such as gaming smartphone where there are as many rams and memory and GPU to boost the performance of the smartphone to run the game smoothly but at the same time it makes the smartphone more weighted and battery to drain faster for the simple process also. This is done for providing more value to the system.

USER VIEW IN OPERATING SYSTEM

The user Viewpoint is all about how the user has to interact with the operating system with the help of various application programs and from the system point of view we will see how the hardware has to interact with the operating system for accomplishing the various tasks.

Single User View Point

Most computer users operate their computer system with the help of a monitor, keyboard, mouse, printer, etc. In such cases, the system is designed for maximizing the work output by one user. And therefore, more attention is given to ease of use and less attention to the allocation of resources. These systems are more designed for the single user experience and to fulfill the requirement from one user point of view where the performance is not given much focus as compared to multiple user systems.

Multiple User View Point

The other example of the user viewpoints where both the importance of user experience and the performance is given is when there are one mainframe computer and the many users one their individual computers who are trying to communicate with their kernels through the mainframe to each other. In such a case the CPU, memory allocation has to be done effectively for a good user experience. Another similar case is the client-server architecture, where many clients can communicate with each other with the help of a remote server and the same conditions of efficient use of the server resource will arise.

Handled User Viewpoint

Also, the era of the touchscreen has brought us the best handheld technology ever. And these smartphones are connected with wireless devices to each other therefore performing various functions but they are not as powerful as a computer interface thus limiting their functionality but their operating system is a great example for creating a device focused on the user's point of view.

Embedded System User View Point

Some systems even do not have a seeming user point of view such as embedded systems. The remote that you use for turning on or off the TV are all part of an embedded system where the electronic device interacts with the other application where the user viewpoint is not much but then also allows the user to interact with the application.

SYSTEM VIEW IN OPERATING SYSTEM

From the user point of view, we have discussed the various applications that involve greater to little user interaction. But from the system point of view, we are more focused on how the hardware has to interact with the operating system than the user. The hardware and the operating interact with each other for the various purpose some of them are

Resource allocation

Many resources are present in the hardware such as register, cache, RAM, ROM, processors, I/O interaction, etc. These are all resources that are demanded by the operating system when it is asked by any application program. This resource allocation has to be done only by the operating system which has used many techniques and strategies such that it brings the most out of its processing and memory space. There are various techniques such as paging, virtual memory, caching, etc. that the operating system uses to make the best out of the hardware resources. And these are especially needed in a multiple user viewpoint because in that case the less resource allocation efficiency can also affect the user viewpoint causing the lag or hang of the user system, therefore decreasing the user experience.

Control Program

The control program is responsible for the interaction of Input and output devices (hardware) with the operating system. The user may request some action that can only be completed with the I/O devices in that case the operating system has to have a proper method of communicating, controlling, error detection, and handling for such devices also.

SERVICES PROVIDED BY OPERATING SYSTEM

There are various services that are offered by the operating system to the end-users as well as to the application program which in turn provide service to the user.

Program execution

The purpose of the operating system to exist is to provide an environment for the application software and program to run on the computer system. The operating system is itself a program that is loaded by the boot loader during the booting of the computer. The operating system works by utilizing the resources of the hardware and providing these resources to the application software to which the end-user is interacting. Therefore to provide an environment for the execution of the program is one of the main services that is provided by the operating system.

I/O operation

The input and output operations are also the services that are provided by the operating system. It may seem very easy to plug and play the devices on the computer system but it is equally complicated to handle these operations. The I/O

operations are used by various applications as an input for execution, during this execution the operating system goes on to interrupt the processing of the CPU and then attend to the signals that are coming from the I/O devices and after attending them the operating system again give back the control to the CPU and the CPU continues its execution of the program.

File operation

There are various techniques that the operating system utilizes in order to handle the file operation. The right method of handling the file operation increases the memory capacity and also an efficient memory increases the speed of execution of the program. When some file is stored in the memory it is the responsibility of the operating system to how to store that file in the memory in an efficient method. There exist various methods for storage of files such as contiguous file allocation and non-contiguous file allocation. Depending on the need of the operating system either uses one of the methods of file allocation or uses both of them. Therefore the file operation is one of the services that are provided by the operating system.

Resource allocation

If some program requires access to the hardware resource of the computer then in that case the operating system will help the program to use the hardware resources such as CPU, memory, I/O devices, etc. The operating system maintains the process in a queue to be executed by the CPU so once the process enters the CPU then it starts its execution and when some other process of higher authority requires to be executed by then the operating system takes the control of the CPU for some time and halt the previous process for the execution of the current process in this way the resource allocation occurs with the help of the operating system.

Communications

Communication between processes is required for the execution of various programs. The program is divided into various processes and these processes increase the speed of the execution of the program. The process is working for the same program so they share the same goal and also they require to share the memory to communicate to each for the execution of the instructions, the operating system takes care whether the process is able to communicate with each

other and apply various methods such as message parsing and shared memory for establishing communication between the various process.

Bottom of Form

OBJECTIVES OF OPERATING SYSTEM

The main objectives of the operating system are

Convenience

Efficiency

Ability to evolve

Convenience

The reason for the operating system to exist is that it can make the utilization of computer systems more convenient to the user. The operating system makes use of the hardware resources to provide service to the end-user in a systematic way. These services can be divided into two categories: services that are provided by the operating system to the end-user through various input-output I/O devices such as keyboard, monitor, printer, speaker, mouse, scanner, etc and the services provided to the application program by the operating system which in return provides service to the end-users.

When you observe the layout of the computer system then you will find that the application and utilities are laid above the operating system. The user interacts with the application and for the application to work programmers will require utility software. The utilities are the APIs and the libraries, they provide the functions that are frequently used in the development of the application with which the end-user interacts with.

There are a variety of applications that the end-user uses to operate the computer system. The end-user mainly interacts with the application of the computer system that is designed by the programmers in a computer programming language. For a programmer to develop these applications, the higher the utilities are the easier it is for the programmer to develop the application and the lower the utilities are the more difficult it gets to develop the application. In the worst case, such as in assembly language which is very close to the machine language (native binary) but instead of binary it uses mnemonic code for the instructions, the programmer has to deal with the overwhelming complexity of the assembly language for manipulating the hardware resources. But in contrast, when we see in higher-level languages such as Python and C++ which come with library rich classes and APIs for almost every common function then in these cases it becomes easier for the programmer to use these utilities and develop the desired application programs.

Efficiency

The services that are provided to the end-user by the application program are due to the operating system is able to exploit the services of the hardware resources. Without the hardware resource and its services to provide the operating system will become useless. It depends on the operating system to use the hardware resource and services in a way that it is able to achieve maximum efficiency.

The operating system does not control the hardware but it depends on hardware resources and manages to work with it.

The operating system by nature is a program and therefore it has instructions that require execution by the CPU and the memory to hold the instructions and the values from instruction. So when some program requires to utilities any hardware resource it has to contact the operating system and the operating system provides it access to the hardware and OS leaves it for the execution to complete and later regain the control of the CPU if some other program requires instruction for execution.

By using the facility that is provided by the hardware the operating system is able to schedule and run different processes at different moment and able to exchange data and instructions between each other by memory devices such as primary or secondary memory. This is all programs in the operating system to achieve the highest efficiency.

FUNCTIONS OF OPERATING SYSTEM

The primary goal of the operating system is making an easy to use interface which is user friendly and can be easy to use. And the second goal of the operating system is efficiency of the operating system. This may sound a little odd to you as an engineer as to why the operating system is kept at the second position and the user-friendly interface is kept in the first position. Then you can understand this by this example, let's compare two operating system one is Linux and the other one is windows, the Linux is much more secure than windows, the Linux has better memory handling technique than windows, the Linux uses much less space of the user device than windows but the market share of the line is only 7% and the Market share of the window is alone more than 80%. You can see the difference in usage. People will prefer the operating system more which is easy to use and user-friendly rather than the operating system in which you have to write code for even opening a movie. That's why the primary goal of the operating system is easy to use and the secondary goal of the operating system is efficiency.

The operating systems came in demand because the business required the use of calculation in huge number and the operating system served its demand but you

have to write lines of codes to interact with the computer and that's where the World for operating system changed when the first GUI was designed and brought to use for the common people earlier only people who have to learn how to use the operating system but the GUI based operating system brought the same power to the hands of everyone. Therefore the user-friendly interface is the topmost priority that the operating system serves.

There are various functions in the operating system that its servers.

Process management

There are various processes in which a program is divided. The operating system has to manage which process to run and which process to stop. This helps to increase the efficiency of the system. To run the various processes simultaneously various protocols exist to avoid deadlock and complete the task in the required time.

Memory management

The memory management in operating systems helps the operating system to utilize the main memory of the computer to its complete efficiency. Various types of memory allocation take place in the operating system and these allocation helps the faster memory access and also reduces the amount of fragmentation that occurs in the main memory.

Input and output

There are many numbers of peripheral devices that are connected to the operating system. Therefore the operating system will turn out to be a mediator between the input and the output devices and also the user as it will interact with both of them to fulfill the needs of the user.

File management system

There are many types of operating systems that are used in the operating system such as Fat32 and NTFS. These types of operating systems decide how the fields are managed in the operating system and how they are stored in the memory. And this happens with the help of the operating system.

Network management

Today in the world of the internet no system in the world is isolated. Each computer is interconnected with the help of the world wide web. So, to manage the network management of the operating system plays an important role such as it receives the data packet from the internet and then performs an error check. Or Another example of network management in operating systems is the various

processes that the internet uses such as HTTPS and FTP to send or receive the file on the internet and all this is maintained by the operating system. There are various other protocols such as SSH which is used to maintain a secure socket before any data packet is sent or received or the telnet which is the method to communicate between the two computers on the same networks. These are all processes that are maintained by the operating system and it's the operating system that decides in which port it has to forward the request of these processes.

Security and protection

The operating system has an important function to maintain the security and privacy of the user and to only allow the people who are authorized to access the system and no unauthorized people can access the system when they need and it also comes as the operating system is on the network and therefore the operating system has to maintain the security and privacy of the user.

Bottom of Form

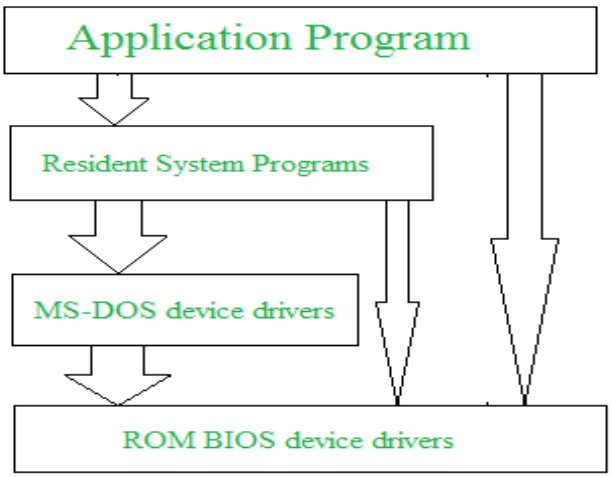
STRUCTURE OF OS:

Operating system can be implemented with the help of various structures. The structure of the OS depends mainly on how the various common components of the operating system are interconnected and melded into the kernel. Depending on this we have following structures of the operating system:

Simplestructure:

Such operating systems do not have well defined structure and are small, simple and limited systems. The interfaces and levels of functionality are not well separated. MS-DOS is an example of such operating system. In MS-DOS application programs are able to access the basic I/O routines. These types of operating system cause the entire system to crash if one of the user programs fails.

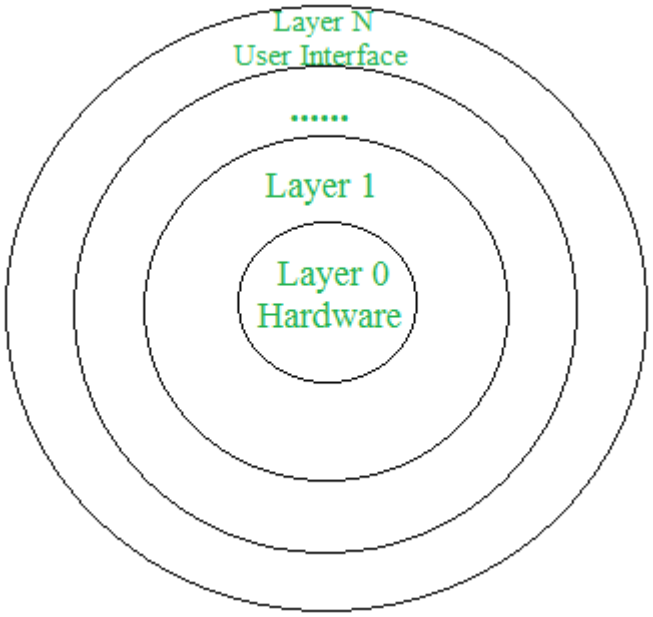
Diagram of the structure of MS-DOS is shown below.



Layered structure:

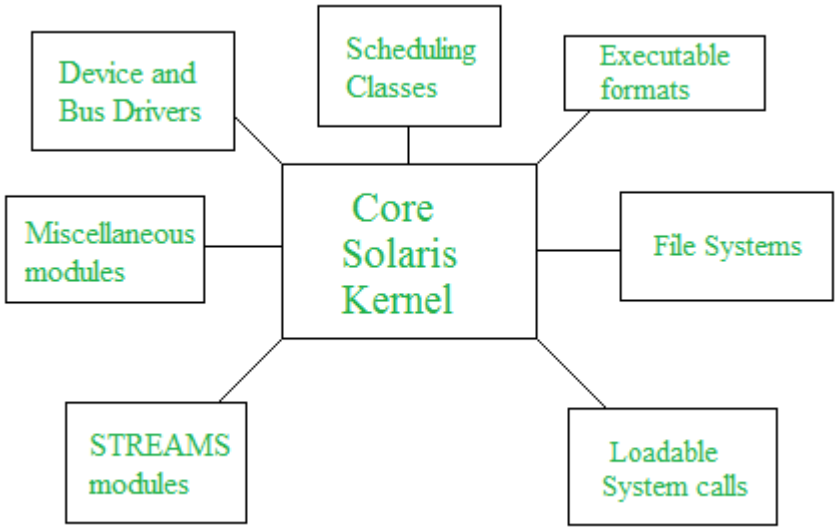
An OS can be broken into pieces and retain much more control on system. In this structure the OS is broken into number of layers (levels). The bottom layer (layer 0) is the hardware and the topmost layer (layer N) is the user interface. These layers are so designed that each layer uses the functions of the lower level layers only. This simplifies the debugging process as if lower level layers are debugged and an error occurs during debugging then the error must be on that layer only as the lower level layers have already been debugged.

The main disadvantage of this structure is that at each layer, the data needs to be modified and passed on which adds overhead to the system. Moreover careful planning of the layers is necessary as a layer can use only lower level layers. UNIX is an example of this structure.



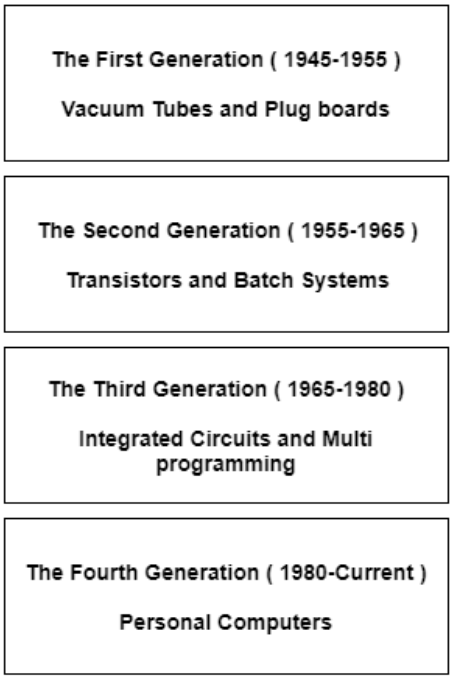
Micro-kernel:
This structure designs the operating system by removing all non-essential components from the kernel and implementing them as system and user programs. This results in a smaller kernel called the micro-kernel.
The advantages of this structure are that all new services need to be added to userspace and do not require the kernel to be modified. Thus it is more secure and reliable as if a service fails then the rest of the operating system remains untouched. Mac OS is an example of this type of OS.

Modular structure or approach:
It is considered as the best approach for an OS. It involves designing of a modular kernel. The kernel has only set of core components and other services are added as dynamically loadable modules to the kernel either during run time or boot time. It resembles layered structure due to the fact that each kernel has defined and protected interfaces but it is more flexible than the layered structure as a module can call any other module.
For example Solaris OS is organized as shown in the figure.



EVOLUTION OF OS

Operating Systems have evolved over the years. So, their evolution through the years can be mapped using generations of operating systems. There are four generations of operating systems. These can be described as follows −



OPERATING SYSTEM GENERATIONS

The First Generation (1945 - 1955): Vacuum Tubes and Plugboards

Digital computers were not constructed until the second world war. Calculating engines with mechanical relays were built at that time. However, the mechanical relays were very slow and were later replaced with vacuum tubes. These machines were enormous but were still very slow.

These early computers were designed, built and maintained by a single group of people. Programming languages were unknown and there were no operating systems so all the programming was done in machine language. All the problems were simple numerical calculations.

By the 1950's punch cards were introduced and this improved the computer system. Instead of using plugboards, programs were written on cards and read into the system.

The Second Generation (1955 - 1965): Transistors and Batch Systems

Transistors led to the development of the computer systems that could be manufactured and sold to paying customers. These machines were known as mainframes and were locked in air-conditioned computer rooms with staff to operate them.

The Batch System was introduced to reduce the wasted time in the computer. A tray full of jobs was collected in the input room and read into the magnetic tape. After that, the tape was rewound and mounted on a tape drive. Then the batch operating system was loaded in which read the first job from the tape and ran it.

The output was written on the second tape. After the whole batch was done, the input and output tapes were removed and the output tape was printed.

The Third Generation (1965 - 1980): Integrated Circuits and Multiprogramming

Until the 1960's, there were two types of computer systems i.e the scientific and the commercial computers. These were combined by IBM in the System/360. This used integrated circuits and provided a major price and performance advantage over the second generation systems.

The third generation operating systems also introduced multiprogramming. This meant that the processor was not idle while a job was completing its I/O operation. Another job was scheduled on the processor so that its time would not be wasted.

The Fourth Generation (1980 - Present): Personal Computers

Personal Computers were easy to create with the development of large-scale integrated circuits. These were chips containing thousands of transistors on a square centimetre of silicon. Because of these, microcomputers were much cheaper than minicomputers and that made it possible for a single individual to own one of them.

The advent of personal computers also led to the growth of networks. This created network operating systems and distributed operating systems. The users were aware of a network while using a network operating system and could log in to remote machines and copy files from one machine to another.