Mrs. P. V. Doijad

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Unit -1

Overview of OS

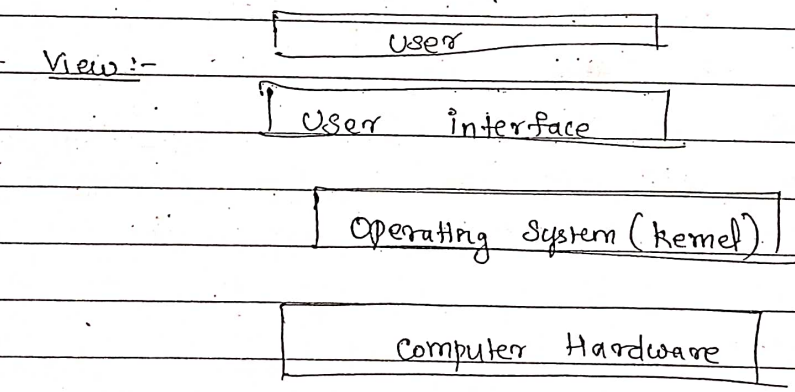
*) **Abstract View of an Operating System :-**

The Operating System or OS, as we will often call it as the intermediary between the user and the Computer System.

A Computer System consist of many resources like hardware and software, which are useful to complete a task. The common required resources are input/output devices, memory, CPU etc.

The OS System acts as a manager for all above resources and allocates them to specific programs and users. An OS is the interface between the user and the machine.

Abstract View :-



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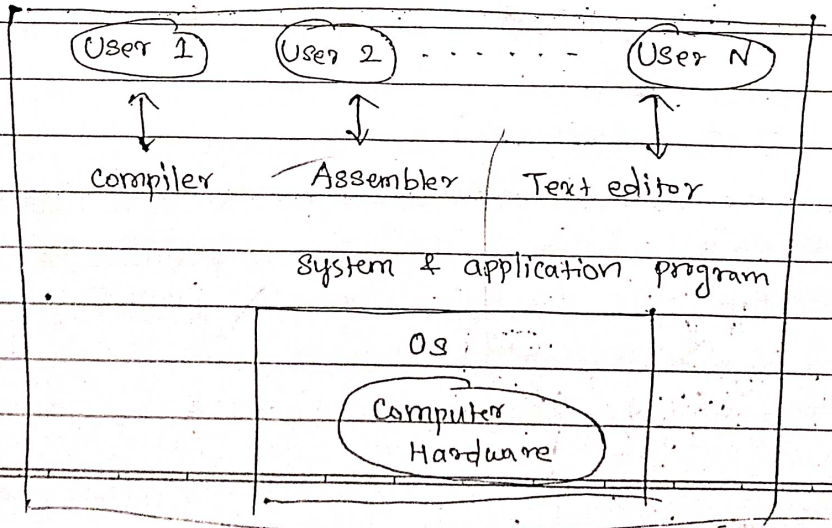

The typical functionalities of these parts are as follows.

Hardware :- The hardware is the physical part which we can touch & feel, the Central processing unit, the memory, and input/output devices are the basic computing resources of a computer system

Kernel :-

The kernel is the core of the OS. It controls operations of the computer and provides a set of function and services to use the CPU, memory and other resources of the computer. The functions and services of the kernel are invoked by the non kernel routines and by user programs.

User interface :-

The user interface accepts commands to execute programs and use resources and services provided by the OS. It is either a command line interface as in Unix (or) Linux. which displays the command prompt to the user and accepts the user command

Users :-

There are different types of users like people, machines and even other computers which are trying to solve different problems.

The abstract view of the operating system has two benefits

→ Managing complexity :-

An abstract view of the system contains only selected features of the system. This property is useful in managing complexity during design (or) study of a system.

→ Presenting a generic scheme

#) Fundamental Principles (or) Functions of an OS :-

The Operating system is an interface between the user and the hardware and enables the interaction of a computer's hardware and software.

Also an OS is a software which performs all the basic tasks like file management, memory management, Storage management, process management, handling input and output and controlling peripheral devices such as disk drivers and printers.

Functions :-

1) Device Management :-

It does the following activities for device management

Keep track of all devices. I/o controller is responsible for this task.

Decides which process gets the device when and for how much time.

Allocates the device in an efficient way

De-allocates the devices.

2) File Management :-

The OS allocates and deallocates resources. It regulates which process gets the file and for what duration. Also, it keep track for information, location, uses, status, etc.

The collective facilities are often known as file system. OS also perform tasks like creating directories and files, copying/moving them and renaming/deleting files.

3) Memory management :-

- Memory management refers to the management of primary (or) main memory. Main memory provides fast storage which can be accessed directly by CPU.

The typical functionalities of these parts are as follows :-

Hardware :- The hardware is the physical part which we can touch and feel, the central processing unit, the memory and the input/output devices are the basic computing resources of a computer system.

The operating system memory manager coordinates the use of various type of memory, which is to be allocated (or) deallocated and how to move data between them.

4) Program Management :-

The OS initiates program, arranges their execution on the CPU, and terminates them when they complete their execution. Since many programs exist in the system at any time, the OS performs a function called scheduling to select a program for execution.

5) Resource Management :-

The OS allocates resources like memory and I/O devices when a program needs them. When the program terminates, it deallocates these resources and allocates them to other programs that need them.

6) Security and Protection :-

For eg: Consider how the OS prevents the illegal access to a file. The security function prevents nonusers from utilizing the services and resources in computer system. hence none of them can access the file. The protection function prevents users other than the file owner (or) users authorized by him, from accessing the file.

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*) OS interaction with the computer and user programs :-

1) Controlling Execution of Programs :-

To control execution of user programs, the OS has to ensure that various fields of the program status word (PSW) contain appropriate information all the time when the user program are in execution, which includes the time when a new program's execution is initiated, and also times when its execution is resumed after an interruption.

i) At the start of execution of a user program, the PSW should contain the following information

a) The program counter field (PC field) should contain the address of the first instruction in the program

b) The Mode field (M field) :- If it contains a 1 such that the CPU is in the user mode, if it is 0 the CPU is in the kernel mode.

c) The memory protection information field :-

It contain the information about the start address and size of the memory area allocated to the program.

d) The interrupt mask :- Indicate which interrupts are enabled and which ones are masked off.

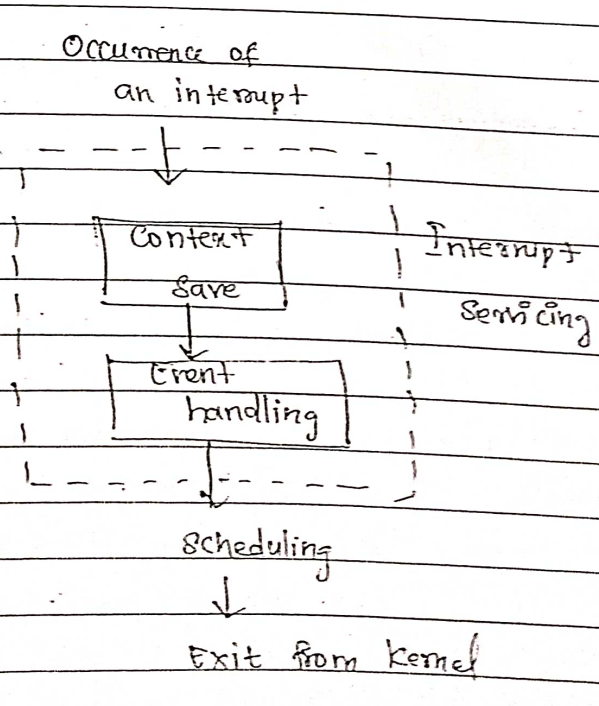
e) Interrupt code :- It contain the information about which class of interrupt has occurred. This information is useful for knowing the cause of the interrupt. For eg :- if a program interrupt occurs, the interrupt code will help to decide whether it was caused by an overflow condition (or) by a software interrupt.

2) Interrupt Servicing :-

An interrupt vector has the same format as the PSW. Each interrupt vector has the following information 0 in the mode (M) field to indicate that the CPU should be in the kernel mode, the address of the first instruction of the interrupt servicing routine in the program counter (PC) field, and size of memory in the memory protection information (MPI) field.

Interrup mask is the field that either disables other interrupt from occuring (or) enables only higher-priority interrupts to occur.

ISR (Interrupt Service Routine). It first saves information about the interrupted program in the program table, for use when the program is scheduled again



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Nested interrupt Servicing :-

While interrupt service routine "a" is servicing the first interrupt, it will lead to identical actions in hardware and software. This time, execution of interrupt service routine "a" is the program that will be interrupted the CPU will be switched to execution of another interrupt service routine, say, interrupt service routine "b". This situation delays servicing of the first interrupt.

OS have used two approaches to nested interrupt servicing. Some OS use the interrupt mask field in the interrupt vector to mask off all interrupts while an interrupt service routine is executing. This approach makes the kernel noninterruptible, which simplifies its design because the kernel would be engaged in servicing only one interrupt at any time. However noninterruptibility of the kernel may delay servicing of high-priority interrupts.

Another method is the kernel will mask-off less critical interrupts such a kernel is called interruptible kernel or a preemptible kernel.

System Call :-

- System call is the programmatic way in which a computer program requests a service from the kernel of the operating system it is executed on. A System call is a way for programs to interact with the OS.
- A computer program makes a system call, when it makes request to the O.S kernel. System call provides the services of the OS to the user program via Application program Interface (API)
- System calls are the only entry point into the kernel system.

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Types :-

1) Process control :- end, abort, create, terminate, allocate & free memory

2) file management :- Create, open, close, delete, read file etc

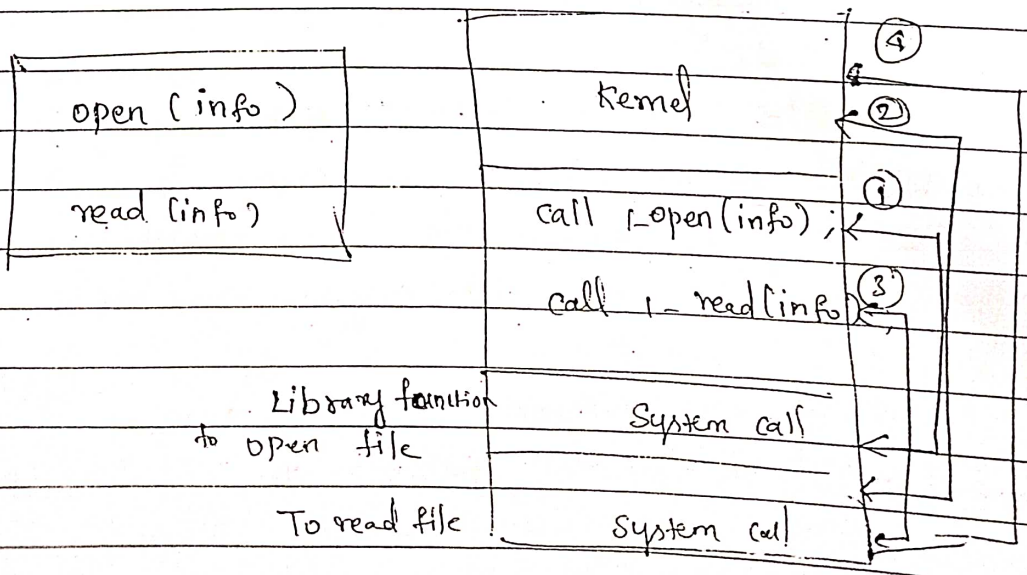
3) Device management

4) Information maintanence

5) communication

Examples of windows and Linux System calls

Process control	Createprocess() Exit process() wait for Single object()
File manipulation	Create file() Read file() write file() CloseHandle()



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4) Efficiency, System Performance, AND User Service :-

- An OS allows the computer system resources to be used efficiently.
- The way to evaluate efficiency of use of a resource is to see how much of the resource is unused (or) wasted.

As an example of efficiency, consider use of the CPU, some amount of CPU time is wasted because the CPU does not have enough work to do so. This happens when all user processes in the system are either performing I/O operations (or) waiting for the users to supply data.

To evaluate efficiency of the CPU use, we should consider what fraction (or) percentage of the total CPU time is used for executing user processes.

Efficiency of use of other resources such as memory, I/O devices are similarly determined.

System Performance :-

System Performance is characterised as the amount of work done per unit time. It is measured as throughput.

Throughput :- The average number of jobs, programs, processes (or) subrequests completed by a system in unit time.

In a noninteractive environment, throughput of an OS is measured in terms of number of jobs (or) programs completed per unit time.

In an interactive environment, it may be measured in terms of number of subrequests completed per unit time.

User Service :-

User Service, which indicates how quickly a user's computation has been completed by the OS.

We define two measures of user service =

1) Turnaround time :-

The time from submission of a job, program, (or) process by a user to the time its result become available to the user

2) Response time :-

The time from submission of a subrequest by a user to the time a process responds to it

Response time is the amount of time after which a process gets the CPU for the first time after entering the ready queue

* Response Time = Time at which process first gets the CPU - Arrival time

* Turn around time is the total amount of time spent by a process in the system.

*) Batch Processing Operating Systems :-

In the beginning, computers were extremely large machines, Punched cards, card readers were used for input. and tape drivers, punch cards and line printers were used for output. Users had no direct interface with the system. A computer operator had to load the cards into the card reader to set up the execution of a job. This process wasted the CPU time, batch processing were invented to prevent this wastage.

· A batch is a sequence of user jobs formed for processing by the operating system A computer operator formed a batch by arranging a

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few user jobs in a sequence and inserting special marker cards to indicate the start and end of the batch. When the operator gave a command to initiate processing of a batch, the batching kernel set up the processing of the first job of the batch. Thus the operator has to intervene only at the start and end of the jobs batch.

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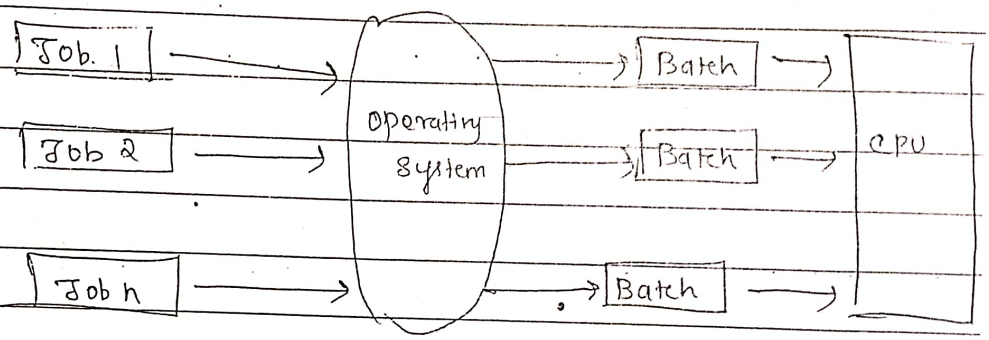

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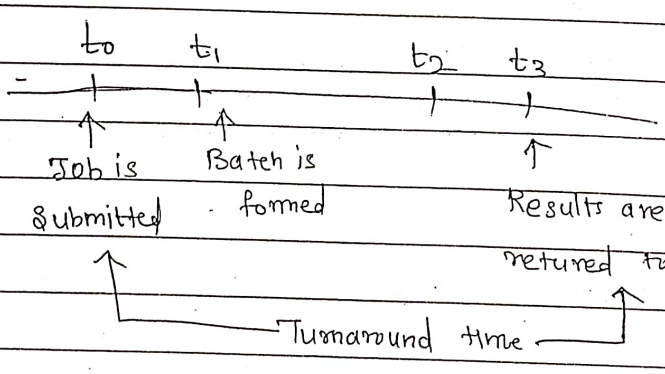

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// Job → Start of job statement

// Exec Fortran → execute the Fortran compiler

} Fortran program

// Exec

} Data for Fortran program

/* → End of data statement

/& → End of job Statement

The batch Operating System required a User to insert a set of Control Statements in the deck of cards ; constituting a job

The batch Processing activities are

1) A job is a single unit that consists of a preset sequence of commands, data and programs

2) Processing takes place in the order in which they are received (i.e) first come first serve

Advantages :-

This System can easily manage large jobs again and again

The batch process can be divided in to several stages to increase processing speed

When a process is finished, the next job from the job pool is run without any User interaction

CPU utilization gets improved

Disadvantages :-

Computer operator must have the full knowledge of batch processing

It is quite difficult to debug

The User has no direct interaction

*) Multiprogramming Operating System :-

In the multiprogramming System, one or multiple programs can be loaded into main memory for getting execute. It is capable only one program (or) process to get CPU for execute for their instructions, and other programs wait for getting their turn. Main goal of using

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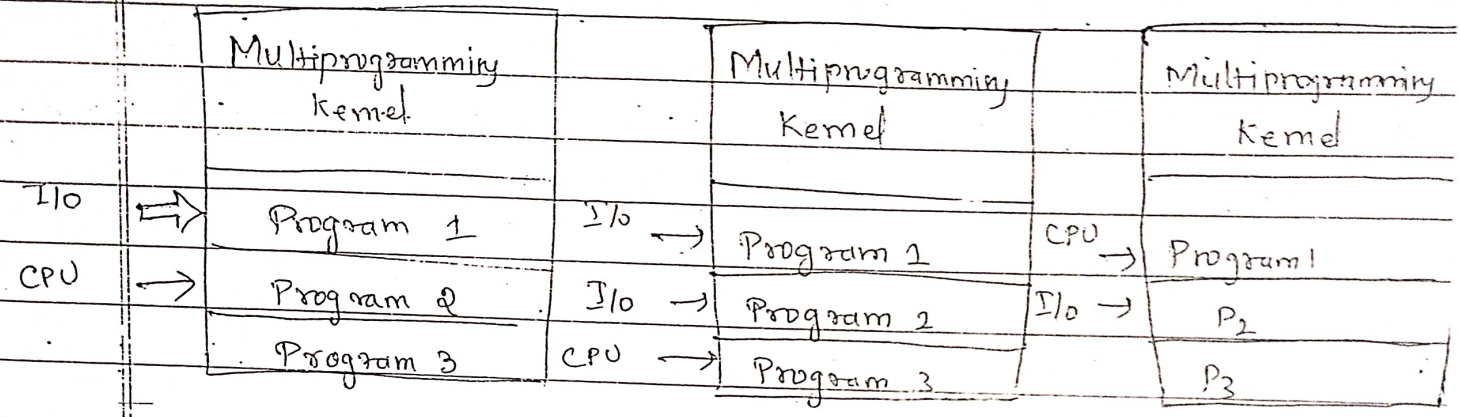
of multiprogramming System is to overcome issue of under-utilization of CPU and primary memory.



In above example, the memory consist of three programs. An I/o operation is in progress for program 1, while the CPU is executing program 2. The CPU is switched to program 3 when program 2 initiates an I/o operation, and it is switched to program 1 when program 2's I/o operation completes.

The multiprogramming kernel perfoms scheduling, memory management and I/o management.

Since several programs are in memory at the same time, the instructions, data, and I/o operations of a program should be protected against interference by other programs.

Priority of Programs :-

Priority is defined as a tie-breaking criterion under which a scheduler decides which request should be scheduled when many requests await service.

The kernel assigns numeric priorities to programs. We assume that priorities are positive integers and a large value implies a higher priority.

When many program needs the CPU at the same time the kernel gives the CPU to the program with the highest priority. It uses priority in the pre-emptive manner. The CPU is always executing the highest priority program that needs it.

The OS keeps sufficient number of programs in memory at all times, so that the CPU and I/O device will have sufficient work to perform. This number is called degree of multiprogramming.

*) Time-Sharing Systems:-

A time-sharing operating system is designed to provide a quick response to subrequests made by users. It achieve this goal by sharing the CPU time among processes in such a way that each process to which a subrequest has been made would get a turn on the CPU without much delay.

The scheduling technique used by a time-sharing kernel is called round-robin scheduling with time slicing.

A time shared operating system allows multiple users to share computer simultaneously. Each action or order at a time the shared system becomes smaller, so only a little CPU time is required for each user. As the system rapidly switches from one user to another, each user is given the impression that the entire computer system is dedicated to its use, although it is being shared among multiple users.

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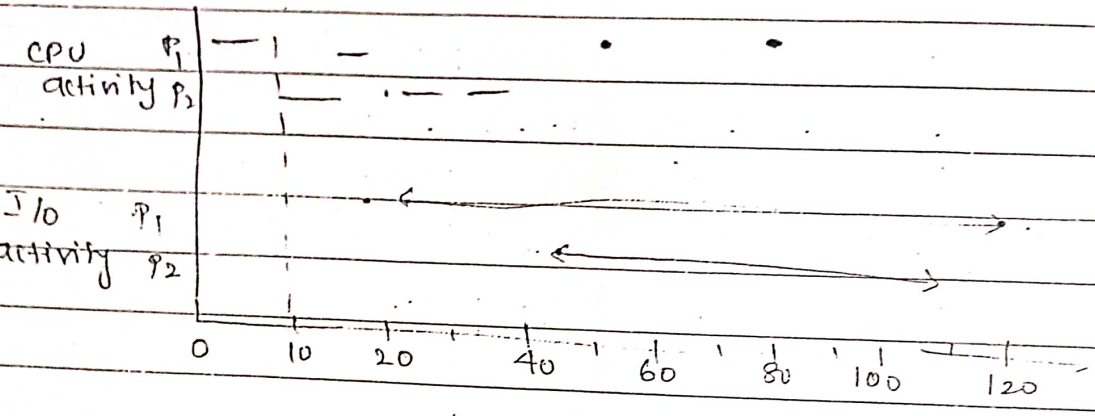
A time shared OS uses CPU scheduling and multiprogramming to provide each with a small portion of a shared computer at once. Each user has at least one separate program in memory. A program loaded into memory and executes, it performs a short period of time either before completion (or) to complete I/O. This short period of time during which users gets attention of CPU is known as time slice, time slot (or) quantum.

Time shared OS are more complex than multiprogramming OS. In both multiple jobs must be kept in main memory simultaneously.

Time	Scheduling list	Scheduled program	Remarks
0	P_1, P_2	P_1	P_1 is preempted at 10ms
10	P_2, P_1	P_2	P_2 is prempted at 20 ms
20	P_1, P_2	P_1	P_1 Starts I/O at 25ms
25	P_2	P_2	P_2 is preempted at 35 ms
35	P_2	P_2	P_2 starts I/O at 45 ms
45	-	-	CPU is idle.



Thus the response time of P_1 and P_2 are 125 ms and 105 ms respectively.

Swapping :- The technique of temporarily removing a process from the memory of a computer system.

Advantages :-

Each task gets an equal opportunity

Less chances of duplication of software

CPU idle time can be reduced

Disadvantages :-

Reliability problem

Data Communication Problem

8) Real-time operating System :-

In a class of applications called real-time applications, users need the computer to perform some actions in a timely manner to control the activities in an external system

RTOS (Real Time OS) are used in environments where a large number of events, mostly external to the computer system must be accepted and processed in a short time (or) with in certain deadlines. Such applications are industrial control, telephone switching equipment, flight-control

With an RTOS, the processing time is measured in tenth of seconds. This System is time-bound and has a fixed deadline. The processing in this type of System must occur within the specific constraints. Otherwise, this will lead to System failure.

There are two types in RTOS

1) Hard - Real time os
2) Soft - Real time os

Hard Real time os :-

These operating Systems guarantee that critical tasks be completed within a range of time.

For eg:- a robot is hired to weld a car body. If the robot welds too early or too late, the car cannot be sold, so it is a hard real-time System that requires complete car welding by robot hardly on time, another eg's are flight control, Railway signaling, Chemical plant etc.

Soft - real time os :- This os provides some relaxation in the time limit.

eg:- Multimedia systems, digital audio systems, Weather forecasting, DVD players etc.

Advantages:-

1) Maximum utilization of devices and systems
2) Task shifting
3) Focus on application
4) Error free

Disadvantages :-

1) Limited Tasks
2) Complex Algorithms
3) Thread priority

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Distributed Operating System :-

A distributed computer system consists of several individual computer systems connected through a network. Each computer system could be a PC, a multiprocess system or a cluster, which is itself a group of computers that work together in an integrated manner.

Resource sharing has been the traditional motivation for distributed OS. A user of a PC or workstation can use resources such as printers over a local area network (LAN) and access specialised hardware or software resources.

A distributed OS provides reliability. If a computer system or a resource used in an application fails, the OS can switch the application to another computer system or resource. and if a path to a resource fails, it can utilize another path to the resource.

High availability of data resource. eg :- a file can be provided by keeping copies of the file in various parts of the system.

Benefits :-

1) Resource sharing
2) Reliability
3) Computation Speedup
4) Communication.

Transparency :- A resource or service can be accessed without having to know its location in the distributed. system.

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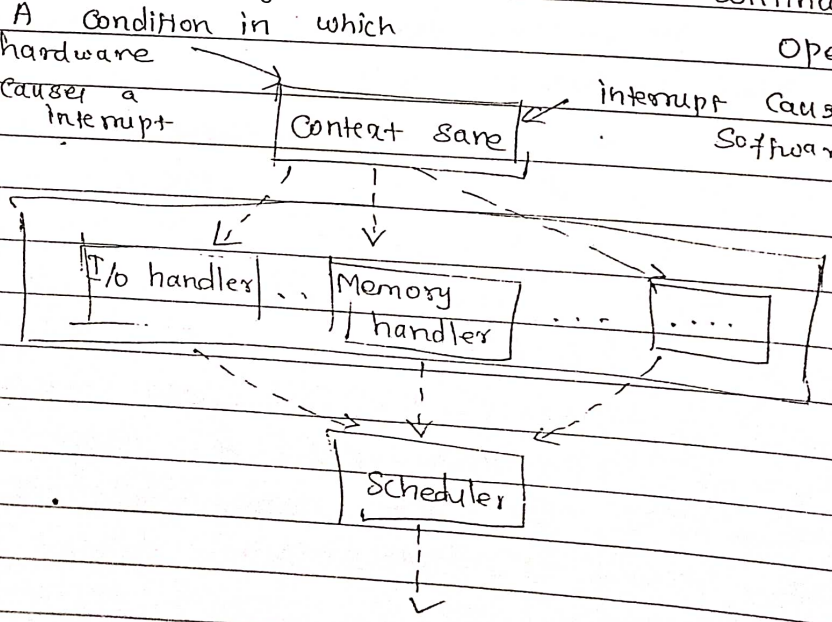
Operations of an OS:-

The primary concern of an OS during its operation are execution of programs, use of resources, and prevention interference with programs and resources

→ Program Management
→ Resource Management
→ Security & Protection

} Refer functions of an OS.

	Task	When Performed
1)	Construct a list of resources	During booting
2)	Maintain information for security	While registering new user
3)	Verify identity of a User	At login time
4)	Initiate execution of programs	At user commands
5)	~~Maintain authorization information~~	
6)	Perform resource allocation	When requested by users or programs
7)	Maintain current status of resource	During resource allocation / Deallocation
8)	Perform Scheduling	continually during OS Operation.



Another operation of an OS is interrupt servicing. The interrupt service routine performs a context save action to save information about the interrupted program and activates an event handler, which takes appropriate action to handle the event.

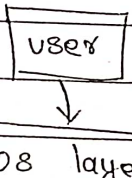
The scheduler selects a process and switches the CPU to it. CPU switching occurs twice during the processing of an event - first to the kernel to perform event handling and then to process selected by the scheduler.

The function of an OS are thus implemented by event handlers when they are activated by interrupt service routines.

*) Operating System with Monolithic Structure :- DOS, CP/M

Early operating system had a monolithic structure, where by the OS performed single layer between the user and the bare machine (i.e) the computer system hardware.

The user interface was provided with a command interpreter



Two kinds of problem with the monolithic structure were realized over a period of time. If any service fails in the monolithic kernel, it leads to the failure of the entire system.

To add any new service, the entire OS needs to be modified by the users. It also made testing and debugging difficult leading to high cost of maintanence and enhancement

Three methods of structuring an OS that have been implemented as solution to these problems.

→ Layered Structure :-

The multiprogramming system of the 1960's is a well known eg of a layered OS.

→ Kernel - based OS :-

The Unix OS has a kernel based structure

→ Micro kernel based OS :-

The microkernel provides a minimal set of faulities and services for implementing an OS. It portability and extensibility

※) Virtual Machine operating System :-

Virtual machine is an execution of a computer system within our physical personal computer.

A virtual machine allows users to install and run multiple OS in a single PC there by making an illusion that each separate execution environment is running its own private computer.

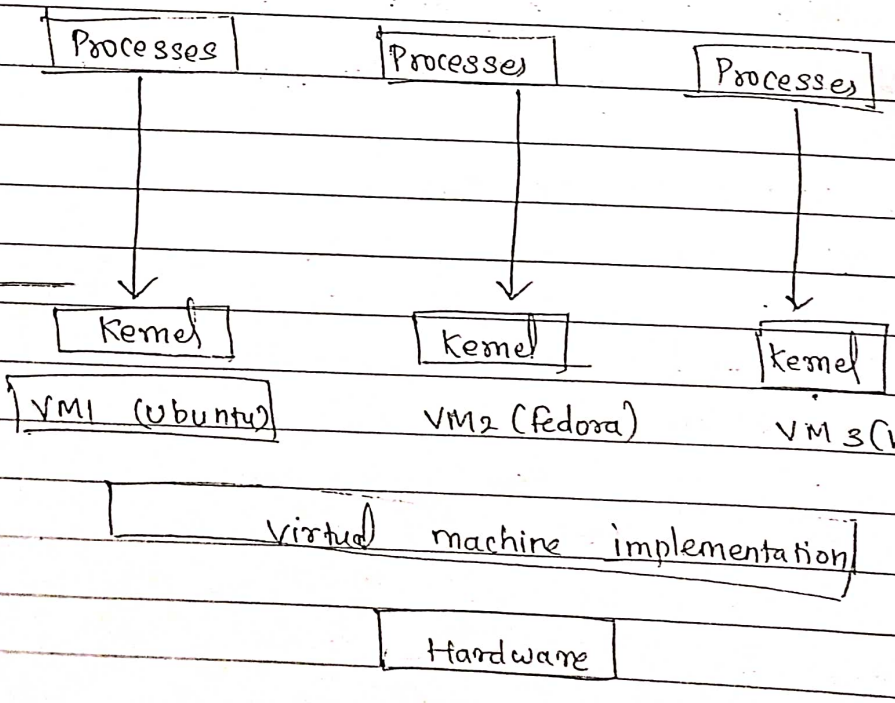
Here resources of computer system are shared to each OS running by virtual machine.

We can call these OS as a guest OS and real computer system OS as is called the host machine.

A somewhat complex arrangement is needed to handle the interrupt that arise when a guest os is in operation.

The host machine sends message to the guest os that the interrupt has occurred. The host os has to save the information of interrupt program in interrupt service rutine. If particular interrupt is not of the guest os. The guest os invoke host os by sending system call that "invoke VM os". This interrupt is not mine. Then VM os arranges to pass the interrupt to another guest os.

This way the interrupt is handled by VM.



The kernel of an OS typically puts the CPU into an idle loop when none of the user process in the OS wishes to use the CPU. However, the CPU time of host machine would be wasted when a guest OS enters into an idle loop.

Modern virtual machine environments employ the technique of para virtualization to overcome the problems faced in full virtualization. Paravirtualization replaces a non virtualization instruction. The primary difference between paravirtualisation & full virtualization is the ability to make modifications to the guest. OS

It is a computer program that is core of OS with complete control everything in system

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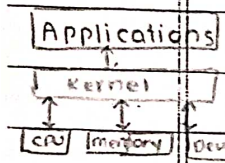
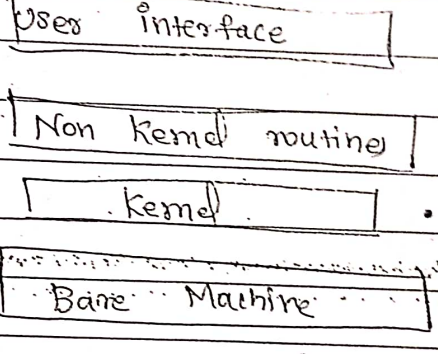
*) Kernel-based operating System:-

- The Kernel is the core of the OS it provides a set of functions and services to support various OS functionalities
- The rest of the OS is organised as a set of nonkernel routines which implement operation on process and resources that are interest to users and a user interface.





User mode — user request
Kernel mode — kernel "
mode bit = 1 for user mode
mode bit = 0 for kernel mode

Structure of a Kernel-based OS.

Kernel loads first into memory when an OS is loaded and remains into memory until operating system is shut down again. It is responsible for various tasks such as disk management task management and memory management.

Objectives:-

To establish communication between user level application & hardware

To decide state of incoming processes

To control task management

To control memory management

Types of Kernel:-

1) Monolithic Kernel
   Eg:- Unix, Linux
2) Micro Kernel
   Eg:- Mach, Minix, Amigaos

3) Hybrid Kernel [combination of monolithic & microkernel]
eg :- Netware, Beos etc.

4) Exo Kernel
eg :- Nemesis, etc.

5) Nano kernel :-
eg :- EROS etc.

*) Micro - Kernel based OS :-
The microkernel was developed in the early 1990's to overcome the problems of portability, extensibility, and reliability of kernels.
It is one of the classification of the Kernel. Being a kernel it manages all system resources But in a microkernel, the user servies and kernel services are implemented in different address spaces. The user spaces are kept in user address space, and the kernel services are kept under kernel address space, thus in microkernel the size also reduces and the size of the OS as well.
It provides minimal service of process and memory management. The communication between client program / application and services running in user address space is established through message passing and reducing the speed of execution microkernel.
If any user service fail it does not affect kernel service. If any new service are to be added they are added to user address space and hence require no modification in kernel space. It is portable, secure & reliable.

The microkernel is responsible for the most important Servies of the OS they are

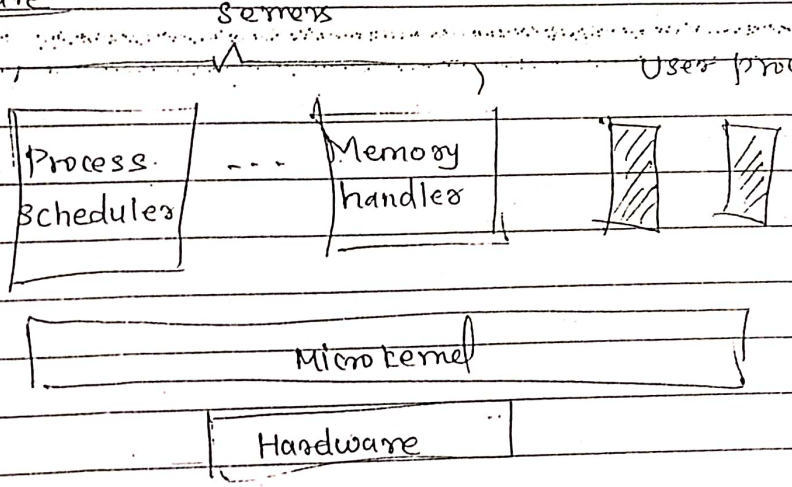
→ Inter process - communication
→ Memory Management
→ CPU Scheduling

Advantages:-

The architecture of this Kernel is small and isolated hence it can function better.

Expansion of the System is easier, it is simply added to the System application without disturbing the Kernel

Architecture :-



The microkernel include memory management Supports only Seven System calls.

The Kernel includes mechanism such as process Scheduling & memory a Servers and user processes that operate on the top of the microkernel, which merely performs interrupt handling and provides communication between the Server and the user processes.