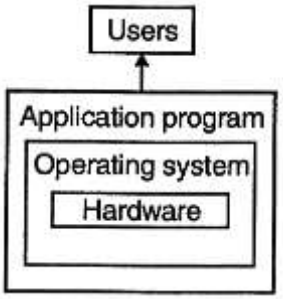
1 OPERATING SYSTEM

WHAT IS OPERATING SYSTEM?

An operating system is the fundamental basis of all other application programs. Operating system is an intermediary between the users and the hardware.
An operating system is a program which acts as an interface between the user and hardware. It provides an environment to run other programs also. It makes system convenient to use. It also performs basic tasks like input and output management i.e. it helps in using hardware in efficient manner.
Operating system controls and coordinates the use of hardware among application programs.



Computer hardware is at the innermost level. Operating system is at outer level to that of computer hardware. Kernel is the heart of the operating system. Application programs are at outer level of operating system. While users interact with the computer hardware through application program and operating system.
The major services of an operating system are –

- Memory management
- Information management
- Process management

Memory management

The services provided under memory management are directed to keeping track of memory and allocating, deallocating it to various processes. The operating system keeps a list of free memory location. Before a program is loaded in memory from the disk, this module consults this free list, allocates the memory to the process, depending upon program size and updates the list of free memory.
Some of the systems calls in this category are as follows,
(1) Allocate a chunk of memory to process
(2) Free a chunk of memory from a process

Information Management

It refers to a set of services used for storing, retrieving, modifying or removing the information on various devices. It manages the organization of information in terms of directories and files, allocating, deallocating the sectors to various files ensuring right people have access to information and driving various devices.

Some of the system calls in this category are as follows:

(1) Create a file
(2) Create a directory
(3) Open a file (for, read, write or both)
(4) Close a file
(5) Read data from file to buffer
(6) Move the file pointer
(7) Read data return file's status
(8) Create a link
(9) Change working directory
(10) Write data from buffer to file

Process Management

If operating system supports multiple users then services under this are very important. In this regard operating system has to keep track of all the completing process (running programs), schedule them, dispatch them one after another. But user should feel that he has the full control of the CPU.

Some of the systems calls in this category are as follows;

(1) Create a child process identical to the parent
(2) Terminate a process
(3) Wait for a child process to terminate
(4) Change the priority of process
(5) Block the process
(6) Ready the process
(7) Dispatch a process
(8) Suspend a process
(9) Resume a process
(10) Delay a process
(11) Fork a process

Applications of Operating System

Following are the major applications of an operating system –

- An operating system is accountable for the formation and deletion of files and directories.
- An operating system manages the process of deletion, suspension, resumption, and synchronization.
- An operating system manages memory space by allocation and de-allocation.
- An operating system stores, organizes, and names and protects the existing files.
- Further, an operating system manages all the components and devices of the computers system including modems, printers, plotters, etc.
- In case, if any device fails, the operating system detects and notify.
- An operating system protects from destruction as well as from unauthorized use.
- An operating system facilitates the interface to user and hardware.

Types of Operating System

Following are the major types of operating system –

- Disk Operating System (DOS)
- Windows Operating System
- Unix Operating System

Let us now discuss each operating system in detail.

Disk Operating System

MS-DOS is one of the oldest and widely used operating system. DOS is a set of computer programs, the major functions of which are file management, allocation of system resources, providing essential features to control hardware devices.

DOS commands can be typed in either upper case or lower case.

Features of DOS

Following are the significant features of DOS –

- It is a single user system.
- It controls program.
- It is machine independence.
- It manages (computer) files.
- It manages input and output system.
- It manages (computer) memory.
- It provides command processing facilities.
- It operates with Assembler.

Types of DOS Commands

Following are the major types of DOS Command –

- **Internal Commands** – Commands such as DEL, COPY, TYPE, etc. are the internal commands that remain stored in computer memory.
- **External Commands** – Commands like FORMAT, DISKCOPY, etc. are the external commands and remain stored on the disk.

Windows Operating System

The operating system window is the extension of the disk operating system.

It is the most popular and simplest operating system; it can be used by any person who can read and understand basic English, as it does not require any special training.

However, the Windows Operating System requires DOS to run the various application programs initially. Because of this reason, DOS should be installed into the memory and then window can be executed.

Elements of Windows OS

Following are the significant element of **W**indows **O**perating **S**ystem (WOS) –

- Graphical User Interface
- Icons (pictures, documents, application, program icons, etc.)
- Taskbar
- Start button
- Windows explorer
- Mouse button
- Hardware compatibility
- Software compatibility
- Help, etc.

Versions of Windows Operating System

Following are the different versions of Windows Operating System –

Version	Year
Window 1.01	1985
Windows NT 3.1	1993
Windows 95	1995
Windows 98	1998
Windows 2000	2000
Windows ME	2000
Windows XP	2001
Windows XP Professional x64	2005
Windows Vista	2007
Windows 7	2009
Windows 8	2012
Windows 10	2015
Windows Server 2016	2016

Unix Operating System

The Unix Operating System is the earliest operating system developed in 1970s. Let us consider the following points relating to the Unix Operating System –

- It is an operating system that has multitasking features.
- It has multiuser computer operating systems.
- It runs practically on every sort of hardware and provides stimulus to the open source movement.
- It has comparative complex functionality and hence an untrained user cannot use it; only the one who has taken training can use this system.
- Another drawback of this system is, it does not give notice or warn about the consequences of a user's action (whether user's action is right or wrong).

Linux Operating System

- Linux is an open-source Unix-like operating system-based family on the Linux kernel, and the OS kernel was first published on 17 September 1991 by ***Linus Torvalds***. Typically, Linux is packaged as the Linux distribution, which contains the supporting libraries and system software and kernel, several of which are offered by the GNU Project. Several Linux distributions use the term ***"Linux"*** in the title, but the Free Software Foundation uses the ***"GNU/Linux"*** title to focus on the necessity of GNU software.

- Linux is one of the most outstanding examples of open-source and free software collaboration. The source code may be distributed, modified, and used non-commercially or commercially by everyone under the conditions of its respective licenses, like the GNU GPL (General Public License). For example, the Linux kernel is licensed upon the GPLv2.

CONCEPTS RELATED TO INFORMATION MANAGEMENT: (ONLY DEFINITION)

Information management (IM) is the process of collecting, storing, managing and maintaining information in all its forms. Information management is a broad term that incorporates policies and procedures for centrally managing and sharing information among different individuals, organizations and/or information systems throughout the information life cycle. Information management may also be called information asset management.

FILE SYSTEM: It allows user to define files and directories and allocate and deallocate the disk space to each file. It uses various data structures to achieve this.

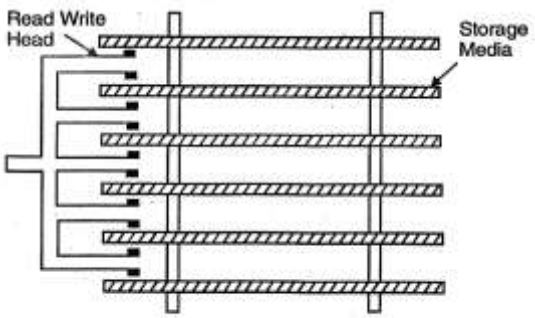
What is a block?

It is a unit of data defined by the operating system for its own convenience. Operating system keeps all its data structures in terms of blocks. Operating would view the disk as comprising of blocks. From hardware point of view the disk consists of tracks and sectors, but from operating system point of view, it consists of no. of blocks where each block is having one or more sectors. Due to this the operating system has to translate the block number into physical sector numbers.

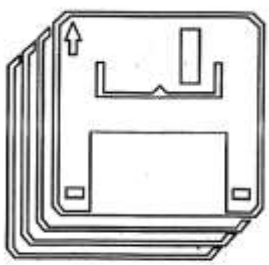
Disk: It is a secondary device. Various types of secondary devices are floppy disk and hard disk.

Floppy disk:

Floppy disk is made up of round piece of plastic material coated with a magnetized recording material. The surface of a floppy disk is made of concentric circles called tracks. Disk can be considered to be consisting of several surfaces, each of which consisting of tracks. The tracks are normally numbered from as the outermost track with the number increase inwards. Each track is divided into a no. of sectors of equal size. Sector capacities may vary; but typically a sector can store up to 512 bytes.



Hard Disk Mechanism



Floppy Disks

Double–sided floppy have two sides on which data can be recorded, so given sector is specified by a components of address, surface no, track no, and sector no.

Hard disk:

Hard disk surface is also made of concentric circles called tracks. Each track is divided into sectors of equal size. The disk drive for hard disk and its read/write mechanism is shown in fig. Read/write head for each surface connected to arm. Arm can move in or out to position itself on any track while disk rotates at a constant speed e.g.

(1) Read a block

(2) It is translated into a sector address surface = 1, track = 10, sector = 5. This is called target address

(3) Read/write heads current position's address is current address. i.e., Surface = 0, track = 7, sector = 7

(4) Move the arm in or out position on correct track. In this e.g. move arm inwards from track 7 to track 10. The time taken to move to correct track is called seek time.

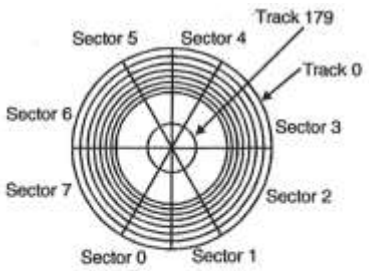


Fig. (a) Tracks and Sectors

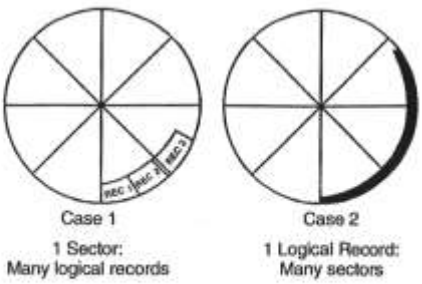


Fig. (b) Logical records and sectors

(5) Wait until desired sector comes under r/w head as disk rotates. Time to reach to particular sector on track is called rotational delay or latency.

(6) Activate R/W head for appropriate surface and read data. The time taken for this operation is called transmission time.

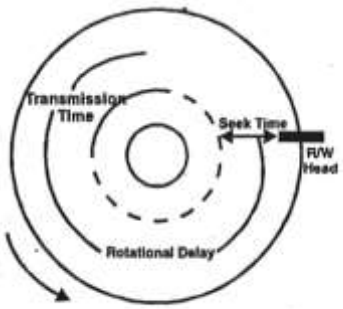


Fig. Stages Of I/O Operations

File

A file is a named collection of related information that is recorded on secondary storage such as magnetic disks, magnetic tapes and optical disks. In general, a file is a sequence of bits, bytes, lines or records whose meaning is defined by the files creator and user.

File Structure

A File Structure should be according to a required format that the operating system can understand.

- A file has a certain defined structure according to its type.
- A text file is a sequence of characters organized into lines.
- A source file is a sequence of procedures and functions.
- An object file is a sequence of bytes organized into blocks that are understandable by the machine.
- When operating system defines different file structures, it also contains the code to support these file structure. Unix, MS-DOS support minimum number of file structure.

File Type

File type refers to the ability of the operating system to distinguish different types of file such as text files source files and binary files etc. Many operating systems support many types of files. Operating system like MS-DOS and UNIX have the following types of files –

Ordinary files

- These are the files that contain user information.
- These may have text, databases or executable program.
- The user can apply various operations on such files like add, modify, delete or even remove the entire file.

Directory files

- These files contain list of file names and other information related to these files.
  Special files
- These files are also known as device files.
- These files represent physical device like disks, terminals, printers, networks, tape drive etc.

These files are of two types –

- **Character special files** – data is handled character by character as in case of terminals or printers.
- **Block special files** – data is handled in blocks as in the case of disks and tapes.

File Access Mechanisms

File access mechanism refers to the manner in which the records of a file may be accessed. There are several ways to access files –

1) Sequential access

2) Direct/Random access

3) Indexed sequential access

1) Sequential access

Sequential access is that in which the records are accessed in some sequence, i.e., the information in the file is processed in order, one record after the other. This access method is the most primitive one. Example: Compilers usually access files in this fashion.

2) Direct/Random access

- Random access file organization provides, accessing the records directly.
- Each record has its own address on the file with by the help of which it can be directly accessed for reading or writing.
- The records need not be in any sequence within the file and they need not be in adjacent locations on the storage medium.

3) Indexed sequential access

- This mechanism is built up on base of sequential access.
- An index is created for each file which contains pointers to various blocks.
- Index is searched sequentially and its pointer is used to access the file directly.

Space Allocation

Files are allocated disk spaces by operating system. Operating systems deploy following three main ways to allocate disk space to files.

- Contiguous Allocation
- Linked Allocation
- Indexed Allocation

1) Contiguous Allocation

- Each file occupies a contiguous address space on disk.
- Assigned disk address is in linear order.
- Easy to implement.
- External fragmentation is a major issue with this type of allocation technique.

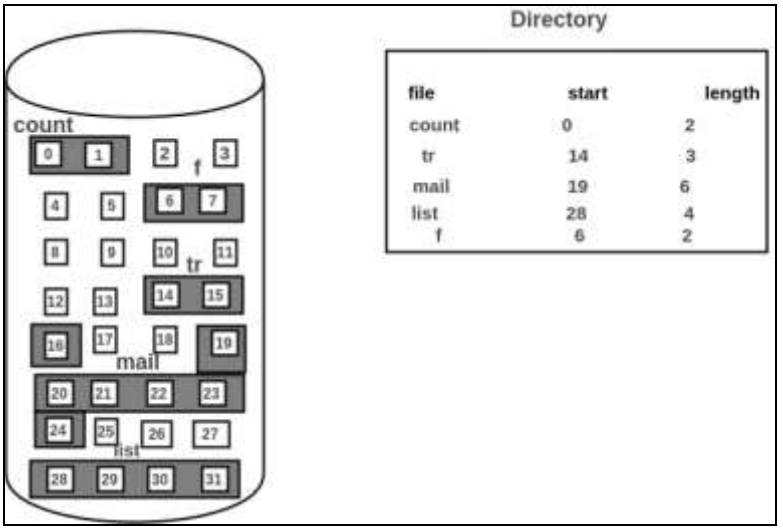


Fig: Contiguous Allocation

2) <u>Linked Allocation</u>

- Each file carries a list of links to disk blocks.
- Directory contains link / pointer to first block of a file.
- No external fragmentation
- Effectively used in sequential access file.
- Inefficient in case of direct access file.

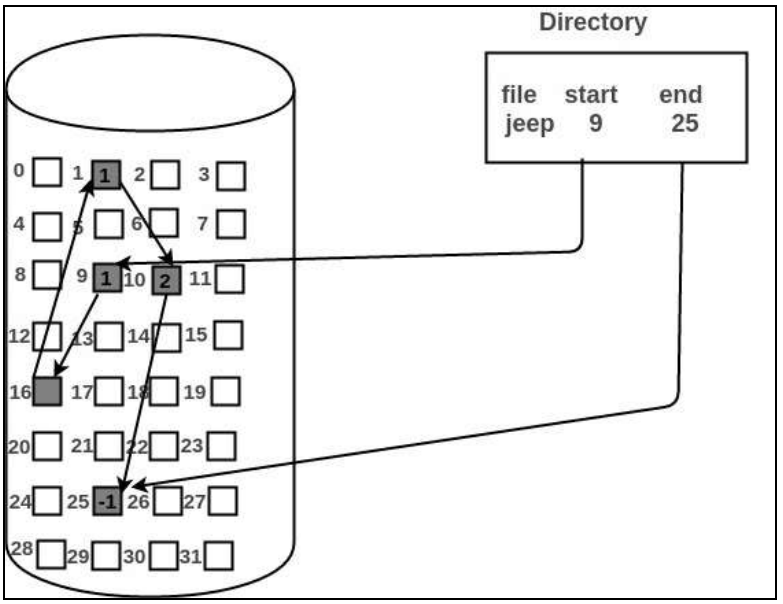


Fig : Linked Allocation

3) Indexed Allocation

- Provides solutions to problems of contiguous and linked allocation.
- A index block is created having all pointers to files.
- Each file has its own index block which stores the addresses of disk space occupied by the file.
- Directory contains the addresses of index blocks of files.

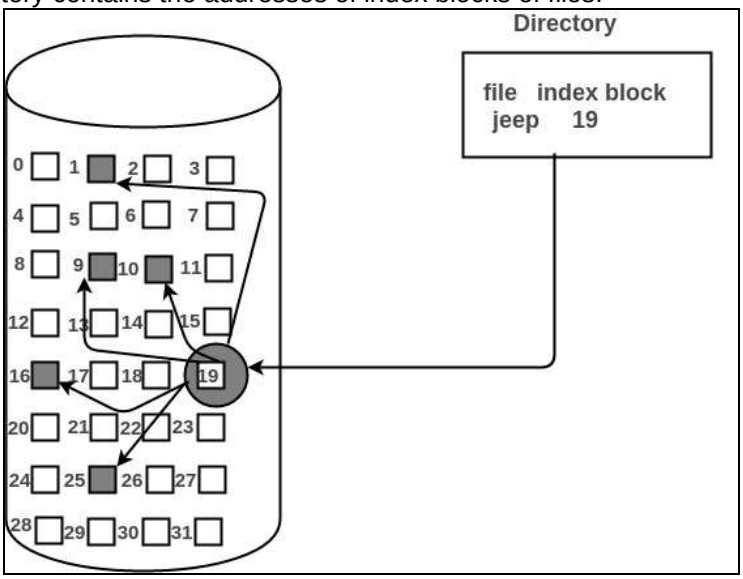


Fig : Indexed Allocation

DEVICE DRIVER

Device Driver in computing refers to a special kind of software program or a specific type of software application which controls a specific hardware device that enables different hardware devices for communication with the computer's Operating System A device driver communicates with the computer hardware by computer subsystem or computer bus connected to the hardware.

Device Drivers are very essential for a computer system to work properly because without device driver the particular hardware fails to work accordingly means it fails in doing a particular function/action for which it has been created.

In a very common way most term it as only a **Driver** also when someone says **Hardware Driver** that also refers to this **Device Driver.**

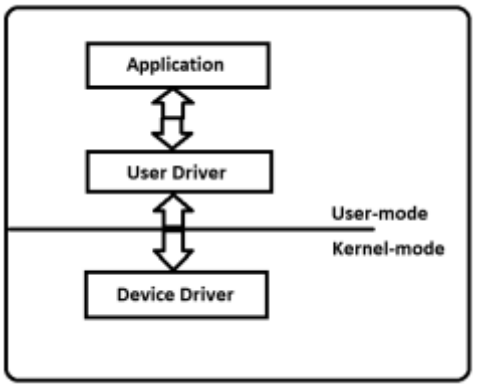


Fig : Device Driver

Working of Device Driver :

Device Drivers depend upon the Operating System's instruction to access the device and performing any particular action. After the action they also shows their reactions by delivering output or status/message from hardware device to the Operating system. For Example a printer driver tells the printer in which format to print after getting instruction from OS, similarly A sound card driver is there due to which 1's and 0's data of MP3 file is converted to audio signals and you enjoy the music. Card reader, controller, modem, network card, sound card, printer, video card, USB devices, RAM, Speakers etc. needed by Device Drivers to operate.
The following figure illustrates the interaction between user, OS, Device driver and the devices:

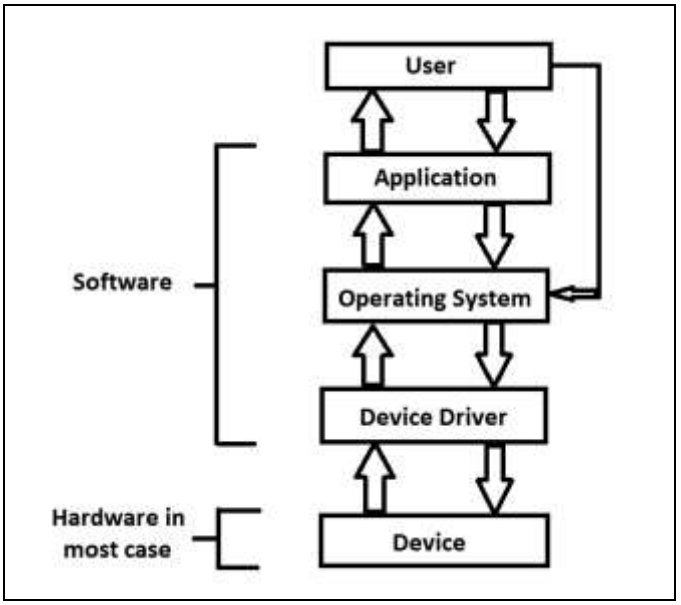


Fig : Working of device driver

MULPROGRAMMING:

Multiprogramming OS is an ability of an operating system that executes more than one program using a single processor machine.

More than one task or program or jobs are present inside the main memory at one point of time.

Buffering and spooling can overlap I/O and CPU tasks to improve the system performance but it has some limitations that a single user cannot always keep CPU or I/O busy all the time.

To increase resource utilization, multiprogramming approaches.

For example

Operating system
Job 1
Job 2
– – –
Job N
Empty space

The OS could pick and start the execution of one of the jobs in memory, whenever the jobs does not need CPU that means the job is working with I/O at that time the CPU is idle at that time the OS switches to another job in memory and CPU executes a portion of it till the job issues a request for I/O and so on.

Let's P1 and P2 are two programs present in the main memory. The OS picks one program and starts executing it.

During execution if the P1 program requires I/O operation, then the OS will simply switch over to P2 program. If the p2 program requires I/O then again it switches to P3 and so on.

If there is no other program remaining after P3 then the CPU will pass its control back to the previous program.

PROCESS MANAGEMENT

A Program does nothing unless its instructions are executed by a CPU. A program in execution is called a process. In order to accomplish its task, process needs the computer resources.

There may exist more than one process in the system which may require the same resource at the same time. Therefore, the operating system has to manage all the processes and the resources in a convenient and efficient way.

Some resources may need to be executed by one process at one time to maintain the consistency otherwise the system can become inconsistent and deadlock may occur.

PROCESS STATES

State Diagram

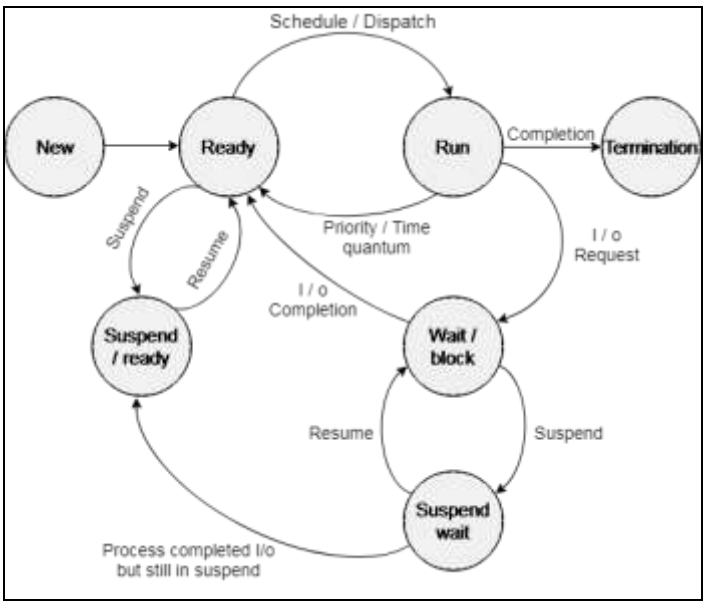


Fig : Process lifecycle

The process, from its creation to completion, passes through various states. The minimum number of states is five.

The names of the states are not standardized although the process may be in one of the following states during execution.

1. **New**
   A program which is going to be picked up by the OS into the main memory is called a new process.
2. **Ready**
   Whenever a process is created, it directly enters in the ready state, in which, it waits for the CPU to be assigned. The OS picks the new processes from the secondary memory and put all of them in the main memory.
   The processes which are ready for the execution and reside in the main memory are called ready state processes. There can be many processes present in the ready state.
3. **Running**
   One of the processes from the ready state will be chosen by the OS depending upon the scheduling algorithm. Hence, if we have only one CPU in our system, the number of running processes for a particular time will always be one. If we have n processors in the system then we can have n processes running simultaneously.
4. **Block or wait**
   From the Running state, a process can make the transition to the block or wait state depending upon the scheduling algorithm or the intrinsic behaviour of the process.

When a process waits for a certain resource to be assigned or for the input from the user then the OS move this process to the block or wait state and assigns the CPU to the other processes.

5. **Completion or termination**
   When a process finishes its execution, it comes in the termination state. All the context of the process (Process Control Block) will also be deleted the process will be terminated by the Operating system.

6. **Suspend ready**
   A process in the ready state, which is moved to secondary memory from the main memory due to lack of the resources (mainly primary memory) is called in the suspend ready state.
   If the main memory is full and a higher priority process comes for the execution then the OS have to make the room for the process in the main memory by throwing the lower priority process out into the secondary memory. The suspend ready processes remain in the secondary memory until the main memory gets available.

7. **Suspend wait**
   Instead of removing the process from the ready queue, it's better to remove the blocked process which is waiting for some resources in the main memory. Since it is already waiting for some resource to get available hence it is better if it waits in the secondary memory and make room for the higher priority process. These processes complete their execution once the main memory gets available and their wait is finished.

PRIORITY

Processes are executed on the basis of priority so **high priority does not need to wait for long which saves time**. This method provides a good mechanism where the relative important of each process may be precisely defined.

TYPES OF PRIORITY

1) **Internal priority**
   Internal priorities are assigned by technical quantities such as memory usage, and file I/O operations.
   It depends upon scheduling algorithms such as shortest job first (SJF)
   SJF:- the job whose expected time for completion is less is completed first. Due to this the number of processes competing for CPU will decrease and no. of satisfied users will increase. But if a number of small jobs are coming, it will cause large jobs to suffer as they will be postponed.

2) **External priority**
   The user specifies it externally at the time of initiating the process. If user does not specify any external priority then the operating system assumes a certain priority called default priority. Most of the processes run at the same default priority.

CONTEXT SWITCHING

The Context switching is a technique or method used by the operating system to switch a process from one state to another to execute its function using CPUs in the system. When switching perform in the system, it stores the old running process's status in the form of registers and assigns the CPU to a new process to execute its

tasks. While a new process is running in the system, the previous process must wait in a ready queue. The execution of the old process starts at that point where another process stopped it. It defines the characteristics of a multitasking operating system in which multiple processes shared the same CPU to perform multiple tasks without the need for additional processors in the system.

SCHEDULING PHILOSOPHIES

There are basically two scheduling philosophies

1) Non-preemptive policy
2) Preemptive policy

1) Non-preemptive policy

A running process retains the control of the CPU and all the allocated resources until it surrenders control to the OS on its own. Even if higher priority process enters the system, running process cannot be forced to give control. It is not suited for real time systems.

2) Preemptive policy

A preemptive policy allows higher priority process to replace currently running process even if it has not requested for any I/O or its time slice is not over. It requires more context switching. It is well suited for real time systems where higher priority processes requires immediate attention.

MULTITASKING

Multitasking term used in a modern computer system. It is a logical extension of a multiprogramming system that enables the execution of **multiple** programs simultaneously. In an operating system, multitasking allows a user to perform more than one computer task simultaneously. Multiple tasks are also known as processes that share similar processing resources like a **CPU**. The operating system keeps track of where you are in each of these jobs and allows you to transition between them without losing data.

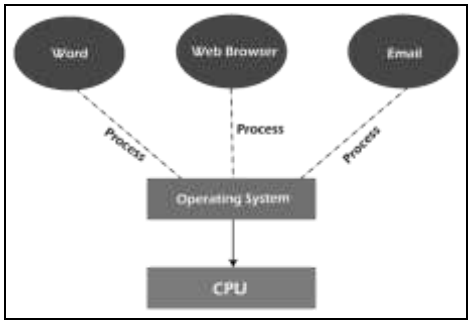


Fig : Multitasking

TIME SHARING

Time-sharing is a technique that enables many people located at various terminals to use a particular computer system simultaneously. Time-Sharing is the logical extension of multiprogramming. In this time-sharing Operating system, many processes are allocated with computer resources in respective time slots. In this, the processor's time is shared with multiple users. That's why it is called a time-sharing operating system. It has a fixed time slice for the different processes. Its main purpose is interactive response time.

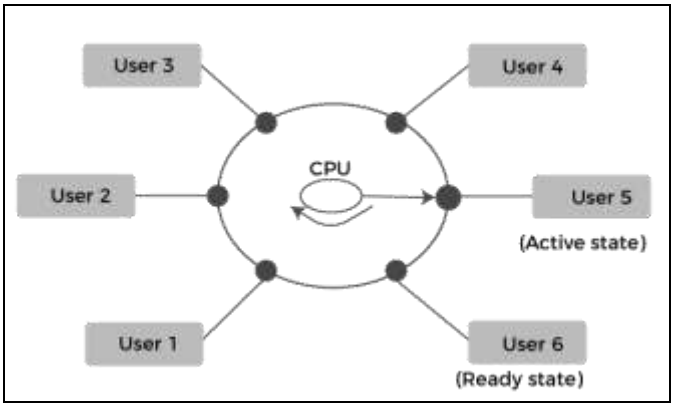


Fig : Time sharing

The CPU executes multiple jobs by switching between them, but the switches occur so frequently. Thus, the user can receive an immediate response. The operating system uses CPU scheduling and multiprogramming to provide each user with a small amount of time. Computer systems that were designed primarily as batch systems have been modified to time-sharing systems.

The main difference between Multi programmed Batch Systems, and Time-Sharing Systems is that in multi-programmed batch systems, the objective is to maximize processor use. In contrast, in Time-Sharing Systems, the objective is to minimize response time.

MEMORY MANAGEMENT

Memory is the important part of the computer that is used to store the data. Its management is critical to the computer system because the amount of main memory available in a computer system is very limited. At any time, many processes are competing for it. Moreover, to increase performance, several processes are executed simultaneously. For this, we must keep several processes in the main memory, so it is even more important to manage them effectively.

Memory management plays several roles in a computer system.

Following are the important roles in a computer system

- Memory manager is used to keep track of the status of memory locations, whether it is free or allocated. It addresses primary memory by providing abstractions so that software perceives a large memory is allocated to it.
- Memory manager permits computers with a small amount of main memory to execute programs larger than the size or amount of available memory. It does this by moving information back and forth between primary memory and secondary memory by using the concept of swapping.
- The memory manager is responsible for protecting the memory allocated to each process from being corrupted by another process. If this is not ensured, then the system may exhibit unpredictable behaviour.
- Memory managers should enable sharing of memory space between processes. Thus, two programs can reside at the same memory location although at different times.

Memory management Techniques:

The Memory management Techniques can be classified into following main categories:

- Contiguous memory management schemes
- Non-Contiguous memory management schemes

Contiguous memory management schemes:

In a Contiguous memory management scheme, each program occupies a single contiguous block of storage locations, i.e., a set of memory locations with consecutive addresses.

FIXED AND VARIABLE PARTITIONING

Fixed Partitioning:

Multi-programming with fixed partitioning is a contiguous memory management technique in which the main memory is divided into fixed sized partitions which can be of equal or unequal size. Whenever we have to allocate a process memory then a free partition that is big enough to hold the process is found. Then the memory is allocated to the process. If there is no free space available then the process waits in the queue to be allocated memory. It is one of the most oldest memory management technique which is easy to implement.

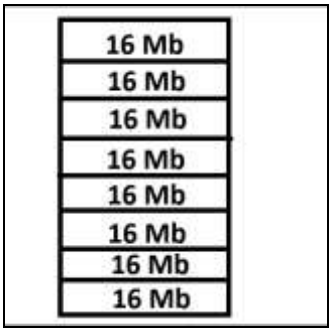


Fig : Fixed partitioning

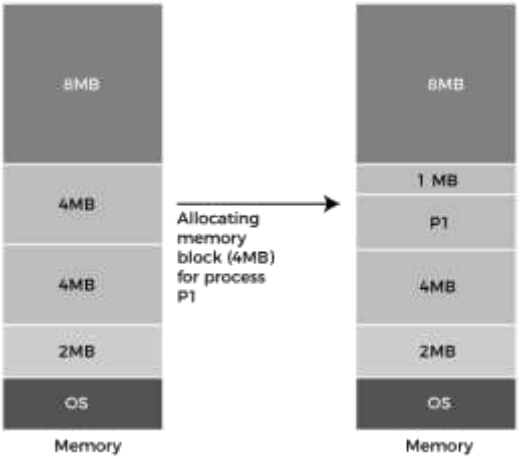
What is Fragmentation?

Fragmentation is an unwanted problem in the operating system in which the processes are loaded and unloaded from memory, and free memory space is fragmented. Processes can't be assigned to memory blocks due to their small size, and the memory blocks stay unused. It is also necessary to understand that as programs are loaded and deleted from memory, they generate free space or a hole in the memory. These small blocks cannot be allotted to new arriving processes, resulting in inefficient memory use.

Internal fragmentation

When a process is allocated to a memory block, and if the process is smaller than the amount of memory requested, a free space is created in the given memory block. Due to this, the free space of the memory block is unused, which causes **internal** fragmentation.

For Example:
Assume that memory allocation in RAM is done using fixed partitioning (i.e., memory blocks of fixed sizes). **2MB, 4MB, 4MB**, and **8MB** are the available sizes. The Operating System uses a part of this RAM.

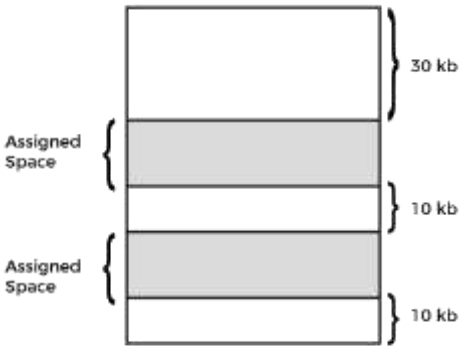


Let's suppose a process **P1** with a size of **3MB** arrives and is given a memory block of **4MB**. As a result, the **1MB** of free space in this block is unused and cannot be used to allocate memory to another process. It is known as **internal fragmentation**.

External fragmentation

External fragmentation happens when a dynamic memory allocation method allocates some memory but leaves a small amount of memory unusable. The quantity of available memory is substantially reduced if there is too much external fragmentation. There is enough memory space to complete a request, but it is not contiguous. It's known as **external** fragmentation.

For Example:



Process 05 needs 45kb memory space

Let's take the example of external fragmentation. In the above diagram, you can see that there is sufficient space **(50 KB)** to run a process **(05) (need 45KB)**, but the memory is not contiguous. You can use compaction, paging, and segmentation to use the free space to execute a process.

Variable Partitioning :

Multi-programming with variable partitioning is a contiguous memory management technique in which the main memory is not divided into partitions and the process is allocated a chunk of free memory that is big enough for it to fit. The space which is left is considered as the free space which can be further used by other processes. It also provides the concept of compaction. In compaction the spaces that are free and the spaces which not allocated to the process are combined and single large memory space is made.

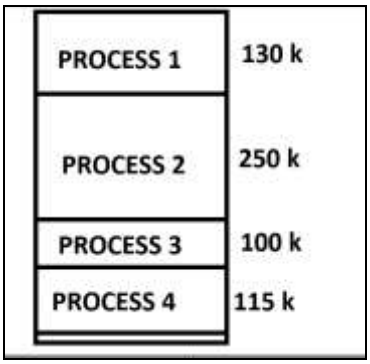


Fig : Variable partitioning

Difference between Fixed Partitioning and Variable Partitioning :

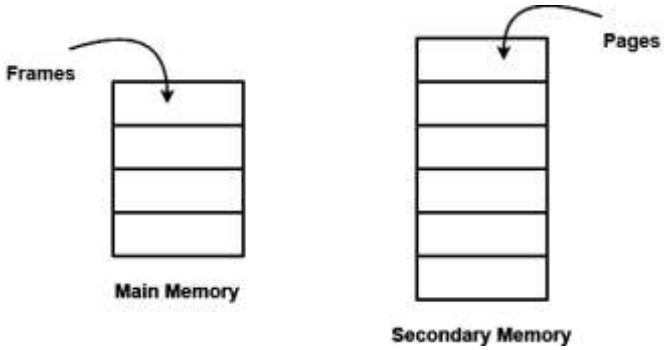
Sr. No.	Fixed partitioning	Variable partitioning
1.	In multi-programming with fixed partitioning the main memory is divided into fixed sized partitions.	In multi-programming with variable partitioning the main memory is not divided into fixed sized partitions.
2.	Only one process can be placed in a partition.	In variable partitioning, the process is allocated a chunk of free memory.
3.	It does not utilize the main memory effectively.	It utilizes the main memory effectively.
4.	There is presence of internal fragmentation and external fragmentation.	There is external fragmentation.
5.	Degree of multi-programming is less.	Degree of multi-programming is higher.
6.	It is more easier to implement.	It is less easier to implement.
7.	There is limitation on size of process.	There is no limitation on size of process.

Non-Contiguous memory management schemes:

In a Non-Contiguous memory management scheme, the program is divided into different blocks and loaded at different portions of the memory that need not necessarily be adjacent to one another. This scheme can be classified depending upon the size of blocks and whether the blocks reside in the main memory or not.

PAGING

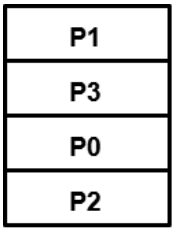
- Paging is a fixed size partitioning scheme.
- In paging, secondary memory and main memory are divided into equal fixed size partitions.
- The partitions of secondary memory are called as **pages**.
- The partitions of main memory are called as **frames**.



- Each process is divided into parts where size of each part is same as page size.
- The size of the last part may be less than the page size.
- The pages of process are stored in the frames of main memory depending upon their availability.

Example-

- Consider a process is divided into 4 pages P_0, P_1, P_2 and P_3.
- Depending upon the availability, these pages may be stored in the main memory frames in a non-contiguous fashion as shown-



Main Memory

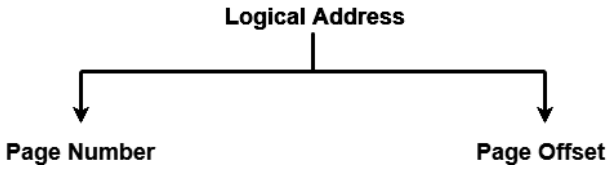
Translating Logical Address into Physical Address-

- CPU always generates a logical address.
- A physical address is needed to access the main memory.

Following steps are followed to translate logical address into physical address-

CPU generates a logical address consisting of two parts-

1. Page Number
2. Page Offset



- Page Number specifies the specific page of the process from which CPU wants to read the data.
- Page Offset specifies the specific word on the page that CPU wants to read.

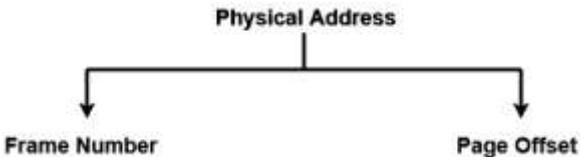
Step-02:

For the page number generated by the CPU,

- **Page Table** provides the corresponding frame number (base address of the frame) where that page is stored in the main memory.

Step-03:

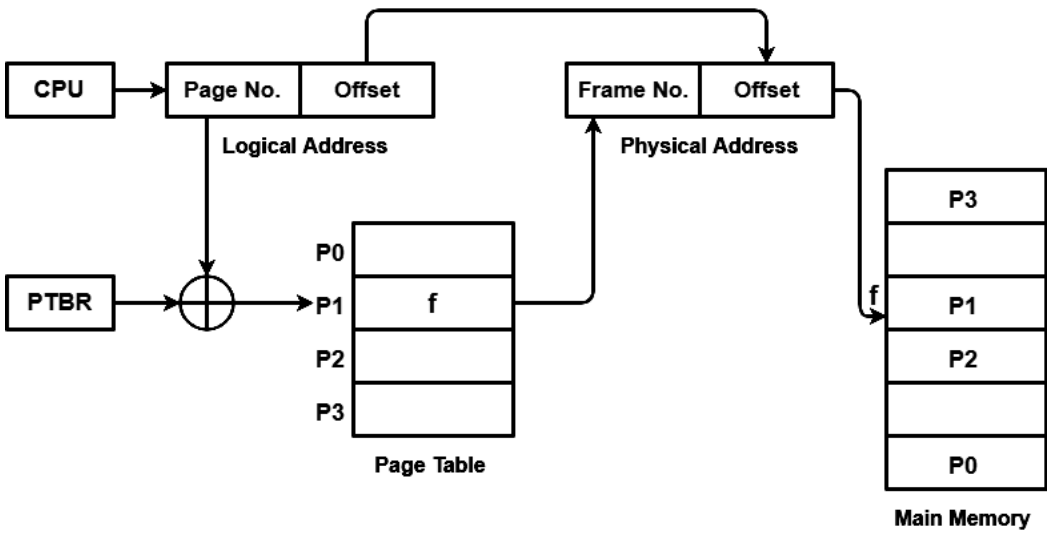
- The frame number combined with the page offset forms the required physical address.



- Frame number specifies the specific frame where the required page is stored.
- Page Offset specifies the specific word that has to be read from that page.

Diagram-

The following diagram illustrates the above steps of translating logical address into physical address-



Translating Logical Address into Physical Address

Advantages-

The advantages of paging are-

- It allows to store parts of a single process in a non-contiguous fashion.
- It solves the problem of external fragmentation.

SEGMENTATION

In Operating Systems, Segmentation is a memory management technique in which the memory is divided into the variable size parts. Each part is known as a segment which can be allocated to a process.

The details about each segment are stored in a table called a segment table. Segment table is stored in one (or many) of the segments.

Segment table contains mainly two information about segment:

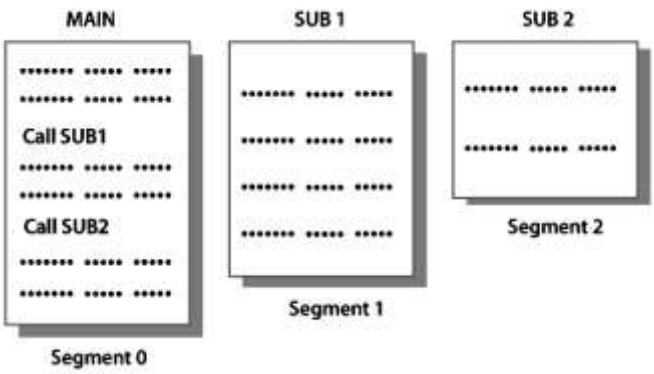
1. Base: It is the base address of the segment
2. Limit: It is the length of the segment.

Why Segmentation is required?

Till now, we were using Paging as our main memory management technique. Paging is more close to the Operating system rather than the User. It divides all the processes into the form of pages regardless of the fact that a process can have some relative parts of functions which need to be loaded in the same page.

Operating system doesn't care about the User's view of the process. It may divide the same function into different pages and those pages may or may not be loaded at the same time into the memory. It decreases the efficiency of the system.

It is better to have segmentation which divides the process into the segments. Each segment contains the same type of functions such as the main function can be included in one segment and the library functions can be included in the other segment.



Translation of Logical address into physical address by segment table

CPU generates a logical address which contains two parts:

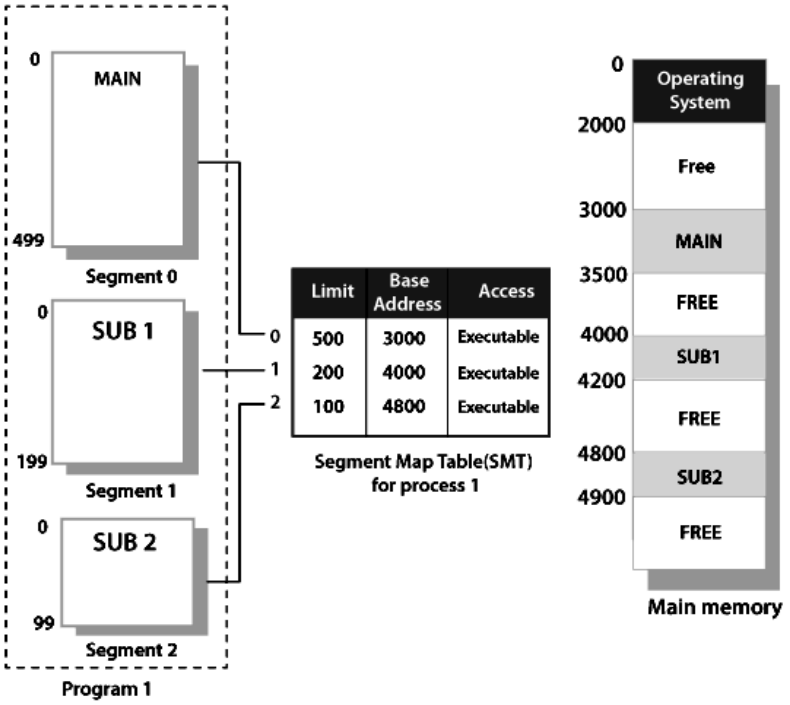
1. Segment Number
2. Offset

For Example:

Suppose a 16 bit address is used with 4 bits for the segment number and 12 bits for the segment offset so the maximum segment size is 4096 and the maximum number of segments that can be refereed is 16.

When a program is loaded into memory, the segmentation system tries to locate space that is large enough to hold the first segment of the process, space information

is obtained from the free list maintained by memory manager. Then it tries to locate space for other segments. Once adequate space is located for all the segments, it loads them into their respective areas.
The operating system also generates a segment map table for each program.



With the help of segment map tables and hardware assistance, the operating system can easily translate a logical address into physical address on execution of a program.
The **Segment number** is mapped to the segment table. The limit of the respective segment is compared with the offset. If the offset is less than the limit then the address is valid otherwise it throws an error as the address is invalid.
In the case of valid addresses, the base address of the segment is added to the offset to get the physical address of the actual word in the main memory.
The above figure shows how address translation is done in case of segmentation.

Advantages of Segmentation

1. No internal fragmentation
2. Average Segment Size is larger than the actual page size.
3. Less overhead
4. It is easier to relocate segments than entire address space.
5. The segment table is of lesser size as compared to the page table in paging.

Disadvantages

1. It can have external fragmentation.
2. it is difficult to allocate contiguous memory to variable sized partition.
3. Costly memory management algorithms.

SINGLE USER COMPUTER MEMORY MAP

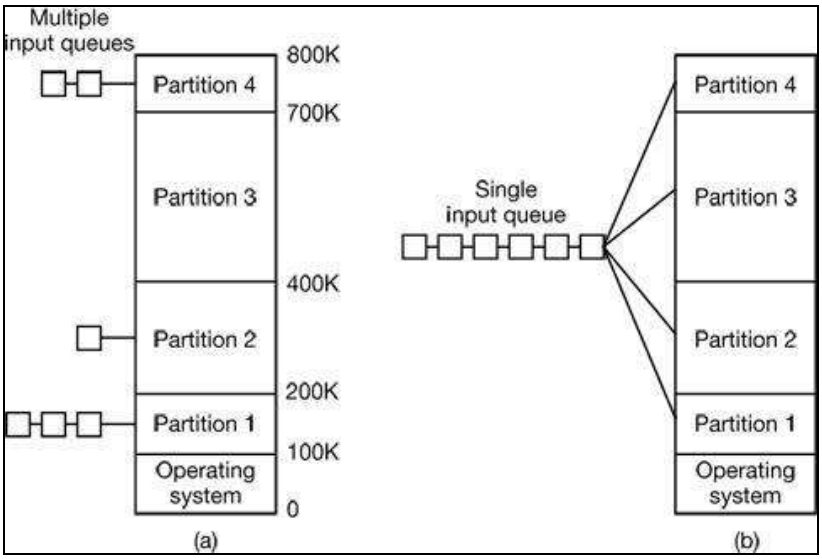


Fig : Single user computer memory map

It controls when programs and data are placed in the main memory. Many OS's allow more than one program to be in memory at the same time. Memory management ensures that any program does not overwrite any other program (including the OS itself).

VIRTUAL MEMORY

A computer can address more memory than the amount physically installed on the system. This extra memory is actually called **virtual memory** and it is a section of a hard disk that's set up to emulate the computer's RAM.

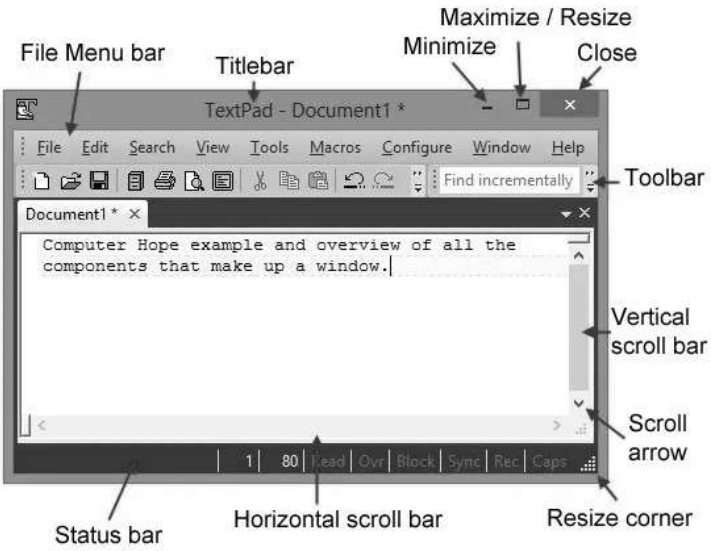
The main visible advantage of this scheme is that programs can be larger than physical memory. Virtual memory serves two purposes. First, it allows us to extend the use of physical memory by using disk. Second, it allows us to have memory protection, because each virtual address is translated to a physical address.

Following are the situations, when entire program is not required to be loaded fully in main memory.

- User written error handling routines are used only when an error occurred in the data or computation.
- Certain options and features of a program may be used rarely.
- Many tables are assigned a fixed amount of address space even though only a small amount of the table is actually used.
- The ability to execute a program that is only partially in memory would counter many benefits.
- Less number of I/O would be needed to load or swap each user program into memory.
- A program would no longer be constrained by the amount of physical memory that is available.
- Each user program could take less physical memory, more programs could be run the same time, with a corresponding increase in CPU utilization and throughput.

GUI BASICS OF WINDOWS

- **Elements in Graphical User Interface**
  Graphical User Interface makes use of visual elements mostly. These elements define the appearance of the GUI. Some of these are described in detail as follows –
- **Window**
  This is the element that displays the information on the screen. It is very easy to manipulate a window. It can be opened or closed with the click of an icon. Moreover, it can be moved to any area by dragging it around. In a multitasking environment, multiple windows can be open at the same time, all of them performing different tasks.
  There are multiple types of windows in a graphical user interface, such as container window, browser window, text terminal window, child window, message window etc.
- **Menu**
  A menu contains a list a choices and it allows users to select one from them. A menu bar is displayed horizontally across the screen such as pull down menu. When any option is clicked in this menu, then the pull down menu appears.
  Another type of menu is the context menu that appears only when the user performs a specific action. An example of this is pressing the right mouse button. When this is done, a menu will appear under the cursor.
- **Icons**
  Files, programs, web pages etc. can be represented using a small picture in a graphical user interface. This picture is known as an icon. Using an icon is a fast way to open documents, run programs etc. because clicking on them yields instant access.
- **Controls**
  Information in an application can be directly read or influences using the graphical control elements. These are also known as widgets. Normally, widgets are used to display lists of similar items, navigate the system using links, tabs etc. and manipulating data using check boxes, radio boxes etc.
- **Tabs**
  A tab is associated with a view pane. It usually contains a text label or a graphical icon. Tabs are sometimes related to widgets and multiple tabs allow users to switch between different widgets. Tabs are used in various web browsers such as Internet Explorer, Firefox, Opera, Safari etc. Multiple web pages can be opened in a web browser and users can switch between them using tabs.
- **Title bar**
  The **title bar** is a horizontal bar located at the top of a window in a GUI. It displays the title of the software, name of the current document or file, or other text identifying the contents of that window. For example, in the picture below, the title bar displays the program name "TextPad" and the document name "Document1" that is currently being edited.



Besides giving a description of the open program or window, the title bar may also contain other useful features that depend on the operating system and program showing the title bar.

- **Scroll bar**

  A **scrollbar** is an interaction technique or widget in which continuous text, pictures, or any other content can be scrolled in a predetermined direction (up, down, left, or right) on a computer display, window, or viewport so that all of the content can be viewed, even if only a fraction of the content can be seen on a device's screen at one time. It offers a solution to the problem of navigation to a known or unknown location within a two-dimensional information space.[1] It was also known as a **handle** in the very first GUIs. They are present in a wide range of electronic devices including computers, graphing calculators, mobile phones, and portable media players. The user interacts with the scrollbar elements using some method of direct action, the scrollbar translates that action into scrolling commands, and the user receives feedback through a visual updating of both the scrollbar elements and the scrolled content.

- **Maximize Button** 

  Maximizing a window refers to enlarging it to fit the size of your entire screen. The menus and toolbars remain, but the title bar disappears. Essentially, you want to maximize the space used by the window.

  To maximize a window, click  on the right corner of a window's title bar or a minimized window (referred to as an icon).
  In a Chart Analysis window, you can also double-click the right mouse button to maximize the window. To restore the window, double right-click the right mouse button again. To enable this option, see Chart Analysis Preferences.

- **Minimize Button** 
  Minimizing a window refers to collapsing the window into an icon. The window is still open (and therefore analysis techniques are still calculating), but it takes up very little screen space.

  To minimize a window, click  on the window's title bar.
- **Restore Button** 
  Restoring a window refers to returning the window to its original state. If the window was in its default state and is maximized or minimized, restoring the window returns the window to its default state. If the window maximized and then minimized, restoring the window returns the window to the maximized state. To restore a window to its original state, click  on the right corner of a window's title bar or a window's icon.

ACCESS AND SECURITY ASPECT OF OS

Security refers to providing a protection system to computer system resources such as CPU, memory, disk, software programs and most importantly data/information stored in the computer system. If a computer program is run by an unauthorized user, then he/she may cause severe damage to computer or data stored in it. So a computer system must be protected against unauthorized access, malicious access to system memory, viruses, worms etc. We're going to discuss following topics in this chapter.

- Authentication
- One Time passwords
- Program Threats
- System Threats
- Computer Security Classifications

Authentication

Authentication refers to identifying each user of the system and associating the executing programs with those users. It is the responsibility of the Operating System to create a protection system which ensures that a user who is running a particular program is authentic. Operating Systems generally identifies/authenticates users using following three ways –

- **Username / Password** – User need to enter a registered username and password with Operating system to login into the system.
- **User card/key** – User need to punch card in card slot, or enter key generated by key generator in option provided by operating system to login into the system.
- **User attribute - fingerprint/ eye retina pattern/ signature** – User need to pass his/her attribute via designated input device used by operating system to login into the system.

One Time passwords

One-time passwords provide additional security along with normal authentication. In One-Time Password system, a unique password is required every time user tries to login into the system. Once a one-time password is used, then it cannot be used again. One-time password are implemented in various ways.

- **Random numbers** – Users are provided cards having numbers printed along with corresponding alphabets. System asks for numbers corresponding to few alphabets randomly chosen.
- **Secret key** – User are provided a hardware device which can create a secret id mapped with user id. System asks for such secret id which is to be generated every time prior to login.
- **Network password** – Some commercial applications send one-time passwords to user on registered mobile/ email which is required to be entered prior to login.

Program Threats

Operating system's processes and kernel do the designated task as instructed. If a user program made these process do malicious tasks, then it is known as **Program Threats**. One of the common example of program threat is a program installed in a computer which can store and send user credentials via network to some hacker. Following is the list of some well-known program threats.

- **Trojan Horse** – Such program traps user login credentials and stores them to send to malicious user who can later on login to computer and can access system resources.
- **Trap Door** – If a program which is designed to work as required, have a security hole in its code and perform illegal action without knowledge of user then it is called to have a trap door.
- **Logic Bomb** – Logic bomb is a situation when a program misbehaves only when certain conditions met otherwise it works as a genuine program. It is harder to detect.
- **Virus** – Virus as name suggest can replicate themselves on computer system. They are highly dangerous and can modify/delete user files, crash systems. A virus is generatlly a small code embedded in a program. As user accesses the program, the virus starts getting embedded in other files/ programs and can make system unusable for user.

  Types of virus

  There are several types of computer virus as follows:

  (a) Boot sector virus

  (b) Memory resident virus

  (c) File virus

  (d) Command processor virus

  (e) General purpose virus

  Generally classification is done based on what is affected or where the virus resides.

  Infection methods

  (a) **Append:** In this method viral code appends itself to the unaffected program.

  (b) Replace: In this method viral code replaces original executable program completely or partially.

(c) Insert: In this method the viral code is inserted in the body of an executable code to carry out some funny actions.

(d) Delete: In this case viral code deletes some codes from executable program.

(e) Redirect: In this case the normal control flow of a program is changed to execute some other code.

Modes of operation

Virus work in number of ways. Generally developer of virus produces any interesting or useful program such as a game or utility. But his progam has viral code embedded in it. Generally this program is developed under DOS. Then it is distributed to people .

Virus detection

Normally virus detection program checks integrity of binary files. It maintains a checksum on each file. At regular frequency detection program calculates checksum and matches with original one. If there is mismatch then that program may be infected.

Virus removal

There are some viruses whose bit pattern in the code can be predicted. The virus removal program scans the disk for the patterns of know viruses and on detection it removes them.

Virus prevention

For prevention of virus always buy legal copies of software. Again take frequent backups of data and run monitor programs frequently to detect virus.

Difference between computer virus and computer worm

	Computer Virus		Computer Worm
(1)	It is not a complete program by itself.	(1)	It is a complete program.
(2)	Viruses cause direct 1 arm to the system by corrupting codes as well as data.	(2)	Worm generally consumes system resources.
(3)	It cannot operate independently	(3)	It operates independently

- **Line Tapping**- Tappings in communication line can access/modify confidential data.

- **Electronic data capture**- using wire taps or mechanism to pick up screen radiation and recognize what is displayed on screen is termed as electronic data capture.
- **Waste recovery**- If block is deleted its information will be as it is, until it is allocated to another file. Intruder may use some mechanism to scan these blocks.

System Threats

System threats refers to misuse of system services and network connections to put user in trouble. System threats can be used to launch program threats on a complete network called as program attack. System threats creates such an environment that operating system resources/ user files are misused. Following is the list of some well-known system threats.

- **Worm** – Worm is a process which can choked down a system performance by using system resources to extreme levels. A Worm process generates its multiple copies where each copy uses system resources, prevents all other processes to get required resources. Worms processes can even shut down an entire network.

  Safeguards against worms

  a) Prevent its creation: This is achieved by strong security and protection policies.

  b) Prevent its spreading: Before transferring any file on a network, user should be forced to sanction transfer.

  Mode of operation:

  Worms simply create multiple copies of itself on the network which chokes the network and causes bottleneck making it difficult to do any further processing.
- **Port Scanning** – Port scanning is a mechanism or means by which a hacker can detects system vulnerabilities to make an attack on the system.
- **Denial of Service** – Denial of service attacks normally prevents user to make legitimate use of the system. For example, a user may not be able to use internet if denial of service attacks browser's content settings.

Exercise

Select the correct alternative and rewrite the following.

1. Operating system is _____
   (1) hardware (2) software (3) input device (4) output device
1. (2) software

2. _____ is service in operating system.
   (1) Information management (2) Process
   (3) G.U.I. (4) None of these
2. (1) Information management

3. Windows NT is_____ operating system.
   (1) Single user multitasking (2) Multiuser multitasking
   (3) Time sharing (4) None of these
3. (2) Multiuser multitasking

4. Linux is a_____ software.
   (1) public domain (2) free (3) paid (4) private
4. (2) free

5. Windows 98 is _____ operating system.
   (1) Single user multitasking (2) Multiuser
   (3) Timesharing (4) Multithreading
5. (1) Single user multitasking

6. The time required for read-write head to move to the correct track is_____
   (1) Seek time (2) Rotational delay (3) Latency time (4) None of these
6. (1) Seek time

7. Termination of a process is done by
   (1) Memory management (2) Process management
   (3) Device driver (4) Information management
7. (2) Process management

8. The time lost in turning the attention of processor from one process to other is called as _____.
   (1) Circuit switching (2) Band width
   (3) Context switching (4) None of these
8. (3) Context switching

9. _____ is a function of memory management.
   (1) Creation of file (2) Halting process
   (3) Paging (4) None of these
9. (3) Paging

10. If the page size for 2 MB memory is 2 kB, then the number of higher order bits on address bus, used to denote page number is _____
    (1) 11 (2) 10 (3) 9 (4) 8
10. (2) 10

11. Wastage of memory space within the partition is called as _____
    (1) Internal fragmentation (2) External fragmentation
    (3) Compaction (4) None of these
11. (1) Internal fragmentation

12. If a page is modified after it is loaded in main memory, then it is called as _____
    (1) Page fault (2) Dirty page
    (3) Paging (4) Locality of reference
12. (2) Dirty page

13. Pages are physical in nature, while segments are_____
    (1) logical (2) virtual
    (3) either physical or logical (4) either virtual or physical
13. (1) logical

14. Following is not a process state_____
(1) ready (2) blocked (3) resumed (4) running
14. (3) resumed

15. Windows NT is _____ operating system.
(1) Multiuser (2) Multitasking (3) Multithreading (4) All of the above
15. (4) All of the above

16. _____ is not an operating system.
(1) UNIX (2) LINUX (3) MS–DOS (4) C++
16. (4) C++

17. _____ spread more rapidly but causes less damage to computer networks.
(1) Virus (2) Worms (3) Bombs (4) None of these
17. (2) Worms

18. _____ are the operating system programs.
(1) Application program (2) User program
(3) Process management program (4) Antivirus program
18. (3) Process management program

19. _____ is given to each process so that a process does not use the CUP indefinitely.
(1) Context Switching (2) Time Slice
(3) Token Time (4) Purchased Priority
19. (2) Time Slice

20. In Information management _____ service is provided by operating system.
(1) Change the priority of process
(2) To allocate a chunk of memory to process
(3) Open a file (for read, write or both)
(4) Wait for a child process to terminate
20. (3) Open a file (for read, write or both)

21. _____ is an operating system.
(1) C++ (2) C (3) VB (4) LINUX
21. (4) LINUX

22. Scheduling Policy is the term related to _____Management of O.S.
(1) Information (2) Process (3) Device (4) Memory
22. (2) Process

23. Terminate a Process is the system call available in _____ management.
(1) Process (2) Memory (3) Information (4) File
23. (1) Process

24. _____ program is a part of operating system.
(1) Application (2) Antivirus
(3) Process Management (4) File
24. (3) Process Management

25. Data is instantly updated, in case of _____Operating System.
    (1) Batch Processing (2) Multi Programming
    (3) Multi User (4) Real Time
25. (4) Real Time

26. _____ are not operating system programs.
    (1) Process Management Programs (2) Information management Programs
    (3) Memory management Programs (4) Anti–Virus Programs
26. (4) Anti–Virus Programs

27. A program under execution, which competes for the CPU time and other resources is Called _____.
    (1) Process (2) Multi–programming
    (3) Context Switching (4) None of these
27. (1) Process

28. It the page size for 1 MB is 2 KB then the number of higher order bit of the address bus used to denote the page number is _____
    (1) 11 (2) 10 (3) 9 (4) 8
28. (3) 9

29. "Terminate a Process" is System call in _____
    (1) Information Management (2) Process Management
    (3) Memory Management (4) None of these
29. (3) Memory Management

30. If the page size of 1 MB Memory is 1 KB, then the number of higher order bits of the address bus used to denote page number is _____
    (1) 10 (2) 11 (3) 12 (4) 9
30. (1) 10

31. If the page of 4 MB Memory is 1 KB, then the number of higher order bits of the address bus used for page number is _____.
    (1) 11 (2) 21 (3) 12 (4) 22
31. (2) 21

32. _____ is a free software.
    (1) UNIX (2) DOS (3) LINUX (4) WINDOWS
32. (3) LINUX

33. The time required to more R/W head to the particular track is called _____
    (1) Latency time (2) Seek time (3) Waiting time (4) Response time
33. (2) Seek time

34. _____ is not a process state in OS.
    (1) Ready (2) Running (3) Exited (4) Blocked
34. (3) Exited

35. _____ is an Operating System.
    (1) VBSCRIPT (2) UNIX (3) C (4) BASIC
35. (2) UNIX

36. Context Switching is a term related to _____ Management.
    (1) Process (2) Memory (3) Information (4) Device
36. (1) Process

37. In memory management system, where the part of the process image is in the main memory and the other part is on the disk, is known as _____.
    (1) Segmented Memory Management System
    (2) Single Contiguous Memory Management System
    (3) Virtual Memory Management System
    (4) Combined Memory Management System
37. (3) Virtual Memory Management System

38. Turning attention of CPU from one process to another is called _____.
    (1) reference (2) Context switch
    (3) Process scheduling (4) Multiprogramming
38. (2) Context switch

39. _____ is the only operating system from the following list.
    (1) MS Point (2) Unix (3) MS Excel (4) Oracle
39. (2) Unix

40. _____ is oldest secondary storage medium.
    (1) Hard Disk (2) Magnetic Tape (3) CD-ROM (4) Floppy Disk
40. (2) Magnetic Tape

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