Introduction to Operating System

1.1 INTRODUCTION

In the early days of computer use, computers were huge machines, which were expensive to buy, run, and maintain. The user at that time interacted directly with the hardware through machine language. A software was required which could perform basic tasks, such as recognizing input from the keyboard, sending output to the display screen, keeping track of files and directories on the disk, and controlling peripheral devices such as printer and scanner. The search for such software led to the evolution of modern day *Operating System* (*OS*). This software is loaded onto the top of memory and performs all the aforesaid basic tasks, Initially, the operating system's interface was only character-based. This interface provides the user with a command prompt, and the user has to type all the commands to perform various functions. As a result, the user had to memories many commands. With the advancement in technology, operating system became even more user-friendly by providing graphical user interface (GUI). The GUI-based operating system allows manipulation of software by using visual objects such as windows, pull-down menus, mouse pointers, and icons. Consequently, operating the computer became easy and intuitive.

1.1.1 Operating System: Definition

An *operating system* is a collection of system programs that together controls the operation of a computer system. The operating system along with hardware, application and other system softwares, and users constitute a computer system. It is the most important part of any computer system. It acts as an intermediary between a user and the computer hardware. The operating system has two objectives. Firstly, an operating system controls the computer's hardware. The second objectives are to provide an interactive interface to the user and interpret commands so that it can communicate with the hardware.
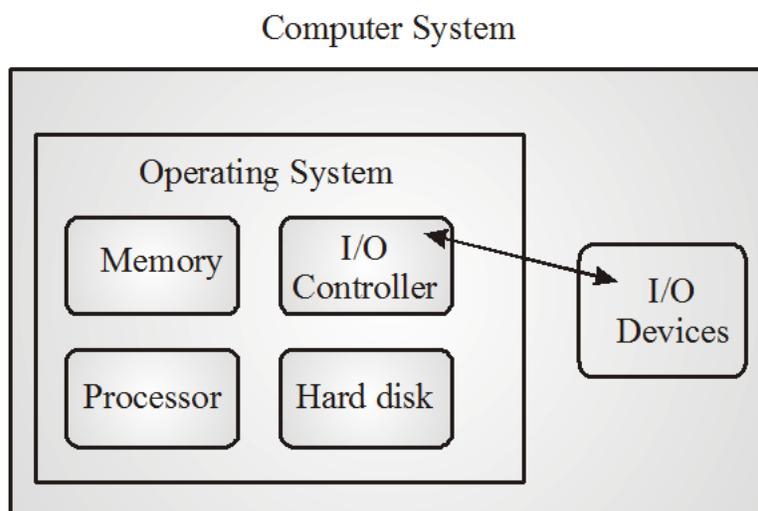

Fig. 1.1 *Managing Hardware*

1. **Managing Hardware:** The prime objective of the operating system is to manage and control the various hardware resources of a computer system. These hardware resources include processor, memory, disk space, and so on. It receives the user's input from the keyboard, and then outputs the data to the monitor. The operating system supervises which input device's data is requesting for being processed and which processed data is ready to be displayed on the output device. In addition to communicating with hardware, the operating system provides an error handling procedure and display an error notification. If a device is not functioning properly, the operating system tries to communicate with the device, it provides an error message notifying the user about the problem. Figure 1.2 illustrates how operating system manages the hardware resources of a computer system.

2. **Providing an Interface:** The operating system organizes applications so that users can easily access, use, and store them. When an application is opened, the operating system assists the application to provide the major part of the user interface. It provides a stable and consistent way for applications to deal with the hardware without the user having to know all the details of the hardware. If the program is not functioning properly, the operating system again takes control, stops the application, and displays appropriate error message.
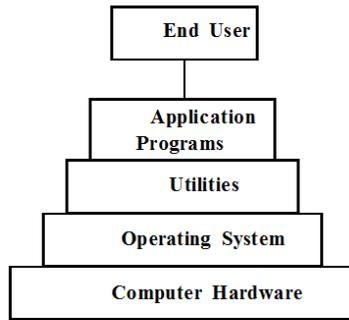
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Fig. 1.2 *Computer System Components*

An operating system (OS) is a set of computer programs that manages the hardware and software resources of a computer. It processes raw data which is given to the computer as input. It then allocates and manages the tasks of the internal system resources of the computer. It is the operating system which performs basic tasks such as controlling and allocating memory, prioritizing system requests, controlling input and output devices, facilitating networking and managing file systems.

Most operating systems come with an application that provides an interface to the operating system managed resources. These applications have had command line interpreters as a basic user interface, but more recently have been implemented as a Graphical User Interface (GUI) for ease of operation.

The operating system forms a platform for other system software and for application software. Windows, Linux, and Mac operating systems are some of the most popular Operating Systems.

The Operating System of a computer is a large program which manages the overall operation of the computer system. On a simple one-user computer the Operating System will:

1. Provide an interface to allow the user to communicate with the computer. This interface may be a text-oriented interface where the user types commands in response to a prompt from the computer or may be a mouse-driven Windows operating system.
2. Control the various peripherals e.g. Keyboard, Video Display Unit (VDU), Printer etc. using special programs called Device Drivers.
3. Manage the user's files, keeping track of their positions on disk, updating them after user makes changes to them etc. An important facility that the Operating System must supply in this respect is an **Editor** which allows users to edit their files.
4. Provide system facilities, e.g. **Compilers** to translate from high-level programming languages used by the user to the internal machine language the computer uses.

1.2 OPERATING SYSTEM AS COMPUTER CONTROLLER

A computer system can be divided into four components; the hardware, the operating system, the application programs and the user. Operating systems are found on almost any device that contains a computer from cellular phones and video games to supercomputers and web servers. Some of the commonly used operating systems are Microsoft Windows, Solaris, Mac, Red Hat Linux etc.

In the early days, the computers lacked any form of operating system. The user would arrive at the machine armed with his program and data, often on punched paper tape. The program would be loaded into the machine, and the machine set to work. Then came machine with machines with libraries of support code (initial operating systems), which were linked to the user's program to assist in operations such as input and output. At this stage, operating systems were very diverse, with each vendor producing one or more operating system specific to its particular hardware. Typically, every time new hardware architecture as introduced, there was a need of new operating system compatible with the new architecture. This state of affairs continued until 1960s when IBM developed the S/360 series of machines. Although there were enormous performance differences across the range, all the machines ran essentially the same operating system called S/360.

Then came the small 4 bit and 8 bit processors known as *microprocessors*. The development of microprocessors provided inexpensive computing for the small businesses. This led to the widespread use of interchangeable hardware components using a common interconnection and thus an increasing need for standardized operating system to control them. The most important of the early operating system was CP/M-80 for the 8080/8085/Z-80 microprocessors. With the development of microprocessors like 386, 486, and the Pentium series by Intel, the whole computing world got a new dimension. AT&T and Microsoft came up with character-based operating system, namely, Unix and Disk Operating System, Microsoft and Apple Macintosh came with their Windows 3.1 and MAC, which were GUI-based operating systems and well suited for the Desktop PC market. Today, operating systems such as Windows XP and Red Hat Linux have taken the driver's seat in personal desktops. These operating systems with their remarkable GUI and network support features can handle diverse hardware devices.

The placement of operting system is as follows:

(1) **Hardware:** The control processing unit, the memory and the I/O devices used to provide the basic computing resources. It consists of integrated circuit chips, wires, power supplies, cathode ray tubes (CRT) etc.
(2) **Application Programs:** Such as word processors, spread sheets, compilers and web browsers used by users to solve a particular computing problem.

(3) **Users:** Persons or human beings using various application programs on particular hardware to perform some task.

(4) **Operating System:** Controls and coordinates the use of the hardware among various application programs. The operating system provides the most basic level of control over all of the computer's hardware devices. It also manages memory access for programs during run time.

(5) **Kernel:** It is the most important component of an operating system. A kernel connects the application software to the H/W of a computer.

Operating System Components

O.S. denotes those programme modules within a computer system that governs. Control of equipment resources. The resolve conflict, attempt to optimize performance and simplicity effective use of system. It acts as a interface between user programme and physical M/C hardware. If provides many features including:

1. Define users interface.
2. Sharing the hardware among users sequential/concurrent sharing.
3. Allow users to share data among themselves.
4. Scheduling resources among users.
5. Resource Pre-emption (Resource deallocation).
6. Efficient utilization of computing resources.
7. New features in computer architecture.
8. New users requirement.
9. Facilitate input/output.
10. Recover from error.
11. Accounting resource usage.
12. Facilitate parallel operation.
13. Organise data to secure and rapid access.
14. Handling network communication.
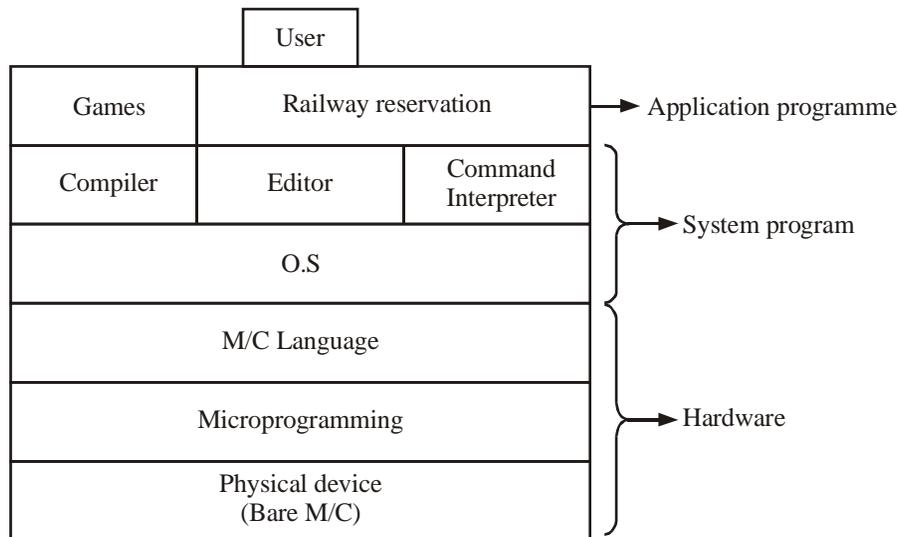
Various views of O.S.

1. Resource manager view.
2. Process view.
3. Hierarchical and extended M/C view.
4. Historical view.
5. Other view.

Resoure manager view

It is collection of programmes designed to manage the resources namely.

1. Memory
2. Processor
3. Device
4. Informations

It must perform following functions.

(i) Keeping track of resources.
(ii) Enforce policy which determines who gets what, when and how much.
(iii) Allocate the resource.
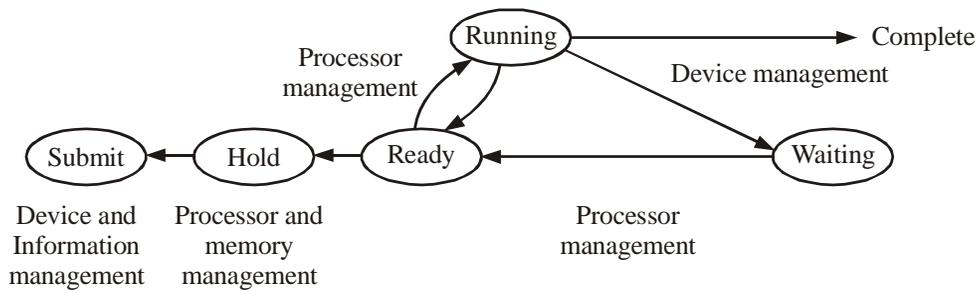(iv) Deallocate the resource.

All programmes of O.S. are grouped into four resource categories.

1. Memory mangement function
2. Processor management function

3. Device management function
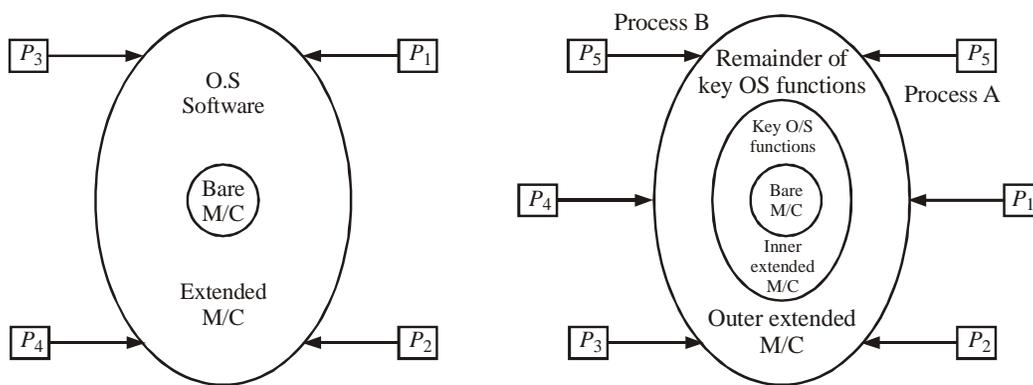4. Information management function

Process view

(where these resources are activated).

Hierarchical and Extended M/C view

(How are these resource managers called into play and where do they logically reside in required to each other)

1.3 Brief History of Computers

As we know that the humane always needs Some Changing's in the Environment in which they are working So that we can also say "Necessity is Mother of invention" because the demands of the humane are now growing and they wants to built Some Fast and calculating devices means they wants to develop the Huge Size of Computer to Small Size Computer. There are many computers developed and they also use the Different Technology in Compare to other Computers. Some Examples of Computers those have been developed are as followings:-

Note : This is also called as the Zeros Generation Computers because they uses Some Mechanical Techniques Means at that time there is no Specific Manner to Compute the Computation and at that Time the Computer just uses the Some General things For Example Wooden Frames. Wheels and also Some gears etc.

1) **ABACUS:** This Computer is developed in the China and this Computer is used for Mathematical Operations.

2) **Napier Bones:** This Computer is developed by the John Napier and this Computer contains Some Wooden boards and the small Beads those are also called as the small bolls those are used for calculation and this also uses the Strips or Some Rows for Counting.

3) **Babbage Engine:** The Charles Babbage which is also known as the Father of Computer also has made the Modern Computer which is also used for performing all the Calculations and the Computer was developed in the Cambridge University. And he was the Professor of Mathematics.

4) **First Computer Programmer (Lady Augusta ADA): The** First Lady or First Computer Programmer which Translate the Computer Language of Babbage into the English form.

5) **ENIAC:-** The Electrical Numerical Integrator and Calculator Machine , is the name if First Generation Computer which uses the Vacuum Tubes which consume 20 by 40 Square Feet Large Room For Operating. And this Computer was developed in the Moore School of Pennsylvania. But it operates on Limited Information and this is very difficult to detect the Errors.

6) **EDSAC:** The Electronic Delay Storage Automatic Calculator was the first Computer which is used for Storing the Instructions those are given by the user and the EDSAC Computer was used for taking input from the Tapes and also Stores the Results on the Media.

7) **UNIVAC-I:** This Computer was developed by Eckert and Mauchly in 1952 and this Computer was developed in the 1952 and this Computer was developed in the USA. And this Computer was developed for processing the Commercial Data.

8) **MARK –I** : The Mark-I Computer is also called as the Automatic Sequence Control Calculator and this Computer is designed by the Howard in the Howard University and with the Collaboration of IBM or International Business Machines. And these Machines were also used for performing the Mathematical Operations.

9) **Von Neumann :** This is the Name of Mathematician which gives the idea of Storing the data into the Computers and the idea was that Computer first Process the data and then Store into his Memory for Displaying and when a user Enters Some data then that data is Stored into some Place of Computer for Processing's

The term Generation is used which distinguish the various techniques those have already been developed.

Generation of Computers

Generations of Computer Specifies the Changing's those Comes Time By Time. Or we can say Generations Refers to the Changes those are occurred in the Technology of the Computers. The Generations also Specifies the Changing's those are made by modifying the Previous Systems. All the Generations of the Computer are Classified into the Five Categories those are as followings:-

1) **First Generation:** The First Generation Computers are developed in 1947 and those Computers are used up to 1955. The Computers of First Generations use the Vacuum tubes these tubes are Made up of Glass .and these Computers just perform the Addition and Multiplication of Numbers and these Computers consumes lots of power and these Computers generates lots of heat. Because there are 18,000 vacuum tubes those are used in these Computers. So that they are also big in Size and Consumes lots of Power of Lights and they have only the Limited Operations that they can Performed. And these Computers are also known as the ENIAC or Electronic Numerical Integrator and Calculator Computers. And they are used for just Performing the two Operations first Sum and second the Multiplication. And For Addition they uses the 200 microseconds and 2000 micros seconds will be used for Performing the Product on Two Numbers. But those Computers are Not Used many Times because the Size of those computers is very large and those Computers Consumes a Large Size Room. The Main advantage and disadvantages of the First generation Computers are as follows-

   Advantages of First Generation Computers are:

   1) Vacuum Tubes are used for Storage and Calculations.

   2) The Concept of Stored Programs has been developed.

   3) Perform all the Mathematical Operations like addition, Multiplication, Subtraction etc. at a high speed and they were the fast calculating machines at that time.

   Limitations of First Generations computers are:

   1) They have a Huge Size, they consumes a Large Room to setup.

   2) Near About 18,000 Vacuum tubes were used for Computations.

   3) Have a Great Possibility of failure.

   4) Maintenance Cost of those Computers was very high.

2) **Second Generation(1955-65) Transistors and Batch Systems:** The Second Generations Computers are designed in the 1951 and in the Second Generation, The Technology of the Computers has changed and they use transistors instead of Vacuum tubes. The Transistors are made up of silicon Materials or aluminum. The Mai Advantage of these dives is that they have the smaller size in compare to the other devices but these devices so cheaper and they consume small amount of Space and Heat in Compares to the Vacuum tubes.
So that the Size of those Computers becomes less and reduces in compare to the First Generation Computer.

Advantages of Second Generation Computers are

1)   Have the Greater Speed.

2)   Consume Less Electricity and Less heat Generated.

3)   Small size in Compare to First Generation.

4)   Better Portability.

5)   Takes Milliseconds instead of microseconds.

6)   Less Chances of Hardware Failure.

Limitation of Second Generation Computers:-

1)   For Placing Many Vacuum Tubes Some Special Unit is required.

2)   Chances of Damage are more because Many Vacuum Tubes are placed on the Single Chip.

3)   Maintenance required for performing day to day Activities.

3) **Third Generation Computers (1965-1980) Integrated Circuits & Multiprogramming :** The Third Generation Computers are designed in the 1965 and the technology also has been changed from transistors to Resisters. There are Many Transistors those are integrated into the Single Chip which is also known as the Registers and there are Many Registers those are placed onto the Single Motherboard. There are Many Circuit Elements those are integrated into the Single Chip which are also known as the ICs. And thousands of Transistors are placed on the Single Chip which is also known as the IC chip or Small Scale Integration Chip.

Advantages of Third Generation Computers:-

1) Less Amount of heat has generated.

2) Cost of Maintenance is Lowe in Compare to the first and second generation Computers.

3) Smaller in the Size and have More Reliability.

4) These Computers can perform many Operations.

5) They are used for general Purpose. And they are also used in all Types of Works.

6) They have more speed and they consume less Amount of Heat and they have the more Operating Speed.

7) Have a Large Memory Area for Storing the Data and Results after the Processing.

Limitation of Third Generation Computers:-

1) Require Some Advanced Techniques to develop these types of Computers.

2) Requires also some Controls those are also called as the Temperature Control. As there are Many Enhancements performed into the Technique so that this will also leads to the increasing the Cost of Purchasing.

3) Requires highly Maintenance.

4) ***Fourth Generation Computers (1980-Present) Microprocessors.*** The Fourth generation Computers were brings the new Technology and them also uses the Chips but the Integration of Circuits were high Means now it is Possible to Integrate the 30,000 Circuits on the Single Chip. That was also called as the Small Scale Integration but with the advent of fourth generation Computers it is Possible to integrate the 10,000, 0000, 000 Circuits of Registers on the Single Chip. And this Technology is also called as the LSI or Large Scale integration. The Size of the Computers now has reduced and the Speed of Processing is also high. And these Computers bring the Revolution in the Technology of the Computers. And they have also called as high Speed calculation Machines.

Advantages of the Fourth Generation Computers are:

1) They have the Reduced Size in Compare to the other Computers.

2) They have designed for the General Purpose Works.

3) The Chances of Failure are now few.

4) The Speed of Production is high and they have More Processing Power in compare to the Other Generation Computers.

5) The Cost of these Computers is also less in compare to the Other Computers.

Limitations of Fourth Generation Computers are:

1) They Have designed for the All the General Purposes and they requires higher Maintenance for Processing.

5) **The Fifth Generation Computers (Present and Beyond) Artificial Intelligence**

Fifth generation computing devices, based on artificial intelligence, are still in development, though there are some applications, such as voice recognition, that are being used today. The use of parallel processing and superconductors is helping to make artificial intelligence a reality. Quantum computation and molecular and nanotechnology will radically change the face of computers in years to come. The goal of fifth-generation computing is to develop devices that respond to natural language input and are capable of learning and self-organization.

As we know Computers never think like a Human. But the Computers just perform all the Instructions one by one. And the Computers have lack of imagination and they have lack of logics. So that the Computers those will think and see like humans are going to be developed. So that the Fifth Generation Computers are going to be Developed but they are not already developed. The Fifth Generation Computers have KIPS means Knowledge information Processing System means they will also give us the Information after the Processing means they will also give us some information after Processing. And they will also call as the data or logic information processing System.

Concept of Computer Languages:

For Performing Operations on the Machines we use Some Programs those are also called as the Software's. And there are various types of Software those are used for performing the Activities and the Software's are made by using Some Computer Languages those are also called as the Programming Languages.

Software: The Software are the non-Touchable Parts those are used for Performing the Operations and a user can't touch them he just use them for Processing. And the Software's are also known as the Collections of the instructions, and the Software's are also called as the Application and System Software's.

Application Software's: The Application Software's are those which are used for making an Application or they are used for Preparing any Document For Example Paint is used for Making Some Pictures and the Ms Word is Used for Making Documents. So that Application Software's are used for Making or Designing the Special Applications. Some Examples of Application Software's are as below:-

1) **Word Processor:** Which is also known as Ms-Word or any Processor which Process the data which is written by the user. And the Word Processors are used for Changing the Size of the Text, Colors of the Text and also changing the Alignment of text.

2) **Spread Sheet:** Generally known as Ms-Excel which is used for storing the data of the user into the form of Rows and Columns.

3) **Database Software's:** Used for storing the data of the user in the Form of Tables.

4) **Graphics Packages:** used for making some Models and Design before processing and they are used for Making Some Design Objects.

5) **Anti-virus Software's:** These Software's are used for protecting the Computer Systems from the Virus. And the Anti-virus Software's is used for removing the unwanted data from the Computer Systems.

System Software': The System Software's are those which are used for Operating Other Application Software's. Means if we wants to use any Application Software then this is must that our Computer Must have a System Software For Example Windows. The Windows are also called as the System Software because if our Computer contains a window then we can run.

1.4 FEATURES OF OPERATING SYSTEMS

- general features of an operating system
  - ➢ convenient input/output operations: GUI, printers, disks etc
  - ➢ Fault monitoring – error handling – e.g. on user programs
    - ◆ nobody is perfect
  - ➢ multi-access (multi-user)
    - ◆ allowing several people to use the computer simultaneously
    - ◆ more convenient for users
    - ◆ sharing optimizes usage of resources
    - ◆ sharing of resources done in a controlled and safe manner
  - ➢ file systems
    - ◆ operating system provides a means for users to store/retrieve their information in an orderly manner
    - ◆ directories and files
    - ◆ security of user files
- operating systems used on almost all computers: PCs, mainframes, workstations, servers etc
- most work is now done on PCs and workstations
- look at common examples of operating systems
- DOS

- ◆ Disk Operating System
- ◆ only really provides a files system – as name implies
- ◆ virtually no resource protection
- ◆ no multi-tasking
- ◆ little fault monitoring
- ◆ little convenience in input/output
- ◆ no built-in networking

1.5 FUNCTIONS OF OPERATING SYSTEM

The main functions of the operating system are as follows:

1. **Process Management:** As a process manager, the operating system handles the creation and deletion of processes, suspension and resumption of processes, and scheduling and synchronization of processes.
2. **Memory Management:** As a memory manager, the operating system handles allocation and deallocation of memory space as required by various programs.
3. **File Management:** The operating system is responsible for creation and deletion of files and directories. It also takes care of other file-related activities such as organizing, storing, retrieving, naming, and protecting the files.
4. **Device Management:** Operating system provides input/output subsystem between process and device driver. It handles the device caches, buffers, and interrupts. Operating system also detects device failures and notifies the same to the user.
5. **Security Management:** The operating system protects system resources and information against destruction and unauthorized use.
6. **User Interface:** Operating system provides the interface between the user and the hardware. The user interface is the layer that actually interacts with the computer operator. The interface consists of a set of commands or menus through which a user communicates with a program.

1.6 CHARACTERISTICS OF AN OPERATING SYSTEM

Characteristics of an Operating System can be discussed under the following heads.

1.6.1 Process Management

If more than one program is executing at the same time on the computer, then it is the responsibility of the operating system to allocate CPU and other resources to these programs in turns, so that they can execute properly. At the same time, the OS has keep a track of all these programs and ensure that the execution of one of them does not tamper with that of the other processes.The Processor Management function of operation is related with allocation of process or job to processor. The speed of processor or CPU is much faster than peripheral devices. Every process is completed only after its processor and I/O requries. Since the speed of CPU is much faster I/O devices, the scheduling is done in such a way that CPU remains idle for minimum amout of time. When a process waits for I/O to be completed, during that wait time, the CPU may be allocated to other process waiting for processor. There exists several scheduling techniques which maximizes CPU utilization

Every program running on a computer, be it background services or applications, is a process. As long as it is used to build computers, only one process per CPU can be run at a time. Older microcomputer operating systems such as MS-DOS did not attempt to bypass this limit, with the exception of interrupt processing, and only one process could be run under them (although DOS itself featured TSR as a very partial and not too easy to use solution).

Mainframe operating systems had multitasking capabilities since the early 1960s. Modern operating systems enable concurrent execution of many processes at once via multitasking even with one CPU. Process management is an operating system's way of dealing with running multiple processes. Since most computers contain one processor with one core, multitasking is done by simply switching processes quickly. Depending on the operating system, as more processes run, either each time slice will become smaller or there will be a longer delay before each process is given a chance to run.

Modern operating systems enable concurrent execution of many processes at once via multitasking even with one CPU.

Process management involves computing and distributing CPU time as well as other resources. Most operating systems allow a process to be assigned a priority which affects its allocation of CPU time. Interactive operating systems also employ some level of feedback in which the task, with which the user is working, receives higher priority. Interrupt driven processes will normally run at a very high priority. In many systems there is a background process, such as the System Idle Process in Windows, which will run when no other process is waiting for the CPU.

1.6.2 Memory Management

The memory management function finds all available free space in memory and allocates it to the processes. The process is program/task under execution state. The Operating System manages whole memory by dividing it into several blocks and partitions. Every job under execution stage requires memory. If there exists two or more than two processes, then Operating System allocates the memory segments as per requirement of the job. In case any job execution has to be suspended or it has been terminated, the Operating System combines the memory freed by the process and allocates the memory to other process. The Operating System therefore decides which process gets memory, when and how much and allocates the memory when that process requests it. It finally frees the allocated memory space as and when the process is executed completely. Memory Management is the important function carried out by Operation System. It is also the responsibility of the Operating System that memory be allocated in such a way that the utilization is maximum. The OS has to allocate the main memory and other storage areas to the various programs appropriately

Current computer architectures arrange the computer's memory in a hierarchical manner, starting from the fastest registers, CPU cache, random access memory and disk storage. An operating system's memory manager coordinates the use of these various types of memory by tracking which one is available, which is to be allocated or de-allocated and how to move data between them. This activity, usually referred to as virtual memory management, increases the amount of memory available for each process by making the disk storage seem like main memory.

There is a speed penalty associated with using disks or other slower storage as memory – if running processes require significantly more RAM than is available, the system may start thrashing. This can happen either because one process requires a large amount of RAM or because two or more processes compete for a larger amount of memory than is available. This then leads to constant transfer of each process's data to slower storage.

An operating system's memory manager coordinates the use of these various types of memory by tracking which one is available.

Another important part of memory management is managing virtual addresses. If multiple processes are in memory at once, they must be prevented from interfering with each other's memory (unless there is an explicit request to utilise shared memory). This is achieved by having separate address spaces.

Each process sees the whole virtual address space, typically from address 0 up to the maximum size of virtual memory, as uniquely assigned to it. The operating system maintains a page table that matches virtual addresses to physical addresses. These memory allocations are tracked so that when a process terminates, all memory used by that process can be made available for other processes.

The operating system can also write inactive memory pages to secondary storage. This process is called "**paging**" or "**swapping**" – the terminology varies between operating systems. It is also typical for operating systems to employ otherwise unused physical memory as a page cache; requests for data from a slower device can be retained in memory to improve performance.

The operating system can also pre-load the in-memory cache with data that may be requested by the user in the near future; SuperFetch is an example of this.

1.6.3 Disk and File Systems

The OS manage the storage and retrieval of disk files. It also helps in the copy/movement of files from one disk to another.The file management of Operating System is related with management of files stored onto secondary storage. The file is considered as collection of logically related data item which are organized in records. These files may contain set of commands, executable codes or reports. Purpose of file management is to hide the complex details of device specific aspects from the user. Users wish to rely on a uniform set of file manipulation services which are independent of details of devices from user's perspective. File Management of Operating System keeps track of all information on files. It finds and records the following for all files: location, size usage (attribute), status etc. It also finds as to which process which file is required, checks through the protection routine, opens the file if allowed, and allocates it to the process. It essentially does the task of mapping the request of the file from process to physical disk, swapping the file contents between primary and secondary memory, keeping track of allocation and de-allocation of space and support for protection and sharing

All operating systems include support for a variety of file systems. Modern file systems comprise a hierarchy of directories. While the idea is conceptually similar across all general-purpose file systems, some differences in implementation exist. Two noticeable examples of this are the character used to separate directories, and case sensitivity.

Unix demarcates its path components with a slash (/), a convention followed by operating systems that emulated it or at least its concept of hierarchical directories, such as Linux, Amiga OS and Mac OS X. MS-DOS also emulated this feature, but had already also adopted the CP/M convention of using slashes for additional options to commands, so instead used the backslash (\) as its component separator. Microsoft Windows continues with this convention; Japanese editions of Windows use ¥, and Korean editions use ©.

Unix and Unix-like operating allow for any character in file names other than the slash, and names are case sensitive. Microsoft Windows file names are not case sensitive. File systems may provide journaling, which provides safe recovery in the event of a system crash. A journaled file system writes information twice: first to the journal, which is a log of file system operations, then to its proper place in the ordinary file system.

In the event of a crash, the system can recover to a consistent state by replaying a portion of the journal. In contrast, non-journaled file systems typically need to be examined in their entirety by a utility such as fsck or chkdsk. Soft updates is an alternative to journalling that avoids the redundant writes by carefully ordering the update operations. Log-structured file systems and ZFS also differ from traditional journaled file systems, in that they avoid inconsistencies by always writing new copies of the data, eschewing in-place updates.

A journaled file system writes information twice: first to the journal, which is a log of file system operations, then to its proper place in the ordinary file system.

Many Linux distributions support some or all of ext2, ext3, ReiserFS, Reiser4, GFS, GFS2, OCFS, OCFS2, and NILFS. Linux also has full support for XFS and JFS, along with the FAT file systems, and NTFS. Microsoft Windows includes support for FAT12, FAT16, FAT32, and NTFS. The NTFS file system is the most efficient and reliable of the four Windows file systems, and as of Windows Vista, is the only file system which the operating system can be installed on. Windows Embedded CE 6.0 introduced ExFAT, a file system suitable for flash drives.

Common to all these (and other) operating systems is support for file systems typically found on removable media. FAT12 is the file system most commonly found on floppy discs. ISO 9660 and Universal Disk Format are two common formats that target Compact Discs and DVDs, respectively. Mount Rainier is a newer extension to UDF supported by Linux 2.6 kernels and Windows-Vista that facilitates rewriting to DVDs in the same fashion as what has been possible with floppy disks.

1.6.4 Networking

Most current operating systems are capable of using the TCP/IP networking protocols. This means that one system can appear on a network of the other and share resources such as files, printers, and scanners using either wired or wireless connections. Many operating systems also support one or more vendor-specific legacy networking protocols as well, for example, SNA on IBM systems, DECnet on systems from Digital Equipment Corporation, and Microsoft-specific protocols on Windows. Specific protocols for specific tasks may also be supported such as NFS for file access.

1.6.5 Security

Security in terms of a computer system covers every aspect of its protection in case of a catastrophic event, corruption of data, loss of confidentiality, and so on. Security requires not only ample protection within the system, but from the external variables also, in which the system operates. In this section, we will be covering security in terms of internal protection, which is one of the most important functions of the operating system. This involves protecting information residing in the system from unauthorised access. Various security techniques employed by the operating system to secure the information are user authentication and backup of data.

User Authentication: The process of authentication users can be based on a user's possession like a key or card, user information like the username and password, anduser attributes like fingerprint and signature. Apart from these techniques, user information is often the first and most significant line of defence in a multi-user system. After the user identifies himself by a username, he is prompted for a password. If the password supplied by the user matches the password stored in the system, the system authenticates the user and gives him access to the system. A password can also be associated with other resources (files, directories, and so on), which when requested upon prompts the user for password Unfortunately, passwords can often be guessed, illegally transferred or exposed. To avoid such situations, a user should keep the following points in mind:

- Password should be at least six characters in length.
- The system should keep track of any event about any attempt to break the password.
- The system should allow limited number of attempts for submitting a password on a particular system.
- Password based on dictionary words should be discouraged by the system. Alphanumeric passwords, such as *PASS011*, should be used.

Backup of Data: No matter what kind of information a system contains, backup of data is of most importance to its users. Backup or archiving is an important issue for user and especially for business organizations. Typically, a computer system uses hard drives for online data storage. These drives may sometimes fail, or can be damaged in case of catastrophic event, so care must be taken to ensure that the data is not lost. To ensure this, operating system should provide a feature of backing of data, say from a disk to another storage device such as a floppy disk or an optical disk. The purpose of keeping backups is to restore individual files or complete files or complete file system. Recovery from the loss of an individual file, or of an entire disk, may be done from backup. Operating system usually provides some system software that is used for taking backups of the data.

Many operating systems include some level of security. Security is based on the two ideas that:

- The operating system provides access to a number of resources, directly or indirectly, such as files on a local disk, privileged system calls, personal information about users, and the services offered by the programs running on the system;
- The operating system is capable of distinguishing between some requesters of these resources who are authorized (allowed) to access the resource, and others who are not authorized (forbidden). While some systems may simply distinguish between "privileged" and "non-privileged", systems commonly have a form of requester identity, such as a user name. Requesters, in turn, are divided into two categories:
- *Internal security:* an already running program. On some systems, a program once it is running has no limitations, but commonly the program has an identity which it keeps and is used to check all of its requests for resources.
- *External security:* a new request from outside the computer, such as a login at a connected console or some kind of network connection. To establish identity there may be a process of authentication. Often a username must be quoted, and each username may have a password. Other methods of authentication, such as magnetic cards or biometric data, might be used instead. In some cases, especially connections from the network, resources may be accessed with no authentication at all.

In addition to the allow/disallow model of security, a system with a high level of security will also offer auditing options. These would allow tracking of requests for access to resources (such as, "who has been reading this file?").

Security of operating systems has long been a concern because of highly sensitive data held on computers, both of a commercial and military nature. The United States Government Department of Defense (DoD) created the Trusted Computer System Evaluation Criteria (TCSEC) which is a standard that sets basic requirements for assessing the effectiveness of security. This became of vital importance to operating system makers, because the TCSEC was used to evaluate, classify and select computer systems being considered for the processing, storage and retrieval of sensitive or classified information.

1.6.5.1 Internal Security

Internal security can be thought of as protecting the computer's resources from the programs concurrently running on the system. Most operating systems set programs running natively on the computer's processor, so the problem arises of how to stop these programs doing the same task and having the same privileges as the operating system (which is after all just a program too). Processors used for general purpose operating systems generally have a hardware concept of privilege. Generally less privileged programs are automatically blocked from using certain hardware instructions, such as those to read or write from external devices like disks. Instead, they have to ask the privileged program (operating system kernel) to read or write. The operating system, therefore, gets the chance to check the program's identity and allow or refuse the request.

An alternative strategy, and the only sandbox strategy available in systems that do not meet the Popek and Goldberg virtualization requirements, is the operating system not running user programs as native code, but instead either emulates a processor or provides a host for a p-code based system such as Java.

Internal security is especially relevant for multi-user systems; it allows each user of the system to have private files that the other users cannot tamper with or read. Internal security is also vital if auditing is to be of any use, since a program can potentially bypass the operating system, inclusive of bypassing auditing.

1.6.5.2 External Security

Typically an operating system offers (or hosts) various services to other network computers and users. These services are usually provided through ports or numbered access points beyond the operating systems network address. Services include offerings such as file sharing, print services, email, web sites, and file transfer protocols (FTP), most of which can have compromised security.

At the front line of security are software known as firewalls. At the operating system level, there are a number of software firewalls available. Most modern operating systems include a software firewall, which is enabled by default. A software firewall can be configured to allow or deny network traffic to or from a service or application running on the operating system.

Therefore, one can install and be running an insecure service, such as Telnet or FTP, and not have to be threatened by a security breach because the firewall would deny all traffic trying to connect to the service on that port.

1.6.6 Graphical User Interfaces

Today, most modern operating systems contain Graphical User Interfaces (GUIs, pronounced goo-eez). A few older operating systems tightly integrated the GUI to the kernel—for example, the original implementations of Microsoft Windows and Mac OS. More modern operating systems are modular, separating the graphics subsystem from the kernel (as is now done in Linux, Mac OS X, and to a limited extent in Windows).

Many operating systems allow the user to install or create any user interface they desire. The X Window System in conjunction with GNOME or KDE is a commonly found setup on most Unix and Unix derivative (BSD, Linux, Minix) systems.

Graphical user interfaces tend to evolve over time. For example, Windows has modified its user interface almost every time a new major version of Windows is released, and the Mac OS GUI changed dramatically with the introduction of Mac OS X in 2001.

1.6.7 Device Management

Device management in an operating system refers to the process of managing various devices connected to the computer. The device manager manages the hardware resources and provides an interface of hardware for application programs. A device communicates with the computer system by sending signals over a cable. The device communicates with the machine through a connection point called *port.* The communication using port is done through rigidly defined protocols, like when to send the data and when to stop. These ports are consecutively connected to a bus (a set of wires) which one or more device uses to communicate with the system. The operating system communicates with the hardware with standard software provided by the hardware vendor called *device drivers*. Device driver works as a translator between the electrical signals from the hardware and the application programs of the operating system. Drivers take data that the operating system has defined as a file and translate them into streams of bits placed in specific locations on storage devices. There are differences in the way that the driver program functions, but most of them run when the device is required, and function much the same as any other process. The operating system will frequently assign processes based on priority to drivers so that the hardware resources can be released and set free for further use.

Broadly, managing input and output is a matter of managing queues and buffers. Buffers are special storage facilities that take a stream of bits from a device like keyboard to a serial communication port. Buffers hold the bits and then release them to the CPU at a convenient rate so that the CPU can act on it. This task is important when a number of processes are running and taking up the processor's time. The operating system instructs a buffer to continue taking the input from the device. In addition, it also instructs the buffer to stop sending data back to the CPU while the process, using the input, is suspended. When the process, requiring input, is made active once again, the operating system will command the buffer to send data again. This process allows a keyboard to deal with external users at a higher speed.

A device driver is a specific type of computer software developed to allow interaction with hardware devices. Typically this constitutes an interface for communicating with the device, through the specific computer bus or communications subsystem that the hardware is connected to, providing commands to and/or receiving data from the device, and on the other end, the requisite interfaces to the operating system and software applications. It is a specialized hardware-dependent computer program which is also operating system specific that enables another program, typically an operating system or applications

software package or computer program running under the operating system kernel, to interact transparently with a hardware device, and usually provides the requisite interrupt handling necessary for any necessary asynchronous time-dependent hardware interfacing needs.

The key design goal of device drivers is abstraction. Every model of hardware (even within the same class of device) is different. Newer models are also released by manufacturers that provide more reliable or better performance and these newer models are often controlled differently. Computers and their operating systems cannot be expected to know how to control every device, both now and in the future. To solve this problem, OS essentially dictate how every type of device should be controlled. The function of the device driver is then to translate these OS mandated function calls into device specific calls. In theory a new device, which is controlled in a new manner, should function correctly if a suitable driver is available. This new driver will ensure that the device appears to operate as usual from the operating systems' point of view for any person.

1.6.8 I/O System Management

The OS performs the co-ordinate b/w the various input/output devices, such as the keyboard, mouse, screen, printer and the programs that are executing. This function of Operating System deals with allocation of devices to process. Operating System schedules the I/O devices, I/O channel to process whenever it requires. For managing the different requests arising from different processes for grant of devices, sheduling of I/O devices are done according to some strategies. In I/O scheduling, after finding the status of device, channels, a schedule is prepared to which state, which process, which device is allocated to the process.

I/O system hides the details of hardware evices from user. Only device driver knows the details of the specific device to whom it is assigned.

1.6.9 Protection System

When a computer system has multipler users and allows the concurrent execution of multiple processers, then the various processes in an operating system must be protected from one another's activities. For this purpose various meachanisms can be use dto ensure that the files, memory segments, CPU and other computer resources can be operated only by those processes that have gained the proper authorization from the operating system.

1.6.10   Command-Interpreter System

One of the most important system program for an operating system is the command interpreter, which provides an interface between the user and the operating system. User give comands which are executed by operating system (usually by system calls). The main function of command interpreter system is to get and execute the next command specified by the use.

1.7 SECURITY IN OS

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SUMMARY

1. An operating system (OS) is a set of computer programs that manage the hardware and software resources of a computer.
2. Batch processing requires that a program, its related data and relevant control commands should be submitted together, in the form of a Job.
3. A program in execution is called a Process.
4. The time-sharing interactive systems belong to the era of a large mainframe systems, that were made available to a large number of users for accessing concurrently in an interactive mode.
5. The real time systems are used in environments, where a large number of events, mostly external to the computer system, must be accepted and processed in a highly time-bound manner.
6. Different types of operating systems are optimized or geared up to serve the needs of specific environments.
7. A distributed operating system caters for a distributed environment, wherein a collection of autonomous computer systems, capable of communicating and cooperating with each other through network, are connected to each other through a LAN/WAN.
8. Any operating system should meet the following major goals: Optimize the use of computer resources so as to maximize its throughput and Create a user-friendly computing environment for accessing the computer resources.
9. Every program running on a computer, be it background services or applications, is a process.
10. Process management involves computing and distributing CPU time as well as other resources.