OVER VIEW OF OPERATING SYSTEM & MOTHER BOARD

CHAPTER 9

LEARNING OBJECTIVES

A student can understand the following in this chapter

1. Over view of Operating System and Booting
2. OS Types-Functions, Compenents, Characters
3. Working of Power supply
4. Mother Board-Types, Compenents, Functions
5. CPU Features
6. Memory-RAM, HDD

9.1 OVER VIEW OF OPERATING SYSTEM

Tim Paterson, a designer and engineer at Seattle Computer Products Company needed a way to test a new computer chip, a 16-bit Intel 8086. As a result, he wrote the QDOS -- Quick and Dirty Operating System. This is the first Operating System.

By that time, IBM (International Business Machines) manufactured a PC (Personnel Computer) using INTEL new chip 8088 and approached Bill gates to create an Operating System for their PC-XT(8088 is named as Extended Technology-XT). Rather of writing new OS, Bill gates purchased the QDOS from Tim Paterson and modified the existing QDOS and released a new Operating System called PC-DOS and then later renamed it as Micro Soft Disk Operating System and got license rights.

Microsoft turned it into **Microsoft** Disk Operating System, or MS-DOS, which they introduced on July 27, 1981, which has Character User Interface(CUI) It was developed in parallel under 3 names following the seller: PC - DOS for IBM, DR - DOS for Novell and MS-DOS for all other firms (marketed by Microsoft).

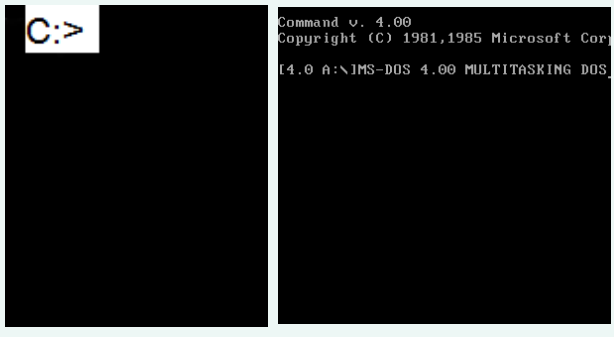

Figure 9.1: Command Prompt

After the MS-DOS is loaded into the RAM, the user will get the Command Prompt as shown in the Figure 9.1. Usually this will be called as "C" prompt. If the PC is booted with the help of floppy disk, it will show you A:> i.e., "A" prompt, whereas 'C' denotes name of Hard disk.

Out of this effort, each and every installation fetched a lot of money to Bill

gates and thus his company Micro Soft start to flourish. He introduced various versions of MS-DOS like MS-DOS 1, 2, 3, 3.1, 3.2, 4, 4.1, 6, 6.1, 6.2, etc. Among these, some versions are very powerful and compatible with all other existing software.

Around 1993, Microsoft introduced a new concept in communicating with PC's. Instead of typing the command at the command prompt, an icon can be clicked or tapped to execute the same. This concept is called Graphic User Interface (GUI). This concept is the basic root of developing Windows which becomes much user friendly nowadays.

9.2 NEED FOR OPERATING SYSTEM

Operating System has become essential to enable the users to design applications without knowing the computer's internal structure of the hardware. Operating System manages all the Software and Hardware. Most of the time, there are many different computer programmes running at the same time, they all need to access the Computers, CPU, Memory and Storage. The need of Operating System is basically - an interface between the user and the hardware, which is diagrammatically shown in Figure 9.2.

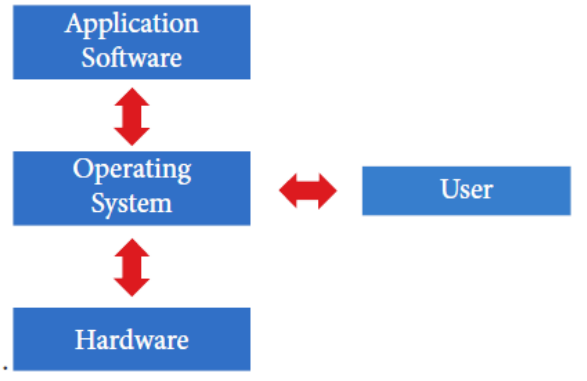

Figure 9.2: Need of Operating System

9.3. BOOTING OF OPERATING SYSTEM (COMPUTER)

An Operating system (OS) is a basic software that makes the computer to work. When a computer is switched on, there is no information in its RAM. At the same time, in ROM, the pre-written program called POST (Power on Self-Test) will be executed first. This program checks the conditions of the devices like RAM, keyboard, etc., for proper functioning and their readiness for operation. If these devices are ready, then the BIOS (Basic Input Output System) gets executed. This process is called Booting. Thereafter, a program called "Bootstrap Loader" transfers OS from hard disk into main memory. Now, the OS gets loaded (Windows/Linux, etc.,) and will get executed. Booting process is of two types as shown in Figure 9.3.

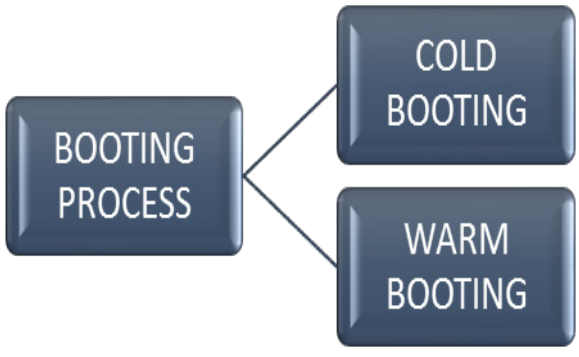

Figure 9.3 : Two types of Booting process

9.3.1. Cold Booting

When the system starts from initial state i.e. it is switched on, we call it cold booting or Hard Booting. When the user presses the Power button, the instructions are read from the ROM to initiate the booting process.

9.3.2. Warm Booting:

When the system restarts or when Reset button is pressed, we call it Warm Booting or Soft Booting. The system does not start

from initial state and so all diagnostic tests need not be carried out in this case. There are chances of data loss and system damage as the data might not have been stored properly.

9.4. TYPES OF OPERATING SYSTEM BASED ON PROCESS CAPABILITY

Operating System can be classified into the following types depending on their processing capabilities.

9.4.1. Single User Operating System

An operating system allows only a single user to perform a task at a time. It is called as a Single user and single Task operating system. For a user, a task is a function such as printing a document, writing a file to disk, editing a file or downloading a file etc. MS-DOS is an example for a single user and single task Operating System.

Initially, Windows was also served as single user system upto the version Windows 98. Really, windows executed its GUI by keeping DOS at its back ground. Windows introduced new product in the Millennium year, called Windows-NT, which has the advantage of sharing one system with other through NT (LAN Cabling).

- MS-DOS - an operating system without a graphical user interface. Windows was an application that allowed you to interact with MS-DOS through a graphical user interface.
- Windows NT - an operating system with its own graphical user interface. So, it does not need an additional application to provide said graphical user interface.

9.4.2. Multi-User Operating System

It is used in computers and laptops that allow same data and applications to be accessed by multiple users at the same time. The users can also communicate with each other (see Figure 9.4).

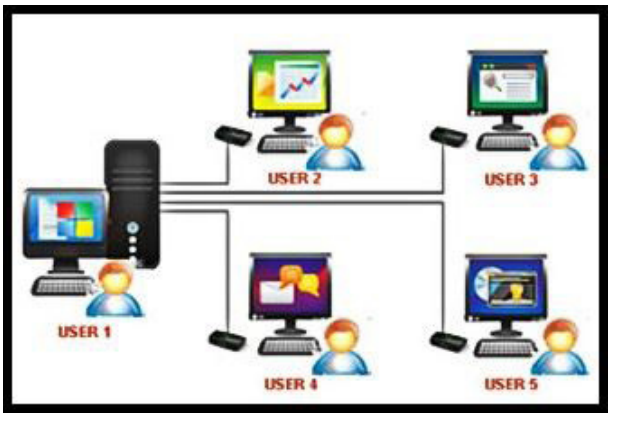

Figure 9.4 : Multi user

But, when we are talking about multi-user system, let us remember the UNIX and LINUX Operating Systems, which are dedicated multi-user operating system. Windows NT, Windows XP, Vista, Linux, UNIX and the present Windows-10 are also multi-user and multi-tasking Operating System.

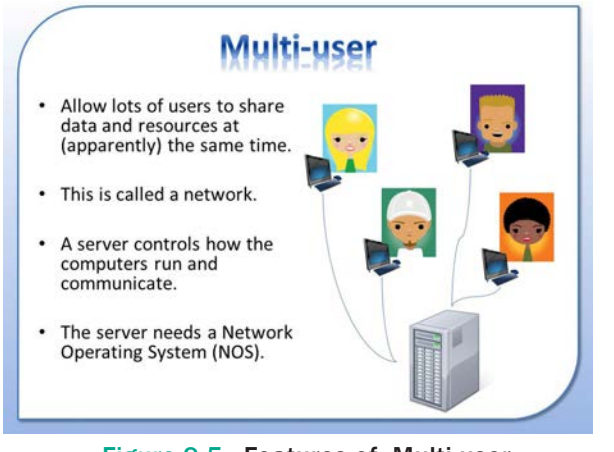

Figure 9.5: Features of Multi-user

Figure 9.5. clearly shows the features of the multi-user operating system.

9.5. FUNCTIONS / KEY FEATURES OF OPERATING SYSTEM

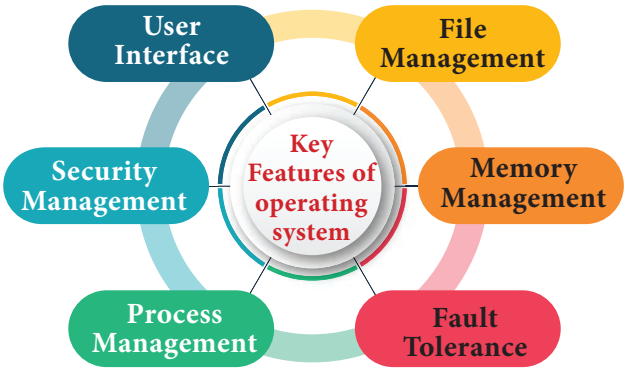

Figure 9.6 : Key features of Operating System

Figure 9.6 shows the various key features of Operating System and are summarized as follows:

- User Interface
- Memory Management
- File Management
- Process Management
- Security Management
- Fault Tolerance
- Multi processing
- Time sharing
- Distributed operating system

9.5.1. User Interface (UI)

User interface is one of the significant features in Operating System and the only way the user can make interaction with a computer. If the computer interface is not user-friendly, the user slowly reduces the computer usage from their normal life.

This is the main reason for the key success of GUI (Graphical User Interface) based Operating System. The GUI is a window-based system with a pointing device to direct I/O, choose from menus, make the selections, and a keyboard to enter text. Every feature is in vibrant colours to attract the users very easily. Beginners are impressed by the help and pop up window message boxes. Icons are playing vital role of the particular application. Now, Linux distribution is also available as GUI based Operating System.

9.5.2. Memory Management

Memory Management is the process of controlling and coordinating computer's main memory and assigning memory block (space) to various running programs to optimize overall computer performance. The memory management involves the allocation of specific memory blocks to individual programs based on user demands. At the application level, memory management ensures the availability of adequate memory for each running program at all times.

The objective of Memory Management process is to improve both the utilization of the CPU and the speed of the computer's response to its users via main memory. For these reasons the computers must keep several programs in main memory that associates with many different Memory Management schemes.

The Operating System is responsible for the following activities in connection with memory management:

- Keeping track of the portions of memory is currently being used by the respective user.
- Determining the processes (or parts of processes) and data to move in and out of memory.
- Allocation and de-allocation of memory blocks as needed by the program in main memory. (Garbage Collection)

9.5.3. Process management

Process management is a function that includes in creating and deleting the processes and providing mechanisms for processes to communicate and synchronize with each other. A process is the unit of work (program) in a computer. A word-processing program being run by an individual user on a computer is a process. A system task, such as sending output to a printer or screen, can also be called as a Process. Computers consist of a collection of processes and are classified as two categories:

- Operating System processes, which are executed by system code
- User Processes, which are execute by user code

All these processes can potentially execute concurrently on a single CPU. A process needs certain resources including CPU time, memory, files and I/O devices to finish its task. The Operating System is responsible for the activities associated with the process management such as, Scheduling processes and threads on the CPUs.

9.5.4. Security Management

The major challenge in computer and software industry is to protect user's legitimate data from hackers. The Operating System provides three levels of securities to the user end. They are

1. File access level
2. System level
3. Network level

In order to access the files created by other users, one should have the access permission. Permissions can either be granted by the creator of the file or by the administrator of the system. System level security is offered by the password in a multi-user environment. Both windows and Linux offer the password facility. Network security is an indefinable one. So, people from all over the world try to provide such a security. All the above levels of security features are provided only by the Operating System.

9.5.5. Fault Tolerance

The Operating Systems should be robust. When there is a fault, the Operating System should not crash, instead the Operating System have fault tolerance capabilities and retain the existing state of system.

9.5.6. File Management

File management is an important function of OS, which handles the data storage techniques. The operating System manages the files, folders and directory systems on a computer. Any type of data in a computer is stored in the form of files and directories /folders through File Allocation Table (FAT). The FAT stores general information about files like filename, type (text or binary), size, starting address and access mode (sequential/indexed/indexed-sequential/direct/relative). The file manager of the operating system helps to create, edit, copy, allocate memory to the files and also updates the FAT. The OS also takes care of the files that are opened with proper access rights to read or edit them. There are few other file management techniques available like Next Generation File System (NTFS) and ext2(Linux).

9.5.7. Multi-Processing

This is a one of the features of Operating System. It has two or more processors for a single running process (job). Processing takes place in parallel (simultaneously) is known as parallel processing. Each processor works on different parts of the same task or on two or more different tasks. Since the execution takes place in parallel, this feature is used for high speed execution which increases the power of computing.

9.5.8. Time-sharing

This is a one of the features of Operating Systems. It allows execution of multiple tasks or processes concurrently. For each task, a fixed time is allocated. This division of time is called Time- sharing. The processor switches rapidly between various processes after a time is elapsed or the process is completed. For example, assume that there are three processes called P1, P2, P3 and time allocated for each process 30, 40, 50 minutes respectively. If the process P1 completes within 20 minutes, then processor takes the next process P2 for the execution. If the process P2 could not complete within 40 minutes, then the current process P2 will be paused and switch over to the next process P3.

9.5.9. Distributed Operating Systems

This feature takes care of the data and application that are stored and processed on multiple physical locations across the world over the digital network (internet/intranet). The Distributed Operating System is used to access shared data and files that reside in any machine around the world. The user can handle the data from different locations as shown in Figure 9.7. The users can access as such, if it is available on their own computer. The advantages of distributed Operating System are as follows:

- A user at one location can make use of all the resources available at another location over the network.
- Many computer resources can be added easily in the network.
- Improves the interaction with the customers and clients.
- Reduces the load on the host computer.

Figure 9.7 : Distributed Operating Systems

9.6. PROMINENT OPERATING SYSTEMS

Prominent OS are as follows:

- UNIX
- Microsoft Windows
- Linux
- iOS
- Android

Modern operating systems use a Graphical User Interface (GUI). A GUI lets the user to click icons, buttons, menus and everything, which are clearly displayed on the screen using a combination of graphics and text elements. OS can be either proprietary with a commercial license or can be open source. Each Operating System's GUI has a different look and feel,

so if the user wants to switch over a different Operating System, it may seem unfamiliar at first. However, modern Operating Systems are designed to be ease of use and most of the basic principles are the same. Figure 9.8 shows some of the Operating System.

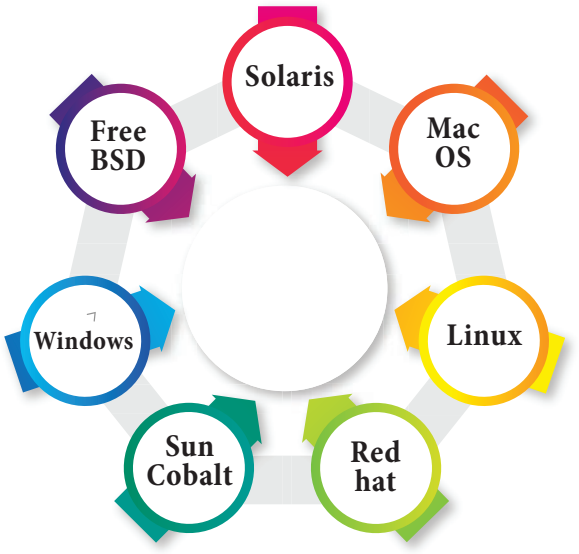

Figure 9.8: Various Operating Systems

Figure 9.9 shows the Operating System companies, which holds Proprietary Licence or open source free licence for their Operating.

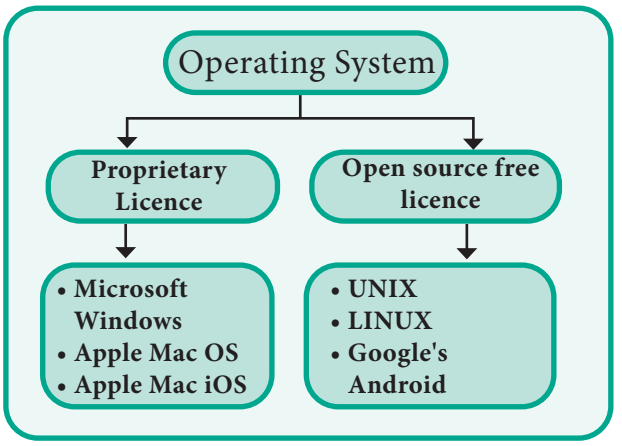

Figure 9.9 : License/Open Source Operating Systems

9.6.1. UNIX

UNIX is a family of multitasking, multi-user operating systems that derive originally from AT&T Bell Labs, where the development began in the 1970s by Ken Thompson and Dennis Ritchie.

9.6.2. Linux

Linux is a family of open-source operating systems. It can be modified and distributed by anyone around the world. This is different from proprietary software like Windows, which can only be modified by the company that owns it. The main advantage of Linux operating system is that it is open source. There are many versions and their updates. Most of the servers run on Linux because it is easy to customize. Figure 9.10 shows Ubuntu Linux Opening Screen.

Figure 9.10 Ubuntu Linux Opening Screen

There are a few different distributions of Linux, like Ubuntu, Mint, Fedora, RedHat, Debian, Google's Android, Chrome OS, and Chromium OS as shown in Figure 9.11, which are popular among users.

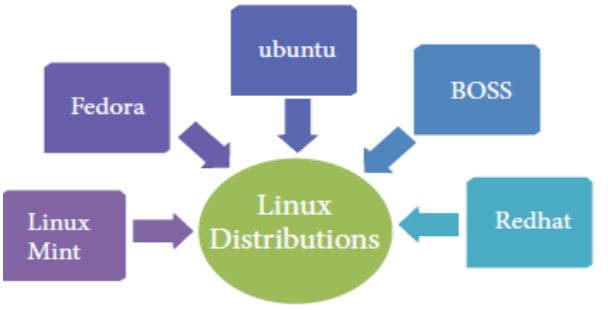

Figure 9.11 Linux Distributions

The Linux operating system was originated in 1991, as a project of "Linus Torvalds" from a university student of Finland. He posted information about his

project on a news group for computer students and programmers. He received support and assistance from a large pool of volunteers, who succeeded in creating a complete and functional Operating System. Linux is similar to the UNIX operating system.

9.6.3. Microsoft Windows

Microsoft Windows is a family of proprietary operating systems designed by Microsoft Corporation and primarily targeted to Intel and AMD architecture-based computers. Figures 9.12 show the Windows basic screens.

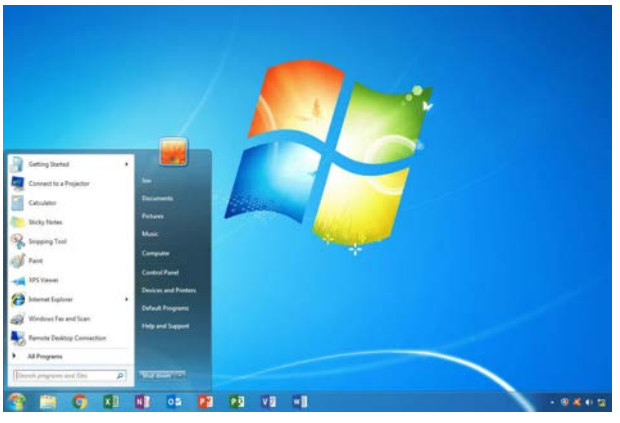

Figure 9.12 : Windows Screen

9.6.4. Macintosh – Operating System (Mac OS)

The Macintosh Operating System (Mac OS) is an operating system (OS) designed by Apple Inc. to be installed and operated on the Apple Macintosh series of computers. Introduced in 1984, it is the first Graphical User Interface (GUI) based OS that has been released as multiple different versions.

9.6.5. Android

Android OS is a linux based mobile OS that primarily runs on smart phones and tablets. Android was released under Apache V2 open source license. This allows for many variation of OS to be developed for other devices such gaming consoles and digital cameras.

9.7. COMPONENTS OF OPERATING SYSTEM

9.7.1. Device Driver

In computing, a device driver is a computer program that operates or controls a particular type of device that is attached to a computer. A driver provides a software interface to hardware devices, enabling operating systems and other computer programs to access hardware functions without needing to know precise details about the hardware being used.

A driver communicates with the device through the computer bus or communications subsystem to which the hardware is connected. When a calling program invokes a routine in the driver, the driver issues commands to the device. Once the device sends data back to the driver, the driver may invoke routines in the original calling program.

Drivers are hardware dependent and operating-system-specific. They usually provide the interrupt handling required for any necessary asynchronous time-dependent hardware interface.

9.7.2. Kernel

The kernel is the core of an operating system. It is the software responsible for running programs and providing secure access to the machines hardware.

A kernel is the most fundamental component of a computer operating system. A comparison of system kernels can provide insight into the design and architectural choices made by the developers of particular operating systems.

The Linux kernel developed by contributors worldwide is a free and open-source, monolithic, modular (i.e., it supports the insertion and removal at runtime of loadable kernel objects), Unix-like operating system kernel.

9.7.3. Shell

In computing, a shell is a user interface for access to an operating system's services. In general, operating system shells use either a command-line interface (CLI) or graphical user interface (GUI), depending on the computer's role and particular operation. It is named a shell because it is the outermost layer around the operating system.

Command-line shells require the user to be familiar with commands and their calling syntax to understand concepts about the shell-specific scripting language (for example, bash).

Graphical shells place a low burden on beginning computer users, and are characterized as being easy to use. Since they also come with certain disadvantages, most GUI-enabled operating systems also provide CLI shells.

9.8 CHARACTERISTICS/ FEATURES OF COMPUTER

1. **Speed:** A computer is a very fast device. The computer takes a fraction of seconds to perform any operation. The speed of computer is measured in micro seconds (10^{-3}), Milliseconds (10^{-6}), nanoseconds (10^{-9}) and even Pico seconds (10.12). A powerful computer is capable of performing about 3-4 million simple operations per second.
2. **Accuracy:** The accuracy of computer is very high and the degree of a particular computer depends upon its design. But for a particular computer, each and every calculation is performed with the same accuracy. Errors can occur in a computer but these are mainly due to human rather than technological weakness.
3. **Storage Capacity :** Computers can store data and instruction with a lot of volume and very high efficiency.

9.9 LIMITATION/DRAWBACK OF COMPUTER

1. **No I.Q. :** Computer is not a magical device. It performs only those works which man can does but the main difference is that computer can work those operations with very high speed and reliable accuracy. It has no any intelligence quality or thinking power
2. **No Feeling:** Because computer is only a machine, it has no feeling like human being. It has no brain for thinking as man can does. Man had successes to make computer memory be different inventions of technology but he couldn't make heart.
3. **Data Machine Readable :** Computer data is read by machine, meaning data obtained from the computer can be read by the computer itself.
4. It required power to operate.
5. Problem may occur due to system breakdown.

9.10. POWER SUPPLY

A power supply is an electrical & electronic device that supplies electric power to an electrical load. The primary function of a

power supply is to convert electric current from a source to the correct voltage, current, and frequency to the load.

Types of Power supply: Power supply is broadly classified into two types.

1. Unregulated Power supply
2. Regulated Power supply.

9.10.1. Unregulated Power supply

Unregulated power supply is not used widely because voltage is fluctuating in this type which may harm electronic equipments.

9.10.2. Regulated Power supply

Regulated Power supply gives constant voltage and current. So it is used in all electronic equipments presently.

Two types of Regulated power supplies are here listed below.

1. **Linear Power Supply**
2. **Switched Mode Power supply (SMPS)**

9.10.3 Linear power supply

A linear regulated power supply regulates the output voltage by dropping excess voltage in a series dissipative component. They use a moderately complex regulator circuit to achieve very low load and line regulation. Its nothing but a Regulated Power Supply.

9.10.4 Switched Mode Power Supply (SMPS)

A switched mode power supply (SMPS) is a type of power supply that uses semiconductor switching techniques, rather than standard linear methods to provide the required output voltage. The basic switching converter consists of a power switching stage and a control circuit. The main advantage of the switching power supply is greater efficiency (up to 96%) than linear regulators because the switching transistor dissipates little power when acting as a switch. Model of SMPS in Figure 9.13

Figure 9.13 : Switched Mode Power supply

9.10.5 Uninterruptible Power Supply (UPS):

An **Uninterruptible Power Supply** (UPS) is defined as an electrical and electronic equipment which can be used as an immediate power source to the connected load when there is any failure in the main input power source. Figure 9.14 shows the uninterruptible power supply.

Figure 9.14 : Uninterruptible Power Supply (UPS)

9.10.6 Printed Circuit Boards (PCB)

Printed circuit boards are used to mechanically support and electrically connect electronic components. PCB's use conductive pathways, tracks etched

from copper sheets laminated onto a non-conductive substrate that does not conduct electricity.

Types of PCB's:

PCBs are classified into three types:

1. Single layer PCB - figure 9.15(a)
2. Double layer PCB – figure 9.15(b)
3. Multilayer PCB – figure 9.15(c)

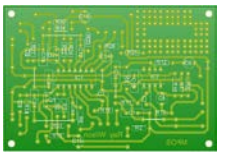

Figure 9.15 (a) : Single layer PCB

Figure 9.15 (b) : Double layer PCB

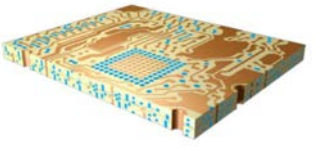

Figure 9.15(c) : Multi layer PCB

9.11. INTRODUCTION TO MOTHER BOARD

The motherboard is comprehensive in all aspects and it contains provisions to connect any kind of components to meet application requirements. The motherboard is self-sufficient to meet all requirements and it is a single board to manage all the functions, unlike backplane which has provision to connect to multiple extension boards to hold more components. The name mother in the motherboard is attributed to its character as it takes a leadership role to manage all the components connected to it.

Mouse, keypads are connected to USB ports on the motherboard. Many boards have a provision of expansion to connect to additional devices. Heat sinks and fan points are available in the modern motherboard to transfer excess heat.

9.11.1. Types of Motherboard

Motherboards are present in Desktop, Laptop, Tablet, and Smartphone and the components and functionalities are the same. But the size of the components and the way they are accommodated on the board varies due to space availability.

Though different motherboards have varying capabilities, limitations, features, Physical size/shapes (form factor), they are identified mostly by their form factors. Each manufacturer has come out with its form factor to suit the design of computers. Motherboard manufactured to suit IBM and its compatible computers fit into other case sizes as well. Motherboards built using ATX form factors were used in most of the computers manufactured in 2005 including IBM and Apple.

Below are few importanat types of Motherboards:

9.11.2. Brief Comparison of the Motherboard Form Factors.

Table 9.2 shows the comparison few of the most popular motherboard form factors.

9.12 MOTHERBOARD COMPONENTS AND THEIR FUNCTIONS

There are many components found in a motherboard. Some of them are major motherboard components while others

Table 9.1 : Comparison of Mother Board Form Factors			
Form Factor	**Manufacturer/Date**	**Dimensions**	**Applications**
Standard-ATX	Intel 1995	12 × 13 in	Workstation/Desktop
Mini-LPX	Intel 1997	9.6 × 9.6 in	Small Form Factor
Mini-ITX	VIA 2001	6.7 × 6.7 in	Small Form Factor

are not. The following is a motherboard components list.

Major Motherboard Components

Figure 9.16 shows Mother Board and its components

1. CPU (Central Processing Unit) chip
2. RAM (Random Access Memory) slots
3. Southbridge/northbridge
4. BIOS (Basic Input/Output System)
5. I/O port
6. USB (Universal Serial Bus)
7. CPU slot
8. PCI (Peripheral Component Interconnect) slot
9. AGP (Accelerated Graphics Port) slot
10. ISA (Industry Standard Architecture) slot
11. Parallel port
12. FDC (Floppy-Disk Controller)
13. IDE (Integrated Drive Electronics) controller
14. CMOS (Complementary Metal-oxide-semiconductor) battery
15. Power supply connector
16. Mouse and keyboard ports
17. DIP (Dual In-line Package) switch
18. Jumper
19. Heat sink (cooling system)
20. Clock generator

1. CPU (Central Processing Unit) chip

CPU is the electronic circuitry in a computer that executes instructions that make up a program. It is also known as a central processor or the main processor. The CPU executes the basic logic, arithmetic, controlling as well as input/output (I/O) operations specified by the instructions in the desktop programs.

2. RAM (Random Access Memory) slots

RAM is a kind of computer memory that can be read and written. It is mainly used to save data and machine code, Of course temporarily. A RAM device permits data to be read or written in nearly the same amount of time no matter where the data's physical location is in the memory. Compared to the direct-access storage devices like hard drives, CD/DVD and magnetic tapes, RAM media is much faster for data reading and writing.

3. Southbridge/northbridge

They are the two chips in the core logic chipset on the motherboard.

1. South Bridge
2. North Bridge

Typically, the south bridge implements the slower capabilities of

the motherboard than the north bridge chipset in computer architecture.

The north bridge, also known as host bridge or Memory Controller Hub, is connected directly to the CPU via the front-side bus (FSB). It is responsible for tasks requiring the highest performance. Together with the south bridge, they manage communications between the CPU and other motherboard components.

4. BIOS (Basic Input/Output System)

BIOS, also called system BIOS, PC BIOS or ROM BIOS, is firmware that is used to perform hardware initialization during the booting process; and to provide runtime services for operating system and programs. The BIOS firmware is the first software to run when powered on; it is re-installed on a PC's system board.

5. I/O port

Input/output ports are the connections between the CPU and peripheral devices on a motherboard. There are two complementary methods to perform input and output processes: memory-mapped I/O (MMIO) and port-mapped I/O (PMIO). Alternatively, you can use dedicated I/O processors, called channels on mainframe computers, which execute their own instructions.

6. USB (Universal Serial Bus)

USB is an industry standard that creates specifications for connectors, cables and protocols for connection; power supply (interfacing) and communication among computers, computer peripherals as well as other desktops. There are many USB hardware including several different connectors, of which USB-C is the latest kind.

7. CPU slot

A CPU slot, also called a CPU socket or Processor socket, contains one or more mechanical components that provide mechanical and electrical connections between the PCB and a microprocessor (CPU). Therefore, you can install a CPU on a motherboard without soldering.

Figure 9.16: Components of Mother Board

8. PCI (Peripheral Component Interconnect) slot

Peripheral Component Interconnect is a local computer bus for connecting hardware to a computer. It supports all the functions of a processor bus. PCI is usually been called Conventional PCI to distinguish it from its successor PCI Express (PCIe, PCI-e or PCI-E).

9. AGP (Accelerated Graphics Port) slot

AGP was designed as a high-speed point-to-point channel for connecting a video card (graphics card) to a computer system. Primarily, it was used to assist in the acceleration of 3D computer graphics. AGP is originally designed to be a descendant of the PCI series of connections for video cards. Yet, it was replaced by the PCIe slots.

10. ISA (Industry Standard Architecture) slot

There was an attempt to extend ISA into a 32-bit bus, called Extended Industry Standard Architecture (EISA). The attempt wasn't very successful and the EISA was largely replaced by the later VESA Local Bus and the PCI bus, Which has modified 32 bits bus what we have today.

11. Parallel port

A parallel port is a kind of interface for attaching peripherals on desktops. The name of this kind of port is derived from the way the data is sent. That is, the parallel ports send multiple bits of data at the same time. Serial interfaces, on the contrary, send bits one data at once. To achieve parallel data transfer, there are multiple data lines in the parallel port cables. The parallel port cable is larger than the cable of a contemporary serial port, which only has one data line within. The components of mother boards is shown in figure 9.16.

12. FDC (Floppy-Disk Controller)

FDC is a special-purpose chip and associated disk controller circuitry. It controls and directs reading from and writing to a computer's floppy disk drive (FDD).

13. IDE (Integrated Drive Electronics) controller

The devices used for connecting IDE, Ethernet, FireWire, USB and other systems can be called host adapter. So, the IDE controller refers to the host adapter. A host adapter, also called a host controller or a host bus adapter (HBA), connects a computer (acting as the host system) to other network and storage devices.

Tip: Host adapter is usually used to indicate devices connecting SCSI, Fibre Channel and SATA devices.

14. CMOS (Complementary Metal-oxide-semiconductor) battery

CMOS battery, also called memory battery, clock battery or real-time clock (RTC), is generally a CR2032 lithium coin cell. The lifespan of the CMOS battery is estimated to be three years when the power supply unit (PSU) is unplugged or switch off.

15. Power supply connector

A power supply provides the necessary electrical power to let the computer to work. It takes standard 110-Volt AC (Alternative Current) power to DC (Direct Current) power of 12 Volt, 5 Volt, 3.3 Volt, etc.

16. Mouse and keyboard ports

All computers have a keyboard port connected directly to the motherboard. Many PCs use the PS/2-style connectors for both keyboard and mouse; and the connectors are marked clearly for different usage.

17. DIP (Dual In-line Package) switch

A DIP switch is a manual electric switch packaged with others in a standard dual in-line package. The term may refer to an individual switch or the whole unit. The DIP switch is designed to be used on a printed circuit board (motherboard) together with other electronic **motherboard components**. It is usually used to customize the behavior of an electronic device for specific situations.

18. Jumper

A jumper is a short length of conductor that is used to close, open or bypass part of an electronic circuit as shown in Figure 9.17. Typically, jumpers are used to set up or configure printed circuit boards like the motherboard.

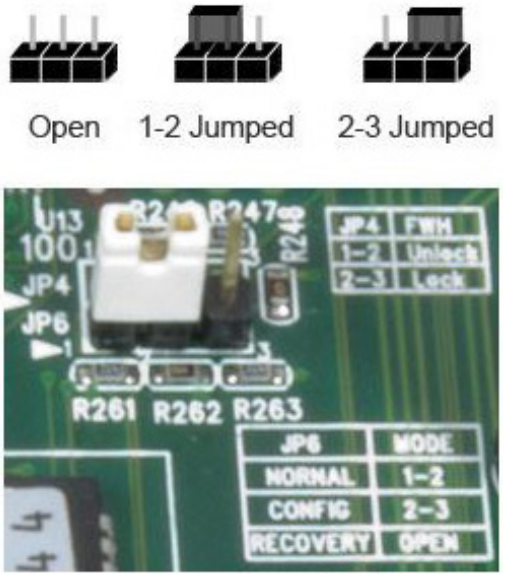

Figure 9.17 : Jumper

A jumper may also be referred to as a jumper shunt or shunt.

Jumpers manually configure computer peripherals, such as the motherboard, hard drives, modems, sound cards, and other components. For example, if your motherboard supported intrusion detection, a jumper can be set to enable or disable this feature.

19. Heat Sink (cooling system)

A heat sink is a passive heat exchanger that transfers the heat generated by **parts of motherboard** into a fluid medium like liquid or air. The fluid medium will dissipate away from the device. Thus, the temperature of the device is kept within a tolerable range. On the motherboard, the heatsink is usually used to cool CPU, GPU (graphics processing unit), chipsets and RAM modules.

20. Clock generator

A clock generator is an electronic oscillator (circuit) that produces a clock signal for usage in synchronizing a circuit's operation. The clock signal ranges between high and low frequencies, thus creating a metronome for the coordination of actions.

9.12.1. The two main components of Mother Board

After reading the above contents, you can figure out **that the two main components on the motherboard are CPU and RAM**. They also list in the first two locations in the above. Actually, the above **motherboard components** are listed mainly based on their importance on the motherboard. Yet, that is just our personal opinion. Those components' importance is different in different situations.

9.13. BUS

A bus is a high-speed internal connection. Buses are used to send control signals and data between the processor and other components. It connects the processor to the RAM, to the hard drive, to the video processor, to the I/O drives, and to all the other components of the computer. For example, a bus carries data between a CPU and the system memory via the motherboard. shown in figure 9.18.

Three types of bus are there:

1. Address bus
2. Data bus or local bus
3. Control bus.

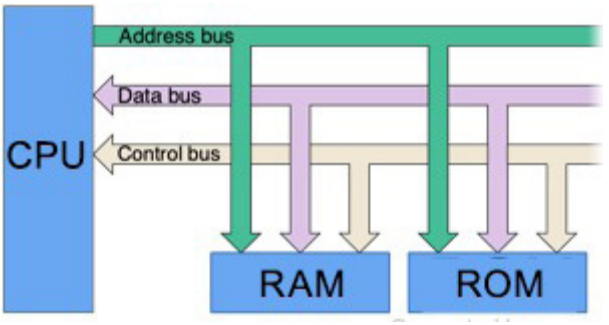

Figure 9.18 : Bus

9.13.1. Bus speed

The motherboard's bus transfers data between parts. The term "bus speed" refers to how quickly the system bus can move data from one computer component to the other. The faster the bus, the more data it can move within a given amount of time.

Bus width refers to the number of bits that can be sent to the CPU simultaneously, and bus speed refers to the number of times a group of bits can be sent each second. A bus cycle occurs every time data travels from memory to the CPU.

The speed of the bus, measured in megahertz (MHz), refers to how much data can move across the bus simultaneously. Bus speed usually refers to the speed of the front side bus (FSB), which connects the CPU to the northbridge. FSB speeds can range from 66 MHz to over 800 MHz.

9.14 BIOS CHIP

Short for Basic Input/Output System, the BIOS (pronounced bye-oss) is a ROM chip found on motherboards that allows you to access and set up your computer system at the most basic level. The picture below is an example of what a BIOS chip may look like on a computer motherboard

9.15 EXPANSION SLOTS

An expansion slot is a socket on the motherboard that is used to insert an expansion card (or circuit board), which provides additional features to a computer such as video, sound, advanced graphics, Ethernet or memory.

- AGP - Video card.
- AMR - Modem, sound card.
- PCI - Network card, SCSI, sound card, video card.
- PCI Express - Video card, modem, sound card, network card.
- VESA - Video card.

Many of the expansion card slots above are obsolete. You're most likely only going to encounter AGP, PCI, and PCI Express when working with computers today. Figure 9.19 shows the control board consists of expansion slots, ports and expansion card.

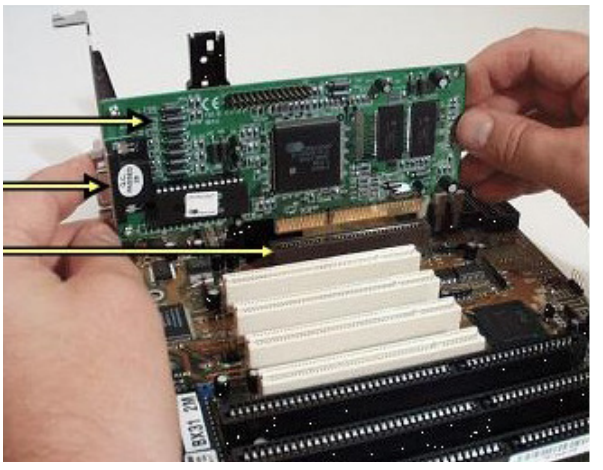

Figure 9.19 : Expansion slots

9.15.1 Expansion Cards

Alternatively called an adapter card, add-on card, expansion board, internal card, interface adapter, or card. An expansion card is a PCB that fits into an expansion slot on the motherboard. It is an internal card that gives a computer additional capabilities, such as enhanced video performance via a graphics card.Expansion cards can sometimes be called daughterboards. Figure 9.20 shows the expansion card.

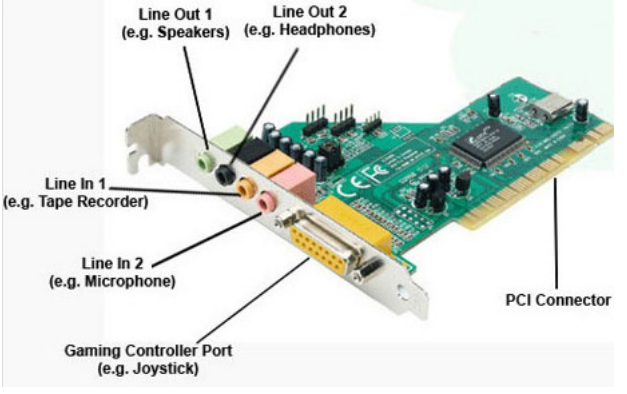

Figure 9.20. Expansion cards

9.15.2 Types of expansion cards in a computer

Interface card (ATA, Bluetooth, EIDE, FireWire, IDE, parallel, RAID, SCSI, serial, and USB).

- MIDI
- Modem
- MPEG decoder
- Network card
- Sound card
- Tuner card
- Video capture card
- Video card

9.16. MEMORY SLOTS

A memory slot, memory socket, or RAM slot allows RAM (computer memory) to be inserted into the computer. Most motherboards have two to four memory slots, which determine the type of RAM used with the computer. The most common RAM types are SDRAM and DDR for desktop computers and SODIMM for laptop computers, each having various types and speeds. The picture below is an example of what memory slots may look like inside a desktop computer. In this picture, there are three open and available slots for three memory sticks. figure 9.21 shows the RAM Chip which is inserted in memory slots.

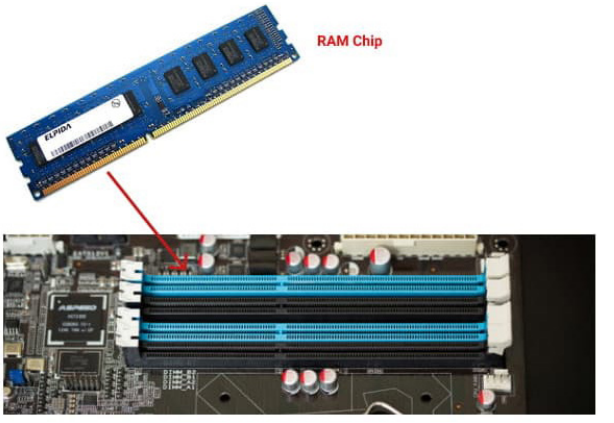

Figure 9.21 : Memory slots

9.17. FRONT PANEL CONNECTOR

Alternatively referred to as the fpanel or the system panel connector or system panel header controls a computer power button, reset button, and LED's. The System panel cables, as shown in the picture are

two wire cables that are color-coded to help identify where they connect to the motherboard system panel connector. The black or white wire is the GND (ground) wire and the colored wire is the powered wire. The cables, colors, and connections vary depending on the computer case and motherboard you have, however, generally include the cables mentioned below show in figure 9.22.

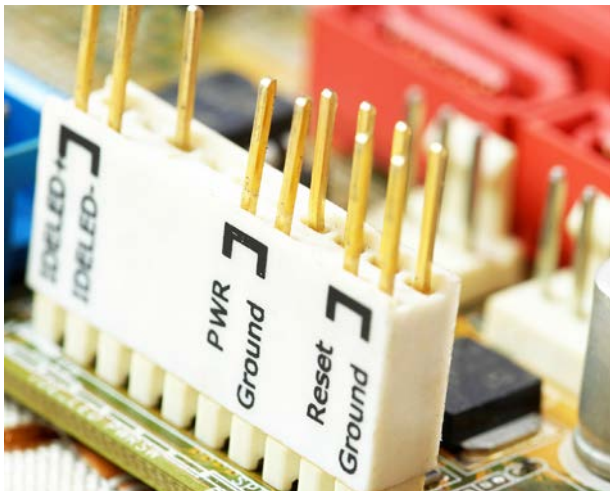

Figure 9.22 : Front Panel Connector

9.17.1. Types of system panel cables

- HDD LED (IDE LED) - The LED activity light for the hard drive. This indicator is the light that flashes as information is being written to and read from the hard drive.
- PLED (Power LED) - The LED power light, which indicates when the computer is on, off, or in Standby.
- PWRSW (Power SW) - Controls the power button that allows you to turn on and off the computer.
- Reset SW - Handles the reset button to restart the computer.
- Speaker - The internal speaker used to sound the beep noises you hear from your computer when it is booting.

With most computer motherboards, the system panel cables are connected directly to the motherboard. However, some motherboard manufacturers include a Q-Connector with the motherboard. With a Q-Connector, the user can connect the system panel cables away from the motherboard and then connect the Q-Connector to the motherboard.

9.18. INPUT OUTPUT PORTS

A connection point that acts as interface between the computer and external devices like mouse, printer, modem, etc. is called port. shown in figure 9.23.

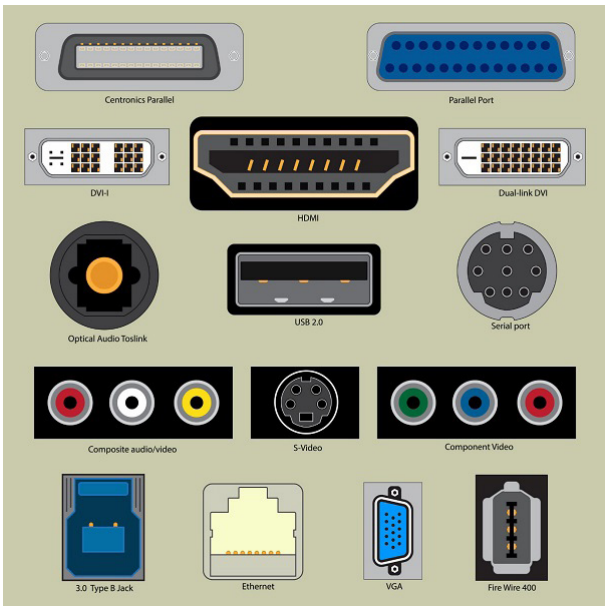

Figure 9.23 : Input Output Ports

Ports are two types

- Internal port – It connects the motherboard to internal devices like hard disk drive, CD drive, internal modem, etc.
- External port – It connects the motherboard to external devices like modem, mouse, printer, flash drives, etc.

Let us look at some of the most commonly used ports.

9.18.1 Serial Port

Serial ports transmit data sequentially one bit at a time. So they need only one wire to transmit 8 bits. However it also makes them slower. Serial ports are usually 9-pin or 25-pin male connectors. They are also known as COM (communication) ports or RS323C ports. Shown in figure 9.24

Figure 9.24 : Serial Port

9.18.2 Parallel Port

Parallel ports can send or receive 8 bits or 1 byte at a time. Parallel ports come in form of 25-pin female pins and are used to connect printer, scanner, external hard disk drive, etc. Shown in figure 9.25.

Figure 9.25 : Parallel port

9.18.3 USB Port

USB stands for Universal Serial Bus. It is the industry standard for short distance digital data connection. USB port is a standardized port to connect a variety of devices like printer, camera, keyboard, speaker, etc. Shown in figure 9.26.

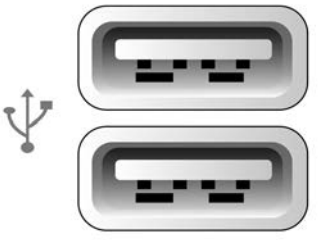

Figure 9.26 : USB port

9.18.4 PS-2 Port

PS/2 stands for Personal System/2. It is a female 6-pin port standard that connects to the male mini-DIN cable. PS/2 was introduced by IBM to connect mouse and keyboard to personal computers. This port is now mostly obsolete, though some systems compatible with IBM may have this port.

9.18.5 Infrared Port

Infrared port is a port that enables wireless exchange of data within a radius of 10m. Two devices that have infrared ports are placed facing each other so that beams of infrared lights can be used to share data.

9.18.6 Bluetooth Port

Bluetooth is a telecommunication specification that facilitates wireless connection between phones, computers and other digital devices over short range wireless connection. Bluetooth port enables synchronization between Bluetooth-enabled devices. There are two types of Bluetooth ports

- Incoming – It is used to receive connection from Bluetooth devices.
- Outgoing – It is used to request connection to other Bluetooth devices.

9.19 BIOS/CMOS SETTING

CMOS (short for complementary metal-oxide-semiconductor) is the term usually used to describe the small amount of memory on a computer motherboard that stores the BIOS settings. Some of these BIOS settings include the system time and date as well as hardware settings.

In order to access BIOS on a Windows PC, you must press your BIOS key set by your manufacturer which could be F10, F2, F12, F1, or DEL. If your PC goes through its power on self-test startup too quickly, you can also enter BIOS through Windows 10's advanced start menu recovery settings.

9.20. INTRODUCTION TO PROCESSOR

A processor (CPU) is the logic circuitry that responds to and processes the basic instructions that drive a computer. The CPU is seen as the main and most crucial integrated circuitry (IC) chip in a computer, as it is responsible for interpreting most of computers commands

9.20.1. CPU Basics

A CPU is often referred to as the brains of a computer. It is the part of your computer that receives instructions, performs calculations, and executes actions. Specifically, a CPU has four functions: to fetch, decode, execute, and store instructions. First, it fetches instructions from your computer's memory.

The five basic operations that a computer performs are input, storage, processing, output and control.

9.20.2 Types of CPU

Single-core CPU. It is the oldest type of CPU which is available and employed in most of the personal and official computers.

- Dual-core CPU.
- Quad-core CPU.
- Hexa Core processors.
- Octa-core processors.
- Deca-core processor.

This CPU is placed on the CPU socket center around the VRM section of the motherboard connected with the other hardware elements inside the computer cabinet. The CPU is a square shape chip in view, consisting of a thin layer of thousands of transistors as shown in figure 9.27.

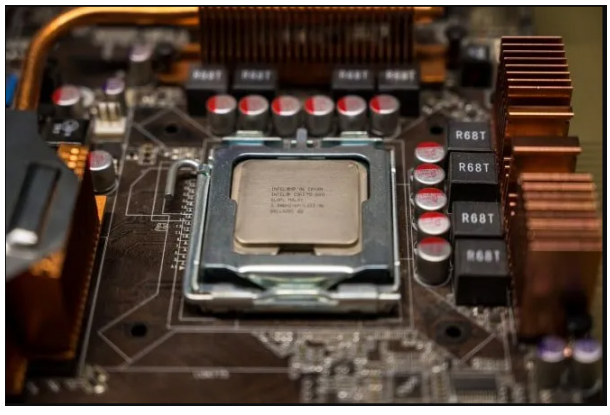

Figure 9.27 : CPU

9.21 THE FUNCTION OF CPU

1. The CPU receives the data when the computer inputs the data through input devices such as a keyboard or mouse. Figure 9.28. shows the the basic function of CPU.
2. After this, the CPU process these input data by performing calculations and technical algorithm.
3. And then CPU provides the processed data through output devices such as on the monitor screen.
4. The CPU also stores the process data in the form of a cache for future use.

9.21.1. Concept of Program Execution

Execution in computer and software engineering is the process by which a computer or virtual machine reads and

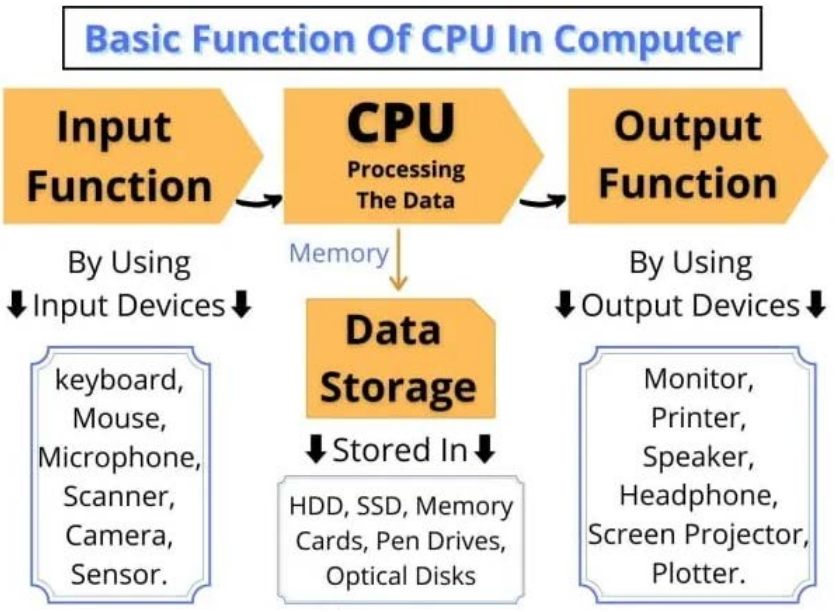

Figure 9.28 : Functions of CPU

acts on the instructions of a computer program. Each instruction of a program is a description of a particular action which must be carried out, in order for a specific problem to be solved. Execution involves repeatedly following a 'fetch–decode–execute' cycle for each instruction. As the executing machine follows the instructions, specific effects are produced in accordance with the semantics of those instructions.

Programs for a computer may be executed in a batch process without human interaction or a user may type commands in an interactive session of an interpreter. In this case, the "commands" are simply program instructions, whose execution is chained together.

The term run is used almost synonymously. A related meaning of both "to run" and "to execute" refers to the specific action of a user starting (or launching or invoking) a program, as in "Please run the application."

9.21.2 Process

Prior to execution, any program must be written first. This is generally termed as source code, which is then compiled at compile time (and statically linked at link time) to produce an executable. This executable is then invoked, most often by an operating system, which loads the program into memory (load time), possibly performs dynamic linking, and then begins execution by moving control to the entry point of the program; all these steps depend on the Application Binary Interface of the operating system. At this point execution begins and the program enters run time. The program then runs until it ends, either normal termination or a crash.

9.21.3 Executable

Executable code, an executable file, or an executable program, sometimes simply referred to as an executable or binary, is a list of instructions and data to cause a computer "to perform indicated tasks according to

encoded instructions", as opposed to a data file that must be interpreted (parsed) by a program to be meaningful.

The exact interpretation depends upon the use. "Instructions" is traditionally taken to mean machine code instructions for a physical CPU. In some contexts, a file containing scripting instructions (such as byte code) may also be considered executable.

9.22 COMMON CPU COMPONENTS

The central processing unit (CPU) consists of six main components:

1. Control Unit (Cu)
2. Arithmetic Logic Unit (Alu)
3. Registers
4. Cache
5. Buses
6. Clock

All components work together to allow processing and system control. Figure 9.29 shows the components of CPU.

9.22.1 Control unit

The CU provides several functions:

- it fetches, decodes and executes instructions
- it issues control signals that control hardware
- it moves data around the system

9.22.2 Arithmetic logic unit

The ALU has two main functions:

- It performs arithmetic and logical operations (decisions). The ALU is where calculations are done and where decisions are made.
- It acts as a gateway between primary memory and secondary storage . Data transferred between them passes through the ALU.

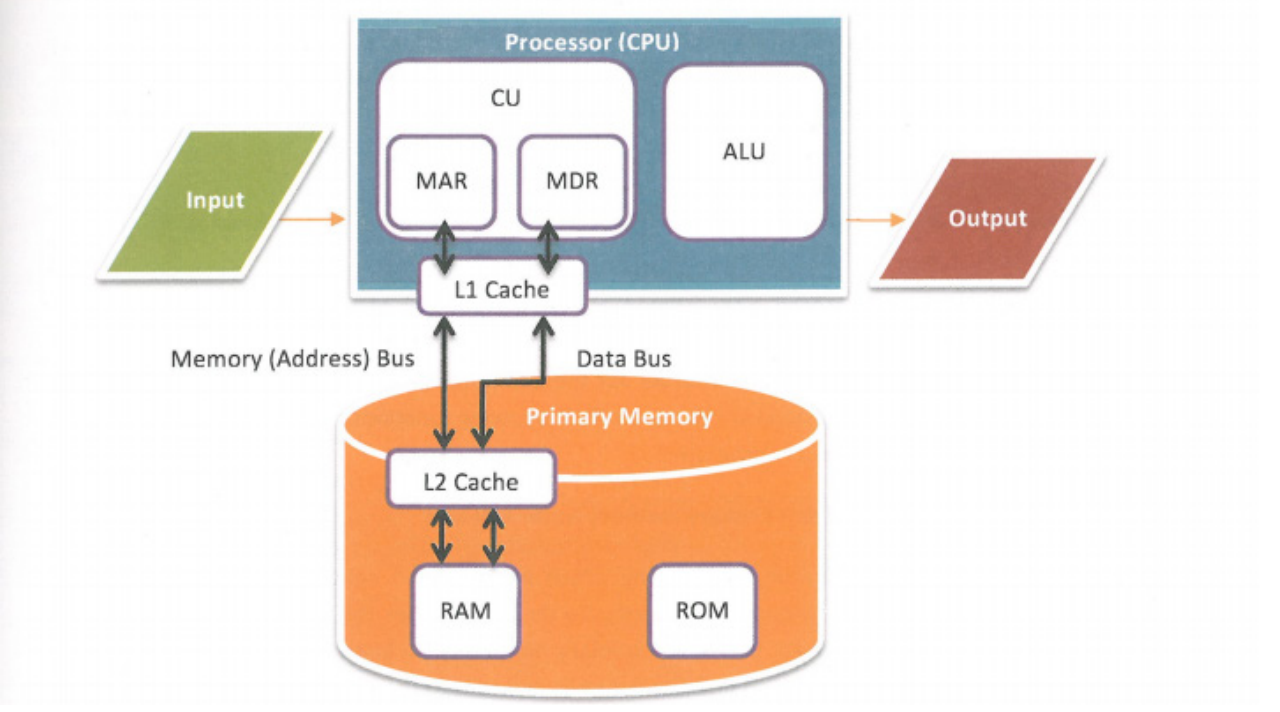

Figure 9.29 : CPU components

The ALU performs calculations and makes logical decisions.

9.22.3 Registers

Registers are small amounts of high-speed memory contained within the CPU. They are used by the processor to store small amounts of data that are needed during processing, such as:

- the address of the next instruction to be executed
- the current instruction being decoded
- the results of calculations

Different processors have different numbers of registers for different purposes, but most have some, or all, of the following:

- program counter
- memory address register (MAR)
- memory data register (MDR)
- current instruction register (CIR)
- accumulator (ACC)

9.22.4 Cache

Cache is a small amount of high-speed random access memory (RAM) built directly within the processor. It is used to temporarily hold data and instructions that the processor is likely to reuse. This allows for faster processing as the processor does not have to wait for the data and instructions to be fetched from the RAM.

9.22.5 Buses

A bus is a high-speed internal connection. Buses are used to send control signals and data between the processor and other components. Three types of bus are used:

- Address bus - carries memory addresses from the processor to other components such as primary memory and input/output devices.
- Data bus - carries the actual data between the processor and other components.
- Control bus - carries control signals from the processor to other components. The control bus also carries the clock's pulses.

9.22.6 Clock

The CPU contains a clock which is used to coordinate all of the computer's components. The clock sends out a regular electrical pulse which synchronises (keeps in time) all the components.

The frequency of the pulses is known as the clock speed. Clock speed is measured in hertz. The higher the frequency, the more instructions can be performed in any given moment of time.

In the 1980s, processors commonly ran at a rate of between 3 megahertz (MHz) to 5 MHz, which is 3 million to 5 million pulses or cycles per second. Today, processors commonly run at a rate of 3 gigahertz (GHz) to 5 GHz, which is 3 billion to 5 billion pulses or cycles per second.

9.23 REGISTER ORGANISATION

A register can hold the instruction, address location, or operands. Sometimes, the instruction has register as a part of itself.

9.23.1 Types of Registers

As we have discussed above, registers can be organized into two main categories i.e.

1. User-Visible Registers
2. Control and Status Registers.

Although we can't separate the registers in the processors clearly among these two categories.

9.24 CPU FEATURES

The CPU performs basic arithmetic, logic, controlling, and input/output (I/O) operations specified by the instructions in the program. This contrasts with external components such as main memory and I/O circuitry, and specialized processors such as graphics processing units (GPUs).

9.25. TYPES OF CPU – 32 BIT AND 64 BIT

What Are 32-Bit and 64-Bit?

When it comes to computers, the difference between 32-bit and a 64-bit is all about processing power. Computers with 32-bit processors are older, slower, and less secure, while a 64-bit processor is newer, faster, and more secure.

But what do the numbers 32 and 64 even mean?

Your computer's central processing unit (CPU) functions like the brain of your computer. It controls all the communication and the flow of data to and from the other parts of your computer. Some computers use two or more processors. However, there are only two main categories of processors now: 32-bit processors and 64-bit processors. The type of processor that your computer uses affects its overall performance and what kind of software it can utilize.

Most computers made in the 1990s to early 2000s have a 32-bit system that can access 2^32 (or 4,294,967,296) bytes (units of digital information) of RAM (random access memory). Meanwhile, a 64-bit processor can handle 2^64 (or 18,446,744,073,709,551,616) bytes of RAM. In other words, a 64-bit processor can process more data than 4 billion 32-bit processors combined.

1. Intel

Intel stands for "Integrated Electronics". Intel Corporation is an American multinational corporation and technology company headquartered in Santa Clara, California, in Silicon Valley. It was invented by Robert Noyce. It is the developer of the first x86 processor -Intel 8086.

If we talk on a scale of 1-10, Intel processors come at a scale of 4-10. These processors have good CPU performance and almost all Intel processors come with iGPU. This processor also clocks higher than AMD processors, at the cost of higher power consumption and battery life. Thus, for short workloads and single-core boosts especially in laptops, newer Intel-powered laptops can be used when battery life is not a concern. If we talk about Desktop, and you want to change processor, motherboard or socket's compatibility, then Intel has fewer options available for that in comparison to AMD processor due to frequent motherboard and chipset changes.

Example – Intel Xeon, Intel Core i series, Intel Core m series

2. Advanced Micro Devices (AMD)

AMD stands for Advanced Micro Devices. It is an American multinational semiconductor company based in Santa Clara, California. It was invented by Jerry Sanders, Jack Gifford, John Carey. It started supplying x86 processors as a

Table 9.2 Difference between Intel and AMD.	
Intel	**AMD**
Less expensive than AMD Processor at the lower range.	Less expensive than Intel at a higher range.
Less efficient than AMD.	More efficient than Intel.
Can heat up when used with Clock Speed Boost(14 nm)	Is generally cooler due to smaller lithography(TSMC 7nm is similar to Intel 10 nm)
IPC (Rocket Lake) is lower than AMD (Zen 3)	IPC(Zen 3) is higher than Intel (Rocket Lake)
Clock speed reaches and surpassed 5.0 GHz	The clock speed can reach 5.0 GHz but results in more heat
It has symmetric multiprocessing capabilities of up to 4 sockets/28 cores.	It has symmetric multiprocessing capabilities of up to 8 sockets/128 cores.

second source manufacturer and became a competitor with Am386.

On a scale of 1-10, AMD processors come at 5-10. It is cheaper than Intel Processors at a similar range. These processors are efficient compared to the current generation Core series. If we talk about the desktop, mobile, and you only want to do normal gaming and for everyday use, then Ryzen APU is the way to go. For heavier tasks like video editing, 3D modelling, etc, Ryzen 7 or 9 CPUs or Thread ripper should be preferred.

For Ryzen Desktop CPUs and APUs in the AM4 platform, the motherboard chipset should be checked for support otherwise PC may not boot, although it can be easily solved with motherboards with USB BIOS flashing for newer processors.

Example – AMD Ryzen, AMD Threadripper, AMD FX-Series, AMD EPYC, AMD Opteron, AMD Athlon 64

Note:

This book was written before the release of Alder Lake and successor to Zen 3 and thus may not reflect future changes.

Difference between Intel and AMD

Table 9.2 shows the difference between Intel and AMD.

9.26. INTRODUCTION TO MEMORY

Computer memory is of two basic types– Primary memory (RAM and ROM) and Secondary memory (hard drive, CD, etc). Random Access Memory (RAM) is primary-volatile memory and Read-Only Memory (ROM) is primary-non-volatile memory.

There are two main types of RAM: Dynamic RAM (DRAM) and Static RAM (SRAM).

- DRAM (pronounced DEE-RAM), is widely used as a computer's main memory.
- SRAM (pronounced ES-RAM) is made up of four to six transistors.

9.27. DIFFERENT TYPES OF RAM (RANDOM ACCESS MEMORY)

RAM (Random Access Memory) is a part of computer's Main Memory which is

directly accessible by CPU. RAM is used to Read and Write data into it which is accessed by CPU randomly. RAM is volatile in nature, it means if the power goes off, the stored information is lost. RAM is used to store the data that is currently processed by the CPU. Most of the programs and data that are modifiable are stored in RAM.

Integrated RAM chips are available in two form:

1. SRAM(Static RAM)
2. RAM(Dynamic RAM)

1. SRAM :

The SRAM memories consist of circuits capable of retaining the stored information as long as the power is applied. That means this type of memory requires constant power. SRAM memories are used to build Cache Memory.

2. DRAM :

DRAM stores the binary information in the form of electric charges applied to capacitors. The stored information on the capacitors tends to lose over a period of time and thus the capacitors must be periodically recharged to retain their usage. The main memory is generally made up of DRAM chips.

Types of DRAM

There are mainly five types of DRAM

1. Asynchronous DRAM (ADRAM)

The DRAM described above is the asynchronous type DRAM. The timing of the memory device is controlled asynchronously. A specialized memory controller circuit generates the necessary control signals to control the timing. The CPU must take into account the delay in the response of the memory.

2. Synchronous DRAM (SDRAM)

These RAM chips' access speed is directly synchronized with the CPU's clock. For this, the memory chips remain ready for operation when the CPU expects them to be ready. These memories operate at the CPU-memory bus without imposing wait states. SDRAM is commercially available as modules incorporating multiple SDRAM chips and forming the required capacity for the modules.

3. Double-Data-Rate SDRAM (DDR SDRAM)

This faster version of SDRAM performs its operations on both edges of the clock signal; whereas a standard SDRAM performs its operations on the rising edge of the clock signal. Since they transfer data on both edges of the clock, the data transfer rate is doubled. To access the data at high rate, the memory cells are organized into two groups. Each group is accessed separately. It has been available in different iterations over time, including DDR2 SDRAM, DDR3 SDRAM and DDR4 SDRAM.

5. Cache DRAM (CDRAM)

This memory is a special type DRAM memory with an on-chip cache memory (SRAM) that acts as a high-speed buffer for the main DRAM.

Table 9.3 shows the differences between SRAM and DRAM

Table 9.3 : Differences between SRAM and DRAM	
SRAM	**DRAM**
1. SRAM has lower access time, so it is faster compared to DRAM.	1. DRAM has higher access time, so it is slower than SRAM.
2. SRAM is costlier than DRAM.	2. DRAM costs less compared to SRAM.
3. SRAM requires constant power supply, which means this type of memory consumes more power.	3. DRAM offers reduced power consumption, due to the fact that the information is stored in the capacitor.
4. Due to complex Internal circuitry, less storage capacity is available compared to the same physical size of DRAM memory chip.	4. Due to the small internal circuitry in the one-bit memory cell of DRAM, the large storage capacity is available.
5. SRAM has low packaging density.	5. DRAM has high packaging density.

9.28. INTRODUCTION OF HARD DISK DRIVE

A hard disk drive (HDD), popularly known as a hard disk/drive (HD), a fixed disk/drive data storage device on your computer – the primary and the largest storage device in fact. It is a piece of hardware that houses the operating system, different software assets and a majority of the other files in your computer.

Have you seen the "C: drive" in your computer? That's your hard disk drive. Though "C drive" is not the technically correct name for a hard disk drive (and refers to only one part of the HDD), it is colloquially used as a popular substitute.

9.28.1. Why are hard disk drives used?

The primary purpose of a hard disk drive is to store digital data on its 'platters' (magnetic-substance coated disks that rotate rapidly) and retrieve the information when needed. It uses random-access to retrieve information (relevant data can be accessed in any order and not sequentially) and retains the data even when the computer is turned off, providing you what is known as "non-volatile storage".

External hard disk drives are used to extend the storage capacity of a system. Since external hard disk drives are easily portable, they allow you to carry important files with you and access them on the go. They are also used to create backups of important data and files on a computer and store elsewhere. Creating and storing backups is in fact, an important function of external hard disk drives. This is because all programs, applications and files within a computer can be corrupted and lost forever if the internal hard disk drive fails.

9.28.2. Logical Drive

A hard disk contains a stack of platters, circular metal disks that are mounted inside the hard disk drive and coated with magnetic material, sealed in a metal case or unit. Fixed in a horizontal or vertical position, the hard disk has electromagnetic read or write heads above and below the platters. The structure of Logical drive is shown in figure 9.30.

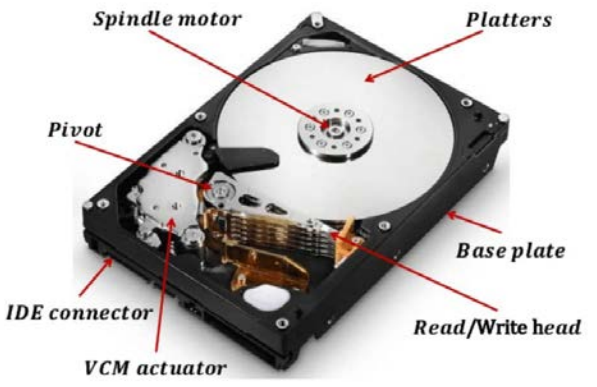

Figure 9.30 : Structure of Logical drive

9.29 PRINCIPLE AND WORKING OF HARD DISK

Principle of Hard Disk

A hard disk typically works on the principle of simple magnetism to store the data and information. A hard drive typically consists of a large plate that is usually made up of a magnetic material and is known as a platter. The figure 9.31 shows the working of HDD. The platter is usually constructed in a circular shape. The surface of the magnetic plate is divided into billions of tiny compartments. The magnetization of the tiny areas can be performed independently. Magnetized tiny area of the plate denotes a binary high and is equivalent to binary value one (1); whereas, the demagnetized tiny area denotes a binary low and is equivalent to binary value zero(0). This indicates that the letters, numbers, and other forms of data stored by the hard disk drive are a combination of binary values, i.e., zeroes or ones. The smallest portion of the information stored by the hard disk drive is known as a bit. The process of magnetization of materials is typically preferred to store information in the disks as it does not get affected by switching off the power supply. The data is retained by the drive even if it is not connected to the power supply for a long time period. The magnetized portion of the hard disk tends to stay magnetized until it is externally demagnetized, thereby allowing reliable storage of data.

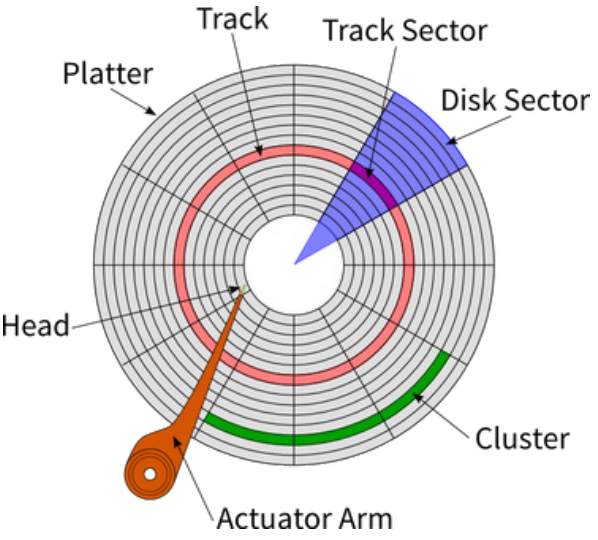

Figure 9.31 : Working of HDD

9.29.1. Physical & Logical Components of HDD

The hard drive, which typically provides storage for data and applications within a computer, has four key components inside its casing the platter (for storing data), the spindle (for spinning the platters), the read/write arm (for reading and writing data) and the actuator (for controlling the actions of the read/write arm). Only the most technically proficient IT professionals should attempt to work on the components inside a hard drive as shown in Figure 9.32

Platter: A typical HDD consists of one or more flat circular disks called platters. The data is Recorded on these platters in binary codes (0s and 1s). The set of rotating platters is sealed in a case, called Head Disk Assembly (HDA). A

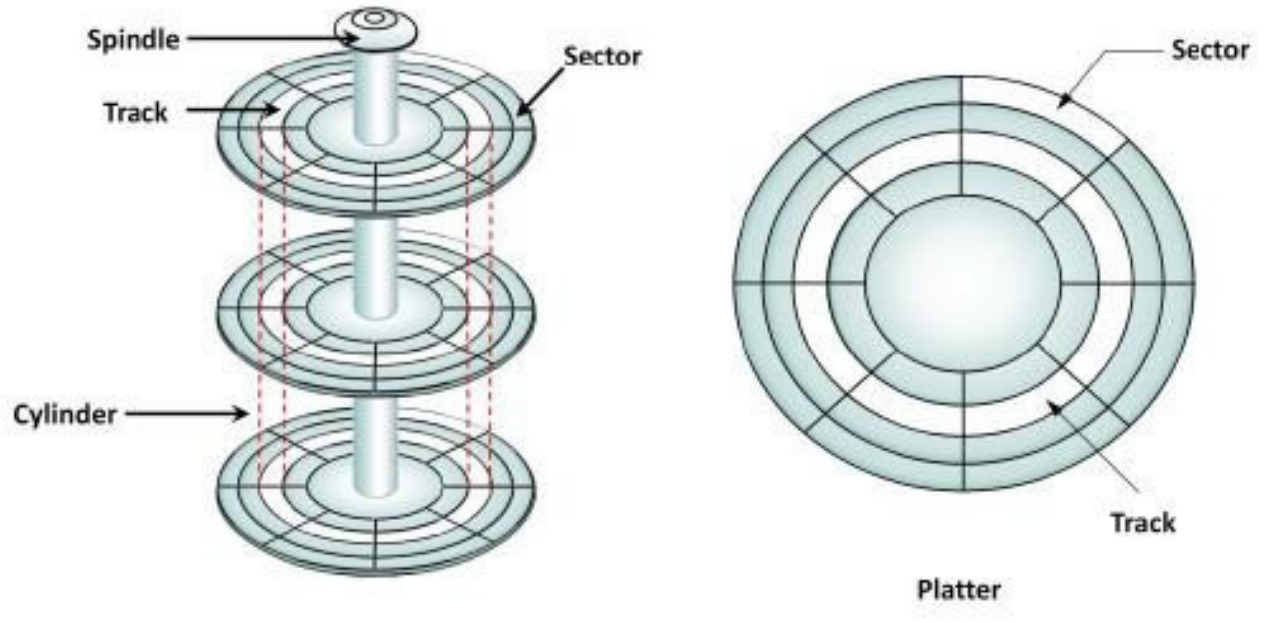

Figure 9.32 : Components of HDD

platter is a rigid, round disk coated with magnetic material on both surfaces (top and bottom). The data is encoded by polarizing the magnetic area or domains of the disk surface. Data can be written to or read from both surfaces of the platter. The number of platters and the storage capacity of each platter determine the total capacity of the drive.

Spindle: A spindle connects all the platters and is connected to a motor. The motor of the Spindle rotates with a constant speed. The disk platter spins at a speed of several thousands of revolutions per minute (rpm). Common spindle speeds are 5,400 rpm, 7,200 rpm, 10,000 rpm, and 15,000 rpm. The speed of the platter increases with the improvement in technology; Although the extent to which it can be improved is limited.

Read/write head: Read/write (R/W) heads, read and write data from or to the platters. Drives have two R/W heads per platter, one for each surface of the platter. The R/W head changes the magnetic polarization on the surface of the platter when writing data. While reading data, the head detects the magnetic polarization on the surface of the platter.

During reads and writes, the R/W head senses the magnetic polarization and never touches the surface of the platter. When the spindle rotates, a microscopic air gap is maintained between the R/W heads and the platters, known as the head flying height. This air gap is removed when the spindle stops rotating and the R/W head rests on a special area on the platter near the spindle. This area is called the landing zone. The landing zone is coated with a lubricant to reduce friction between the head and the platter.

The logic on the disk drive ensures that heads are moved to the landing zone before they touch the surface. If the

drive malfunctions and the R/W head accidentally touches the surface of the platter outside the landing zone, a head crash occurs. In a head crash, the magnetic coating on the platter is scratched and may cause damage to the R/W head. A head crash generally results in data loss.

Actuator arm assembly: R/W heads are mounted on the actuator arm assembly, which positions the R/W head at the location on the platter where the data needs to be written or read. The R/W heads for all platters on a drive are attached to one actuator arm assembly and move across the platters simultaneously.

Drive controller board: The controller is a printed circuit board, mounted at the bottom of a disk drive. It consists of a microprocessor, internal memory, circuitry, and firmware. The firmware controls the power supplied to the spindle motor as well as controls the speed of the motor. It also manages the communication between the drive and the compute system. In addition, it controls the R/W operations by moving the actuator arm and switching between different R/W heads, and performs the optimization of data access.

9.29.2. Other Components

As well as the casing on the outside of the hard disk that holds all of the components together, the front-end circuit board controls input and output signals in tandem with the ports at the end of the drive. No matter what the type of drive, it has one port for a power supply and one port for transferring data and instructions to and from the rest of the system.

9.30 PERFORMANCE OF HDD

The performance of a hard drive is most effectively measured by how fast data can be transferred from the spinning media (platters) through the read/write head and passed to a host computer. This is commonly referred to as data throughput and usually measured in gigabytes (or gigabits) per second.

Types of HDD

The Hard Drive is connected to the motherboard via an interface cable. There are three main types of Hard Drive interface including the older IDE (Integrated Drive Electronics) also called PATA (Parallel ATA), the new SATA (Serial ATA), and SCSI (Small Computer System Interface) which is mainly used on servers and in industry.

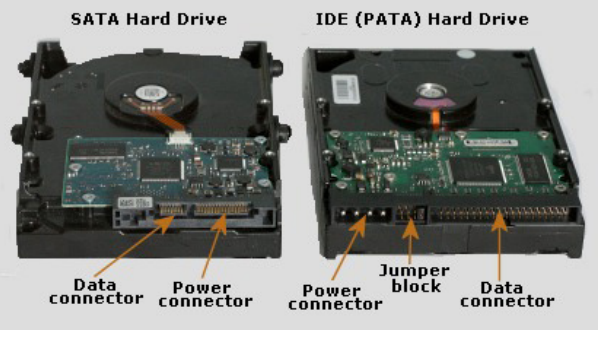

Figure 9.33 : SATA and IDE

The two main types of Hard Drive on a Home Computer include the older IDE Hard Drive, and the new SATA Hard Drive which are shown in figure 9.33. They are both the same size and look identical except for the power and data connectors.

Hard Drives are mechanical devices with moving parts which can fail resulting in the loss of all your data although they are relatively cheap and easy to replace. You may also want to add more Hard Drives to your computer for additional storage space.

First you need to look at your computer's motherboard or look in your motherboard manual and determine if it contains the older IDE connectors or the newer SATA connectors. The motherboard may even contain both types of connector are shown in figure 9.34.

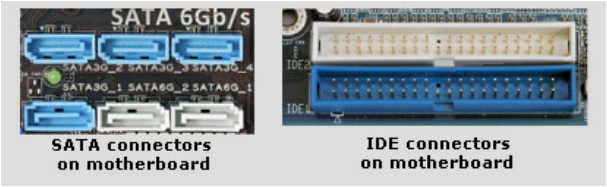

Figure 9.34 : SATA and IDE connectors on mother board

If the motherboard has IDE connectors then you will need an IDE (PATA) Hard Drive. There are usually two IDE connectors on the motherboard and each connector can control up to two drives allowing a total of four drives to be connected in total. A newer computer will most likely have SATA connectors which allow one drive per SATA connector. If you intend to add more internal Hard Drives to your computer then you will not only need a spare data connector but will also need room to install the Drive into the case.

9.30.1. HDD Speeds

The best physical HDD speeds to use are typically 5400rpm for laptops, and 7200rpm for desktops. Higher speed drives typically generate too much heat, noise, vibration, or draw too much power when used a laptop, but there are a few exceptions.

What is RPM? RPM stands for revolutions per minute, and it's used to measure the rotational speeds of hard disk platters. All other things being equal, faster spinning platters will translate to quicker hard disk drives. In fact, the RPM of a hard disk drive makes the biggest impact on its overall speed.

External connection types:

External hard drives can use a number of different connections like:

USB, USB C (a.k.a. USB Type-C)
eSATA, Firewire (400 or 800)
Thunderbolt.

9.31 USB

USB is the most common connection type for external Hard Disk Drives are shown in figure 9.35. It is extremely easy to use.

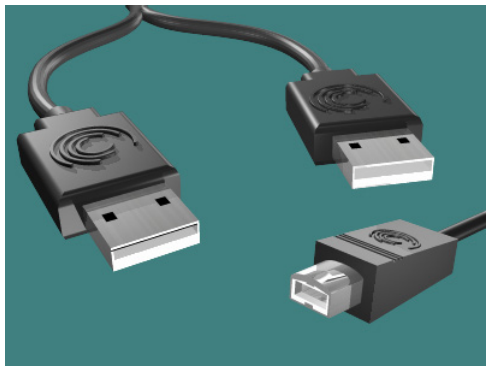

Figure 9.35 : USB

LEARNING OUTCOMES

After studying this chapter, a student can understand the following

1. Fundamentals of computer system
2. Basic Concepts of Operating System
3. Concepts of Motherboard
4. Function of CPU
5. Working of Hard disk drive.

QUESTIONS

I Choose the best answer

1. _____ is an interface between the user and the hardware
   a) CPU b) OS c) ALU d) CU
2. Which of the following is not an Operating System?
   a) Linux b) Windows
   c) Unix d) Oracle
3. Which one of the following is a Single user Operating System
   a) Linux b) Windows
   c) Mac d) DOS
4. _____ in a computer that executes instructions that make up a program
   a) Input unit b) Output unit
   c) Memory unit d) CPU
5. The best physical HDD speeds to use are typically _____ for laptops.
   a) 5400 rpm b) 7200 rpm
   c) 6400 rpm d) 8200 rpm
6. Macintosh OS is Introduced in the year _____
   a) 1984 b) 1970 c) 1982 d) 1988
7. The efficiency of SMPS is _____ greater than linear regulators.
   a) upto 90% b) upto 96%
   c) upto 85% d) upto 88%
8. Which battery is used inside the computer
   a) Nickel – cadmium b) CMOS
   c) Alkaline d) Lithium
9. _____ are the connections between the CPU and peripheral devices on a mother board
   a) Serial port b) USB ports
   c) I/O Ports d) HDMI port
10. Parallel ports can send or Receive _____ bits at a time
    a) 2 b) 4 c) 8 d) 12

II Answer in few sentences.

1. What is the need for operating system?
2. Brief about Single User Operating System.
3. Brief about Multi User Operating System.
4. What are the key Functions of Operating System?
5. Define Microsoft windows.
6. What are the characteristics of a computer?
7. Give the expansion of the following
   a) SMPS b) USB c). GUI
8. What is expansion slot?
9. What is port? Give its types.
10. Define cache.
11. What are type's buses in computer?
12. What are components of operating system?

III Explain the following questions

13. Explain booting of operating system
14. Explain the types of operating system based on process capability
15. Explain the difference between SRAM and DRAM
16. Draw the linux Distributions diagram and explain
17. Compare the Mother board form factors.

IV Briefly explains the following questions

18. Explain any five functions of Mother board components.
19. Give detailed explanation about types of RAM
20. Explain key features of operating system(any five).

Answers: 1. (b) 2. (d) 3. (d) 4. (d) 5. (a) 6. (a) 7. (b) 8. (b) 9. (a) 10. (c)