Unit 1: Introduction to Computer System

Introduction to Computer

*A computer is an electronic machine that takes input from the user, processes the given input and generates output in the form of useful information***.** A computer accepts input in different forms such as data, programs and user reply. Data refers to the raw details that need to be processed to generate some useful information. Programs refer to the set of instructions that can be executed by the computer in sequential manner. User reply is the input provided by the user in response to a question asked by the computer.

A computer is an electronic device that processes data, converting it into information that is useful to people.

Computer is a machine that performs calculations and processes data with astonishing speed and precision. A computer can take thousands of individual pieces of data and turn them into more usable information-with blinding speed and almost unfailing accuracy.

Characteristics of Computers

Computers are what they are because of the following characteristics:

i) Speed

A computer is a fast electronic device that can solve large and complex problems in a fraction of seconds. For example, a microcomputer can execute millions of instructions per second over and over again, without any mistake. The speed of a computer generally depends upon its hardware configuration. For example, supercomputers can operate at speeds measured in nanoseconds and even in picoseconds – one thousand to one million times faster than microcomputers.

ii) Storage

A computer can store huge amounts of data in its different storage components in many different formats. Computers have main memory and auxiliary memory systems. With more and more auxiliary storage devices, which are capable of storing huge amounts of data, the storage capacity of a computer is virtually unlimited.

iii) Accuracy

The accuracy of a computer system is very high. In most cases, the errors are due to the human factor rather than technological flaws. For example, if a program is wrongly coded, the data is corrupted, or the program logics is flawed, then irrespective on which computer we run it, we will always get wrong result. Another area where mistakes can creep in is during data entry. So if a wrong input is given, the output also will be wrong – GIGO (Garbage In Garbage Out).

iv) Versatility

Computers are very versatile machines. They can perform activities ranging from simple calculations to performing complex CAD modeling and simulation to navigation missiles and satellites. In other words, they are capable of performing almost any type of different task.

v) Diligence

Diligence means being constant and earnest in effort application. Computers can perform repetitive calculations any number of times with the same accuracy. Computers don't suffer from human traits, such as tiredness, fatigue, lack of concentration etc.

vi) Word length

A digital computer operates on binary digits – 0 and 1. A binary digit is called a bit. A group of 8 bits is called a byte. The number of bits that a computer can process at a time in parallel is called its word length. Commonly used word lengths are 8, 16, 32 or 64 bits. Word length is the measure of computing

power of a computer. The longer the word length, the more powerful the computer is.

vii) Automation

Computers can be programmed to perform a series of complex tasks involving multiple programs. Computers will perform these things flawlessly. They will execute the programs in the correct sequence, switch on or switch off machines at the appropriate time, monitor the operational parameters, send warning signals or take corrective actions if the parameters exceed the control level, and so on. Computers are capable of these levels of automation, provided they are programmed correctly.

Applications of Computer

Home : In many homes, the family computer is nearly as important as the refrigerator or the washing machine. People cannot imagine living without it. In fact, a growing number of families have multiple PCs in their homes; in most cases, at least one of those computers has an Internet connection. We need computers at home to do communications, to carry out business work done at home, to do schoolwork, for entertainment, to keep personal financial data up-to-date etc.

Education: More and more schools are adding computer technology to their curricula, not only teaching pure computer skills, but incorporating those skills into other classes. Students may be required to use a drawing program, for example, to draw a plan of Alamo for a history class, or use spreadsheet software to analyze voter turnouts during the last century's presidential elections. Educators see computer technology as an essential learning requirement for all students, starting as early as preschool.

Small Business: Many of today's successful small companies simply could not exist without computer technology. Each year, hundreds of thousands of individuals launch businesses based from their homes or in small office locations. They rely on inexpensive computers and software not only to perform basic work functions, but to manage and grow their companies. These tools enable business owners to handle tasks – such as daily accounting chores, inventory management, marketing, payroll, and many others. As a result, small businesses become more self-sufficient and reduce their operating expenses.

Banks : All financial transactions in banks and financial institutions are done by computer software. They provide security, speed and convenience. Different branches are connected with the help of a computer network, one can withdraw and deposit money for any branch system. In an ATM system one can withdraw cash from any ATM machines which are interconnected in the ATM system. Online banking allows you to connect to a bank using a computer via the Internet. We can view our accounts, transfer money between accounts, print copies of checks, statements and pay bills online.

Engineering: Computer is used in engineering to collect and analyze data. Engineers use computer technology for designing and developing any business as well as scientific models using appropriate software tools. For example, the CAD software package helps engineers and architects to prepare machine drawings, building drawings, circuit drawings, and presentation of solid modeling (3D views) of machine parts on the screen. Any design can be drawn using CAD software like AutoCAD.

Health Care: Computers are making health care more efficient and accurate while helping providers bring down costs. Many different health care procedures now involve computers, from ultrasound and magnetic resonance imaging (MRI), to laser eye surgery and fetal monitoring. Surgeons now can use robotics surgical devices to perform delicate operations, and even to conduct surgeries remotely. New virtual-reality technologies are being used to train surgeons in cutting-edge techniques, without cutting an actual patient. The information available on uncommon illnesses in expert system is useful to doctors. Junior doctors can make use of material stored in CDs for learning new information.

Communication: We also have very fast and convenient access to information. Through Email, we can communicate with a person, sitting thousands of miles away in seconds. There is chat software that enables one to chat with another person on a real-time basis. Messages can be sent and the sent

messages are received by their respective destinations in fractions of seconds no matter how many miles they are away. Audio and video conferencing tools are becoming readily available to the common man. All mobiles phones have software embedded in them so that we can communicate with others with low cost and from anywhere using technology.

Ticketing and reservation: One can book air tickets or railway tickets or bus tickets and make hotel reservations online with the help of computer and internet technology that saves time and confirmation. We can also book hall tickets for confirmation watching movies.

Defense: Computers are widely used in defense. Secured databases and records are kept in the computer with the help of software used in the system. There is software embedded in almost every weapon. Software is used for controlling the flight and targeting of ballistic missiles. Software is used to control access to atomic bombs.

Multimedia: Audio or video composition and editing have been made much easier by using computers. Graphics engineers can use computers to generate short or full length films or even to create 3D models. Special effects in science fiction and action movies are created using computers.

Desktop publishing: We can use computers for desktop publishing, for example, one can create page layouts for magazines, newspapers, books etc. with attractive designs by using designing software like Adobe PageMaker, Macromedia Freehand etc. in a personal computer.

Entertainment: Computers are now the major entertainers and the primary time pass machines. We can use computers for playing games, watching movies, listening to music, drawing pictures etc.

Government: Various departments of the government use computer for their planning, control and law enforcement activities. For example, the government uses computers for traffic, tourism, information and broadcasting, education, aviation, and many others.

Weather Forecasting: Computers can be used for weather forecasting like sunrise, sunset, rainfall, humidity, temperature of different places at the same around the globe using super computers and related programs. We can also predict the future weather forecast on the basis of past records. Metrology is the tool to research weather forecasting systems.

Planning and Scheduling: Computers along with software can be used to store contact information, generating plans, scheduling appointments and deadlines as well.

Evolution or History of Computer

Evolution or History of computer is a study of past development of computer i.e. it is meant by the gradual improvement of accuracy, speed and efficiency of computers through generations. Ancient people lived on the earth for centuries without counting. Then they started to count with their ten fingers. It became so difficult to live and to remember more and more facts using their ten fingers. These phenomena were gradually replaced by the use of stones, counting notches on sticks or marks on walls.

According to the concept and technology used on the devices, we can divide the evolution of computers roughly into three eras. The three eras are as follows:

1. The Mechanical Era 2. The Electro-Mechanical Era 3. The Electronic Computers Era 1. The Mechanical Era

In this era several mechanical devices were invented that became the basis for the development of modern computers. The devices and their inventor are as follows:

a.) Abacus : Abacus is a mechanical device that can be used as tool for performing mathematical calculations. It had its origin in ancient-china, Greece (Roman), Egypt and the Great silky road in between 3000 years to 6000 years ago. It was used for performing simple calculations like counting, addition, subtraction and multiplication of numbers.

An abacus consists of a rectangular frame carrying a number of wooden rods. Mid-bar divides each of

these rods into unequal – upper and lower parts. The upper part is called heaven, whereas the lower part is called earth.

b.) Napier's bone: Napier bone, also called Napier's rod, was invented by Scottish mathematician John Napier. The Napier's bones are numbered rods which can be used to perform multiplication. The process of Napier's bone was published by John Napier in his book Rabdologia in 1617 AD. John Napier is also remembered as the inventor of logarithm.

c.) Slide Rule: The Englishman William Oughtred invented a rectangular device-slide rule in 1620 AD. It was a calculating device, based on the principles of logarithm. A slide rule consists of two graduated scales, one of which slips upon the other. The scales are devised in such a manner that suitable alignment of one scale against the other makes it possible to find products and quotients of any numbers.

d.) Pascal's Calculator (Pascaline): Pascaline is a calculating device developed by French mathematician Blaise Pascal in 1642 AD. He was the founder of the modern theory of probability. It could perform addition and subtraction up to 8 digits, that was a great achievement at that time. **e.) Stepped Reckoner:** The Stepped Reckoner, a first mechanical calculator, was invented by German mathematician Baron Gottfried Von Leibniz in 1670 AD. Leibniz extended Blaise Pascal's idea. It could perform addition, subtraction, multiplication, division and evaluate square roots by a series of stepped additions.

f.) Jacquard's Loom: The French Man Joseph Marie Jacquard was a textile manufacturer who invented a mechanism for automated weaving cloths for the textile industry at Lyon in 1802 AD. This machine was used to automatically control weaving looms to facilitate the production of weaving cloth with complex patterns. This machine was controlled by punch-cards i.e. principle of present and absence of holes.

g.) Analytical Engine: The English professor and mathematician Charles Babbage invented the Difference Engine at Cambridge University in 1822 AD. Theoretically, it can solve differential equations and calculate various mathematical functions, logarithmic, polynomial and trigonometric functions. The project could not be completed due to lack of funds. Babbage continued working on his different Engine for a full ten years, but he had a better idea. His new idea was the construction of a general purpose, fully programmable automatic mechanical counting machine, Babbage called his machine an Analytical Engine in 1833 AD.

The Analytical Engine was a general purpose mechanical computer. Babbage continued to refine the design until his death in 1871 AD. It contained all components as follows:

i) The store (equivalent to memory)
ii) The mill (equivalent to CPU)
iii) The input section using punched card
iv) The output section using punched card

For all his contribution and efforts guided a number of principles which have been shown to be fundamental to the design of today's digital computers. That's why he was considered as the "Father of modern computers".

h.) First programmer Ada Lovelace: Lady Augusta Ada Lovelace is considered as the world's first computer programmer. She wrote a program for Analytical Engine. A programming language "Ada" was developed by the US Department of Defense to honor her.

i.) Boolean Algebra: Boolean Algebra is algebra of logic. It was developed by George Boole, an English mathematician, in 1954 AD. It is the basis of design and implementation of digital systems including digital computers. Besides the hardware, it is also useful in programming for logical decisions. **j.) Tabulating Machine:** Tabulating Machine was developed by Herman Hollerith to help in data processing of the 1890 AD national census of the USA. He also created a punch card technology that allowed coding for state of residence, age, gender and other information. Hollerith brought his punch card reader into

the business world, founding Tabulating Machine Company 1896, later to become International Business Machine (IBM).

k.) Turing Machine: Turing Machine is an abstract, theoretical mathematical computing machine designed by Alan Turing in 1937 AD. The ideal machine is composed of a head, tape and a ribbon of paper of indefinite length. The tape is used to store data which is similar to memory and the head simulates the microprocessor of modern computers.

2) The Electro – Mechanical Era

a.) Mark I: A professor of Physics Howard H. Aiken designed a general purpose mechanical computer at Harvard University and IBM, while working on his doctorate in physics, in the year 1937 AD. The machine was called IBM Automatic Sequence Controlled Calculator, it was the first fully automatic calculating machine and later as Harvard Mark I. It was built by IBM. This giant computer used about 18 thousand vacuum tubes (valves) as the main memory device with 7 lakhs 50 thousand parts. It was about 51 feet long, 8 feet height and 3 feet wide. Punch card and card reader are used for input/output operation. Technically, it was a very complicated machine, consumed huge amounts of power and generated a lot of heat during the operation. This computer could carry out addition, subtraction, multiplication, division and table reference.

b.) ABC (Atanasoff Berry Computer): In 1939, John Vincent Atanasoff and Clifford Berry designed Atanasoff-Berry Computer (ABC) for solving systems of mathematical simultaneous equation. It used 18000 valves and other 45 valves for internal logic and capacitors for storage. It used punched cards as input and output operation i.e. secondary storage. It is considered as the first computing machine which introduced the idea of binary arithmetic, regenerative memory, and logic circuits. The main thing is that this computer used electronic vacuum tubes and the circuitry was based on George Boole's Boolean Algebra.

3) The Electronic Computers Era

a) ENIAC: ENIAC stands for "Electronic Numerical Integrator And Calculator" which was the first general purpose electronic computer developed by John William Mauchly and J. Presper Eckert in 1946 AD. It was built to fulfill the requirements of the US armed force. It was 10 feet tall, occupied about 1000 sq. feet, weighed 30 tons and used more than 18,000 vacuum tubes. So, it also consumed a lot of electricity and produced a lot of heat. It could do 5,000 additions and 300 multiplications per second.

b) EDSAC: EDSAC stands for electronic delay storage automatic computer which was made by Maurice Wilkes in 1949 AD by applying J. V. Neumann's "stored program technique". EDSAC contained 3,000 vacuum tubes and used mercury delay lines for memory. Programs were input using paper tape and output results were passed to a tele printer.

C) EDVAC: EDVAC stands for "Electronic Discrete Variable Automatic Computer" designed by J.W. Mauchly and J.P. Eckert in 1952 AD. It was also based on J.V. Neumann's stored program technique. The EDVAC was a binary serial computer with automatic addition, subtraction, multiplication, programmed division and automatic checking with an ultrasonic serial memory capacity of 1000 44 bit words (later set to 1024 words, thus giving a memory, in modern terms of 5.5 kilobytes). **d) UNIVAC:** UNIVAC stands for "UNIVersal Automatic Computer". It was the first general purpose electronic digital computer made for business and administrative use. It was also made by J.W. Mauchly and J.P. Eckert in 1961 AD. It was 8 feet high, 15 feet long and weighed about 15 tons.

Generation of Computers

Over the years, various computing devices were invented that enabled people to solve different types of problems. All these computing devices can be classified into several generations. These generations refer

to the phase of improvement made to different computing devices. The technological development in the field of computers not only refers to the improvements made to the hardware technologies, but also the improvements made to the software technologies.

There are five generation of computers which are as follows:

i) First Generation of Computers (1946 – 1959)

First generation computers were powered by thousands of vacuum tubes or thermionic valves and their memory was stored on magnetic storage devices such as magnetic tapes and drums. Most data were entered onto the computers via punch cards or paper tape. Output was in the same form human operators

had to set switches before a program could run.

Features of First Generation Computers

- These computers were based on vacuum tube technology.
- These computers were very large in size and required a lot of space.
- Processing or operating speed was in terms of milliseconds.
- The power consumption was very high and it generated a lot of heat.
- Programming mainly at the hardware level (Binary or Machine language, in the form of 0s and 1s) hence was very difficult to program and use.
- These machines were unreliable and lacked versatility and speed.
- Electrostatic tubes (internal), paper tape, punched card, magnetic tape were used for computer operation.
- Each machine component had to be assembled manually.
- It could only perform straight forward numerical calculations.

The examples of first generation computers are IBM 700 series, ENIAC, EDVAC, EDSAC and UNIVAC.

ii) Second Generation Computers (1959 – 1965)

In the second generation vacuum tubes were replaced by transistors. Due to the use of transistors, the computers became smaller and cheaper.

Features of Second Generation Computers

- These computers were based on transistors technology.
- They were smaller, faster, more reliable, accurate and more energy efficient as compared to first generation computers.
- They were portable and generated less heat as compared to first generation computers.
- Processing or operating speed was increased to microseconds.
- Magnetic core was used as primary and magnetic drum as secondary memory.
- Assembly languages was used to program and hence programming became more time efficient and less cumbersome.
- It could perform scientific calculations such as solving differential equations.

The examples of second generation computers are IBM 1401, IBM 7090, PDP 8 etc.

iii) Third Generation of Computers (1966 – 1971)

The development of Integrated Circuits (IC) signaled the beginning of the third generation. Transistors were replaced with integrated circuits known popularly as chips.

Features of third generation computers were:

- These computers were based on integrated circuit (IC) technology.
- They were smaller in size, more reliable, accurate than previous generation computer.
- Power consumption and heat generation was less than the previous generation computer.
- Computers became portable for the first time because of personal or desktop computer.

- Semiconductor memory was used as primary memory.
- Magnetic disk was used as secondary memory.
- Keyboard and monitor were used as input and output devices respectively for the first time.
- Processing or operating speed was increased to nanoseconds.
- Multiprogramming and multiprocessing facility was introduced.
- FORTRAN, BASIC and more high level languages are used.
- Database management system was developed.
- Computers were used in census calculation, military, banks and industries.
- Manual assembling of individual components was not required. Hence, commercial production became easier and cheaper.

The examples of third generation computers are IBM 360 series, NCR 395 etc.

iv) Fourth Generation of Computers (1971 – Till Date)

The invention of microprocessor chips marked the beginning of the beginning of the fourth generation computers. The invention of microprocessors led to the development of microcomputers or the personal computer. The first microprocessor called Intel 4004 was developed by American Intel Corporation in 1971.

Features of Fourth Generation Computers

- These computers were based on LSI, VLSI and microprocessors.
- The computers are powerful, compact, affordable, portable and totally reliable.
- Use of magnetic disk and optical disk with huge capacity for secondary storage devices.
- Processing speed increased very fast up to picoseconds.
- Multiprogramming, multi-processing, multi-media and distributed computing are possible.
- Because of microprocessor, micro computers such as PCs, Laptop and Notebook computers were invented.
- Fourth generation language (4GL) and application software for micro computers became popular.
- Graphical user interface and further refinement in input and output devices introduced.
- Interconnection of computers leads to better communication and resource sharing.
- It is used for all scientific, engineering and commercial applications.

The examples of fourth generation computers are IBM-PC, HP, Mac Notebook etc.

v) Fifth Generation Computers (Present and Beyond)

The computers of this generation will use Artificial Intelligence (AI) and Biochips are made up of Biological organisms and protein fibers obtained from the living organism. So these computers will have the power of sense, logic, decision making capability and parallel processing.

Features of Fifth Generation Computers

- These computers will have fully parallel processing capacity.
- Computers will be intelligent and knowledge base because of AI.
- Computers will use super conductor memory like biochips and Gallium Arsenide as memory device so that the speed will be very high.
- These machines will incorporate Ultra Large Scale Integration (ULSI).
- Instead of HLL (High Level Language), natural languages like English, Japanese etc. will be used for giving instruction to the computer and making computer programs.
- The application of AI in fifth generation computers has also enabled expert systems.
- The input and output for these machines will be in the form of speeches or graphic images.
- They are used in the field of medicine, treatment planning, monitoring and so on.

• The language of the operating system will be PROLOG, LISP etc.

Classification of Computer

Computers are classified according to working principle, size, brand, and model. A single computer can be microcomputer on basis of size, IBM compatible on the basis of brand, AT computer on the basis of model and digital computer on the basis of working principle.

i) Classification of Computer on the basis of Working Principle (Application)

a) Analog Computer b) Digital Computer c) Hybrid Computer

a) Analog Computer: The computer which can process analog quantities (continuous data) is called an analog computer. These computers processes continuous values rather than discrete binary values (i.e. 0 and 1). It is a special purpose computer and is mainly used in scientific work and not for commercial or personal purposes. Generally, it has less storage capacity or no storage and its accuracy is poor compared to digital computers. It is specially designed to compute physical forces such as temperature, pressure etc.

Presley is an example of an analog computer. Examples of analog devices are thermometer, barometer, speedometer and ammeter.

b) Digital Computer: The computer which works on discrete data (discontinuous data, binary system or 0 and 1) is known as a digital computer. The basic principle of digital computers is either present (1) or absence (0) of electric pulses in the signals. In digital computers, even letters, words and whole texts are represented digitally. It is multipurpose and programmable. So, it is high cost, fast processing, more accurate and has larger storage capacity. It can perform tasks to control industrial processes and regulate the operations of machines, analyze and organize vast amounts of business data and simulate the behavior of dynamic systems.

C) Hybrid Computer: A computer, which has a combined feature of both analog and digital computers, is called a hybrid computer. It can perform the tasks of an analog computer as well as a digital computer. It converts data from analog to digital and vice-versa. It has high cost. It is a special purpose computer. The practical examples of hybrid computers are:

- During the rocket launching process, the analog computer measures the speed of the rocket, temperature and pressure of the atmosphere. These measurements are then converted into digital signals and supplied to the digital computer to analyze the data for taking appropriate steps on launching.
- In hospitals, analog devices measure the temperature and blood pressure of patients. Then these measurements are converted into digital signals and fed to the digital computer that monitors the patient's vital information.

Classification of Computer on the basis of Power and Size

a) Supercomputer b) Mainframe computer c) Mini computer d) Micro computer

a) Supercomputer

Supercomputer is the largest, most powerful and fastest computer among digital computers. This computer has a special purpose and is capable of handling huge amounts of calculations that are beyond human capabilities. It can perform at billions of instructions per second (BIPS) and more. Some of today's supercomputers have the computing capability equal to that of 40,000 microcomputers. This computer is the most expensive computer (cost about 15-20-million-dollar range). Usually such computer uses parallel processors. Its word length is more than 128 bits. The primary use for supercomputers is in large corporations, universities and government agencies, mainly in the areas of defense and weaponry,

weather forecasting, scientific research, aeronautics, satellite communication and space administration, nuclear research work, petroleum research work, molecular modeling, study of DNA structures.
Example: CRAY X-MP/24, NEC-500, PARAM, ANURAG etc.

b) Mainframe Computer

Mainframes are large, powerful and expensive computers. It is general purpose computing system designed for large scale data processing. It is very large in size with an approximate area of 1000 sq. ft. The largest mainframes can handle the processing needs of thousands of users at any given moment. Its word length is more than 64 bits. It is used mainly by large companies for bulk data processing, commercial data processing, and other large-scale operations such as bank transaction processing, insurance companies, airlines, railway reservation system, and air traffic control.
Example: IBM 1401, VAX 8000, CDC 6600 etc.

C) Mini Computer

Minicomputers are computers that are somewhere in between a microcomputer and a mainframe computer. For this reason, minicomputers are often called midrange computers. Like a mainframe, a minicomputer can handle much more input and output than a micro computer. Minicomputers are smaller, less expensive and more powerful than a personal computer. It can support about 50 terminals and requires an area of around 100 sq. ft. These computers are used for scientific and engineering computation,business transaction processing, file handling, database management, universities, banks and are often now referred to as small or midsize servers.
Example: Prime 9755, VAX 7500, HCL, HP 3000 series etc.

d) Micro Computer

A microcomputer is a small sized personal computer (PC) that is designed for an individual having a microprocessor inside it. It requires small space, can be placed on a table or even kept inside a briefcase. This computer has a central processing unit on a single chip. It is mainly used in office, house, school, shop and store. The smallest of this category are laptop, notebook, palmtop and PDA.
Example, IBM PCs, Apple/Macintosh etc.
A microcomputer can be further categorized as
a) non-portable b) portable category.

a) The microcomputer in non-portable category can be further categorized into:
i) Personal Computer (PC) ii) Workstation Computer (WC)

i) Personal Computer (PC): It is a small computer that easily fits on a normal sized office table. It is generally designed to be used by one person at a time. It is the most common computer and can be found everywhere like in the office, college, home, hospital and shop.

ii) Workstation Computer (WC): A workstation is a specialized computer which has more power and features than a standard desktop PC. It is designed for the network environment in LAN. The processing power is typically 5 to 10 times more than that of PC. It has larger main and backup memory, larger and high resolution monitor and accelerated graphics handling capabilities, making it suitable for small engineering companies, architects, graphic designers, animation and video editing and any organization, department or individual.

b) The microcomputer in portable category can be further categorized into:
i) Laptop ii) Notebook iii) Tablet PC iv) Palm top v) PDA (Personal Digital Assistant) i) Laptop: A laptop computer is a portable personal computer light and small enough to sit on a person's lap. So, it is suitable for the person in the movie. It can be powered by a battery or plugged into the wall. It is lightweight, but incorporates all basic features of the computer like display, keyboard, touch pad, hard

disk CD/DVD drives.

ii) Notebook: Notebook is also designed for people on the move. But it is smaller in size compared to a laptop. It is a device with a reduced keyboard, screen, functionality, and software support than a laptop.

iii) Tablet PC: A tablet PC is a wireless, portable personal computer with a touch screen interface. The tablet is typically smaller than a smartphone and primarily operated by touching the screen rather than using a physical keyboard. It often uses an onscreen virtual keyboard, a passive stylus pen or a digital pen. It has handwriting recognizing software, which recognizes the handwritten text and digitizes it. **iv) Palmtop:** It is also a portable PC which is the size of our palm. Unlike laptop and notebook, it has very small memory and features. It is mainly used for storing phone numbers, addresses, pictures and such other small data. It contains an electronic writing pad and a light-sensitive electronic pen for providing input.

v) PDA : It is also a species of portable computer. It is much limited in terms of the task, it can perform. Nowadays, PDA contains facilities such as colored screens, scientific calculators, digital diary for storing telephone numbers and addresses, web browser, cell phone for communication, audio-video and games.

vi) Ultrabook: An Ultrabook is a category of thin and light laptop computers designed to bridge the market gap between tablets and premium notebook PCs. Ultrabooks provide more business-friendly features than tablets and more portability than enterprise-class notebooks. Ultrabooks are distinguished from notebooks by offering more power in the form of faster processors and additional RAM, as well as better

storage and larger screen sizes as well as long battery life, typically 8 hrs plus, features that also make these laptops significantly more expensive than most notebooks.

ii) Classification of Computer on the basis of Brand

a) IBM Computer

IBM stands for International Business Machine. It is one of the largest computer and other electronic equipment manufacturing companies founded by an American Hermann Hollerith in 1924 AD. It is the first company that manufactured commercial personal computers. IBM computers are of two categories:

1) IBM PC 2) IBM Compatible PC

1) IBM PC : This computer is developed by IBM corporation itself, so it is also called branded or original IBM PC. It is expensive, durable and more reliable than an IBM compatible PC.

2) IBM Compatible PC: This computer is developed by companies other than IBM but uses parts and principles of IBM. It is generally called an assembled or duplicate of IBM PC and is comparatively cheaper than IBM PC.

b) Apple/Macintosh

All the computers manufactured by apple cooperation are known as Apple/Macintosh computers. These computers use their own software and hardware and are totally different from that of IBM computers. Software developed for Apple computer can't run on IBM computers and vice-versa. It uses the MAC operating system. It is used for animation and graphics designing. It is usually costlier, reliable than IBM computers.

iii) Classification of Computer on the basis of Model

a) XT Computer

XT stands for "eXtra Technology" and these computers are old technology computer.It is text based system or CUI (Character User Interface) software. They don't have large storage capacity and fast processing speed, so complex calculation and large data processing speed, so complex calculation and large data processing can't be done. Even the I/O devices used in XT computers are not very flexible and

faster. The processor Intel 8085/8086/8088 lies under the XT technology.

b) AT Computer

AT stands for "Advanced Technology" and these computers are the new technology computers. AT uses advanced GUI based software as well as CUI based software. Their I/O devices are interactive, flexible and faster. Because of their high speed processor and large storage capacity, complex calculation and large data processing can be done easily. Having a processor Pentium 80286/80386/80486/Pentium I/Pentium II/ Pentium III etc.

c) PS/2 Computer

PS stands for "Personal System" and actually these are not totally different models of computers but are refinements of faster AT computers. The PS/2 model was developed after 1990 and mainly used in laptop computers. So these computers can run even on battery. They have faster and flexible I/O devices and use GUI based software.

Computer Architecture

Computer architecture refers to the definitions of basic attributes of hardware components and their interconnections, in order to achieve certain specified goals in terms of functions and performance. In other words, the design, arrangement, construction or organization of the different parts of a computer system is known as computer architecture. It is the conceptual design and fundamental operational structure of a computer system.

There are basically two types of digital computer architecture. The first one is called Von Neumann architecture and later Harvard architecture was adopted for designing digital computers. **Von Neumann Architecture**

It is named after the mathematician and early computer scientist John Von Neumann. According to this architecture, computers have single memory that stores both programs and data. Every computer has a processing unit containing an arithmetic logic unit (ALU), processor registers and a control unit. In this architecture an instruction fetch and a data fetch cannot occur at the same time because they share a common bus.

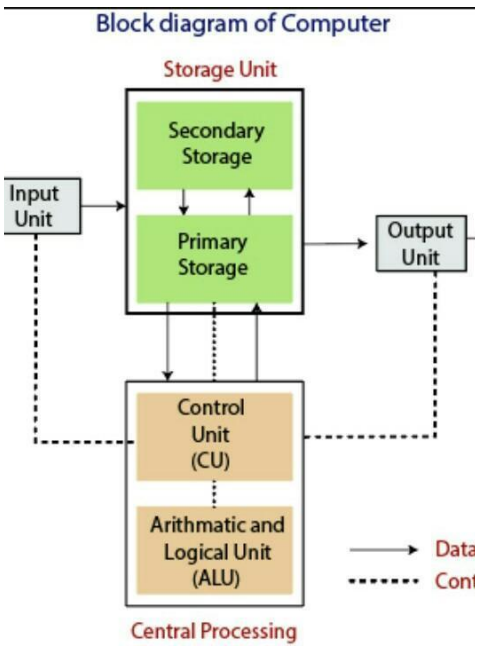
Figure: Von Neumann Architecture

Harvard Architecture

The name originated from an old computer "Harvard Mark I". In this architecture computers have two separate memories for storing data and programs. Most of the modern computer architectures are based on Harvard architecture. Thus it is possible to access program memory and data memory simultaneously. Typically, program memory is read-only and data memory is read-write. Therefore, it is impossible for program contents to be modified by the program itself.

Figure: Harvard Architecture

Anatomy of Digital Computers



A computer contains different hardware components that interact with each other to perform the task. Major hardware components in computer systems are: Input Unit, Output Unit, Processor and Storage. Relationship between these components is shown in above figure:

Input Unit: It accepts data or instructions given by the user and it converts the data and instructions from man readable to machine readable code. Some common input devices are keyboard, mouse, scanner, touch screen, light pen etc.

Output Unit: It provides the result after processing the data to the users. It converts the output into the user understandable format before providing it to the users. Some common output devices are: monitor, printer, speaker, plotter etc.

Processor/Central Processing Unit: The part of the computer that executes program instructions is known as processor or central processing unit (CPU). The central processing unit carries out each instruction program in sequence, to perform the basic arithmetical, logical, and input/output operation of the system. A CPU built on a single chip is called a microprocessor. It consists of three components. They are: Arithmetic Logic Unit (ALU), Control Unit (CU) and Registers.

Storage/Memory: It is responsible for storing data and instructions either for a short or longer period of time. Memory devices are of two types:

a) Primary or main memory b) Secondary or auxiliary memory

a) Primary or Main memory: It is the main memory of the computer. It is used for storing data and instructions during processing. It is the only memory which is directly accessible to the CPU. It is usually expensive, faster for read/write operation and used in small storage capacity. Examples are: RAM, ROM, Cache Memory.

b) Secondary or auxiliary memory: It is the additional memory of the computer. It is used for storing huge amount of data for longer period of time. It is also used for transferring data from one computer to another. It is usually cheaper, slower, and used in larger storage capacity. It is not directly accessible to the CPU; it requires primary memory for its operations. Examples are: Hard disk, CD, DVD, Pen drive etc.

Bus Architecture

In computer architecture, a bus is a collection of wires, chips and slots inside the computer through which data is transmitted from one part or component of the computer to another, to and from peripherals devices. Each component of the computer is connected to these buses.

The functions of bus are:

- It carries information from one computer to another.
- It carries data, address or control signal.
- One component of the computer can interact with others through the bus.

The bus consists of three main parts:

i) Address Bus ii) Data Bus iii) Control Bus

i) Address Bus: Address bus is used to specify the address of the memory location to be accessed. CPU reads data or instructions from memory locations by specifying the address of its location and CPU writes data to the memory locations by specifying the memory address. Address bus is unidirectional. This means, the address bus carries memory location in only one direction, from CPU to memory, both for read and write operation.

ii) Data Bus: Actual data is transferred via the data bus. In case of read operations, the CPU sends an address to memory; the memory will send data via the data bus in return to the CPU. In case of write operation, CPU sends an address via address bus and data via data bus. The data bus is a bidirectional bus, meaning the data can be transferred from CPU to main memory and vice versa.

iii) Control Bus: It is the path for sending the control signals generated by the Control Unit. Data and Address bus is shared by all the components of the system through the control bus. Some control signals are: Read, Write and Fetch etc. Control bus is used to tell what to do with the selected memory location. Various operations are performed by microprocessor with the help of a control bus. If the CPU needs to perform write operation on memory it sends 'write' signal via control bus but if CPU needs to perform read operation on the memory 'read' signal is sent via the control bus. Control bus is also unidirectional because only the CPU sends control signals to other devices.

Central Processing Unit (CPU)

The CPU is like the brain of a computer that organizes and executes instruction. Its primary function is to execute instruction. Besides executing instructions, the CPU controls the operation of all other components such as memory, input and output devices. Under its control, programs and data are stored in memory, displayed on the monitor or printed on the paper. A CPU built on a single chip is called a microprocessor. Nowadays, microprocessors are also called processors.

The functions of the CPU (Processor) are:

- To carry out processing.
- To give commands to all parts of the computer system.
- To control the sequence of operations.
- To control the storage of data or instructions.
- To perform arithmetic and logical calculations.

Some of the primary components of a CPU or microprocessor are given below:

a) Arithmetic and Logic Unit (ALU) b) Control Unit c) Register Array

a) Arithmetic and Logic Unit (ALU): It is the unit of microprocessor where various computing functions are performed on the data. Basic arithmetic functions which an ALU can carry out are an addition, subtraction, multiplication and division. The logical operation which it can carry out greater than, equal to, less than etc.

The main operations are summarized below:

- It performs basic arithmetical calculations such as addition, subtraction, multiplication, division etc.
- It performs logical operations such as comparing greater than, equal to etc.

b) Control Unit: The control unit of CPU controls the entire operation of the computer. It also controls all

other devices such as memory, input and output devices connected to the CPU. It directs the movement of electronic signals between main memory and ALU. It also directs these electronic signals between main memory and IO devices. Hence, the control unit acts as the nerve system of the computer system.

Functions of the Control Unit

- The CU carries out the controlling operations of computers.
- It performs data processing operations.
- It sends control signals to various parts of the computer system for controlling.
- It gives commands to input data from input unit to memory unit to ALU.
- It transforms results from ALU to memory unit to output unit.
- It gives commands to store the data, instruction and program in memory.

c) Register Array: A CPU contains multiple registers to store data temporarily during execution of a program. In order to handle all the operations satisfactorily and to speed up the rate of information transfer, a number of special memory units called registers are used. The length of a register equals the number of bits it can store. Hence, a register that can store 8 bits is referred to as an 8-bit register. Most CPUs sold today have 32-bit or 64-bit registers. The bigger the registers, the faster the computer can process a set of data. Some of the registers include instruction register, program counter, accumulator and memory address register etc. Each register has a specific function. For example, a program counter register holds the address of the next instruction to be executed from memory.

Features of Register

- They are the fastest memory of computer.
- The storage capacity of the register is small.
- They are temporary memories of computers.

Storage or Memory Unit

Memory unit is responsible for storing data and instructions either for a short or longer period of time.

Memory device of two types:

a) Primary Memory or Storage b) Secondary Memory or Storage

a) Primary Memory or Storage: It is also known as system memory or main memory or primary storage or internal memory of the computer. It is used for storing data and instructions during processing. It is the working area for the computer's processor. It is the only memory which is directly accessible to CPU. As soon as a computer starts, primary memory stores all running applications, operating system (OS), user interface and any others.

It has three tasks:

- It holds data for processing.
- It holds instructions (the programs) for processing the data.
- It holds data after it is processed waiting to be sent to an output or storage device.

The primary memories of computers are: RAM, ROM, Cache memory and Register.

Features of Primary Memory

- It is directly accessible to the CPU.
- It is used for storing data and programs while they are being used in computer. It is not used for storing data permanently.
- It is a volatile memory except ROM.
- It is usually expensive and faster for read/write operation than secondary memory. •

It is normally used for smaller storage.

- It is a semiconductor memory.
- It is not used for transferring data from one computer to another.

i) Random Access Memory (RAM) :

RAM is the read/write memory of the computer. It is the memory that holds instructions and data that are used frequently during processing. It is referred to as random access memory because it is possible to randomly select any location of the memory to store and retrieve data. It is volatile memory i.e. it stores data or information as long as the power supply is on, when the power supply goes off, the stored content in the RAM will be lost. RAM is used to store:

- Instruction waiting to be executed by CPU.
- Instruction currently being executed by CPU.
- Data waiting processing.
- Data currently being processed.
- Data waiting output.

Types of RAM

There are two types of RAM:

a) Static RAM (SRAM) b) Dynamic RAM (DRAM)

a) Static Random Access Memory (SRAM): It stores data and programs as long as the computer is ON state. It is expensive but faster for read/write than DRAM. It stores data in the form of voltage. It is rarely used at present due to expensive cost and limited storage capacity.

b) Dynamic Random Access Memory (DRAM): In DRAM, the stored data will be lost after a few milliseconds even if the computer is ON state. So, to prevent data loss, a refreshing circuit is required. It is cheaper but slower for read/write than SRAM. It stores data in the form of charge. It is popularly at present.

SRAM	DRAM
1. It stores data or programs as long as the power supply is 'ON' state.	1. It loses its stored information in a very short time (few seconds) even though the power supply is 'ON' state.
2. It doesn't require a refreshing circuit.	2. It requires a refreshing circuit.
3. It has a higher speed compared to DRAM.	3. It has lower speed than SRAM.
4. It stores data in a flip-flop circuit containing transistors in a memory cell.	4. It requires less number of transistors per memory cell because capacitors and one transistor are needed to form a memory cell.
5. It stores a bit as voltage.	5. It stores a bit as a charge.
6. It is expensive.	6. It is cheaper in cost.
7. The memory cell of SRAM is larger in size and loosely packed.	7. The memory cell of DRAM is smaller in size and tightly packed.
8. It is usually available in a smaller storage capacity of a few MB.	8. It is usually available in a large storage capacity of a few GB.

ii) Read Only Memory (ROM):

It is the primary memory that stores some standard processing programs supplied by the manufacturers

to operate the personal computer. The CPU can only read the content of ROM but it cannot change the content of ROM. The basic input/output program is stored in the ROM that examines and initializes various equipment attached to the PC when the switch is made ON. It is non-volatile memory because it doesn't lose its content on failure of power supply.

Types of ROM

a) Programmable Read Only Memory (PROM): A PROM is a memory chip on which data can be written only once. Once a program has been written into a PROM, it remains there forever. PROMs can also retain their contents when the computer is turned off. To write data onto a PROM chip, we need a special device called a PROM programmer or a PROM burner.

b) Erasable Programmable Read Only Memory (EPROM): EPROM is an erasable PROM. The data stored in EPROM can be erased by exposing it to strong ultraviolet (UV) light. When an EPROM is exposed to ultraviolet light, the entire data are erased. It is usually reprogrammed without removing it from the circuit board.

C) EEPROM (Electrical Erasable Programmable Read Only Memory): EEPROM is an electrically erasable PROM. It can be erased and reprogrammed on the byte by byte basis. Either a single byte or the entire chip can be erased in one operation. It requires much shorter time, a few milliseconds for erasing as compared to EPROM. It need not be removed from the circuit board for erasing as EPROM.

EEPROM is similar to flash memory (sometimes called flash EEPROM). The principle difference is that EEPROM requires data to be written or erased one byte at a time whereas flash memory allows data to be written or erased in blocks. This makes flash memory faster.

Cache Memory

It is extremely fast memory that is built into a computer's CPU or located next to it on a separate chip. The speed of the CPU is extremely high compared to the access time of the main memory. Therefore, the performance of the CPU decreases due to the slow speed of main memory. To overcome such a problem, a small memory chip is attached between CPU and main memory whose access time is very close to the processing speed of the CPU. It is called cache memory. It is used to store instructions and data frequently used by the CPU from RAM.

If the CPU needs data first of all it searches the cache memory for the data. If data is found in cache it is called cache hit and data is sent to the CPU. But if data is not found in cache, it is called cache miss. In case of cache miss, search request for data goes to RAM and the data is sent to CPU as well as one copy of the data is stored in cache so that the data can be found in cache for future references. Therefore, cache memory only stores a copy of data that is present in RAM. It is actually static RAM.

Cache can be further classified into two categories:

Level 1 Cache (L1): It is also called primary or internal cache. It is built directly into the processor chip. It is the smallest, fastest and most expensive cache memory. CPU looks to L1 cache first for data.

Level 2 Cache (L2): It is slower than L1 cache. Its storage capacity is more and it is also less expensive than L1. This cache is separate from the processor chip on the motherboard.

b) Secondary Memory or Storage Devices

Secondary memory is non-volatile memory i.e. stored data and instructions retained even if the power supply is cut off. It is also called auxiliary memory or backup memory. It is used primarily to store large volumes of data on a permanent basis that can be partially transferred to primary storage, whenever required for processing. Comparatively, secondary memory is cheaper than the main memory according to per bit cost.

Features of Secondary Memory

- It is called the auxiliary, external or backup memory.
- It is not directly accessible to the CPU; it requires primary memory for its operation.
- It is used for storing data and programs permanently.
- It is usually nonvolatile memory.
- It is usually cheaper and slower for read/write operation than primary memory.
- It is normally used in larger storage capacity.
- It can be magnetic, optical or semiconductor memory.
- It can be used for transferring data from one computer to another.

Examples are: Magnetic disks, Magnetic Tape, Flash memory, Optical storage etc.

The modern computer uses the following types of memory

a) Magnetic Disk or Memory b) Optical Disk or Memory

a) Magnetic Disk or Memory

It is the most common secondary storage device in a computer system. Generally, it is a random access device. It contains circular disks, which are made of metal (aluminum) or a thin plastic (Mylar) coated with iron oxide on both sides. It allows the recording of data in the form of magnetized spots. The data are stored on the disks in a number of concentric circles called tracks. Tracks are divided into sectors. All the tracks have the same number of sectors. The most common magnetic disks are floppy disk and hard disk.

Advantages

- Magnetic disk supports direct access of data making them more suitable for a wider range of applications.
- It is suitable for both on-line and off-line storage of data.
- It can be erased and reused many times.
- Its data transfer rate is higher than a tape system.

Disadvantages

- It is less efficient for sequential applications.
- It must be stored in a dust-free environment.
- It is less portable.
- Cost of magnetic disk storage is more expensive than the cost of magnetic tape.

Hard disk

Hard disk is a magnetic disk that is used as secondary memory for mass storage of data permanently. It stores programs, data, operating system, compilers, assembler, application program, and database. A single hard disk usually consists of several platters. Each platter requires two read/write heads, one for each side. All the read/write heads are attached to a single access arm so that they can move independently. It is generally made up of aluminum and is coated on both sides with the special iron oxide to store data in the form of magnetized spots. The platter is mounted on a stack on a spindle driven by the motor connected to the spindle. It rotates at very high speed between 3600 rpm to 15000 rpm (revolution per minute) or more. The average access time is about 15ms.

Floppy disk

A floppy disk, also known as diskette, is a removable round, flat piece of Mylar plastic, that stores data and programs as magnetized spots. It is used to move files between different computers, load new programs onto the computer, or store backup of data and small programs. It is not very reliable and can be damaged easily. Floppy comes in two basic sizes: 5.25 inch, which can hold 1.2 MB of data and 3.5 inch, which can hold 1.44 MB of data.

Magnetic Tape

The magnetic tape used for computers is made from the same material used for audio tape and video tape. It is a thin plastic tape coated with a substance that can be magnetized. It is a sequential access type storage device which is suitable for backup or duplicate storage. When a large volume of information is to be processed sequentially it can be stored magnetically. They are durable, can be written, erased, and re-written. It is also used for transporting data from one computer to another.

Flash Memory

It is used in small portable computers. Flash memory or flash RAM cards, consists of circuitry on credit card-size cards that can be inserted into slots connecting to the motherboard. Unlike standard RAM chips, flash memory is nonvolatile. Flash memory can be used not only to simulate main memory but also to supplement or replace hard disk drives for permanent storage.

b) Optical Disk

It is a removable disk on which data is written and read through the use of laser beams. A laser beam is a concentrated narrow beam of light, focused and directed on a particular location to read or write data. It is used as backup memory.

Advantages

- Cost-per-bit of storage for optical disks is very low because of their low cost and high storage density.
- The use of a single spiral track makes an optical disk an ideal storage medium for reading large blocks of sequential data such as audio or video.
- Since data once stored on this disk becomes permanent, the danger of stored data getting inadvertently erased or overwritten is not there.
- Due to its compact size and lightweight, it is easy to handle, store, and carry from one place to another.

Limitations

- It is a largely read only storage medium. Data once recorded, cannot be erased and hence the optical disks cannot be reused.
- The data access speed for optical disk is slower than magnetic disk.
- It requires more complicated drive mechanism than magnetic disk.
- Since it is a removable media, it is prone to scratches, dust, sticky prints (including fingerprints) while handling.

Types of Optical Disk

There are three types of optical disks: **a) CD (Compact Disk), b) DVD (Digital Versatile Disk) and c) BD (Blu-Ray Disk)**

a) Compact Disk (CD)

It is a data storage format, which basically means that it is used to store data. It is portable and its capacity usually ranges from 650 to 750 MB. There are three basic types of compact disk(CD). **i) CD-ROM (Compact Disk Read Only Memory)**

It stands for CD-Read Only memory. It is written during the process of manufacturing by high power laser beam. The data is permanent and can be read any number of times, but CD-ROMs cannot be modified. **ii) CD-R (Compact Disk Recordable)**

It stands for CD-Recordable. It is a CD format that allows you to write data onto a specially manufactured disk, which can then be read by a standard CD-ROM drive. It is once writable CD, i.e. the change of state is permanent, so it is also called WORM (Write Once Read Many) media.

iii) CD-RW (Compact Disk Rewritable)

It can be reused by erasing the content of the CD and again writing data on it. Using, CD-RW drive, users can write data onto a special rewritable compact disk, then overwrite it with new data. It has the same capacity as a standard compact disk, and most can be overwritten up to 100 times.

b) Digital Versatile Disk (DVD)

It is primarily used to store movies or music. However, it can hold any type of information. It is similar to a CD but has larger storage capacity, up to 4.7 GB on one disc. Like CDs, DVDs also have three types: DVD-ROM, DVD-R, DVD-RW.

C) Blu-Ray Disk (BD)

It is the name of the new generation optical disk. It is developed to enable recording, rewriting and playback of high definition video (HD), as well as storing large amounts of data. It can hold up to 25 GB on a single layered disk and 50 GB on a dual layered disk. The current optical disk technology such as DVD uses red laser to read and write data, the new disk, BD uses blue-violet laser beam, hence the name Blu-ray. Similar to CD and DVD, it also has different variations. Such as BD-ROM, BD-R and BD-RW.