UNIT 1 Introduction to Computer System

What is Computer?

A computer is a programmable electronic device that accepts raw data as input and processes it with a set of instructions (a program) to produce the result as output. It renders output just after performing mathematical and logical operations and can save the output for future use. It can process numerical as well as non-numerical calculations. The term "computer" is derived from the Latin word "computare" which means to calculate.

A computer is designed to execute applications and provides a variety of solutions through integrated hardware and software components. It works with the help of programs and represents the decimal numbers through a string of binary digits. It also has a memory that stores the data, programs, and result of processing. The components of a computer such as machinery that includes wires, transistors, circuits, hard disk are called hardware. Whereas, the programs and data are called software.

It is believed that the Analytical Engine was the first computer which was invented by Charles Babbage in 1837. It used punch cards as read-only memory. Charles Babbage is also known as the father of the computer.

The basic parts without which a computer cannot work are as follows:

- **Processor:** It executes instructions from software and hardware.
- **Memory:** It is the primary memory for data transfer between the CPU and storage.
- **Motherboard:** It is the part that connects all other parts or components of a computer.
- **Storage Device:** It permanently stores the data, e.g., hard drive.
- **Input Device:** It allows you to communicate with the computer or to input data, e.g., a keyboard.
- **Output Device:** It enables you to see the output, e.g., monitor.

Benefits of Using a Computer:

- **Increases your productivity:** A computer increases your productivity. For example, after having a basic understanding of a word processor, you can create, edit, store, and print the documents easily and quickly.
- **Connects to the Internet:** It connects you to the internet that allows you to send emails, browse content, gain information, use social media platforms, and more. By connecting to the internet, you can also connect to your long-distance friends and family members.
- **Storage:** A computer allows you to store a large amount of information, e.g., you can store your projects, ebooks, documents, movies, pictures, songs, and more.
- **Organized Data and Information:** It not only allows you to store data but also enables you to organize your data. For example, you can create different folders to store different data and information and thus can search for information easily and quickly.
- **Improves your abilities:** It helps write good English if you are not good at spelling and grammar. Similarly, if you are not good at math, and don't have a great memory, you can use a computer to perform calculations and store the results.
- **Assist the physically challenged:** It can be used to help the physically challenged, e.g., Stephen Hawking, who was not able to speak used computer to speak. It also can be used to help blind people by installing special software to read what is on the screen.
- **Keeps you entertained:** You can use the computer to listen to songs, watch movies, play games and more.

Basic Characteristics of Computer

- Speed
- Accuracy
- Diligence
- Reliability
- Memory
- Logical
- Versatility
- Automation
- Consistency
- Remembrance Power

Characteristics of Computers and their Explanation

Speed

A computer device's speed is extremely fast, as it can perform any calculation in seconds. This is one of the key characteristics of computers. This computer characteristic also enhances the versatility of the computer.

It can open any website or application in the blink of an eye. In real life, the computer is like our superhero, Flash. It can travel at the speed of light.

Accuracy

This is an incredible characteristic of computers, which is their high level of accuracy. It is capable of performing 100% accurate calculations.

Nothing in this world is perfect or accurate, but the computer proves these statements false with its precise results, calculations, and logic. The computer is comparable to our own Avenger Hawkeye, whose shooting accuracy is unrivaled.

Diligence

A computer is free of fatigue, lack of concentration, and so on. It can work for hours without making any mistakes.

It's like a superman who can fly and fight for hours and hours without tiring.

Reliability

A computer is a dependable machine that is capable of performing all tasks and operations at high speeds and with near-perfect accuracy.

Just like humans, computer software and hardware respond to the requests or demands made by users.
Spiderman and Iron Man have a relationship in which they are like mentors and students, and they completely trust each other.
Similarly, we are computer mentors, and the computer learns from us and is completely dependable.

Memory

Memory on computers is comparable to that in the human brain. It is used to store data and directions.
Computer memory is the storage space on the computer where data to be processed and processing instructions are stored. It has both primary and secondary memories.
The task we are currently working on is saved in the main memory, and the task we saved is saved until we delete it.
Just as in X-Men, Professor X has an excellent memory, just as that computer has excellent memory and storage capacity.

Logical

A computer system has certain characteristics, such as the capability of thinking, reasoning, and learning.
These characteristics of computers help them perform tasks logically and these characteristics have been further developed into what we today know as Artificial Intelligence.
For example, Batman uses his logical thinking and intelligence to create various gadgets using artificial intelligence.

Versatility

Because computers are so versatile, they can perform almost any task that can be reduced to a series of logical steps.

It refers to the ability or adaptation to quickly switch from one task to another.
The computer can smoothly transition from one task to another, much like an ant-man can shift and shrink himself into different shapes.

Automation

Automation is the use of technology to complete a task with as little human interaction as possible.
In computing, automation is typically accomplished through the use of a program, a script, or batch processing.
As in Guardians of the Galaxy, we have a baby Groot who can perform all of these tasks automatically without the assistance of other people thanks to the available programming data stored in it. Computers also automatically complete the instructed tasks.

Consistency

In the context of databases, consistency means that data cannot be written because it would violate the database's own rules for valid data.

Remembrance Power

A computer is capable of storing an unlimited amount of information or data. Any information can be stored and retrieved for as long as you need it, for an unlimited number of years.
It is entirely up to you how much data you want to store on a computer and when you want to lose or retrieve it.
Hulk is a scientist with an exceptional memory. When necessary, he remembers and recalls everything. Similarly, another excellent computer feature is its ability to recall and memorize information.

precisely. All these features of computers are responsible for providing the versatility of computers.

The Limitations of the Computer

Computers are still far from reaching a few major milestones. Humans continue to surpass computers in some tasks. Computers may be able to get around these restrictions in the near future. The limitations of computers will be discussed, but for the time being, human labor is still indispensable.

1. No IQ: Unfed or unprogrammed events cannot cause a computer to react. They are incapable of learning anything (zero intelligent quotients). The user's input determines these results entirely. That is, instead of correcting the incorrect input, they produce the incorrect result.

2. No feelings/ EQ: While the computer may function nonstop and relentlessly. Few activities, though, call for advice and concepts. Only those who have positive, negative, or mixed feelings about the task will be able to accomplish it.

In these situations, a machine fails because it lacks emotional intelligence (EQ) (Emotional Quotient).

3. Lack of Decision-Making: A computer cannot decide on its own. Each operation that the computer performs is fed with an algorithm to perform different processes for each situation. However, if it faces a problem that is not fed into the system, the computer is not ready for it. It either gets corrupted or does not respond.

4. Lack of Common Sense: Despite the fact that computers are automated devices, they nevertheless need human intervention. Only

when some input is given will it function. You might have to perform calculations for your math homework, for instance. Each sum must be fed in order to obtain the output. There are other characteristics of computers that make them lacking in some fields.

5. Human dependency: Once turned on, a computer is a mechanism that operates entirely automatically. But it is unable to operate in order to turn on. Without such a program, the computer does not know when to start and when to stop.

A computer has both its strengths and weaknesses, much like a coin has two sides. Humans have used computers for a very long time. However, they do contain restrictions that can only be removed with human aid.

Some Fun Things to Learn on a Computer

We've all read about the great characteristics of computers, so let's now read about some amazing things to do using this great machine!

1. Play Games: There's no need to explain the amount of fun you can have while playing games on a computer and having your dose of adrenaline rush. You can play several games, like Minecraft, Fortnite, etc. But always be careful to not stress yourself out.

2. Listen to online music: Music has been permanently transformed by computers. Music and digital technology are as integral to the music industry as guitars, from the way it is created to the way we listen to it. You can enjoy music from across the world on this compact machine.

3. Paint and Explore your creativity: One of the great ways to enhance your skills and practice your creativity is by using computer digital

painting software like MS Paint and Autodesk Sketchbook to doodle or even create masterpieces!

4. Learning to Code: The characteristics we discussed above enhance the versatility of computers and make them extremely compatible as a medium to learn to code. There are great resources available online which can help you with this, like BrightChamps, etc.

Conclusion

So, these were some fantastic **characteristics of computers**. Thanks to the amazing features of computers, which make our lives easier just like a superhero does all the time.

Because of the characteristics mentioned above, computers complete every task on time and with unparalleled accuracy and efficiency.

Applications of computer

Computers play a role in every field of life. They are used in homes, business, educational institutions, research organizations, medical field, government offices, entertainment, etc.

Home

Computers are used at homes for several purposes like online bill payment, watching movies or shows at home, home tutoring, social media access, playing games, internet access, etc. They provide communication through electronic mail. They help to avail work from home facility for corporate employees. Computers help the student community to avail online educational support.

Medical Field

Computers are used in hospitals to maintain a database of patients' history, diagnosis, X-rays, live monitoring of patients, etc. Surgeons nowadays use robotic surgical devices to perform delicate operations, and conduct surgeries remotely. Virtual reality

technologies are also used for training purposes. It also helps to monitor the fetus inside the mother's womb.

Entertainment

Computers help to watch movies online, play games online; act as a virtual entertainer in playing games, listening to music, etc. MIDI instruments greatly help people in the entertainment industry in recording music with artificial instruments. Videos can be fed from computers to full screen televisions. Photo editors are available with fabulous features.

Industry

Computers are used to perform several tasks in industries like managing inventory, designing purpose, creating virtual sample products, interior designing, video conferencing, etc. Online marketing has seen a great revolution in its ability to sell various products to inaccessible corners like interior or rural areas. Stock markets have seen phenomenal participation from different levels of people through the use of computers.

Education

Computers are used in education sector through online classes, online examinations, referring e-books, online tutoring, etc. They help in increased use of audio-visual aids in the education field.

Government

In government sectors, computers are used in data processing, maintaining a database of citizens and supporting a paperless environment. The country's defense organizations have greatly benefitted from computers in their use for missile development, satellites, rocket launches, etc.

Banking

In the banking sector, computers are used to store details of customers and conduct transactions, such as withdrawal and deposit of money through ATMs. Banks have

reduced manual errors and expenses to a great extent through extensive use of computers.

Business

Nowadays, computers are totally integrated into business. The main objective of business is transaction processing, which involves transactions with suppliers, employees or customers. Computers can make these transactions easy and accurate. People can analyze investments, sales, expenses, markets and other aspects of business using computers.

Training

Many organizations use computer-based training to train their employees, to save money and improve performance. Video conferencing through computers allows saving of time and travelling costs by being able to connect people in various locations.

Arts

Computers are extensively used in dance, photography, arts and culture. The fluid movement of dance can be shown live via animation. Photos can be digitized using computers.

Science and Engineering

Computers with high performance are used to stimulate dynamic process in Science and Engineering. Supercomputers have numerous applications in area of Research and Development (R&D). Topographic images can be created through computers. Scientists use computers to plot and analyze data to have a better understanding of earthquakes.

History of Computers

The first counting device was used by the primitive people. They used sticks, stones and bones as counting tools. As human mind and technology improved with time more computing devices were developed. Some of the popular computing devices starting with the first to recent ones are described below;

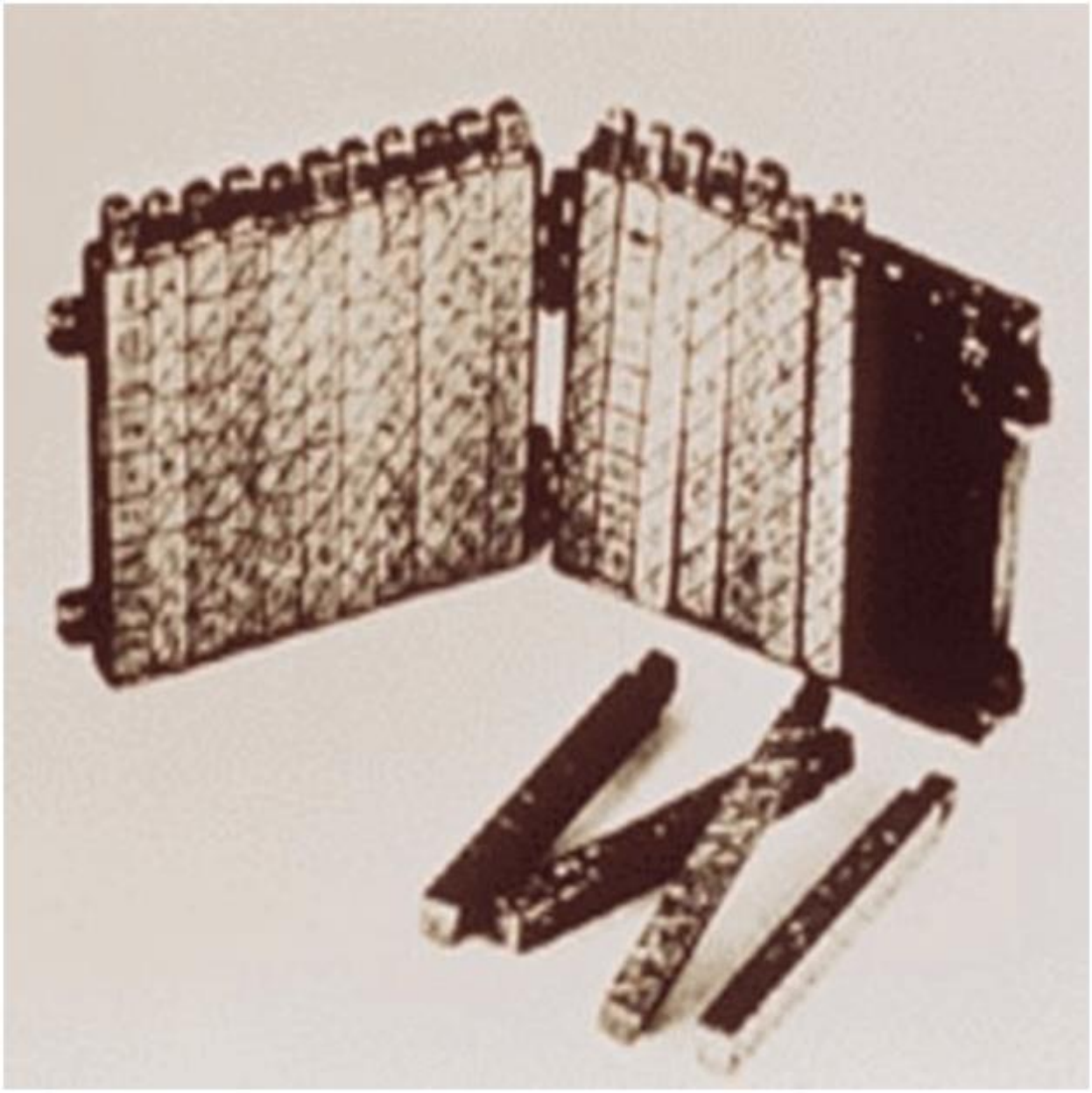
Abacus

The history of computer begins with the birth of abacus which is believed to be the first computer. It is said that Chinese invented Abacus around 4,000 years ago.

It was a wooden rack which has metal rods with beads mounted on them. The beads were moved by the abacus operator according to some rules to perform arithmetic calculations. Abacus is still used in some countries like China, Russia and Japan. An image of this tool is shown below;

Napier's Bones

It was a manually-operated calculating device which was invented by John Napier (1550-1617) of Merchiston. In this calculating tool, he used 9 different ivory strips or bones marked with numbers to multiply and divide. So, the tool became known as "Napier's Bones. It was also the first machine to use the decimal point.



Pascaline

Pascaline is also known as Arithmetic Machine or Adding Machine. It was invented between 1642 and 1644 by a French mathematician-philosopher Biaise Pascal. It is believed that it was the first mechanical and automatic calculator.

Pascal invented this machine to help his father, a tax accountant. It could only perform addition and subtraction. It was a wooden box with a series of gears and wheels. When a wheel is rotated one revolution, it rotates the neighboring wheel. A series of windows is given on the top of the wheels to read the totals. An image of this tool is shown below;

Stepped Reckoner or Leibnitz wheel

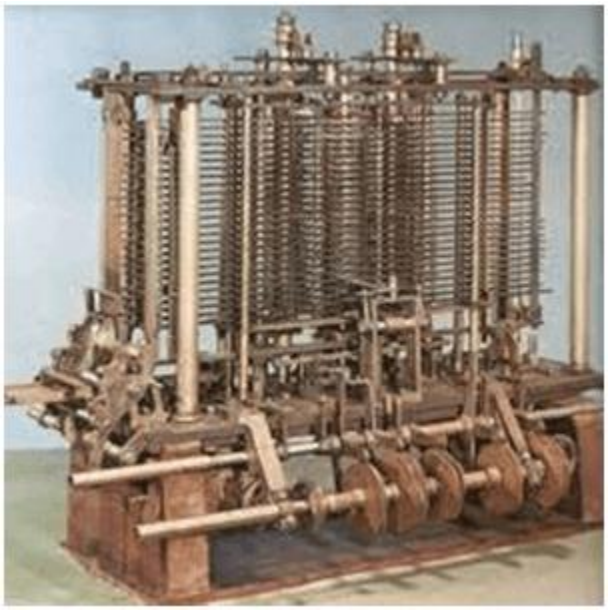
It was developed by a German mathematician-philosopher Gottfried Wilhelm Leibnitz in 1673. He improved Pascal's invention to develop this machine. It was a digital mechanical calculator which was called the stepped reckoner as instead of gears it was made of fluted drums. See the following image;

Difference Engine

In the early 1820s, it was designed by Charles Babbage who is known as "Father of Modern Computer". It was a mechanical computer which could perform simple calculations. It was a steam driven calculating machine designed to solve tables of numbers like logarithm tables.

Analytical Engine

This calculating machine was also developed by Charles Babbage in 1830. It was a mechanical computer that used punch-cards as input. It was capable of solving any mathematical problem and storing information as a permanent memory.

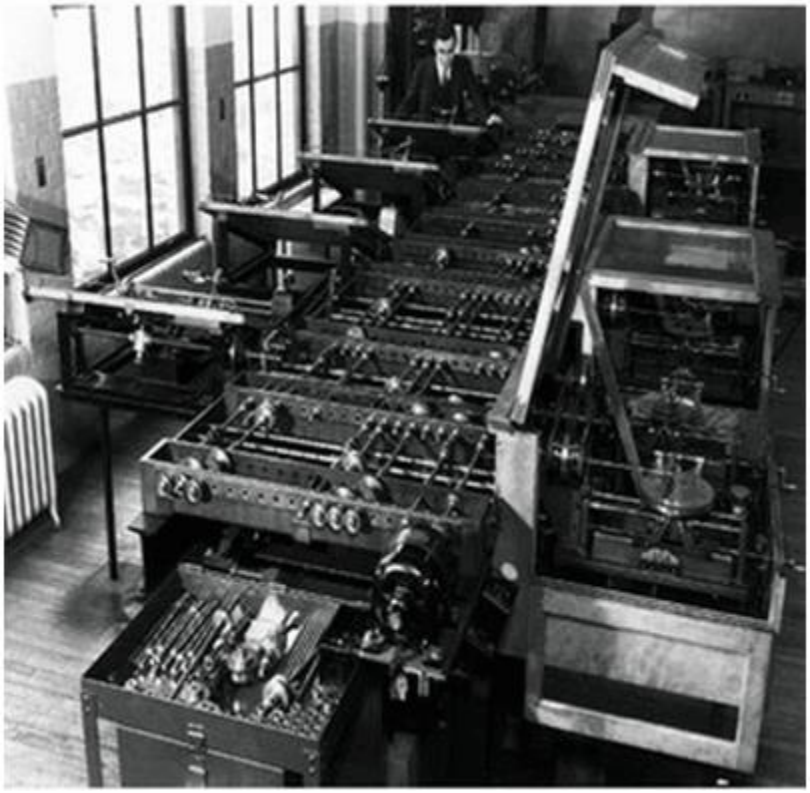


Tabulating Machine

It was invented in 1890, by Herman Hollerith, an American statistician. It was a mechanical tabulator based on punch cards. It could tabulate statistics and record or sort data or information. This machine was used in the 1890 U.S. Census. Hollerith also started the Hollerith?s Tabulating Machine Company which later became International Business Machine (IBM) in 1924.

Differential Analyzer

It was the first electronic computer introduced in the United States in 1930. It was an analog device invented by Vannevar Bush. This machine has vacuum tubes to switch electrical signals to perform calculations. It could do 25 calculations in few minutes.



Mark I

The next major changes in the history of computer began in 1937 when Howard Aiken planned to develop a machine that could perform calculations involving large numbers. In 1944, Mark I computer was built as a partnership between IBM and Harvard. It was the first programmable digital computer.

Generations of Computers

A generation of computers refers to the specific improvements in computer technology with time. In 1946, electronic pathways called circuits were developed to perform the counting. It replaced the gears and other mechanical parts used for counting in previous computing machines.

In each new generation, the circuits became smaller and more advanced than the previous generation circuits. The miniaturization helped increase the speed, memory and power of computers. There are five generations of computers which are described below;

First Generation Computers

The first generation (1946-1959) computers were slow, huge and expensive. In these computers, vacuum tubes were used as the basic components of CPU and memory. These computers were mainly depended on batch operating system and punch cards. Magnetic tape and paper tape were used as output and input devices in this generation;

Some of the popular first generation computers are;

- **ENIAC** (Electronic Numerical Integrator and Computer)
- **EDVAC** (Electronic Discrete Variable Automatic Computer)
- **UNIVACI**(Universal Automatic Computer)
- **IBM-701**
- **IBM-650**

Second Generation Computers

The second generation (1959-1965) was the era of the transistor computers. These computers used transistors which were cheap, compact and consuming less power; it made transistor computers faster than the first generation computers.

In this generation, magnetic cores were used as the primary memory and magnetic disc and tapes were used as the secondary storage. Assembly language and programming languages like COBOL and FORTRAN, and Batch processing and multiprogramming operating systems were used in these computers.

Some of the popular second generation computers are;

- **IBM 1620**
- **IBM 7094**
- **CDC 1604**
- **CDC 3600**
- **UNIVAC 1108**

Third Generation Computers

The third generation computers used integrated circuits (ICs) instead of transistors. A single IC can pack huge number of transistors which increased the power of a computer and reduced the cost. The computers also became more reliable, efficient and smaller in size. These generation computers used remote processing, time-sharing, multi programming as operating system. Also, the high-level programming languages like FORTRON-II TO IV, COBOL, PASCAL PL/1, ALGOL-68 were used in this generation.

Some of the popular third generation computers are;

- **IBM-360 series**
- **Honeywell-6000 series**
- **PDP(Personal Data Processor)**
- **IBM-370/168**
- **TDC-316**

Fourth Generation Computers

The fourth generation (1971-1980) computers used very large scale integrated (VLSI) circuits; a chip containing millions of transistors and other circuit elements. These chips made this generation computers more compact, powerful, fast and affordable. These generation computers used real time, time sharing and distributed operating system. The programming languages like C, C++, DBASE were also used in this generation.

Some of the popular fourth generation computers are;

- **DEC 10**
- **STAR 1000**
- **PDP 11**
- **CRAY-1(Super Computer)**
- **CRAY-X-MP(Super Computer)**

Fifth Generation Computers

In fifth generation (1980-till date) computers, the VLSI technology was replaced with ULSI (Ultra Large Scale Integration). It made possible the production of microprocessor chips with ten million electronic components. This generation computers used parallel processing hardware and AI (Artificial Intelligence) software. The programming languages used in this generation were C, C++, Java, .Net, etc.

Some of the popular fifth generation computers are;

- **Desktop**
- **Laptop**
- **NoteBook**
- **UltraBook**

- **ChromeBook**

Types of Computer

On the basis of data handling capabilities, the computer is of *three* types:

- Analogue Computer
- Digital Computer
- Hybrid Computer

1) Analogue Computer

Analogue computers are designed to ***process analogue data***. Analogue data is continuous data that changes continuously and cannot have discrete values. We can say that analogue computers are used where we don't need exact values always such as speed, temperature, pressure and current.

Analogue computers directly accept the data from the measuring device without first converting it into numbers and codes. They measure the continuous changes in physical quantity and generally render output as a reading on a dial or scale. ***Speedometer*** and ***mercury thermometer*** are examples of analogue computers.

Advantages of using analogue computers:

- It allows real-time operations and computation at the same time and continuous representation of all data within the rage of the analogue machine.
- In some applications, it allows performing calculations without taking the help of transducers for converting the inputs or outputs to digital electronic form and vice versa.
- The programmer can scale the problem for the dynamic range of the analogue computer. It provides insight into the problem and helps understand the errors and their effects.

Types of analogue computers:

- **Slide Rules**: It is one of the simplest types of ***mechanical analogue computers***. It was developed to perform ***basic mathematical calculations***. It is made of two

rods. To perform the calculation, the hashed rod is slid to line up with the markings on another rod.

- **Differential Analysers**: It was developed to perform ***differential calculations***. It performs integration using wheel-and-disc mechanisms to solve differential calculations.
- **Castle Clock**: It was invented by ***Al-Jarazi***. It was able to save programming instructions. Its height was around 11 feet and it was provided with the display of time, the zodiac, and the solar and lunar orbits. This device also could allow users to set the length of the day as per the current season.
- **Electronic Analogue Computer**: In this type of analogue computer, electrical signals flow through capacitors and resistors to simulate physical phenomena. Here, the mechanical interaction of components does not take place. The voltage of the electrical signal generates the appropriate displays.

2) Digital Computer

Digital computer is designed to perform calculations and logical operations at high speed. It accepts the raw data as input in the form of digits or binary numbers (0 and 1) and processes it with programs stored in its memory to produce the output. All modern computers like laptops, desktops including smartphones that we use at home or office are digital computers.

Advantages of digital computers:

- It allows you to store a large amount of information and to retrieve it easily whenever you need it.
- You can easily add new features to digital systems more easily.
- Different applications can be used in digital systems just by changing the program without making any changes in hardware
- The cost of hardware is less due to the advancement in the IC technology.
- It offers high speed as the data is processed digitally.
- It is highly reliable as it uses error correction codes.
- Reproducibility of results is higher as the output is not affected by noise, temperature, humidity, and other properties of its components.

3) Hybrid Computer

Hybrid computer has features of both analogue and digital computer. It is ***fast like an analogue*** computer and has memory and ***accuracy like digital computers***. It can process both continuous and discrete data. It accepts analogue signals and convert them into digital form before processing. So, it is widely used in specialized applications where both analogue and digital data is processed. For example, a processor is used in petrol pumps that converts the measurements of fuel flow into quantity and price. Similarly, they are used in airplanes, hospitals, and scientific applications.

Advantages of using hybrid computers:

- Its computing speed is very high due to the all-parallel configuration of the analogue subsystem.
- It produces precise and quick results that are more accurate and useful.
- It has the ability to solve and manage big equation in real-time.
- It helps in the on-line data processing.

On the basis of size, the computer can be of *five* types:

1) Supercomputer

Supercomputers are the ***biggest and fastest computers***. They are designed to process huge amount of data. A supercomputer can ***process trillions of instructions in a second***. It has thousands of interconnected processors.

Supercomputers are particularly used in ***scientific and engineering applications*** such as weather forecasting, scientific simulations and nuclear energy research. The first supercomputer was developed by ***Roger Cray in 1976***.

Characteristics or applications of supercomputers:

- It has the ability to decrypt your password to enhance protection for security reasons.
- It produces excellent results in animations.
- It is used for virtual testing of nuclear weapons and critical medical tests.

- It can study and understand climate patterns and forecast weather conditions. It can run in NOAA's system (National Oceanic and Atmospheric Administration) that can execute any type of simple and logical data.
- It helps in designing the flight simulators for pilots at the beginner level for their training.
- It helps in extracting useful information from data storage centres or cloud system. For example, in insurance companies.
- It has played a vital role in managing the online currency world such as stock market and bitcoin.
- It helps in the diagnosis of various critical diseases and in producing accurate results in brain injuries, strokes, etc.
- It helps in scientific research areas by accurately analysing data obtained from exploring the solar system, satellites, and movement of Earth.
- It also used in a smog control system where it predicts the level of fog and other pollutants in the atmosphere.

2) Mainframe computer

Mainframe computers are designed to support hundreds or thousands of users simultaneously. They can support multiple programs at the same time. It means they can execute different processes simultaneously. These features of mainframe computers make them ideal for big organizations like banking and telecom sectors, which need to manage and process high volume of data.

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Characteristics of Mainframe Computers:

- It can process huge amount of data, e.g. millions of transactions in a second in the banking sector.
- It has a very long life. It can run smoothly for up to 50 years after proper installation.

- It gives excellent performance with large scale memory management.
- It has the ability to share or distribute its workload among other processors and input/output terminals.
- There are fewer chances of error or bugs during processing in mainframe computers. If any error occurs it can fix it quickly without affecting the performance.
- It has the ability to protect the stored data and other ongoing exchange of information and data.

Applications of mainframe computers:

- In ***health care,*** it enabled hospitals to maintain a record of their millions of patients in order to contact them for treatment or related to their appointment, medicine updates or disease updates.
- In the ***field of defence***, it allows the defence departments to share a large amount of sensitive information with other branches of defence.
- In the ***field of education***, it helps big universities to store, manage and retrieve data related to their courses, admissions, students, teachers, employees and affiliated schools and colleges.
- In the ***retail sector***, the retail companies that have a huge customer base and branches use mainframe computers to handle and execute information related to their inventory management, customer management, and huge transactions in a short duration.

3) Miniframe or Minicomputer

It is a ***midsize multiprocessing computer***. It consists of two or more processors and can support ***4 to 200 users at one time***. Miniframe computers are used in institutes and departments for tasks such as billing, accounting and inventory management. A minicomputer ***lies between the mainframe and microcomputer*** as it is smaller than mainframe but larger than a microcomputer.

Characteristics of miniframe or minicomputer:

- It is light weight that makes it easy to carry and fit anywhere.

- It is less expensive than mainframe computers.
- It is very fast compared to its size.
- It remains charged for a long time.
- It does not require a controlled operational environment.

Applications of minicomputers:

A minicomputer is mainly used to perform three primary functions, which are as follows:

- **Process control**: It was used for process control in manufacturing. It mainly performs two primary functions that are collecting data and feedback. If any abnormality occurs in the process, it is detected by the minicomputer and necessary adjustments are made accordingly.
- **Data management**: It is an excellent device for small organizations to collect, store and share data. Local hospitals and hotels can use it to maintain the records of their patients and customers respectively.
- **Communications Portal**: It can also play the role of a communication device in larger systems by serving as a portal between a human operator and a central processor or computer.

4) Workstation

Workstation is a ***single user computer*** that is designed for ***technical or scientific applications***. It has a faster microprocessor, a large amount of RAM and high speed graphic adapters. It generally ***performs a specific job with great expertise***; accordingly, they are of different types such as graphics workstation, music workstation and engineering design workstation.

Characteristics of workstation computer:

- It is a high-performance computer system designed for a single user for business or professional use.
- It has larger storage capacity, better graphics, and more powerful CPU than a personal computer.
- It can handle animation, data analysis, CAD, audio and video creation and editing.

Any computer that has the following ***five features***, can be termed as a workstation or can be used as a workstation.

- **Multiple Processor Cores**: It has more processor cores than simple laptops or computers.
- **ECC RAM**: It is provided with Error-correcting code memory that can fix memory errors before they affect the system's performance.
- **RAID (Redundant Array of Independent Disks)**: It refers to multiple internal hard drives to store or process data. RAID can be of different types, for example, there can be multiple drives to process data or mirrored drives where if one drive does not work than other starts functioning.
- **SSD**: It is better than conventional hard-disk drives. It does not have moving parts, so the chances of physical failure are very less.
- **Optimized, Higher end GPU**: It reduces the load on CPU. E.g., CPU has to do less work while processing the screen output.

5) Microcomputer

Microcomputer is also known as a personal computer. It is a general-purpose computer that is designed for individual use. It has a microprocessor as a central processing unit, memory, storage area, input unit and output unit. Laptops and desktop computers are examples of microcomputers. They are suitable for personal work that may be making an assignment, watching a movie, or at office for office work.

Characteristics of a microcomputer:

- It is the smallest in size among all types of computers.
- A limited number of software can be used.
- It is designed for personal work and applications. Only one user can work at a time.
- It is less expansive and easy to use.
- It does not require the user to have special skills or training to use it.
- Generally, comes with single semiconductor chip.
- It is capable of multitasking such as printing, scanning, browsing, watching videos, etc

What is mobile computing?

Mobile computing refers to the set of IT technologies, products, services and operational strategies and procedures that enable end users to access computation, information and related resources and capabilities while mobile. Mobile most commonly refers to access in motion, where the user is not restricted to a given geographic location.

Mobile may also refer to access in a fixed location via equipment that users can relocate as required but is stationary while in operation. This mode of operation is often called nomadic computing.

Today, mobile computing technology is everywhere. It has applications in business and consumer markets, industrial and entertainment industries, as well as many specialized vertical markets.

Desktop computers offer more hardware configuration capabilities and computational performance. However, the majority of end users prefer mobile devices. The key advantage of mobile computing is convenience, where users have access to information and computational resources anytime and anywhere.

How does mobile computing work?

Generally, a mobile computing system involves a mobile device, such as a laptop computer, tablet or smartphone, and a wireless network connection based on Wi-Fi or cellular wireless technology, such as 5G. Mobile devices typically can store data locally, and access to that data doesn't require a network connection.

Mobile computers typically accommodate access to both wireless and wired technology. Access to shared network resources, including mobile cloud-based resources, is essential given the collaborative nature of work today. Integrated, rechargeable batteries power mobile devices, and most can run on an alternating current (AC) power source when used from a fixed location.

In addition to laptops, tablets and smartphones, there are many mobile computing devices for vertical and specialized applications. These include devices for medical, surveillance, security, and telemetry and control uses.

Device selection is based on the application. For example, laptops are better suited for content creation, and tablets are often preferred for content consumption. Smartphones function as pocket-size computers and communication devices, but they have small screen sizes and screen-based keyboards.

Why is mobile computing used?

Mobile computing is used in most facets of life both in business and by consumers. It enables users to be untethered from a power source for periods of time. This is advantageous for traveling workers who want to stay connected to their work while on the move. It's also useful for remote workers who may not have all the connectivity and power options they have in an office setting.

Consumers use mobile computing in several ways, including the following:

- internet access
- mobile communications
- web browsing
- mobile applications
- entertainment streaming media

Mobile devices and apps can collect user data in various environments and contexts. Fitbits and smartwatches are examples of wearable technology that collect user data in novel contexts, including fitness and health settings.

Mobile computing also makes the internet of things (IoT) possible. The nontraditional computers, sensors and other devices that make up IoT are able to connect and communicate without direct human intervention.

What are the types of mobile computing?

Mobile computing is a combination of infrastructure, hardware and software technology. The various parts of mobile computing are as follows:

- **Mobile infrastructure.** Infrastructure refers to the technical pieces that allow devices to communicate. Mobile infrastructure includes the wireless networks, wireless protocols and data formats.
- **Mobile hardware.** The physical mobile device and supporting hardware that users interact with make up the mobile hardware. This may include cell phones, laptops, tablets, wearable computers and accompanying chargers and accessories.
- **Mobile software.** This refers to the applications that run on mobile devices, including mobile operating systems (OSes) and user-facing applications, such as mobile browsers and e-commerce applications.

Low-code mobile apps enable enterprises to quickly configure mobile apps for enterprise needs, providing them with useful features like push notifications.

Some different types of mobile computing include the following examples:

- **Consumer use.** Consumers can use mobile devices like laptops, smartphones, wearables and tablets for an array of activities, including communication, entertainment, banking, bill paying and health and fitness tracking.
- **Remote work.** Employees use laptops or tablets to work and collaborate. Delivery personnel use mobile devices for logistical and management information, and to verify that deliveries were made to the right place. Field

service technicians use mobile devices for field service management, tracking and support capabilities.

- **IoT.** Consumer and enterprise IoT devices are used to communicate with other devices without human intervention. For example, self-driving cars use sensors, onboard computers and other connected devices to connect with GPS, weather and other systems to navigate the road safely. Smart sensors are also used in supply chain management systems to track the progress of goods in transit.

Mobile technologies

Most microprocessor vendors offer mobile versions of their products. These products consume less power and are physically smaller than their desktop counterparts. Consequentially, they often don't perform as well as the desktop products. However, this is not an issue for most mobile applications because a range of products at various price points are available that address most application demands.

Today's Wi-Fi and 5G networks offer ultra-low latency throughput that supports most mobile applications. Unlimited cellular data plans make data costs manageable, offering good availability, reliability, throughput and bandwidth.

Color graphics displays are universal on mobile devices, and touch is the primary user interface. These displays consume a lot of battery power, which is why product engineers continue to improve backlighting for LCD screens and OLED displays.

Mobile devices today use a mix of cloud and local storage. They typically use solid-state storage designs based on flash memory technology instead of physically heavier and more fragile hard drives.

What are the advantages of mobile computing?

The advantages of mobile, ubiquitous computing include the following:

- **Portability.** Mobile devices are smaller and more portable than traditional computers, making them easy to carry and use in a range of contexts. They work disconnected from a power source and without a physical network connection and when disconnected from the network.
- **Affordability.** Over time, mobile devices have become less expensive and easier to obtain. Increasingly, people opt for smartphones and tablets as their primary means of online connectivity. And it is often cheaper to buy a smartphone than a desktop PC.
- **Wireless communications.** Mobile devices let users engage in phone, video and various text and instant messaging applications.
- **Data.** Mobile devices and applications enable companies to collect more consumer data than was possible with traditional computing. For example, mobile devices can record geolocation of the device and its user. A marketing company can use a behavioral analytics application to match the location of a device with the user's behavior on the device, and then target advertisements to the user at that given moment. This is a common practice in neuromarketing. Some mobile applications also collect biometric data, such as heart rate readings, which can help users track their health.

What are the limitations of mobile computing?

Mobile computing is not without issues such as the following ones:

- **Power.** Despite increasing battery life, power consumption continues to be an issue, and mobile devices must be recharged regularly.
- **Connectivity.** While the mobile infrastructure continues to improve, there are areas where signal strength is poor or nonexistent.
- **Data security.** Mobile computing raises significant data security vulnerabilities because business users, especially, may have sensitive data on their devices while traveling or working remotely. Companies must implement security measures and policies to keep corporate data secure.

- **Dependence.** The flip side to the convenience of mobile devices is that consumers may become overly reliant on them, which can lead to compulsive or unhealthy behaviors such as smartphone addiction.
- **Distraction.** Mobile devices can be distracting and potentially dangerous in a hazardous work environment that requires the employee's attention, such as a construction site. They pose dangers if used inappropriately while driving.

Mobile security is one of the challenges of mobile computing. See some of the ways mobile devices can be compromised.

Evolution of mobile computing

In the early 1970s, mainframe computing sometimes provided remote access using a modem-based dial-up connection, typically at 300 to 1,200 bits per second (bps). Users worked teletype or cathode ray tube (CRT) terminals. Mobile terminals appeared during this era as well. These portable devices were larger, heavier and more expensive than today's mobile computers, and network speeds were slow.

The development of the first mobile computers in the late 1970s were on sewing machine-size PCs, such as the Osborne 1 and the Compaq Portable. These were based on early OSes, such as CP/M and MS-DOS. They used floppy disks, small monochrome CRT displays and, when available, plug-in (RJ-11) modems of up to 2,400 bps. These nomadic devices still required AC power, but they enabled portable computing.

Early laptop computers, such as the GRiD Systems Compass Computer 1101, also required AC power and were large, heavy and expensive. Laptops became popular in the 1990s as technology improved and design became more portable, especially as the smaller notebook form factor evolved. Add-on and internal Wi-Fi links, reliable battery power and contemporary OSes, such as Microsoft Windows, MacOS and Linux improved displays and reduced prices.

Personal digital assistants (PDAs), which first appeared in the early 1990s, were an outgrowth of personal organizer devices. These were designed to store and retrieve information needed for personal productivity, such as calendars and phone directories.

The first commercial mobile phone appeared in 1983. Phones gained popularity as they became more portable and networks became more ubiquitous. The addition of cellular voice, data and Wi-Fi led to the smartphone. Blackberry introduced the first smartphone in 2002, and the Apple iPhone's launch in 2007 opened the floodgates of user demand. Improvements in hardware components led to the development of mobile OSes; Apple iOS was introduced in 2007 and Android in 2008.

The tablet PC, featuring touchscreen and pen interfaces, is rooted in popular industrial and commercial applications of the 1980s. Apple released the first iPad in 2010. It introduced many consumers to this form factor, and both iOS and Android models remain popular today. Contemporary tablets are essentially smartphones in large form factors that offer larger displays. Many tablet models do not include cellular communication but do connect to Wi-Fi.

Today, mobile computing architecture is increasingly cloud-centric, with web and cloud-based access essential for many applications. Key cloud computing services include software distribution, device management, data storage and sharing, and access to shared applications.

Mobile computing is expected to play an increasingly important role in people's lives as the use of edge computing, IoT and 5G technologies expands. Mobile computing

and distributed computing complement each other, and information systems will become increasingly reliant on both.

Anatomy of a Digital Computer

What is Digital Computer ?

Digital computer is any of a class of devices capable of solving problems by processing information in discrete form. It operates on data, including magnitudes, letters, and symbols, that are expressed in binary form i.e., using only the two digits 0 and 1. By counting, comparing, and manipulating these digits or their combinations according to a set of instructions held in its memory, a digital computer can perform such tasks as to control industrial processes and regulate the operations of machines.

What is Anatomy ?

As per definition of Oxford dictionary, Anatomy stands for “the scientific study of the physical structure of humans, animals or plants”. But here we are using Anatomy in context of Digital computer but as you can see from definition we will only focus on the Physical aspect of it and not software or OS level.

Characteristic of Digital Computer ?

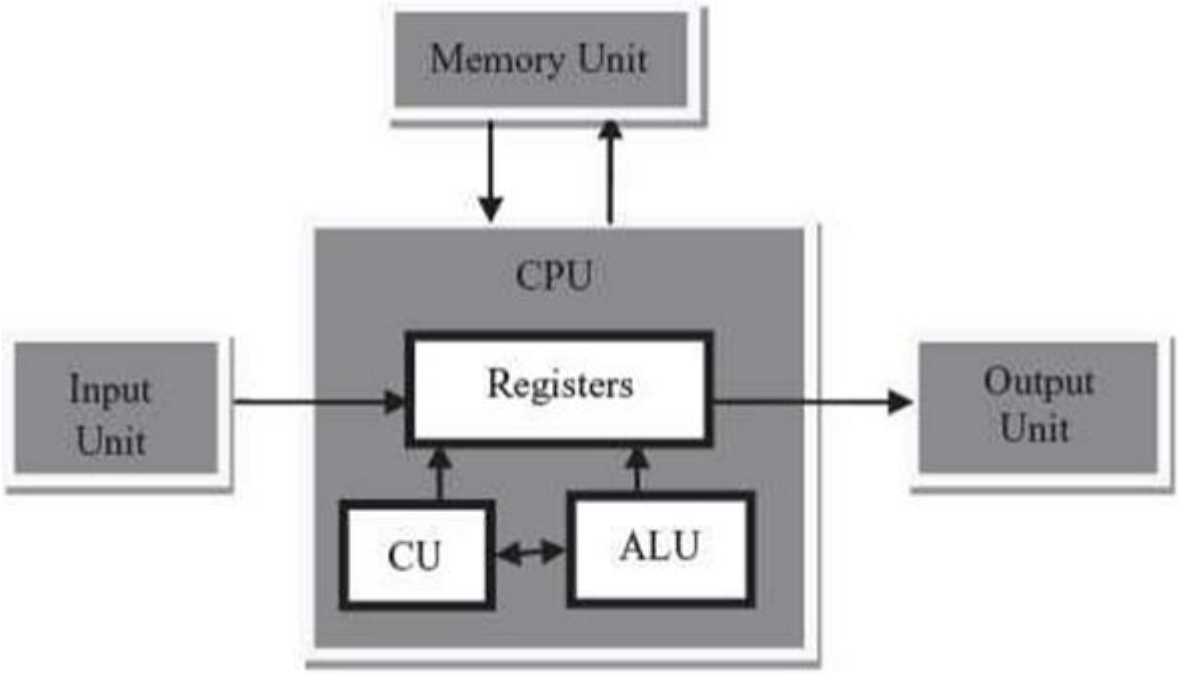
We should keep in mind that a computer is a programmable machine. The two main characteristics of a computer are:

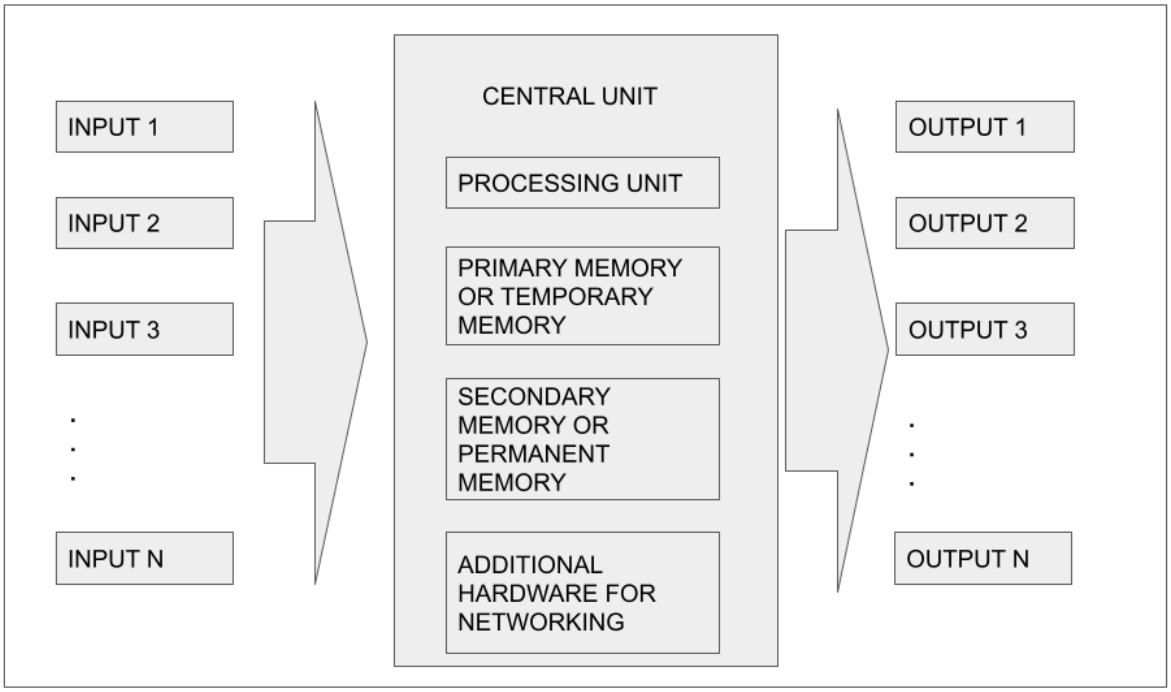
1. It responds to a specific set of instructions in a well-defined manner.
2. It can execute a pre-recorded list of instructions (a program).

Hardware Components

Modern computers are electronic and digital. The actual machinery – wires, transistors and circuits is called hardware. The instructions and data are called

software. All general purpose computers require the following hardware components:





1. **Input device(s)** – There can be one or more input devices, Usually a keyboard, mouse, touchpad, touchscreen, microphone, camera, scratch pad, digital pencil or any such device which is used to generate digital data and passes on this data to central processing unit.
2. **Output device(s)** – Any device or hard ware which allows output of the processed data in human readable or understandable form can be categorized as an output devices, example for such devices can be: a display screen, printer, speaker, graph plotter etc.
3. **Central Unit** – This is a set of hardware devices which combined together connected by a common base usually called `Motherboard`. They communicate with each other and take input from Input devices, process them as per software instructions stored in processing and memory units and finalize the output of the same.
    1. **Processing Unit** – Commonly known as CPU is a micro processor which is fastest component in terms of processing provided data. This device is can be as small to use inside a digital watch to as collective to form GPUs which can process huge graphical data in microseconds. some examples of CPU are: Intel i3, i5, i7, i9 or X processors, some examples of GPU are Nvidia GTX series graphics cards. The memory capacity of the CPU units are very low, but slowly increasing with more and more technological advancements.
    2. **Primary Memory** – commonly and majorly known as RAM or Random access Memory is known as primary memory this is way bigger then the memory of CPU, now days many systems can be configured with RAMs up to 64GB as well. Even cellphones come with RAM of upto 8GB and digital watches support RAMs upto 1GB. The primary function of RAM is to keep data in the form of quick access blocks, whenever CPU wants to access some data, RAM is ready with an indexed block of data. If the size is full it stores old and unused data on Hard drives and loads useful data into ram. This process is known as Paging.

3. **Hard Drives** – Also known as secondary memory is a block of data storage unit which can store data even when there is no power in the system. This kind of data drives are able to store up to many TBs of data and with collaborative algorithms in place RAID systems can be create which can connect many drives together to multiply the capacity of the storage. In computers though SATA storage drives are still popular a faster version of SSD(solid state drive) are becoming more common. SSDs are faster than SATA but still not as fast as RAM. In the mobile devices the alternative is known as ROM which is a combined set of storage and software installed over it and acts almost like a tightly coupled unit.
4. **Networking Device(s)** – Now days it is very common to have constant access of either local or global network using Internet. Even in mobile devices cellular technologies are now obvious. Thus almost all the digital devices in market are equipped with networking hardware by default in order to support internet connectivity. Though a decade ago this was not common but now it has become integrated part of any digital devices you may think of unless there is some specific security reason to not do so.

In addition to these components, many others make it possible for the basic components of a computer to work together efficiently.

Functions and Components of a Computer

To function properly, the computer needs both hardware and software. Hardware consists of the mechanical and electronic devices, which we can see and touch. The software consists of programs, the operating system and the data that reside in the memory and storage devices. A computer does mainly the following four functions:

1. **Receive input** – Accept data/information from outside through various input devices like the keyboard, mouse, scanner, microphone, camera, touch screen etc.
2. **Process information** – Perform arithmetic or logical operations on data/information.
3. **Produce output**—Communicate information to the outside world through output devices like Screen, printer, speaker etc.
4. **Store information**—Store the information in storage devices like SATA HDD, SDD, USB Flash Drive or Cloud Network Storage.

These four basic functions are responsible for everything that computers do. The hardware components of the computer specialize in any one of these functions. Computer hardware falls into two categories:

1. **Processing hardware:** The Processing hardware consists of the Central Processing Unit (CPU), and as its name implies, is where the data processing is done.
2. **The peripheral devices:** Peripheral devices allow people to interact with the CPU. Together, they make it possible to use the computer for a variety of tasks.

Central Processing Unit (CPU)

This part of the computer that executes program instructions is known as the processor or Central Processing Unit (CPU). In a microcomputer, the CPU is based on a single electronic component, the microprocessor chip, within the system unit or system cabinet. The system unit also includes circuit boards, memory chips, ports and other components. A microcomputer's system cabinet.
will also house disk drives, hard disks, etc., but these are considered separate from the CPU. The CPU has two parts :

The Control Unit (CU)

The control unit tells the rest of the computer system how to carry out a program's instructions. It directs the movement of electronic signals between memory – which temporarily holds data, instructions and processes

information – and the ALU. It also directs these control signals between the CPU and input/output devices.

Note : In a microcomputer, both are on a single microprocessor chip.

Arithmetic/Logic Unit (ALU)

Arithmetic Logic Unit, usually called the ALU, performs two types of operations – arithmetical and logical. Arithmetical operations are the fundamental mathematical operations consisting of addition, subtraction, multiplication and division. Logical operations consist of comparisons. That is two pieces of data are compared to see whether one is equal to, less than, or greater than the other.

Memory

Memory – also known as the primary storage or main memory – is a part of the microcomputer that holds data and instructions. Part of the contents of the memory is held only temporarily, that is, it is stored only as long as the microcomputer is turned on. When you turn the machine off, the contents are lost. The capacity of the memory to hold data and program instructions varies in different computers. The original IBM PC could hold approximately several thousand characters of data or instructions only. But modern microcomputers can hold millions or even billions of characters in their memory.

Registers

Computers also have several additional storage locations called registers. These appear in the Control Unit and ALU and make processing more efficient. Registers are a sort of special hi-speed storage areas that hold data and instructions temporarily during processing. They are parts of the Control Unit and ALU rather than the memory. Their contents can, therefore be handled much faster than the contents of the memory.

Addresses

To locate the characters of data or instructions in the main memory, the computer stores them in locations known as addresses. A unique number designates each address. Addresses can be compared to post office mailboxes. Their numbers remain the same, but contents continuously change.

How the CPU and Memory work – explained with example program

1. The control unit recognizes that the program has been loaded into the memory. It begins to execute the first step in the program.
2. The program tells the user, "Enter 1st Number".
3. The user types the number 100 on the keyboard. An electronic signal is sent to the CPU.
4. The control unit recognizes this signal and routes the signal to an address in memory – say address 7.
5. After completing the above instruction, the next instruction tells the user, "Enter 2nd Number."
6. The user types the number 4 on the keyboard. An electronic signal is sent to the CPU.
7. The control unit recognizes this signal and routes it to memory address
8. The next program instruction is executed – "Multiply 1st and 2nd Numbers."
9. To execute this instruction, the control unit informs the ALU that two numbers are coming and the ALU is to multiply them. The control unit next sends to the ALU a copy of the contents of address 7 (100) and address 8(4).
10. ALU performs the multiplication : 100 × 4 = 400
11. The control unit sends a copy of the multiplied result (400:) back to memory to store it in address 9.
12. The next program instruction is executed : "Print the Result."
13. To execute this instruction, the control unit sends the contents of the address 9 (400) to the monitor.
14. Monitor displays the value 400.

15.Final instruction is executed: “End”. The program is complete

Computer Architecture

Computer architecture comprises rules, methods, and procedures that describe the execution and functionality of the entire computer system. In general terms, computer architecture refers to how a computer system is designed using compatible technologies. This article will tell you how computer architecture is classified into a disciplinary method.

History of Computer Architecture

The term architecture in computer literature signifies the efforts of Sir Lyle R. Johnson and Sir Frederick P. Brooks, members of the Machine Organization department, in 1959. Sir Johnson noted his description of formats, instruction types, hardware limitations, along with speed improvements. These were at the level of system architecture, a term that is more useful than machine organization. Succeedingly, a computer user can use that term in many less precise methods.

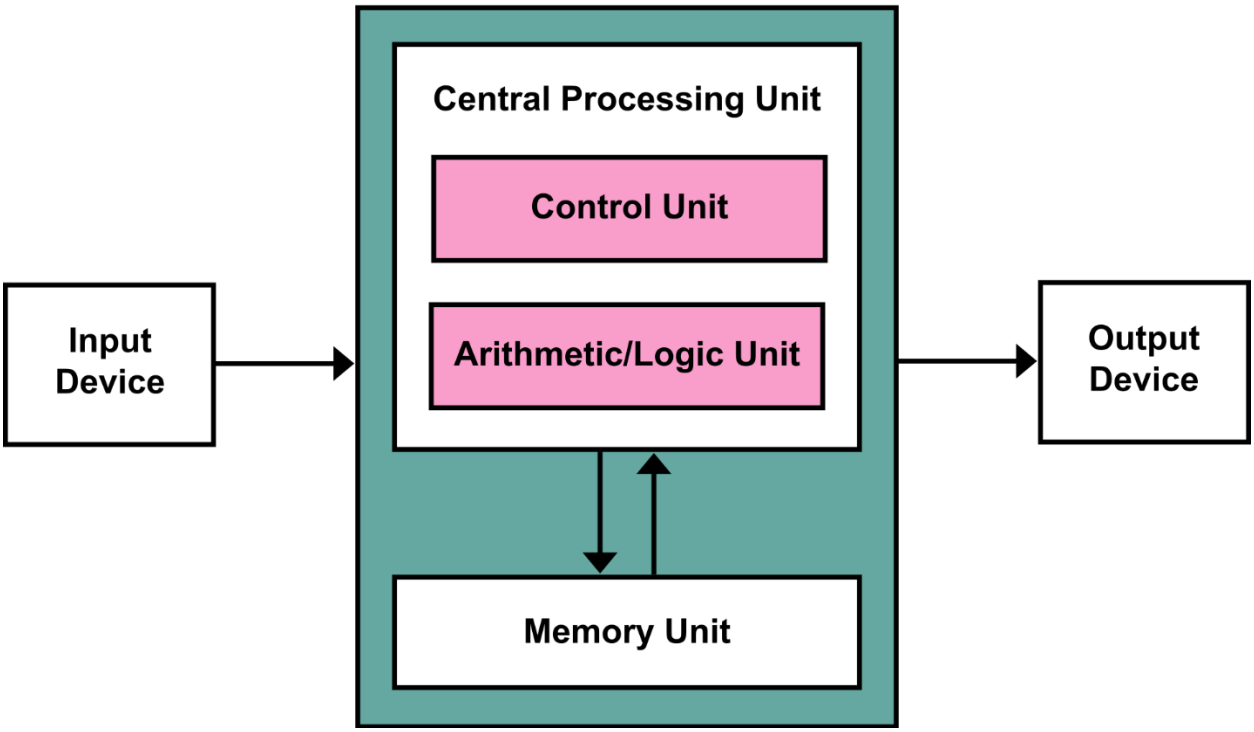
Earlier, computer architects designed computer architecture on paper. It was then directly built into a final hardware form. Later, they assembled computer architecture designs materially in the form of transistor-transistor logic (TTL) computers. By the 1990s, new computer architectures are typically built, examined, and tweaked inside another computer architecture, in a computer architecture simulator, or the interior part of an FPGA, as a microprocessor before perpetrating to the ultimate hardware form.

Types of Computer Architecture

Here are the various categories of architecture that exist in our computer systems.

- Von-Neumann Architecture
- Harvard Architecture
- Instruction Set Architecture
- Micro-architecture
- System Design

Von-Neumann Architecture (Neumann Model or Princeton Architecture)

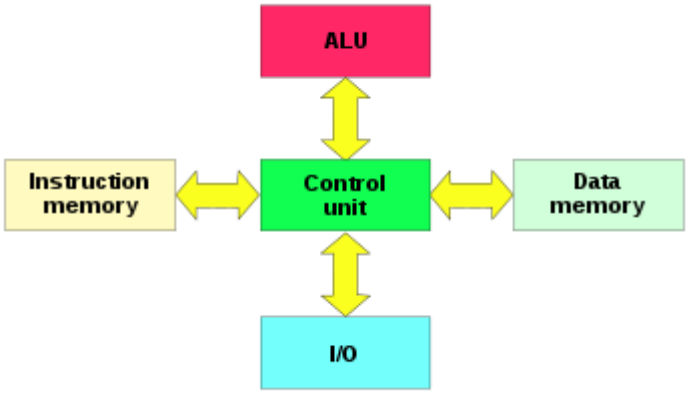


John von Neumann coined and developed this architecture. The computer we are using nowadays is based on the von Neumann architecture. It has some concepts. It is also known as Princeton architecture. It renders a unique design for the electronic digital systems having the following components:

- A Central Processing Unit (CPU) with arithmetic and logic unit (ALU) and processors with attached registers.
- A memory that can store data and instructions.
- External mass storage or secondary storage.
- A Control Unit (CU) with the ability to hold instructions in the program counter (PC) or instruction register (IR).
- Input and output mechanisms and peripherals.

The von Neumann design thus constitutes the foundation of modern computing. The Harvard architecture, a similar model, had committed data addresses and buses for reading and writing to memory. It wins because von Neumann's architecture was easier to execute in real hardware.

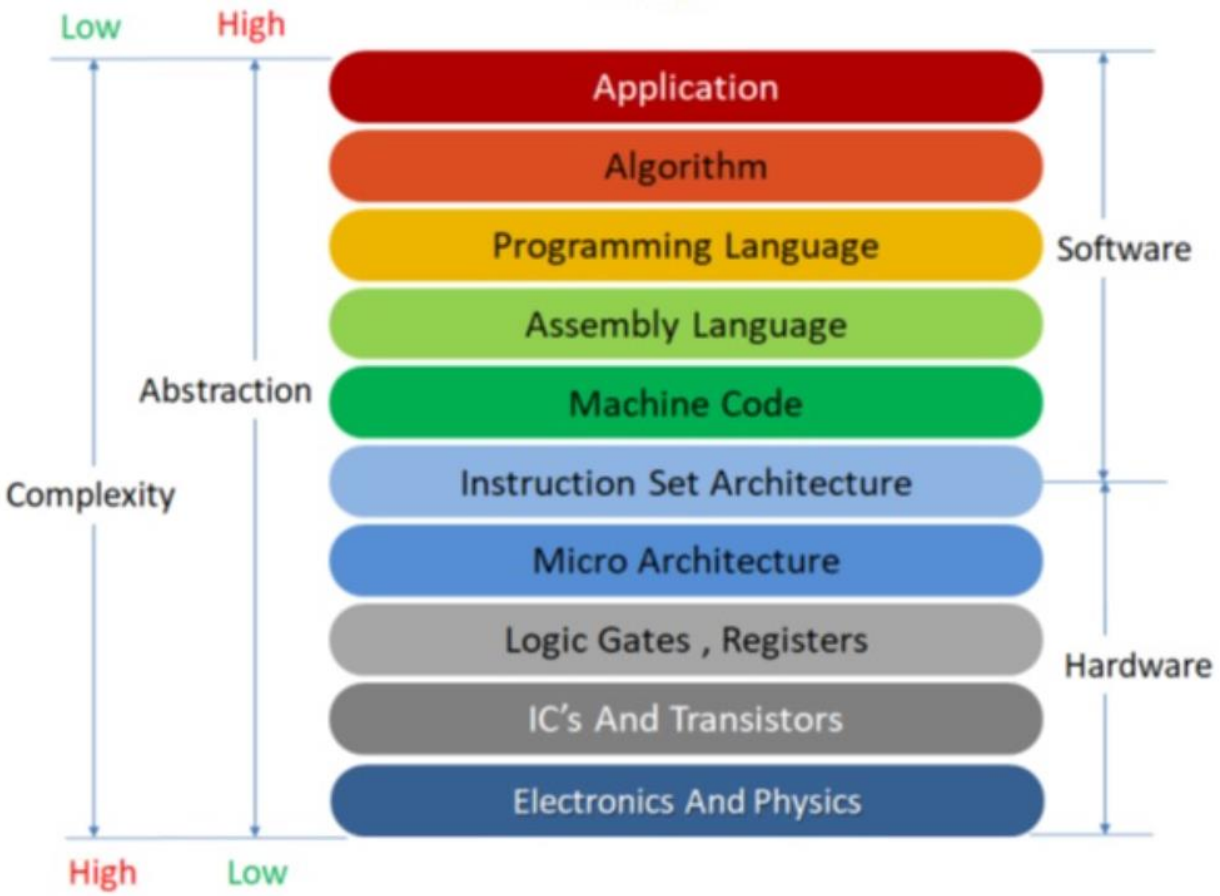
Harvard Architecture



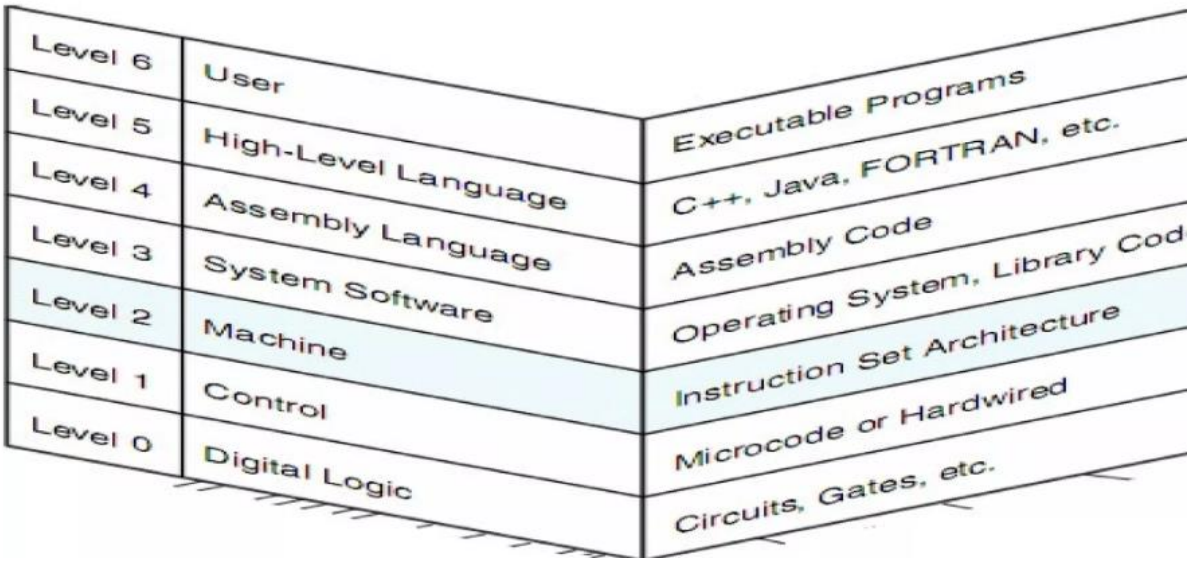
Harvard Architecture consists of code and data laid in distinct memory sections. It requires a separate memory block for data and instruction. It has solely contained data storage within the Central Processing Unit (CPU). A single collection of clock cycles is needed. Data accessibility in one memory is done by a single memory location in the case of Harvard architecture.

One typical example is the Punch card. Moreover, modern computers may have the latest CPU processes for both methods but disparate them in a hardware design.

Instruction Set Architecture



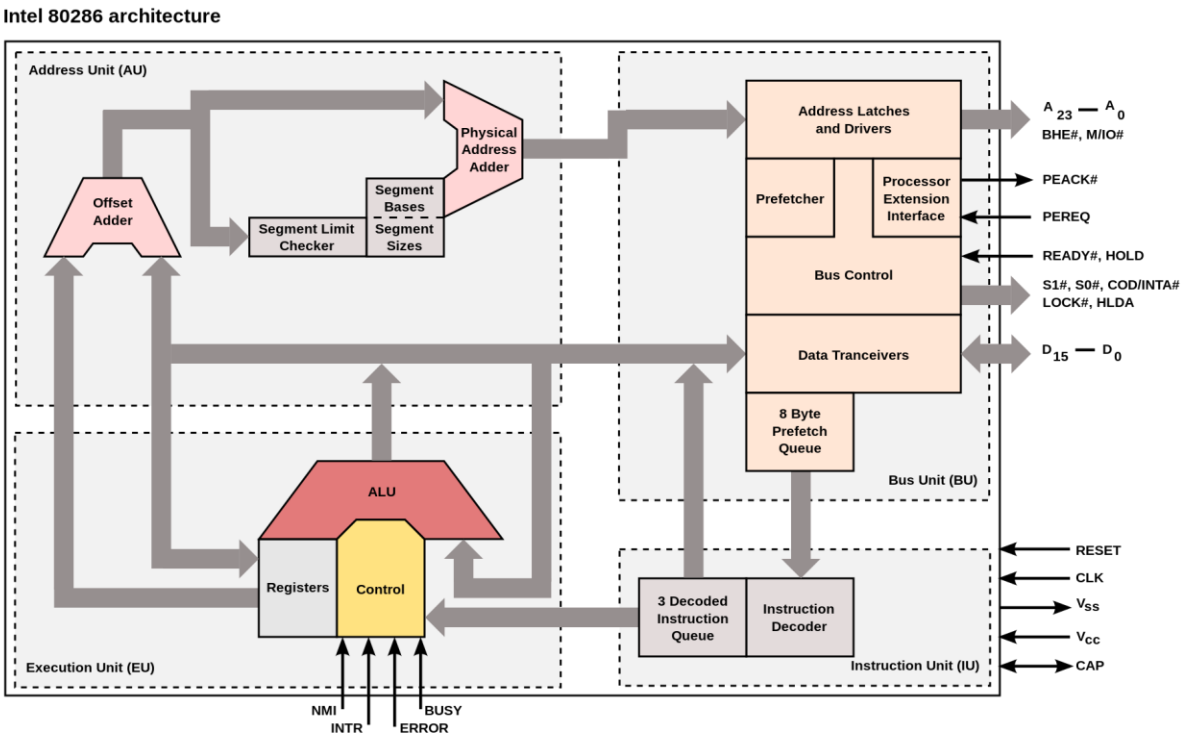
– Interface between all the **software** that runs on the machine and the **hardware** that executes it



Another notable digital computer architecture is the Instruction Set Architecture. The architecture holds a collection of instructions that the processor renders and surmises. It consists of two instruction sets: RISC (Reduced Instruction Set Computer) and CISC (Complex Instruction Set Computer).

It enables versatile implementations of an ISA; commonly differ in features such as performance, physical size, and monetary price. It empowers the evolution of the micro-architectures, implementing ISA as an exclusive, higher-performance system that can run software on preceding generations of execution.

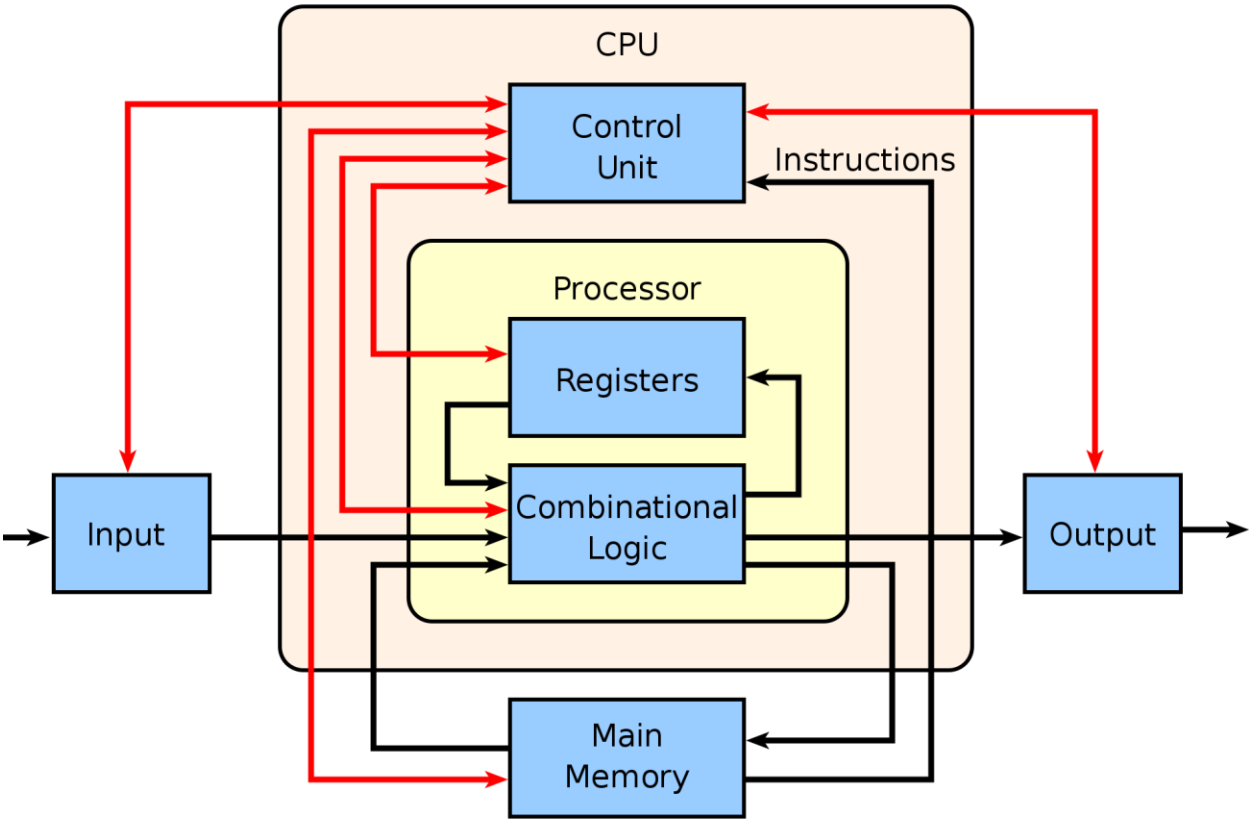
Micro-architecture



Micro-architecture is the structural design of a microprocessor. This computer organization leverages a method where the instruction set architecture holds a built-in processor. Engineers and hardware scientists implement instruction set architecture (ISA) with various micro-architectures that vary because of changing technology. It includes the technologies used, resources, and methods. Using this, the processors physically devised to administer a particular instruction set.

Simply, it is a logical form of all electronic elements and data pathways present in the microprocessor, designed in a specific way. It allows for the optimal completion of instructions. In academe, it is called computer organization.

System Design



System design itself defines a design that can serve user requirements like system architecture, computer modules having various interfaces, and data management within a system. The term product development is connective to the system design. It is the process by which we can take marketing information to create a product design.

What is computer memory?

"Memory" refers to the location in which the program's instructions and data are stored so that they can be processed later. A computer requires space to store information and instructions that it will use at a later time.

The central processing unit is not equipped with the memory necessary to permanently store computer programs or extensive data sets. It only includes the most fundamental instructions necessary for the computer to function. Because of this, having a good memory is essential.

Internal Memory

Because it is required for the operation of the computer, the internal memory is considered to be the most important type of memory. This memory is used by the system to store the data that is used the most often.

Internal memory can also be called primary or main memory.

Internal memories (except ROM) are volatile, which means that they do not store data permanently. As a result, everything inside the internal memory will be erased or deleted when the system turns off.

Internal memory is classified into two types: RAM and ROM. These two categories are further subdivided. That is, there are two types of RAM: SRAM and DRAM, and four types of ROM: MROP, PROM, EPROM, and EEPROM. Let us now go over each of these types one by one, beginning with RAM.

Random Access Memory (RAM)

RAM is the internal memory of the CPU for storing data, programs, and program results. It is read-only memory.

Because memory location address has no effect on RAM access time, each storage location within the memory is equally accessible and takes the same amount of time.We can access memory at random and extremely quickly, but it can also be quite expensive.

RAM is volatile; that is, data stored in it is lost when we switch off or turn off the computer or if there is a power failure. Hence, a backup uninterruptible power system (UPS) is often used with computers.

RAM is small, both in terms of its physical size and in the amount of data that it can hold.

Types of RAM

RAM is of two types:

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

Static RAM (SRAM)

When you hear the word "static," it means that the memory will keep its previous data for as long as the power is on.

On the other hand, due to the volatile nature of the data, it is lost whenever the power goes out.

The matrix of static RAM chips consists of six transistors, and the chips do not use capacitors.

As a result of the fact that transistors do not need power in order to prevent leakage, static RAM does not need to be refreshed on a regular basis. Because of the additional space in the matrix, static random access memory (RAM) requires more chips than dynamic random access memory (RAM) to achieve the same amount of storage space, which results in higher manufacturing costs.

Cache memory, which must operate at extremely high speeds and have a very small footprint, is typically implemented using static RAM.

Dynamic RAM (DRAM)

In contrast to static RAM, dynamic RAM necessitates constant upgrading in order to guarantee the integrity of stored information. The memory is then placed on a refresh circuit, which causes the data to be rewritten several hundred times per second. This achieves the desired result.

Because of its low cost and small size, dynamic random access memory (RAM) makes up the majority of the system memory.

Memory cells are the building blocks of all dynamic RAMs. These cells each have a capacitor and a transistor inside of them.

Read-Only Memory (ROM)

Read-only memory is what is meant when someone refers to something as "ROM." The portion of our memories from which we are only able to read and never write.

This kind of memory doesn't lose its data if the power goes out. During the manufacturing process, the information is saved in such memories in an irreversible manner.

The process of "bootstrapping" a computer, which occurs when the power supply is initially activated, is named after the read-only memory (ROM) that stores the necessary instructions for starting the computer.

ROM chips are not only used in computers but also in other electronic devices like washing machines and microwave ovens. These devices can read and write data to the chips.

Types of ROM

Let's take a quick look at the following list of computer ROMs:

1. Masked Read-Only Memory (MROM)
2. Programmable Read-Only Memory (PROM)
3. Erasable and Programmable Read-Only Memory (EPROM)
4. Electrically Erasable and Programmable Read-Only Memory (EEPROM)

Masked Read-Only Memory (MROM)

The very first read-only memories, or ROMs, were physical devices that held a data or instruction set that had been pre-programmed. This type of ROM is known as a "masked ROM," and it is a more affordable option than other kinds of ROM.

Programmable Read-Only Memory (PROM)

PROM is read-only memory that can be modified only once by a user. The user will first purchase a blank PROM and then use a PROM programmer to enter the desired information into the PROM.

The programming process involves the opening of several tiny fuses that are located inside the PROM. It can only be programmed once, and once is all that can be done because it cannot be erased.

Erasable and Programmable Read-Only Memory (EPROM)

It is possible to delete the information stored on the EPROM by exposing it to ultraviolet light for a period of time of up to 40 minutes.

In most cases, an EPROM eraser is used to accomplish this task. An electrical charge is held hostage in an insulated gate region while the programming is being done.

Due to the absence of a path through which the charge could escape, it will be held for more than ten years. In order to neutralize this charge, ultraviolet light is shone through a window made of quartz crystal (lid). The charge is neutralized as a result of the exposure to ultraviolet light. The quartz lid has a sticker on it that keeps it sealed when it is being used normally.

Electrically Erasable and Programmable Read-Only Memory (EEPROM)

Electrical signals are used to write to and erase from the EEPROM. It is possible to delete and re-program it approximately ten thousand times.

Erasing data and programming typically take between 4 and 10 milliseconds respectively. Any location in an EEPROM chip is capable of being selectively erased and programmed.

Instead of having to erase an entire EEPROM chip, a single byte at a time can be done so. As a result, the procedure of reprogramming is adaptable but time-consuming.

Sequential Access Memory

When using sequential access, the computer needs to start its search for the required piece of data at the very beginning of the memory address and work its way backwards until it locates it.

Memory devices that allow access in this manner are referred to as sequential access memories or serial access memories, respectively.

A type of memory known as serial access memory is represented by magnetic tape.

Cache Memory

The CPU can be sped up with the help of cache memory, which is a very fast semiconductor memory. Between the central processing unit and the main memory, it serves as a buffer.

Its purpose is to store the portions of data and programs that are most frequently accessed by the central processing unit (CPU). The components of the data and programs are moved from the disc to the cache memory by the operating system. The CPU is then able to access these components from the cache memory.

Cache memory is located in between the central processing unit (CPU) and the main memory.

It is also referred to as "CPU memory," and it is a type of memory that a computer's central processing unit (CPU) can access much more quickly than standard RAM.

The majority of the time, this memory is either directly integrated into the CPU chip or is located on a separate chip that is connected to the CPU via its own dedicated bus.

Because it stores the data that was most recently processed and makes it easier to retrieve, cache memory helps save time and increases overall productivity.

Advantages of Cache Memory

The following is a list of some of the most significant benefits that a cache memory provides in a computer system:

- The speed of cache memory is much higher than that of main memory.
- When compared to main memory, it requires a shorter amount of time to access data.
- It stores the program in a way that allows it to be executed in a relatively short amount of time.
- It stores data for use in the short term only.

Disadvantages of Cache Memory

The following is a list of some of the most significant disadvantages of cache memory:

- The capacity of cache memory is restricted.
- The cost of cache memory is quite high.

Virtual Memory

It is a method that enables the execution of processes even when not all of those processes are present in memory at the same time. The fact that

programs can be larger than the available physical memory is the most obvious benefit of using this scheme.

The user's logical memory is kept separate from their physical memory through the use of virtual memory. Because of this separation, it is possible to offer programmers access to an extremely large virtual memory even when only a limited amount of physical memory is available.

External Memory

External memory, also known as secondary memory or auxiliary memory, is significantly larger in size than main memory; however, its access speed is significantly lower. Typically, it stores programs, instructions, and data files for the operating system. It is also possible to use it as an overflow or virtual memory in the event that the capacity of the main memory has been reached.

A processor does not have direct access to secondary memory and cannot use it. After the data and information contained in the secondary memory have been moved to the main memory, the central processing unit will then be able to access the information it contains.

Characteristics of Secondary Memory

Here are the characteristics of secondary memory:

- **Non-volatile memory**: Data is not lost when power is cut off.
- **Reusable**: The data stages in the secondary storage on a permanent basis until it is not overwritten or deleted by the user.
- **Reliable**: Data in secondary storage is safe because of the high physical stability of the secondary storage device.
- **Convenience**: With the help of computer software, authorized people can locate and access the data quickly.
- **Capacity**: Secondary storage can store large volumes of data on sets of multiple disks.
- **Cost**: It is much less expensive to store data on a tape or disc than in primary memory.

We can also say that secondary memory is the other type of memory that is required to store the data permanently for a long time.

Types of Secondary Storage Devices

There are various types of secondary storage devices available to store data for future use. These devices allow you to read or write anywhere in memory.

Commonly used secondary storage devices are:

- Hard Disk Drive (HDD)
- Solid State Drive (SSD)
- USB Flash Drive
- Magnetic Tape
- Magnetic Disk
- and Optical Disk etc.

Hard Disk Drive (HDD)

A hard disc drive (HDD), also called a hard disc, hard drive, or fixed disc, is an electro-mechanical data storage device that is used to store data in a permanent manner.

All of the drives and other devices that are used to store information are independent of a computer. This piece of hardware might or might not be connected to the computer at any given time. For instance, a laptop has a hard drive that can permanently store any information. This drive can have a capacity of 500 gigabytes, 1 terabyte, 2 terabytes, etc. The use of an external hard disc drive, also known as an HDD, is common practice these days among a significant number of individuals for the purpose of storing important or additional information on the device.

Solid State Drive (SSD)

The term "solid state drive" refers to a type of non-volatile storage device known as an SSD. SSDs store data indefinitely by using integrated circuit assemblies as memory.

SSDs are increasingly replacing HDDs because they are faster, smaller, more durable, and have a variety of other advantages.

USB Flash Drive

A flash drive connected to a computer via USB is a solid-state device, which means that it does not contain any moving parts. Information is stored digitally in a USB flash drive through the use of millions of small gates, each of which can take on the value of either zero (0) or one (1). (1).

To put it another way, it is a piece of hardware that is employed for the purpose of archiving information. A flash memory and an integrated Universal Serial Bus (USB) interface are both included in this product.

USB flash drives are more portable than traditional hard drives because of their smaller size and "pocket-friendly" design, which allows for easy handling and storage in a pocket. It indicates that you can store all of the information on a USB flash drive and carry it around in your pocket.

Magnetic Tape

It is similar to audio tape containing a plastic strip coated with magnetic material. The data is encoded on the magnetic material in the form of electric current. Conduction state (ON) represents one (1), and non-conduction state (OFF) represents zero (0).

The type of data encoding is called binary data storage. Magnetic tape has a large storage capacity and is inexpensive; it can store data from 60 MB to 24 GB.

Magnetic Disk

These are direct-access storage media, which allow for much faster data access because there is no need to go through previous data to get to a specific data.

In this type of storage device, there is a round diskette (round disk) of plastic material coated with magnetic ink, on which data encoding is done.

The magnetic disc commonly comes in three types, which are:

- floppy disk
- hard disk
- Winchester disk

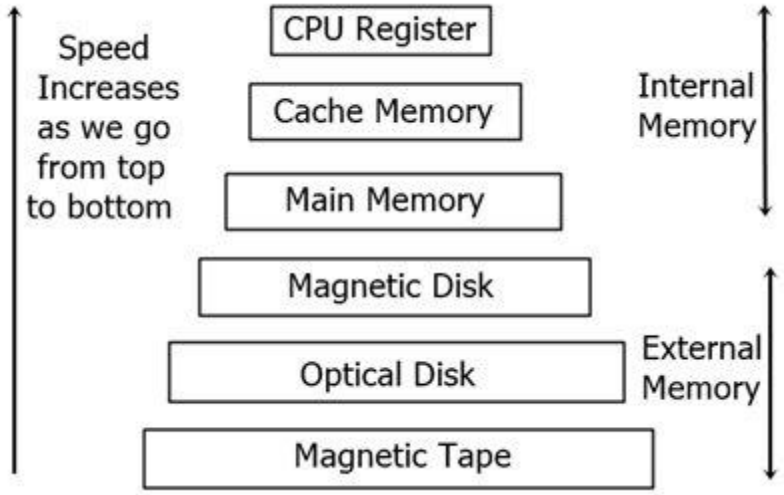
Optical Disk

The data can be read from and written to the optical disc by a laser beam. These discs can hold large amounts of data in GB.These are available as CD-ROMs and WORM (write-once, read-only) erasable optical disks.

On CD-ROM, data can be stored once and made read-only. These are called compact discs with read-only memory. These can store data from 600 MB to 1 GB. A special device called a CD-ROM player is used to read the data from a CD-ROM.

Memory Hierarchy

Let's look at a picture or diagram of the memory hierarchy and its characteristics.



The above diagram represents the hierarchy of computer memory. From top to bottom, the following are the characteristics of memory hierarchy:

- Storage capacity increases.
- Cost per bit of storage decreases.
- The CPU's memory access frequency decreases.
- The CPU's access time increases.

Compact Disk (CD)

CD-ROM stands for "compact disc read-only memory," and it refers to a specific kind of compact disc that can store data that can be accessed by a computer. Despite the fact that the compact disc format was initially developed for the purpose of storing and playing back music, it has since been modified to store any kind of binary data.

Because virtually any type of data can be stored on CD-ROMs, they are frequently used as a medium for the distribution of computer software, including games and multimedia programs.

Some compact discs store both audio and computer data; however, only the audio can be played on a CD player, whereas the data, which may include software or digital video, can only be accessed and used on a computer. CDs with extra features are known as enhanced CDs. Despite the fact that many people write this acronym with lowercase letters, the correct way to present it is with all capital letters and a hyphen in between the words CD-ROM and ROM. A second point of contention is whether "read-only memory" or "media" is the more appropriate term to use. It is generally agreed upon that "media" is the appropriate terminology to use when speaking in technical terms.

However, because ROM is commonly used to refer to other devices such as EEPROM and Flash-ROM (where memory is the correct terminology), the majority of people define CD-ROM as also being memory. This is because the abbreviation sounds like it originated from the same place as ROM.

Hard Disk (HD)

A hard disc, also known as an HDD (hard disc drive) or hard drive, was formerly known as a fixed disc. It is a type of non-volatile storage device that stores digitally encoded data on rapidly rotating platters with magnetic surfaces. Other common names for hard discs include hard drive and hard disc.

The term "hard disc" (sometimes referred to as "platter" or "disc") refers to the storage medium itself, while the term "drive" refers to an entire unit that contains multiple platters, a read/write head assembly, driver electronics, and a motor. The use of hard discs on computers was the original motivation behind their creation.

In the 21st century, in addition to computers, hard discs are utilized in digital video recorders, digital audio players, personal digital assistants (PDAs), and digital cameras.

In 2005, the Samsung Group and Nokia were the first to introduce mobile phones that included a hard disc. These phones were manufactured by Nokia.

The requirement for efficient access to large amounts of data led to the development of storage configurations such as RAID, hardware such as network attached storage (NAS) devices, and systems such as storage area networks (SANs). These advancements were made possible as a result of the need for large-scale, reliable storage that was not dependent on a specific device.

Floppy Disk

A floppy disc is a storage medium that consists of a thin and flexible magnetic disc inside a plastic carrier.

A floppy disc drive, also called an FDD or floppy drive, is a device that is used to read information that is stored on data storage media.

Floppy discs have a relatively low capacity for data storage.

Heat can have an adverse effect on floppies. As a result, they are required to handle with a higher degree of care.

Pen Drive

When compared to more conventional methods of data storage, pen drives offer superior levels of protection due to their durability and inability to become damaged by scratches.

There are many software packages available for personal computers that will allow you to run an operating system from a bootable flash drive. In addition, many companies that sell flash drives do so in conjunction with additional products such as MP3 players, LEDs, Swiss knives, and other similar items.

Input Devices

An input device in computing is **a piece of computer hardware equipment used to supply a data processing system including a computer or information appliance with control and data signals**. Keyboards, scanners, mouses, joysticks and digital cameras are examples of input devices.

Mouse

Mouse is the most popular pointing device. It is a very famous cursor-control device having a small palm size box with a round ball at its base, which senses the movement of the mouse and sends corresponding signals to the CPU when the mouse buttons are pressed.

Generally, it has two buttons called the left and the right button and a wheel is present between the buttons. A mouse can be used to control the position of the cursor on the screen, but it cannot be used to enter text into the computer.

Advantages

- Easy to use
- Not very expensive
- Moves the cursor faster than the arrow keys of the keyboard.

Joystick

Joystick is also a pointing device, which is used to move the cursor position on a monitor screen. It is a stick having a spherical ball at its both lower and upper ends. The lower spherical ball moves in a socket. The joystick can be moved in all four directions.

The function of the joystick is similar to that of a mouse. It is mainly used in Computer Aided Designing (CAD) and playing computer games.

Light Pen

Light pen is a pointing device similar to a pen. It is used to select a displayed menu item or draw pictures on the monitor screen. It consists of a photocell and an optical system placed in a small tube.

When the tip of a light pen is moved over the monitor screen and the pen button is pressed, its photocell sensing element detects the screen location and sends the corresponding signal to the CPU.

Track Ball

Track ball is an input device that is mostly used in notebook or laptop computer, instead of a mouse. This is a ball which is half inserted and by moving fingers on the ball, the pointer can be moved.

Since the whole device is not moved, a track ball requires less space than a mouse. A track ball comes in various shapes like a ball, a button, or a square.

Scanner

Scanner is an input device, which works more like a photocopy machine. It is used when some information is available on paper and it is to be transferred to the hard disk of the computer for further manipulation.

Scanner captures images from the source which are then converted into a digital form that can be stored on the disk. These images can be edited before they are printed.

Digitizer

Digitizer is an input device which converts analog information into digital form. Digitizer can convert a signal from the television or camera into a series of numbers that could be stored in a computer. They can be used by the computer to create a picture of whatever the camera had been pointed at.

Digitizer is also known as Tablet or Graphics Tablet as it converts graphics and pictorial data into binary inputs. A graphic tablet as digitizer is used for fine works of drawing and image manipulation applications.

Microphone

Microphone is an input device to input sound that is then stored in a digital form.

The microphone is used for various applications such as adding sound to a multimedia presentation or for mixing music.

Magnetic Ink Card Reader (MICR)

MICR input device is generally used in banks as there are large number of cheques to be processed every day. The bank's code number and cheque number are printed on the cheques with a special type of ink that contains particles of magnetic material that are machine readable.

This reading process is called Magnetic Ink Character Recognition (MICR). The main advantages of MICR is that it is fast and less error prone.

Optical Character Reader (OCR)

OCR is an input device used to read a printed text.

OCR scans the text optically, character by character, converts them into a machine readable code, and stores the text on the system memory.

Bar Code Readers

Bar Code Reader is a device used for reading bar coded data (data in the form of light and dark lines). Bar coded data is generally used in labelling goods, numbering the books, etc. It may be a handheld scanner or may be embedded in a stationary scanner.

Bar Code Reader scans a bar code image, converts it into an alphanumeric value, which is then fed to the computer that the bar code reader is connected to.

Optical Mark Reader (OMR)

OMR is a special type of optical scanner used to recognize the type of mark made by pen or pencil. It is used where one out of a few alternatives is to be selected and marked.

It is specially used for checking the answer sheets of examinations having multiple choice questions

Output Devices

These provide either hardcopy or softcopy results for the users.

Monitors

Monitors, commonly called as **Visual Display Unit** (VDU), are the main output device of a computer. It forms images from tiny dots, called pixels that are arranged in a rectangular form. The sharpness of the image depends upon the number of pixels.

There are two kinds of viewing screen used for monitors.

- Cathode-Ray Tube (CRT)
- Flat-Panel Display

Cathode-Ray Tube (CRT) Monitor

The CRT display is made up of small picture elements called pixels. The smaller the pixels, the better the image clarity or resolution. It takes more than one illuminated pixel to form a whole character, such as the letter ‘e’ in the word help.

A finite number of characters can be displayed on a screen at once. The screen can be divided into a series of character boxes - fixed location on the screen where a standard character can be placed. Most screens are capable of displaying 80 characters of data horizontally and 25 lines vertically.

There are some disadvantages of CRT –

- Large in Size
- High power consumption

Flat-Panel Display Monitor

The flat-panel display refers to a class of video devices that have reduced volume, weight and power requirement in comparison to the CRT. You can hang them on walls or wear them on your wrists. Current uses of flat-panel displays include calculators, video games, monitors, laptop computer, and graphics display.

The flat-panel display is divided into two categories –

- **Emissive Displays** – Emissive displays are devices that convert electrical energy into light. For example, plasma panel and LED (Light-Emitting Diodes).
- **Non-Emissive Displays** – Non-emissive displays use optical effects to convert sunlight or light from some other source into graphics patterns. For example, LCD (Liquid-Crystal Device).

Printers

Printer is an output device, which is used to print information on paper.

There are two types of printers –

- Impact Printers
- Non-Impact Printers

Impact Printers

Impact printers print the characters by striking them on the ribbon, which is then pressed on the paper.

Characteristics of Impact Printers are the following –

- Very low consumable costs
- Very noisy
- Useful for bulk printing due to low cost
- There is physical contact with the paper to produce an image

These printers are of two types –

- Character printers
- Line printers

Character Printers

Character printers are the printers which print one character at a time.

These are further divided into two types:

- Dot Matrix Printer(DMP)
- Daisy Wheel

Dot Matrix Printer

In the market, one of the most popular printers is Dot Matrix Printer. These printers are popular because of their ease of printing and economical price. Each character printed is in the form of pattern of dots and head consists of a Matrix of Pins of size (5*7, 7*9, 9*7 or 9*9) which come out to form a character which is why it is called Dot Matrix Printer.

Advantages

- Inexpensive
- Widely Used
- Other language characters can be printed

Disadvantages

- Slow Speed
- Poor Quality

Daisy Wheel

Head is lying on a wheel and pins corresponding to characters are like petals of Daisy (flower) which is why it is called Daisy Wheel Printer. These printers are generally used for word-processing in offices that require a few letters to be sent here and there with very nice quality.

Advantages

- More reliable than DMP
- Better quality
- Fonts of character can be easily changed

Disadvantages

- Slower than DMP
- Noisy
- More expensive than DMP

Line Printers

Line printers are the printers which print one line at a time.

These are of two types –

- Drum Printer
- Chain Printer

Drum Printer

This printer is like a drum in shape hence it is called drum printer. The surface of the drum is divided into a number of tracks. Total tracks are equal to the size of the paper, i.e. for a paper width of 132 characters, drum will have 132 tracks. A character set is embossed on the track. Different character sets available in the market are 48 character set, 64 and 96 characters set. One rotation of drum prints one line. Drum printers are fast in speed and can print 300 to 2000 lines per minute.

Advantages

- Very high speed

Disadvantages

- Very expensive
- Characters fonts cannot be changed

Chain Printer

In this printer, a chain of character sets is used, hence it is called Chain Printer. A standard character set may have 48, 64, or 96 characters.

Advantages

- Character fonts can easily be changed.
- Different languages can be used with the same printer.

Disadvantages

- Noisy

Non-impact Printers

Non-impact printers print the characters without using the ribbon. These printers print a complete page at a time, thus they are also called as Page Printers.

These printers are of two types –

- Laser Printers
- Inkjet Printers

Characteristics of Non-impact Printers

- Faster than impact printers
- They are not noisy
- High quality
- Supports many fonts and different character size

Laser Printers

These are non-impact page printers. They use laser lights to produce the dots needed to form the characters to be printed on a page.

Advantages

- Very high speed
- Very high quality output
- Good graphics quality
- Supports many fonts and different character size

Disadvantages

- Expensive
- Cannot be used to produce multiple copies of a document in a single printing

Inkjet Printers

Inkjet printers are non-impact character printers based on a relatively new technology. They print characters by spraying small drops of ink onto paper. Inkjet printers produce high quality output with presentable features.

They make less noise because no hammering is done and these have many styles of printing modes available. Color printing is also possible. Some models of Inkjet printers can produce multiple copies of printing also.

Advantages

- High quality printing
- More reliable

Disadvantages

- Expensive as the cost per page is high
- Slow as compared to laser printer

Interfaces

In computing the term *interface* can have various meanings, but all relate to the interaction between one object and another.

Interface may refer to a hardware interface, a software interface, or sometimes it can refer to the interaction between the user and the computer via an input device such as the keyboard

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Hardware interfaces

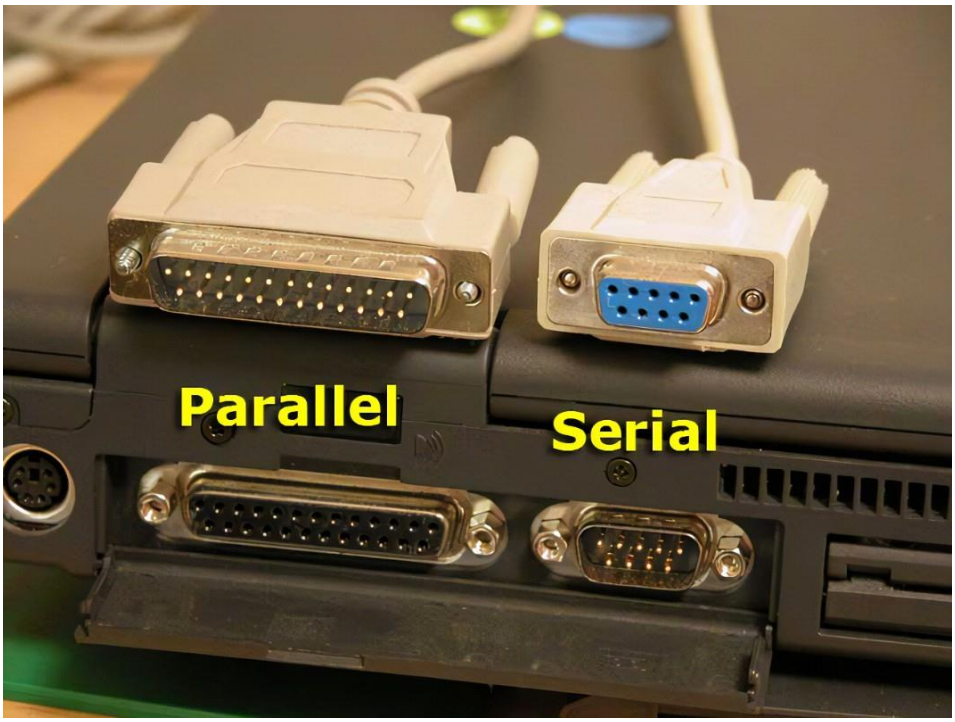
Hardware interfaces refer to the connection and communication of different devices.

For example, a printer being connected to a USB port is actually connected to the *USB interface* of the system. Another example of a hardware interface is a graphics card plugged into a PCI slot, which is using the *PCI interface* to connect and communicate.

There are various different hardware interfaces found in computing, here we will take a brief look at some of them.

Serial and parallel interfaces

A serial interface, commonly used in commmunications, allows data to be sent *one bit at a time* (sequentially) down the same line/channel. A parallel interface is capable of sending many bits of data at a time via numerous lines/channels.



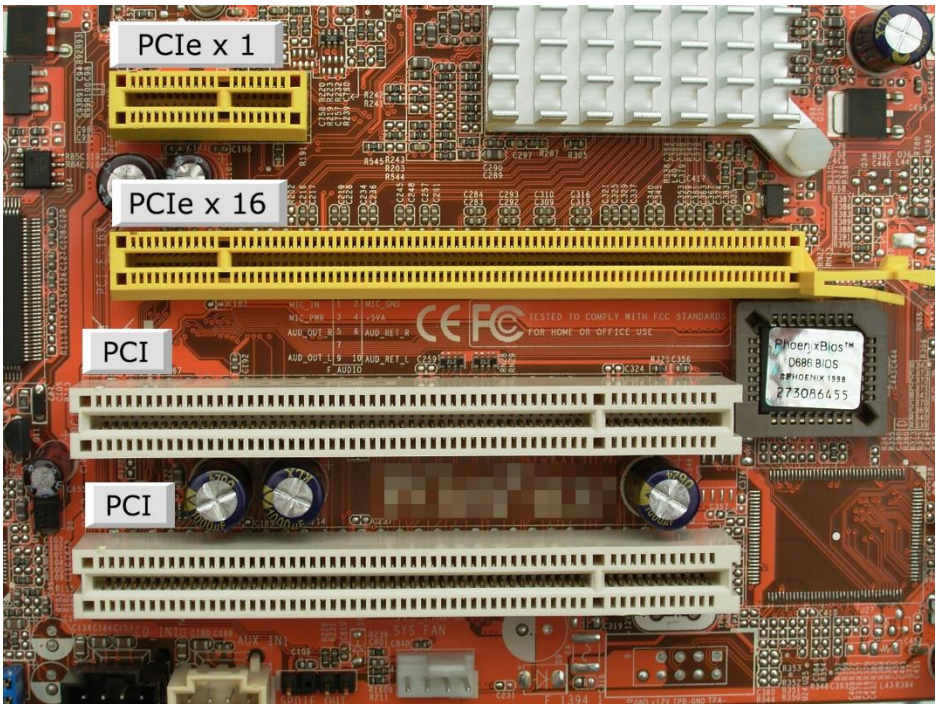
An analogy could be: Serial communication is like a dripping tap/faucet, one drop of water (data) at a time. Parallel communication is like a shower head, delivering many drops of water (data) at any one time. Hardware interfaces are typically serial or parallel.

USB interfaces

The USB interface is a serial interface which is commonly used to connect all sorts of devices, including printers, scanners, external storage devices, mice, digital cameras and more. It has become one the most common interfaces for external devices.

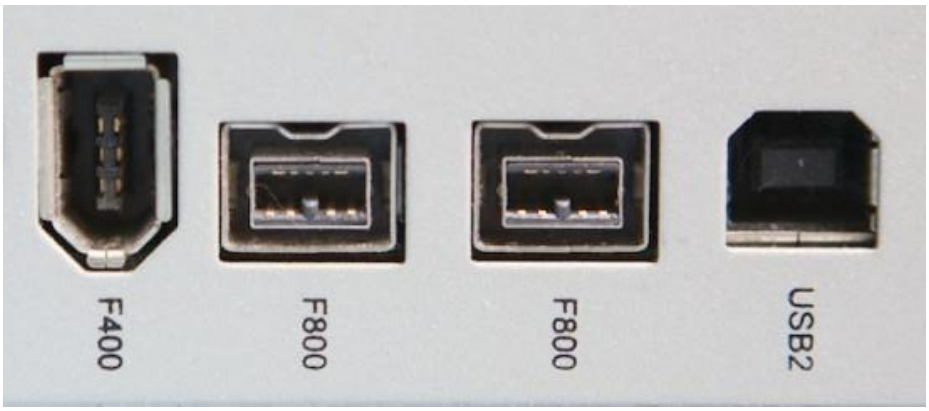
PCI, PCI-X and PCI Express interfaces

With the exception of PCI Express, which uses high-speed serial logic, PCI uses multiple parallel communication. The PCI family of interfaces are used for countless internal devices, including sound cards, modems, graphics cards and many other expansion cards.



The IEEE 1394/ Firewire / iLink interface

The IEEE 1394, often referred to as Firewire and iLink, interface is a serial interface with high-speed capabilities. It is commonly used for the connection and communication of audio and video devices. For more on this interface.



Software interfaces

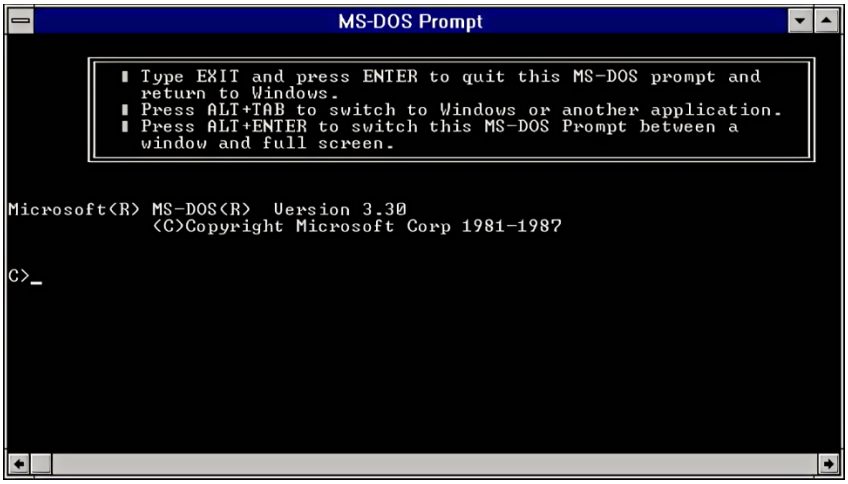
A software interface is used to allow either two pieces of software to communicate with each other (software-software interface), or to allow software to communicate with a hardware device (software-hardware interface).

User interface, or UI, describes the way in which a human interacts with a machine. Though technically something as simple as a light switch could be considered an instrument of UI, most modern references relate to computers and other electronic devices.

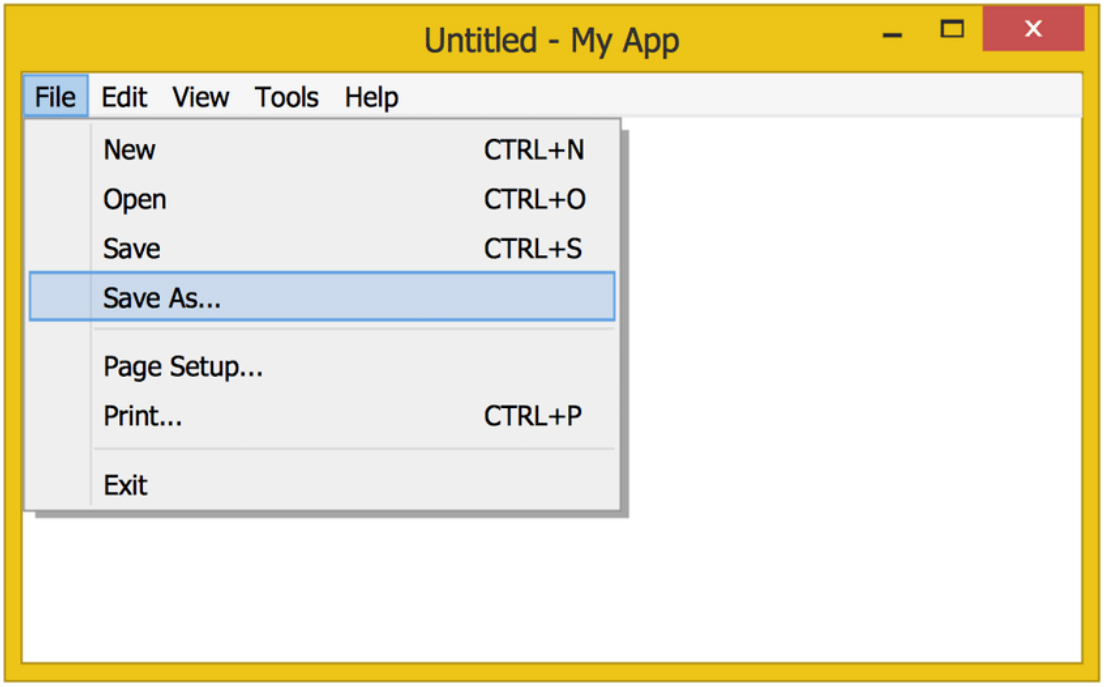
UI makes the exchange between users and machines possible. Without it, this vital form of communication ceases to exist.

There are four prevalent types of user interface and each has a range of advantages and disadvantages:

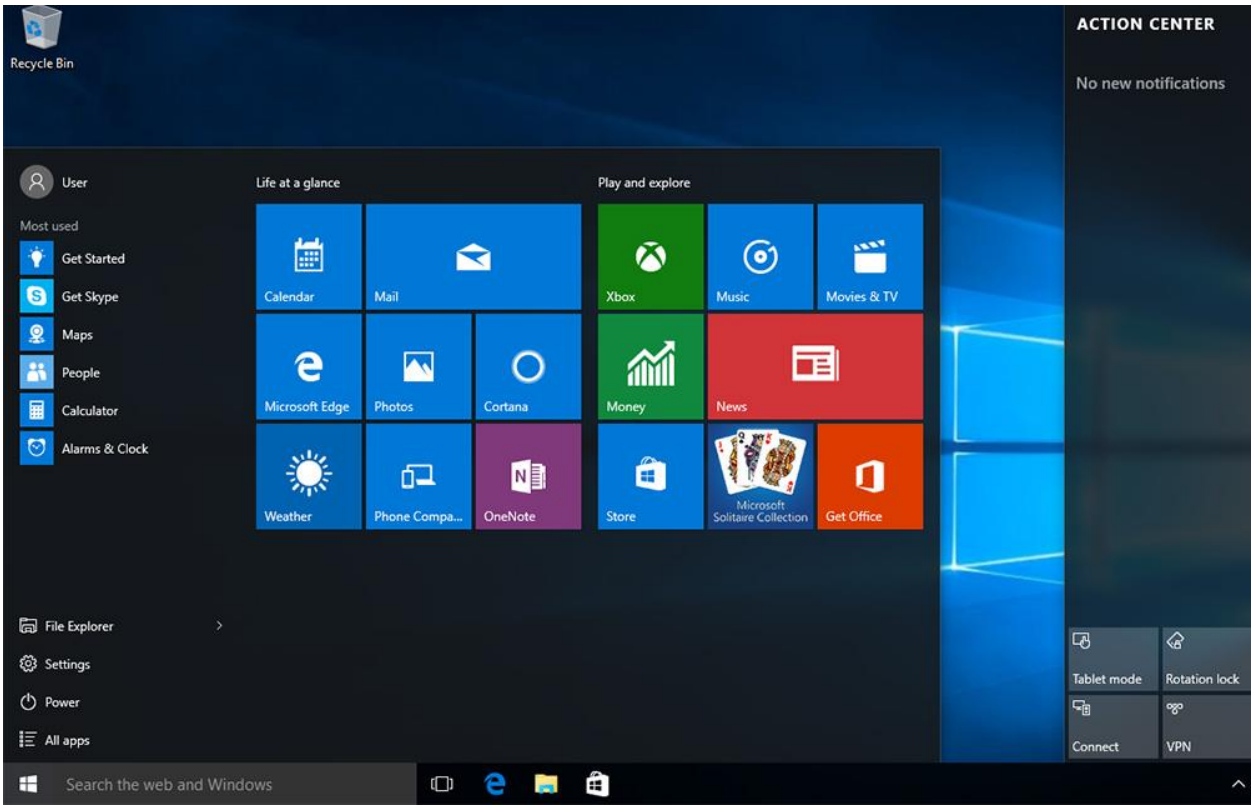
- Command Line Interface



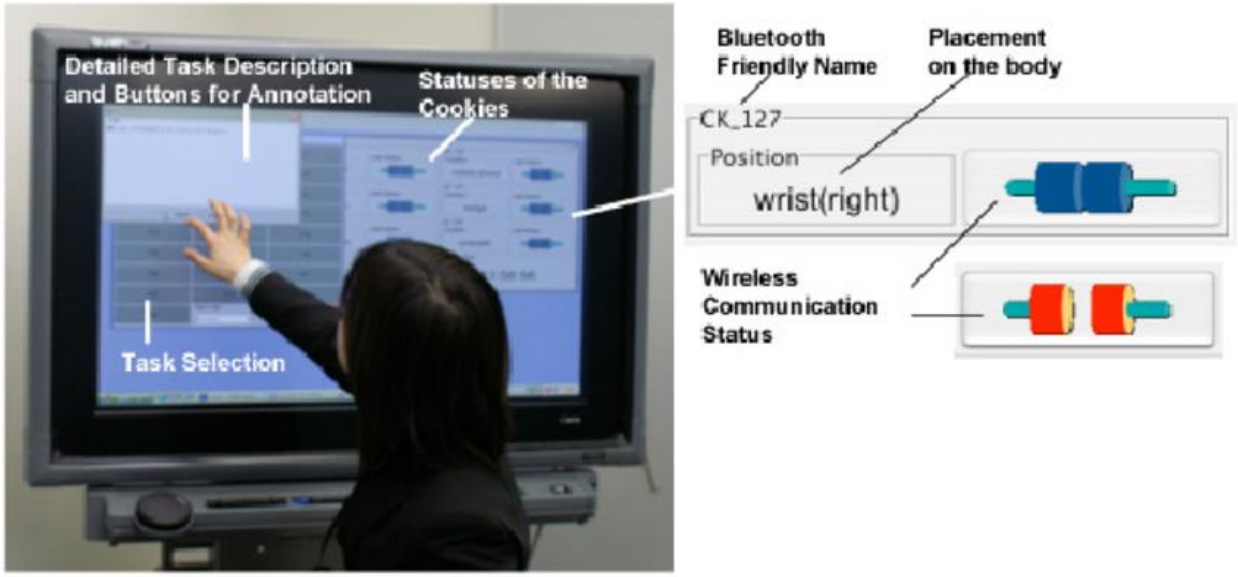
- Menu-driven Interface



- Graphical User Interface



- Touchscreen Graphical User Interface



Command Line Interface

The command line interface is no longer common as a form of basic user interface in everyday consumer products, but it is still in use under certain circumstances. Command Line Interface requires users to type appropriate instructions into the command line. The computer is commanded to first go to the required file or directory. From there, a whole host of commands become available, from retrieving files to running programs.

Advantages:

- Simple structure
- Minimal memory usage
- Great for slow-running computers, or those low on memory
- An expert CLI user can give commands and perform tasks much faster than when using an alternative UI type

Disadvantages:

- Difficult to learn command language
- Complex for novice users
- Minimal error message information

Menu-Driven Interface

The menu-driven user interface provides you with a range of commands or options in the form of a list or menu displayed in full-screen, pop-up, pull-down, or drop-down. An ATM is an example of a menu-driven interface.

Advantages:

- It is not necessary to remember a long list of manual commands
- Simple interface for novices
- Self-explanatory menu options

Disadvantages:

- Slower for experienced users
- Limited menu options
- Often requires you to access multiple menu screens to perform simple functions

Graphical User Interface

The graphical user interface, or GUI, is the type of interface with which the majority of people are the most familiar. You interact with these interfaces by using a mouse, tack pad, or other peripheral to point and click on graphics or icons.

Advantages:

- Self-explanatory
- Easy to use
- Memorizing command lists is not necessary
- Allows for running multiple applications, programs, and tasks simultaneously
- Solid support facilities
- The similar format among different programs adds familiarity
- WYSIWYG makes for easy design and formatting

Disadvantages:

- Uses large amounts of memory – although this is less of a concern as computers get more powerful

Touchscreen Graphical User Interface

The touchscreen GUI is very similar to the regular GUI, except that you use your fingers or a stylus to select icons and perform tasks, rather than a mouse or trackpad. Touchscreen GUIs are commonly found on tablets, smartphones, and medical devices etc. The touchscreen GUI has the same benefits and disadvantages as standard GUIs, but also offers a more intimate method of interaction. The lack of peripherals makes touchscreen GUIs very convenient.

Of the four types of user interface, the graphical user interface is by far the most common, followed by the touchscreen variation. Despite the alternative technologies that already exist and continue to emerge, the GUI remains the preferred standard. This is largely due to the simplicity and ease of use.

Graphical user interfaces are easier for most end users to understand as the icons and menus are generally self-explanatory and the GUI does not require the user to remember or input complex commands.

While they do take up considerable memory space compared to other UIs, this is a secondary concern as devices continue to have larger, more efficient storage than their predecessors.