Introduction to Computer

(1) **Definition**

A computrer is an electronic device for processing and storing data. Examples of processing include typing of documents, sending emails, playing games, browsing the web, creating spreadsheets, presentations, audio and video files.

(2) **Characteristics of a Computer**

Some characteristices of a computer include:

i. Speed: ability to perform calculations at exceptionally high speed.
ii. Accuracy: there are no errors in the calculations performed by a computer system so long as the instructions (program) given to it are correct.
iii. Diligence: a computer system can work continuosly without experiencing fatigue. However, this requires that the operating environment be optimal.
iv. Versatility: it can be used for various tasks and applications.
v. Storage: it can be used to store large volume of data.

(3) **Classification of Computers**

Computers can be classified in three (3) ways.

i. **Purpose**:

(a) *General Purpose*: a general purpose computer is used for a variety of tasks, for example, word processing, games, etc.

(b) *Special purpose*: a special purpose computer is designed to perform just one special purpose, for example, computers that regulate room temperature.

ii. **Size**:

(a) *Super computers*: designed for high capacity computing, they offer very high processing speed and are very large in size. They are used for complex scientific computations (eg. geological data, weather data, genetic engineering, etc.)

(b) *Mainframe computers*: they can support many peripheral devices. Mainframe computers also have high processing speed. They are less in size and speed that the super computers.

(c) *Mini computers*: they are smaller than the former two as the name implies but offer as much speed. Mini computers have the ability to offer interactive access to multiple users.

(d) *Micro computers*: they are micro in size but not in capacity. Desktops, laptops, notbooks, palmtops all belong to this category.

iii. **Type**:

(a) *Analogue*: this class use analogue signals represented by continous set of varying voltages (or other signals). Examples of computers in this category include computers designed to regulate room temperature or open and close doors.

(b) *Digital*: uses digital signals of 0 or 1 (or state of ON or OFF). It represents data in 0s or 1s. Our regular computer is an example of this.

(c) *Hybrid*: this class combines the features of both analogue and digital computers. Petrol pump is an example. It measures fuel via analogure and displays price, volume in digital form. Other examples include ECG machine and Ultrasound machine.

(4) Evolution of Computers

	Inventor	Date	Invention	Capability	Description
1.	Ancient Mesopotamians of Sumeria	2700BC – 2300BC	Abacus	Adding machine	Sliding beads arranges in a rack
2.	Blaise Pascal (1623 - 1662)	1642	Pascaline (numerical wheel calculator)	It was able to only add numbers.	It was made up of 8 movable disks to add numbers with up to 8 digits.
3.	Gottfried Wilhelm Von Leibniz (1646 – 1716)	1694	Improved the Pascaline	Addition and multiplication of numbers	Made use of a system of gears and dials.
4.	Charles Xavier Thomas de Colmar		Mechanical calculator	Addition, subtraction, multiplication and division	
5.	Charles Babbage (1791 – 1871) Ada Lovelace (1815 – 1842)	1822	Diffeence engine Analytical engine	 It was the first general purpose computer	It was able to use stored program, perform calculations and print results
6.	Herman Hollerith (1860 – 1929)	1889	Applied Jacquard loom concept to computing. It made use of pucnhed cards.	Used punched cards to store instruction and data.	
7.	Vannevar Bush (1870 – 1974)	1931	Developed a calculator for solving differential equations		

(5) Generations of Computers

First Generation (1939-1954) - vacuum tube

The first computers used vacuum tubes for circuitry and magnetic drums for memory, and were often enormous, taking up entire rooms. They were very expensive to operate and in addition to using a great deal of electricity, generated a lot of heat, which was often the cause of malfunctions.

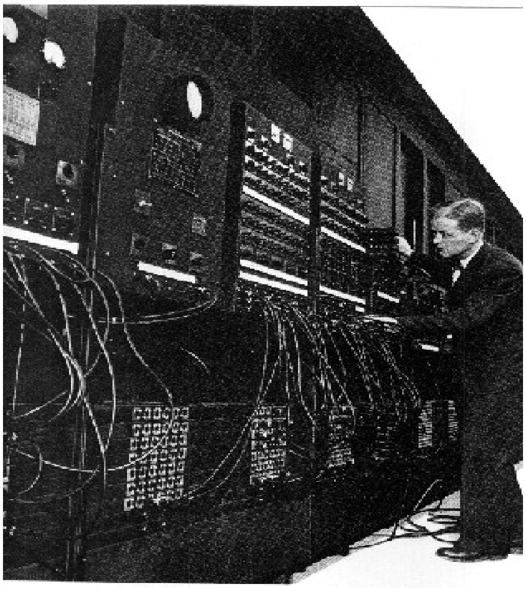
First generation computers relied on machine language, the lowest-level programming language understood by computers, to perform operations, and they could only solve one problem at a time. Input was based on punched cards and paper tape, and output was displayed on printouts.

The UNIVAC and ENIAC computers are examples of first-generation computing devices. The UNIVAC was the first commercial computer delivered to a business client, the U.S. Census Bureau in 1951.

Vacuum tubes were highly inefficient, required a great deal of space, and needed to be replaced often. Computers of the 1940s and 50s had 18,000 tubes in them and housing all these tubes and cooling the rooms from the heat produced by 18,000 tubes was not cheap.

The first was the giant ENIAC machine by John W. Mauchly and J. Presper Eckert at the University of Pennsylvania. ENIAC (Electrical Numerical Integrator and Calculator) used a word of 10 decimal digits instead of binary ones like previous automated calculators/computers. ENIAC was also the first machine to use more than 2,000 vacuum tubes, using nearly 18,000 vacuum tubes. Storage of all those vacuum tubes and the machinery required to keep the cool took up over 167 square meters (1800 square feet) of floor space. Nonetheless, it had punched-card input and output and arithmetically had 1 multiplier, 1 divider-square rooter, and 20 adders employing decimal "ring counters," which served as adders and also as quick-access (0.0002 seconds) read-write register storage.

The executable instructions composing a program were embodied in the separate units of ENIAC, which were plugged together to form a route through the machine for the flow of computations. These connections had to be redone for each different problem, together with presetting function tables and switches. This "wire-your-own" instruction technique was inconvenient, and only with some license could ENIAC be considered programmable; it was, however, efficient in handling the particular programs for which it had been designed. ENIAC is generally acknowledged to be the first successful high-speed electronic digital computer (EDC) and was productively used from 1946 to 1955. A controversy developed in 1971, however, over the patentability of ENIAC's basic digital concepts, the claim being made that another U.S. physicist, John V. Atanasoff, had already used the same ideas in a simpler vacuum-tube device he built in the 1930s while at Iowa State College. In 1973, the court found in favour of the company using Atanasoff claim and Atanasoff received the acclaim he rightly deserved.



ENIAC

UNIVAC 1951, from Smithsonian NMAH

UNIVAC I ca. 1955, from Smithsonian

Second Generation Computers (1954-1959) - transistor

Transistors replaced vacuum tubes and ushered in the second generation of computers. The transistor was invented in 1947 but did not see widespread use in computers until the late 50s. The transistor was far superior to the vacuum tube, allowing computers to become smaller, faster, cheaper, more energy-efficient and more reliable than their first-generation predecessors. Though the transistor still generated a great deal of heat that subjected the computer to damage, it was a vast improvement over the vacuum tube. Second-generation computers still relied on punched cards for input and printouts for output.

First transistor (model), December 1947. Constructed by John Bardeen, Walter Brattain and William Shockley at Bell Laboratories,

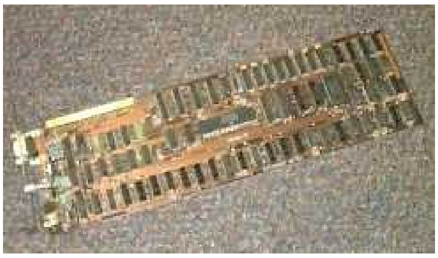
Second-generation computers moved from cryptic binary machine language to symbolic, or assembly, languages, which allowed programmers to specify instructions in words. High-level programming languages were also being developed at this time, such as early versions of COBOL and FORTRAN. These were also the first computers that stored their instructions in their memory, which moved from a magnetic drum to magnetic core technology.

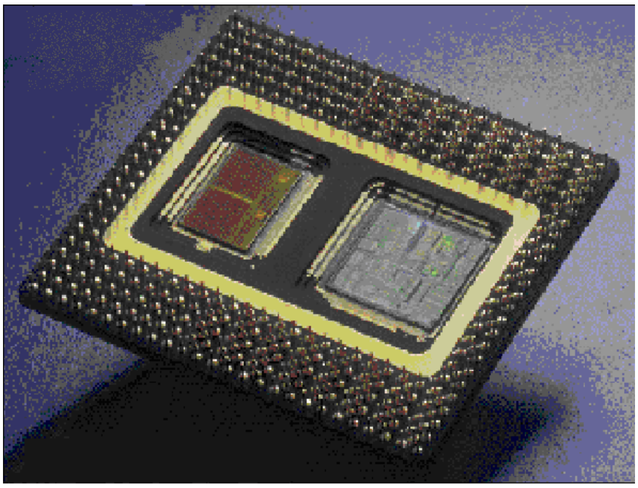
Third Generation Computers (1959-1971) - IC

In 1958, this problem too was solved by Jack St. Clair Kilby of Texas Instruments. He manufactured the first integrated circuit or chip.

The development of the integrated circuit was the hallmark of the third generation of computers. Transistors were miniaturized and placed on silicon chips, called semiconductors, which drastically increased the speed and efficiency of computers.

Instead of punched cards and printouts, users interacted with third generation computers through keyboards and monitors and interfaced with an operating system, which allowed the device to run many different applications at one time with a central program that monitored the memory. Computers for the first time became accessible to a mass audience because they were smaller and cheaper than their predecessors.





Circuit Board **Silicon Chip**

Fourth Generation (1971-1991) - microprocessor

The microprocessor brought the fourth generation of computers, as thousands of integrated circuits were built onto a single silicon chip. What in the first generation filled an entire room could now fit in the palm of the hand. The Intel 4004 chip, developed in 1971, located all the components of the computer - from the central processing unit and memory to input/output controls - on a single chip.

In 1981 IBM introduced its first computer for the home user, and in 1984 Apple introduced the Macintosh. Microprocessors also moved out of the realm of desktop computers and into many areas of life as more and more everyday products began to use microprocessors.

As these small computers became more powerful, they could be linked together to form networks, which eventually led to the development of the Internet. Fourth generation computers also saw the development of GUIs (Graphical User Interfaces), the mouse and handheld devices.

Fifth Generation (1991 and Beyond) – Artificial Intelligence

Fifth generation computing devices, based on artificial intelligence[1], are still in development, though there are some applications, such as voice recognition, that are being used today. The use of parallel processing and superconductors is helping to make artificial intelligence a reality. Quantum computation and molecular and nanotechnology will radically change the face of computers in years to come. The goal of fifth-generation computing is to develop devices that respond to natural language input and are capable of learning and self-organization.

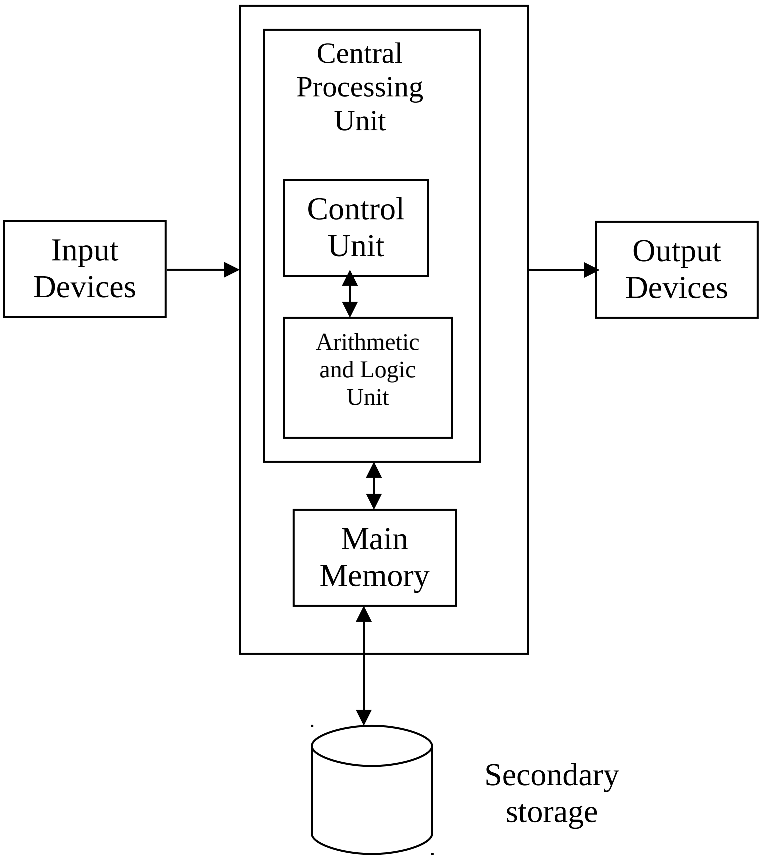
1

THE COMPUTER SYSTEM

The computer system needs two main components to make it function – the computer hardware and the software.

The Computer Hardware

This refers to objects that you can actually touch, like disks, disk drives, display screens, keyboards, printers, boards, and chips.



Organisation of a computer system

The Central Processing Unit (CPU)
It is the heart of the computer. It executes machine instructions. These instructions are encoded in binary form (i.e. 1s and 0s) corresponding to the operation of digital circuitry (on/off). The ***Control Unit*** of the CPU fetches instructions one by one from the main memory, retrieves data for each instruction from the main memory as needed, and stores the result back in the main memory. The control unit sends signals that tell other units of the computer system what to do.

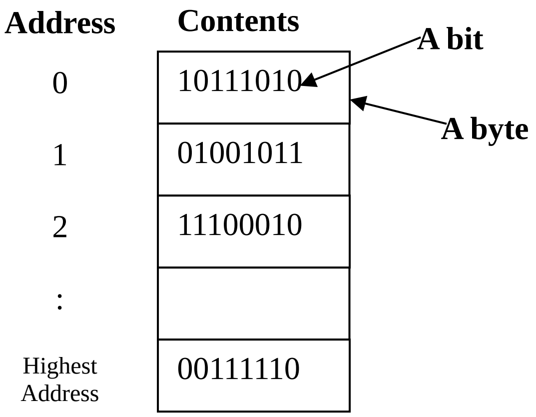
A machine instruction does very detailed work; for example,

- An arithmetic operation, such as addition of two numbers.
- A logical operation, such as a comparison of two values, or inverting all the bits of a value: changing 0s to 1s and vice versa.
- The movement of data from one location to another, including input from or output to a peripheral device.

- The selection of which program instruction to be executed next, depending on a certain condition. This ability to carry out sequence of instructions conditionally or repeatedly defines much of the computer's power

When arithmetic and logical operations are to be carried out, the ***arithmetic-logic unit (ALU)*** of the CPU is used. This circuitry can add or multiply operands, as well as perform logical operations (such as comparison, AND, or OR).

Main Memory
To be ready for execution, the programs and the data they require must be transferred into the main memory. The main memory of the computer consists of a large number of locations, identified by their addresses as shown below.



The elementary unit of representation is a ***bit*** (short for binary digit). The value of a bit is either 0 or 1. Character representations are built out of combinations of bit, with each character represented by a sequence of bits, called ***byte***. Thus each memory location, identified by its own address, Can store one letter, digit, or a special symbol (e.g. *) encoded in the binary code used by the machine. Processors can generally fetch from the main memory and manipulate larger sequences of bits at one time; such an entity is called a ***word***. Thus, a 32-bit machine has a word that equals 4 bytes.

A thousand byte is referred to as a ***Kilobyte (1KB)***, a million bytes as a ***Megabyte (1MB)***, a thousand, million bytes as a ***Gigabyte (1GB)*** and a million, million bytes as a ***Terabyte (1TB)***.

Today's main memory are made of semiconductor chips, which are referred to as random access memory (RAM), since it takes the same amount of time to access any randomly chosen location.

Even though a computer's main memory contains a number of such chips, its capacity is still limited as compared to the total requirements for the storage of data and programs. In addition to this, semiconductor RAMS are volatile: when power is removed, their contents disappear.

Secondary storage device
To extend memory capacity in a cost effective manner and to provide more permanent memories, secondary storage devices are used. Such devices include the hard disk, floppy disks, flash drives and others.

Input and output device

Input and output devices transfer programs and data between the outside world and the main memory. Together with the secondary storage, these devices are called peripherals. They can be configured as the system's objectives require.

Input Devices

Input devices are used to supply programs and data to the computer system. Examples of input devices include:

Keyboards, Mice, Joysticks, Scanners, Terminals (including point of sales terminals), Voice recognition devices, Video cameras, Optical character readers (OCR), Magnetic ink character readers (MICR), Bar code readers, Punched cards reader, Magnetic stripes reader.

Output Devices

Output devices are used to deliver the results of the execution to users. Examples of output devices include:

Monitor (visual display unit), Printers, Plotters, Terminals, Floppy disks, Flash drives etc.

The Computer Software

The computer software is the abstract part of the computer system. It is not something you can see or touch. It simply represents a set of instructions that are carried out by the computer system. There are two types of software: the system software and the application software.

A) System Software

System software control the hardware resources, carry out housekeeping functions for the effective performance of the computer system. There are three different categories of system software:

- Operating system
- Language translators
- Utilities

Operating System
The operating system is an interface between the computer hardware and the user (and application software). It is a collection of programs designed to control (and manage) the operations of the computer system. It controls input and output peripherals. It tells the computer how to work and set up an environment in which the computer can execute other application programs. Examples of operating systems are:

- DOS (Disk Operating System): it is a single user operating system for personal computers. MS DOS (from Microsoft Coporation) PC DOS (IBM) are variances.

- UNIX, LINUX and other variances: multiuser operating systems that allow multiple users to access a system via terminals.

- Machintosh Operating System (MacOS): was the first Graphical User Interface (GUI) platform.

- Windows Operating system: another GUI-based operating system

Language Translators
These are designed to convert programs written in either High Level Language or Assembly language to machine codes. There are 3 categories of language translators:

- **Compiler**:- this converts program written in high level language to machine codes. The program written in high level language is the source code while the result of the compilation is the object code. For example, FORTRAN, PASCAL, etc.
- **Interpreter**:- it also converts instructions in high level language to machine codes, but contrary to the mode of operation of the compiler, the conversion is done line by line. Example of an interpreter is the BASIC language.
- **Assembler**:- this converts program written in assembly language to an equivalent machine code. Example is the Microsoft Assembler.

Utilities
These are designed to enhance the capabilities of the operating system. This is by carrying out tasks that are beyond the capabilities of the operating system and also carrying out operating system tasks in a more efficient way. Examples of utilities include antivirus programs, disk partitioning programs, spooling programs, etc.

B) Application Packages

This class of software is designed for a specific purpose such as writing letters, memo, playing games, etc. Examples of application packages are word processing software, spreadsheet software, graphical software, accounting software, etc.

Computing Disciplines

The major career options in computing can be classified into:

i. **Computer Engineering**: This involves software and hardware and the development of systems that involve software, hardware, and communications. Computer engineering (CE) students study the design of digital hardware and software systems including communications systems, computers and devices that contain computers. For them, programming is focused on digital devices and their interfaces with users and other devices. An important area within computing engineering is the development of embedded systems. Devices such as cell phones, digital audio players, digital video recorders, alarm systems, x-ray machines, and laser surgical tools all require integration of hardware and embedded software, and are all the result of computer engineering.

   Computer hardware engineers research, design, develop, test, and oversee the installation of computer hardware and supervise its manufacture and installation. Hardware refers to computer chips, circuit boards, computer systems, and related equipment such as keyboards, modems, and printers. The work of computer hardware engineers is very similar to that of electronics engineers, but, unlike electronics engineers, computer hardware engineers work exclusively with computers and computer-related equipment. The rapid advances in computer technology are largely a result of the research, development, and design efforts of computer hardware engineers.

ii. **Computer Science**: it is currently the most popular of the computing disciplines. It is relatively broad and emphases on the underlying science aspects. Computer science (CS) covers the range from theory through programming to development of computing solutions. Computer science offers a foundation that permits graduates to adapt to new technologies and new ideas. The work of computer scientists falls into three categories: a) designing and building software; b) developing effective ways to solve computing problems, such as storing information in databases, sending data over networks or providing new approaches to security problems; and c) devising new and better ways of using computers and addressing particular challenges in areas such as robotics, computer vision, or digital forensics.

iii. **Information Systems**: this is computing in an organizational context, typically in businesses. Information systems (IS) is concerned with the information that computer systems can provide to aid a company or organization in defining and achieving its goals. It is also concerned with the processes that an enterprise can implement and improve using information technology. IS professionals must understand both technical and organizational factors, and must be able to help an organization determine how information and technology-enabled business processes can provide a foundation for superior organizational performance. They serve as a bridge between the technical and management communities within an organization.

iv. **Information Technology**: focuses on computing infrastructure and needs of individual users. It involves a study of systems (e.g. software systems, systems in support of learning, of information dissemination, etc.). Information technology (IT) is a label that has two meanings. In common usage, the term “information technology” is often used to refer to all of computing. As a name of an undergraduate degree program, it refers to the preparation of students to meet the computer technology needs of business, government, healthcare, schools, and other kinds of organizations. IT professionals possess the right combination of knowledge and practical, hands-on expertise to take care of both an organization’s information technology infrastructure and the people who use it. They assume responsibility for selecting hardware and software products appropriate for an organization. They integrate those products with organizational needs and infrastructure, and install, customize and maintain those applications, thereby providing a secure and effective environment that supports the activities of the organization’s computer users. In IT, programming often involves writing short programs that typically connect existing components (scripting). Planning and managing an organization’s IT infrastructure is a difficult and complex job that requires a solid foundation in applied computing as well as management and people skills.

v. **Software Engineering**: focuses on large-scale software systems. It employs ideas from the world of engineering in building reliable software systems. Software engineering (SE) is concerned with developing and maintaining software systems that behave reliably and efficiently, are affordable to develop and maintain, and satisfy all the requirements that customers have defined for them. It is important because of the impact of large, expensive software systems and the role of software in safety-critical applications. It integrates significant mathematics, computer science and practices whose origins are in engineering. Software engineering focuses on software development and goes beyond programming to include such things as obtaining customers’ requirements, and designing and testing software. SE students learn how to assess customer needs and develop usable software that meets those needs. Both computer science and software engineering curricula typically require a foundation in programming fundamentals and basic computer science theory. They diverge in their focus beyond these core elements. Computer science programs tend to keep the core small and then expect students to choose among more advanced courses (such as systems, networking, database, artificial intelligence, theory, etc.). In contrast, SE programs generally expect students to focus on a range of topics that are essential to the SE agenda (problem modelling and analysis, software design, software verification and validation, software quality, software process, software management, etc.). While both CS and SE programs typically require students to experience team project activity, SE programs tend to involve the students in significantly more of it, as effective team processes are essential to effective SE practices. In addition, a key requirement specified by the SE curriculum guidelines is that SE students should learn how to build software that is genuinely useful and usable by the customer and satisfies all the requirements defined for it. In general, a CS degree from a respected program is the most flexible of degrees and can open doors into the professional worlds of CS, SE, IT, and sometimes CE. A degree from a respected IS program allows entry to both IS and IT careers.

Job Specializations for Computing Professionals

Areas of specializations available in the computing field include:

1. **Network administrators:** manage networks and technical systems. They are responsible for troubleshooting issues, anticipating the company's needs and ensuring effective communication throughout the business. These professionals conduct maintenance, implement upgrades to the systems as needed and work to reduce downtime. Network administrators may also teach new hires how to use the company's systems and access the files they need.
2. **Network security engineer**: is an IT professional who installs safeguards to protect a computer network from harm, which can include viruses and malware. Network security engineers analyze the performance of the computer to identify malfunctions and prevent them from recurring, and they conduct tests to see how vulnerable the network is to external threats. Examples of defense mechanisms for the network include encrypting the data on important files, implementing firewalls to stop the entry from unauthorized users.
3. **Web developers** create websites and web applications. They must have a strong understanding of programs like HTML, CSS and JavaScript. Web developers often work closely with their clients to create custom websites. They may also analyze user data to make sure the content they create is useful and easily accessible.
4. **Systems engineer**: is an industry expert who creates a process for conceptualizing, developing and implementing a system, such as a new software application or piece of computer hardware. To maximize efficiency for the process, the systems engineer compiles a list of necessary resources, collaborating with professionals and establishing parameters to evaluate the success of the project. They also prioritize the safety and security of their products and lend technical expertise to assist other technology specialists on their team
5. **Systems analysts**: evaluate business technology to identify potential problems, resolve issues and suggest improvements. Systems analysts are responsible for designing and integrating custom solutions for the businesses and clients they work with. As information technology professionals, they are in high demand in nearly every industry. This allows them to work with a single company or offer their services to several clients at once.
6. **Application developers**: may also be referred to as programmers or software developers. They are responsible for creating software applications for computers, mobile devices and other technologies. They must have a strong understanding of computer systems and programming languages to create user-friendly applications. They may also create upgrades for existing applications and perform maintenance tests on software.
7. **Mobile application developer**: is a type of engineer who designs and builds programs that are compatible with mobile devices, such as cell phones, tablets and laptops. They use source code that allows the program to perform certain tasks and execute commands, and they conduct testing to determine the program's compliance with the devices that consumers typically use. Once the products are available for users to download, the mobile application developer performs maintenance on the products and creates updates to boost their performance.

8. **Information security analysts**: protect companies from cyberattacks. They are responsible for developing new security measures, monitoring information security systems and fighting back against cyberattacks when they occur. They may also assist in the maintenance of these systems.
9. **Database administrator**: oversees activities in databases that a company uses to store and organize information, such as user login credentials, client interactions and survey results. To maintain the confidentiality of the records, the database administrator ensures the structures are working effectively, and they install security procedures to identify threats, remove viruses and restore lost data. The administrator may also install updates on the databases to boost their performance and expand their capabilities.
10. **Database developers**: create, implement and maintain computer databases. They work with companies or clients to identify their data collection, retrieval and storage needs. Then, they develop a safe system for storing and retrieving data. Database developers must be skilled in various computer languages and systems.
11. **IT auditors**: are responsible for managing the evaluation of a company's IT systems. They often work with a team of IT auditors to run system audits. IT auditors also communicate strengths and weaknesses of the IT system to company stakeholders, research how to solve IT issues and update software as needed.
12. **Front-end developer**: is an industry expert who builds the front end of a website, which is the part that users can see when they use the product. To create the interface, the front-end developer uses programming languages, such as HTML, and they control how information and visual elements display on the screen so users can navigate the website. The professional also ensures the interface performs optimally and maintains its layout regardless of the browser and type of device the user chooses to access the website.
13. **Video game designer:** creates visual elements for video games for mobile devices, computers, and gaming systems. Using programming languages and graphic design, the video game designer builds characters and settings that coincide with the games' storylines, and they test the game for functionality, easy navigation and visual appeal. The professional works closely with animators and programmers to build the game, and they strategize ways to advertise it to encourage consumers to purchase it.
14. **Cloud engineer:** is an IT professional who oversees cloud-based programs on behalf of a company or organization. To keep the systems secure and functional, the cloud engineer authorizes information that the systems can store, and they perform maintenance to identify and resolve issues. They also work closely with upper management and fellow IT specialists to discuss the process for transporting company records to databases on the cloud.

DIVERSE AND GROWING COMPUTER DIGITAL APPLICATIONS

The term "diverse and growing computer digital applications" refers to the wide range of tools, platforms, and systems developed for various computing needs across different sectors. These applications span numerous industries and purposes, showcasing the versatility of digital technology in modern society.

Below is a discussion of key areas where computer digital applications are diverse and continually expanding:

1. Healthcare

- **Applications**: Electronic Health Records (EHRs), telemedicine platforms, diagnostic tools, wearable devices for health monitoring.
- **Advances**: AI-driven diagnostics, personalized medicine, and robotic-assisted surgeries.
- **Impact**: Improved patient care, faster diagnosis, and more accessible healthcare services.

2. Education

- **Applications**: Learning Management Systems (LMS), virtual classrooms, and digital tutoring tools.
- **Advances**: AI-enabled personalized learning, gamification, and augmented/virtual reality for immersive learning.
- **Impact**: Increased access to quality education, remote learning opportunities, and enhanced student engagement.

3. Business and Finance

- **Applications**: Enterprise Resource Planning (ERP) systems, online banking, e-commerce platforms, and blockchain technologies.
- **Advances**: Smart contracts, AI-driven financial analytics, and real-time fraud detection.
- **Impact**: Streamlined operations, better decision-making, and secure financial transactions.

4. Entertainment and Media

- **Applications**: Streaming platforms, video games, music production software, and digital content creation tools.
- **Advances**: Virtual reality experiences, AI-generated content, and interactive media.
- **Impact**: Enhanced consumer engagement and new creative possibilities.

5. Government and Security

- **Applications**: E-governance platforms, surveillance systems, and cybersecurity tools.
- **Advances**: AI-enabled surveillance, blockchain for transparent governance, and advanced threat detection systems.
- **Impact**: Improved public service delivery, enhanced security, and data transparency.

6. Social Networking and Communication

- **Applications**: Social media platforms, video conferencing tools, and messaging apps.
- **Advances**: AI-based recommendation systems, real-time translation, and augmented reality interactions.
- **Impact**: Broader connectivity and the ability to maintain relationships globally.

7. Transportation and Logistics

- **Applications**: Fleet management systems, ride-sharing apps, and autonomous vehicle technology.
- **Advances**: AI-based route optimization, drone deliveries, and predictive maintenance tools.

- **Impact**: Reduced costs, improved efficiency, and better customer satisfaction.

8. Research and Development

- **Applications**: Simulation tools, big data analytics platforms, and collaboration software.
- **Advances**: Quantum computing, AI for hypothesis generation, and real-time data sharing.
- **Impact**: Accelerated innovation and improved research accuracy.

Future Trends in Computer Digital Applications

The evolution of computer digital applications is driven by advancements in technology, changing user demands, and emerging global challenges. Below are key future trends in this domain:

1. Artificial Intelligence and Machine Learning Integration
    - **Personalized Experiences**: AI will further enhance personalization in applications, adapting to user behaviors and preferences.
    - **Automation**: Industries will increasingly adopt AI for automation in areas such as customer service (chatbots), healthcare diagnostics, and financial modeling.
    - **Generative AI**: Applications leveraging AI to create content, such as text, images, and videos, will become more prevalent.
2. Edge Computing
    - **Decentralized Processing**: With the rise of IoT, applications will move processing closer to the source of data to reduce latency.
    - **Real-time Decision Making**: Edge computing will enable faster processing for critical applications like autonomous vehicles and industrial automation.
3. 5G and Beyond
    - **Enhanced Connectivity**: The rollout of 5G networks will allow for faster data transfer, supporting applications like AR/VR, real-time gaming, and high-definition streaming.
    - **IoT Expansion**: 5G will drive the growth of smart cities, connected devices, and remote monitoring systems.
4. Blockchain Technology
    - **Decentralized Applications (DApps)**: Blockchain will underpin secure, transparent, and tamper-proof applications for finance, healthcare, and supply chain management.
    - **Smart Contracts**: Automated and self-executing agreements will become standard in various industries.
5. Quantum Computing Applications
    - **Breakthroughs in Problem Solving**: Quantum computing will tackle complex problems in cryptography, optimization, and material science.
    - **Simulation and Modeling**: Industries like pharmaceuticals and logistics will benefit from precise simulations powered by quantum algorithms.
6. Augmented Reality (AR) and Virtual Reality (VR)
    - **Immersive Experiences**: Applications in gaming, education, and training will provide more engaging and realistic environments.
    - **Remote Collaboration**: AR/VR will redefine virtual meetings and collaborative workspaces.
7. Cybersecurity and Privacy Enhancements
    - **Zero Trust Architectures**: Applications will increasingly adopt this approach to ensure robust security.

- **AI-Driven Security**: Cybersecurity tools leveraging AI to detect and respond to threats will be critical for safeguarding applications.

8. Sustainable Computing
    - **Energy-Efficient Applications**: The focus on green computing will drive the development of applications optimized for minimal energy consumption.
    - **Circular Economy**: Digital platforms will promote recycling, reuse, and efficient resource utilization.
9. Natural Language Processing (NLP) and Conversational Interfaces
    - **Enhanced Communication**: Applications will offer seamless human-computer interaction through voice, text, and gesture recognition.
    - **Multilingual Support**: NLP will break language barriers, enabling applications to cater to a global audience.
10. Healthcare Innovations
    - **Telemedicine Expansion**: Digital applications will provide advanced remote healthcare solutions.
    - **Wearable Technology**: Integrated health monitoring through wearable devices will improve diagnostics and preventive care.
11. Digital Twin Technology
    - **Simulation and Optimization**: Applications will simulate real-world objects and processes, aiding in design, monitoring, and predictive maintenance.
    - **Smart Manufacturing**: Digital twins will drive efficiencies in production lines and supply chain management.
12. Ethics and Governance in Digital Applications
    - **Bias Mitigation**: Developers will focus on ensuring fairness and transparency in AI-driven applications.
    - **Regulatory Compliance**: Applications will adapt to comply with evolving data privacy laws and ethical standards.

These trends highlight the dynamic and transformative future of digital applications, emphasizing the importance of adaptability and innovation in a rapidly evolving technological landscape.

INFORMATION PROCESSING AND ITS ROLES IN SOCIETY

Definition of Information Processing

Information processing refers to the methods and systems used to collect, organize, store, retrieve, and manipulate data to produce meaningful information or knowledge. It encompasses a broad spectrum of activities, including input, processing, storage, and output, often leveraging computers and digital systems.

Key Stages of Information Processing

1. **Input**: Data acquisition through sensors, manual entry, or automated systems.
2. **Processing**: Analyzing, interpreting, and transforming data into useful formats using algorithms or computational methods.
3. **Storage**: Safeguarding processed data in databases, cloud systems, or physical storage for future use.
4. **Output**: Delivering meaningful results in forms like reports, visuals, or real-time dashboards.
5. **Feedback**: Using output to refine processes, improve decision-making, or adapt systems.

Roles of Information Processing in Society

1. Decision-Making and Problem Solving

- **Policy and Governance**: Governments rely on information systems for policy development, resource allocation, and public administration.
- **Business Strategies**: Organizations use processed information for market analysis, financial planning, and operational efficiency.
- **Personal Decisions**: Individuals utilize information from apps and tools to make informed choices in areas like health, education, and finance.

2. Enhancing Productivity

- **Automation**: Information processing automates repetitive tasks, reducing manual labor and increasing efficiency.
- **Workflow Optimization**: By streamlining operations, it minimizes delays and redundancies in both businesses and public services.
- **Data-Driven Insights**: It supports productivity by identifying trends and patterns that guide improvements.

3. Enabling Communication and Collaboration

- **Global Connectivity**: Digital systems process and transmit information across borders, fostering collaboration and understanding.
- **Team Coordination**: Platforms like project management tools and communication apps enhance collaboration in workplaces.
- **Social Interaction**: Social media platforms process vast amounts of user data, enabling virtual interactions and community building.

4. Education and Knowledge Dissemination

- **Digital Learning**: Information processing facilitates online education through e-learning platforms, virtual classrooms, and adaptive learning technologies.
- **Access to Resources**: Libraries, search engines, and academic repositories use advanced systems to provide easy access to information.
- **Research Advancements**: Scientists and researchers rely on high-speed processing to analyze complex datasets and conduct simulations.

5. Healthcare Transformation
  - **Patient Care**: Information systems manage medical records, enable remote consultations, and support diagnostics through AI.
  - **Medical Research**: Big data processing aids in understanding diseases, developing treatments, and tracking health trends.
  - **Health Monitoring**: Wearable devices and apps process real-time data to provide personalized health recommendations.
6. Economic Development
  - **E-Commerce**: Online platforms process transactions and customer behavior to personalize shopping experiences.
  - **Market Analysis**: Financial systems analyze market trends, enabling better investment and trading decisions.
  - **Job Creation**: The demand for skilled workers in IT and information systems has grown, creating new opportunities.
7. Security and Surveillance
  - **Crime Prevention**: Processed data from surveillance systems helps detect, prevent, and investigate crimes.
  - **National Security**: Governments use advanced processing for intelligence gathering and threat analysis.
  - **Personal Security**: Applications process information for identity verification, fraud detection, and cybersecurity.
8. Cultural and Social Impact
  - **Media Production**: Information processing powers content creation, distribution, and streaming platforms.
  - **Cultural Preservation**: Digital systems archive historical data, preserving cultural heritage.
  - **Community Engagement**: Platforms process feedback and data to foster citizen engagement and social change initiatives.

Challenges in Information Processing

- **Data Privacy**: Ensuring the ethical handling of personal data.
- **Bias and Fairness**: Preventing algorithmic biases in decision-making systems.
- **Scalability**: Managing the rapid growth of data in a cost-effective and sustainable way.
- **Digital Divide**: Addressing unequal access to information processing tools and technologies.

The Future of Computing

Some of the technologies in the future of computing are explained below.

1. **Graphene-based transistors**: Graphene is a material that is extracted from graphite and is made up of pure carbon, one of the most important elements in nature and which we find in daily objects like the lead of a pencil. Graphene is one carbon-atom thick and more conductive than any other known material. It can be rolled up into tiny tubes and combined with other 2D materials to move electrons faster, in less space and using less energy, than even the smallest silicon transistor. Graphene stands out for being tough, flexible, light, and with a high resistance. It's calculated that this material is 200 times more resistant than steel and five times lighter than aluminum. Graphene has applications in the energy, construction, health, and electronics sectors.

   The most outstanding properties of graphene includes:

   i. Its semiconductor properties
   ii. Graphene's high elasticity and h ardness
   iii. Its high thermal and electric conductivity
   iv. Its resistance (the toughest material in the world)
   v. It supports ionizing radiation
   vi. Graphene is very light, like carbon fiber, but more flexible
   vii. Graphene can react chemically with other substances to form compounds with different properties.
   viii. It consumes less electricity for the same task than silicon which gives this material great potential for development.
   ix. Less Joule effect heats up less when driving electrons.

2. **Quantum computing**: IQuantum computing is a multidisciplinary field comprising aspects of computer science, physics, and mathematics that utilizes quantum mechanics to solve complex problems faster than on classical computers. The field of quantum computing includes hardware research and application development. Quantum computers are able to solve certain types of problems faster than classical computers by taking advantage of quantum mechanical effects, such as superposition and quantum interference. Some applications where quantum computers can provide such a speed boost include machine learning (ML), optimization, and simulation of physical systems. Quantum computing uses subatomic particles, such as electrons or photons. Quantum bits, or qubits, allow these particles to exist in more than one state (i.e., 1 and 0) at the same time. Classical computers today employ a stream of electrical impulses (1 and 0) in a binary manner to encode information in bits. This restricts their processing ability, compared to quantum computing which can be miltidimensional. Whereas the power of quantum computers grows exponentially with more qubits, classical computers that add more bits can increase power only linearly.

   Some potential benefits of quantum computing:

i. Financial institutions may be able to use quantum computing to design more effective and efficient investment portfolios for retail and institutional clients. They could focus on creating better trading simulators and improve fraud detection.
ii. The healthcare industry could use quantum computing to develop new drugs and genetically-targeted medical care. It could also power more advanced DNA research.
iii. For stronger online security, quantum computing can help design better data encryption and ways to use light signals to detect intruders in the system.
iv. Quantum computing can be used to design more efficient, safer aircraft and traffic planning systems.

3. **DNA data storage**: Current storage technologies, including optical and magnetic devices, are almost at their information density limits and are thus not suitable for long-term (>50 years) storage. This means that valuable information needs to regularly be transferred to newer storage media if it is to be preserved for future generations. Innovative methods are required for long-term information storage to avoid this hectic and costly process and to combat other pitfalls associated with current storage media. DNA offers better compression, higher physical density, longer stability, and lower energetic cost than traditional digital methods. Convert data to base 4 and you can encode it on synthetic DNA. Process of sequencing (reading), synthesizing (writing to), and copying DNA is already known. A little bit of it stores a whole lot of information.

4. **Neuromorphic technology**: Neuromorphic computing is a method of computer engineering in which elements of a computer are modeled after systems in the human brain and nervous system. The term refers to the design of both hardware and software computing elements. Using artificial neurons and synapses, neuromorphic computers simulate the way our brains process information, allowing them to solve problems, recognize patterns and make decisions more quickly and efficiently than the computers we commonly use today. Neuromorphic computing is sometimes referred to as neuromorphic engineering. The goal of this technology is to create a computer that mimics the architecture of the human brain in order to achieve human levels of problem solving. It requires hundreds of thousands of times less energy than a traditional transistor. The field of neuromorphic computing is still relatively new. It has very few real-world applications beyond the research being carried out by universities, governments and large tech companies like IBM and Intel Labs. Even so, neuromorphic computing shows a lot of promise — particularly in areas like edge computing, autonomous vehicles, cognitive computing and other applications of artificial intelligence where speed and efficiency are imperative.

5. **Optical computing**: Optical computing (also known as *optoelectronic computing* and *photonic computing*) is a computation paradigm that uses photons (small packets of light energy) produced by laser/ diodes for digital computation. Photons have proved to give us a higher bandwidth than the electrons we use in conventional computer systems. The optical computers, would give us a higher performance and hence be faster than the electronic ones. It has the ability to compute using photons, that is, by mapping data onto light-intensity levels and then varying the light intensity to perform calculations. This is still in its earliest stages but could enable high-efficiency, low-power processing and data transmission. Optical computing at nanoscale would be possible at the literal speed of light.

6. **Distributed computing**: Distributed computing is the method of making multiple computers work together to solve a common problem. It makes a computer network appear as a powerful single computer that provides large-scale resources to deal with complex challenges. For example, distributed computing can encrypt large volumes of data; solve physics and chemical equations with many variables; and render high-quality, three-dimensional video animation. Every computer that's idling in sleep mode or isn't operating at full capacity has compute cycles that can be used for other things. A client that runs in the background allows that computer to download workloads from a remote server, perform calculations locally, and upload the results back to the server.

   Some adavantages of distributed systems over single system computing include:

   i. Scalability: Distributed systems can grow with your workload and requirements. You can add new nodes, that is, more computing devices, to the distributed computing network when they are needed.
   ii. Availability: Your distributed computing system will not crash if one of the computers goes down. The design shows fault tolerance because it can continue to operate even if individual computers fail.
   iii. Consistency: Computers in a distributed system share information and duplicate data between them, but the system automatically manages data consistency across all the different computers. Thus, you get the benefit of fault tolerance without compromising data consistency.
   iv. Transparency: Distributed computing systems provide logical separation between the user and the physical devices. You can interact with the system as if it is a single computer without worrying about the setup and configuration of individual machines. You can have different hardware, middleware, software, and operating systems that work together to make your system function smoothly.
   v. Efficiency: Distributed systems offer faster performance with optimum resource use of the underlying hardware. As a result, you can manage any workload without worrying about system failure due to volume spikes or underuse of expensive hardware.

Silicon chips may be approaching its limits, but technology itself is still accelerating. It is unlikely that is will stop being the driving force in modern life. Its influence will only increase as new computing technologies push robotics, artificial intelligence, machine-to-human interfaces, nanotechnology, and other world-shaking advances past today's accepted limits. In short, exponential growth in computing may not be able to go on forever, but its end is still much further in the future than we might think.

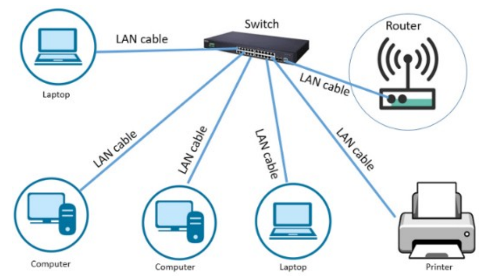
Internet and its Applications

1. Introduction

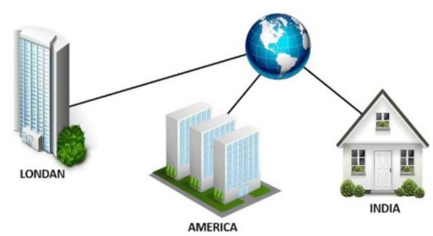
A computer network is an interconnection of independent computers. The connection may be through cables or wireless media. The main benefits of a computer network are communication between users and data/resource sharing.

2. Types of Network

i. **Local Area Network (LAN):** it is connection of computers within a building or adjacent buildings. It is a small network that connects few computers. It may also connect resources like printers, etc. The distance covered is usually between 10m – 1.5km.



ii. **Wide Area Network (WAN):** it is a connection of computers within a wide geographical spread. It is usually to connect different LANs at distant locations. A WAN may spread from one country to another.



iii. **Metropolitan Area Network (MAN):** this is a connection of computers within a metropolitan area (city). It connects LANs at different locations within a city. Distance varies from 1 – 100km.

3. Internet, Intranet and Extranet

The **Internet** may be defined as a super network of many computer networks. It is a global network of computers that provide information and communication facilities. It consists of interconnected networks using standardized communication protocols.

The **Intranet** is a mini (or scaled-down) internet. It is specific to particular organizations, that is, each organization may have its own intranet. It is made up of a collection of computers (clients) communicating using standard internet protocols like TCP/IP.

The **Extranet** is also a mini internet, but it is between selected organizations. It is intranet that permits limited, controlled and secure access between an organization's intranet and designated users from remote locations.

4. Origin of Internet

The development of internet started when US Defense Department set up the ARPANET (Advanced Research Project Agency Network) to have a failure proof communication network for defense department of US (1983).

This architecture was later adopted by an educational institute for an exchange of views among research scholars and then, it was thrown open to the public. Since 1994, the internet has grown, driven by cheaper cost, easier to use and increase in information.

5. Applications

i. **Online communication**: this pertains to the use of E-mail and chat services to communicate with each other. Pictures, documents, videos, audio files can be attached and sent during such communication. For example. Google, Hotmail, Yahoo, etc.

ii. **Business**: organizations use the internet to gather information about the satisfaction of customers with existing products and market opportunities of new products.

    Internet services are also used for promoting products and services through advertisements and different social networks.

    Provision of customer support using the internet has been very beneficial to businesses.

iii. **On-line shopping:** the internet has aided the introduction of online shopping (or virtual market). Prospective customers are able to check for available products and make purchase at any time and from any location all around the world. For example, Amazon, Konga, Jumia, etc.

iv. **Research:** electronic versions of journals and magazines are widely available on the internet for research purposes. For example, IEEE, ACM, Science Direct, PC Mag, etc.

v. **Job search**: users can search for jobs on the internet, submit CVs on recruitment sites and follow-up on their applications online. Examples of job search engines include: Indeed Job Search, LinkedIn, Google for Jobs, Jobberman, etc.

vi. **Stock Market Updates:** it is possible to check values of stock on the internet, make purchases or sell as desired. Examples of online stock marketing sites include FXTM, TD Ameritrade, E*TRADE, Bamboo, Fidelity Investments, Interactive Brokers, etc.

vii. **Real-time updates:** it helps to provide news and other happenings that may be on-going in different parts of the word but with the use of the internet, we come to know about the real-time updates in every field be it in business, sports, finance, politics, entertainment and others very easily.

    Many times the decisions are taken on the real-time updates that are happening in the various parts of the world and for this, the internet is very essential and helpful.

viii. **Financial Transaction:** It is a term which is used when there is an exchange of money. With the use of internet in the financial transaction, the work has become a lot easier.

Payments, Funds transfer, banking transactions can be done through on-line banking service.

ix. **Entertainment:** The Internet is also used for entertainment. Such as chatting with friends, sharing videos, watching movies, listening to music, live telecast of sports and other events, playing games, etc.

x. **Blogging:** There are many people who are very much interested in writing blogs and for them the internet is the best place. They can not only write blogs as per their wish but can also publicize their work so that their work reaches to most of the people and they get appreciated.

6. Positive Impacts of internet on the Society

The positive impacts of internet on the society include:

i. Faster, cheaper and easier medium of communication.
ii. Information sharing and browsing.
iii. Reach to the worldwide audience.
iv. Effective, easier, faster and cheaper promotion of product or service.
v. Better customer support and customer relationship management (CRM).
vi. Online services like banking, shopping, education, etc.
vii. E-mail communication for sending and receiving an electronic document.
viii. Enhanced collaboration between different organizations.
ix. Effective Supply Chain Management (SCM).
x. Newsgroups for instant sharing of news and feedback system.
xi. Creation of new job opportunities related with the internet.
xii. Source for entertainment.
xiii. Social networking for instant touch with friends and relatives.

7. Negative Impacts of internet on the Society

The down sides of internet are as follow:

i. It is the most common medium for spreading malicious software like virus, etc.
ii. It has increased piracy of software, audio, video or other intellectual contents.
iii. Pornography (uploading, publishing in the form of text, image, audio and video).
iv. Stealing, modifying or destruction of data.
v. Hacking of organizational system, website, database etc.
vi. It is also used to harass people by sending insulting comments, making vulgar cartoons, blackmailing, etc. (cyber bullying)

Network topologies

Network topology refers to the layout of the devices in a network and how they are connected to each other. There are several types of network topologies, including:

1. *Bus*: all devices are connected to a single cable.

	Advantages	**Disadvantages**
1	It is cheapter than other topologies	It is vulnerable to cable failures
2	It requires no additional power source	It is not ideal for large networks
3	It is easily scalable	Troubleshooting individual device issues is very difficult

2. *Ring*: each device is connected to its two neighboring devices forming a ring.

	Advantages	**Disadvantages**
1	It is simple and easy to install	It has limited scalability
2	It offers efficient data transfer	The network is difficult to troubleshoot
3	It is cost-effective	Data transfer gets slower with increasing devices

3. *Star*: all devices are connected to a central device.

	Advantages	**Disadvantages**
1	It is very reliable	Requires more cables than bus topology
2	No data collisions occur	If the connecting device fails, the network fails.
3	It is easy to setup	It is more expensive due to additiomal hardware

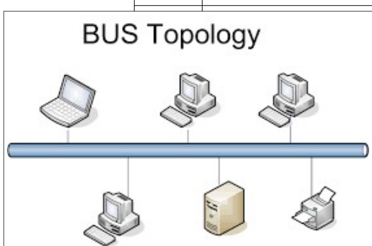
4. *Mesh*: all devices are interconnected.

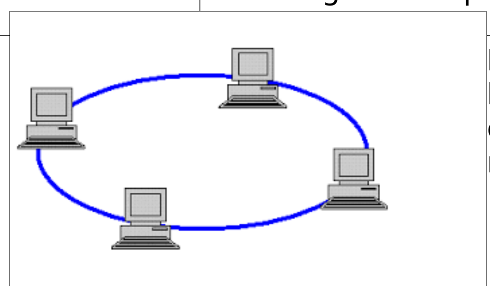
	Advantages	**Disadvantages**
1	Failure of a single device does not disable the network	Difficult installation

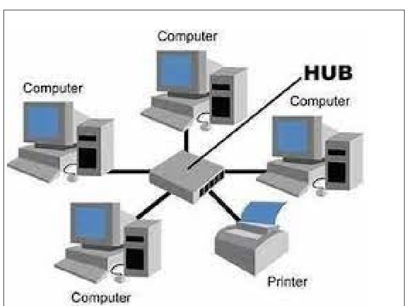
2	High privacy and security provided	It is very costly to implement
3	Faults can be identified easily	It requiresa lot of power because all nodes are required to be active

5. *Hybrid*: combines two or more topologies to form a more robust network.

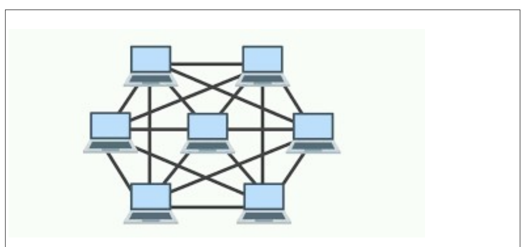
	Advantage	**Disadvantage**
1	It is very flaxible and reliable	It is expensive
2	It can handle large traffic	It’s design is complex
3	It is easily scalable because it enables easy integration of new hardware components	It requirew additional hardware (hubs) to connect different networks.

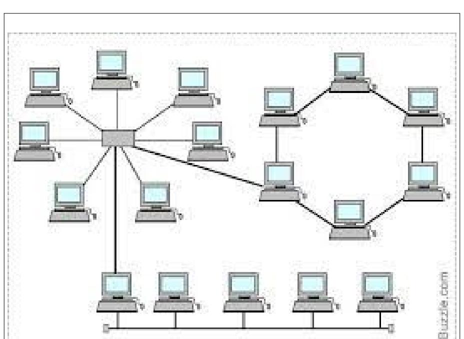



Ring Topology



Star Topology


Mesh Topology



Hybrid Topology