

CHAPTER # 1: COMPUTER SYSTEMS

Give short answers to the following Short Response Questions (SRQs)

Q.1: What is the function and significance of Napier's Bone in early computing?

Ans: It is created by John Napier in the year 1617. It is the better calculating device invented at that time period. It is the type of operating device which is operated manually for the purpose of calculations of quotients and products of the given numbers. All the mathematical calculations like addition, subtraction, multiplication, and division are calculated and performed by it.

Q.2: How did Charles Babbage's Difference Engine differ from the Analytical Engine?

Ans: The Difference Engine and Analytical Engine were two early mechanical computers designed by Charles Babbage. The Difference Engine was a large calculator designed to compute polynomial functions, while the Analytical Engine was a more advanced general-purpose computer that used punched cards for input and output, and was capable of performing a wide range of calculations.

Q.3: What is the primary goal of fifth generation computers?

Ans: The primary goal of fifth generation of computers is to develop devices that can understand natural languages and have thinking power. This is a big challenge for computer developers and programmers to design such systems and software for us.

Q.4: Write down characteristics of fifth generation computers.

Ans: The computers made in the fifth generation are more powerful, functional, fast in speed, even if they are still in the development phase. There are some characteristics of the computers that use ULSI (Ultra Large-Scale Integration) technology, which are given below:

- ❖ The computers of fifth-generation use AI (artificial intelligence) technology that includes: Development of expert systems, Game Playing, Robotics, Natural language understanding, and Neural Networks.
- ❖ The AI technology made these computers to understand human language as well as recognize graphs and pictures.
- ❖ The development of fifth-generation computers is intended to solve highly complex problems, including working with natural language.

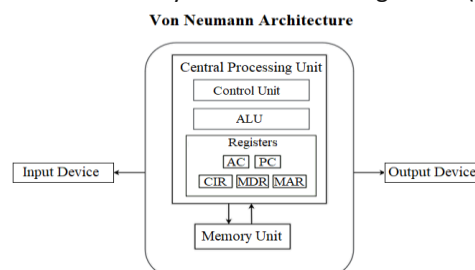
Q.5: Explain Von Neumann architecture. Name the three types of memory maintained on the motherboard in the Von Neumann architecture.

Ans: Von Neumann architecture is the design upon which many general purpose computers are based. The key elements of von Neumann architecture are:

- ❖ Data and instructions are both stored as binary digits
- ❖ Data and instructions are both stored in primary storage
- ❖ Instructions are fetched from memory one at a time and in order (serially)
- ❖ The processor decodes and executes an instruction, before cycling around to fetch the next instruction
- ❖ The cycle continues until no more instructions are available

A processor based on von Neumann architecture has five special registers which it uses for processing:

- ❖ The program counter (PC) holds the memory address of the next instruction to be fetched from primary storage
- ❖ The memory address register (MAR) holds the address of the current instruction that is to be fetched from memory, or the address in memory to which data is to be transferred
- ❖ The memory data register (MDR) holds the contents found at the address held in the MAR, or data which is to be transferred to primary storage
- ❖ The current instruction register (CIR) holds the instruction that is currently being decoded and executed
- ❖ The accumulator (ACC) is a special purpose register and is used by the arithmetic logic unit (ALU) to hold the data being processed and the results of calculations



Memory listed on Motherboard in Von Neumann architecture are Registers RAM and Secondary Storage.

Q.5: Differentiate between volatile and non-volatile memory.

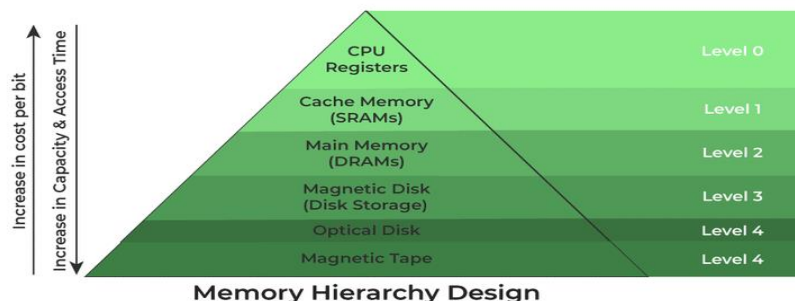
Ans: The following table highlights the major differences between Volatile and Non-volatile memory:

Parameter	Volatile Memory	Non-Volatile Memory
Data Retention	Requires continuous power supply to retain data.	Retains data even when power is turned off.
Data Storage	Temporary storage of data.	Permanent storage of data.
Speed	Faster access and data retrieval.	Slower access and data retrieval compared to volatile memory.
Examples	RAM (Random Access Memory), cache memory.	ROM (Read-Only Memory), flash memory, hard disk drives (HDD), solid-state drives (SSD).
Usage	Mainly used for short-term storage and quick access to data.	Used for long-term storage, firmware, and system software.
Data Integrity	Data is lost when power is interrupted or turned off.	Data is preserved even in the absence of power.
Write Endurance	Can be written multiple times without limitations.	Limited write endurance, but varies depending on the technology.
Cost	Generally more expensive compared to non-volatile memory.	Generally less expensive compared to volatile memory.
Volatility	Highly volatile, meaning data is lost when power is lost or turned off.	Non-volatile, meaning data is retained even when power is lost or turned off.
Power Consumption	Requires constant power supply to maintain data.	Does not require power to retain data.

Q.6: show memory hierarchy with the help of diagram.

Ans: This Memory Hierarchy Design is divided into 2 main types:

- **External Memory or Secondary Memory:** Comprising of Magnetic Disk, Optical Disk, and Magnetic Tape i.e. peripheral storage devices which are accessible by the processor via an I/O Module.
- **Internal Memory or Primary Memory:** Comprising of Main Memory, Cache Memory & CPU registers. This is directly accessible by the processor.



Q.7: Why is the word size of a processor important and how does it affect the computer's performance?

Ans: **Word length** or **word size** is an important characteristic of processor design. It refers to the amount of data that can be handled at one time by the processor. The larger the word size, the greater the amount of data that can be transferred to the CPU in one pass. This is an important factor for the processor performance, as to process an instruction it might well require multiple fetches of data from the main memory. Therefore, being able to pass larger amounts of data to the processor with every pass, the system is likely to carry out instructions faster.

Q.8: What is pipelining, and how does it improve the efficiency of a CPU?

Ans: Pipelining is a technique in which multiple instructions are overlapped during execution. It is used primarily to create and organize instructions in a processor so that the processes run in concurrent fashion. Basically, Pipelining is a process to manage the addition of new tasks frequently by removing the completed tasks. Pipelining improves CPU performance by allowing multiple instructions to be executed simultaneously, reducing overall processing time.

The basic idea behind pipelining is to break down the execution of an instruction into a series of independent steps, with each step being handled by a different part of the processor. This allows the processor to work on several instructions at once, much like an assembly line in a factory.

Imagine a simple CPU that executes instructions in four stages: fetch, decode, execute, and write back. Without pipelining, the CPU would have to complete all four stages for one instruction before it could start the next. This means that most of the CPU's components would be idle most of the time. With pipelining, as soon as the CPU finishes fetching the first instruction, it can start fetching the second, while the first moves on to the decode stage. This way, all parts of the CPU can be working on different stages of different instructions at the same time, which greatly increases the CPU's efficiency and speed.

Q.9: Imagine you are building a custom computer for a friend. Give three considerations you would take into account when choosing the type and size of memory for this computer.

Ans: Almost everything you do on a computer relies on having sufficient memory. This includes moving your mouse cursor, which uses a minimal amount of RAM, and multitasking across multiple apps, which uses more RAM. There are many processes constantly running in the background, such as system updates and security software that also consume RAM.

That is not to say that RAM is the only source of memory storage; solid state drives (SSD) or hard drives (HD) are also used for memory storage. While RAM is used for short-term storage, such as undoing a previous action, SSDs or HDs are used for long-term storage, such as saving a document.

To put it simply, the more things you do on your computer, the more GB of RAM you need. As time goes on you will likely need to increase your computer memory as newer programs demand more memory bandwidth.

If this is how you use your computer	Here's how much memory we recommend
Casual User Internet browsing, email, listening to music, or watching videos	At least 8GB
Intermediate User Internet browsing, email, Word Processing, spreadsheets, running simple graphics programs, flash games, music, videos or multitasking	At least 16GB
Professional User / Gamer / Graphic Designer High performance gaming, multimedia editing, high-definition video, graphic design / 3D modeling, intensive multitasking	At least 32GB

Q.10: You are a computer technician tasked with upgrading an older computer with a slow CPU. How might you improve its performance without replacing the entire CPU?

Ans: There are several ways to improve your computer's processing speed without upgrading the CPU:

1. **Increase RAM:** Adding more RAM can help your computer handle more tasks simultaneously, which can improve overall performance.
2. **Use an SSD:** Upgrading to a solid-state drive (SSD) from a traditional hard drive can significantly improve the speed of your computer, as SSDs have faster read and write speeds.
3. **Close unnecessary programs:** Running too many programs at once can slow down your computer. Closing unnecessary programs and background processes can free up resources for the tasks you're currently working on.
4. **Clean up disk space:** Removing unnecessary files and programs can free up disk space and improve overall system performance.
5. **Update software and drivers:** Keeping your operating system, software, and drivers up to date can improve compatibility and performance.
6. **Use a cooling pad:** If your computer tends to overheat, using a cooling pad can help maintain optimal operating temperatures, preventing thermal throttling that can slow down the CPU.
7. **Adjust power settings:** Changing your computer's power settings to prioritize performance over energy saving can improve processing speed.
8. **Disable startup programs:** Disabling unnecessary programs from starting up with your computer can reduce the time it takes for your system to boot up and free up resources.

By implementing these strategies, you can potentially improve your computer's processing speed without the need to upgrade the CPU.

Q.11: Your school is planning to purchase new printers for the computer lab. Give three advantages and disadvantages of impact and non-impact printers to help them make a decision.

Ans: Following are some advantages and disadvantages of Impact and Non-Impact printers:

Impact printers:

- ❖ Impact printers will work like typewriter and use striking/hammering action.
- ❖ Print in black or single color.
- ❖ Impact printers are noisy
- ❖ High Resolution graphics cannot be produced.
- ❖ Examples: Dot Matrix Printer, Character Printer and Line Printer

Non-Impact Printers

- ❖ They use thermal, electrostatic chemical and inkjet technologies.
- ❖ Produce Single color/multicolor output.
- ❖ Almost noiseless.
- ❖ High resolution graphics can be produced.
- ❖ Examples, Inkjet, Laser printer, Plotters etc.

Both types of printers have their own advantages and disadvantages. From the above comparison, it is clear that non-impact printers are more efficient and economical as compared to impact printers. The most significant difference that you should note here is that impact printers use inked ribbon and a mechanical printing head to produce prints onto a paper, while non-impact printers use non-mechanical and silent printing technology.

Q.12: Define protocol in the context of data communication.

Ans: A protocol is a set of rules and guidelines for communicating data. Rules are defined for each step and process during communication between two or more computers. Networks have to follow these rules to successfully transmit data.

Q.13: Define Simplex, Half-Duplex and Full-Duplex modes of communication with one example each.

Ans: Simplex: In simplex transmission mode, the communication between sender and receiver occurs in only one direction. The sender can only send the data, and the receiver can only receive the data. The receiver cannot reply to the sender. Real-life examples of this communication mode include:

- ❖ Radio broadcasting
- ❖ Television broadcasting
- ❖ Computer to printer

- ❖ Monitor output
- ❖ Mouse/keyboard/joystick to computer
- ❖ Fire alarm system
- ❖ Loud speaker

Half Duplex:

- ❖ Data can flow in both directions but not simultaneously.
- ❖ Speed of half duplex is slow.

Real-life examples of half-duplex communication include:

- ❖ A walkie-talkie
- ❖ A two-way radio that has a push-to-talk button
- ❖ Browsing the internet (requests and responses)
- ❖ Universal Serial Bus (USB)
- ❖ Cash withdrawal from ATM machines.

Full Duplex:

- ❖ Data can flow in both directions simultaneously.
- ❖ Speed of full duplex is fast.

Some real-life examples of full duplex communication include:

- ❖ Video calls/video conferencing
- ❖ Audio calls
- ❖ Live chats

Comparison Chart:

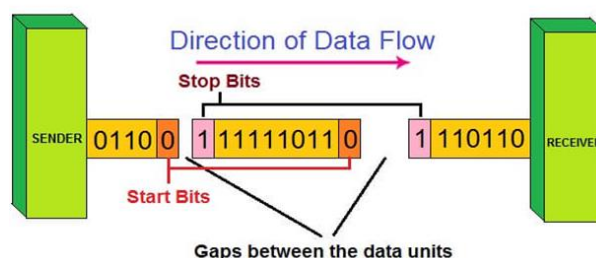
Basis for Comparison	Simplex	Half Duplex	Full Duplex
Direction of Communication	Unidirectional	Two-directional, one at a time	Two-directional, simultaneously
Send / Receive	The sender can only send data	The sender can send and receive data, but one a time	The sender can send and receive data simultaneously
Performance	Worst performing mode of transmission	Better than Simplex	Best performing mode of transmission
Example	Keyboard and monitor	Walkie-talkie	Telephone

Q.14: What are start and stop bits and where they are used in data transmission?

Ans: Start Bit: The transmission begins with the transmission of a START bit, which is always a logic 0 (low voltage level). This START bit alerts the receiving device that the data is about to be transmitted and it helps the receiver synchronize its internal clock with the sender's clock.

Stop Bit: After the data bits one or more STOP bits are sent. The STOP bit(s) indicate the end of the data character. In most cases one or two STOP bits are used depending on the system configuration. These STOP bits are always logic 1 (high voltage level).

Asynchronous Communication



The above START and STOP bits are used in Asynchronous transmission mode.

Q.15: How does a switch differ from a hub in a network?

Ans: Following is the difference between Hub and Switch:

Hub	Switch
<ul style="list-style-type: none"> ❖ Hub is operated on Physical layer of OSI model. ❖ Hub is a broadcast type transmission. ❖ Hub have 4/12 ports. ❖ Hub is a half-duplex transmission mode. ❖ Hub is not an intelligent device that sends message to all ports hence it is comparatively inexpensive. ❖ Hub is simply old type of device and is not generally used. ❖ Cheaper as compared to switch. 	<ul style="list-style-type: none"> ❖ While switch is operated on Data link layer of OSI Model. ❖ While switch is a Unicast, multicast and broadcast type transmission. ❖ While switch can have 24 to 48 ports. ❖ While switch is a full duplex transmission mode. ❖ While switch is an intelligent device that sends message to selected destination so it is expensive. ❖ While switch is very sophisticated device and widely used. ❖ Expensive as compared to HUB.

Q16: How does asynchronous transmission differ from synchronous transmission and in what situation are they typically used?

Ans: Now, let's see the difference between Synchronous Transmission and Asynchronous Transmission:

Synchronous Transmission	Asynchronous Transmission
In Synchronous transmission, data is sent in form of blocks or frames.	In Asynchronous transmission, data is sent in form of bytes or characters.
Synchronous transmission is fast.	Asynchronous transmission is slow.
Synchronous transmission is costly.	Asynchronous transmission is economical.
In Synchronous transmission, the time interval of transmission is constant.	In Asynchronous transmission, the time interval of transmission is not constant, it is random.
In this transmission, users have to wait till the transmission is complete before getting a response back from the server.	Here, users do not have to wait for the completion of transmission in order to get a response from the server.
In Synchronous transmission, there is no gap present between data.	In Asynchronous transmission, there is a gap present between data.

Synchronous Transmission	Asynchronous Transmission
Efficient use of transmission lines is done in synchronous transmission.	While in Asynchronous transmission, the transmission line remains empty during a gap in character transmission.
The start and stop bits are not used in transmitting data.	The start and stop bits are used in transmitting data that imposes extra overhead.
Synchronous transmission needs precisely synchronized clocks for the information of new bytes.	Asynchronous transmission does not need synchronized clocks as parity bit is used in this transmission for information of new bytes.
Errors are detected and corrected in real time.	Errors are detected and corrected when the data is received.
Low latency due to real-time communication.	High latency due to processing time and waiting for data to become available.
Examples: Telephonic conversations, Video conferencing, Online gaming.	Examples: Email, File transfer, Online forms.

Q17: Explain the concept of a peer-to-peer network and its limitations compared to a client/server network.

Ans: Difference between Client-Server and Peer-to-Peer Network:

Client-Server Network	Peer-to-Peer Network
In Client-Server Network, Clients and server are differentiated, Specific server and clients are present.	In Peer-to-Peer Network, Clients and server are not differentiated.
Client-Server Network focuses on information sharing.	While Peer-to-Peer Network focuses on connectivity.
In Client-Server Network, Centralized server is used to store the data.	While in Peer-to-Peer Network, Each peer has its own data.
In Client-Server Network, Server respond the services which is request by Client.	While in Peer-to-Peer Network, Each and every node can do both request and respond for the services.
Client-Server Network are costlier than Peer-to-Peer	While Peer-to-Peer Network are less costlier than

Client-Server Network	Peer-to-Peer Network
Network.	Client-Server Network.
Client-Server Network are more stable than Peer-to-Peer Network.	While Peer-to-Peer Network are less stable if number of peer is increase.
Client-Server Network is used for both small and large networks.	While Peer-to-Peer Network is generally suited for small networks with fewer than 10 computers.

Q.18: Compare and contrast the star and ring network topologies.

Ans: Comparison between Star and Ring Topology.

Basis	Star topology	Ring topology
Connection of nodes	In star topology, all the nodes are connected to a central controller directly. It has no connection between all the nodes.	In a ring topology, all the nodes are connected in the form of a ring or loop in a network.
Expansion of nodes and flexibility	In star topology, adding a new node or modifying any existing node is easier without disturbing the network, i.e., flexibility is very high.	In a ring topology, adding a new node or modifying any existing node is difficult i.e., flexibility is very low.
Communication Delay	In star topology, adding new nodes does not increase communication delay.	In-ring topology, the addition of new nodes increases communication delay.
Failure of Node	In star topology, failure of one node can affects the whole network and the hub is a failure point.	In ring topology if one link fails then there is no alternative to connect it with rest of the network.
Response time	In this topology, response time is good.	In a ring topology, response time is relatively good as compared to star topology.
Data Transfer	In a star topology, data travel through all devices via a hub.	In a ring topology, data travel either in clockwise or anticlockwise.
Fault identification and Isolation	In star topology, fault identification and Isolation are relatively easy as compared to ring topology.	In this topology, it is easier to locate the problems with devices and cable, i.e., fault identification and Isolation are easy but not better as star topology.
Transmission Speed	In star topology, transmission speed is faster.	In a ring topology, transmission speed is slow.
Complexity	Star topology has average complexity.	A ring network requires more cable to connect nodes hence complexity increased.
Troubleshooting	Star topology is easy to configure and troubleshoot.	Ring topology is relatively difficult to reconfigure and troubleshoot.
Installation and Maintenance	In star topology, Installation and maintenance is easy.	In ring topology, Installation and maintenance is difficult as compared to star topology in a network.

Q.19: Why is mesh topology considered the most reliable but also the most expensive to implement?

Ans: Due to the following points the Mesh topology is most reliable among other topologies:

- ❖ Failure during a single device won't break the network.
- ❖ There is no traffic problem as there is a dedicated point to point links for every computer.
- ❖ This topology provides multiple paths to succeed in the destination and tons of redundancy.
- ❖ It provides high privacy and security.
- ❖ Data transmission is more consistent because failure doesn't disrupt its processes.
- ❖ Adding new devices won't disrupt data transmissions.
- ❖ This topology has robust features to beat any situation.

Yes mesh is the most expensive because in a mesh environment, a cable runs from every computer to every other computer. If you have four computers, you must have six cables three coming from each computer to the other computers.

Q.20: What is the role of the Application Layer in the OSI model?

Ans: Each Layer in OSI Model Performs some important duties. Important functions performed by Application Layer are listed here:

- ❖ Application Layer **manages applications** software running on a computer or terminal. This is the most important function of Applications Layer.
- ❖ It works like an interface between Network Services & applications. Application Layer **supplies Network Services to End User.**
- ❖ It is also responsible for End User Processes Management.
- ❖ Miscellaneous other services are also provided by application including Naming Services (e.g. DNS), Mail Services (e.g. SMTP/POP3), Remote Login Services (e.g. Telnet/SSH), Remote Host Management (e.g. SNMP) etc.

Give long answers to the following Extended Response Questions (ERQs)

Q.1: Describe the evolution of computer generations from the first generation to the fifth generation, highlight the technological developments and their impact on computing.

Ans: There are five generations of computer and they are divided on the basis of major technological development at that time.

- ❖ 1st Generation (1940-1956)
- ❖ 2nd Generation (1956-1963)
- ❖ 3rd Generation (1963-1971)
- ❖ 4th Generation (1971-Present)
- ❖ 5th Generation (Present-beyond)

1st Generation (1940-1956):

- ❖ 1st Generation computers used Vacuum tubes and they had to be cooled by air conditioners.
- ❖ Slow speed, Small memory.
- ❖ Very expensive and unreliable.
- ❖ Used input as punched cards and for output electric typewriter.
- ❖ Use machine language e.g. ENIAC, UNIVAC etc..

2nd Generation (1956-1963):

- ❖ Use transistors instead of Vacuum tubes.
- ❖ Small size and high speed.
- ❖ Reliable and cheaper.
- ❖ Assembly language was used e.g. UNIVAC II etc..

3rd Generation (1963-1971):

- ❖ ICs(Integrated Circuits) were used in this generation.
- ❖ Memory size and speed were improved.

Muhammad Sikandar Dar, Assistant Professor, IMCB, G-11/1, Islamabad

- ❖ Use less power, smaller in size and more reliable.
- ❖ Keyboard and monitor used as Input / Output devices.

4th Generation (1971-Present):

- ❖ LSI(Large Scale Integrated Circuits) and VLSI(Very Large Scale Integrated Circuits) were developed.
- ❖ Very fast, large storage capacity and advance Input / Output devices.
- ❖ Variety of software available for use i.e. Multimedia support.
- ❖ Modern programming languages i.e. C++, Java were developed.
- ❖ Also support portable and wireless Input/ Output devices e.g. Dual core

5th Generation (Present-beyond):

- ❖ In fifth generation computers Artificial Intelligence was introduced means devices behave like human being and understand natural languages.
- ❖ User can give command to computer in any natural language like English e.g. Robots, Expert system.

Q.2: Discuss the importance of categorizing and understanding different types of systems, both natural and artificial and provide examples of each type.

Ans: What does a “system” mean? *The word “system” is derived from the Latin word “systema”, which describes the relation between several working elements or units. Systems are built to produce one or more specific goals. In our daily life, we come in contact with various systems, such as the accounting system, the transportation system, the computer system, and so on. What is a simple definition of a system? We can define a system as a group of components or subsystems that integrate and function together in order to achieve a specific goal.*

Understanding and categorizing systems is important for various fields, including engineering, biology, sociology and management as it allows for better analysis, design, and optimization of these systems to achieve their intended goals.

Natural Systems: A natural system is an interconnected collection of elements that exist in the nature. These systems are typically found in the environment and are characterized by their ability to self-regulate, adapt and maintain a certain degree of stability. Following are few examples of Natural Systems:

Ecosystems: In the word “ecosystem”, “eco” means environment, and “system,” refers to connected processes or elements. Ecosystems are made up of both biotic (and alive) and abiotic (or nonliving) components. It is a biological community where living and non-living components of the planet interact with each other. Ecosystem varies in the size and number of organisms they consist of. When the ecosystem is land-based it is called a terrestrial ecosystem and when it is water-based it is called an aquatic ecosystem.

Solar System: The solar system consists of the Sun; the eight official planets, at least three “dwarf planets”, more than 130 satellites of the planets, a large number of small bodies (the comets and asteroids), and the interplanetary medium. (There are probably also many more planetary satellites that have not yet been discovered.)

Artificial Systems: Artificial systems are known as man-made or human made systems are created and designed by humans to serve specific purposes, solve problems or achieve particular goals. Artificial Systems are essential component of modern society contributing to our ability to meet a wide range of needs and advance in various fields. Following are few examples of Artificial Systems:

Communication System includes the following systems:

Internet and Computer Networks: A computer network is any group of interconnected computing devices capable of sending or receiving data. A computing device isn't just a computer—it's any device that can run a program, such as a tablet, phone, or smart sensor.

Satellite Communication Systems: Satellite communication plays a vital role in our daily life. Following are the applications of satellite communication –

- ❖ Radio broadcasting and voice communications

**Muhammad Sikandar Dar, Assistant Professor, IMCB, G-11/1, Islamabad.
Mr. Iftikhar Hussain, Lecturer, IMCB, G-10/4, Islamabad.**

Muhammad Sikandar Dar, Assistant Professor, IMCB, G-11/1, Islamabad

- ❖ TV broadcasting such as Direct To Home (DTH)
- ❖ Internet applications such as providing Internet connection for data transfer, GPS applications, Internet surfing, etc.
- ❖ Military applications and navigations
- ❖ Remote sensing applications
- ❖ Weather condition monitoring & Forecasting

Information System includes the following systems:

Database Management System: The database is a collection of inter-related data which is used to retrieve, insert and delete the data efficiently. It is also used to organize the data in the form of a table, schema, views, and reports, etc.

The college Database organizes the data about the admin, staff, students and faculty etc. Using the database, you can easily retrieve, insert, and delete the information.

Application Software: Application software is a program designed to help users perform specific application tasks. These applications fulfill various purposes like word processing, data handling, data analysis, and much more, saving the time and resources that would be utilized manually. Some of the well-known examples of application software are Microsoft Word, Excel and search engines like Opera and Google Chrome. It also includes a class of mobile applications, including communication apps like WhatsApp and games like Subway Surfers.

Q.3 Explain the characteristics and potential challenges associated with fifth generation computers that aim to understand natural languages and possess thinking capabilities. What are the implications of such advancement in computing society?

Ans: NLP is one of the ways that people have humanized machines and reduced the need for labor. It has led to the automation of speech-related tasks and human interaction. Some applications of NLP include:

- ❖ Translation Tools: Tools such as Google Translate, Amazon Translate, etc. translate sentences from one language to another using NLP.
- ❖ Chatbots: Chatbots can be found on most websites and are a way for companies to deal with common queries quickly.
- ❖ Virtual Assistants: Virtual Assistants like Siri, Cortana, Google Home, Alexa, etc can not only talk to you but understand commands given to them.
- ❖ Targeted Advertising: Have you ever talked about a product or service or just googled something and then started seeing ads for it? This is called targeted advertising, and it helps generate tons of revenue for sellers as they can reach niche audiences at the right time.
- ❖ Autocorrect: Autocorrect will automatically correct any spelling mistakes you make, apart from this grammar checkers also come into the picture which helps you write flawlessly.

Applications of Artificial Intelligence

Artificial intelligence (AI) has a wide range of applications across various industries and domains. Here are some notable applications of AI:

- ❖ **Natural Language Processing (NLP)**
AI is used in NLP to analyze and understand human language. It powers applications such as speech recognition, machine translation, sentiment analysis, and virtual assistants like Siri and Alexa.
- ❖ **Image and Video Analysis**
AI techniques, including computer vision, enable the analysis and interpretation of images and videos. This finds application in facial recognition, object detection and tracking, content moderation, medical imaging, and autonomous vehicles.
- ❖ **Robotics and Automation**
AI plays a crucial role in robotics and automation systems. Robots equipped with AI algorithms can perform complex tasks in manufacturing, healthcare, logistics, and exploration. They can adapt to changing environments, learn from experience, and collaborate with humans.
- ❖ **Recommendation Systems**
AI-powered recommendation systems are used in e-commerce, streaming platforms, and social media to personalize user experiences. They analyze user preferences, behavior, and historical data to suggest relevant products, movies, music, or content.

❖ **Financial Services**

AI is extensively used in the finance industry for fraud detection, algorithmic trading, credit scoring, and risk assessment. Machine learning models can analyze vast amounts of financial data to identify patterns and make predictions.

❖ **Healthcare**

AI applications in healthcare include disease diagnosis, medical imaging analysis, drug discovery, personalized medicine, and patient monitoring. AI can assist in identifying patterns in medical data and provide insights for better diagnosis and treatment.

❖ **Virtual Assistants and Chatbots**

AI-powered virtual assistants and chatbots interact with users, understand their queries, and provide relevant information or perform tasks. They are used in customer support, information retrieval, and personalized assistance.

❖ **Gaming**

AI algorithms are employed in gaming for creating realistic virtual characters, opponent behavior, and intelligent decision-making. AI is also used to optimize game graphics, physics simulations, and game testing.

❖ **Smart Homes and IoT**

AI enables the development of smart home systems that can automate tasks, control devices, and learn from user preferences. AI can enhance the functionality and efficiency of Internet of Things (IoT) devices and networks.

❖ **Cyber security**

AI helps in detecting and preventing cyber threats by analyzing network traffic, identifying anomalies, and predicting potential attacks. It can enhance the security of systems and data through advanced threat detection and response mechanisms.

These are just a few examples of how AI is applied in various fields. The potential of AI is vast, and its applications continue to expand as technology advances.

Artificial Intelligence Examples in Our Daily Life

Artificial Intelligence (AI) has become an integral part of our daily lives, revolutionizing various industries and enhancing user experiences. Here are some notable examples of AI applications:

ChatGPT

ChatGPT is an advanced language model developed by OpenAI, capable of generating human-like responses and engaging in natural language conversations. It uses deep learning techniques to understand and generate coherent text, making it useful for customer support, chatbots, and virtual assistants.

Google Maps

Google Maps utilizes AI algorithms to provide real-time navigation, traffic updates, and personalized recommendations. It analyzes vast amounts of data, including historical traffic patterns and user input, to suggest the fastest routes, estimate arrival times, and even predict traffic congestion.

Smart Assistants

Smart assistants like Amazon's Alexa, Apple's Siri, and Google Assistant employ AI technologies to interpret voice commands, answer questions, and perform tasks. These assistants use natural language processing and machine learning algorithms to understand user intent, retrieve relevant information, and carry out requested actions.

Snapchat Filters

Snapchat's augmented reality filters, or "Lenses," incorporate AI to recognize facial features, track movements, and overlay interactive effects on users' faces in real-time. AI algorithms enable Snapchat to apply various filters, masks, and animations that align with the user's facial expressions and movements.

Self-Driving Cars

Self-driving cars rely heavily on AI for perception, decision-making, and control. Using a combination of sensors, cameras, and machine learning algorithms, these vehicles can detect objects, interpret traffic signs, and navigate complex road conditions autonomously, enhancing safety and efficiency on the roads.

Wearables

Wearable devices, such as fitness trackers and smartwatches, utilize AI to monitor and analyze users' health data. They track activities, heart rate, sleep patterns, and more, providing personalized insights and recommendations to improve overall well-being.

Q.4: Explain the fundamental components of network communication and how do they work together to facilitate data transfer?

Ans: Communication is defined as a process in which more than one computer transfers information, instructions to each other and for sharing resources. Or in other words, communication is a process or act in which we can send or receive data. A network of computers is defined as an interconnected collection of autonomous computers. Autonomous means no computer can start, stop or control another computer.

Components of Data Communication:

A communication system is made up of the following components:

1. **Message:** A message is a piece of information that is to be transmitted from one person to another. It could be a text file, an audio file, a video file, etc.
2. **Sender:** It is simply a device that sends data messages. It can be a computer, mobile, telephone, laptop, video camera, or workstation, etc.
3. **Receiver:** It is a device that receives messages. It can be a computer, telephone mobile, workstation, etc.
4. **Transmission Medium / Communication Channels:** Communication channels are the medium that connect two or more workstations. Workstations can be connected by either wired media or wireless media.
5. **Set of rules (Protocol):** When someone sends the data (The sender), it should be understandable to the receiver also otherwise it is meaningless. For example, Sonali sends a message to Chetan. If Sonali writes in Hindi and Chetan cannot understand Hindi, it is a meaningless conversation.

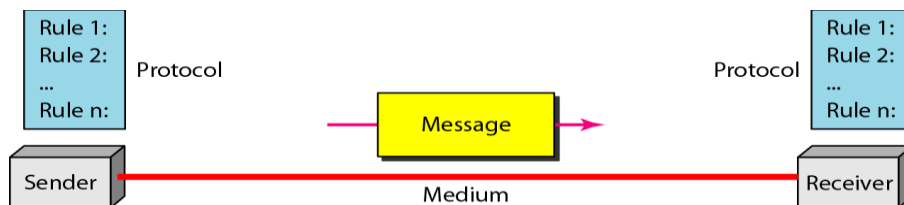
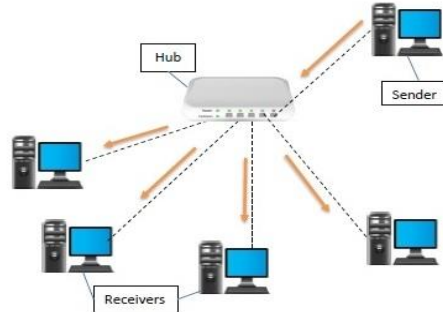


Diagram: Components of Computer Network

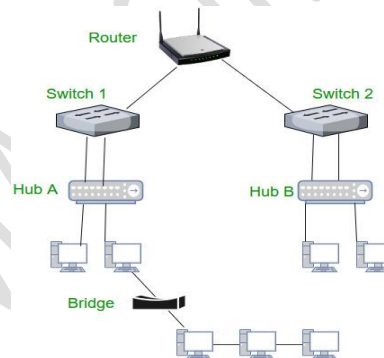
Q.5: Describe the roles of common communication devices like hubs, switches, routers and gateways in data communication. How do they contribute to the functionality of a network?

Ans: Hub: A hub is a **physical layer** networking device which is used to connect multiple devices in a network. They are generally used to connect computers in a LAN. A hub has many ports in it. A computer which intends to be connected to the network is plugged in to one of these ports. When a data frame arrives at a port, it is broadcast to every other port, without considering whether it is destined for a particular destination or not.



Switch: A switch like a hub is a device that connects number of computers together in a LAN. The typical use of a switch is at a center of a star network or as part of hybrid network. Switch has cables plugged into it from each computer. Switch is more intelligent than hub.

Router: A router is a device like a switch that routes data packets based on their IP addresses. The router is mainly a Network Layer device. Routers normally connect LANs and WANs and have a dynamically updating routing table based on which they make decisions on routing the data packets. The router divides the broadcast domains of hosts connected through it.



Gateway: A gateway, as the name suggests, is a passage to connect two networks that may work upon different networking models. They work as messenger agents that take data from one system, interpret it, and transfer it to another system. Gateways are also called protocol converters and can operate at any network layer. Gateways are generally more complex than switches or routers. A gateway is also called a protocol converter.

Q.6: Discuss the advantages and limitations of different network topologies, including bus, star, ring and mesh. When should each topology be used in a network design?

Ans: Bus Topology Advantages and Disadvantages:

Advantages:

- ❖ **Easy installation**, each cable needs to be connected with backbone cable.
- ❖ **Less Expensive: Less cables** are required than Mesh and star topology
- ❖ **Limited failure:** The connection failure of one device doesn't affect the connections of other devices on network.

Disadvantages:

- ❖ Difficultly in fault detection.
- ❖ **Not scalable** as there is a limit of how many nodes you can connect with backbone cable.
- ❖ **Difficult to troubleshoot:** It is difficult to identify the cause of failure.
- ❖ **Data collision:** When two or more devices send the data simultaneously then there is a chance of data collision.

Star Topology Advantages and Disadvantages:

Advantages:

- ❖ **Less expensive:** Less expensive because each device only need one I/O port and needs to be connected with hub with one link.
- ❖ **Easier to install**
- ❖ **Cost effective:** Less amount of cables required because each device needs to be connected with the hub only.
- ❖ **Robust:** If one link fails, other links will work just fine.
- ❖ **Easy to troubleshoot:** Easy fault detection because the link can be easily identified.
- ❖ **Reliable:** Each device is separately connected to the hub, so a connection failure between a device and hub doesn't affect the connection of the other devices.

Disadvantages:

- ❖ If hub goes down everything goes down, none of the devices can work without hub.
- ❖ Hub requires more resources and regular maintenance because it is the central system of star topology.
- ❖ **Not Scalable:** There is a limit to add new devices as each device increase the load on the central unit (hub or switch). This is why it is not suitable for the large networks.

Ring Topology Advantages and Disadvantages:

Advantages:

- ❖ Easy to install.
- ❖ Managing is easier as to add or remove a device from the topology only two links are required to be changed.
- ❖ **Less expensive:** Generally Twisted pair cabling is used in ring topology which is inexpensive and easily available.
- ❖ **Easy maintenance:** The network in ring topology is easy to maintain as a system failure doesn't affect other systems on network, the failed system can be easily removed and installed again after fixing the issue.

Disadvantages:

- ❖ A link failure can fail the entire network as the signal will not travel forward due to failure.
- ❖ Data traffic issues, since all the data is circulating in a ring.

Mesh Topology Advantages and Disadvantages:

Advantages:

- ❖ **No data loss:** No data traffic issues as there is a dedicated link between two devices which means the link is only available for those two devices.
- ❖ **Reliable:** Mesh topology is reliable and robust as failure of one link doesn't affect other links and the communication between other devices on the network.
- ❖ **Secure:** Mesh topology is secure because there is a point to point link thus unauthorized access is not possible.
- ❖ **Easy to troubleshoot:** Fault detection is easy as there is a separate connection between each devices.
- ❖ **Fast communication:** As there is a dedication connection between two devices on a network, the communication is fast.

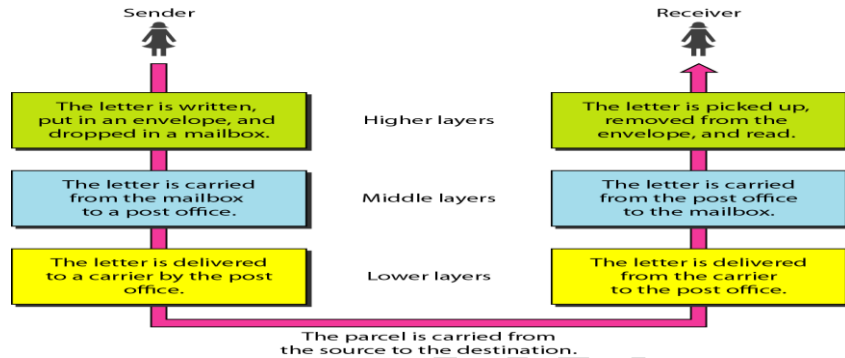
Disadvantages:

- ❖ Amount of wires required to connected each system is tedious and headache.
- ❖ Since each device needs to be connected with other devices, number of I/O ports required must be huge.
- ❖ Scalability issues because a device cannot be connected with large number of devices with a dedicated point to point link.

Q.7: What is OSI model and how does it help in understanding the process of data communication? Explain each of the seven layers and their functions.

Ans: OSI Model: OSI stands for Open System Interconnection. It was developed by International Standard Organization (ISO), developed standards for international and national data communications. It consists of seven layers i.e. Application layer, Presentation layer, Session layer, Transport layer, Network layer, Data unit layer and Physical layer. Each layer perform specific task during data communication. In OSI Model, control is passed from one layer to the next, starting at the application layer in one station and proceeding to the bottom layer (the physical layer), over the physical Unit to the next station and back up to the Application layer. The seven layers of OSI Model are as follows:

- ❖ Application layer
- ❖ Presentation layer
- ❖ Session layer
- ❖ Transport layer
- ❖ Network layer
- ❖ Data link layer
- ❖ Physical layer



Application layer:The application layer is the top most layer of OSI Model. It provides services to end user. It interacts with the OS or application software. Whenever user wants to send files, read messages or perform other network related activities.

Presentation Layer:The presentation layer is the sixth layer of OSI Model. It receives data from application layer. It performs data reformatting, data compression and encryption.

Session layer:Session layer perform functions that enable two applications or two pieces of the same application to communicate across the network. It establishes, maintains and terminates the session user connection. It also maintains. Security and perform the task such as name recognition and logging.

Transport layer:It provides the mechanism to transport data between network devices. It controls the four of data. It ensures that messages are delivered without any error. The data is retransmitted if there are any error in the transmission.

Network Layer: It decides which physical path-way data should take to reach the destination. There may be many networks between two computers. The communication device Router works in network layer.

Data link layer:It is responsible for node to node delivery of data. It divides the stream of bits received from network layer inter manageable data units called frames. It also performs the following functions i.e. Flow control, Error control and Access control.

Physical layer:It transmits stream of bits and defines how the data is transmitted over the network and what control signals are used. Physical layer must decide the following media characteristics, representation of bits, transmission mode etc.

Layer	Application/Example	Central Device/Protocols	DOD4 Model
Application (7) Serves as the window for users and application processes to access the network services.	End User layer Program that opens what was sent or creates what is to be sent Resource sharing • Remote file access • Remote printer access • Directory services • Network management	User Applications SMTP	Process
Presentation (6) Formats the data to be presented to the Application layer. It can be viewed as the "Translator" for the network.	Syntax layer encrypt & decrypt (if needed) Character code translation • Data conversion • Data compression • Data encryption • Character Set Translation	JPEG/ASCII EBDIC/TIFF/GIF PICT	
Session (5) Allows session establishment between processes running on different stations.	Synch & send to ports (logical ports) Session establishment, maintenance and termination • Session support - perform security, name recognition, logging, etc.	Logical Ports RPC/SQL/NFS NetBIOS names	Host to Host
Transport (4) Ensures that messages are delivered error-free, in sequence, and with no losses or duplications.	TCP Host to Host, Flow Control Message segmentation • Message acknowledgement • Message traffic control • Session multiplexing	TCP/SPX/UDP	
Network (3) Controls the operations of the subnet, deciding which physical path the data takes.	Packets ("letter", contains IP address) Routing • Subnet traffic control • Frame fragmentation • Logical-physical address mapping • Subnet usage accounting	Routers IP/IPX/ICMP	Internet
Data Link (2) Provides error-free transfer of data frames from one node to another over the Physical layer.	Frames ("envelopes", contains MAC address) (end to end) Establishes & terminates the logical link between nodes • Frame traffic control • Frame sequencing • Frame acknowledgement • Frame delimiting • Frame error checking • Media access control	Switch Bridge WAP PPP/SLIP	Network
Physical (1) Concerned with the transmission and reception of the unstructured raw bit stream over the physical medium.	Physical structure Cables, hubs, etc. Data Encoding • Physical medium attachment • Transmission technique - Baseband or Broadband • Physical medium transmission Bits & Volts	Hub Land Based Layers	

Q.8: Explain the evolution of the internet from its origins to the modern day global network. What major technological advancements contributed to its growth?

Ans: The first question that pops into your mind is probably, "Who started the internet?". The Internet was developed by Bob Kahn and Vint Cerf in the 1970s. They began the design of what we today know as the 'internet.' It was the result of another research experiment which was called ARPANET, which stands for Advanced Research Projects Agency Network. This was initially supposed to be a communications system for the Defense Team of the United States of America - a network that would also survive a nuclear attack. It eventually became a successful nationwide experimental packet network. But when was the first Internet started? It is believed that on 6 August 1991, when the World Wide Web opened to the public.

Evolution of the Internet

Although the Internet was developed much earlier, it only became popular in households in the 1990s. The emergence of the Internet can be tracked by how many businesses and homes started changing the way they worked and started connecting their laptops and other devices to the Internet. However, the concept of hypertext transfer protocol (HTTP) as we know it today, was created only during this time. This meant that people could access the same web pages on their devices now and share information.

There has been a dramatic growth in the number of internet users since its inception. As a result, the number of computer networks that are connected has grown exponentially too. It started with only connecting less than ten computers initially. Today, 440 million computers can be connected directly, making life easier for people across the globe. Sharing information and knowledge has become extremely easy for those that have access to the Internet. The country with the highest number of internet users is China, with 1.4 billion users, followed by India with 1.3 billion and the United States of America with a little over 0.3 billion users. Technological advancements have been shaping the global economy in significant ways, from the way we communicate, do business and access information. From the internet and the rise of e-commerce to automation and artificial intelligence, technology is driving economic growth and changing the way we live and work. How technological advancements are shaping the global economy? One of the most significant ways that technology is shaping the global economy is through the rise of e-commerce and online marketplaces. The internet has made it possible for businesses of all sizes to reach customers all over the world, creating new opportunities for entrepreneurs and small businesses. Additionally, online marketplaces such as Amazon and Alibaba have disrupted traditional brick-and-mortar retail, leading to significant changes in the way goods are produced, distributed and consumed.

Q.9: Discuss the advantages and disadvantages of the internet, considering factors like global connectivity, information access, privacy concern and digital addiction.

Ans: Advantages of the Internet:

- ❖ **Instant Messaging:** You can send messages or communicate to anyone using internet, such as email, voice chat, video conferencing, etc.
- ❖ **Get directions:** Using GPS technology, you can get directions to almost every place in a city, country, etc. You can find restaurants, malls, or any other service near your location.
- ❖ **Online Shopping:** It allows you to shop online such as you can buy clothes, shoes, book movie tickets, railway tickets, flight tickets, and more.
- ❖ **Pay Bills:** You can pay your bills online, such as electricity bills, gas bills, college fees, etc.
- ❖ **Online Banking:** It allows you to use internet banking in which you can check your balance, receive or transfer money, get a statement, request cheque-book, etc.
- ❖ **Online Selling:** You can sell your products or services online. It helps you reach more customers and thus increases your sales and profit.
- ❖ **Work from Home:** In case you need to work from home, you can do it using a system with internet access. Today, many companies allow their employees to work from home.
- ❖ **Entertainment:** You can listen to online music, watch videos or movies, play online games.
- ❖ **Cloud computing:** It enables you to connect your computers and internet-enabled devices to cloud services such as cloud storage, cloud computing, etc.
- ❖ **Career building:** You can search for jobs online on different job portals and send you CV through email if required.

Disadvantages of the Internet

- ❖ **Time wastage:** Although, Internet has a lot of advantages, it also contains some limitations. Time wasting is one of among them. It can decrease your productivity if you are spending too much time on the Internet using social media apps while doing nothing. Rather than squandering time, one should use that time to do something useful and even more productive.

Muhammad Sikandar Dar, Assistant Professor, IMCB, G-11/1, Islamabad

- ❖ **Bad impacts on health:** You can get health related issues if you spend too much time online; your body needs outside activities, exercise, and many other things. If you look at the screen for a long time, it causes negative effects on the eyes.
- ❖ **Cyber Crimes:** These days, crimes including cyberbullying, spam, viruses, hacking, and data theft are increasing day by day. Cybercriminals can quickly break into your system, which store all of your private information.
- ❖ **Effects on children:** The constant watching of videos and playing games on the Internet by young children is bad for their social and overall personality development.
- ❖ **Bullying and spreading negativity:** Social media applications have provided a free tool to all those people who regularly attempt to spread negativity with really repulsive and humiliating comments and try to bully each other, which is wrong and does bad impact on society.

Q.10: Explore common applications of the internet and their impact on various aspects of society, including communication, education, business, entertainment and research.

Ans: Common Applications of Internet: Applications of Internet have revolutionized the way we live, work, learn, and communicate. What started as a military communication network has grown into a global system that connects billions of users and devices around the world. The applications of the internet are vast, changing how we do everything from shopping and banking to entertainment and business. In this blog post, we'll explore the applications of the internet and how they impact our daily lives.

Communication: The Applications of internet has dramatically transformed communication by providing free or low-cost ways for people to connect. Email was one of the earliest internet applications, allowing virtually instant communication worldwide. Video calling services like Skype and FaceTime have made it possible to communicate face-to-face over the Internet. Messaging apps like WhatsApp and Facebook Messenger allow instant messaging, while social networks like Facebook and Twitter enable public conversations.

Education: The internet has created revolutionary changes and opportunities in education. It has enabled the widespread availability of online education through platforms like Coursera, Udemy, edX and Khan Academy. Massive open online courses (MOOCs) have made courses from leading universities around the world accessible to anyone with an Applications of internet connection. K-12 schools utilize online learning software and educational apps to augment in-classroom teaching.

Students can also easily access digital textbooks, papers and journals for research online through library databases and search engines. The internet provides unlimited educational content for learning and opens doors for people everywhere to access education.

Business: The internet has revolutionized the way we live, communicate, and conduct business. Its widespread adoption has had a profound impact on various aspects of society, but perhaps one of the most significant areas of transformation has been in the realm of business and commerce. The internet has completely reshaped the way companies operate, connect with customers, and conduct transactions. The rise of e-commerce has been one of the most transformative aspects of the Internet for businesses. Online retail has exploded in popularity, with consumers increasingly turning to the internet to make purchases. Companies like Amazon and Alibaba have become giants in the industry, disrupting traditional brick-and-mortar retail and forcing businesses to adapt or risk being left behind. E-commerce offers convenience, choice, and competitive pricing, making it an attractive option for consumers and a vital channel for businesses.

Entertainment: Internet plays a vital role in Entertainment as Internet is a sole, easy and cost effective source available in today's world.

- ❖ Provides dual experience of Entertainment and learning.
- ❖ Easy Accessibility.
- ❖ Easy Availability in a spare time anywhere anytime.
- ❖ Innovative ideas comes up for entertainment via public source.
- ❖ More alternative options are available in a short span of time at one place for entertainment eg: movies, games etc.

Research: Technological advances, especially the internet, opened new horizons for almost all scientific fields. As an integral part of science, research also took advantage of the benefits internet brought. Now, it is practically impossible to imagine any researcher who doesn't use the internet for research purposes in one way or another. For instance, currently, using the internet is the best way to measure customer satisfaction. Thousands of companies around the world use it for this purpose. Another benefit internet brings for researchers is software. Both desktop and web versions of available research tools save a significant amount of time and money and help get more effective results. The survey, automated transcription, analysis software have become go-to tools for researchers and for most of them, it is difficult to picture research without those tools.

MUHAMMAD SIKANDAR DAR