

Evolution of Computer Networks and Foundations of Modern Digital Communication

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ABSTRACT: The evolution of media from traditional platforms such as radio and television to the Internet has profoundly transformed human communication, giving rise to a globally connected digital society. Cyberspace has introduced new cultural and social practices by redefining how individuals interact, share information, and access resources beyond geographical limitations. Computer networks form the backbone of this digital transformation by enabling efficient data exchange, supporting distributed work environments, and providing access to remote computing resources. This paper presents a concise historical overview of the development of computer networking and examines its fundamental components, including communication protocols and network architectures. In addition, the study discusses widely adopted networking technologies such as Ethernet and the Transmission Control Protocol/Internet Protocol (TCP/IP), highlighting the core principles and mechanisms that underpin modern digital communication systems.

KEYWORDS: Computer Networks, Hardware, LAN, IP, TCP, Ethernet.

1. INTRODUCTION

A computer network forms the foundation of communication in information technology. It enables the exchange of data and sharing of resources among multiple computing devices. Computer networks are used in various applications and can consist of different types of network architectures, including local area networks (LANs), wireless networks, and wide area networks such as the Internet. Technically, a computer network is a digital telecommunications system that allows interconnected nodes to share resources efficiently.

In a computer network, computing devices exchange data using defined communication links known as data links. These links may be established through wired transmission media, such as twisted-pair cables, coaxial cables, and optical fibers, or through wireless media, including radio waves and microwaves. A computer network is composed of both hardware components such as computers, servers, switches, routers, and transmission media and software components, including network operating systems and communication protocols.

Computer networking involves connecting a group of computers and peripheral devices to facilitate communication and resource sharing. Network-connected devices may include printers, scanners, storage systems, and servers, along with essential networking hardware such as switches and routers. To ensure reliable and structured data exchange, computer

networks rely on standardized protocols and algorithms, such as TCP/IP, which define how data is transmitted, received, and interpreted across the network.



Figure 1: Computer Networks

Each device connected to a network, often referred to as an endpoint or host, is assigned a unique identifier. This identifier is typically an Internet Protocol (IP) address or a Media Access Control (MAC) address, which helps in identifying the source and destination of data transmissions. Endpoints may include servers, desktop computers, laptops, smartphones, and various networking devices.

In a network, two or more devices are interconnected to enable the sharing of data, applications, and services. Routers play a crucial role by connecting multiple networks and directing data packets between them. Modern networks also incorporate several essential features to enhance security and functionality. Firewalls are used to protect the network from unauthorized access, IP phones enable voice communication over the network using Voice over Internet Protocol (VoIP), and Virtual Private Networks (VPNs) provide secure communication channels over public networks.

Overall, a computer network is a complex and dynamic system that integrates multiple technologies to support communication, data exchange, and resource sharing. Its design and management require careful planning to ensure reliability, scalability, performance, and security in today's interconnected digital environment.

2. COMPUTER NETWORK

When more than one computer is connected through some medium and the information is shared, then this technique is called network. This connection can be wired and also wireless, when talking about Wire Medium, it twisted. Pair cable, coaxial cable and fiber optics cable can be anything. If you talk about Wireless Medium, it can be anything from Radio Wave, Bluetooth, Infrared, Satellite. In computing, a network is a group of two or more devices through which we can communicate.

In practice, networks consist of many different computer systems connected by physical and wireless connections. A network is a collection of computers, servers, mainframes, network devices or other interconnected devices that allow sharing of data among themselves. An excellent example of a network is the Internet, which connects millions of people all over the world.



Figure 2: Computer Networking

3. HARDWARE

All the mechanical, electronic and electrical parts used in computer which we can see with eyes and touch with hands are called hardware. Such as - monitors, keyboards, hard-disks, circuits, memory chips, etc. Computer hardware has two types depending on its function and structure -

CPU (Central Processing Unit) - The task of CPU is to process the given data and extract the information from it in the output form. Peacock is also called the brain of the computer. Deccan is mainly divided into three parts -

1. Control Unit - The Control Unit works to control or control the data and instructions given to the computer. The control unit controls the computer's internal functions, controlling them. These actions are then exchanged between ALU and memory.

2. Arithmetic logic unit - Arithmetic logic unit is used to perform arithmetic actions and logical actions on data and instructions given on the computer. ALU sends data and instructions from the control unit to memory as information.

3. Memory - This is the part of the computer in which all data and instructions are stored. If it is not part, then the data and instructions given to the computer will be immediately destroyed. There are mainly two types of memory-

1. Main Memory
2. Auxiliary memory

Peripheral -

Input devices, output devices, and secondary storage devices are collectively called peripherals. It is of three types -

1. Input Unit
2. Output Unit
3. Collection Unit

IP address

An Internet Protocol address (IP address) is a numeric label assigned to each device connected to a computer network that uses the Internet protocol for communication. An IP

address performs two main functions: host or network interface identification and location addressing.

LAN:

Its full name is Local Area Network. It is a network that is used to connect two or more computers. Local area network is a locally functioning network. It is called Lean in Sanskrit. It is a computer network that covers the local millions of office buildings.

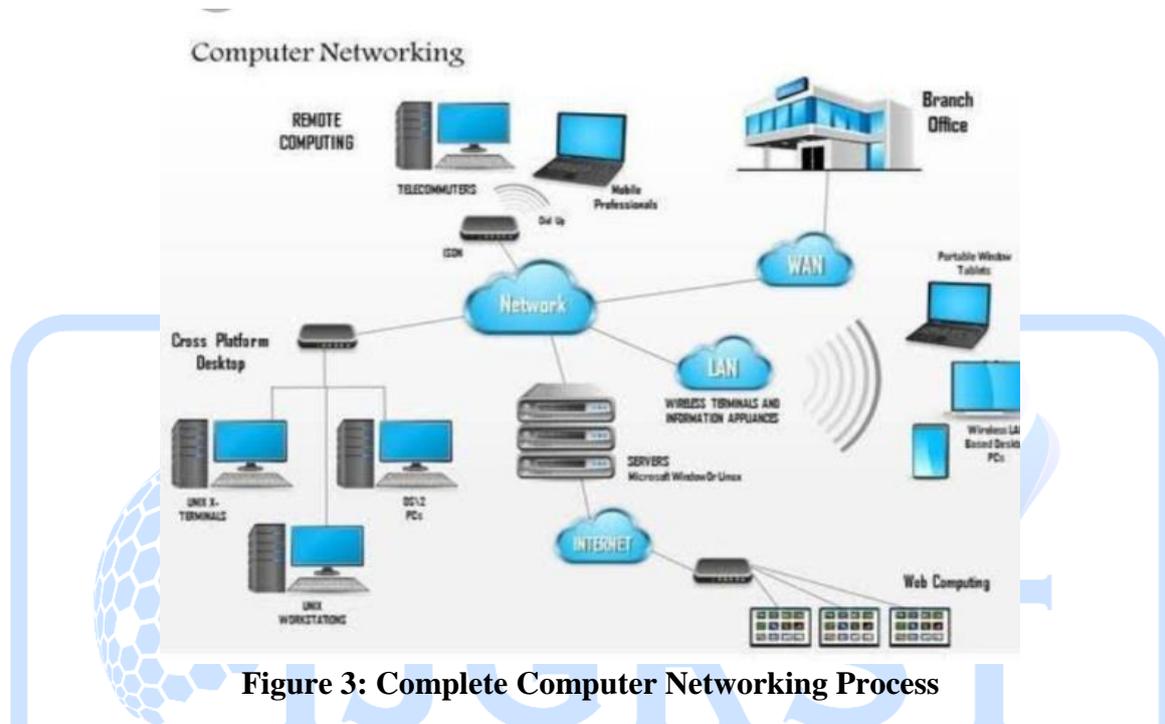


Figure 3: Complete Computer Networking Process

LAN Features: -

- It is limited to one room or one building.
- Its data transfer speed is high.
- It does not have to hire external networks.
- Data is safe in this.
- It is easy to organize data.

Different types of LAN: -

- Network Adapter
- Network Medium
- Cable Connector
- Power Supply
- Hub/ Switch /Router
- Network Software.

Network adapter : A computer needs a network adapter to connect to the network. It converts computer data into electronic signals.

Network medium: Wire networks require a cable such as Trusted Table, Coaxial, Cable Wire, Optical, Cable etc. Wireless networks do not require cables. In these radio waves are used for data transfer.

Network Connector: RJ45 is the most common character in a bad network. Each computer with networking capability has an Rj45 port. Everyone in it ever.



Figure 4: Network Connector

Rj45 is the most commonly used connector in cable connectors by networks. Each computer with networking capability has an rj45 port. It is sometimes a network port. Firewall calls.

Power supply: Requires power supply in both types of networks and wire. Wireless networks use current to generate radio waves. Cable networks send data in the form of an electronics pulse.

Hub /Switch/ Router: Acts as a centralized point for transmitting scolded computers to us. When data is sent to us from one computer, it is transmitted to all computers connected to the data network. Then whether it is for any specific computer! There is an option of switch hub. It is a new networking technology that assigns a specific ambacy address to each computer in the network. For this reason, you can use the switch in the information lane on the computer.

You can connect multiple networks with the help of routers as opposed to switches and hubs.

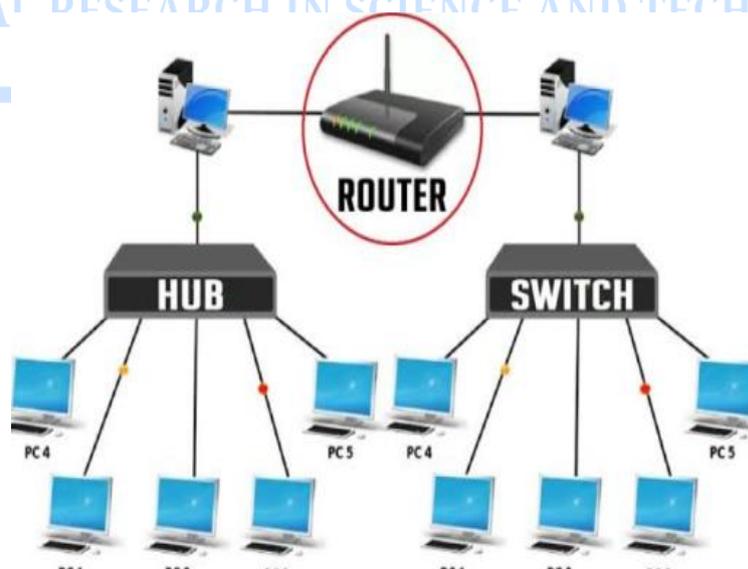


Figure 5: Hub- Switch- Router Connectivity

The router also connects computers located in remote areas. Routers are the most complex and have the ability to send messages around the world. Larger networks sometimes also use routers to achieve plane. A wireless networking device is called a valence router.

TCP:-

TCP stands for Transmission Control Protocol and IP stands for Jai Internet Protocol.

It is a set of rules that decide how the Internet functions. It enables information transfer and communication between two computers. They are used to send data securely. The role of TCP is to divide the data into smaller parts and the IP marks the address of the target site on these packets.

TCP / IP is a protocol available in the Internet. Through which information is exchanged between internet, network or other internet device. TCP / IP are a group of protocols that make communication between a computer and a network. Through which we can exchange information from the Internet with the help of our mobile and other devices.

4. ETHERNET

Ethernet is a technology commonly used in wired local area networks (LANs). A LAN is a network of computers and other electronic devices that cover a small area such as a room, office, or building.

It is used in contrast to the Wide Area Network (WAN), which spreads over a very large geographical area.



Figure 6: Ethernet

Ethernet is a network protocol that controls how data is transmitted over a LAN. Technically it is known as the IEEE 802.3 protocol.

Ethernet is a technology used in the Wired Local Area Network. A LAN is a computer network that covers small areas such as home, office, school, college, meaning that LAN works to establish computer network in small area.

It is a network protocol that controls the data being transmitted through the LAN (Local Area Network), that is, it tells how to transmit the data.

WAN:-

WAN (wild area network) is a telecommunications network or computer network that spans vast geographical distances. Wide area networks are often set up with a leased

telecommunications circuit. A wide area network (WAN) is a telecommunications network that is spread over a large geographic area for the primary purpose of computer networking. Wide area networks are often installed with leased telecommunications circuits.

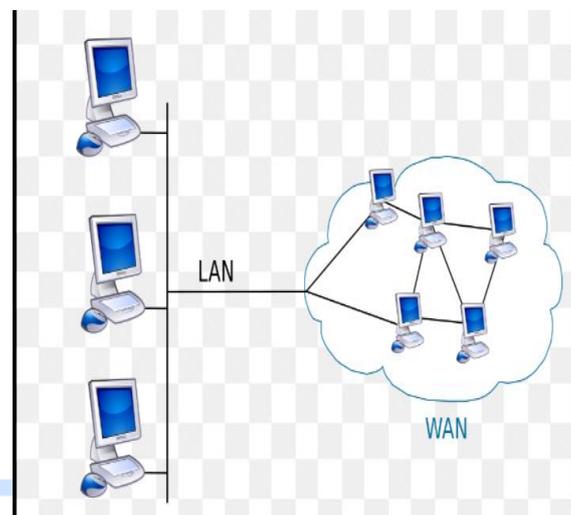


Figure 7: WAN

Businesses, as well as education and governmental entities use extensive field networks to relay data to employees, students, customers, buyers, and suppliers from various locations around the world. In short, this mode of telecommunications allows a business to carry out its daily work effectively regardless of location. Internet can be considered as WAN.

5. METROPOLITAN AREA NETWORK/MAN

MAN connects two or more local area networks. It is a network of computers located within the city limits. Routers, switches, and hubs together form a MAN.

Similar networks are individual area networks (PANs), local area networks (LANs), campus area networks (CANs) or metropolitan area networks (MANs), which are usually limited to a room, building, campus, or specific metropolitan area.

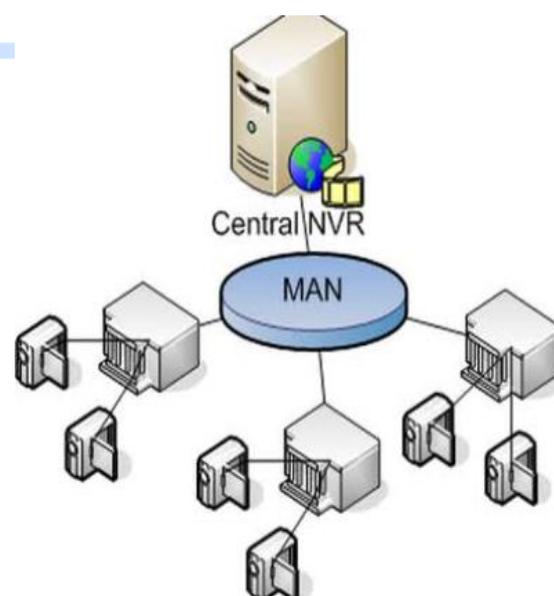


Figure 8: MAN

6. CONCLUSION

A network is a collection of many computers that are connected with each other, these computers share information with each other. However, this system works independently. As a result, a combination of computer and network provides a system in which data and information are transmitted in all forms. There are differences in data communication and data processing. Similarly, there is no distinct difference between data, voice and video communication.

Major networking technologies are designed and designed to achieve a certain objective. For example, many organizations run their own network, which connects many departments and employees of that organization to that system. Therefore each organization selects the appropriate hardware technology for communication needs and budget.

In addition, it is not possible to create a network technology that allows a network technology to provide its service to many types of networks. Because some applications require a high-speed network to connect their computers to a building. Many expensive technologies cannot extend geographic distances and low-speed network link machines to meet its requirement. Basically, there are three types of networks - LAN, MAN and WAN.

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