# UNIT 1: INTRODUCTION

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**Definition:**

**A computer network is a system in which multiple computers (devices) are connected to each other to share information and resources.**


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## 1.1. NETWORK AS AN INFRASTRUCTURE FOR DATA COMMUNICATION:

**Network infrastructure *is the hardware and software resources of an entire network* that enable network connectivity, communication, operations and management of an enterprise network.**

- **Hardware:** Cables, wireless routers, LAN cards, switches, routers, and more.
- **Software:** Network security applications, firewalls, operating systems, network management, network operations, and more.
- **Services:** IP addressing, wireless protocols, satellite, DSL, T-1 Line, and more.

# DATA COMMUNICATION

***Data communications are the exchange of data between two devices via some form of transmission medium such as a wire cable.***

***The effectiveness of a data communications system depends on four fundamental characteristics:***

***Delivery,***

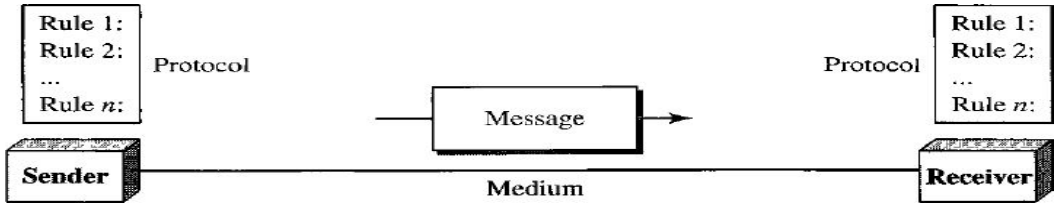
***Accuracy***

***Timeliness,***

***Jitter:*** Jitter refers **to the variation in the packet arrival time**.

# *DATA COMMUNICATIONS COMPONENTS*

1. *Message*
2. *Sender*
3. *Receiver*
4. *Protocol*
5. *Medium*



***Direction of Data Flow***

1. **Simplex,**
2. **Half-duplex, or**
3. **Full-duplex**

# Simplex

- In simplex mode, the communication is **unidirectional**, as on a one-way street.
- **Only one** of the two devices on a link can transmit; the other can only receive.
- **Radio, Keyboards** and traditional **monitors** are examples of simplex devices.

***Half-Duplex***

- In half-duplex mode, each station can **both transmit and receiv**e, but not at the same time.
- **When one device is sending, the other can only receive, and vice versa.**
- In a half-duplex transmission, the entire capacity of a channel is taken over by whichever of the two devices is transmitting at the time.
- **Walkie-talkies and CB** (citizens band) radios are both half-duplex systems.

***Full-Duplex***

- In full-duplex made (also, called **duplex**), **both stations can transmit and receive** simultaneously.
- One common example of full-duplex communication is the **telephone network.**

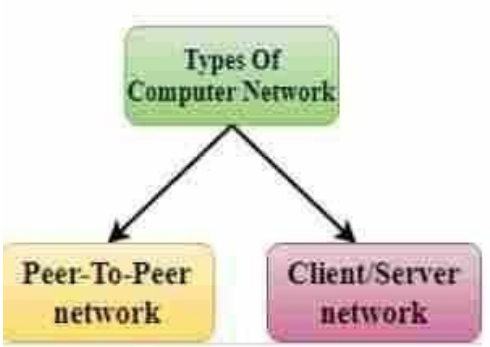
## 1.2. APPLICATION AREAS OF COMPUTER NETWORK

**ASSIGNMENT**

1. **Business Applications**
2. **Home Application**
3. **Mobile Computers, & etc.**

## 1.3. NETWORK ARCHITECTURE

- Computer Network Architecture is ***defined as the physical and logical design of the software, hardware, protocols, and media of the transmission of data.***



## *Peer to Peer architecture*

- In peer to peer architecture all the computers in a computer network are **connected with every computer** in the network.
- Every computer in the network uses the same resources as other computers.
- There is no central computer that acts as a server rather all computers acts as a server for the data that is stored in them.

***Advantages of a Peer to Peer Architecture***

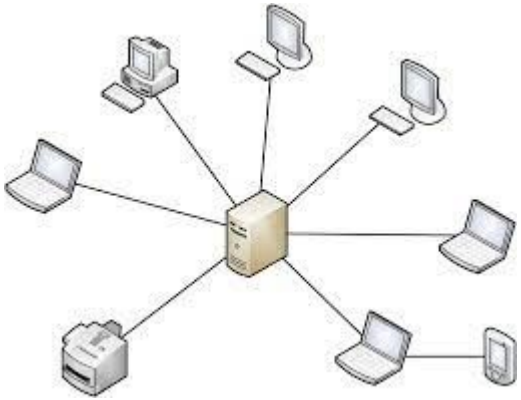
1. Less costly as there is no central server that has to take the backup.
2. In case of a computer failure all other computers in the network are not affected and they will continue to work as same as before the failure.
3. Installation of peer to peer architecture is quite easy as each computer manages itself.

***Disadvantages of a Peer to Peer Architecture***

1. Each computer has to take the backup rather than a central computer and the security measures are to be taken by all the computers separately.
2. Scalability is an issue in a peer to Peer Architecture as connecting each computer to every computer is a headache on a very large network.

## *Client/Server Network*

- **In Client Server architecture a central computer acts as a hub and serves all the requests from client computers.**
- All the shared data is stored in the server computer which is shared with the client computer when a request is made by the client computer.
- All the communication takes place through the server computer



**Advantage**

Data Backup

Performance

Security

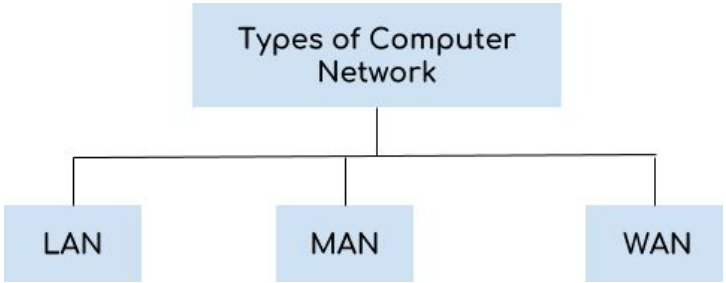
Scalability

***Disadvantages of Client Server Architecture***

- In case of server failure entire network is down.
- Server maintenance cost is high as the server is the main component in this Architecture.
- Cost is high as the server needs more resources to handle that many client requests and to be able to hold large amount of data.

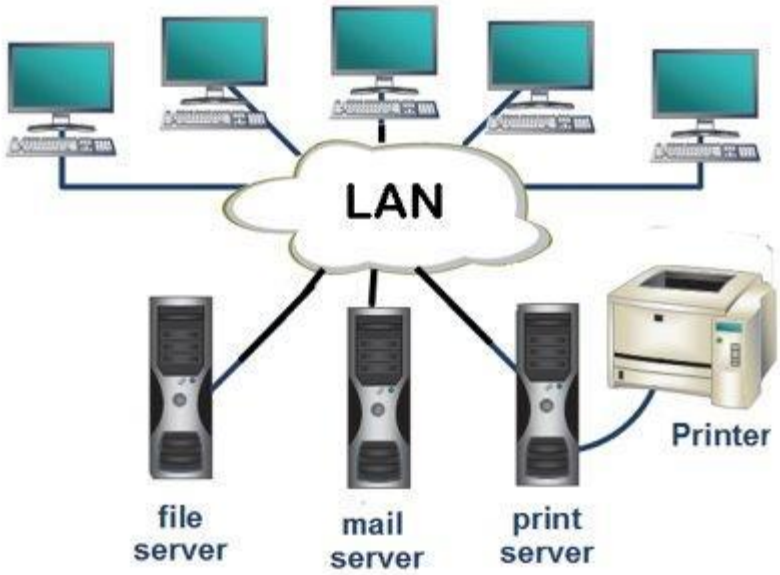
## 1.4. TYPES OF COMPUTER NETWORKS

- ***A computer network is a group of computers linked to each other that enables the computer to communicate with another computer and share their resources, data, and applications.***
- ***A computer network can be categorized by their size.***


Types of Computer Network
LAN
MAN
WAN

# LAN

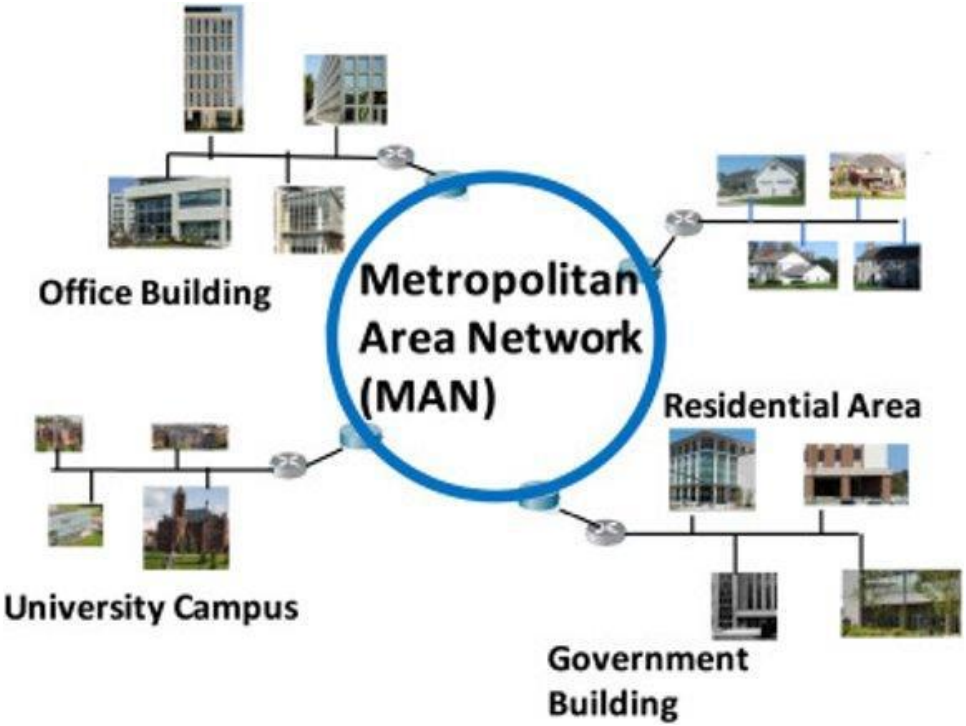
- **A local-area network (LAN) is a computer network that spans a relatively small area.**
- Most often, a LAN is confined to a single room, building or group of buildings;
- however, one LAN can be connected to other LANs over any distance via telephone lines and radio waves.
- LAN is less expensive than WAN or MAN.


LAN
Printer
file server
mail server
print server

# MAN

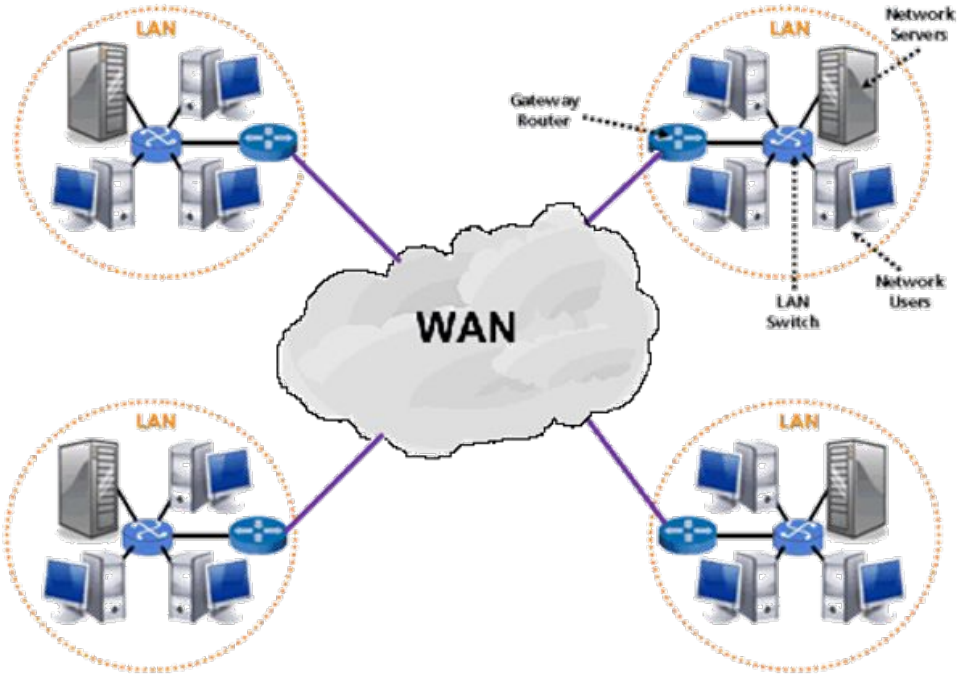
1. **MAN (Metropolitan Area Network)**

- MAN network covers larger area by connections LANs to a larger network of computers.
- MAN is the abbreviation for Metropolitan Area Network and bigger than LAN network.
- It connects computer users that are in a specific geographical area.
- An example of MAN is a large university.
- MAN's data transmission speed is 5-10Mbps, which is faster and more expensive than LAN but slower and smaller than WAN.
- In MAN various Local area networks are connected with each other through telephone lines.


Office Building
Metropolitan Area Network (MAN)
Residential Area
University Campus
Government Building

# WAN

- A Wide Area Network is a network that extends over a large geographical area such as states or countries.
- A WAN connects more than one LAN and is used for larger geographical areas.
- WANs are similar to a banking system, where hundreds of branches in different cities are connected with each other in order to share their official data.
- A WAN works in a similar fashion to a LAN, just on a larger scale.


LAN
LAN
Network
Servers
Gateway
Router
WAN
LAN
Switch
Network
Users
LAN
LAN

## 1.5. PROTOCOLS AND STANDARDS

A protocol is a **set of rules that governs(control)** data communications.

A protocol defines **what** is communicated, **how it is communicated**, and **when** it is communicated.

The key elements of a protocol are :

1. **Syntax,**
2. **Semantics**
3. **Timing**

1. **Syntax**
    - Structure or format of the data.
    - Indicates how to read the bits - field delineation (border or boundary).
    - Syntax should be same in sender and receiver for to communicate.

2. **Semantics**
- Interprets the meaning of the bits
- Knows which fields define what action
- Interpretation of the syntax should be same

3. **Timing**
- When data should be sent and what
- Speed at which data should be sent or speed at which it is being received

## Standards

Standards provide **guidelines** to manufacturers, vendors, government agencies, and other service providers to ensure the kind of interconnectivity necessary in today's marketplace and in international communications.

***Data communication standards fall into two categories:***

1. **de facto (meaning "by fact" or "by convention")**
2. **de jure (meaning "by law" or "by regulation").**

## Standards Organizations

- *Standards are developed through the cooperation of standards creation committees, forums, and government regulatory agencies.*

# *Standards Creation Committees*

**International Standards Organization (ISO)**

**International Telecommunications Union–
Telecommunication Standards Sector (ITU-T)**

**American National Standards Institute (ANSI)**

**Institute of Electrical and Electronics Engineers (IEEE)**

**Electronic Industries Association (EIA)**

## 1.6. OSI REFERENCE MODEL

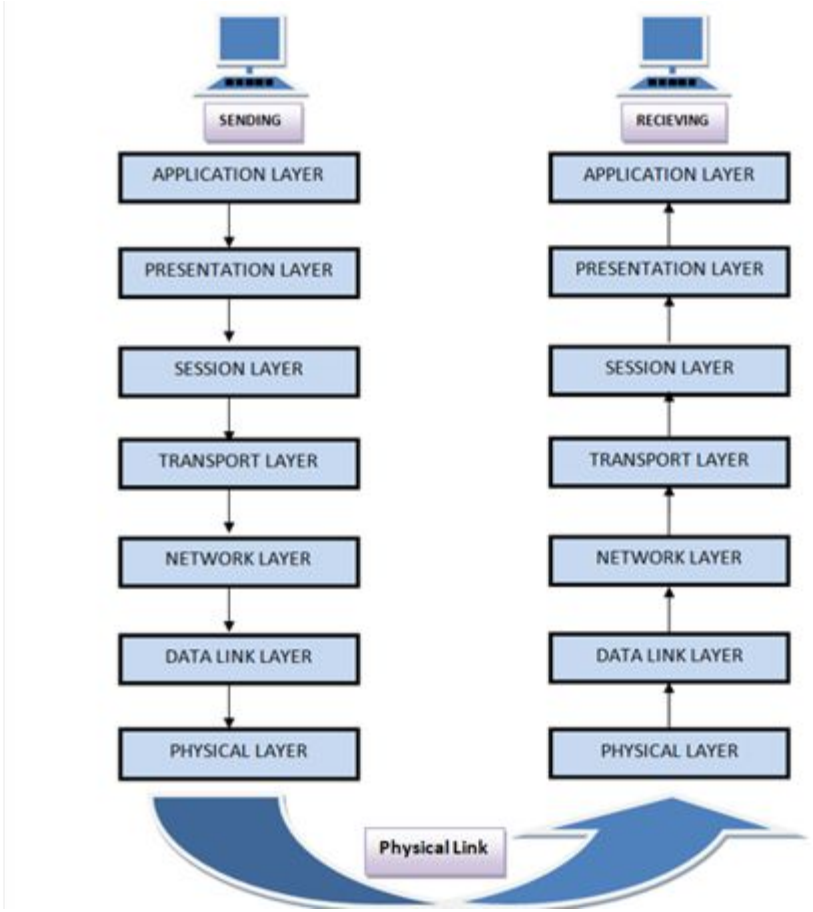
There are many users who use computer network and are located all over the world.

To ensure national and worldwide data communication ISO (ISO stands for International Organization of Standardization.) developed this model.

This is called a model for open system interconnection (OSI) and is normally called as OSI model.

There are **7 layers in OSI Reference model**

- It is also **called OSI layered architecture /OSI Protocol architecture**
- ***The process of breaking up the functions or tasks of networking into layers reduces complexity.***
- Each layer **provides a service to the layer** above it in the **protocol** specification.
- Each layer communicates with the **same layer's software or hardware on other computers.**
- The **lower 4 layers are concerned with the flow of data from end to end** through the network
- The upper **Three layers of the OSI model are orientated more toward services** to the applications


SENDING
APPLICATION LAYER
PRESENTATION LAYER
SESSION LAYER
TRANSPORT LAYER
NETWORK LAYER
DATA LINK LAYER
PHYSICAL LAYER
RECIEVING
APPLICATION LAYER
PRESENTATION LAYER
SESSION LAYER
TRANSPORT LAYER
NETWORK LAYER
DATA LINK LAYER
PHYSICAL LAYER
Physical Link

## Physical Layer

- The physical layer coordinates the functions required to carry a bit stream over a physical medium.
- It deals with the mechanical and electrical specifications of the interface and transmission medium.
- It also defines the procedures and functions that physical devices and interfaces have to perform for transmission to occur.

## Data Link Layer

- The data link layer transforms the physical layer, a raw transmission facility, to a reliable link.
- It makes the physical layer appear error-free to the upper layer (network layer).

# Network layer

- **Routing:** When a packet reaches the router's input link, the router will move the packets to the router's output link. **Logical Addressing:** Logical addressing is also used to distinguish between source and destination system. The network layer adds a header to the packet which includes the logical addresses of both the sender and the receiver.
- **Internetworking:** This is the main role of the network layer that it provides the logical connection between different types of networks.
- **Fragmentation:** The fragmentation is a process of breaking the packets into the smallest individual data units that travel through different networks.

**Layer 4: Transport Layer:**

It decides if data transmission should be on parallel path or single path.

Functions such as Multiplexing, Segmenting or Splitting on the data are done by this layer

It receives messages from the Session layer above it, convert the message into smaller units and passes it on to the Network layer.

Transport layer can be very complex, depending upon the network requirements.

Transport layer breaks the message (data) into small units so that they are handled more efficiently by the network layer.

**Session Layer**

- The services provided by the first three layers (physical, data link, and network) *are not sufficient* for some processes.
- The session layer is the network dialog controller. It establishes, maintains, and synchronizes the interaction among communicating systems.

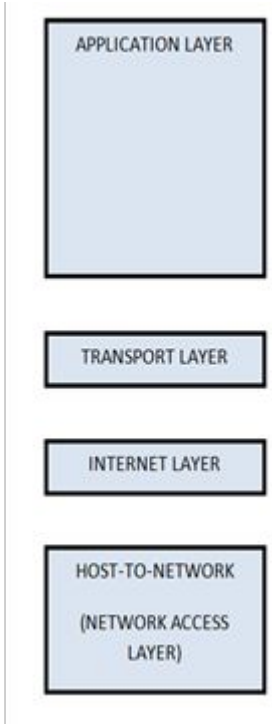
**Presentation Layer**

- **Translation**. The processes (running programs) in **two systems** are usually exchanging information in the ***form of character strings, numbers,*** and so on.
- **Encryption**. To carry sensitive information, a system must be able to ensure privacy. Encryption means that the sender transforms the original information to another form and sends the resulting message out over the network. Decryption reverses the original process to transform the message back to its original form.
- **Compression**. Data compression reduces the number of bits contained in the information. Data compression becomes particularly important in the transmission of multimedia such as text, audio, and video.

## Application Layer

- The application layer enables the user, whether human or software, to access the network.
- It provides user interfaces and support for services such as electronic mail, remote file access and transfer, shared database management, and other types of distributed information services.

# TCP/IP REFERENCE MODEL



TCP/IP that is Transmission Control Protocol and Internet Protocol was developed by Department of Defense's Project Research Agency (ARPA, later DARPA) as a part of a research project of network interconnection to connect remote machines.

**Layer 1: Host-to-network Layer**

Lowest layer of the all.

Protocol is used to connect to the host, so that the packets can be sent over it.

Varies from host to host and network to network.

**Layer 2: Internet layer**

Selection of a packet switching network which is based on a connectionless internetwork layer is called a internet layer.

It is the layer which holds the whole architecture together.

It helps the packet to travel independently to the destination.

Order in which packets are received is different from the way they are sent.

IP (Internet Protocol) is used in this layer.

**Layer 3: Transport Layer**

It decides if data transmission should be on parallel path or single path.

Functions such as multiplexing, segmenting or splitting on the data is done by transport layer.

The applications can read and write to the transport layer.

Transport layer adds header information to the data.

Transport layer breaks the message (data) into small units so that they are handled more efficiently by the network layer.

Transport layer also arrange the packets to be sent, in sequence.

**Layer 4: Application Layer**

The TCP/IP specifications described a lot of applications that were at the top of the protocol stack. Some of them were TELNET, FTP, SMTP, DNS etc.

TELNET is a two-way communication protocol which allows connecting to a remote machine and run applications on it.

FTP (File Transfer Protocol) is a protocol that allows File transfer amongst computer users connected over a network. It is reliable, simple and efficient.

SMTP (Simple Mail Transport Protocol) is a protocol, which is used to transport electronic mail between a source and destination, directed via a route.

DNS (Domain Name Server) resolves an IP address into a textual address for Hosts connected over a network.

*The Transmission Control Protocol/Internet Protocol (TCP/IP) model came before the Open Systems Interconnection (OSI) model*

# 1.9. CRITIQUES OF OSI AND TCP/IP REFERENCE MODEL

**A Critique of the OSI Model and Protocols**

Why OSI did not take over the world

- Bad timing
- Bad technology
- Bad implementations
- Bad politics
- Bad timing

## A Critique of the TCP/IP Reference Model

- **Problems:**

- Service, interface, and protocol not very successful
- Not a general model
- Host-to-network “layer” not really a layer
- No mention of physical and data link layers
- Minor protocols deeply establish, hard to replace