

COMPUTER NETWORK

Introduction

A computer network is a collection of computers and devices connected to each other. The network allows computers to communicate with each other and share resources and information. The Advanced Research Projects Agency (ARPA) designed "Advanced Research Projects Agency Network" (ARPANET) for the United States Department of Defense. It was the first computer network in the world in late 1960s and early 1970s.

NETWORK CLASSIFICATION The following list presents categories used for classifying networks.

Today the world scenario is changing. Data Communication and network have changed the way business and other daily affair works. Now, they rely on computer networks and internetwork. A set of devices often mentioned as nodes connected by media link is called a Network. A node can be a device which is capable of sending or receiving data generated by other nodes on the network like a computer, printer etc. These links connecting the devices are called Communication channels.

Computer network is a telecommunication channel through which we can share our data. It is also called data network. The best example of computer network is Internet. Computer network does not mean a system with control unit and other systems as its slave. It is called a distributed system

A network must be able to meet certain criteria, these are mentioned below:

- 1) Performance
- 2) Reliability
- 3) Scalability

Performance

It can be measured in following ways :

- **Transit time** : It is the time taken to travel a message from one device to another.
- **Response time** : It is defined as the time elapsed between enquiry and response.

Other ways to measure performance are :

- 1) Efficiency of software
- 2) Number of users
- 3) Capability of connected hardware

Reliability

It decides the frequency at which network failure take place. More the failures are, less is the network's reliability.

Security

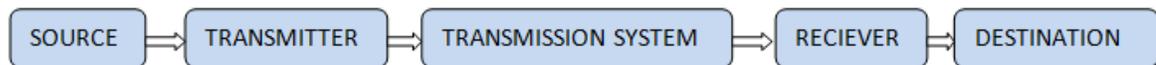
It refers to the protection of data from the unauthorised user or access. While travelling through network, data passes many layers of network, and data can be traced if attempted. Hence security is also a very important characteristic for Networks.

Properties of Good Network

- 1) **Interpersonal Communication** : We can communicate with each other efficiently and easily example emails, chat rooms, video conferencing etc.
- 2) **Resources can be shared** : We can use the resources provided by network such as printers etc.
- 3) **Sharing files, data** : Authorised users are allowed to share the files on the network.

Basic Communication Model

Communication model is used to exchange data between two parties. For example communication between a computer, server and telephone (through modem).



Source

Data to be transmitted is generated by this device, example: telephones, personal computers etc.

Transmitter

The data generated by the source system are not directly transmitted in the form they are generated. The transmitter transforms and encodes the information in such a form to produce electromagnetic waves or signals.

Transmission System

A transmission system can be a single transmission line or a complex network connecting source and destination.

Receiver

Receiver accepts the signal from the transmission system and converts it to a form which is easily managed by the destination device.

Destination

Destination receives the incoming data from the receiver.

DATA COMMUNICATION

The exchange of data between two devices through a transmission medium is Data Communication. The data is exchanged in the form of 0's and 1's. The transmission medium used is wire cable. For data communication to occur, the communication device must be part of a communication system. Data Communication has two types Local and Remote which are discussed below :

Local :

Local communication takes place when the communicating devices are in the same geographical area, same building, face-to-face between individuals etc.

Remote :

Remote communication takes place over a distance i.e. the devices are farther. Effectiveness of a Data Communication can be measured through the following features :

- 1) **Delivery** : Delivery should be done to the correct destination.
- 2) **Timeliness** : Delivery should be on time.
- 3) **Accuracy** : Data delivered should be accurate.

Components of Data Communication

- 1) **Message** : It is the information to be delivered.
- 2) **Sender** : Sender is the person who is sending the message.
- 3) **Receiver** : Receiver is the person to whom the message is to be delivered.
- 4) **Medium** : It is the medium through which message is to be sent for example modem.
- 5) **Protocol** : These are some set of rules which govern data communication.

Line Configuration in Computer Networks

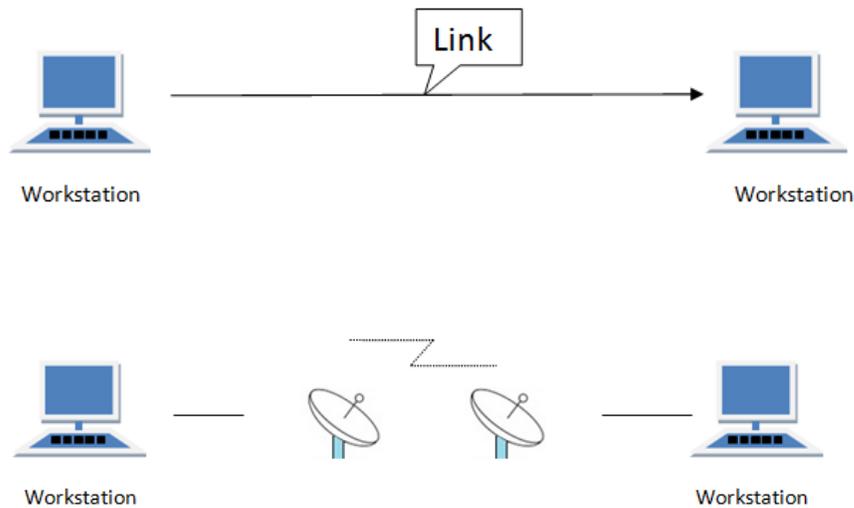
Network is a connection made through connection links between two or more devices. Devices can be a computer, printer or any other device that is capable to send and receive data. There are two ways to connect the devices :

1. Point-to-Point connection
2. Multipoint connection

Point-To-Point Connection

It is a protocol which is used as a communication link between two devices. It is simple to establish. The most common example for Point-to-Point connection (PPP) is a computer connected by telephone line. We can connect the two devices by means of a pair of wires or using a microwave or satellite link.

Example: Point-to-Point connection between remote control and Television for changing the channels.

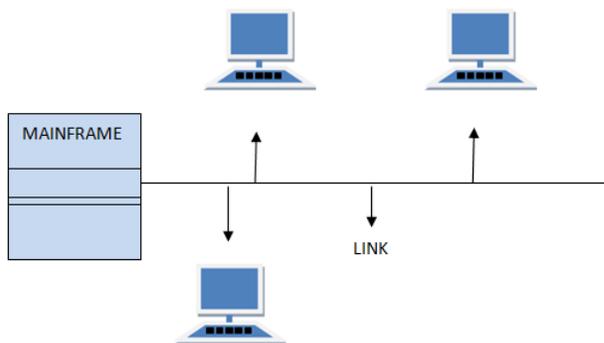


MultiPoint Connection

It is also called Multidrop configuration. In this connection two or more devices share a single link.

There are two kinds of Multipoint Connections :

- If the links are used simultaneously between many devices, then it is spatially shared line configuration.
- If user takes turns while using the link, then it is time shared (temporal) line configuration.



Practical Task 1:

1. Understanding the concept of Network.
2. Viewing the configuration of computers in your computer Lab. Checking Hardware components related to computer network such as Network Interface Card (NIC), LAN cables, switch, Hub, Routers, etc.
3. Click on Network properties and then click on adapter setting.
4. Click on internet protocol i.e. TCP/IPv4 and then check the properties.
5. Check the IP address, subnet mask, default gateway and obtain IP address automatically and check the internet connection.

BASIC HARDWARE COMPONENTS

All networks are made up of basic hardware building blocks to interconnect network nodes, such as Network Interface Cards (NICs), Bridges, Hubs, Switches, and Routers. In addition, some method of connecting these building blocks is required, usually in the form of galvanic cable (most commonly Category 5 cable). Less common are microwave links (as in IEEE 802.12) or optical cable ("optical fiber"). An Ethernet card may also be required.

NETWORK INTERFACE CARDS

A network card, network adapter or NIC (network interface card) is a piece of computer hardware designed to allow computers to communicate over a computer network. It provides physical access to a networking medium and often provides a low-level addressing system through the use of MAC addresses.

REPEATERS

A repeater is an electronic device that receives a signal and retransmits it at a higher power level, or to the other side of an obstruction, so that the signal can cover longer distances without degradation. In most twisted pair Ethernet configurations, repeaters are required for cable, which runs longer than 100 meters.

HUBS

A hub contains multiple ports. When a packet arrives at one port, it is copied unmodified to all ports of the hub for transmission. The destination address in the frame is not changed to a broadcast address.

BRIDGES

A network bridge connects multiple network segments at the data link layer (layer 2) of the OSI model. Bridges do not promiscuously copy traffic to all ports, as hubs do, but learn which MAC addresses are reachable through specific ports. Once the bridge associates a port and an address, it will send traffic for that address only to that port. Bridges do send broadcasts to all ports except the one on which the broadcast was received.

Bridges come in three basic types:

- 1) Local bridges: Directly connect local area networks (LANs)
- 2) Remote bridges: Can be used to create a wide area network (WAN) link between LANs. Remote bridges, where the connecting link is slower than the end networks, largely have been replaced by routers.
- 3) Wireless bridges: Can be used to join LANs or connect remote stations to LANs.

SWITCHES

Switch is a device that forwards and filters OSI layer 2 data grams (chunk of data communication) between ports (connected cables) based on the MAC addresses in the packets.[5] This is distinct from a hub in that it only forwards the packets to the ports involved in the communications rather than all ports connected. Strictly speaking, a switch is not capable of routing traffic based on IP address (OSI Layer 3), which is necessary for communicating between network segments or within a large or complex LAN. Some switches are capable of routing based on IP addresses but are still called switches as a marketing term. A switch normally has numerous ports, with the intention being that most or all of the network is connected directly to the switch, or another switch that is in turn connected to a switch.[6]

ROUTERS

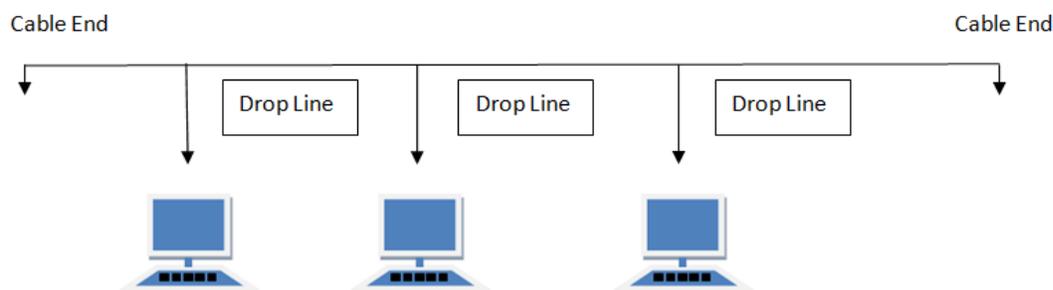
Routers are networking devices that forward data packets between networks using headers and forwarding tables to determine the best path to forward the packets. Routers work at the network layer.

TYPES OF NETWORK TOPOLOGY

Network Topology is the schematic description of a network arrangement, connecting various nodes(sender and receiver) through lines of connection.

BUS Topology

Bus topology is a network type in which every computer and network device is connected to single cable. When it has exactly two endpoints, then it is called **Linear Bus topology**.



Features of Bus Topology

- 1) It transmits data only in one direction.
- 2) Every device is connected to a single cable

Advantages of Bus Topology

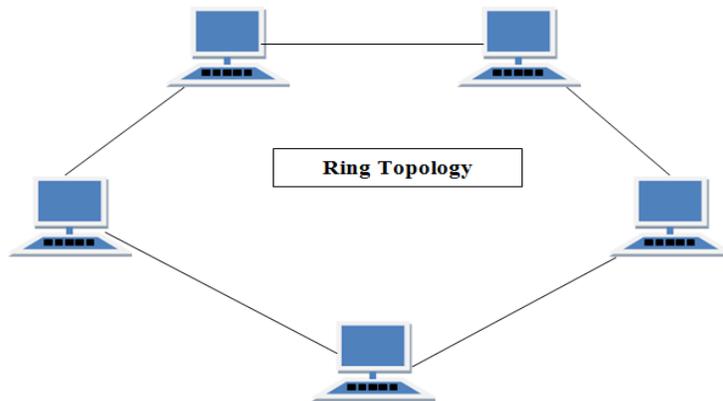
- 1) It is cost effective.
- 2) Cable required is least compared to other network topology.
- 3) Used in small networks.
- 4) It is easy to understand.
- 5) Easy to expand joining two cables together.

Disadvantages of Bus Topology

- 1) Cables fails then whole network fails.
- 2) If network traffic is heavy or nodes are more the performance of the network decreases.
- 3) Cable has a limited length.
- 4) It is slower than the ring topology.

RING Topology

It is called ring topology because it forms a ring as each computer is connected to another computer, with the last one connected to the first. Exactly two neighbours for each device.



Features of Ring Topology

- 1) A number of repeaters are used for Ring topology with large number of nodes, because if someone wants to send some data to the last node in the ring topology with 100 nodes, then the data will have to pass through 99 nodes to reach the 100th node. Hence to prevent data loss repeaters are used in the network.
- 2) The transmission is unidirectional, but it can be made bidirectional by having 2 connections between each Network Node, it is called Dual Ring Topology.

- 3) In Dual Ring Topology, two ring networks are formed, and data flow is in opposite direction in them. Also, if one ring fails, the second ring can act as a backup, to keep the network up.
- 4) Data is transferred in a sequential manner that is bit by bit. Data transmitted, has to pass through each node of the network, till the destination node.

Advantages of Ring Topology

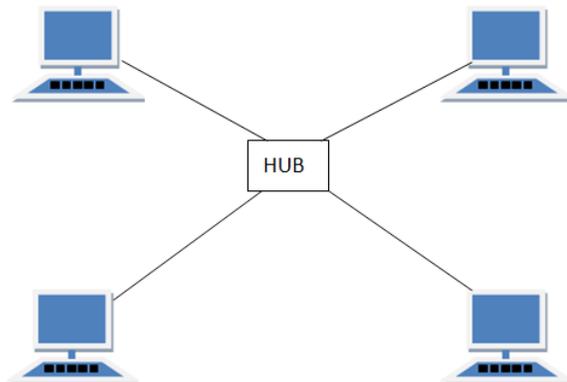
- 1) Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.
- 2) Cheap to install and expand

Disadvantages of Ring Topology

- 1) Troubleshooting is difficult in ring topology.
- 2) Adding or deleting the computers disturbs the network activity.
- 3) Failure of one computer disturbs the whole network.

STAR Topology

In this type of topology all the computers are connected to a single hub through a cable. This hub is the central node and all others nodes are connected to the central node.



Features of Star Topology

- 1) Every node has its own dedicated connection to the hub.
- 2) Hub acts as a repeater for data flow.
- 3) Can be used with twisted pair, Optical Fibre or coaxial cable.

Advantages of Star Topology

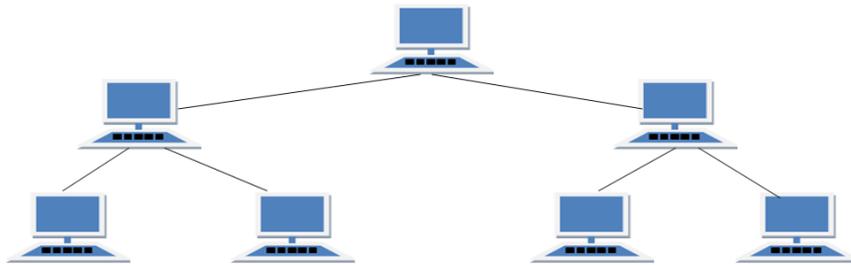
- 1) Fast performance with few nodes and low network traffic.
- 2) Hub can be upgraded easily.
- 3) Easy to troubleshoot.
- 4) Easy to setup and modify.
- 5) Only that node is affected which has failed, rest of the nodes can work smoothly.

Disadvantages of Star Topology

- 1) Cost of installation is high.
- 2) Expensive to use.
- 3) If the hub fails then the whole network is stopped because all the nodes depend on the hub.
- 4) Performance is based on the hub that is it depends on its capacity

TREE Topology

It has a root node and all other nodes are connected to it forming a hierarchy. It is also called hierarchical topology. It should at least have three levels to the hierarchy.



Features of Tree Topology

- 1) Ideal if workstations are located in groups.
- 2) Used in Wide Area Network.

Advantages of Tree Topology

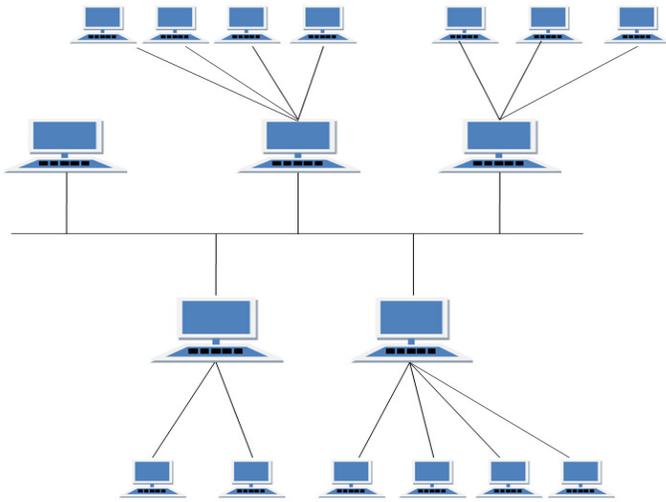
- 1) Extension of bus and star topologies.
- 2) Expansion of nodes is possible and easy.
- 3) Easily managed and maintained.
- 4) Error detection is easily done.

Disadvantages of Tree Topology

- 1) Heavily cabled.
- 2) Costly.
- 3) If more nodes are added maintenance is difficult.
- 4) Central hub fails, network fails.

HYBRID Topology

It is two different types of topologies which is a mixture of two or more topologies. For example if in an office in one department ring topology is used and in another star topology is used, connecting these topologies will result in Hybrid Topology (ring topology and star topology).



Features of Hybrid Topology

- 1) It is a combination of two or topologies
- 2) Inherits the advantages and disadvantages of the topologies included

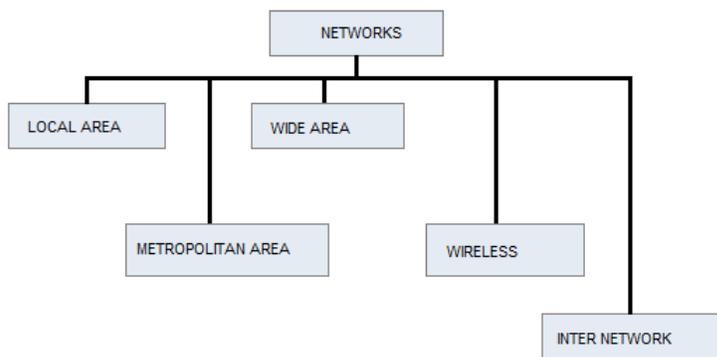
Advantages of Hybrid Topology

- 1) Reliable as Error detecting and trouble shooting is easy.
- 2) Effective.
- 3) Scalable as size can be increased easily.
- 4) Flexible.

Disadvantages of Hybrid Topology

- 1) Complex in design.
- 2) Costly.

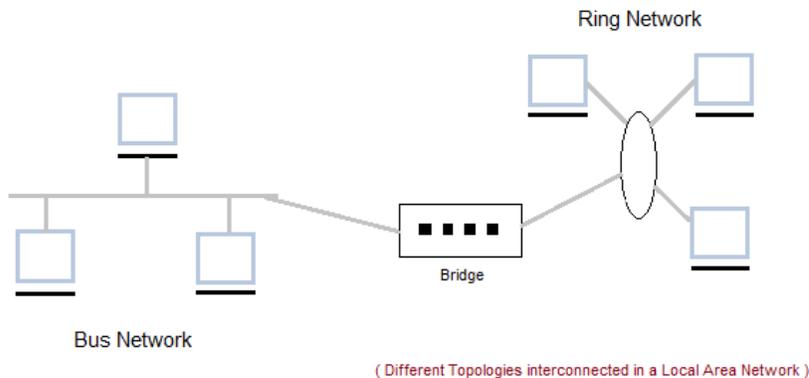
TYPES OF COMMUNICATION NETWORKS



Local Area Network (LAN)

It is also called LAN and designed for small physical areas such as an office, group of buildings or a factory. LANs are used widely as it is easy to design and to troubleshoot. Personal computers and workstations are connected to each other through LANs. We can use different types of topologies through LAN, these are Star, Ring, Bus, Tree etc. LAN can be a simple network like connecting two computers, to share files and network among each other while it can also be as complex as interconnecting an entire building.

LAN networks are also widely used to share resources like printers, shared hard-drive etc.

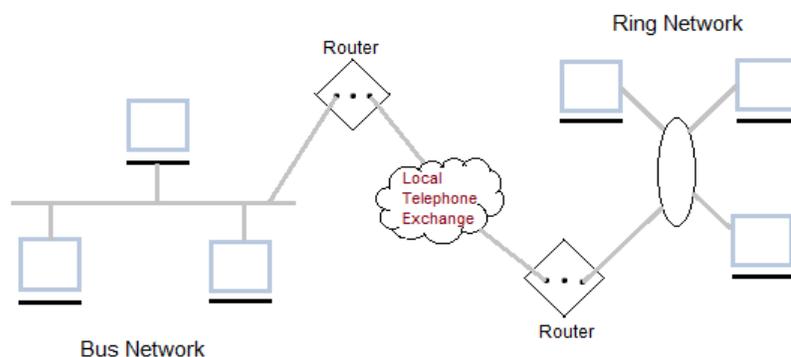


Applications of LAN

- One of the computer in a network can become a server serving all the remaining computers called clients. Software can be stored on the server and it can be used by the remaining clients.
- Connecting Locally all the workstations in a building to let them communicate with each other locally without any internet access.
- Sharing common resources like printers etc are some common applications of LAN.

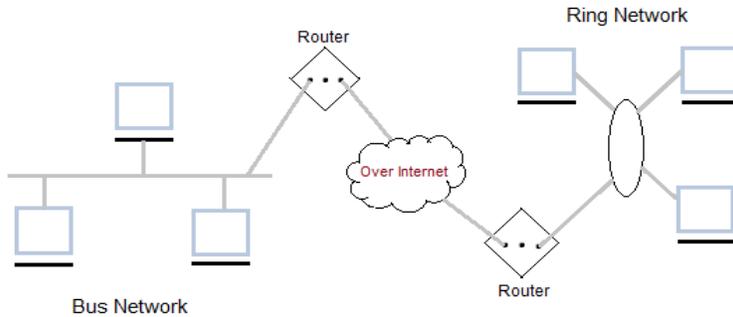
Metropolitan Area Network (MAN)

It is basically a bigger version of LAN. It is also called MAN and uses the similar technology as LAN. It is designed to extend over the entire city. It can be means to connecting a number of LANs into a larger network or it can be a single cable. It is mainly hold and operated by single private company or a public company.



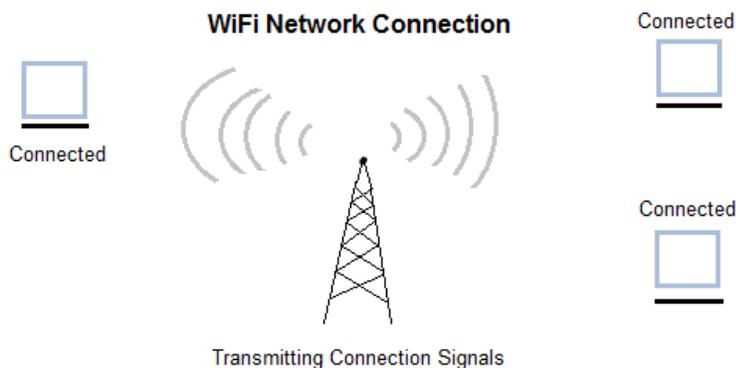
Wide Area Network (WAN)

It is also called WAN. WAN can be private or it can be public leased network. It is used for the network that covers large distance such as cover states of a country. It is not easy to design and maintain. Communication medium used by WAN are PSTN or Satellite links. WAN operates on low data rates.



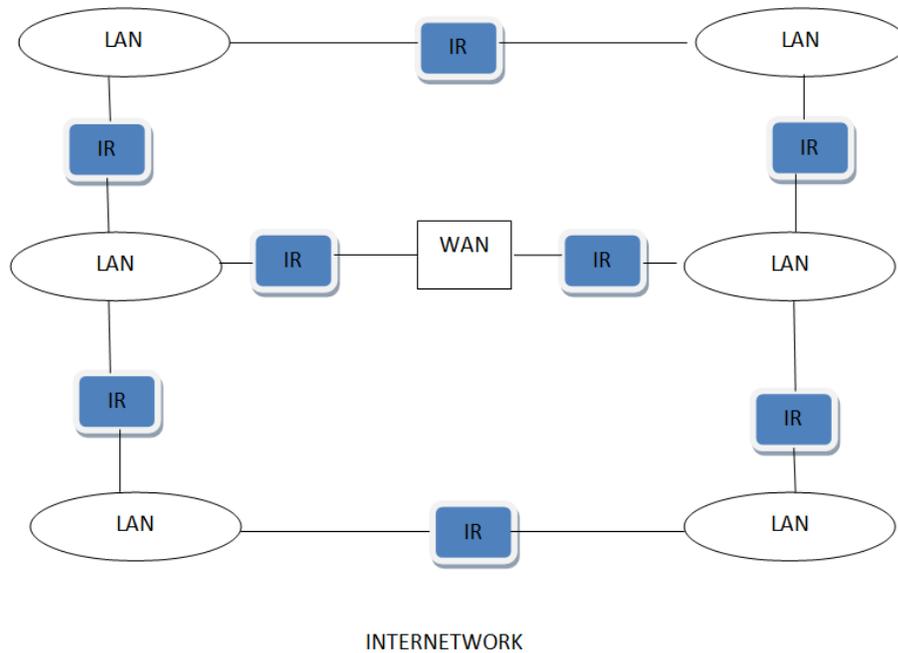
Wireless Network

It is the fastest growing segment of computer. They are becoming very important in our daily life because wire connections are not possible in cars or aeroplane. We can access Internet at any place avoiding wire related troubles.. These can be used also when the telephone systems gets destroyed due to some calamity/disaster. WANs are really important now-a-days.



Inter Network

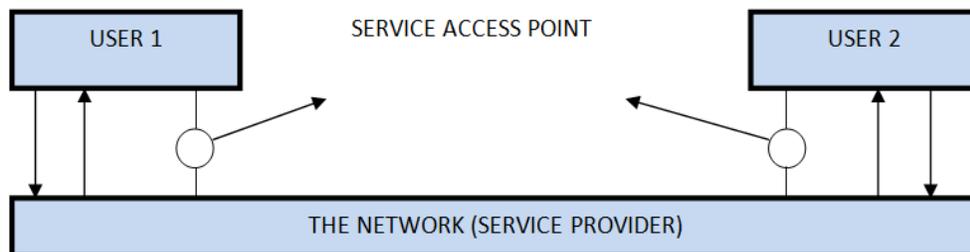
When we connect two or more networks then they are called internetwork or internet. We can join two or more individual networks to form an internetwork through devices like routers gateways or bridges.



RELATIONSHIP OF SERVICES TO PROTOCOL

Services

These are the operations that a layer can provide to the layer above it. It defines the operation and states a layer is ready to perform but it does not specify anything about the implementation of these operations.



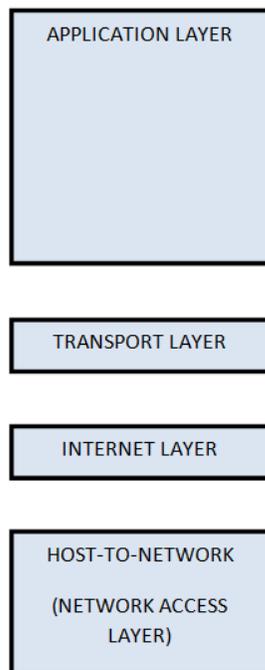
Protocols

These are set of rules that govern the format and meaning of frames, messages or packets that are exchanged between the server and client.

The TCP/IP Reference Model

TCP/IP means Transmission Control Protocol and Internet Protocol. It is the network model used in the current Internet architecture as well. Protocols are set of rules which govern every possible communication over a network. These protocols describe the movement of

data between the source and destination or the internet. These protocols offer simple naming and addressing schemes.



Overview of TCP/IP reference model

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

The features that stood out during the research, which led to making the TCP/IP reference model were:

- Support for a flexible architecture. Adding more machines to a network was easy.
- The network was robust, and connections remained intact until the source and destination machines were functioning.

The overall idea was to allow one application on one computer to talk to (send data packets) another application running on different computer.

Merits of TCP/IP model

- 1) It operated independently.
- 2) It is scalable.
- 3) Client/server architecture.
- 4) Supports a number of routing protocols.
- 5) Can be used to establish a connection between two computers.

Demerits of TCP/IP

- 1) In this, the transport layer does not guarantee delivery of packets.
- 2) The model cannot be used in any other application.
- 3) Replacing protocol is not easy.
- 4) It has not clearly separated its services, interfaces and protocols.

Practical Task 2:

1. Try changing the TCP/IP settings and assign IP address, subnet mask, default gateway. Check the internet connection after assigning IP address.
2. Ping IP address and check the connection. Also double click on Network icon and check other computers on network.
3. Browse the internet after setting your LAN.
4. Try disconnecting the LAN cable.
5. Also assign different IP address on network computers and check the LAN settings.
6. Try installing printer and share that printer on network.
7. Open Google.com and search more information regarding computer Network.

KEY TERMS IN COMPUTER NETWORKS

Following are some important terms, which are frequently used in context of Computer Networks.

Terms	Definition
1. ISO	The OSI model is a product of the Open Systems Interconnection project at the International Organization for Standardization. ISO is a voluntary organization.
2. OSI Model	Open System Interconnection is a model consisting of seven logical layers.
3. TCP/IP Model	Transmission Control Protocol and Internet Protocol Model is based on four layer model which is based on Protocols.
4. UTP	Unshielded Twisted Pair cable is a Wired/Guided media which consists of two conductors usually copper, each with its own colour plastic insulator
5. STP	Shielded Twisted Pair cable is a Wired/Guided media has a metal foil or braided-mesh covering which encases each pair of insulated conductors. Shielding also eliminates crosstalk
6. PPP	Point-to-Point connection is a protocol which is used as a communication link between two devices.

7. LAN	Local Area Network is designed for small areas such as an office, group of building or a factory.
8. WAN	Wide Area Network is used for the network that covers large distance such as cover states of a country
9. MAN	Metropolitan Area Network uses the similar technology as LAN. It is designed to extend over the entire city.
10. Crosstalk	Undesired effect of one circuit on another circuit. It can occur when one line picks up some signals travelling down another line. Example: telephone conversation when one can hear background conversations. It can be eliminated by shielding each pair of twisted pair cable.
11. PSTN	Public Switched Telephone Network consists of telephone lines, cellular networks, satellites for communication, fiber optic cables etc. It is the combination of world's (national, local and regional) circuit switched telephone network.
12. File Transfer, Access and Management (FTAM)	Standard mechanism to access files and manages it. Users can access files in a remote computer and manage it.
13. Analog Transmission	The signal is continuously variable in amplitude and frequency. Power requirement is high when compared with Digital Transmission.
14. Digital Transmission	It is a sequence of voltage pulses. It is basically a series of discrete pulses. Security is better than Analog Transmission.

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