Computer Networks & Communication

The field of networking & communication includes the analysis, design, implementation, & use of local, wide-area, & mobile networks that link computers together. The internet itself is a network that makes it feasible for nearly all computers in the world to communicate.

Purpose of Computer network.

A computer network comprises two or more computers that are connected either by cables (wired) or wifi (wireless) with the purpose of transmitting, exchanging, or sharing data & resources.

Types

The are three component of computer communication.

(i) Transmitter
(ii) Receiver
(iii) Medium
(iv) Protocol

Data transmission

5. Data transmission is the process of sending digital or analog data over a communication medium to one or more computing, network, communication or electronic devices. It enables
6. the transfer & communication of devices in a Point-to-Point, Point-to-multiPoint & multiPoint-to-multiPoint environment.
7. Data transmission is also known as digital transmission or digital communications.

1. Mode of Communication

The transmission mode is also known as the communication mode. The transmission mode is divided into three categories.

(i) Simplex mode:

- In simplex mode, the communication is unidirectional, i.e, the data flow in one direction.
- It is a one-way communication.
- A device can only send the data but cannot receive it or it can receive the data but cannot send the data. Ex: Remote, television.

Adv: The main adv: of the simplex mode is that the full capacity of the communication channel can be utilized during transmission.

Disadv: Communication is unidirectional, so it has no inter-communication b/w devices.

(ii) Half-duplex

- In a half-duplex, channel, direction can be reversed, i.e the station can transmit & receive the data as well.
- It is a two-way of communication or a either direction.
- The entire bandwidth of the communication channel is utilized in one direction at a time.
  - Ex: Police radio

Adv:

In half-duplex mode, both the devices can send & receive the data & also can utilize the entire bandwidth of the communication channel during the transmission of data.

Disadv:

In Half-duplex mode, when one devices is sending the data, then another has to wait, this causes the delay in sending the data at the right time.

(iii) Full-duplex

- In full duplex mode, the communication is bi-directional, i.e., the data flow in both the directions.
- Both the stations can send & receive the message simultaneously.
- Full-duplex has two simplex channels. One channel has traffic moving in one direction, & another channel has traffic following in the opposite direction.
- The full-duplex mode is fastest mode of

Communication blw devices.
Ex: tele Phone, google.

Adv:

5. • Both the stations can send & receive the data at the same time.

Disadv: If there is no dedicated Path exists blw

6. the devices, then the capacity of the communication channel is divided into two parts.

7. 2. Links / connections

(iv) Broadcast

Broadcast links connect two or more nodes & support broadcast transmission, where one node can transmit so that all others nodes can recieve the same transmission.
Ex: Classical Ethernet

(v) Private & Public

• A Private link is a link that is either owned by a specific entity or a link that is only accessible by a specific entity.
• A Public is a link that uses the Public Switched telephone network or other Public utility or entity to Provide the link & which may also be accessible anyone.

3. Time-domain Concepts

An electromagnetic signal can be continuous, discrete or Periodic.

(i) **Continuous Signal**

A continuous signal is one in which the signal intensity or signal strength varies in a smoth fashion overtime. There is no break or discontinuities in the signal.

(ii) **Discrete Signal**

A discrete signal is one in which the signal intensity maintains a constant level for some period of time & then changes to another constant level.

(iii) **Periodic Signal**

In Periodic signal, same signal patterns repeats over time. There are two types of Periodic signals used as Analog signal (Sinewaves) & Digital signal (Square waves).

(iv) **A Periodic Signal**

A Periodic signal is one that repeats the sequence of values exactly after a fixed length of time.

A signal that does not repeat itself after a specific interval of time is called an aperiodic signal.
Pattern not repeated overtime.

(v) **Analog Signals**

An analog signal is time-varying & generally bound to range (e.g +12V to -12V). An analog signal uses a given property of the medium to convey the signals information, such as electricity moving through a wire.

(vi) Digital Signal

A digital signal is a signal that represents data as a sequence of discrete values, Simple digital signals represent information in discrete bands of analog levels. All levels within a band of values represent the same information state.

(vii) Baseband & Broadband Signals

In baseband LANs, the entire frequency spectrum of the medium is utilized for transmission hence the frequency division multiplexing cannot be used. Baseband systems extended only to limited distances because at higher frequency.

Broadband System analog signalling, frequency division multiplexing is possible, where the frequency spectrum of the cable is divided into several sections of bandwidth. Unlike, baseband, broadband is a unidirectional medium where the signal inserted into the media propagates in only one direction.

4. Transmission media

Transmission is a communication channel that caries information from the sender to the receiver. Data is transmitted through the electromag-netic signals. The main functionality of the transmission media is to carry the information in the form of bits through LAN (local area network). It is a physical path between transmitter & receiver in data communication.

There are two types

Mediums Classification of transmission media.

1. **Guided medium:**

It is defined as the physical medium through which the signals are transmitted. It is also known as Bounded media.

There are two types.

(i) **Twisted Pair cable.**

Twisted Pair is a physical media made up of a pair of cables twisted with each other. A twisted pair cable is cheap as compared to other transmission media. Installation of the twisted pair cable is easy & it is a lightweight cable. The frequency range for twisted pair cable is from 0 to 3.5 kHZ. It is a electronic signals.

Types of twisted Pair:

- **Unshielded Twisted Pair**

An unsheilded twisted pair is widely used in telecommunication. They have 5 categories.

- **Shielded Twisted Pair:**

A shielded twisted pair is a cable that contains the mesh surrounding the wire that allows the higher transmission rate. The cost of the shielded twisted pair cable is not very high & not very low.

(ii) **Optical fibre**

Optical fibre cable that uses electrical signal for communication. Fibre optic is a cable that holds the optical fibres coated in plastic that are used to send the data by pulses of light. The plastic coating protects the optical fibres from heat, cold, electromagnetic interference from other types of wiring. fibre optics provide faster data transmission than copper wires.

Basic elements of fibre optic cable:

There are 3 elements.

- **Core:**

The optical fibre consists of a narrow stand of glass or plastic known as core.

- **Cladding:**

The concentric layer of glass is known as cladding.

- **Jacket:**

The protective coating consisting of plastic is known as a jacket.

2. UnGuided Transmission.

An unguided transmission transmits the electromagnetic waves without using any Physical medium. Therefore it is also known as wirless transmission. In unguided media, air is the media through which the electromagnetic energy can flow easily.
Unguided is broadly classified into three categories.

(i) Radio waves:

Radio waves are the electromagnetic waves that are transmitted in all the directions of free space. Radio waves are omnidirectional, i.e, the signals are Propagated in all the directions. The range in frequencies of radio waves is from 3kHz to 1kHz. A Radio wave is useful for multicasting when there is one Sender & many receivers.
Ex: FM radio, television, cordless Phones etc.

(ii) Microwaves:

Are of two types.

- **Terrestrial Microwave.**

Is a technology that transmits the focused beam of a radio signal from one ground-based microwave transmission antenna to another. Microwaves are the electromagnetic waves having the frequency in the range from 1GHz to 1000 GHz. Microwave transmission Provides an easy communication in terrains as the installation of cable

In terrain is quite a difficult task. Communication over oceans can be acheived by using microwave transmission.

- ~~Stat~~
- **Satellite Microwaves:**

A satellite is a Physical object that revolves around the earth at a known height. Satellite communication is more reliable nowdays it offers more flexibility than cable & fibre optic systems. The ~~satellll~~ satellite accepts the signal that is transmitted from the earth station, & it amplifies the signal. The amplified signal is retransmitted to another earth station.

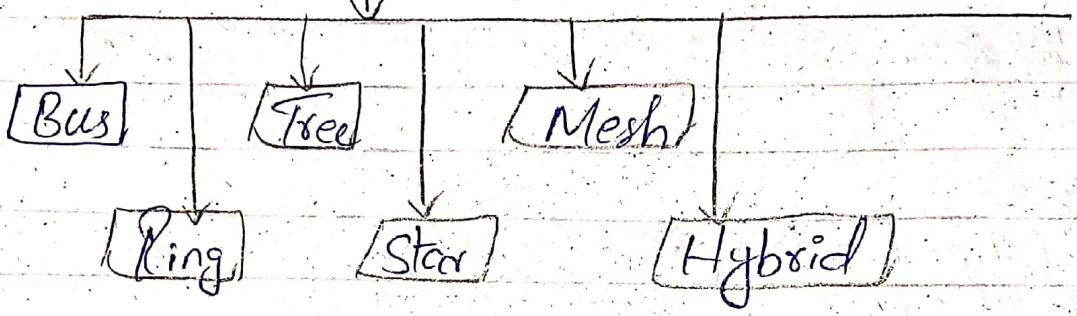
(iii) **Infrared**

An infrared transmission is a wirless technology used for communication over short ranges. The frequency of the infrared in the range from 300GHz to 400 THz. It is used for short-range communication such as data transfer blw two cell phones, TV remote operation, data transfer blw a blw a computer & cell phone resides in the same closed area.

5. Topology

Defines the structure of the network of how all the components are interconnected to each other. There are two types of topology: Physical & logical.

Types of Network Topology



1. Bus Topology:

Is designed in such a way that all the stations are connected through a single cable known as a backbone cable. Each node is either connected to the backbone cable by drop cable or directly connected to the backbone cable. The bus topology is mainly used in 802.3 (ethernet) & 802.4 standard networks. The most common access method of the bus topologies is CSMA (Carrier Sense Multiple Access).

Adv:

- low-cost cable
- Moderate data speeds
- Familiar technology
- Limited failure.

Disadv:

- Extensive cabling
- Difficult troubleshooting
- Signal interference
- Reconfiguration difficult
- Attenuation.

2. Ring Topology

Is like a bus topology, but with connected ends. The node that receives the message from the previous computer will retransmit to the next node. The data in a ring topology flow in a clockwise direction. The most common access method of ring topology is token passing.

Adv:
- Network Management • Product availability • cost • Reliable.

Disadv:
- Difficult troubleshooting • failure • Reconfiguration difficult • Delay.

3. Star Topology

Is an arrangement of the network in which every node is connected to the central hub, switch or a central computer. The central computer is known as a server, & the peripheral devices attached to the server are known as clients. Coaxial cable or RJ-45 cables are used to connect the computers. Star topology is the most popular topology in network implementation.

Adv:
- Efficient troubleshooting • Network control • Limited ~~cont~~ failure • familiar technology • Easily expandable. • cost effective • High data speeds.

Disadv:
- A central point of failure • cable.

4. Tree Topology.

Tree topology combines the characteristics of bus topology & star topology. A tree topology is a type of structure in which all the computers are connected with each other in hierarchical fashion. The top-most node in tree topology is known as a root node, & all other nodes are the descendants of the root node.

Adv:

- Support for broadband transmission.
- Easily expendable
- Easily managable
- Error detection
- Limited failure
- Point-to-Point wiring.

Disadv:

- Difficult troubleshooting
- High cost
- failure
- Reconfiguration difficult.

5. Mesh Topology.

Mesh technology is an arrangement of the network in which computers are interconnected with each other through various redundant connections. There are multiple Paths from one computer to another computer. It does not contain the switch, hub or any central computer which acts as a central point of communication. Mesh topology is mainly used for wireless networks. The internet is an ex of Mesh. Mesh is divided into two categories:

- **Full Mesh Topology:**

In a full mesh topology, each computer is connected to all the computers available in the network.

- **Partial Mesh Topology:**

Not all but certain computers are connected to those computers with which they communicate frequently.

Adv:

- Reliable • Fast communication • Easier Reconfiguration

Disadv:

- Cost • Management • Efficiency.

6. Hybrid Topology

The combination of various different topologies is known as hybrid topology. A hybrid topology is a connection b/w different links & nodes to transfer the data. When two or more different topologies are combined together is termed as hybrid topology & if similar topologies are connected with each other will not result in hybrid topology.

Adv:

- Reliable • Scalable • Flexible • Effective

Disadv:

- Complex design • Costly Hub • Costly infrastructure

Communication Networks

-> Two types of communication Networks.

1. Traditional Network.
2. High-speed network.

1. Traditional Network

- Traditional local area network (LAN)
- Traditional wide area network (WAN).
  - Provide
  - less data rate is 1 to 20 Mbps.

2. Higher-Speed

- High-speed local area networks (LAN)
- Metropolitan area Network (MAN)
- High-Speed wide area Network (WAN).

3. Characteristics of WANs:

- Covers large geographical areas.
- Circuits provided by a common carrier
- Consists of interconnected switching nodes
- Traditional WANs provide modest capacity.
  - 64000 bps common
  - Business subscribers using T-1 service — 1.544 Mbps common.

- Higher-speed WANs use optical fiber & transmission technique known as asynchronous transfer mode (ATM).
  - 10s & 100s of MbPs common.

4. Characteristics of LANs:

- Like WAN, LAN interconnects a variety of devices & provides a means for information exchange among them.
- Traditional LANs.
  - Provide data rates of 1 to 20 MbPs.
- High-Speed LANs
  - Provide data rates of 100 MbPs to 1 GbPs.

5. The Need for MANs:

- Traditional Point-to-Point & switched network techniques used in WANs are inadequate for growing needs of organizations.
- Need for high capacity & low costs over large area.

- MAN Provides:
  - Service to customers in metropolitan areas
  - Required capacity
  - lower cost & greater efficiency than equivalent service from telephone company.

2. Switching:

When a user accesses the internet or another computer network outside their immediate location, messages are sent through the network of transmission media. This technique of transferring the information from one computer network to another network is known as switching.

- A switch is a small hardware device which is used to join multiple computers together with one local area network (LAN)
- Switches are used to forward the Packets based on MAC address.
- Switching concept is developed because of the following reasons.
  - Bandwidth
  - Collision

Switching Modes:

The layer 2 switches are used for transmitting the data on the data link layer, & it also performs error checking on transmitted & received frames. The layer 2 switches forward the Packets with the help of MAC address. In switching mode, Different Parts of a frame are recognized. The frame consists of several parts such as preamble, destination MAC address, source MAC address, user's data, FCS. There are types of switching modes.

1, Store-and-forward. 2, Cut-through
3, Fragment-free.

Switching techniques

In large networks, there can be multiple paths from sender to receiver. The switching technique will decide the best route for data transmission. Switching technique is used to connect the systems for making one-to-one communication.

Classification of switching techniques.

(i) Circuit Switching

- Circuit switching is a switching that establishes a dedicated path between sender & receiver.
- Circuit switching in a network operates in a similar way as the telephone works.
- A complete end-to-end path must exist before the communication take place.
- Circuit switching is used in public telephone network. It is used for voice transmission.
- Fixed data can be transferred at a time in circuit switching technology.
- Circuit switching has 3 phases.
  - Circuit establishment
  - Data transfer
  - Circuit Disconnect.

(ii) Message Switching

Message Switching is a switching technique in which a message is transferred as a chil' & routed through intermediate nodes at which it is stored & forwarded.

- In Message Switching technique, there is no establishmen of a dedicated path blw the Sender & receiver.
- Message Switches are Programmed in such a way so that they can provide that most efficient routes.
- Each & every node stores the entire message & then forward it to next node. This type of network is known as store & forward network.
- Message switching treats each message as an independent entity.

(iii) Packet Switching

The Packet Switching is a switching technique in which the message is sent in one go, but it is divided into Smaller Pieces, & they are Sent individually.

- The message splits into Smaller Pieces known as Packets & Packets are given a unique number to identify their Order at the receiving end.
- Every Packet contains some information in its headers such as Sourceaddress, destination address & sequence number.
- If any Packet is missing or corrupted, then the message will be Sent to resend the message.

There are two approaches of Packet Switching.
(i) Datagram Packet switching.
(ii) Virtual circuit switching.

Adv: of Packet switching.
- Cost-effective
- Reliable
- Efficient.

3. TCP/IP model.

The TCP/IP model was developed prior to the OSI model.
- The TCP/IP model is not exactly similar to the OSI model.
- The TCP/IP model consist of five layers: the application layer, transport, network layer, data link layer & physical layer.
- The first four layers provide Physical standards, network interfaces, internetworking, & transport functions that correspond to the first four layers of the OSI model & these four layers are represented in TCP/IP model by a single layer called application layer.
- TCP/IP is a hierarchical Protocol made up of interactive modules, & each them provides specific functionality. Here's hierarchical means that each upper-layer protocol is supported by two or more lower-level protocols.

Functions of TCP/IP layers:

(i) Network layer

- A Network layer is the lowest layer of the TCP/IP model.
- It defines how the data should be sent physically through the network.
- This layer is mainly responsible for the transmission of the data b/w two devices on the same network.
- The protocols used by this layer are ethernet, token ring FDDI, X.25, frame relay.

(ii) Internet layer:

- An internet layer is the second layer of TCP/IP model.
- An internet layer is also known as the network layer.

Protocols used in this layer are:

- IP Protocol
  - IP addressing.
  - Host-to-Host communication
  - Data Encapsulation & formatting
  - Fragmentation & Reassembly.
  - Routing.
- ARP Protocol
  - ARP request.
  - ARP reply.
- ICMP Protocol.
  - ICMP Test
  - ICMP Reply.

(iii) Transport layer.

The transport layer is responsible for the reliability, flow control, & connection of data which is being send over the network. The two protocols used.

- User Datagram Protocol (UDP)
  - Source Port address
  - Destination Port address
  - Total length
  - Checksum
- Transmission control Protocol (TCP)
  - It Provides a full transport layer services to applications.
  - At the receiving end, TCP collects all the segments & recordes them based on sequence numbers.

(iv) Application layer

- Is the topmost layer in the TCP/IP model.
- It is responsible for handling high-level Protocols.
- This layer allows the user to interact with the application.

Main Protocols used in.

- HTTP
- SNMP
- SMTP
- DNS
- TELNET
- FTP

OSI Model:

OSI stands for Open System interconnection is a reference model that describes how information from a software application in one computer moves through a physical medium to the software application in other computer.

- OSI consists of seven layers, & each layer performs a particular network function.
- OSI model was developed by the international organigation of standardigation (ISO) in 1984, & it is now considered as an architectual model for the inter-computer communications.
- Each layer is self-contained, so that task assigned to each layer can be performed independtly.

Functions of the OSI layers:

1. **Physical layer:**
   - Line configuration • Data transmission • Topology
   - Signals.
2. **Data-Link layer:**
   - Framing • Physical address • flow control • Error control
   - Access control
3. **Network layer:**
   - Internetworking • Addressing • Routing • Packeting
4. **Transport layer:**
   - Transmission control Protocol • Service-Point addressing
   - Segmentation & reassembly • Connection control
   - flow control • Error control.

5. Session Layer:
- Dialog control
- Synchronization

6. Presentation Layer:
- Translation • Encryption • ~~Comparison~~ Compression

7. Application Layer:
- file transfer • access • management (FTAM)
- Mail services.

3. Asynchronous Transfer Mode (ATM):

- This is switching Technique.
- ATM is used cell Switching
- Resembles Packet Switching
- fixed-Size cells Simplify Processing at ATM nodes
- This also connected Traditional Networks.
- ATM is a form of cell Switching using small fixed sized Packets. in cell 53 bytes.
- Vast majority of ATM networks will run on optical fibre networks.

Traffic Integration:

- voice, video & data traffic.
- Multimedia became the "buzzword"
  - one-way batch → web traffic.
  - Two-way batch → voice messages
  - one-way interactive → broadcasts
  - Two-way interactive → video conferencing.

1. ATM Connections:

Two levels of ATM connections:

(i) Virtual channel connection (VCC).
- Logical connection in ATM
- Basic unit of switching in ATM network.
- Analogous to a virtual circuit in Packet switching networks.

(ii) Virtual Path connection (VPC)
- Bundle of VCCs that have the same end Points.

- **(VCC) Uses:**
  - Between end users
  - Between an end user & a network entity
  - Between two network entities.

2. ATM Services Categories

- Real-time Service
  - Constant bit rate (CBR)
  - Real-time variable bit rate (rt-VBR).

- Non-real-time Service
  - Non-real-time variable bit rate (nrt-VBR)
  - Available bit rate (ABR)
  - UnsPecified bit rate (UBR).

Examples of CBR:

- Video conferencing
- Interactive audio (e.g., telephony)
- Audio/video distribution (e.g., television, distance learning, Pay-Per-View)
- Audio/video retrieval (e.g., video-on-demand, audio library).

Examples of UBR

- Text/data/image transfer, messaging, distribution, retrieval
- Remote terminal (e.g., telecommuting)

(VCC):
The bandwidth of a logical virtual path is further divided into separate channel. Each channel is is given a virtual channel identifier in the ATM header.

(VPC):
The transmission path is logically divided into separate virtual paths identified using the virtual path identifier (VPI) in the ATM header.

ATM cell Header fields:

There are 6 header fields.

1. Generic flow control (GFC)
2. Virtual Path Identifier (VPI)
3. Virtual Channel Identifier (VCI)
4. Payload Type (PT)
5. Cell loss Priority (CLP)
6. Header Error Control (HEC)

Multiplexing in ATM (MUX):

Multiplexing is a technique used to combine & send the multiple data streams over a single medium. The process of combining the data streams is known as multiplexing & Hardware used for multiplexing is known as a multiplexer.

- Multiplexing is achieved by using a device called Multiplexer (MUX) that combines n input lines to generate a single output line. Multiplexing follows many-to-one, i.e. n input lines & one input line.
- Demultiplexing is achieved by using a device called Demultiplexer (DeMUX) available at the receiving end.
- The 'n' input lines are transmitted through a multiplexer & multiplexer combines the signals to form a composite signal.

MUX Techniques:

1. Frequency-division Multiplexing (FDM):
   - It is an analog technique.
   - FDM is a technique in which the available bandwidth of a single transmission medium is subdivided into several channels.
   - FDM is used in radio broadcasts & TV networks.
2. Wavelength Division Multiplexing (WDM):
   - WDM is same as FDM except that the optical signals are transmitted through the fibre optic cable.
   - WDM is used on fibre optics to increase the capacity of a single fibre.
   - It is used to utilize the high data rate capability of fibre optic cable.
   - It is an analog multiplexing technique.
   - Multiplexing & Demultiplexer separates can be achieved by using a prism.
3. Time division Multiplexing (TDM):
   - It is a digital technique
   - In (TDM) all signals operate at the same frequency with different time.
   - In TDM, the signal is transmitted in the form of frames. frames contain a cycle of time slots in which each frame contains one or more slots dedicated to each user.

   Two types of TDM:
   - Synchronous TDM
   - Asynchronous TDM.

. ATM is a form of cell switching using small fixed sized Packets.
in cell 53 bytes.

Interfaces: There are different networks are connected ATM.

UNI. User to network interface.

NNI. Network to Network interface
To connect the one ATM switch to another ATM switch.

B-ICI Broadband-inter carrier ~~it~~ interface
use in ATM.

There are