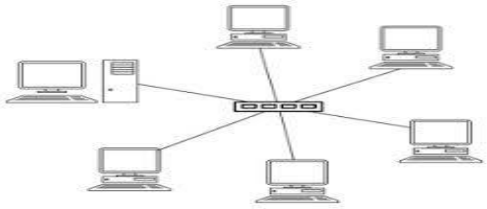
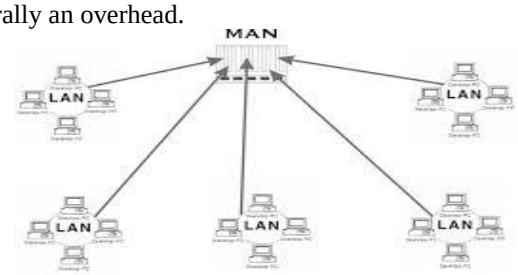
Chapter 2
Overview of Data Communication Networking

-Network are known as medium of communication and has became the basis of connection that we can do so that we share some information among the people.
-As there are lots of network that have been made possible by computers and technology, some well-known network types are LAN, MAN and WAN.

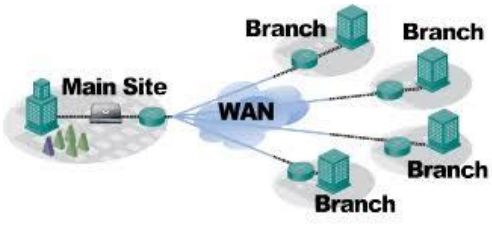
1) Local Area Network:
-Generally used for group of computers.
-They are privately owned and links the devices in a single office, building or campus.
-Limited to fewer distance.
-Channels are of relatively high capacity (Mbits/sec)
-Channels seems to be error-free.



2) MAN(Metropolitan Area Network):
-It is a larger network that usually spans several buildings in the same city or town.
-They are the networks generally owned by and operated by public company. Eg: Telephone company, an internet company.
-The propagation delay in MAN is moderate.
-Congestion is generally high.
-Design and maintenance is generally an overhead.



3)WAN(Wide Area Network):
-WAN generally covers wide areas.
-It spans large locality and connects countries together.
-Channels are relatively of low capacity (kbps).
-Generally, WAN network are less tolerant to faults.
-Data transmission errors and noise are somewhat moderate in WAN.

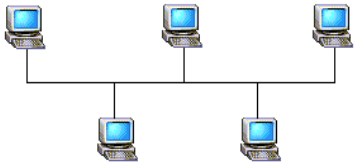


TOPOLOGY
-A network topology is the arrangement of network, including its nodes and connecting lines.

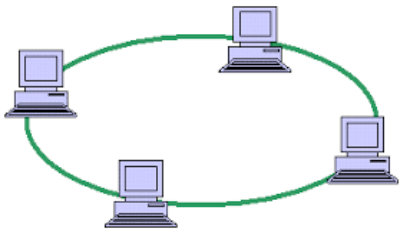
-Generally, there are two ways of defining network geometry
-the physical topology.
-the logical topology.

Other forms of topology are:
1) Bus topology
2) Ring topology
3) Star topology
4) Mesh topology
5) Tree topology
6) Hybrid topology

1)Bus topology:
-Every devices is connected to a single cable.
-When it has exactly two end points, it's called linear bus topology.



Features:
-Transmits data in only one direction.
-Every device is connected to single cable.
Advantages:
-Cost effective
-Used in small networks
-easily understood
-Cable is least required to other network topology.
Disadvantage:
-Cables fail when whole network fails.
-Cable has a limited length.
-Its slower than ring topology.
2) Ring topology:
-Forms a ring as each computers are connected to another computer.



Features:
-Repeaters are used in the nodes to prevent data loss.
-Transmission is unidirectional and bidirectional as well.
-Data transfer is of sequential form that is bit by bit.
Advantage:
-Transmitting network isn't affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.
-Cheap to install and expand.
Disadvantage:
-Troubleshooting is difficult in ring topology.
-Adding or deleting devices disturbs the network activity.

3) Star topology:

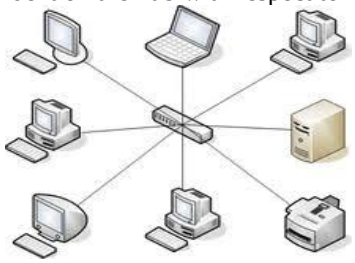
-All computers are connected to a single hub through a cable.
-Every node has dedicated connection to a hub.
-Hub acts as a repeater for data flow.
-Can be used with twisted pair, optical fiber or co-axial cable.

Advantage:

-Fast performance
-Easy to troubleshoot
-Only that node is affected which has failed, rest can function well.

Disadvantage:

-Installation cost is high
-Expensive to use
-Performance of network is dependent on the hub with respect to its capacity.



4) Mesh topology:

-It's a point-to-point connection to other nodes or devices.
-All network nodes are connected to each other.
-Mesh has n(n-1)/2 physical channels to link n devies.

Types:

i)Partial Mesh Topology:
-All devices aren't connected to each other.

ii)Full Mesh toplogy:
-Each and every nodes or devices are connected to each other.

Features:

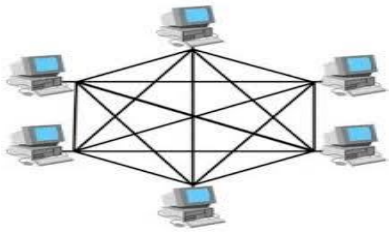
-Fully connected
-Robust
-Not flexible

Advantage:

-Fault is diagnosed easily
-Cabling cost is more
-Provides security and privacy

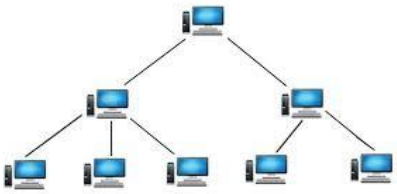
Disadvantage:

-Installation and configuration is difficult
-Cabling cost is more
-Bulk wiring is required



5) Tree topology:

-has a root node and all other nodes are connected to a form of hierarchy
-also called hierarchical topology
-it should have at least three levels to the hierarchy



Features:

-ideal if workstations are located in group

-used in WAN

Advantage:

-extension of bus and star topology

-expansion of node is possible and easy

-easily managed and maintained

-error detection is done easily

Disadvantage:

-heavily cabled

-costly

-if central hub fails, the network fails

6) Hybrid topology:

-Hybrid topologies generally include mixture of two or more topologies

Features:

-it's a combination of two or more topology

-inherits the advantage and disadvantage of other topologies included

Advantage:

-Reliable

-Effective

-Flexible

Disadvantage:

-Complex in design

-Costly

Open System Interconnection (OSI) Model

-OSI model is a reference model for how applications communicated over a network

-OSI model defines a networking framework to implement protocols in layers, with control passed from one layer to the next.

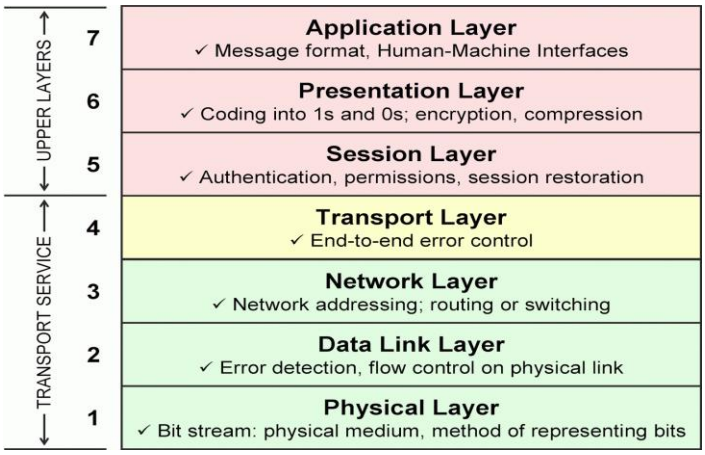
-This model allows two different systems to communicate regardless of their architecture.

-Consists of seven separate but related layers.

-It breaks n/w communication into smaller and more manageable forms

-It prevents changes in one layer from affecting the other layers

-The OSI model is given as:



1) Physical Layer:
-The physical layer is called layer1. Here, are some basic functionalities of the physical layer
-responsible for electrical signals, light signal, radio signal etc.
-hardware layer of the OSI model
-devices like repeater, hub, cables, Ethernet work on this layer
-protocols like RS232, ATM, FDDI, Ethernet work on this layer

2) Data Link Layer:
-Also called layer 2 of the OSI model. Here are some basic functionalities of the data link layer
-responsible for encoding and decoding of the electrical signals into bit
-Manages data errors from the physical layer
-Converts electrical signals to frame
-The data link layer is sub-divided as:

i) Media Access Control(MAC) layer: The MAC sublayer controls how a computer on the network gains access to the data and permission to transmit it.

-Mac address is part of layer 2 and devices like switch work at this layer.

ii) Logical Link Control(LLC) layer: The LLC controls the frame synchronization flow control and error checking.

3) Network Layer:
-Also called layer 3 of OSI model. Here are the basic functionalities of network layer.
-Switching and routing technologies work here.
-Creates logical paths between two hosts across the www called virtual circuits.
-Routes the data packet to the destination
-Routing and forwarding of the data packets
-Internetworking, error handling, congestion control and packet sequencing work at this layer
-Router works at layer 3
-Different network protocols like TCP/IP, IPX, AppleTalk works at this layer

4) Transport Layer:
-Also called layer 4 of the OSI model. Here are the basic functionalities of transport layer.
-Responsible for the transparent data between end systems.
-Responsible for end-to-end error recovery and flow control
-Respnosible for complete data transfer
-Protocols like SPX, TCP, UDP work here

5) Session Layer:
-Also called layer 5 of the OSI model
-Responsible for establishment, management and termination of connections between applications
-The session layer sets up, co-ordinates and terminates conversations, exchanges and dialogues between the applications at each end.
-It deals with session and connection co-ordination

-Protocols like NFS, NetBIOS name, RPC, SQL work at this layer

6) Presentation Layer:

-Here are the basic functionalities of layer 6 of OSI model
-Responsible for data representation on your screen
-Encryption and decryption of data
-Data Semantics and syntax
-Later 6 presentation examples include encryption, ASCII, EBCDIC, FIFF,GIF,PICT,JPEG,MPEG,MIDI

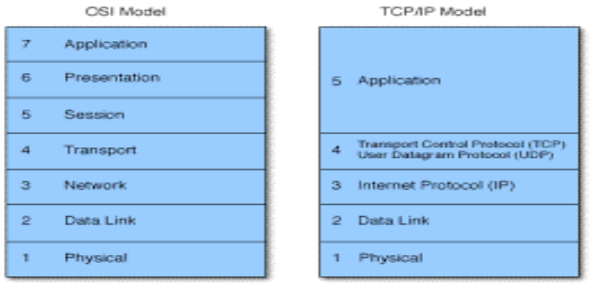
7) Application Layer:

-The layer 7 of the OSI model is as:
-Application layer supports application, apps and end-user process
-Quality of service
-Also responsible for five transfers, email and other network services
-Protocols like telnet, ftp, http work at this layer

TCP/IP Layer

-TCP/IP protocol suite was developed prior to the OSI model
-It has four layers:

-Host-to -host (network)
-Internet
-Transport
-Application



RELATED TERMS WITH OSI MODEL:

`Physical address:

-It's the address of node defined by LAN or WAN
-The physical address have authority over network
-size and format of these addresses vary depending upon the network
-for eg. Ethernet addresses are 6 bytes (48 bit) physical addresses i.e. imprinted on the NIC
Eg.07:01:02:01:2C:43

Logical address:

-logical addresses are for universal communications that are independent of underlying physical networks
-It's a 32-bit address that can uniquely define a host connected to the internet.
-For eg. IP address: 192.168.1.1

Port address:

-It's a label assigned to a process after the arrival of data at the destination host is a port address.
-It's a 16 bit in length in TCP/IP.

LAN ARCHITECTURE

-lan architecture defines the overall design of a LAN
-includes hardware, software, topology and MAC protocol

Aspects of LAN architecture includes:
-LAN physical topology
-LAN logical topology
-LAN MAC protocol

LLC/MAC

-The data-link layer of the OSI model is subdivided into two layers and they are LLC and MAC
-LLC is a high level interface which is associated with logical addressing
-MAC is low level interface associated with physical addressing and access control.
-Eg. CSMA/CD (Media Access Control)
-Other functionalities of LLC and MAC are as:

LLC: -provides the frame and packets
-provides flow control and sequencing of control bits

MAC: -defines how packet are placed on the media
-contention based media access "first come/first served"
-performs:
-line discipline
-error notification
-the ordered delivery of packets
-optional flow control can be used at this sub layer

ROUTING

-Routing refers to establishing the routes that data packets take on their way to particular destination
-Routing is performed on many types of networks and they are circuit switching in telephone network and packet switching on the Internet and transportation network.
-In packet switching networks, routing directs packet forwarding using various intermediate nodes, typically hardware devices such as routers , switches , bridges etc.
-Routing process forwards packets based upon the routing table which maintains a record of routes to the various network destination.
-The routing table is stored in routers memory and they are gradually increased for efficient routing.
-Generally most routing algorithms use only one network path at a time but multiple routing techniques enable the use of multiple alternative paths.
-Routing protocols are: static routing and dynamic routing
Eg.- RIP, OSPF, EIGRP are dynamic RP's
-Routing algorithms include: shortest path routing algorithm , Dijkstra's algorithm

IEEE STANDARDS

-IEEE 802 is a family of standards dealing with LAN and MAN
-IEEE 802 standards are restricted to networks carrying variable-size packets.

IEEE 802	LAN/MAN
IEEE 802.1	Standards for LAN/MAN bridging, management and remote MAC and bridging
IEEE 802.2	Standards for LLC standards for connectivity
IEEE 802.3	Standards for CSMA/CD
IEEE 802.4	Standards for token passing bus access
IEEE 802.5	Standards for token ring access and for commn. between LANs and MANs
IEEE 802.6	Standards for information exchange between systems
IEEE 802.7	Standards for broadband LAN cabling
IEEE 802.8	Fiber optic connection
IEEE 802.9	For integrated service like voice and data
IEEE 802.10	LAN/MAN security implementation
IEEE 802.11	Wireless networking

Multiple Access Protocols

-The lower sub layer of data link layer i.e. MAC is responsible for multiple access resolution

-When nodes use a common link called a multipoint or broadcast link, we need a multiple-access protocol to co-ordinate access to the link.

-Multiple access protocols are classified as:

1)Random Access Protocols
- -ALOHA
- -CSMA
- -CSMA/CD
- -CSMA/CA

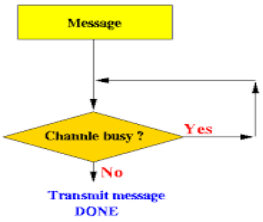
2) Controlled Access Protocols
- -Reservation
- -Polling
- -Token Ring

3)Channelization Protocol
- -FDMA
- -TDMA
- -CDMA

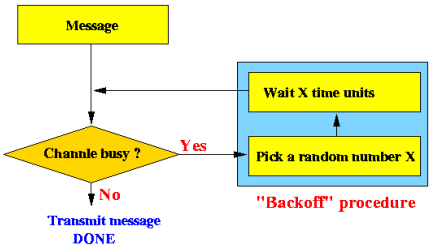
CSMA/CD (Carrier Sense Multiple Access / Collision Detection)

-CSMA is used to minimize the chance of collision and to increase the performance
-CSMA can reduce the chance of collision but it can't reduce it
-CSMA uses persistence methods which decides what should the station do if the channel is busy or if channel is idle ?

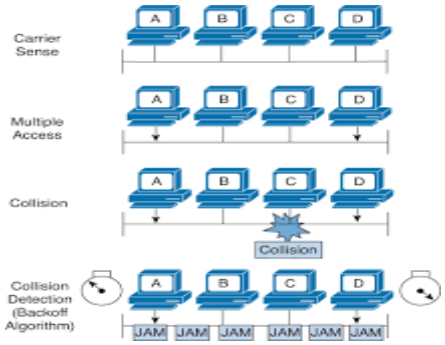
1-persistent



Non-persistent



-CSMA/CD helps the network devices to share the bandwidth evenly while preventing two devices from transmitting simultaneously on the same network medium.



-The host on network want to retransmit, it first checks for the presence of a digital signal on the wire. If it is all clear & no other hosts are transmitting, the host will proceed with transmission.

-The transmitting host constantly monitors the wire to make sure, no other hosts begin transmitting . If the host detects the another signal it sends out an extended jam signal that causes all nodes on the segment to stop sending data-think busy signal.

-The nodes respond to that jam signal by waiting a bit before attempting to transmit again.

-Backoff algorithm determines when the colliding stations can retransmit. If collision keeps occurring after 15 tries, the nodes attempting to transmit will then time out.

When collision occurs on LAN, the following occurs:

1) A jam signal informs all devices that a collision has occurred
2) The collision invokes a random backoff algorithm
3) Each device on the Ethernet segment stops transmitting for a short time until its backoff timer expires
4) All hosts have equal priority to transmit after the timer have expired

X.25

-X.25 protocol, adopted as a standard by CCITTI (Consulatative Committee for International Telegraph and Telephone) is a commonly used network protocols for WANs.

-X.25 protocol allows computers on different public networks to communicate through an intermediary computer at the network layer.

-X.25's protocols corresponds to the data link and physical layer protocols defined in the OSI model.

Three levels of X.25:

i)Physical layer:

These layer specify physical, electrical, functional and procedural characterstics to control the physical link between a DTE and DCE.

ii)Link level:

Provides reliable transfer of data across physical link. It is also referred as link access protocol.

iii)Packet level:

Provides virtual circuit services, enables any subscribers to the network to setup logical conditions.

Features and characterstics of X.25

-Multiple logical channels can be set on a single physical line.

-Terminals of different communication speed can communicate

-The procedure for transmission controls can be changed.

Drawbacks

-X.25 has a low 64 kbps data rate.

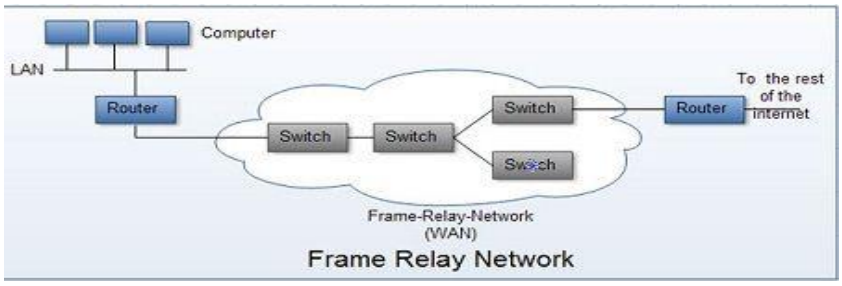
-It has extensive flow and error control at both data link layer and network layer which create a large overhead and slows down transmission.

Frame Relay

-Similar to X.25 but operates at the higher speed (1.54 Mbps and now 44.376 Mbps)

-Operates at the physical layer and data link layer

-Can be easily used as backbone network to provide services to protocols that already have a network layer protocol, such as internet



Features:

-Operates at higher speed (1.54 Mbps to 44.376 Mbps)

-It operates in the physical and data link layer

-It allows bursty data

-It has a large frame size of 9000 bytes and accommodate all LAN frame sizes

-It has error detection at data link layer only so it has no overhead

ATM

-It's a cell relay protocol designed by the ATM forum and adapted by ITU-T

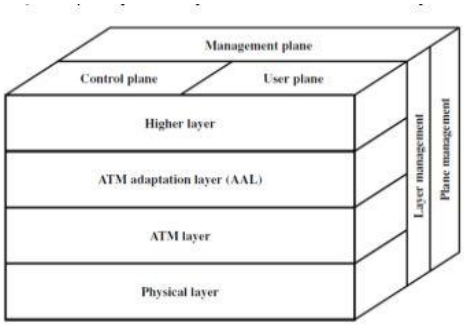
-It is a streamlined packet transfer interface

-Cell is fixed sized packet

-Data rate ranges from 25.6 Mbps to 622.08 Mbps

-It differs from frame relay as ATM uses variable-length packets called frames and ATM uses fixed-length packets called cells.

-The ATM protocols architecture is as:



-ATM is a streamlined protocol with minimal error and flow control capabilities

-The layers and planes involved in protocol reference model exhibit the following duties:-

i)Physical layer defines transmission medium and signal encoding schemes.

ii)ATM layer defines transmission of data in fixed size cells and defines the use of logical connection.

iii)ATM adaptation layer maps higher layer information into ATM cells to be transported over an ATM network.

iv)User plane provides user information into ATM cells to be transported over an ATM network.

v)Control plane provides call control and connection control functions.

vi)Management plane performs co-ordination between all the planes and layer management.