UNIT 1 TYPES OF NETWORKS

Structure

1.0 OBJECTIVES

After reading this unit you will be able to:

- know the functioning of modern communication computer networks like LAN and WAN; and
- be acquainted with different methods used to deal with LAN and WAN topologies and LAN protocols.

1.1 INTRODUCTION

With the increasing use of computers it was observed that the use of the computer could not be restricted to a particular place. A need was felt to link computers located at different places, e.g., either in the same room or scattered through a building or at distant places for exchange of data/information. A major development, in the early 1950s, was the use of communication links to connect central computers to remote terminals and other peripheral devices. The number of such devices expanded rapidly in the 1960s with the development of time-shared computer systems and with the increasing power of central computers. With the proliferation of remote peripheral devices, it became uneconomical to provide a separate long-distance communication link to each peripheral. Finally to free the central processor from handling all this communication, special processors called front ends were developed to control the communication to and from all the peripherals. Such connectivity of the computer with remote peripherals was referred to as Data Network or Computer Communication Network.

1.2 NETWORK COMPONENTS

The following are the essential components for computer networking.

1.2.1 Network Software

Software is the first part of the network. Before selecting a suitable software, the network card, cable and the topology to be used must be decided. The main categories of network software are:

1.2.1.1 Peer-to-Peer

Peer-to-peer network operating systems allow users to share resources and files located on their computers and to access shared resources found on other computers. However, they do not have a file server or a centralized management source. In a peer-to-peer network, all computers are considered equal; they all have the same abilities to use the resources available on the network.

1.2.1.2 Client/Server-based

Client server operating systems allow the network to centralize functions and applications in one or more dedicated file servers. The file servers become the heart of the system, providing access to resources and providing security. Individual workstations (clients) have access to the resources available on the file servers. The network operating system allows multiple users to simultaneously share the same resources irrespective of physical location. Some server-based networking softwares' are: Novell Netware, Windows NT, Unix, Windows 2000, etc.

1.2.2 Network Card

The network card in the computer represents the middle and most important part of the connection. The network software dictates the network protocol, which in turn dictates the speed at which the network can operate and the kind of cable used. Network cards must match the system bus structure. The bus is physically represented on the bottom card edge that slides into the main system board called motherboard.

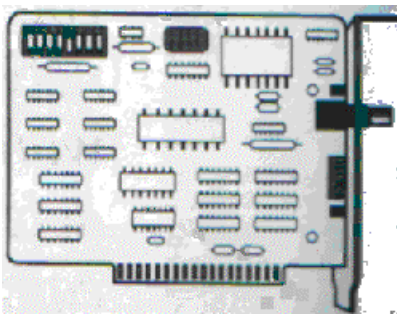


Figure 1: Network Cards

Once the card is inserted into the slot of the motherboard it becomes a part of the computer. The cards are physically different. Depending upon the architecture the cards are of three types. They are 8-bit cards, 16-bit cards and 32 bit cards. Each card has its own method of sending information (network protocol) through the cable. The most commonly used protocol is Ethernet protocol. It's a standard for Media Access Control (MAC) sub-layer. This is preferred for smaller networks. It provides a decent *transmission* speed when compared to the cost of the card and cabling. Xerox Corporation developed it in the 1970's. The transmission speed is rated at 10 megabits per second called 10BaseT or 100 megabits per second called 100BaseT. The maximum length of the cable between two computers ranges from 500 to 1500 feet. Gigabit Ethernet built on top of the Ethernet protocol provides high bandwidth capability for backbone design, i.e., 1 Gbps (1000 Mbps). Another type of card eliminates the need to run cable from system to system. Wireless LAN is the method for doing so. The signal used in this is radio or infrared.

- Simplex transmission refers to one-way data exchanges. This requires only a single pair of wires.
- Duplex transmission refers to two-way data exchanges between two parties.
  - — In half duplex transmission, signals are sent in only one direction at a time.
  - — In full-duplex transmission, signals are sent in both directions simultaneously.

1.2.2.1 Transmission Media

Communication of data propagation and processing of signals is called transmission. Transmission systems allow transport of signal from one point to another. At the transmitter end, the data is encoded as energy and the energy is transmitted through some sort of medium. At the receiver end, the energy is decoded back into data. The energy can be electrical, light, radio, sound, etc. Each form of energy has different properties and requirements of transmission. Electrical/Radio transmission from transmitter to receiver goes over some transmission medium using electromagnetic (EM) waves. The transmission media are as under:

1.2.2.1.1 Guided Media

Waves are guided along a physical path; Coaxial cable, Twisted pair, Optical fibre

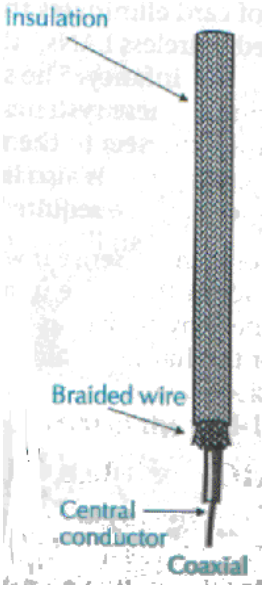
1.2.2.1.2 Baseband Coaxial cable and BNC Connections

Coaxial cable, abbreviated "coax" looks like the cable used to bring the cable TV signal to television. One strand (a solid core wire) runs down the middle of the

cable. Around the strand is insulation. Covering the insulation are braided wire and possible metal foil, which shield against electromagnetic interference. A final layer of insulation covers the braided wire.

Two kinds of coaxial cables are widely used. The 50 - ohm cable is used for digital transmission. The other kind, 75 - ohm cable, is used for analogue transmission.

Coaxial Cable for Ethernet networks is either Thick Ethernet which can carry signals up to 500 metres or Thin Ethernet which can carry signals up to 180 meters. Thin Ethernet is mostly used with Ethernet cards. This cable uses BNC connectors and sleeves of .2 inch diameter.



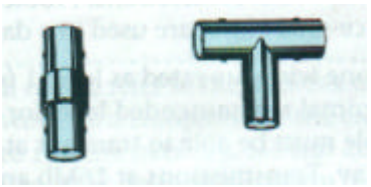


Figure 2: Coaxial Cable **Figure 3: BNC Connector**

These connectors use a twist-to-lock sleeve that attaches to the T-connector on the back of the network card. Cable can be attached to the connector only after carefully stripping the insulation from each layer. Once the cable is inserted the sleeve must be crimped. Many network problems can be traced to poor cable connections. Coaxial cable is not easy to install. It cannot be pulled into a sharp 90 degree angle and requires careful attachment to the BNC connectors.

1.2.2.1.3 Broadband Coaxial Cable

Cable uses analogue transmission on standard cable television cabling. It is called broadband. Although the term "broadband" comes from the telephone world, where it refers to anything wider than 4 KHz, in the computer networking world "broadband" means any cable network using analogue transmission.

Since broadband networks use standard cable television technology. The cables can be used upto 300 MHz (and sometimes up to 450 MHz) and can run for nearly 100 kms due to the analogue signaling, which is much more critical than digital signaling. Typically, a 300 MHz cable will support a total rate of 150 Mbps.

One key difference between baseband and broadband is that broadband systems need analogue amplifiers to strengthen the signal periodically. These amplifiers can only transmit signals in one direction. Therefore Dual Cable Systems have two identical cables running next to each other. All computers transmit on cable 1 and receive on cable 2.

1.2.2.1.4 Twisted Pair Copper Wire

Unshielded Twisted-Pair (UTP) cable and RJ-45 connectors

Unshielded Twisted-Pair (UTP) cables look like phone cables. Each of the pair of wires contained in the cable is twisted with the other. The typical twisted-pair cable rated for network use contains three or four pairs of wires. The arrangement helps shield against electromagnetic interference. There are generally three categories of UTP cabling.

Category 3: UTP cables and associated connecting hardware whose transmission characteristics are specified up to 16 MHz.

Category 4: UTP cables and associated connecting hardware whose transmission characteristics are specified up to 20 MHz

Category 5: UTP cables and associated connecting hardware whose transmission characteristics are specified up to 100 MHz

Category 6: UTP cables and associated connecting hardware whose transmission characteristics are specified up to 250 MHz

The higher the category, the greater the level of protection from any outside (electrical) interference, and of course, the higher the price.

The twisted-pair cable uses small plastic connectors designated as RJ-45. These are similar to the phone connectors except that instead of the four wires, RJ-45 uses eight wire contact.

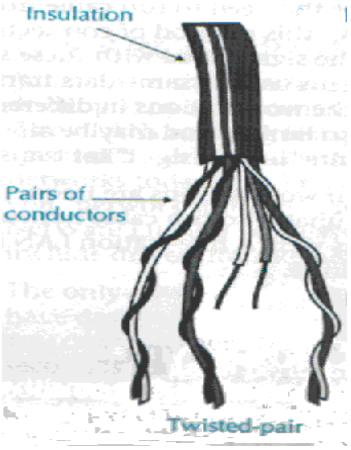


Figure 4: UTP Cable

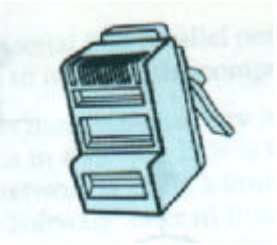


Figure 5: RJ - 45 Connector

1.2.2.1.5 Fibre Optic Cable

These cables contain a hair-thin strand of optically pure plastic fibre, surrounded by special shielding and insulation. An optical fibre cable carries pulses of light as opposed to bursts of electricity carried by the twisted-pair or coaxial cables. A fibre optic network uses either a laser or a light emitting diode (LED) to translate electrical signals into light pulses, and then transmits those pulses through the core of the cable.

All fibres are made up of three general parts:

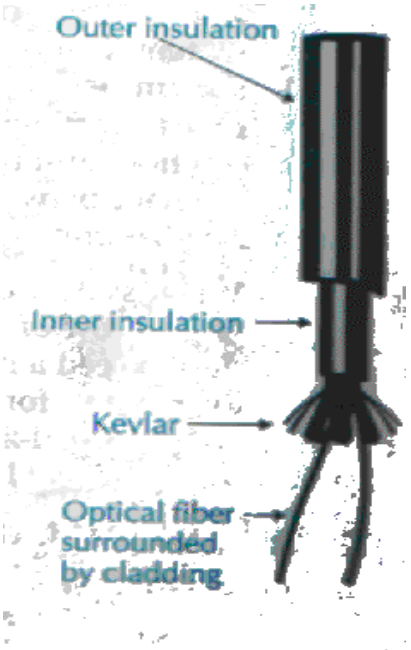
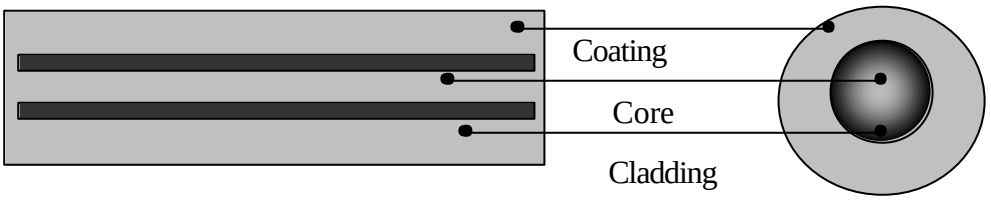


Figure 6: Fibre Optic Cable

Core: The innermost section, where the light travels, is made from doped silica,. i.e., chemicals are added to pure silica (glass) to provide various light transmission properties.

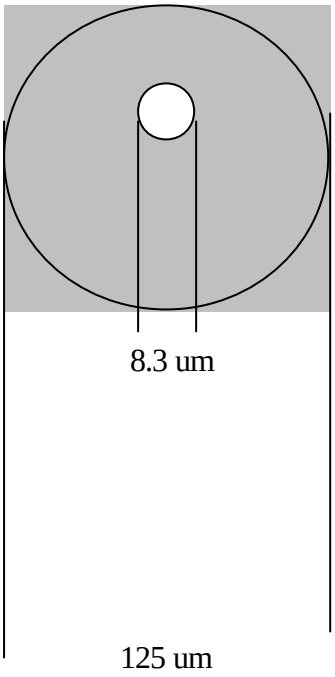
Cladding Layer: The cladding layer is made of pure silica and has a lower refractive index than the core. This difference in refractive index is what allows the light to travel within the core. The core/cladding interface acts like a mirror to keep the light from refracting out of the fibre. Optical fibre works because of principle of total internal reflection.



Coating: The outer layer of the fibre is coating. Generally made of an acrylate material, the coating has no affect on the transmission properties. It protects the fibre when it is being processed into a cable and when being handled during installation and termination

Types of Fibre: There are two general types of fibres available for use in data communication networks today - Multi mode and Single mode.

Multi mode : At presently backbones in buildings or campuses use multimode fibres which meet both the distance and data rate demands of most LAN networks. Multimode cables cost far less than single mode cables since the optoelectronics used with multimode fibres are much cheaper than those used with single mode fibre. This cost advantage is the main reason for the popularity of multimode fibre over single mode fibre in LANs. Because of larger core diameter, multimode fibre LED sources are cheap.



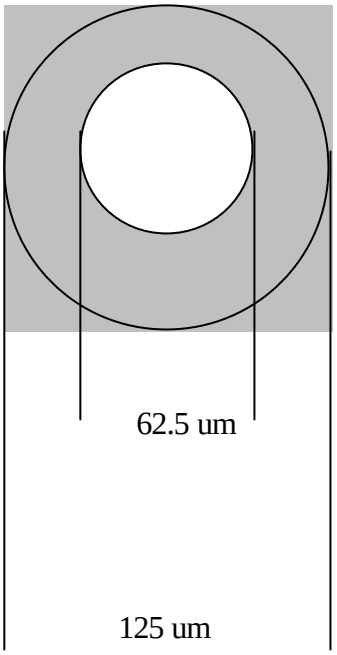


Figure 7: Single Mode Fibre **Multi Mode Fibre**

Single Mode : As the name suggests, single mode fibre is designed to support one mode of light. It is used with a very narrow laser source and carries large amount of information over long distances. Its core size is typically around 8.5 um and cladding diameters are the standard 125 um. Single mode fibre cables are preferred where long distance and higher information carrying capacity is required. Because of small core diameters, single made fibres require lasers for effectively launching light into the fibre. Lasers are costlier than LEDs.

Connectors: There are many types of fibre optic connectors available today. They differ in their installation method, materials and shape, but perform the same basic function. Some of the most popular connectors are SC, ST, SMA, D4 connectors etc.

1.2.2.1.6 Unguided media: Waves are not guided; air waves, radio

Data communications through space are predominantly sent by radio communications microwave links. The space media can be infrared, light, microwave and radio carrier.

1.2.2.1.7 Microwave

A microwave link can carry huge traffic/data between two stations without a physical connection. It can connect longer distances with the help of a repeater. It is used for the connectivity between two distant stations where legacy connectivity with cable/ optical fibre laying is difficult. It requires Parabolic dish antenna, about 3m in diameter, fixed rigidly with a focused beam and its coverage per hop is limited by line-of-sight. Long distance microwave transmission is achieved by a series of microwave relay towers. With no obstacles, maximum distance (D, in km) between antennae can be

$$D = 7.14 \sqrt{} Kh$$

Where ‘h’ is antenna height and ‘K’ is an adjustment factor to account for the bend in microwave due to earth’s curvature, enabling it to travel further than the line of

sight; typically K=4/3. For example two microwave antennae at a height of 100 m may be as far as

$$7.14 \times \sqrt{133} = 82 \text{ km}$$

The range of operational frequency is, mainly from 2 GHz to 8 GHz. The microwave link is susceptible to fading in atmosphere specially heavy rain absorbing microwave, resulting in attenuation. The transmission hierarchy can be PDH/ or SDH (Synchronous Digital Hierarchy). It normally uses Quadrature Amplitude Modulation (QAM) technique.

1.2.2.1.8 Radio Communication

Radio Channels carry signals in the electromagnetic spectrum. They are an attractive media because they require no physical "wire" to be installed, can penetrate walls, provide connectivity to a mobile user, and can potentially carry a signal for a long distance. The characteristics of a radio channel depend significantly on the propagation environment and the distance over which a signal is to be carried. Environmental considerations determine path loss and shadow fading (which decreases a signal's strength as it travels over a distance and around/through obstructing objects), multiple fading (due to signal reflection off interfering objects), and interference (due to other radio channels or electromagnetic signals). It operates at a lower frequency than microwave mainly hundreds MHz. It may operate in Time Division Multiple Access (TDMA) in Coded Division Multiple Access mode (CDMA).

Terrestrial radio channels can be broadly classified into two groups: those that operate as local area networks (typically spanning 10's to be a few hundred meters) and wide area radio channels that are used for mobile data service (typically operating within a metropolitan region). A number of wireless LAN products are in the market, operating in the 1 to 10's of Mbps range. Mobile data service typically provides channels that operate at 10's of Kbps.

1.2.2.1.9 Satellite Communication

The communication satellite is a microwave relay station between two or more ground stations (also called earth stations). It uses different frequency bands for incoming (uplink) and outgoing (downlink) data. Satellite communication is mainly a broadcast network. It can operate in C-Band, KU-Band etc. Access of satellite is FDMA,TDMA. Most satellites use 5.925 - 6.425 GHz band for uplink and 3.7-4.2 GHz band for downlink (4/6 band). A single satellite can operate on a number of frequency bands, known as transponder channels or transponders. The propagation delay of about a quarter second due to long distance leads to problems in error control and flow control. Geostationary satellites permanently remain above the same spot on the earth. This stationary presence is achieved by placing the satellite in orbit at 36,000 kilometers above the Earth's surface. This huge distance between ground station through satellite back to ground station introduces a signal propagation delay of 250 milliseconds. Nevertheless, satellite links are often used in telephone networks and in the backbone of the Internet. VSATs (Very Small Aperture Terminals) are used to share a satellite capacity for data transmission.

VSATs are basically satellite earth terminals having very small antennae (diameter of 2.4 m or less). They normally use geosynchronous satellites for supporting two way telecommunication and information services such as voice, data and video. Two VSATs cannot directly communicate with each other but they do so via a large

earth station called the Hub Station. A VSAT network offers several advantages like better reliability, high availability, modular/easy network growth, network access to/from remote places. They are cost effective and simple to operate, maintain, monitor and control.

A VSAT consists of two units viz. an outdoor unit (ODU) and an indoor unit (IDU). The outdoor unit is basically mounted alongside the antenna. Because of it small size, the antenna and ODU can be installed on rooftops. The ODU contains RF and IF electronics whereas the baseband electronics comprising digital circuits is housed in the IDU. These two units are connected to each other by a cable. In addition to RF/IF signals, this cable carries power supply for the ODU. A personal computer can directly be hooked onto the indoor unit of VSAT. Alternatively, the indoor unit can be interfaced with LAN via a suitable router.

1.2.2.1.10 Infrared Communication

Limited to short distances and highly directional, it cannot penetrate walls. It requires no licensing; and no frequency allocation issues.

1.2.2.2 Transmission capacity

1.2.2.2.1 Bandwidth

The amount of data that can be transmitted via a given route of lines from server to client and vice versa.

1.2.2.2.2 Data transmission rates expressed in bits/second are unambiguous and indicate the rate of data transfer exactly. The baud rate, however refers to the rate of transitions imposed onto a transmission line.

1.2.2.3 Measure of Performance

1.2.2.3.1 Throughput

Throughput and Latency are completely independent issues. A channel with high throughput can move large quantities of data rapidly, but the first bit of data can never arrive faster than the latency permits.

Connectionless network, such the Internet and other IP-based networks, use throughput capacity efficiently, rather than minimizing latency.

1.2.2.3.2 Latency

Latency refers to the delay between the occurrence of two events. Some of the most widely used latency measures for networks are end-to-end trip time, round-trip-time, key-stroke response time, and transaction complete time.

End-to-end trip time is the time it takes a packet or other unit of data to travel from source to destination. Round-trip time adds the time for a return response or acknowledgement to the end-to-end latency.

1.2.2.3.3 Data Transfer Rate

Speed at which data can be transferred, once transmission has begun. (bit/sec)

Message transfer time = latency + length of message / Data transfer rate

Shannon's limit (on ideal conditions):

Max. data rate [bit/s] = carrier BW [Hz] · log2 (1 + (signal / noise))

ex.: *phone line* BW=3 kHz, S/N = 30 dB = 1000 Max. data rate = 30 kbit/s

1.3 CATEGORIES OF NETWORK

The system for connecting computers using a single transmission technology is called Computer Networking. Computer networks can be classified under the following heads:

1.3.1 Local Area Network (LAN)

A local area network is a communication network that interconnects a variety of devices and provides a means for information exchange among those devices over a small physical area, viz., a single building or a cluster of buildings spread over a campus. The way the computers are physically connected is called the network topology.

1.3.1.1 Bus Topology

The Bus Topology is a straight line data highway that carries network information from one network workstation to another. Bus topology results in information being broadcast to all workstations on the network in both directions. A workstation desirous of sending information to another workstation transmit packets of data along with the address of the receiver. Each workstation examines the address on the packets of information of the Bus and accepts only those meant for it discarding others. Bus topology is easy to install. At each end of the Bus is a terminator, which absorbs signals flowing out of the Bus avoiding their getting reflected back into the Bus. But the biggest drawback of the topology is that a break in the cable can bring down the whole network. The cable used for Bus topology is coaxial cable.

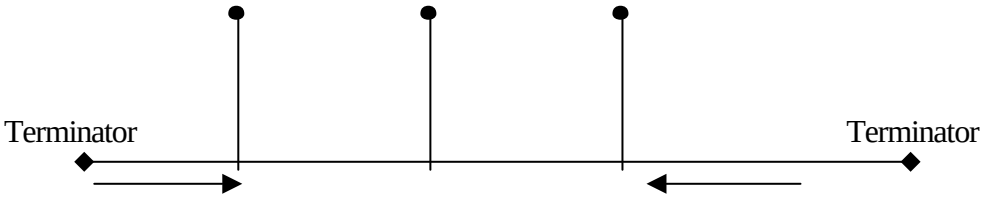


Figure 8: Bus Topology

In a Bus network, at any instant, one machine is the master and is allowed to transmit. All other machines are required to refrain from sending.

1.3.1.2 Star Topology

Star Topology is a LAN architecture in which the end points on a network are connected to a common central Hub or Switch, by dedicated links. Star topology looks more like a tree. The message works its way to the top and is then rebroadcast down to all stations. Large LANs use the star topology.

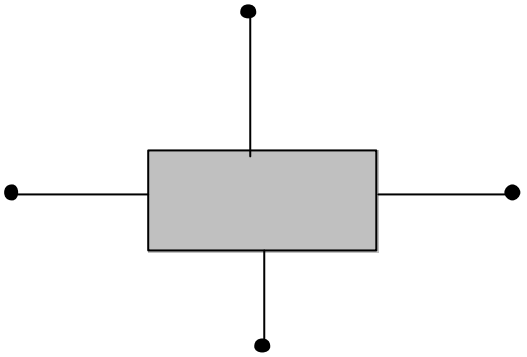


Figure 9: Star Topology

The advantage of star topology is that a single break will not bring down the entire network. The cables used are CAT 5, Fibre Optic, etc.

1.3.1.3 Tree

Here, the Server Computer is situated at the highest order of hierarchy and workstations are connected in a tree-like hierarchical fashion. But the drawback of this topology is that if the upper level computer fails to work, the computer network working is held up.

1.3.1.4 Ring Topology

A Ring Topology is a LAN architecture that consists of devices called repeaters connected to one another by point-to-point transmission links to form a single closed loop. Each station is attached to the ring and receives all messages on the ring. Therefore this network is a broadcast technology in that one station broadcast to all. Each station examines a destination address that resides in the message passing on the ring. If the message is destined for this station, it copies it. If not, it ignores it. The ring is usually unidirectional. That is, the traffic passes in one direction around the ring. 10baseT/100baseT implements a ring topology.

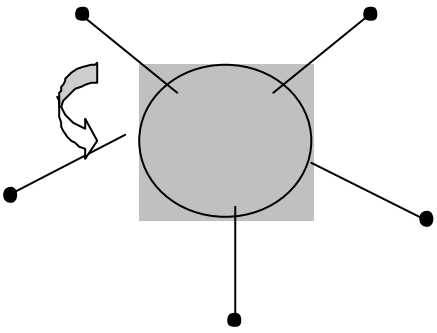


Figure 10: Ring Topology

In a ring each bit propagates around on its own, not waiting for the rest of the packet to which it belongs.

1.3.1.4.1 Fibre Distributed Data Interface (FDDI) : Ring with a Difference

Fibre Distributed Data Interface (FDDI) is a new entrant of the nineties. Fibre Distributed Data Interconnect (FDDI) is another ring technology. FDDI uses the

high bandwidth provided by fibre optics to support data transmission rates of 100 mbps. FDDI features multi-mode optical fibre of 62.5/125 microns, operating in the 850 mm and 1,300 mm windows where loss over the fibre is low. LEDs are used as transmitters and photo-detectors as receivers. FDDI consists of two counter-rotating fibre rings. One transmits clock-wise and other anti-clockwise. The dual rings are independent till such time as a fault occurs. In the event of a cable break, both stations wrap around to restore the ring to its original state. If a break occurs at two places, two disjointed rings function independently. Redundancy is FDDI's forte. A total of 500 stations can be connected spanning a fibre distance of 200 kilometers. Stations that connect to both rings are called Dual Attachment Stations (DAS). A Single Attachment station (SAS) is one which connects to the main ring via a concentrator which is the basic building block of FDDI. The concentrator attaches itself directly to the dual ring and both DAS and SAS can be connected to it.

Data is transmitted serially as a symbol stream from station to station. Each station in turn regenerates, repeats, and passes the symbol down the line. Unlike the conventional token ring, the FDDI ring is initialised by a bidding process. The right to transmit data is controlled by a token which is generated by the winner of the bidding process. The token, a unique sequence travelling around the ring, is divided into fields which define token, type and end of token. A station wishing to transmit captures the token, sends all its data frames and releases the token on to the ring again. At the end of the transmission, the frame returns to the sending station which removes the frame from the ring.

1.3.1.5 Mesh or Point-to-Point Network

Each communication channel connects exactly two computers. It allows flexibility in communication hardware, packet formats, etc. It also provides security and privacy because the communication channel is not shared. The number of wires grows as a function of the square of number of computers, i.e, For N computers:

$$\text{Connections} = (N^2 - N) / 2$$

But connections between buildings can be prohibitive because adding a new computer requires $N - 1$ new connections.

1.3.2 LAN Standards

IEEE (Institute of Electrical and Electronic Engineers) is a US publishing and standards organization responsible for many LAN standards such as the 802 series.

- IEEE 802.2 is the Data Link standard for use with IEEE 802.3, 802.4 and 802.5 standards. It specifies how the basic data connection should be set up over the cable.
- IEEE 802.3 is the IEEE standardization of Ethernet. A Physical Layer definition that includes specification for physical cabling plus the method of transmitting data and controlling access to the cable. It uses the CSMA/CD access method on a bus topology LAN. CSMA/CD is the result of an evolution from multiple access (MA) to carrier sense multiple access (CSMA), and finally, to carrier sense multiple access with collision detection (CSMA/CD). The IEEE 802.3 standards defines five different physical standards:
  - — 10 Base5 (Thick Ethernet)
  - — 10 Base 2 (Thin Ethernet)

— 10 Base T (Twisted Pair Ethernet)

— 100 Base T (Fast Ethernet)

— 10 Broad 36 (Broadband Ethernet)

- IEEE 802.4 is the IEEE standardization of Token Bus, a Physical Layer standard that uses the Token Ring passing access method on a bus topology LAN. It is used by LANs implementing the Manufacturing Automation Protocol. The older Arcnet operates in a similar way but does not follow 802.4, but Arcnet supporters have been trying to get the technology ratified by IEEE without success.
- IEEE 802.5 is the IEEE standardization of IBM Token Ring. A LAN Physical layer standard that uses the Token Ring passing access method on a ring topology LAN.
- IEEE 802.6 The standard that defines Mans, an SMDS-based, short packet ATM transmission.

1.3.3 Metropolitan Area Network (MAN)

A Metropolitan Area Network is basically a bigger version of a LAN and normally uses similar technology. It might cover a group of nearby corporate offices or a city and might be either private or public.

1.3.4 Wide Area Network (WAN)

Wide Area Networks (WANs) are those networks that cover a large geographic area, spanning cities, countries or even continents. Typically, a WAN consists of a number of interconnected switching nodes. Some of the important WAN technologies are given below :

1.3.4.1 Point-to-Point Links (Leased Lines)

A point-to-point link provides a single, pre-established WAN communication path from the customer premises through a carrier network, such as a telephone company, to a remote network. Point-to-Point lines are usually leased from a carrier and thus are often called Leased Lines. For a point-to-point line, the carrier allocates pairs of wire and facility hardware to your line only. These circuits are generally priced based on the bandwidth required and the distance between the two connected points

Leased lines in India are provided by the Bharat Sanchar Nigam Ltd. (BSNL), and the Mahanagar Telephone Nigam Ltd. (MTNL).

1.3.4.2 Circuit Switching

Circuit switching is based on the division of the transmission capacity into fixed timeslots called channels or circuits. Channels are allocated end to end between users. Switched circuits allow data connections that can be initiated when needed and terminated when communication is complete. This works much like a normal telephone line works for voice communication. Integrated Services Digital Network (ISDN) is a good example of circuit switching. When a router has data for a remote site, the switched circuit is initiated with the circuit number of the remote network. In this case of ISDN circuits, the device actually places a call to the telephone number of the remote ISDN circuit. When the two networks are connected and authenticated, they can transfer data. When the data transmission is complete, the call can be terminated.

1.3.4.3 Packet Switching

Packet Switching is a WAN technology in which users share common carrier resources. Because this allows the carrier to make more efficient use of its infrastructure, the cost is generally much better than point-to-point lines. In a packet switching setup, networks have connections into the carrier's network, and many customers share the carrier's network. The section of the carrier's network that is shared is often referred to as cloud.

There are two broad classes of packet switched networks: datagram networks and virtual-circuit networks. They differ according to whether they route packets according to host destination addresses or according to virtual circuit numbers. Any network that routes packets according to host destination addresses is called a datagram network. The IP protocol of the Internet routes packets according to the destination addresses; hence the Internet is a datagram network. Any network that routes packets according to virtual-circuit numbers is called virtual-circuit network. Examples of packet-switching technologies that use virtual circuits include X.25, Frame Relay, and ATM.

1.3.4.4 WAN Dial up Services

Dial-up services offer cost-effective methods for connectivity across WANs. Two popular dial-up implementations are dial-on-demand routing (DDR) and dial backup.

DDR is a technique whereby a router can dynamically initiate and close a circuit-switched session as transmitting end stations demand. A router is configured to consider certain traffic interesting (such as traffic from a particular protocol) and other traffic uninteresting. When the router receives interesting traffic destined for a remote network, a circuit is established and the traffic is transmitted normally. The router maintains an idle timer that is reset only when interesting traffic is received when, no circuit exists, the router drops the traffic. Upon receiving interesting traffic, the router will initiate a new circuit. DDR can be used to replace point-to-point links and switch multi-access WAN services.

Dial backup is a service that activates a backup serial line under certain conditions. The secondary serial line can act as a backup link that is used when the primary link fails or as a source of additional bandwidth when the load on the primary link reaches a certain threshold. Dial backup provides protection against WAN performance degradation and downtime.

1.4 INTER NETWORKS

The term Internet evolves out of the term "inter-networking" meaning "inter-connecting networks". Because of the Internet, any information, residing on any computer in any of the networks is just a click away. A variety of universities, Government agencies and computer firms are connected to an internet-work, i.e., Internet which follows the TCP/IP (Transmission Control Protocol/ Internet Protocol).

Self-Check Exercise

1) Describe the type of media access used by Ethernet.
2) Describe the type of media access used by Token Ring.
3) Describe unicast, multicast, and broadcast transmissions.

4) What is the difference between a modem and an ISDN terminal adapter?

.....

.....

.....

.....

.....

.....

1.5 SUMMARY

The physical layer is the basis of all networks. Signals travel from transmitter to receiver via a path. This path called the medium can be guided or unguided. The principal guided media are twisted pair, coaxial cable and fiber optics. The choices for cable is affected by the network card, cable layout, possibility of electromagnetic interference and of course the budget.

Unguided media include radio, microwaves, infrared, and lasers through air. In LANs there is less emphasis on error recovery and flow control and there are differences in protocol layering arising from differences in topology. The IEEE 802 and CCITT x.25 define standards of LAN and WAN respectively. Optical Networking is the future, fast replacing the traditional media of communications. Internet, Intranet and e-commerce applications are the key factors driving the growth of networks subsequently exploding the demand for high-bandwidth data services. SONET (Synchronous Optical Network)/SDH (Synchronous Digital Hierarchy) has a well-defined, multiplexing structure based on TDM (Time Division Multiplexing), which enables it to carry a very large number of fixed-rate streams with perfect isolation among them. Thus, providing a guaranteed amount of bandwidth to each customer's is relatively easy to accomplish using SONET/ SDH. Ethernet uses packet multiplexing to carry traffic from different users and will likely to be implement than SONET?SDH.

1.6 ANSWERS TO SELF CHECK EXERCISES

1) Ethernet uses carrier sense multiple access collision detect (CSMA/CD). Each network station listens before and after transmitting data. If a collision is detected, both stations wait a random time before trying to resend.

2) Token Ring passes a special type of packet called a token around the network. If a network device has data to send, it must wait until it has the token to send it. After the data has been sent, the token is released back on the network.

3) A unicast is a transmission from one source to one destination. A multicast is a transmission from one source to many stations that register to receive the traffic. A broadcast is a transmission from one source to every station on the local network segment.

4) A modem converts digital signals into analogue for transmission and vice versa for reception over a telephone line. Because ISDN circuits are digital, the conversion from digital to analogue is not required.

1.7 KEYWORDS

Attenuation : Reduction of signal magnitude or signal loss, usually expressed in decibels.

Bandwidth : Information-carrying capacity of communication channel. Analogue bandwidth is the range of signal frequencies that can be transmitted by a communication channel or network.

Bits per second (bit/s) : The number of bits passing a point every second. The transmission rate for digital transmission.

Broadband : Service requiring over 2 Mbit/s transport capacity.

1.8 REFERENCES AND FURTHER READING

Andrew S. Tanenbaum(1996). *Computer Networks.* New Delhi: Prentice Hall.

Gilbert Held (1998). *Data Communications Networking Devices.* New Delhi: Wiley.

Miller, M. A. (1991). *Internetworking: A Guide to Network Communications LAN to LAN; LAN to WAN*. New York: M&T Books.

Radia Perlman (1999). *Interconnections, Bridges, Routers, Switches, and Internetworking Protocols.* Addison Wesley.

Vineet Joshi: *Networking and Cabling, Information Today,* October, 1998.

William Stallings (1997) *"Data and Computer Communications"*, New Delhi: Prentice Hall of India.

http://williamstallings.com/DCC6e.html

http://www.csc.uvic.ca/~csc450/slides.html