KEY ELEMENTS

OF

COMPUTER NETWORK

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Unit - 3

Network Hardware

3.1 Introduction to Guided Transmission Media-Twisted Pair, Coaxial cable, Optical Fiber

3.2 Wireless transmission-Radio waves, microwaves, infrared waves, Satellite Communication.

3.3 Networking devices (repeater, hub, switch, router, bridge, modem)

3.1 INTRODUCTION TO GUIDED TRANSMISSION MEDIA-TWISTED PAIR, COAXIAL CABLE, OPTICAL FIBER

INTRODUCTION TO GUIDED TRANSMISSION MEDIA

Transmission media is a communication channel that carries the information from the sender to the receiver. Data is transmitted through the electromagnetic signals.

The main functionality of the transmission media is to carry the information in the form of bits through LAN(Local Area Network).

Each type of transmission media has special characteristics that make it suitable for specific type of service. Each media type should be discussed keeping the following factors in the mind:

- Cost
- Capacity (bandwidth)
- Ease of installation
- Attenuation
- Immunity from electromagnetic interference (EMI)

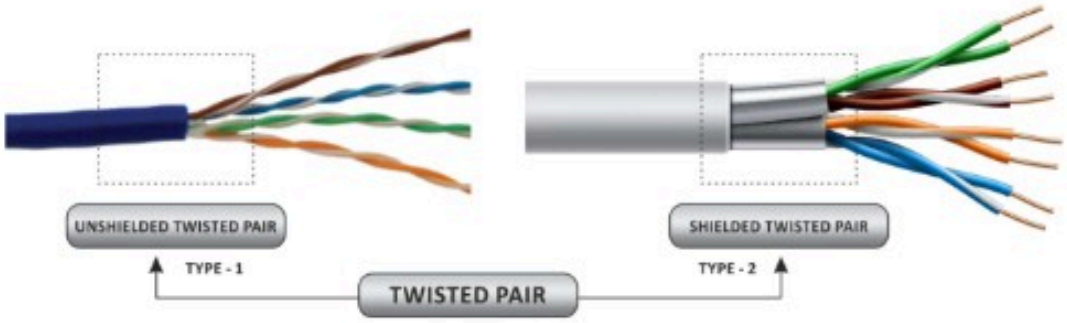
TWISTED PAIR

Although the bandwidth characteristics of magnetic tapes are excellent, the delay characteristics are poor. Transmission time is measured in minutes or hours, not milliseconds. For many applications an online connection is needed. The oldest and still most common transmission medium is twisted pair, which employs copper cable. One more reason for popularity of twisted pair is low cost. This type of cable is inexpensive to install and offers the lowest cost per foot of-any cable type.

A basic twisted pair cable consists of two strands of copper wire twisted together, as shown below. This twisting reduces the sensitivity of the cable to EMI and also reduces the tendency of the cable to radiate radio frequency noise that interferes with nearby cables and electronic components. This is because the radiated signals from the twisted wires tens to cancel each other out. Antennas, which are purposely designed to radiate radio frequency signals, consist of parallel, not twisted wires)

Twisting also controls the tendency of the wires in the pair to cause EMI each other. Whenever two wires are in close proximity, the signals in each wire tend to produce noise, called crosstalk, in the other. Twisting the wires in the pair reduces crosstalk in much the same way that twisting reduces the tendency of the wires to radiate EMI.

Two types of twisted-pair cable are used in LANs :



3.2 TWISTED SHIELDED AND UNSHIELDED CABLE

- Shielded twisted Pair
- Unshielded Twisted Pair

SHIELDED TWISTED-PAIR (STP) CABLE:

Shielded twisted-pair cabling consists of one or more twisted pairs of cables enclosed in a foil wrap and woven copper shielding as shown above. Diagram shows IBM type 1 cabling, the first cable type used with IBM token Ring. Early LAN designers used shielded twisted-pair cable because shield further reduces the tendency of the cable to radiate EMI and thus reduces the cable's sensitivity to outside interference.

Co-axial and STP cable used shields for the same purpose. The shield is connected to the ground is a portion of the electronic device to which the cable is connected. A ground is a portion of the device that serves as an electrical reference point. Usually it literally connected to a metal stake driven into the ground. A property grounded shield prevents signals from getting in to or of the cable.

In IBM Type 1 cable include twisted pairs of wire within a single shield Various types of STP cable exist. Some shield each pair individually, and others shield several pairs. The engineers who design a network's cabling system choose the exact configuration. IBM design, and each several twisted pair cable types to use with their Token ring network design, and each cable type is appropriate for a given kind of installation.

STP cables cost more than thin coaxial or unshielded twisted pair cable. STP is less costly, than thick coax or fiber-optic cable.

CAPACITY:

STP cable has a theoretical capacity of 500 Mbps, although few implementations exceed 153 Mbps with 100 meters cable runs. The most common data rate for STP cable is 16 Mbps, which is the top data rate for token Ring networks.

ATTENUATION:

All varieties of twisted-pair cable have attenuation characteristics that limit the length pf cable runs to a few hundred teeters, although a 100-flfteter limit is most common.

EMI CHARACTERISTICS

The shield in STP cable results in good EMI characteristic for copper cable, comparable to the EMI characteristic of coaxial cable. This is one reason STP might be preferred to unshielded twisted-pair cable in some situations. As with all copper cables. STP is sensitive to interference and vulnerable to electronic eavesdropping.

ADVANTAGES:

- Better performance at a higher data rate in comparison to UTP
- Eliminates crosstalk
- Comparatively faster

DISADVANTAGES:

- Comparatively difficult to install and manufacture
- More expensive
- Bulky

3.3 SHIELDED TWISTED-PAIR (UTP) CABLE

UNSHIELDED TWISTED-PAIR (UTP) CABLE

Unshielded Twisted-pair cable does not incorporate a braided shield into its structure; however, the characteristics of UTP are similar in many ways to STP, differing primarily in attenuation and EMI. As shown in figure, several Twisted-pairs can be bundled in a single cable. These pairs typically are colour-coded to distinguish them.

Telephone systems commonly use UTP cabling. Network engineers can sometime use existing UTP telephone cabling (if it is new enough and of high-enough quality to support network communications) for network cabling.

UTP cable is a latecomer to high-performance LANs because engineers only recently solved the problems of managing radiated noise and susceptibility to EMI. However, a clear trend toward UTP is in operation, and all new copper based cabling schemes are based on UTP.

UTP cable is available in the following five grades, or categories :

- Categories 1 and 2 - These voice-grade cables are suitable only for voice and for low rates (below 4 mbps). Category 1 was once the standard voice-grade cable for telephone systems. The growing need for data-ready cabling systems, however, has caused Categories 1 and 2 cables to be supplanted by category 3 for new installation.
- Category 3 - As the tower data-grade cable, this type of cable generally is suited for data rates 10 mbps. Some innovative schemes, however, let the cable support data rates up to 100 mbps. Category 3, which uses four twisted pairs with three twists per foot, is now the standard cable used for most telephone installations.
- Category 4 - This data grade cable, which consist of four twisted pairs, is suitable for data rates up to 16 Mbps.
- Category 5 - this data grade cable, which also consist of four twisted pairs, is suitable for data range up to 100 mbps. Most new cabling systems; for 100 Mbps data rates designed around Category 5 cable.

DTP cable offers an excellent balance of cost and performance characteristics, a discussed in the following sections.

3.4 UNSHIELDED TWISTED-PAIR (UTP) CABLE

COST

UTP cable is the least costly of any cable type, although properly installed Category 5 tends to be fairly expensive. In some cases existing cable in buildings can be used for LANs, although you should verify the category of the cable and know the length of the cable in the walls. Distance limits for voice cabling are much less stringent than for data-grade cabling.

INSTALLATION

UTP cable is easy to install. Some specialized equipment might be required, but the equipment is low in cost and can be mastered with a bit of practice. Properly designed UTP cabling systems easily can be reconfigured to meet changing requirements.

As noted earlier, however, Category 5 cable has stricter installation requirements than lower categories of UTP. Special training is recommended for dealing with Category 5 UTP.

CAPACITY

The data- rates possible with UTP have increase from 1 Mbps; pat 4 and 16 Mbps, to the point where 100 Mbps data rate are now common,

ATTENUATION

UTP cable share similar attenuation characteristics with other copper cables. UTP cable runs are limited to a few hundred meters, with 100 meters as the most frequent limit.

EMI CHARACTERISTICS

Because DTP cable lacks a, shield, it is more sensitive to EMI than coaxial or STP cables. The latest technology makes it possible to use UTP in the vast majority of situation, provided that reasonable care is taken to avoid electrically noisy devices such as motors and fluorescent lights. Nevertheless, UTP might not be suitable for noisy environments such as factories. Cross talk between nearby unshielded pairs limits the maximum length of cable runs.

Connectors for UTP

The most common connector use with UTP cables is the RJ-45 connector. These connectors are easy to install on cables and are also extremely easy to connect and disconnect.

ADVANTAGES OF UTP CABLE

- Relatively inexpensive
- Easily installed, managed, and reconfigured
- Basic technology and standards are matured and stable

DISADVANTAGES OF UTP CABLE

- Only categories 5,6,7 UTP cables are capable of high-speed (> 100 Mbps) data transmission.
- Relatively high rate of attenuation
- Sensitive to EMI

COAXIAL CABLES

Coaxial cables were the first cable types used in LANs. Coaxial cable gets its name because two conductors share a common axis. The cable is most frequently referred as coax. It has better shielding than twisted pair, so it can span longer distances at higher speed two kinds of co-axial cable are widely used.

1. 50-ohm cable (Base band coaxial cables / Thinnet) is commonly used for digital transmission.

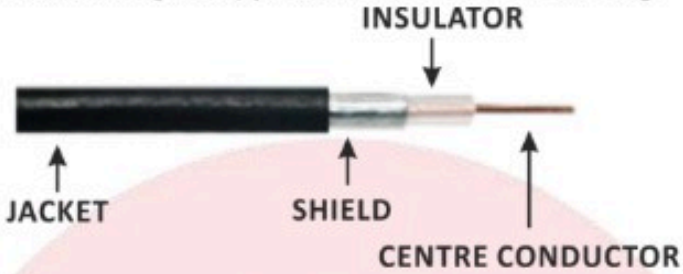
2. 75-ohm cable (Broad band coaxial cables / thicknet) is commonly used for analog transmission.

This distinction is based on historical, rather than technical, factors (e.g.- early dipole antennas had an impedance of 300 ohms, as it was easy to built 4:1 impedance matching transformers)

THE COMPONENTS OF THE CO-AXIAL CABLE ARE AS FOLLOWS:

- A central conductor, although usually solid copper wire, this sometimes is also made of standard wire.

- An outer conductor forms a tube surrounding the central conductor. This conductor can consist of braided wires, metallic foil or both. The outer conductor, frequency called the shield, servers as a ground and also protects the inner conductor from EMI.
- An insulation layer keeps the outer conductor spaced evenly from the inner conductor.
- A plastic encasement (jacket) protects the cable from damage



3.4 THE COMPONENTS OF THE CO-AXIAL CABLE

The construction and shielding of the co-axial cable give it a good combination of high bandwidth and excellent noise immunity. The possible bandwidth depends on the cable length.

TYPES OF CO-AXIAL CABLES

BASEBAND CO-AXIAL CABLES (THINNET)

This is light and flexible cabling-medium that is inexpensive and easy to install. Following table illustrate some thinnet classifications. Note that thinnet falls under the RG-58 family, which has 50 ohm impedance. Thinnet is approximately .25 inches (6 mm) in thickness.

CABLE	DESCRIPTION	IMPEDANCE
RG-59/U	Solid copper centre	50 ohm
RG-58A/U	Wire stand centre	50 ohm
RG-58C/U	Military version of RG-58 A/ U	50 ohm

Thinnet cable can reliably transmit a signal for 185 meters (about 610 feet). Although it's called 10Base2 to give the impression that it can run 200 meters, this is erroneous. It should really be called 10Base 1.85.

BROADBAND CO-AXIAL CABLES (THICKNET)

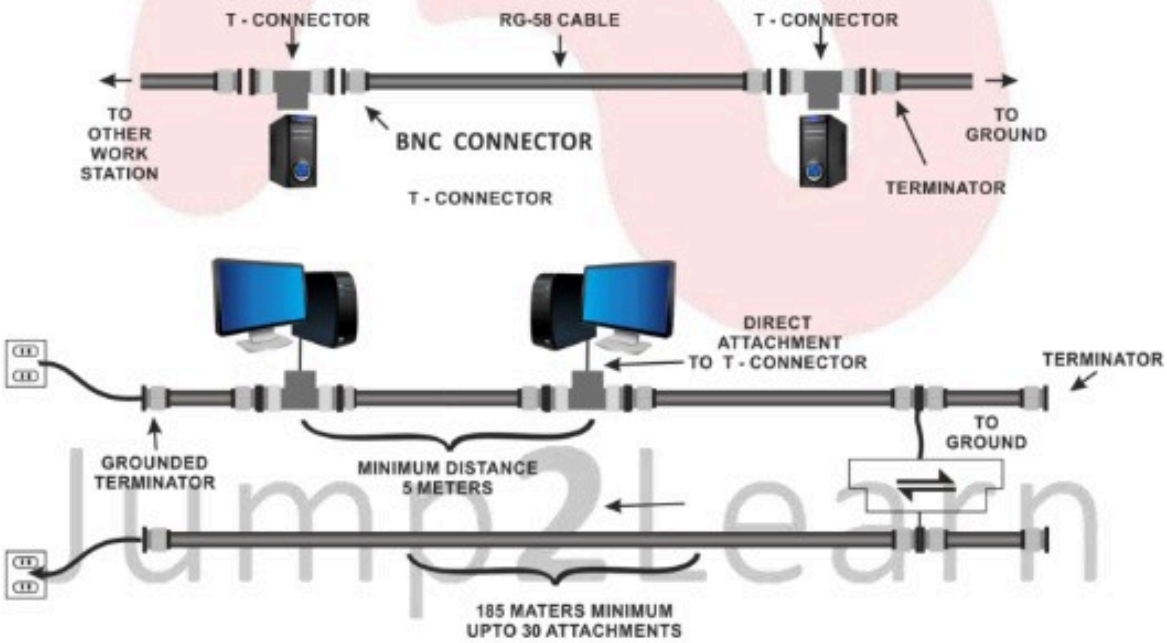
Thicknet is thicker in diameter that thinnet (approximate 0.5 inches). Because it is thicker and doesn't bend as readily as Thinnet. Thicknet cable is harder to work with. A thicker center core, however, means that Thicknet can carry more signals for a greater distance than Thinnet. Thicknet can transmit a signal approximately 500 meters (1650 feet). Thicknet cable is sometimes called Standard Ethernet (although other cabling types are also useful for Ethernet) Thicknet can be used to connect two or more small thinnet LANs into a larger network. Because of its greater size, Thicknet is also more expensive than thinnet It can be installed, safely outside, running from building to building, such as with cable TV.

CO-AXIAL CHARACTERISTICS

You should be familiar with the installation cost. Bandwidth and EMI cost, bandwidth and EMI resistance characteristics of coaxial cable.

INSTALLATION

Co-axial cable typically is installed in two configurations: daisy chain (from device to device-Ethernet) and star (ARC net)



3.5 CO-AXIAL CABLE INTALLATION

The Ethernet cabling shown in the figure is an example of Thinnet, which uses RG-58 cable. Devices are connected to the cable by means of T. connectors. Cables are used to provide connections between T-Connectors. One characteristic of this type of cabling is that a special connector, called terminator, must terminate the ends of cable run. The terminator contains a resistor that is-matched to the characteristics of the cable. The resister prevents signals that reach the end of the cable from bouncing back and causing interference.

Co-axial cable is reasonably easy to install because it is robust and difficult to damage. In addition, connectors can be installed with inexpensive tools and a bit of practice. The device -to-device cabling approach can be difficult to reconfigure, however, when new devices cannot installed near an existing cabling path.

The co-axial cable used for Thinnet fall at the low end of the cost spectrum, whereas Thicknet is among the more costly options.

BANDWIDTH

LANs that employ coaxial cable typically have a bandwidth between 8.5 mbps and 10 Mbps. Thicker co-axial cables offer higher bandwidth, and the potential bandwidth of co-axial is much higher than 10 Mbps. Current LAN technologies, however don't take advantage of take of this potential.

EMI CHARACTERISTIC

All copper media are sensitive to EMI, although the shield in coax makes the cable fairly resistant, Coaxial cables, however, do radiate a portion of their signal, and electronic eavesdropping equipment can detect this radiated signal.

CONNECTORS FOR COAXIAL CABLES

Two types of connectors are commonly used with coaxial cable. The most common is the BNC corrector mainly used for thinnet cabling. In contrast Thicknet uses N-Connectors, which Screw instead of using a twist lock.

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ADVANTAGES OF COAXIAL CABLE:

- The data can be transmitted at high speed.
- It has better shielding as compared to twisted pair cable.
- It provides higher bandwidth.

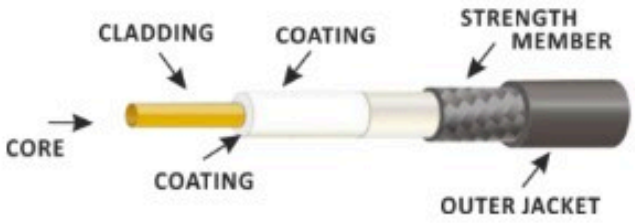
DISADVANTAGES OF COAXIAL CABLE:

- It is more expensive as compared to twisted pair cable.
- If any fault occurs in the cable causes the failure in the entire network.

FIBER-OPTIC CABLE

In almost every way, fiber-optic cable is the ideal cable for data transmission. Not only does this type of cable accommodate extremely high bandwidth's, but it also presents no problems with EMI and supports durable cables an cable runs as long as several kilometers. The two disadvantages of fiber-optic, however, are cost difficulty of installation.

The center conductor of a fiber-optic cable is a fiber that consists of highly refined glass or plastic designed to transmit light signals with little loss. A glass core supports a longer cabling distance, but a plastic core is typically easier to work with. The fiber is coated with a cladding that reflected signals back into the fiber to reduce signal loss. A plastic sheath protects the fiber.



3.6 FIBER-OPTIC CABLE

Optical fibers are much smaller and more lightweight than copper wires. Therefore, large fiber optic cables carry more conductors than similar sized copper cables. There are two types of optical fibers.

1. Multimode fiber 2. Single mode fiber

The following table shows the comparison between single mode and multimode fibers.

SR. NO	SINGLE MODE FIBER	MULTIMODE FIBER
1	High capacity Lesser	capacity than single mode
2	More costlier	Cheaper than single mode
3	Light pulses are generated by injection Laser diode (ILDs)	Light pulses are generated by light emitted diodes (LEDs)
4	Can sustain a transmission rate of 100 Mbps at distance of 20 KM	Pan sustain a transmission rate of 100 Mbps at distance of 2 KM
5	Has been, optimized to allow one light path	Has been optimized to multiple one light path

A fiber-optic network cable consists of two strands separately enclosed in plastics sheaths- one strand sends and the other receives.

Two types of cable configuration are available:

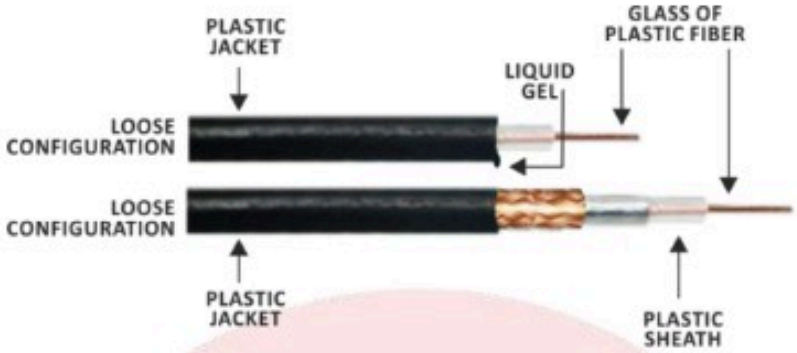
- **LOOSE CONFIGURATION**

Loose configuration incorporates a space between the fiber sheath and the outer plastic encasement; this space is filled with gel or other material.

- **TIGHT CONFIGURATION**

Tight configuration contains strength wires between the conductor and the outer plastic encasement.

In both cases, plastic encasement must supply the strength of the cable, while the get layer or strength wires protect the delicate fiber from mechanical damage.



3.8 LOOSE & TIGHT CONFIGURATION

Fiber optic cable doesn't transmit electrical signals. Instead, the data signals must be converted into light signals. Light sources include lasers and light-emitting diodes (LEDs). LEDs are inexpensive but produce a fairly poor quality of light suitable for less-stringent application. The end of the cable that receives the light signal must convert the signal back to an electrical form. Several types of solid-state components can perform this service.

One of the significant difficulties of installing fiber-optic cable arises when two cables must be joined. The small cores of the two cables (some are as small as 8.3 microns) must be lined up with extreme precision to prevent excessive signal loss.

As with all cable types, fiber-optic cable has their share of advantages and disadvantages.

COST

The cost of the cable and connector has fallen significantly in recent years. However, the electronic devices required are significantly more expensive than comparable devices for copper cable. Fiber-optic cable is also the most expensive cable type to install.

INSTALLATION

Greater skill is required to install fiber-optic cable than to install most copper cables. However, improved tools and techniques have reduced the training required. Still, fiber-optic cable requires greater care, because the cable must be treated fairly gently during installation. Every cable has a minimum bend radius, for example, and fibers are damaged if the cables are bent too sharply. It is also important not to stretch the cable during installation.

CAPACITY

Fiber-optic cable can support high data fates (as high as 200,000 Mbps), even with long cable runs. Although UTP runs cable are limited to less than 100 meters with

TOO Mbps data rates, fiber optic cable can transmit 100 Mbps signals for several kilometers.

ATTENUATION

Attenuation in fiber-optic cables is much lower than in copper cables. Fiber optic cables can carry signals for several kilometers.

EMI CHARACTERISTICS

Because fiber-optic cable doesn't use electrical signals to transmit data, they are totally immune to electromagnetic interference. These cables are also immune to a variety of electrical effects that must be taken into account when designing copper cabling systems. Because the signals in fiber-optic cable are not electrical in nature, they can't be detected by the electronic eavesdropping equipment that detects electromagnetic radiation. Therefore, fiber-optic cable is the perfect choice for high-security networks.

ADVANTAGES OF FIBER OPTIC CABLE

- Supports very high bandwidth- from 100 Mbps to >2Gbps
- Very low alteration
- Immune to EMI or eavesdropping

.DISADVANTAGES OF FIBER OPTIC CABLE

- Very expensive cables
- More complex to install
- High precision required for connections

3.2 WIRELESS TRANSMISSION-RADIO WAVES, MICROWAVES, INFRARED WAVES, SATELLITE COMMUNICATION.

WIRELESS TRANSMISSION

Our age has given rise to in formation junkies: people who need to be online all the time. For these mobile users, twisted pair, coax, and fiber optics are of no use. They need to get their hits of data for their laptop, notebook or palm top. Without being depending on the terrestrial communication infrastructure, for these users wireless communication is the answer. In this section we will look at wireless communication in general, as it has many other important applications besides providing connectivity to users who want to read their e-mail in airplanes. Technology is expanding rapidly and will continue to expand into the near future, offering more and better options for wireless networks.

Presently, you can subdivide wireless networking technology into three basic types that corresponds to three basic networking scenarios :

- **LOCAL AREA NETWORKS (LANS)**

Occasionally you will see a fully wireless LAN, but more typically, one or more wireless machines will function as members of cable-based LAN. A LAN with both wireless and cable-based components is called as hybrid.

- **EXTENDED LOCAL NETWORKS**

A wireless connection serves as a backbone between two LANs, For instance, a company with office networks in two nearby but separate buildings could connect those networks using a wireless bridge.

- **MOBILE COMPUTING**

A mobile machine connects to the home network using cellular or satellite technology.

WIRELESS NETWORKS ARE ESPECIALLY USEFUL IN THE FOLLOWING SITUATIONS :

1. Spaces where cabling would be impossible or incontinent. These includes open lobbies, inaccessible
   parts of buildings, older buildings, historical buildings where renovation is prohibited, and outdoor
   installations.
2. People who move around a lot within their work environment Network administrators, for instance,
   must trouble shoot a large office networks.
3. Temporary installations. These situations include any temporary department set up for a specific
   purpose that soon will be torn down or relocated.
4. People who travel outside of the work environment and need instantaneous access to to network
   resources.

Wireless media transmits and receives EM (electromagnetic signals without an electrical or optical conductor. Thus earth's atmosphere provides the physical data path for most wireless transmissions. Followings are some transmission Medias, which normally used for wireless transmissions.

- Radio wave
- Microwave
- Infrared light
- Satellite Communication

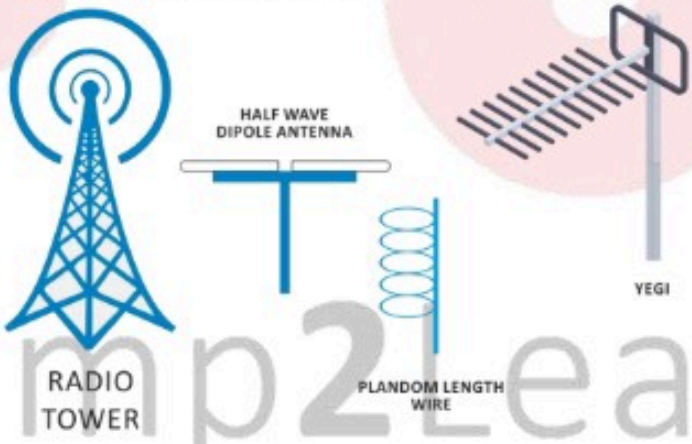
3.9 WIRELESS MEDIA

RADIO WAVE

The portion of EM spectrum between 10KHz- 1 GHz is considered as radio frequency (RE) this range of radio frequencies includes broadcast bands commonly called as

- Short-wave (SW) radio
- Very high frequency (VHP) television and FM radio.
- Ultra-High frequency (UHF) radio and TV

Radio frequencies have divided between regulated and unregulated. Users of regulated frequencies must get a license from the regulatory bodies. Error-free transmissions are impossible to guarantee in uncontrolled frequency bands. Following are the typical radio frequency equipment's:



3.10 TYPICAL RADIO FREQUENCY EQUIPMENT

TYPICAL RADIO FREQUENCY EQUIPMENT

Radio frequency waves can be broadcast in all directions. Typical antennas include omni directional towers, random length wire, half wave dipole and beam (such as yagi). Global systems use short wave, which propagates beyond the horizon and local systems are use nearly line-of-sight VHF or UHF.

FREQUENCY RANGE

Radio frequency operates within the entree RF range. Computer networks typically use the higher GHz ranges because they offer higher transmission rates.

COST

Depending upon the combination of transceiver and antenna used, radio frequency systems are moderately priced compared to other wireless media.

EASE OF INSTALLATION

Ease of installation is also dependent upon the combination of transceiver and antenna used. Most systems are easily installed with pre-configured antenna and other equipment. Low power single-frequency systems are simple to install compared to high-power, single frequency systems.

BANDWIDTH

Single frequency radio systems offer transmission rate ranging from 1 Mbps to 10Mbps. Spread spectrum radio which uses multiple frequencies simultaneously) offer transmission rates ranging from 2 to 6 Mbps.

ATTENUATION

Attenuation of all RF ranges are dependent upon frequency and power of the signal. Because low-power, single frequency devices normally operate at very low power, they usually suffer from relatively high attenuation. The, high power, single frequency devices sustain the signal and resist attenuation much better that low-power devices.

IMMUNITY FROM EMI

Single frequency signals have extremely low immunity from EMI, compared to spread spectrum. Spread spectrum resists eavesdropping.

ADVANTAGES

- No intervening ground facilities are required between stations. Directional equipment is not needed.
- Stations can be stationary or mobile; even on aircraft or marine vessels.
- Radio is accessible to users thought the world
- Radio transceivers are inexpensive.

DISADVANTAGES

- AH RF transmission devices may require frequency licensing.
- Only low bandwidths are offered (between 1 Mbps to 10 Mbps)
- Highly susceptible to external interference and jamming.
- Except spread spectrum radio, al single-frequency radio devices are susceptible to eavesdropping.

Microwave

Microwave data communication system is' exit in two forms:

- Terrestrial (earth-based) systems
- Satellite systems

Functionally both terrestrial and satellite systems use the same frequencies (in the range of 1 GHz to 300 GHz) and are similar, but the capabilities of each are somewhat different.

Terrestrial (earth-based) systems

Terrestrial, microwave typically uses directional parabolic antennas that require an unobstructed |^|h or line-of-sight to other units. Terrestrial microwave signals, commonly in the low GHz frequency ranged are generated by a transceiver. Terrestrial microwave links are often used to link separate buildings where cable installation would be troublesome or more expensive, Smaller scale terrestrial microwave may also be used within buildings.

Frequency range

Terrestrial microwave system usually operate in the low GHz range, typically between 4 to 6-GHz and 21 to 23 GHz

Costs

Equipment costs are most dependent upon the operating signal strength and frequency. Short-distance systems, used within hundreds of meters of .distance, are relatively inexpensive. Long-distance systems, used at kilometers of distance, may be quite expensive. Terrestrial microwave systems may be leased from service providers to reduce the initial fixed costs.

Ease of installation

Line-of sight systems are difficult to install because they require very exacting adjustments often made by trial error, to ensur proper alignment. Since Terrestrial microwaves typically operate in licensed frequencies, installations, require expensive and time-consuming licensing procedures.

Bandwidth

Typical data rates for a single-frequency range between 1 to 10 Mbps.

Attenuation

Attenuation varies with the signal frequency and antenna size. Higher frequency microwaves are attached more by rain and fog over long distances, but across short distances attenuation is not much.

Immunity from EMI

Microwave links are susceptible to external interference, jamming, and eavesdropping.

Advantages

- Potentially much less expensive than digging trenches etc.
- High bandwidths are possible

Disadvantages

- Require government licensing and approved equipment
- Susceptible to external interference, jamming and eavesdropping
- Installation is complex when direct line-of-sight is not available

Satellite microwave

Like Terrestrial microwave, satellite microwave systems use low GHz frequency range microwaves. However, they are beamed line-of-sight between directional parabolic antennas located on earth and geo-synchronous orbiting satellites. A basic satellite network installation includes a network connectivity device called VSAT (very small Aperture Terminal), which is attached to a parabolic antenna (popularly known as satellite disk) of 2-meter diameter approximately, by means of cable media. The dish antenna reflects signals generated by transponder to a satellite.

The beauty of satellite microwave communication is that it requires the same time and expense whether two VSAT station are away from each other, 10 or 10000 kilometers. In case of one top transmission a signal has to travel about 72000 kilometers of distance. While in case of two hop transmission, a signal has to travel about 1,44,000 kilometers of distance. Due to this long travel in space satellite transmissions are subject to propagation delay of how a second to 5 seconds. However they can provide a signal to the most remote and undeveloped areas on the globe.

Advantages

- Propagation delay and communication cost are independent of distance between sending and receiving stations.
- High bandwidths possible
- No intervening ground facilities are require between transmission points even between continents.
- Earth stations can be fixed positions or relatively mobile, even on aircraft or marine vessels.
- Satellite communication supports narrow or wide beam paths, so transmission can be relatively selected or broad-based.

Disadvantages

- Susceptible to external interference, jamming, and eavesdropping.
- Require high precision. Complex equipment's cost can be reduced by hiring services from satellite service providers.
- Propagation delay of 1 to 5 seconds

• Apart from one time installation cost, organizations may have to very high annual operation charges to the satellite service providers

Infrared Light

Infrared links are light emitting diodes (LEDs) or Injection laser diodes (ILDs) and photodiodes to exchange data between stations. Infrared signals -are not capable of penetrating walls or other opaque objects and are diluted by strong light.

This system will fail in two categories

1. Point to point
2. Broadcast

Point to point

Because infrared waves may be cheaply and easily Segregated, pure beams may be focused tightly and directed at specific targets. This strategy reduces the effects of attenuation and possibility of eavesdropping. Remote control device to operate TV is file best example of point-to-point infrared system:

Advantages

- Mass production makes interface relatively
- High transmission rates possible, but current technology support bandwidth up to 16Mbps.
- Resists eavesdropping.

Disadvantages

- Requires strict line-of-sight paths and exact positioning.
- Susceptible to high intensity light and atmospheric conditions.

Broadcast Infrared systems

A broadcast infrared system relaxes the focus of the beam to broadcast or diffuse the signal to span a wide area. This method is also commonly used with remote controls and other user devices. It is much easier to line up transceivers using this technique and receiving devices have much more flexibility to move around. One transceiver may communicate with multiple

Advantages

- Mass manufacturing makes some interface devices relatively inexpensive
- Does not require exact positioning and is ideal for locally mobile devices

Disadvantages

- Lower transmission rates than point to point infrared systems.
- Susceptible to high intensity light and atmospheric conditions.
- Highly susceptible to eavesdropping.

Satellite Communication

In general, a satellite is anything that orbit something else, as, for example, the moon orbit the earth. In a communication context, a satellite is specialized wireless receiver / transmitter that is launched by a rocket and placed in orbit around the earth. There are hundreds of satellite currently in operation. They are used for such diverse purposes as weather forecasting, television broadcast, internet communication and the Global Positioning System (GPS).

The first artificial satellite, launched by Russia(then know as Soviet Union) in the late 1950s, was about the size of a basketball. It did nothing but transmit a simple Morse code signal over and over. In contract, modern satellites can receive and re-transmit thousands of singles simultaneously, from simple digital data to the most complex television programming.

'The Satellite itself is also know as space segment. The primary role of a satellite is to reflect electronic signals. In the case of a telecom satellite, the primary task is to receive signals from a grounds station and send them down to another ground station located a considerable distance away from the first.

NEED OF SATELLITE COMMUNICATION

The following two kinds of propagation are used earlier for communication up to some distance.

- **GROUND WAVE PROPAGATION** – Ground wave propagation is suitable for frequencies up to 30MHz. This method of communication makes use of the troposphere conditions of the earth.
- **SKY WAVE PROPAGATION** – The suitable bandwidth for this type of communication is broadly between 30–40 MHz and it makes use of the ionosphere properties of the earth.

The maximum hop or the station distance is limited to 1500KM only in both ground wave propagation and sky wave propagation. Satellite communication overcomes this limitation. In this method, satellites provide communication for long **distances**, which is well beyond the line of sight.

Since the satellites locate at certain height above earth, the communication takes place between any two earth stations easily via satellite. So, it overcomes the limitation of communication between two earth stations due to earth's curvature.

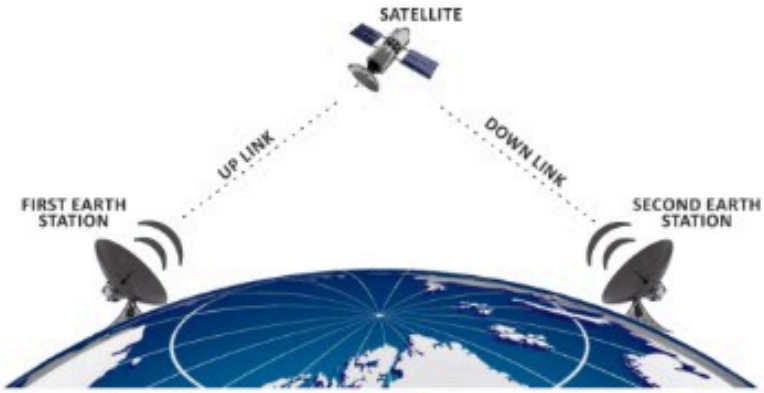
HOW A SATELLITE WORKS

A satellite is a body that moves around another body in a particular path. A communication satellite is nothing but a microwave repeater station in space. It is helpful in telecommunications, radio and television along with internet applications.

A repeater is a circuit, which increases the strength of the received signal and then transmits it. But, this repeater works as a transponder. That means, it changes the frequency band of the transmitted signal from the received one.

The frequency with which, the signal is sent into the space is called as Uplink frequency. Similarly, the frequency with which, the signal is sent by the transponder is called as Downlink frequency. The following figure illustrates this concept clearly.

The transmission of signal from first earth station to satellite through a channel is called as uplink. Similarly, the transmission of signal from satellite to second earth station through a channel is called as downlink.



3.11 SETELLITE UP AND DOWN LINK

Uplink frequency is the frequency at which, the first earth station is communicating with satellite. The satellite transponder converts this signal into another frequency and sends it down to the second earth station. This frequency is called as Downlink frequency. In similar way, second earth station can also communicate with the first one.

The process of satellite communication begins at an earth station. Here, an installation is designed to transmit and receive signals from a satellite in an orbit around the earth. Earth stations send the information to satellites in the form of high powered, high frequency (GHz range) signals.

The satellites receive and retransmit the signals back to earth where they are received by other earth stations in the coverage area of the satellite. Satellite's footprint is the area which receives a signal of useful strength from the satellite.

ADVANTAGES AND DISADVANTAGES OF SATELLITE COMMUNICATION

In this section, let us have a look at the advantages and disadvantages of satellite communication.

FOLLOWING ARE THE ADVANTAGES OF USING SATELLITE COMMUNICATION:

- Area of coverage is more than that of terrestrial systems
- Each and every corner of the earth can be covered
- Transmission cost is independent of coverage area
- More bandwidth and broadcasting possibilities

FOLLOWING ARE THE DISADVANTAGES OF USING SATELLITE COMMUNICATION –

- Launching of satellites into orbits is a costly process.
- Propagation delay of satellite systems is more than that of conventional terrestrial systems.

- Difficult to provide repairing activities if any problem occurs in a satellite system.
- Free space loss is more
- There can be congestion of frequencies.

3.3 NETWORKING DEVICES (REPEATER, HUB, SWITCH, ROUTER, BRIDGE, MODEM)

NETWORKING DEVICES

The interfaces and devises that are used to connect computing devices and transmission media are called connectivity hardware or network connectivity devices.

Network connectivity hardware connects individual devices and transmission media are called connectivity hardware or network connectivity devices".

Network connectivity hardware connects individual devices to a single network, for example a PC or printer would use network connectivity devices to connect to UTP or some other that we are going to study in particular section of your book.

- Repeaters
- Hubs
- Bridges
- Switches
- Routers
- Modem

REPEATERS

- The repeater also called a regenerator.
- It is an electromagnetic device that simply regenerates a signal.
- A repeater is a simplest low level device.
- It works at physical layer of OSI reference mode
- They are often used if a few network stations are located far from the rest of the network.
- A repeater installed on a link, receive the signal before it becomes too week of or corrupted, regenerates the origin at big pattern and put the refreshed copy back on to the link.
- A repeater allows us to extended only physical length of network.
- The repeater does not change the functionality of the networks in anyway.

HOW IT WORKS?

- A repeater just forward bits from one network to another, making two networks logically like one network.

- They are passive in nature, do not look at or alter the content of the packet flowing across the wire. That is, repeater are dumb, they just copy bits blindly without understanding what they are doing.
- Signals travels across physical wire. After traveling some distance, they become weak or get corrupted.
- A repeater receive corrupted and weak signal and regenerate it.
- For ex, if station A sends a frame to station b, all station will receive the frame just as they would without repeater.
- The repeater does not have the intelligence to keep the frame from passing to the right side when actual station on the left side.
- The difference is that with repeater station C and D receive a truer copy of the frame.

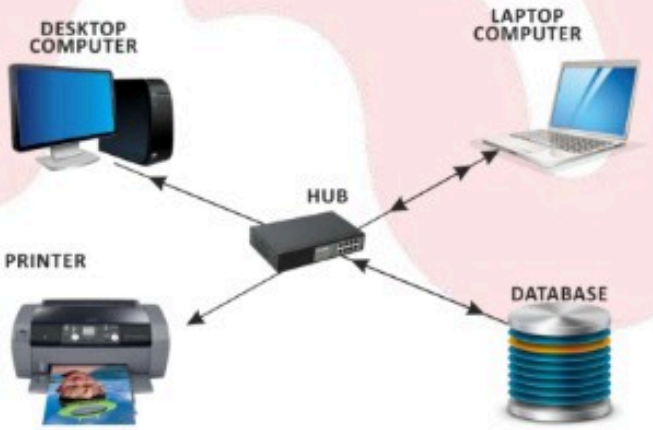
3.12 REPEATER

ADVANTAGES AND DISADVANTAGES OF REPEATERS

ADVANTAGES	DISADVANTAGES
Allow you to extend the network over large distances	Have no knowledge of addressing or data types.
Do not affect the speed of network	Can't ease network congestion problems
Can connect network segments of different media.	Limit the number of repeaters that can be used.

Hubs

- It is physical layer device. It is the simplest network device so, it has low cost.
- It serves central connection point fro several network devices. Hub is nothing more than a multiport repeater.
- A hub repeats what it receives one port to all other ports. They do not alter or look at the contents of the packet traveling across the wire.
- Hub joins two or more twisted pair cables. It provide from 8 to 24 twisted pair connection depending on the manufacturer and the model of the hub.
- A hub is a medium used to collect signals from the input lines and redistribute them in various available wiring around a topology.
- Hub is basically act as a signal splitters, it accept signal through it input port and outputs it to the outputs ports.
- Some hubs help in regenerating the weak signals before, sending them to the intended output lines. Generally hubs are used more commonly, where star topology used



3.13 HUB WORKING

CLASSIFICATION OF HUB

- There are many types of hub with various features or specifications, which provide the type of functionality you need in building networks.
- There are 3 main types of Hub.
  1. Active Hub
  2. Passive Hub
  3. Intelligence Hub

1. ACTIVE HUB

- Active hub is a type of hub that takes active participation in data communication within the network
- Active hub come with carious features such as receiving the signal from the input port and storing it for sometimes before forwarding it.
- Some hub comes with a feature that helps in transmitting data that has high priority before the data that has lower priority before the data that has lower priority.
- Some hubs help in synchronizing data communication by retransmitting the packet.
- Active hubs come with a feature that rectifying the feature before forwarding it in the LAN or in a network.

2. PASSIVE HUB

- Passive hub does not provide any additional feature accept working just as n interface between the topology
- These types of hubs do not help in rectifying on enhancing the which they pass on the network.
- It is very hard to get from the passive hub while troubleshooting in case if there is any fault in the hardware on in the network.
- It does not regenerate the received signal before forwarding.

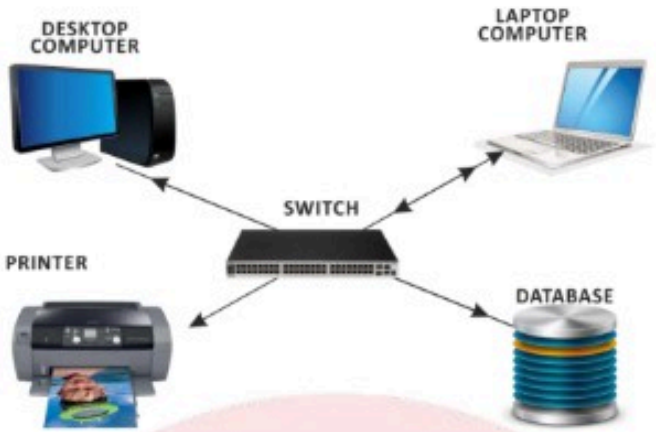
3. INTELLIGENCE HUB

- Intelligence hub adds some more feature to provide by the active hub. It also provides some feature, which help in managing he network resource effectively and efficiently.
- Intelligent hub helps in improving the performance of network and LAN.
- Intelligent hub has feature that helps in determining the exact cause and exact place of the fault, which save lot of time and energy.
- It helps in controlling and minimizing data traffic in the network.
- Intelligent hub also helps in managing the data communication within the network by recognized the slower device automatically and helps them to transmit the data with their own speed.

HOW IT WORKS ?

- When a hub received data from one of the connected devices. It passes data to all other ports without checking for the destination device except the port through which it receives the data.

SWITCHES



3.14 SWITCH WORKING

- A switch is a device that provides bridging functionality with greater efficiency. A switch may act as a multiport bridge to connect devices or segment in LAN.
- The switch normally has a buffer for each network or link to which it is connected.
- When it receives a packet, it stored the packet in the buffer of the receiving link and checks the address to find the out going link (Destination station)
- If the out going link is free, the switch sends the frame to that particular link.
- Switches are smart hubs that send data directly to the destination rather than everywhere within a network.
- Switches are easy to install. Switches can connect different network types or a network of the same types.
- A switch is available in 8,16,24 and 48 ports.
- It operates in data link layer of the OSI reference model.
- There are 2 types of switches
  1. Store and forward switches
  2. Cut through switches

1. STORE AND FORWARD SWITCHES

- Examine the entire packet. Each in coming packet in buffered that examine.
- Filters out any bad packets if it detect.
- Good packets are forwarded to the correct segment
- It detects more errors than cut through variety

2. CUT THROUGH SWITCHES

- Only the first few bytes of the packets are read to obtain the source and destination address.
- The packets are than passed through the destination segment without checking the rest of the packet errors.
- Invalid packet can still be passed on to other segment.
- This kind of switching allows the switch to begin forwarding the frame when enough of the frame is received to make forwarding decision.

- Switches construct a reference table of the computers connected to them and then send data only to correct computers.
- This limits unnecessary traffic on the network

HOW SWITCHES WORKS ?

- In above figure B a frame arrives at port 2 and is stored in the buffer. The CPU and the control unit, using the information in the frame, consult the switching table to the output port.
- The frame is than send to port 5 for transmission.

ADVANTAGES OF SWITCHES

- Isolate traffic
- Separate collision domains
- Reducing collision

DISADVANTAGES OF SWITCHES

- Currently its price is 3 to 5 times more than price of the hub.
- Packet processing time is longer than in a hub.
- Monitoring the network is more complicated.

ROUTER

- Repeaters and bridges are simple hardware devices which are capable of executing specific task.
- Routers are more sophisticated.
- Router checks the destination address of the received packet.
- Depending on the destination, router selects the best route the packet from its routing table.
- Router operates at network layer of OSI reference model.
- It forwards packets based on the network id.
- Router act like specialized computer.

3.15 ROUTER WORKS

HOW ROUTER WORKS?

- Router maintain routing table.
- Routing table contains information of network id to know how to get to that network.
- Router makes the decision based on the routing table.
- Above figure shows a possible internetwork of five networks.
- A packet sent from a station on one network to a station on another network.

- It first goes to the jointly held router, which switches it over to the destination network.
- It there is no one router connected to both, the sending and receiving networks, the sending routers transfer the packet across one of its connected networks to the next router in the direction of the destination.
- That router forwards the packet to the next router on the path and so on, until the destination reached.

TYPES OF ROUTER

- There are two types of router
  a. Static Router
  b. Dynamic Router

a. STATIC ROUTER

- It enables the network administrator to enter the route information manually in th following routing table
- This process is very time consuming.

b. DYNAMIC ROUTER

- It updates the routing table automatically according to the changes in network topology and information received from other router.

ADVANTAGES OF ROUTER

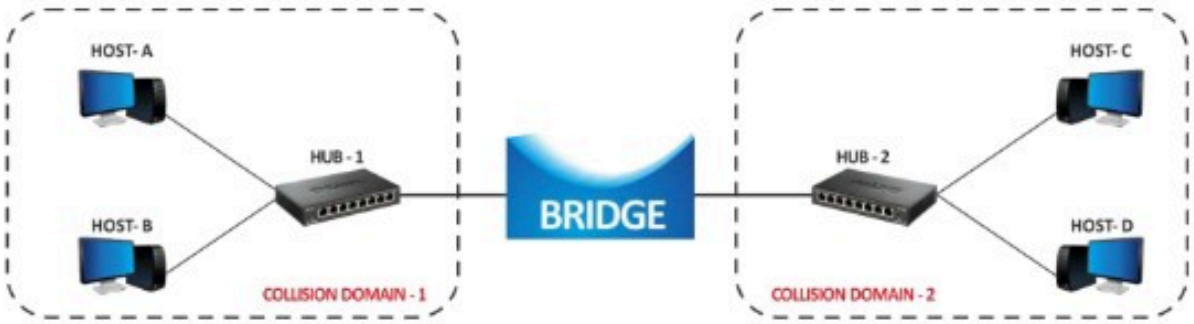
- Transfer data to the destination node by selecting the best path.
- Connect different type of networks.
- Share information with other router in the network.
- Contains routing table that keep track of the routes to the network.

DISADVANTAGES OF ROUTER

- More expensive than bridges and routers
- Operates slowly than bridges and repeaters

BRIDGE

- Bridge operates at the data link layer of the OSI reference model.
- A bridge is sometimes combining with router in a product called Brouter.
- The main idea of using a bridge is to divide a big network into smaller sub network called segment.
- It logically separates a single network in to two segments of the network to which the destination station attached. It will not pass to the other segment.
- Bridges can connect dissimilar network type, For ex, token ring and Ethernet.
- It the bridges operate at the lower layer,the bridge can connect only similar network types. For ex, token ring and Ethernet to Ethernet.



3.16 BRINGE OPERATION

HOW BRIDGES WORK?

1. **How it reduce the traffic?**

- If you have a group of workstation that constantly exchange data on the same network segment. As a group of workstation that do not use the network much, the busy group will slow down the performance of the network for the other users.
- If you put the bridge to separate two groups, only traffic destined for a workstation on the other side of the bridge will pass to that side only. All the other traffic stays local.
- A bride access the physical addresses of all the stations connected to it. When a frame enters a bridge, the bridge not only regenerates the signal but also checks the address of the destination and forward the new copy only to the segment to which the address Belongs.
- As a bridge encounter packet, it reads the address contained in the frame and compares that address with a table station on both segment. When it find the match, it discovers to which segment the station belongs and relays the packet only to that segment.
- For ex, two segments join by a bridge in above figure a packet from station A address to station D arrives at the bridge. The station D therefore a packet Is blocked from crossing in to the lower segment. If a packet from station A address to the station G, the bridge allow the packet to cross and relates it entire lower segment.

TYPES OF BRIDGE

- There are several types of bridge:

1. Simple bridge
2. Multiport bridge
3. Transport bridge
4. Source Routing bridge

1. SIMPLE BRIDGE

- Simple bridges are least expensive type of bridge.
- A simple bridge links two segments and contains a table that least the addresses of all the station included in each of them.
- In this type of bridge addresses must be entered manually

2.MULTIPORT BRIDGE

- A multiport bridge can because to connect more then two LANs.
- Each bridge holding the physical addresses of stations reachable through the corresponding port.

3.TRANSPORT BRIDGE

- A bridge is called transport Bridge if it is invisible to other devices on the network.
- When transport is first install, it's table is empty.
- Transport bridge only blocks or forwards frame, If address is not found in the forwarding table, the frame is flooded to all the ports of the bridge.

4.SOURCE ROUTING BRIDGE

- it is found in a token ring environment
- Source routing bridge provides an alternative to transport bridge.

ADVANTAGES OF BRIDGE

- In case the number of attached workstations and network segment.
- By sub dividing the LAN into smaller segment, overall reliability ios increased and the network becomes easier to maintain.
- Help to localize network traffic by only forwarding data on to other segment as required.

DISADVANTAGES OF BRIDGE

- Bridges may overload during periods of high traffic.
- In complex networks data may be sent over redundant path and the shortest path is not always taken.

MODEM (MODULATOR/ DEMODULATOR)

Modem converts your computer digital signal to an analog transmission signal to use with telephone tines or microwave transceivers. Modem is necessary because telephone lines and microwave media uses electromagnetic waves, but your computer uses electric pulses. Modems are also useful when the signal from the transceiver is hot powerful enough to travel a required, distance without significant loss of data, modems can be used to amplify signals.