

Transmission Media

The physical path between transmitter and receiver.

- **Repeaters or amplifiers** may be used to extend the length of the medium.
- Communication of electromagnetic waves is *guided* or *unguided*.

Data Transmission Channel

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graph TD; A[Data Transmission Channel] --> B[Guided Channels]; A --> C[Unguided Channels]; B --> D[Twisted pair cable]; B --> E[Coaxial Cable]; B --> F[Optical Fibre]; C --> G[Radio waves]; C --> H[Micro waves]; C --> I[Infrared];
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Guided Channels

Twisted pair cable

Coaxial Cable

Optical Fibre

Unguided Channels

Radio waves

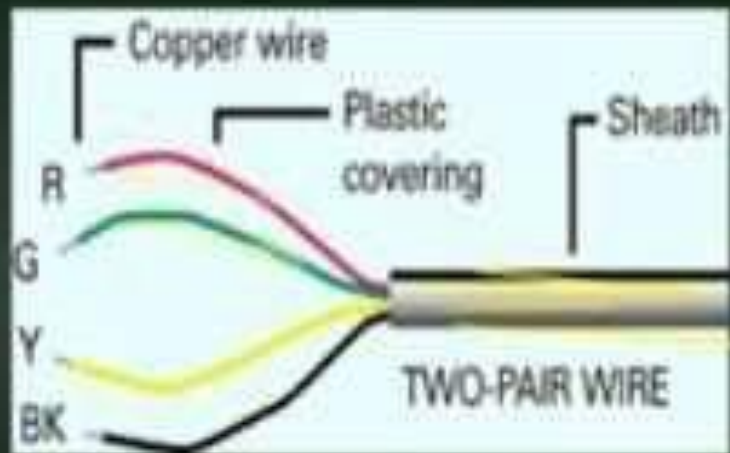
Micro waves

Infrared

Guided Media

- Guided media **provide a physical connection** using wire or cable between two devices.
- A signal traveling through guided media is **directed and contained within the physical limits of the medium**

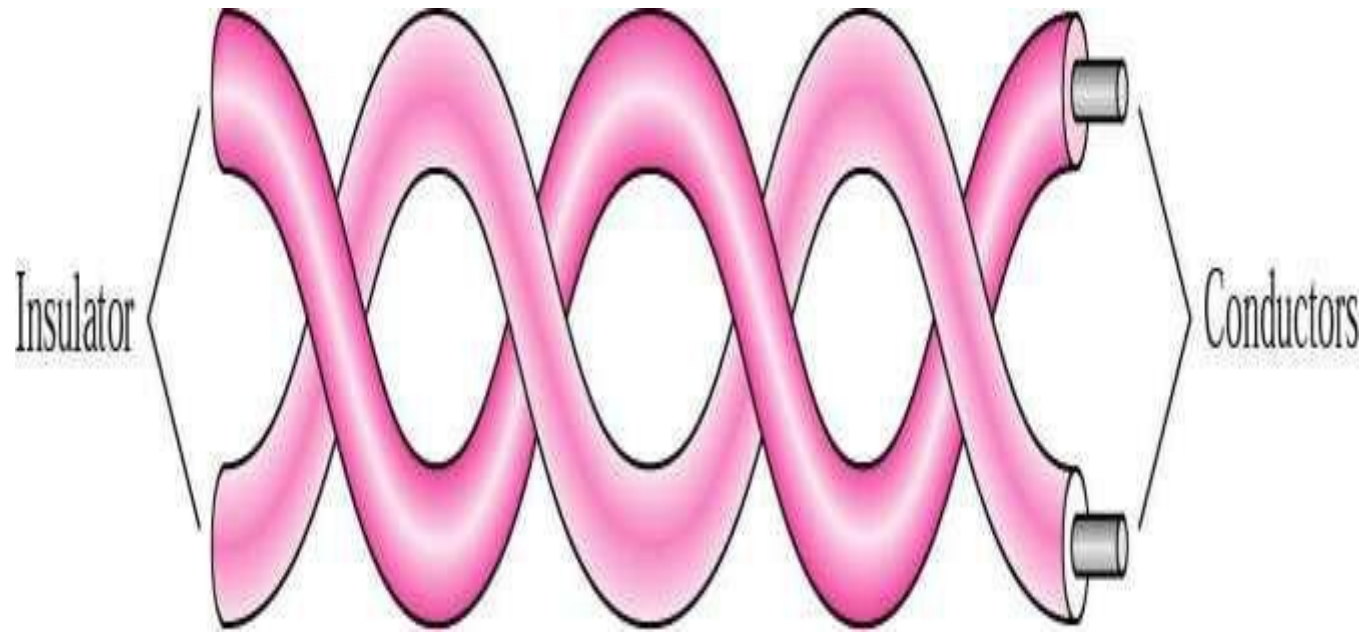
Twisted pair cable

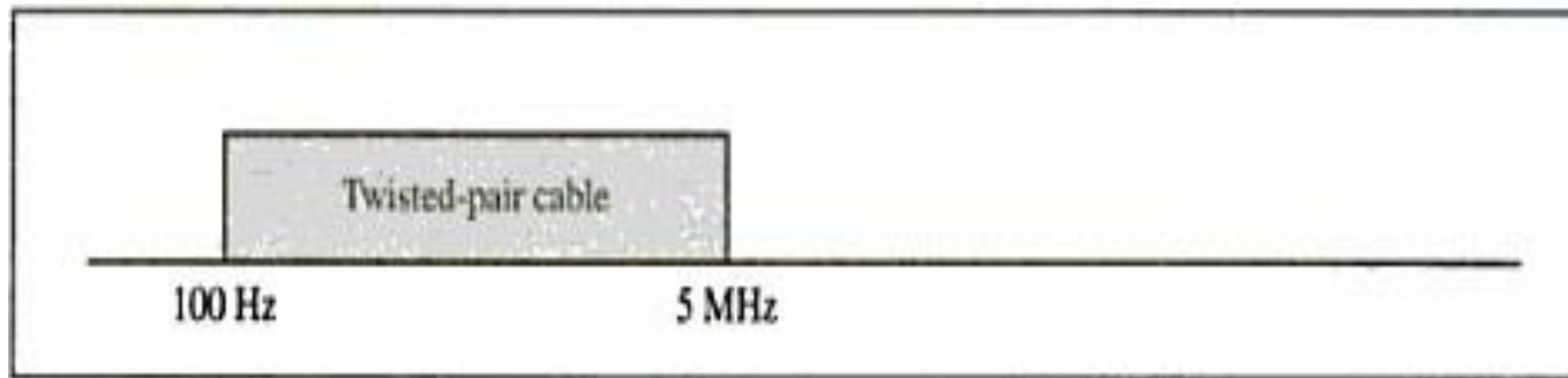
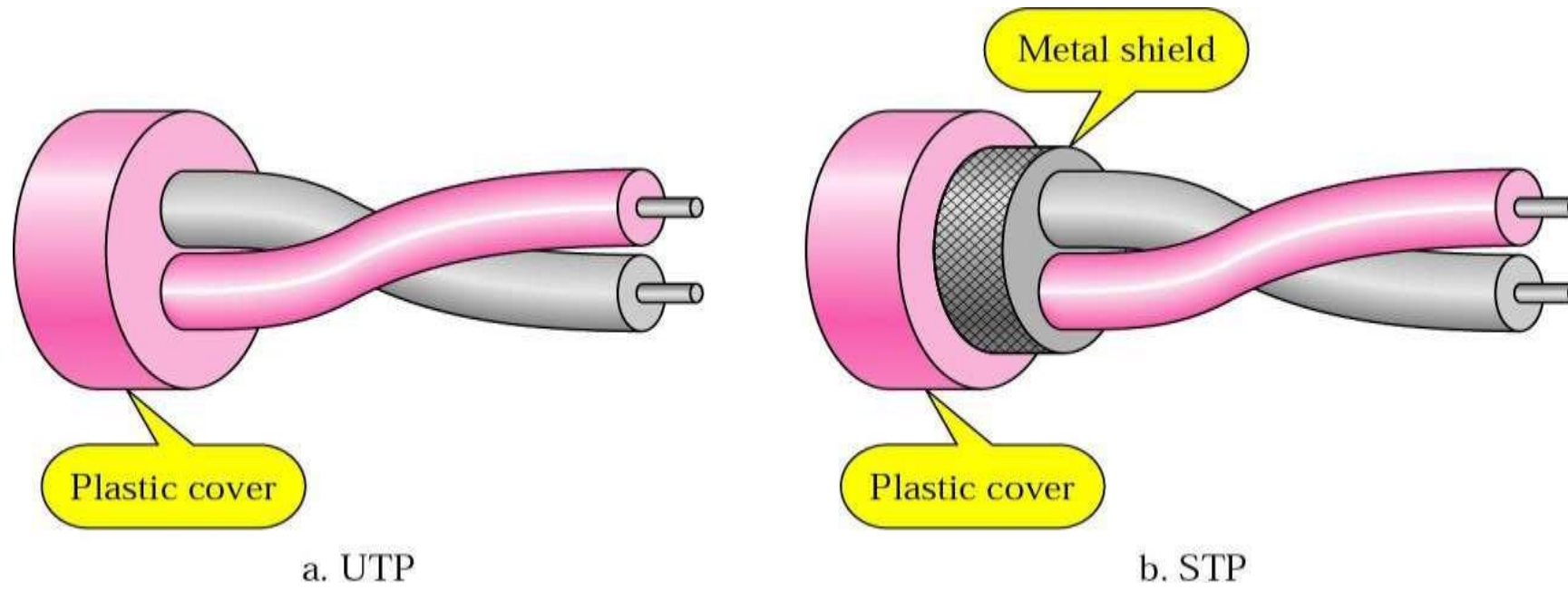


- This cable is the most commonly used and is **cheaper** than others.
- It is **lightweight, cheap, can be installed easily**, and they support **many different types of network**.
- A twisted pair cable **consists of two conductors** which are normally **made of copper**.
- Each conductor has its **own plastic insulation typically 1 mm thick**.
- These cables are twisted together.



Twisted-pair cable





Unshielded Twisted Pair Cable

- It is the most common type of telecommunication which consists of two conductors usually copper, each with its own colour plastic insulator.
- Identification is the reason behind coloured plastic insulation.
- UTP cables consist of 2 or 4 pairs of twisted cable. Cable with 2 pair use RJ-11 connector and 4 pair cable use RJ-45 connector.

RJ 11 Connector (phone)



RJ 45 Connector (ethernet)

Advantages :

Installation is easy

Flexible

Cheap

It has high speed capacity,

100 meter limit

Higher grades of UTP are used in LAN technologies like Ethernet

Disadvantages :

- Bandwidth is low when compared with Coaxial Cable
- Provides less protection from interference.

Shielded Twisted Pair Cable

- This cable has a metal foil or braided-mesh covering which encases each pair of insulated conductors.



- Electromagnetic noise penetration is prevented by metal casing.
- Shielding also eliminates crosstalk
- It is faster than unshielded and coaxial cable.
- It is more expensive than coaxial and unshielded twisted pair.

Advantages :

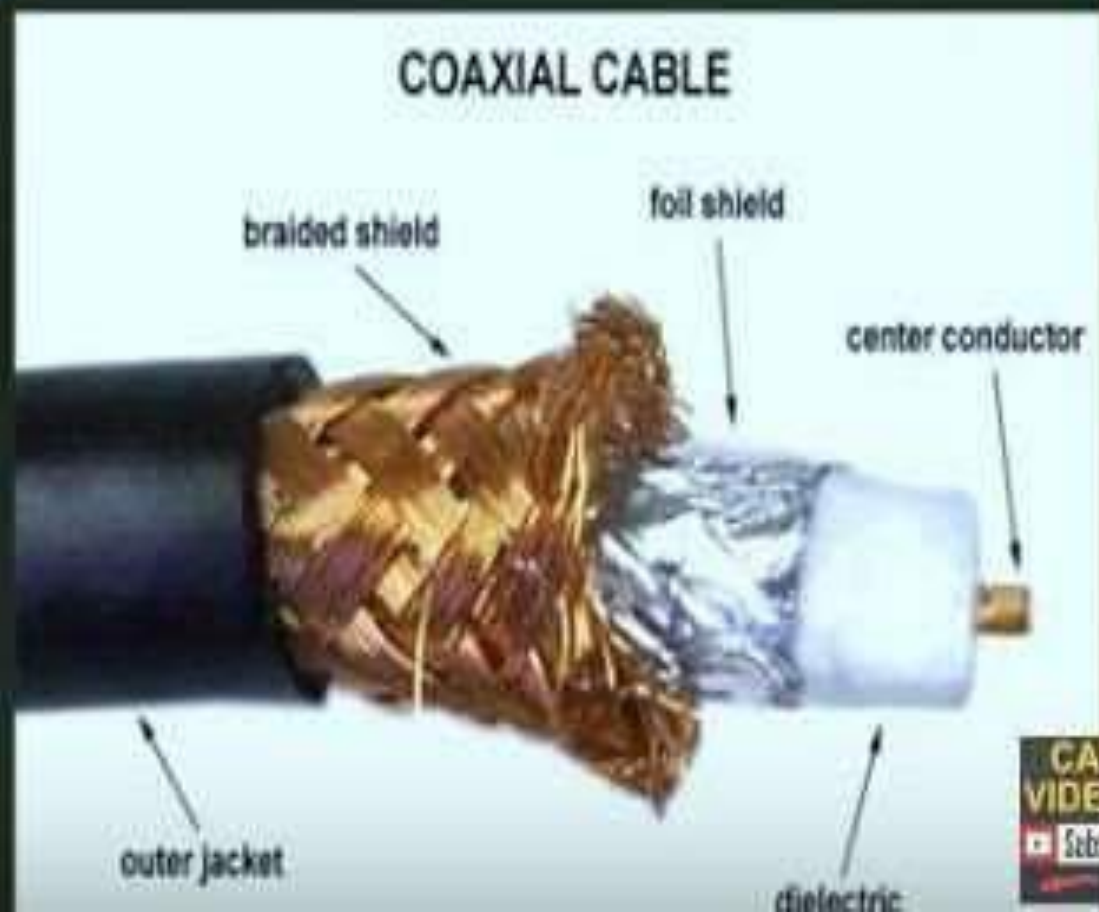
- | | |
|--|--|
| • Easy to install | • Increases the signalling rate |
| • Performance is adequate | • Higher capacity than unshielded twisted pair |
| • Can be used for Analog or Digital transmission | • Eliminates crosstalk |

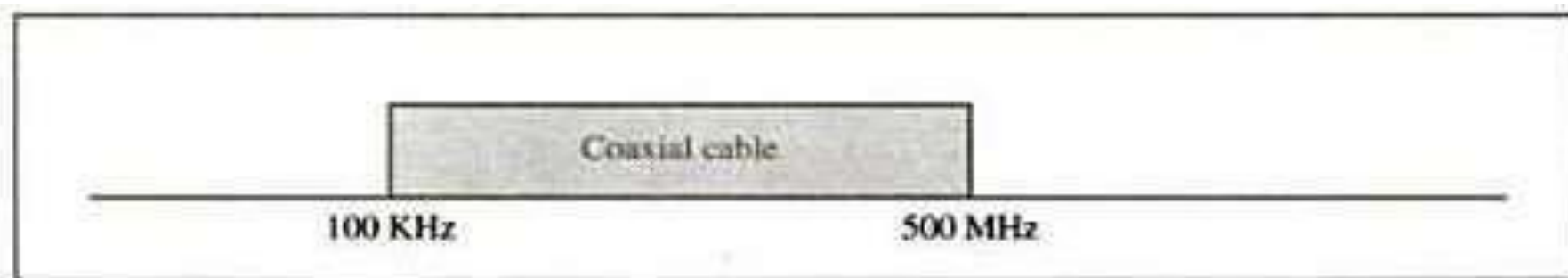
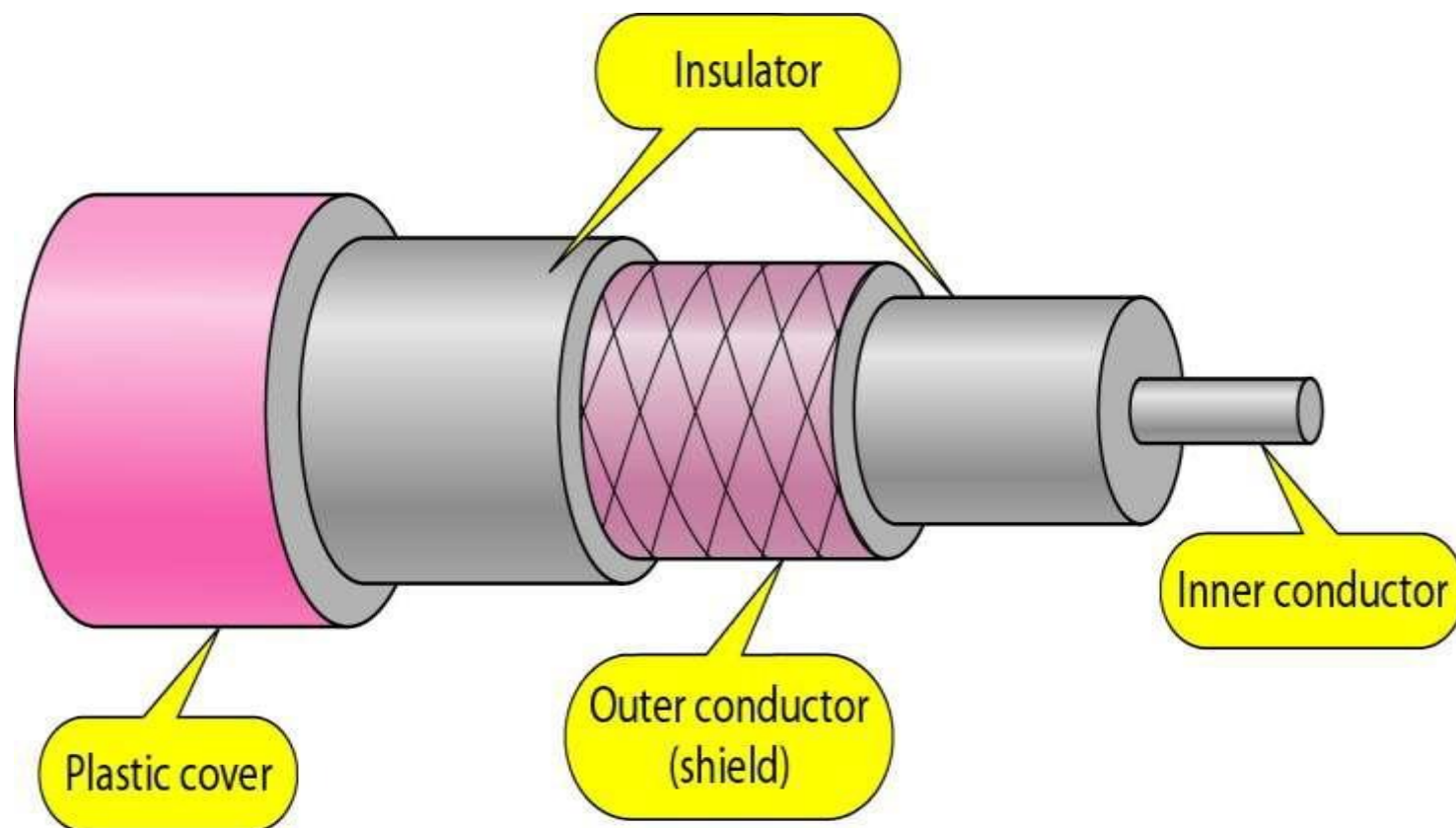
Disadvantages :

- Difficult to manufacture
- Heavy

Coaxial Cable

- Copper is used in this as centre conductor which can be a solid wire or a standard one.
- It is surrounded by PVC installation, a sheath which is encased in an



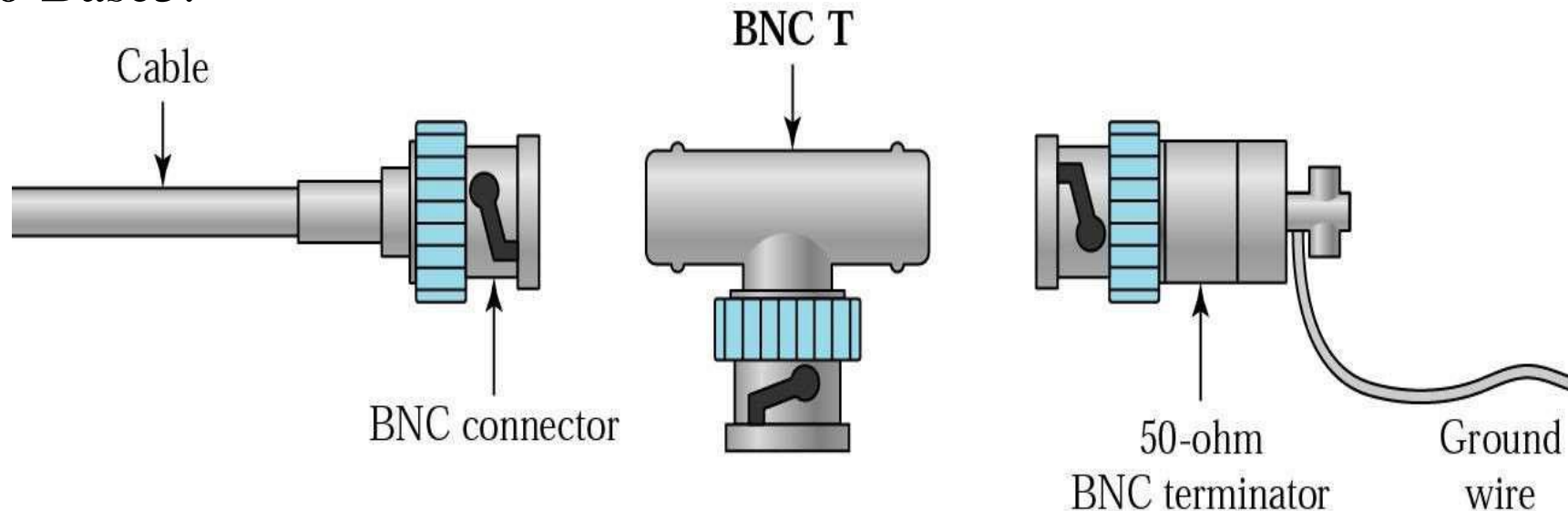


BNC connectors

- To connect coaxial cable to devices, it is necessary to use coaxial connectors. The most common type of connector is the Bayone-Neill- Concelman, or BNC, connectors.

There are three types: the BNC connector, the BNC T connector, the BNC terminator.

Applications include cable TV networks, and some traditional Ethernet LANs like 10Base-2, or 10-Base5.



outer conductor of metal foil, braid or both.

- Outer metallic wrapping is used as a shield against noise and as the second conductor which completes the circuit.
- The outer conductor is also encased in an insulating sheath.
- The outermost part is the plastic cover which protects the whole cable.

Advantages :

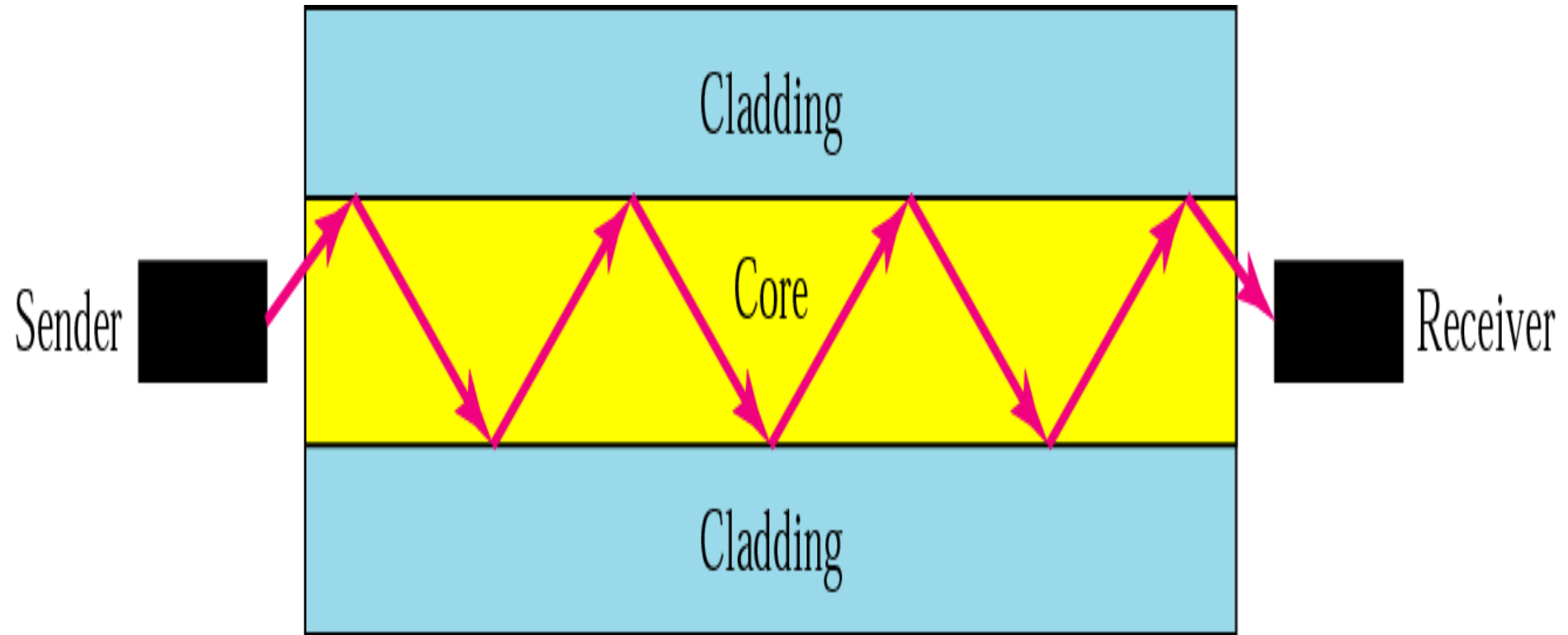
- Bandwidth is high
- Transmits digital signals at a very high rate of 10Mbps.
- Used in long distance telephone lines.
- Much higher noise immunity

Optical Fibre

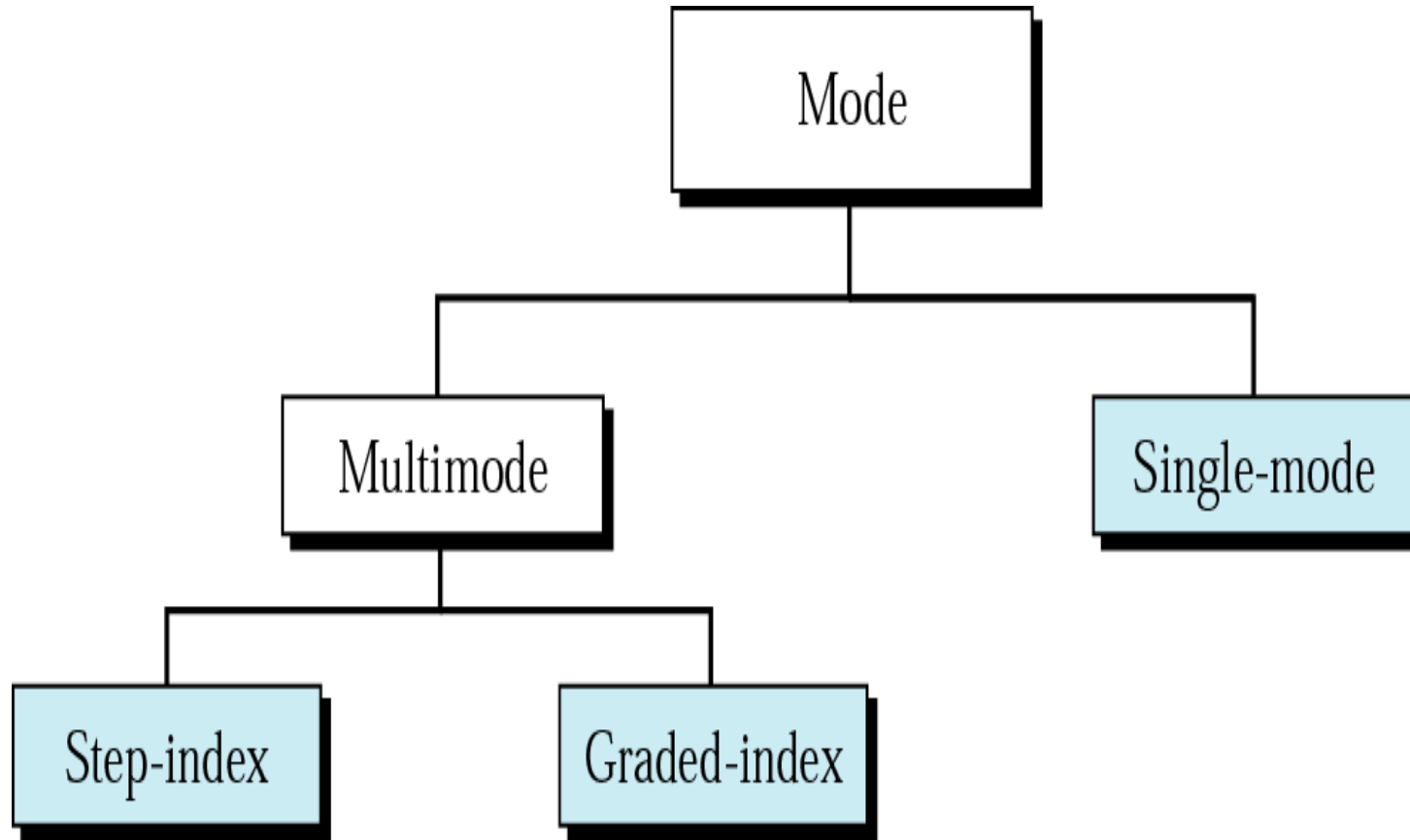
- A technology that uses glass (or plastic) threads (fibres) to transmit data.
- A fibre optic cable consists of a bundle of glass threads, each of which is capable of transmitting messages modulated onto light waves.
- Fibre optic cable has bandwidth more than 2 gbps (Gigabytes per Second)

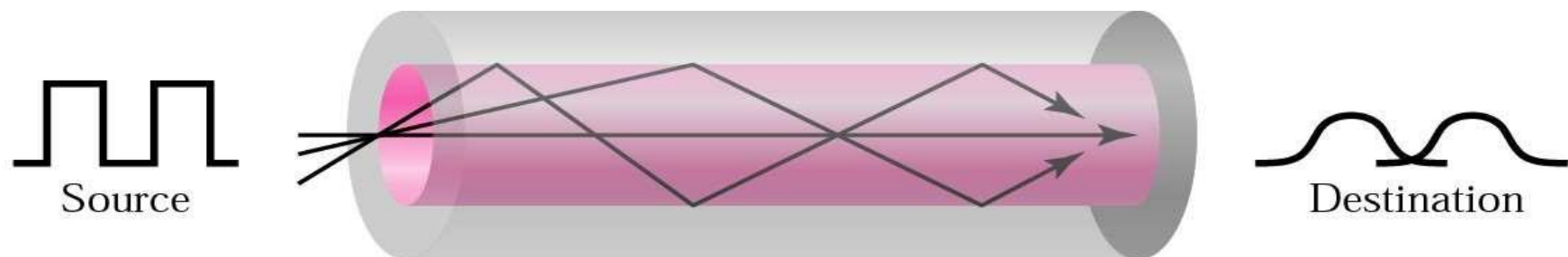


Optical fibers

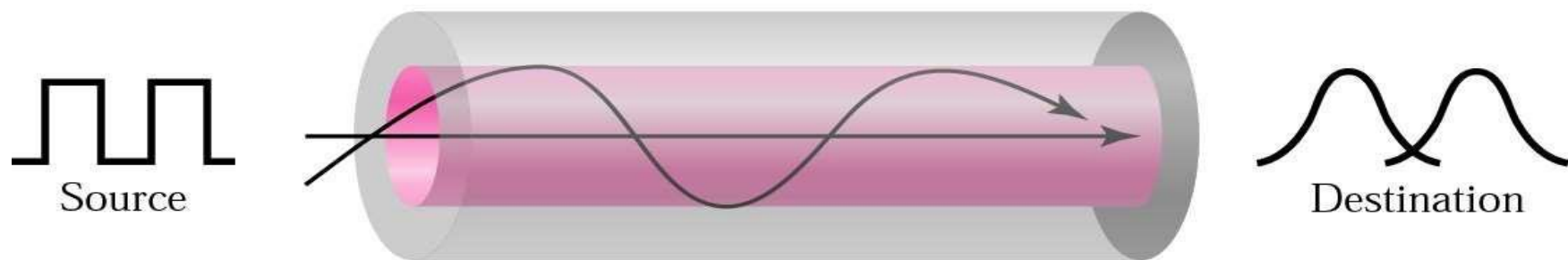


Propagation Modes (Types of Optical Fiber)





a. Multimode, step-index



b. Multimode, graded-index



c. Single-mode

Advantages

- Provides high quality transmission of signals at very high speed.
- Used for both analog and digital signals.
- These cables are much lighter than the copper cables
- Its transmission distance is greater than the twisted pair and it can run for 50Kms without regeneration.
- These are not affected by electromagnetic interference, so noise and distortion is very less.

Disadvantages

- It needs expertise which is not available everywhere. So it is difficult to install.
- Propagation of light is unidirectional and we need two fibers for bidirectional communication.
- It is expensive because the cables and interfaces used are relatively expensive.

Unguided Media

- Unguided media is used for **transmitting the signal without any physical media.**
- It transports electromagnetic waves and is often called **wireless communication.**
- Signals are **broadcast through air** and received by all who have devices to receive them.

Radio waves

- Radio frequency (RF) waves are easy to generate, **can travel long distances, and can penetrate buildings easily**, so they are widely used for communication, both indoors and outdoors.
- Radio waves also are **omnidirectional**, meaning that they travel in all directions from the source, so the transmitter and receiver do not have to be carefully aligned physically.



- Radio waves can be received both inside and outside the building.
- Radio waves are very useful in multicasting and hence used in AM and FM radios, cordless phones and paging.
- If the communication is between single source and destination then it is called **unicast**;
- on the other hand, if one source is transmitting signal and any destination that is in the range may be able to reach it then it is called **broadcast**.

- **Multicast** is when a source transmits a signal for some specific group of destinations which may be more than one.

Bluetooth

- Bluetooth is a very popular application of short wave length radio transmission in the frequency band of 2400 to 2480 MHz.
- It is a proprietary wireless technology standard used for exchanging data over short distances in mobile phones and other related devices.

It allows wireless devices to be connected to wireless host which may be a computer over short distances. You may have it for transferring data between a mobile phone and a computer provided **both have Bluetooth technology.**



Microwave Transmission

- Travels in straight lines and therefore narrowly focused concentrating all the energy into a beam.
- Periodic repeaters are necessary for long distances.
- For transmitting and receiving, antennas should be aligned accurately.
- Can not penetrate through buildings.



- It operates in the GHz range with data rates in order of hundreds of Mbps per channel.
- Telecommunication carriers and TV stations are the primary users of microwave transmission.
- Before fiber optics, for decades these microwaves formed the heart of the long-distance telephone transmission system.

Types of microwave communication systems

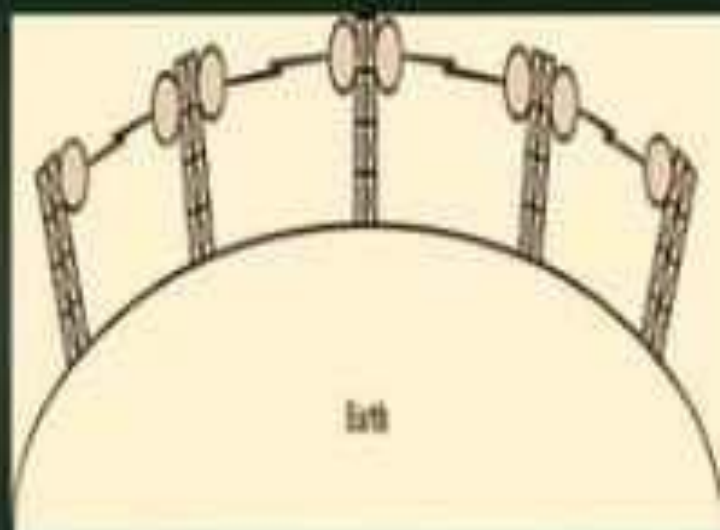
1. Terrestrial

2. Satellite



Terrestrial Microwave

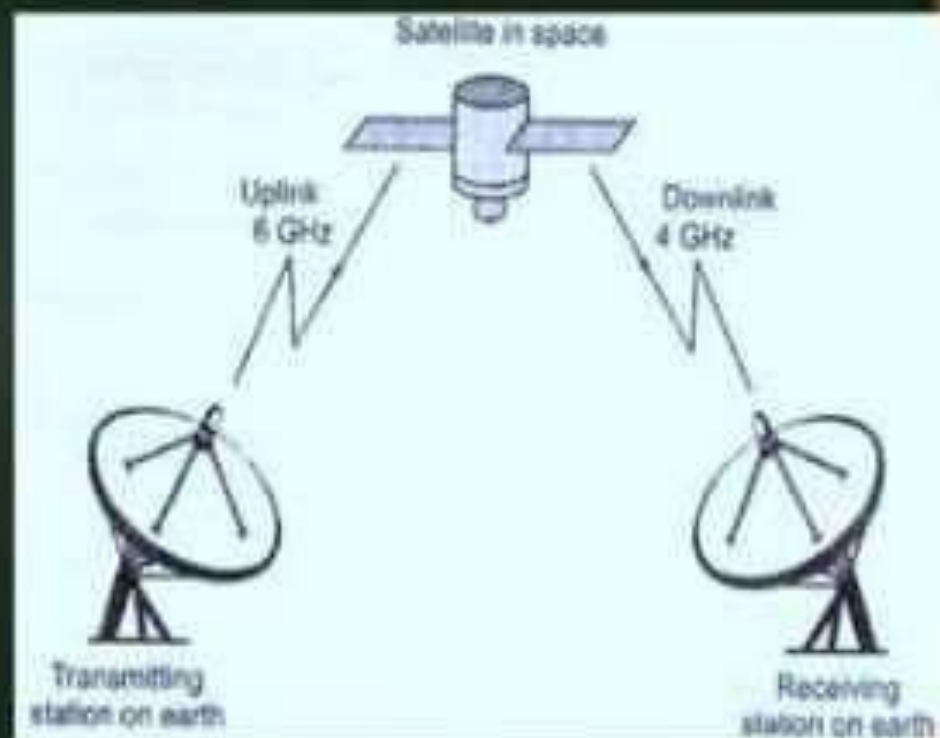
- The terrestrial microwave transmission typically uses the **radio frequency spectrum 2 to 40 GHz**.
- The transmitter is a **parabolic dish** (shaped like a bowl) and is mounted as high as possible to get the best frequency and transmission.
- An unblocked line of sight must be available between the source and the receiver.



- Terrestrial microwaves are used for both radio (voice) and television transmission.
- It can be expensive to adhere to the 30-mile line of sight requirement.
- The towers and repeaters can be fairly costly and there is a risk of interference from aeroplanes, birds and rain.

Satellite Microwave

- This is a microwave relay station which is placed in **outer space**.
- The satellites are launched either by rockets or space shuttles carry them.
- The signals **transmitted by earth stations are received, amplified, and retransmitted to other earth stations by the satellite.**
- These are positioned **3600KM above the equator with an orbit**



speed that exactly matches the rotation speed of the earth.

- As the satellite is positioned in a **geo-synchronous orbit**, it is stationery relative to earth and always stays over the same point on the ground. This is usually done to allow ground stations to aim antenna at a fixed point in the sky.
- Transmitting station can receive back its own transmission and check whether the satellite has transmitted information correctly.
- A single microwave relay station which is visible from any point.

- Satellite manufacturing **cost is very high**
- Cost of **launching satellite is very expensive**
- Transmission highly **depends on whether conditions**, it can go down in bad weather

Infrared

- Infrared signals range between **300 Giga-Hertz to 400 Tera-Hertz**.
- These can be used for **short range** communication.



- High range infrared rays cannot be used for long range communication as it cannot penetrate walls.
- Infrared signals are generated and received using optical transceivers.
- Infrared systems represent a cheap alternative to most other methods, because there is no cabling involved and the necessary equipment is relatively cheap.
- However, applications are limited because of distance limitations (of about one kilometer).

- It cannot be used outside building as rays of sun contain infrared which leads to interference in communication.
- Infrared having wide bandwidth can be used to transmit digital data with a very high data rate.

IEEE IEEE STANDARDS

Ethernet: It is a LAN protocol that is used in Bus and Star topologies and implements CSMA/CD as the medium access method

- Original (traditional) Ethernet developed in 1980 by three companies: Digital, Intel, Xerox (DIX).
- In 1985, the Computer Society of the IEEE started a project, called Project 802, to set standards to enable intercommunication among equipment from a variety of manufacturers.
 - Current version is called IEEE Ethernet

- IEEE 802.3 supports LAN standard Ethernet
- IEEE802.3 defines two categories
 - Baseband
 - Broadband
- Base band has five different category
 - 10Base5 10Base2 10BaseT 1Base5
- Broad band has a category
 - 10Broad36

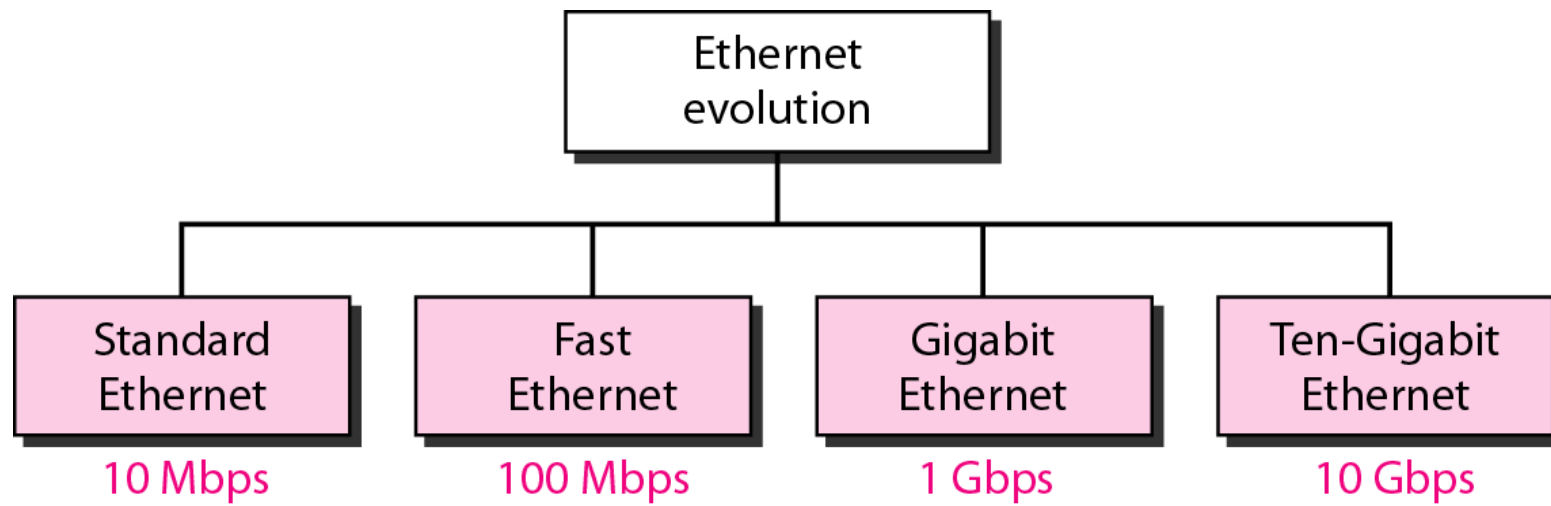
Ethernet address

- Six bytes = 48 bits
- Flat address not hierarchical
- Burned into the NIC ROM
- First three bytes from left specify the vendor. Cisco 00-00-0C, 3Com 02-60-8C and the last 24 bit should be created **uniquely** by the company
- Destination Address can be:
 - Unicast: second digit from left is even (one recipient)
 - Multicast: Second digit from left is odd (group of stations to receive the frame – conferencing applications)
 - Broadcast (ALL ones) (all stations receive the frame)
- Source address is always Unicast

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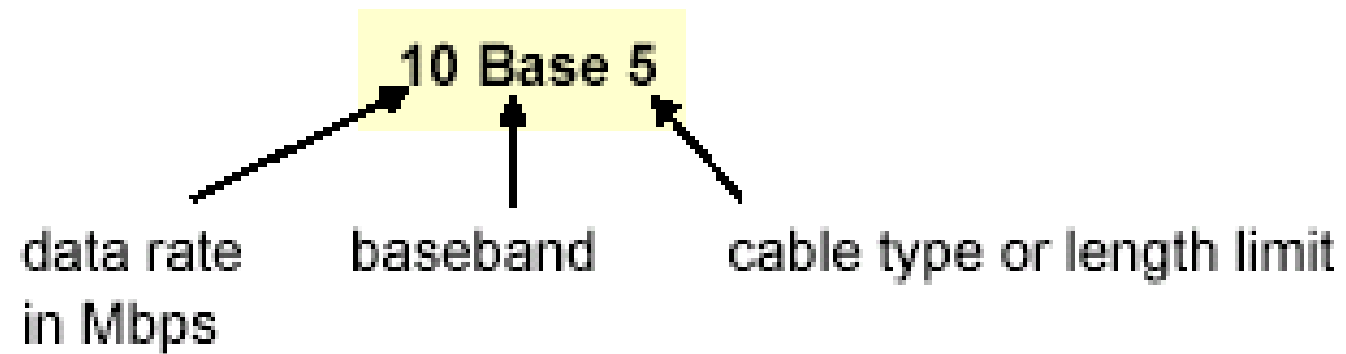
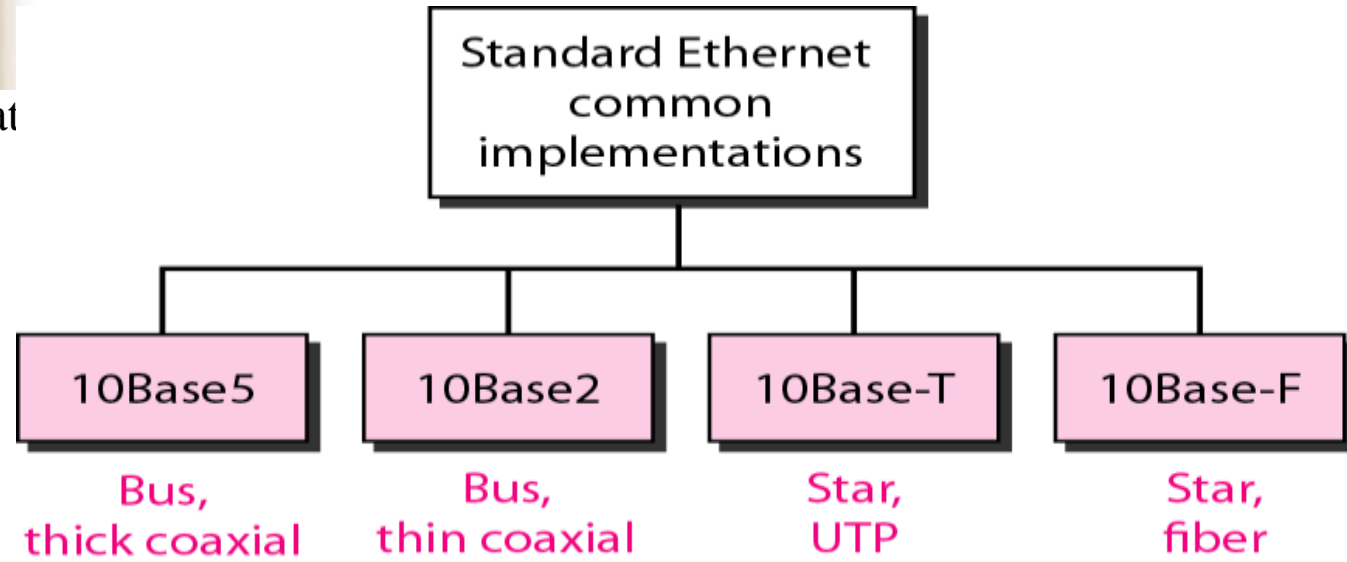


Figure 13.3 *Ethernet evolution through four generations*





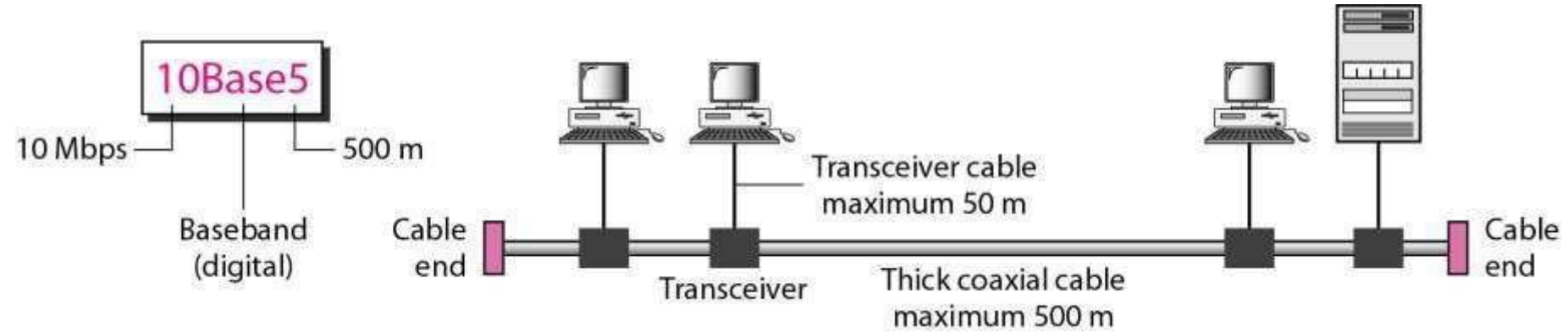
Cat



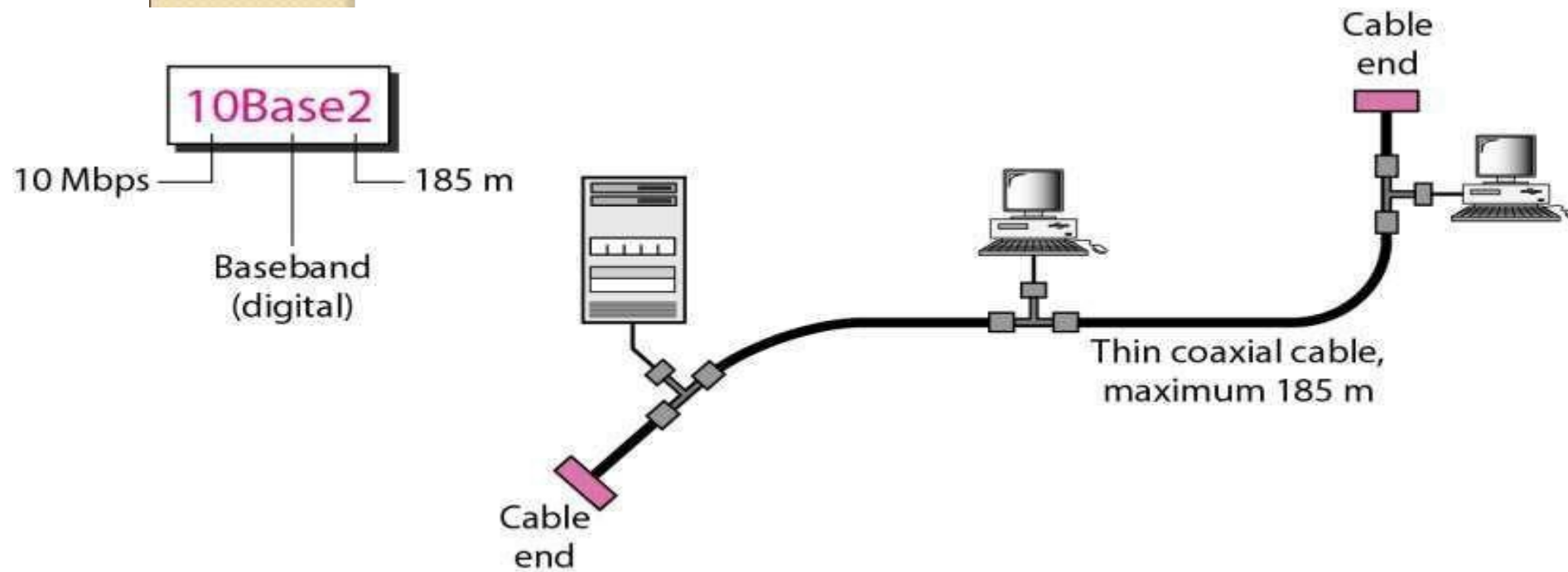
IEEE 802.3 Cable Types

Name	Cable Max.	Max Cable Segment Length	Nodes /segment	Topology
10Base5	thick coax	500 meters	100	Bus
10Base2	thin coax	185 meters	30	Bus
10BaseT	twisted pair	100 meters	1	Star
10BaseF	Fiber Optic	2Km	1	Star

Figure 13.10 *10Base5 implementation*



Connection of stations to the medium using 10Base2



10BaseT

- Uses twisted pair Cat3 cable
- Star-wire topology
- A hub functions as a repeater with additional functions
- Fewer cable problems, easier to troubleshoot than coax
- Cable length at most 100 meters

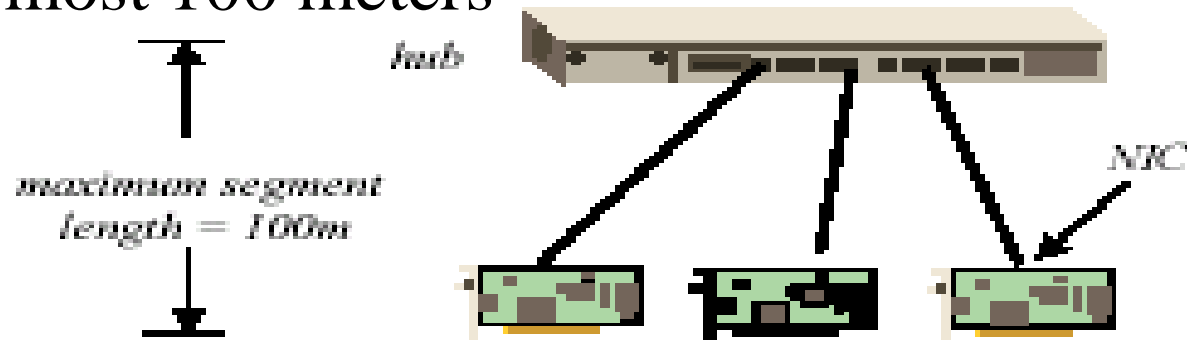


Figure 13.12 *10Base-T Implementation*

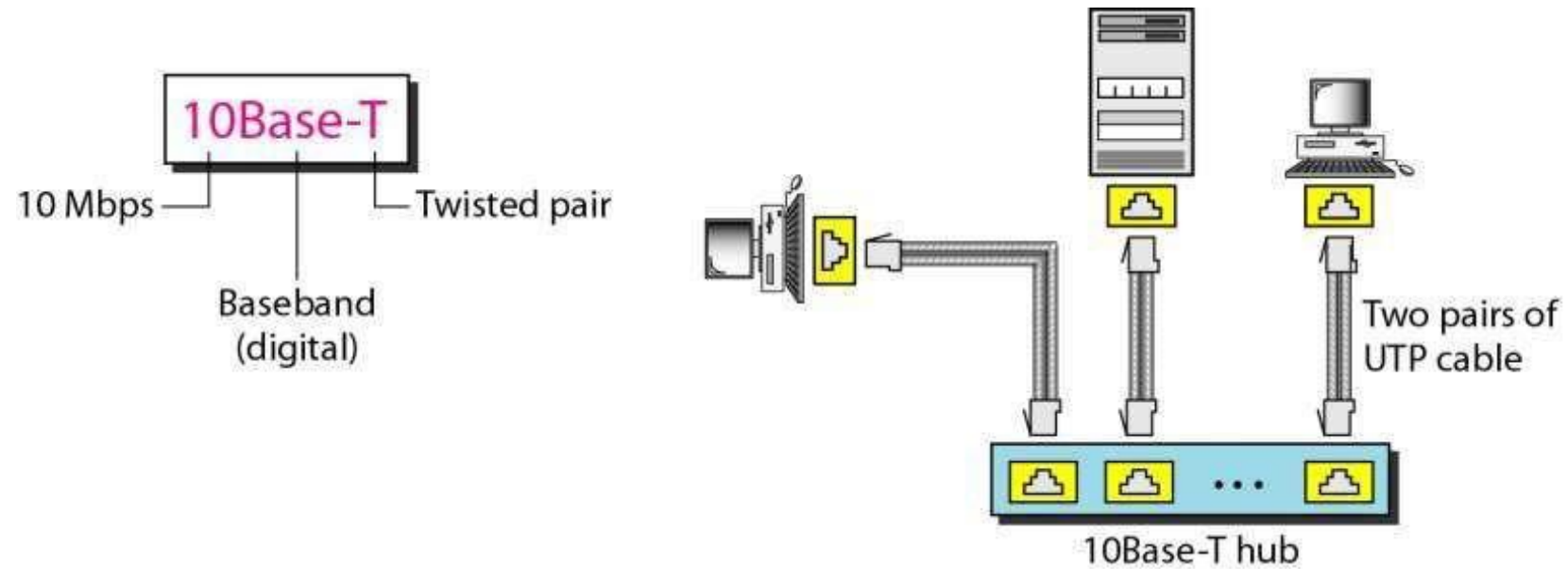
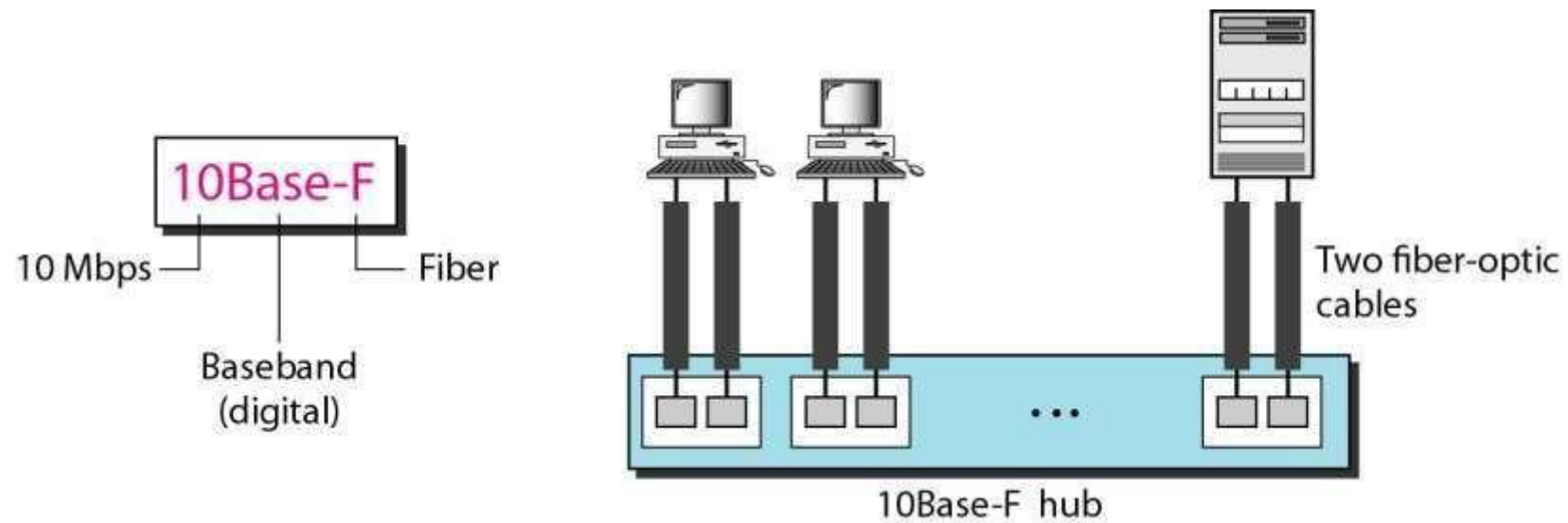


Figure 13.13 *10Base-F implementation*



Fast Ethernet

100 Mbps transmission rate

same frame format, media access, and collision detection rules as 10 Mbps Ethernet

can **combine 10 Mbps** Ethernet and Fast Ethernet on same network using a **switch**
media: twisted pair (CAT 5) or fiber optic cable (no coax)

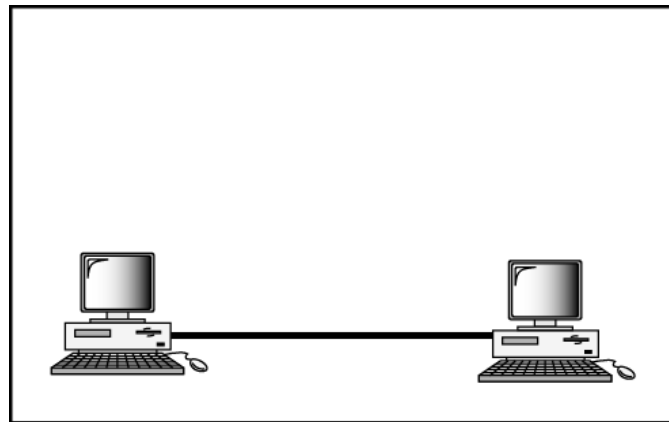
Star-wire topology

- Similar to 10BASE-T

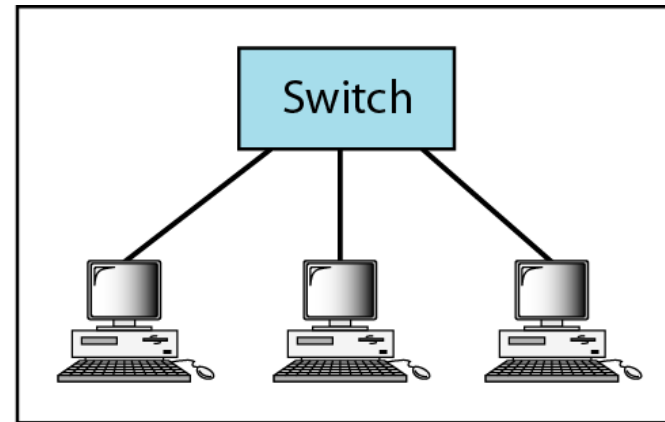


Name	Cable	Max. segment	
100Base-T4	Twisted pair	100 m	CAT 3
100Base-TX	Twisted pair	100 m	CAT 5
100Base-FX	Fiber optics	2000 m	

Figure 13.19 *Fast Ethernet topology*

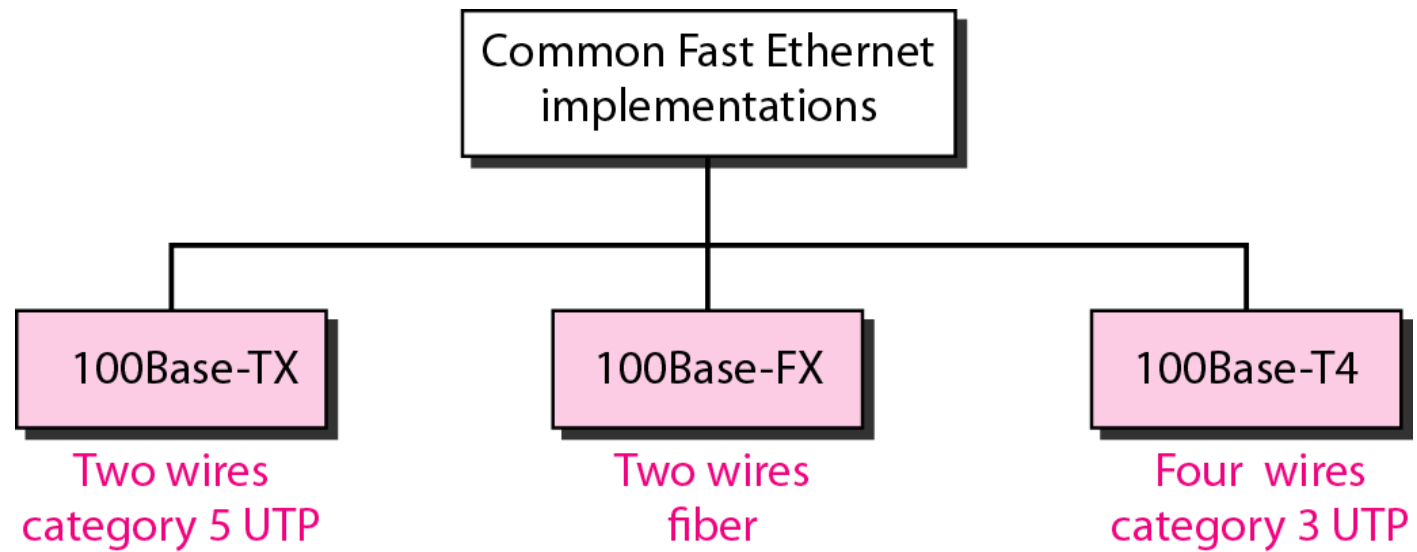


a. Point-to-point



b. Star


Figure 13.20 *Fast Ethernet implementations*



Gigabit Ethernet

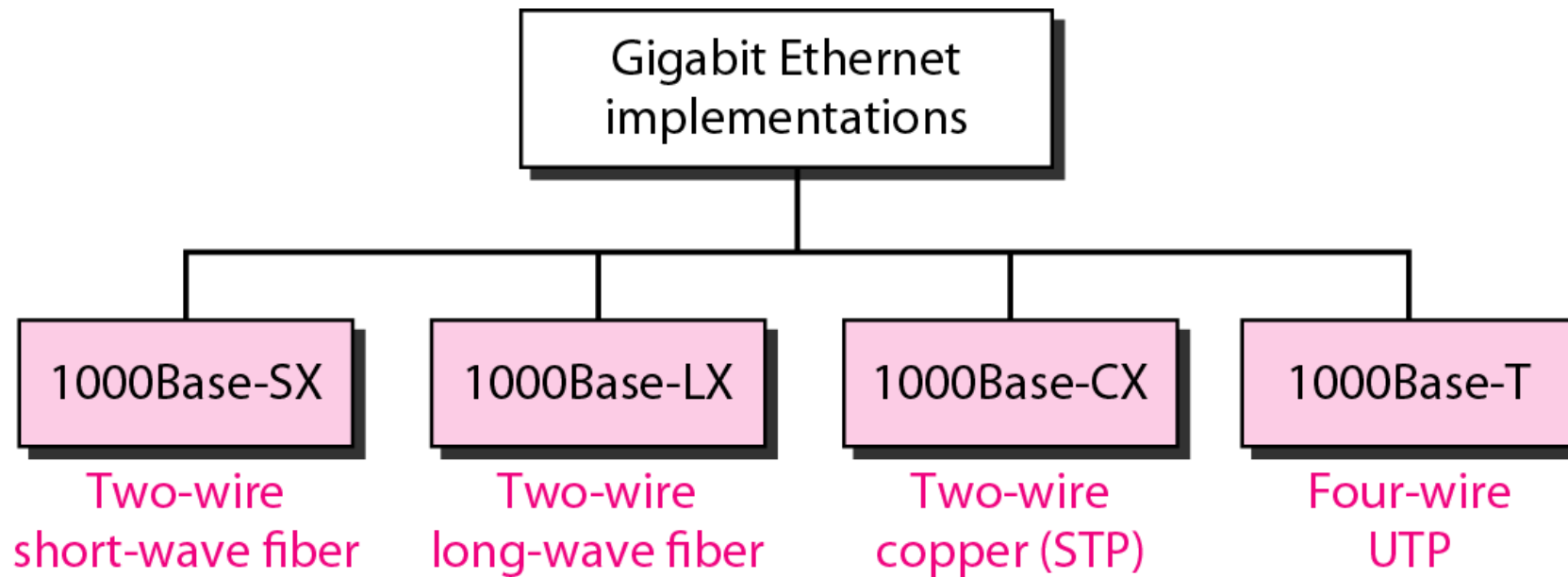
- Speed 1Gpbs
- Minimum frame length is 512 bytes Operates in full/half duplex modes mostly full duplex

Name	Cable	Max. segment
1000Base-SX	Fiber optics	550 m
1000Base-LX	Fiber optics	5000 m
1000Base-CX	2 Pairs of STP	25 m
1000Base-T	4 Pairs of UTP	100 m



In the full-duplex mode of Gigabit Ethernet,
there is no collision;
the maximum length of the cable is
determined by the signal attenuation
in the cable.

Figure 13.23 *Gigabit Ethernet implementations*



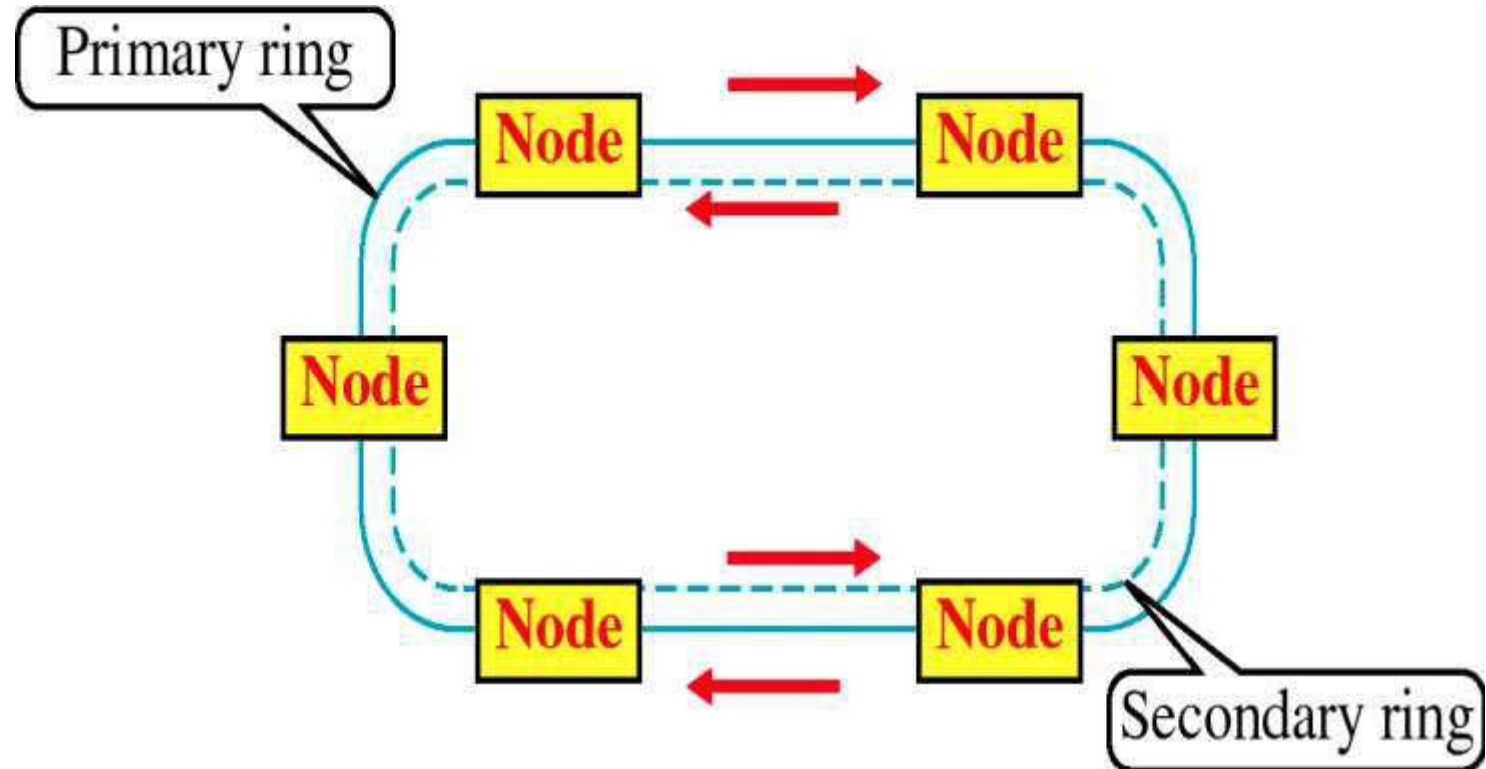
10Gbps Ethernet

- Maximum link distances cover 300 m to 40 km
- Full-duplex mode only
- No CSMA/CD
- Uses optical fiber only

FDDI

- Fiber Distributed Data Interface
- local area network protocol standardized by ANSI
- 100-Mbps token passing
- Dual-ring LAN
- A high-speed backbone technology
- High bandwidth
- Optical fiber transmission
- Allows up to 500 stations

FDDI Architecture



Components of FDDI

- Fiber optic cable
- A concentrator (ring)
- Stations: 2 types
 - DAS (Dual Attachment Station) or Class A:
 - Connected to both the rings
 - SAS (Single Attachment Station) or Class B:
 - Connected to primary ring

Networking and internetworking devices:

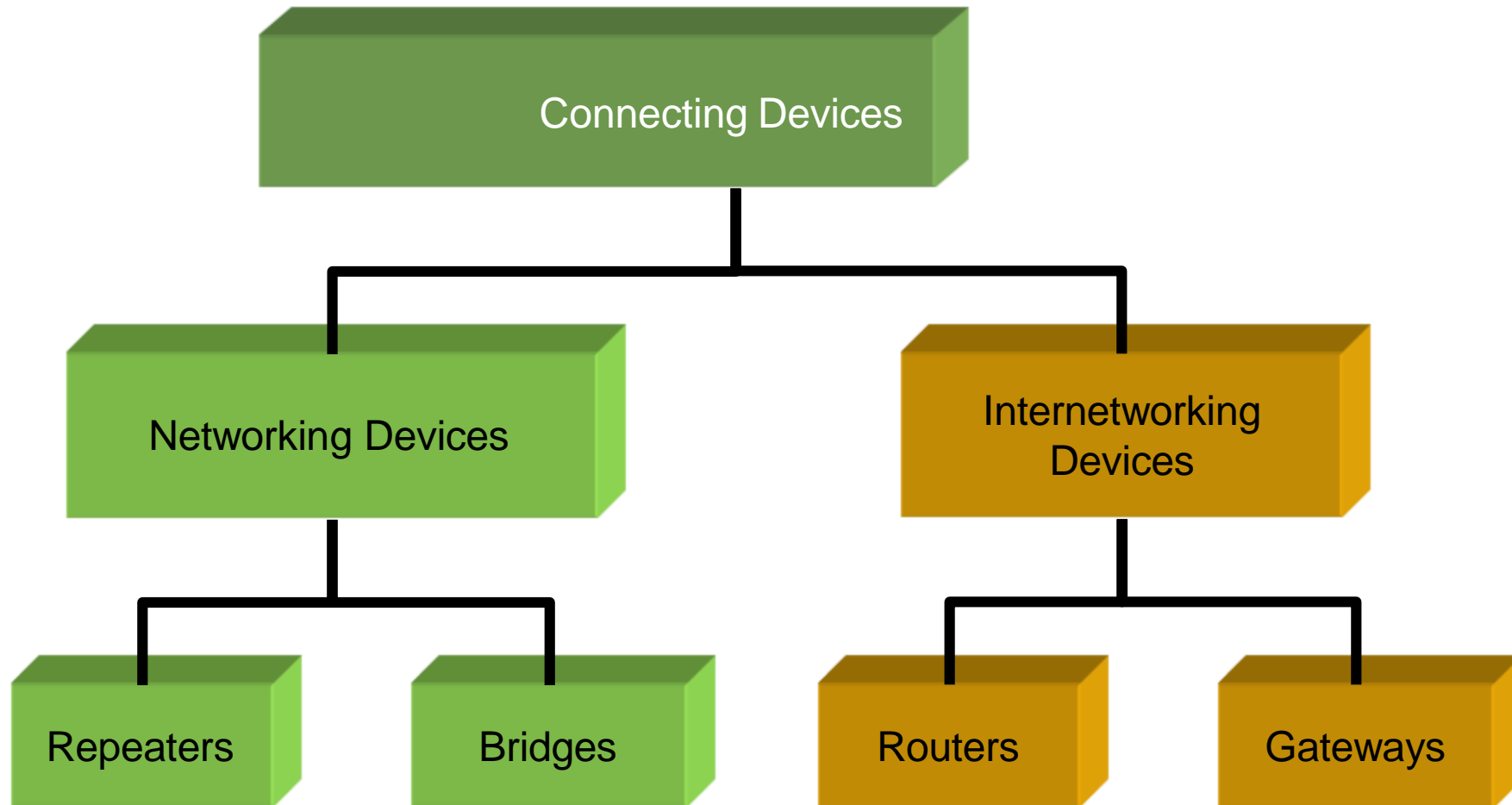
An internet is an interconnection of individual networks. So to create an internet we need internetworking devices. ie) Linking a number of LAN's

Internet - WWW

internet-Interconnection of LAN

Why Interconnect?

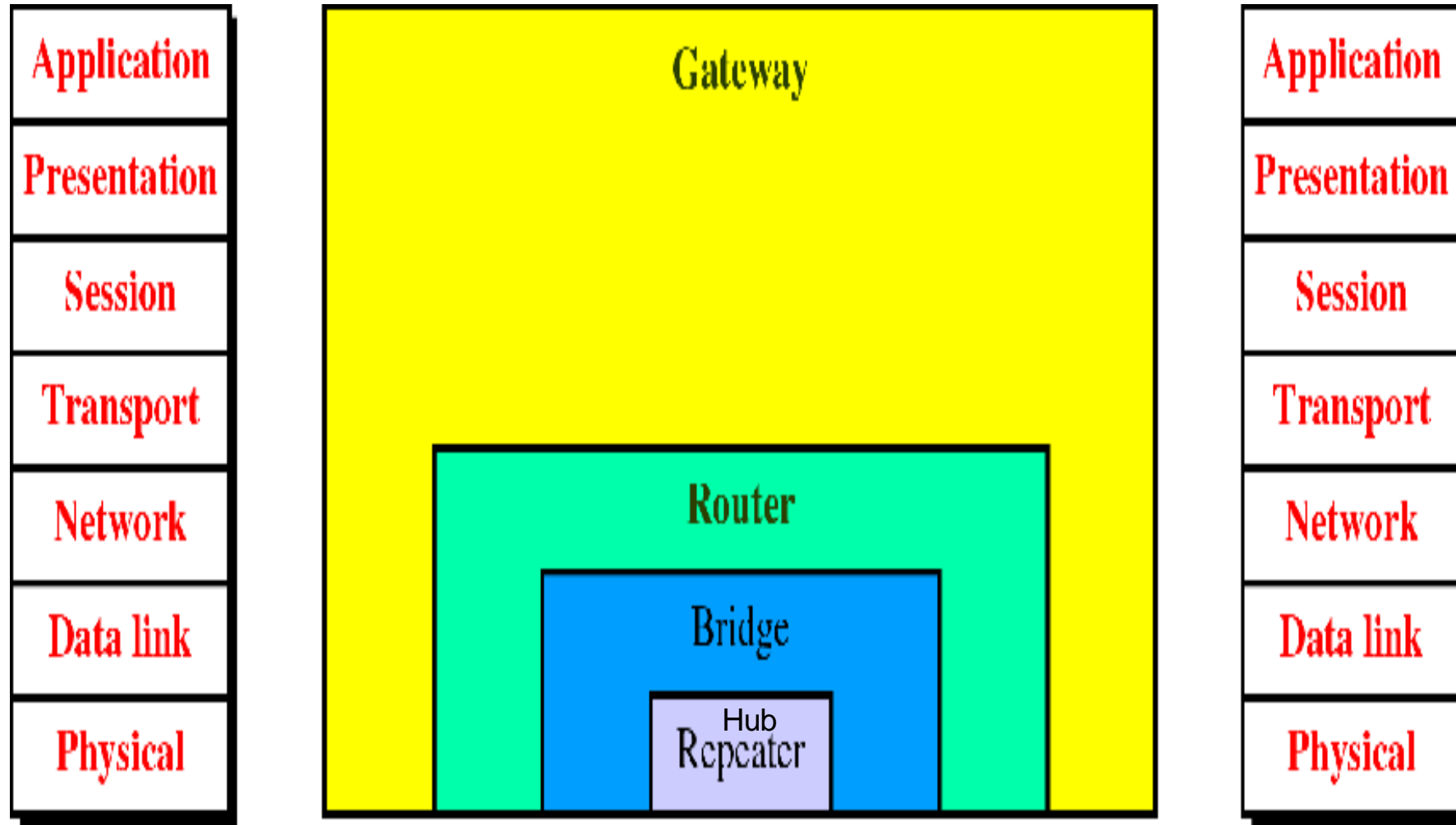
- To separate / connect one corporate division with another.
- To connect two LANs with different protocols.
- To connect a LAN to the Internet.
- To break a LAN into segments to relieve traffic congestion.
- To provide a security wall between two different types of users.



Introduction

- Many times it is necessary to connect a local area network to another local area network or to a wide area network.
- Local area network to local area network connections are usually performed with a **bridge**.
- Local area network to wide area network connections are usually performed with a **router**.
- A third device, the **switch**, can be used to interconnect segments of a local area network.

Connecting Devices



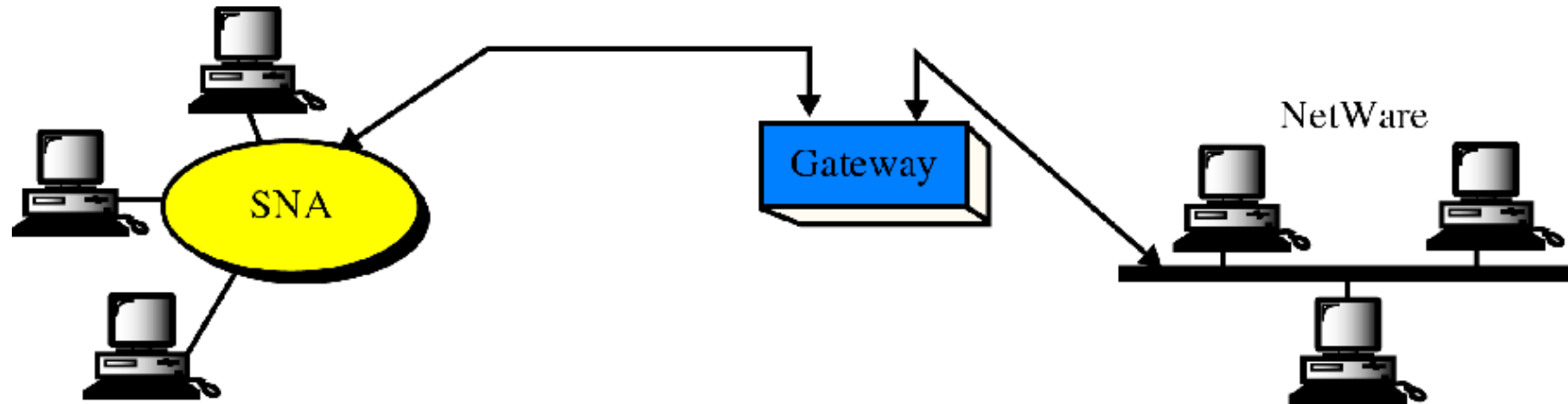
Repeater:

- A repeater is a regenerator, not an amplifier
- A repeater installed on a link receives the signal before it becomes too weak or corrupted ,regenerates the original bit pattern, and put the refreshed copy back onto the link.

Gateways:

- - A gateway is a protocol convertor
 - - It accepts a packet format for one protocol (e.g., Apple Talk) and converts it into a packet format for another protocol (e.g., TCP/IP).

A gateway



SNA network (IBM)
Netware network (Novell)

Bridges

- Divide a large network into smaller segment
- It filters the traffic . It contains logic(Bridge table) that allows them to keep the traffic for each segment separate.
- le) Isolating and controlling the link problems (e.g. congestion)
- Bridges have look-up table that contains physical address of every station connected to it.

Figure 8-2
*A bridge interconnecting
two identical local
area networks*

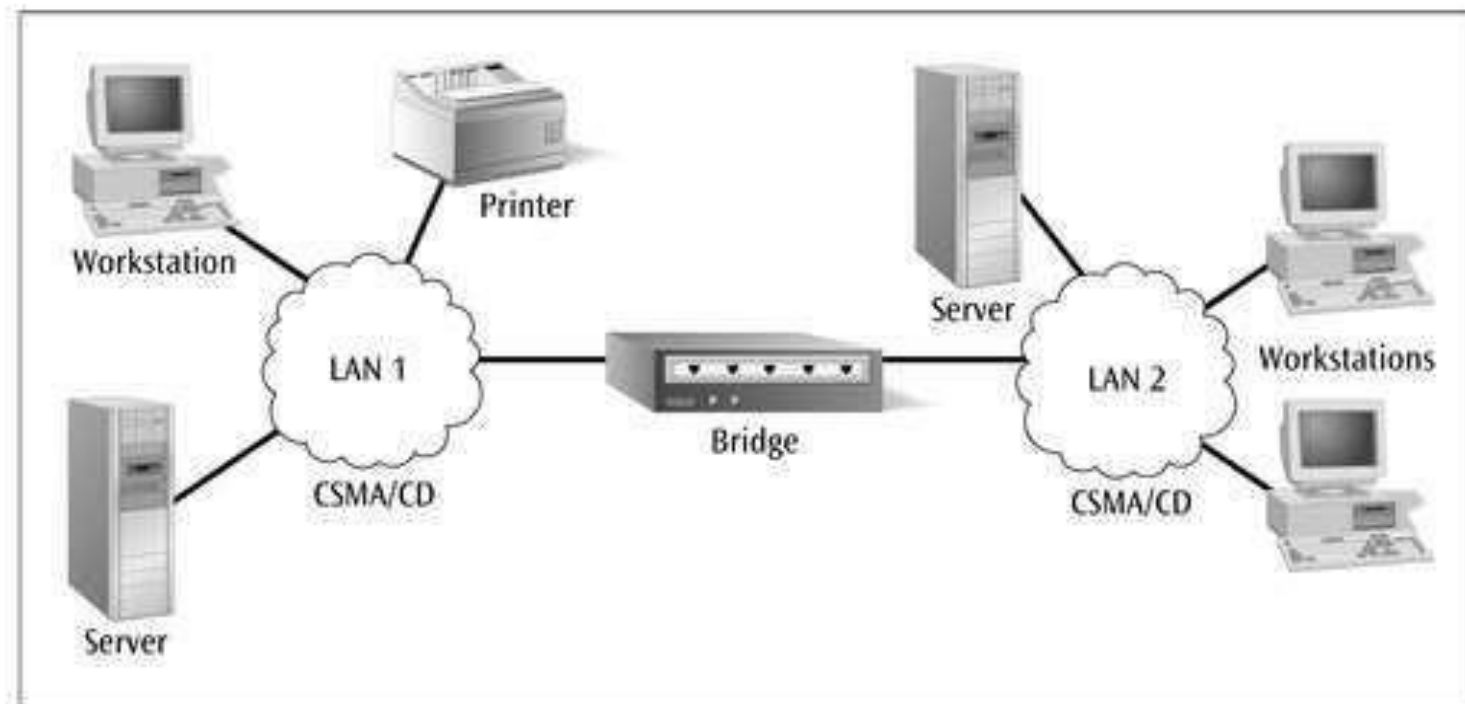
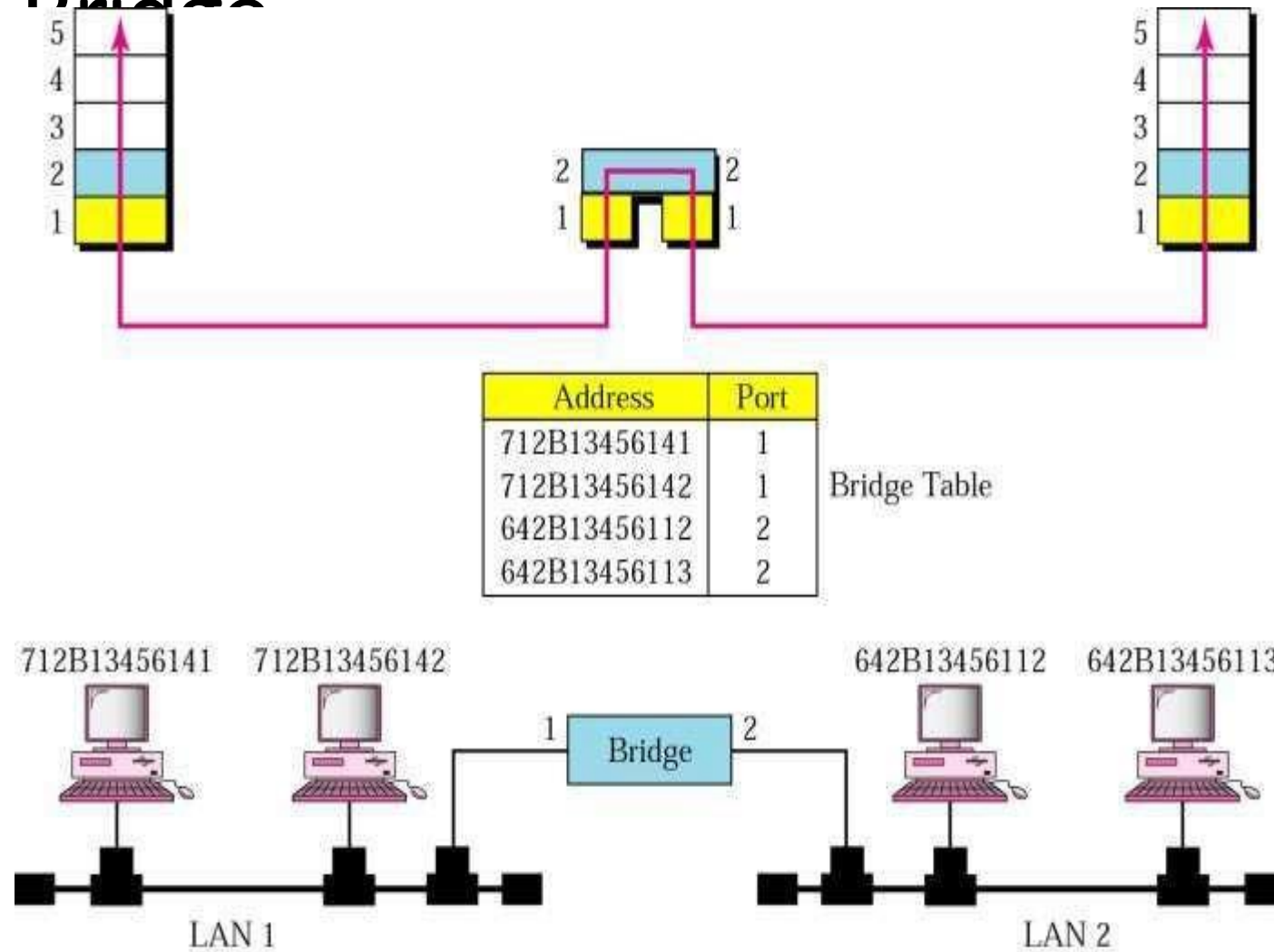
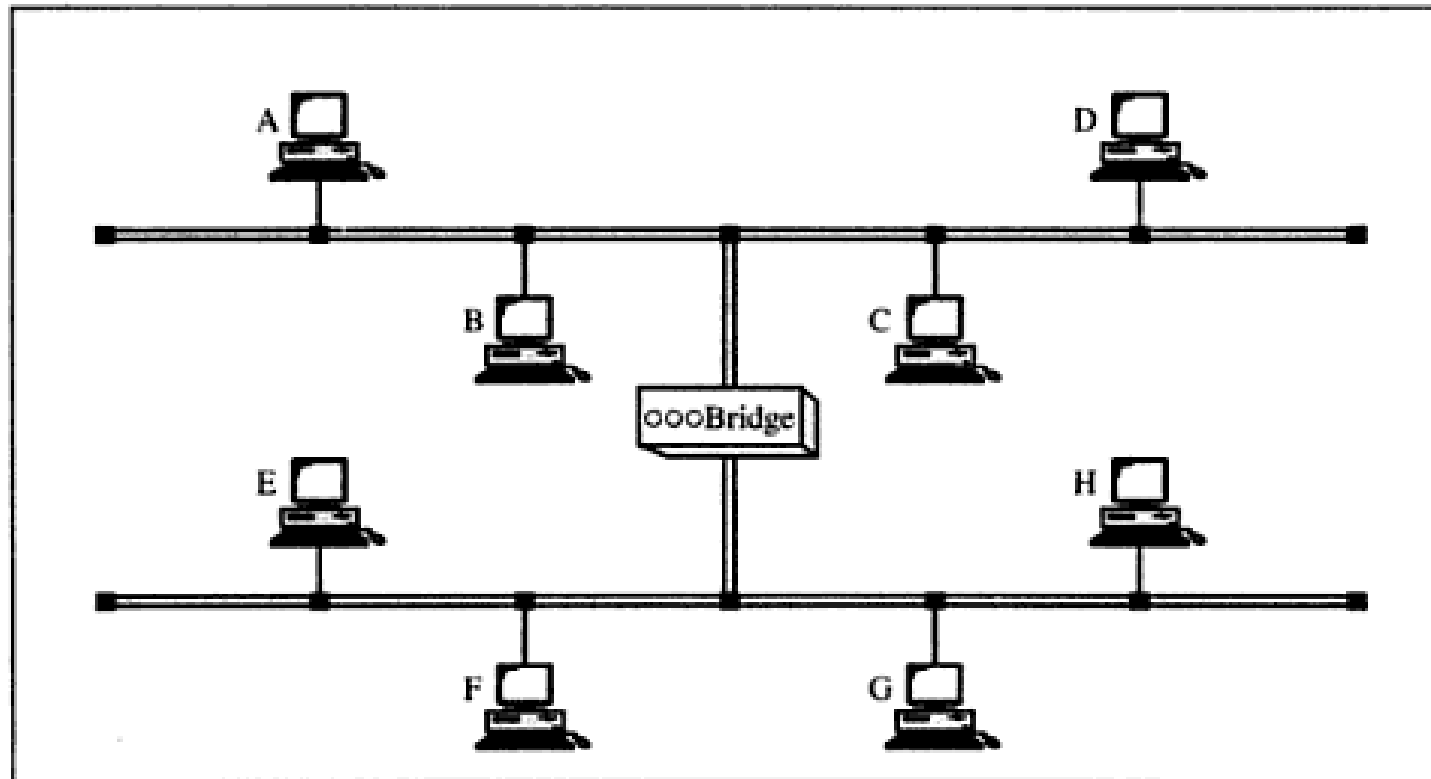


Diagram 3



- When a frame enters a bridge, it checks the address of the destination and forwards the new copy only to the segment to which the address belongs

Figure 21.7 *A bridge*



- # Types
- Simple
 - Multiport
 - Transparent
 - Remote
 - Source routing

Simple Bridge

- It is a less expensive type of bridge
- It links **2 segments** (LANs) and lists the address of all the stations in table included in each of them.
- Here address must be entered **manually**.
- The table is modified when stations are added and removed.

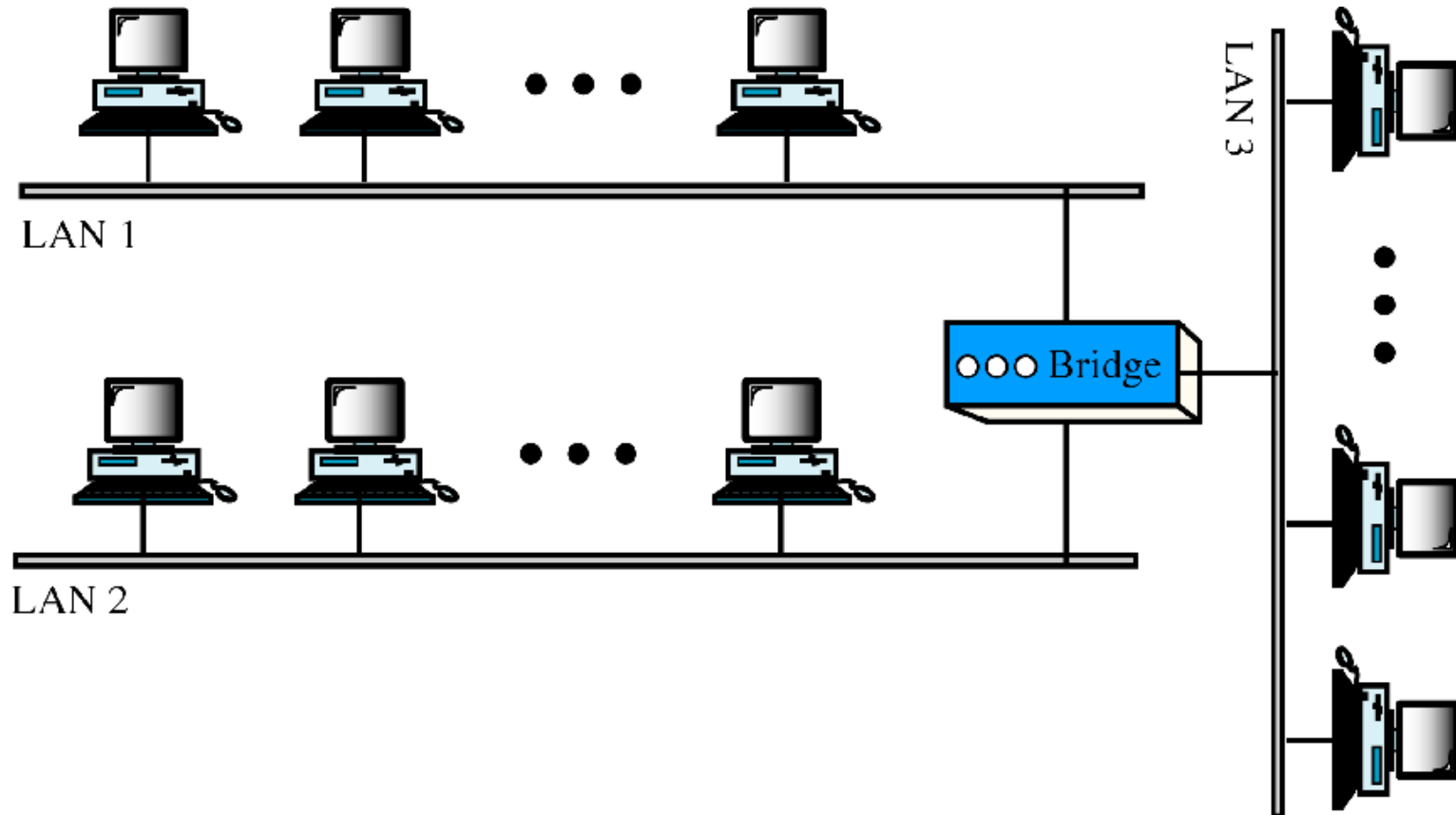
Multiport Bridge

- It is used to connect more than two LANs.
- So the bridge has 3 tables.
- Here address must be entered manually

Transparent Bridge:

- A transparent or learning bridge builds its table of station on its own (automatically).
- The table is empty when it is installed, it builds its table when it encounters the packet for transmission. It uses the source address for building table.
- It identifies the changes and update the table when system moved from one station to another

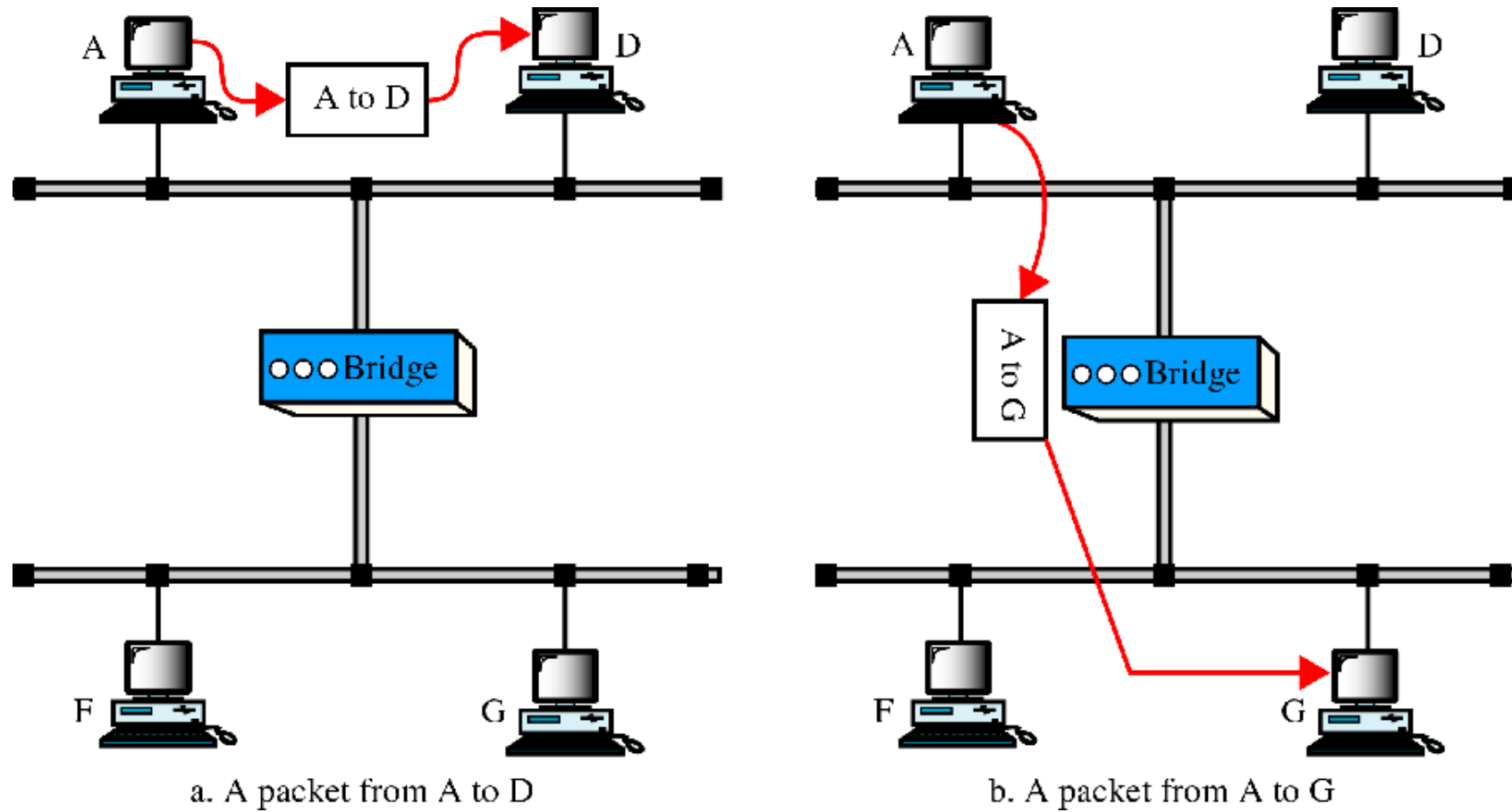
Multiport bridge

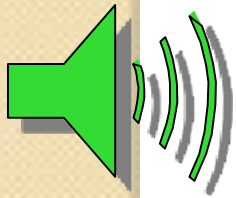


Cont.,

- Bridges are normally installed redundantly, that is two LANs may be connected by more than one bridge. in this cases they may create a loop.
- So packet may go round and round, It can be avoided by algorithms like
 - Spanning tree algorithm
 - Source routing

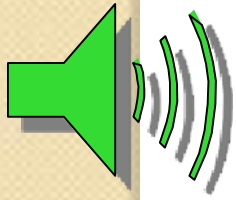
Function of a bridge





Remote Bridges

- A remote bridge is capable of passing a data frame from one local area network to another when the two LANs are separated by a **long distance** and there is a wide area network connecting the two LANs.
- A remote bridge takes the frame before it leaves the first LAN and encapsulates the WAN headers and trailers.
- When the packet arrives at the destination remote bridge, that bridge removes the WAN headers and trailers leaving the original frame.



Switches

- A switch is a **combination of a hub and a bridge** (multi-port bridge).
- It can interconnect two or more workstations, **but like a bridge, it observes traffic flow** and learns.
- When a frame arrives at a switch, the switch examines the destination address and forwards the frame out the one necessary connection.
- Workstations that connect to a hub are on a shared segment.
- Workstations that connect to a switch are on a switched segment.