

Chapter 1

INTRODUCTION TO COMPUTER NETWORKS

Network History

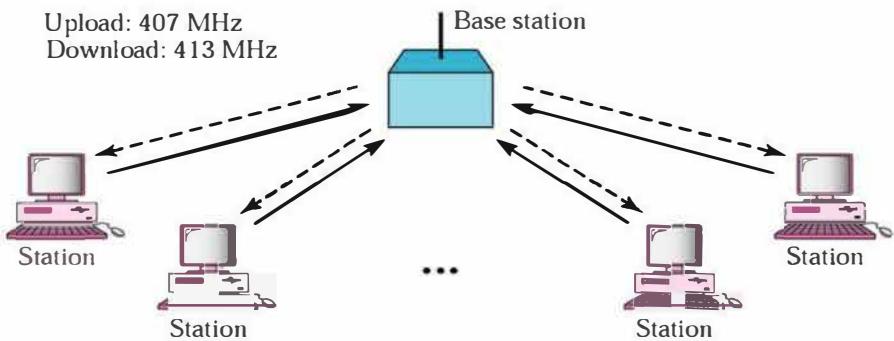
- In the 1960s, Paul Baran and Donald Davis independently developed the concept of using packets to transfer information between computers over a network. Davis implemented the local network concept at the National Physical Laboratory (UK).
- In 1965, Western Electric introduced the first widely used phone switch to realize accurate computer control.
- In 1966, Thomas Maril and Lawrence G. Roberts published an experimental WAN for computer time sharing.
- In 1969, the first four nodes of ARPANET were connected via 50 kbit/s chains between the University of California, Los Angeles, Stanford Research Institute, the University of California, Santa Barbara, and the University of Utah.

ARPANET 1970



- In 1972, commercial services using X.25 were introduced and later used as the primary infrastructure for expanding TCP / IP networks.
- In 1973, Robert Metcalfe wrote a note at Xerox PARC about the Ethernet networking system based on the Aloha network, developed in the 1960s by Norman Abramson and colleagues from the University of Hawaii. In July 1976, Robert Metcalfe and David Boggs published their article "Ethernet: Distributed Switches for Local Computer Networks Packages" [8] and collaborated on several patents received in 1977 and 1978. In 1979, Robert Metcalfe pursued Ethernet as an open standard.

ALOHA Network



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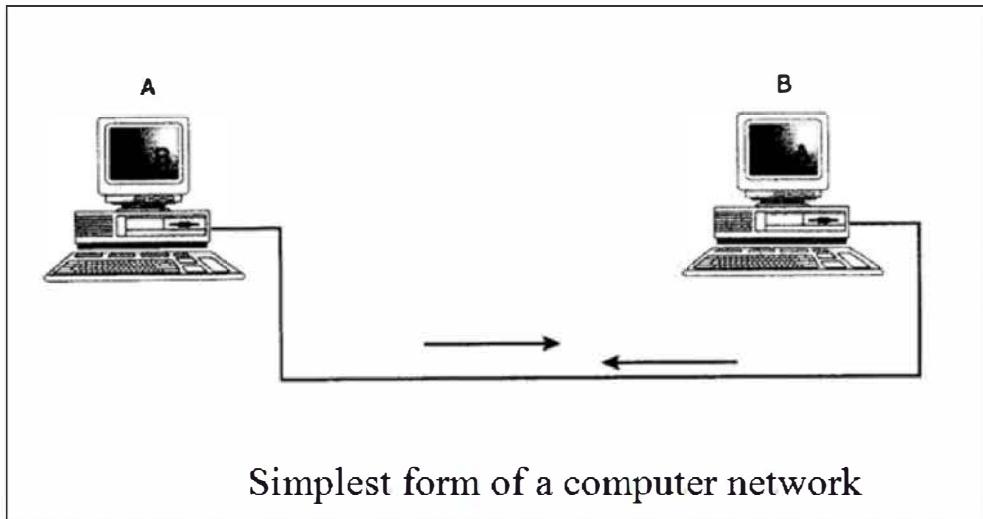
In 1976, John Murphy established ARCNET, a token-passing network used for sharing storage devices. Ethernet's transmission capacity increased from 10 Mbit/s to 100 Mbit/s in 1995 and is now capable of Gigabit transmission speeds. Its easy scalability, such as rapid adaptation to new optical cable speeds, has contributed to its widespread use.

Computer network definition:

A computer network is a group of interconnected electronic devices that share resources and services through communication links. The networks vary from local to campus-wide to global and use various transmission media such as copper cables, optical fiber, wireless technology, and radio transmissions. Networking depends on protocols that control computer communication and ensure data reaches the destination and the sender and receiver recognize each other

1. A resource to share (resources)
2. A transport path (support for data transmission)
3. A set of policies) of communication Rules

(Protocols)



When two units communicate with each other, there is not only an exchange of information, but they must understand each other. Therefore, a computer network is not only for the exchange of data but also for the understanding and use of data from other devices in the network.

Benefits of the network computer:

Suppose you have a family of seven, each with a device that must connect to the internet and printer. Instead of connecting each device individually, connect them all to one computer that shares the internet connection and printer. You can share a folder on the network so that all

users can access it. There are many benefits to using the network, such as:

File Sharing:

The network shares files directly. Instead of using CD-ROM or USB memory for transporting files from one computer to another or the Office, you can work with files directly on a network.

Security:

Folders defined can be protected by a password to restrict access to authorized users. In addition, files and programs in a network can be used as a "copy" of the lock.

Resource Sharing:

All computers on the network can share resources such as printers and scanners.

Communication:

People can communicate by electronic mail via the network. If you use the Internet, you can communicate via the network with the world community through the network.

Flexible access:

Access files on the computers of the network to make sure that a user can start to work on a team project.

Multiple users can work together on the same project, through the network.

The working groups:

The Microsoft BackOffice software enables multiple users to collaborate on a document simultaneously, facilitating interactive work on the computer.

Reduction of the error:

It helps to reduce errors and to further develop the coherence of the work of the staff as a source of

information.

The manuals and directories can be available and you can ensure that the data is from a single point regularly, to ensure consistency.

Network Applications

There is a long list of applications. Many of the applications of computer networks such as the following:

- search books, reports, and scientific articles on specific topics
- Booking of airline tickets, hotel reservations, train, rental car, etc.
- A Writer's aid: a dictionary, glossary of terms, word generator, indexed dictionary, and the encyclopedia.
- Information on the stock market with those who seek a population, that meets certain criteria, the comparative analysis,
- Electronic Financial Transactions
- Games.

- E-mails (EMM).
- The information systems of the company.
- The commercial applications of various systems, such as an order entry system, central purchasing, decentralized control of the inventory, etc.
- Online System for investment advice and management, etc.
- Resources of interest for a home.
- Sports application
- Theater, cinema, events,
- Purchase information, pricing, and advertising.
- Restaurants; good food guide.
- Magazine, recipes, and book reviews.
- Holidays, hotels, and reservations for a trip.
- The radio and television programs.
- Medical Assistance Service.
- Information on insurance
- Computer-assisted instruction (CAI).
- School Homework, quizzes, tests.

- The sending of messages.
- Consumer Reports.
- Employment Opportunities.
- Information on taxes and support.
- The support of route planning, i.e. The bus, train, plane, etc.
- The course content at the Open University and the virtual university.

Keys to computer network

The following points are very important before you start to study a computer network:

- The nature of the involved nodes:
- homogeneous or heterogeneous.
- Topology
- Reliability.
- The capacity of distribution channels - if the allocation of capacity of channels time division or frequency division?

- Techniques for routing
- Models: analytical models, the queue simulation models, modeling, measurement, and validation of models are applicable.
- Access: if access to a computer on the network can be viewed directly or through a sub-network?
- The protocols, the levels, which are the standards and formats that must be followed to establish the communication between nodes participating?
- The performance of the network.

Examples of fields of network applications:

Business applications Field:

Most businesses use multiple computers, such as one for each worker to develop products, draft brochures, and run payroll. Over time, these devices were connected to distribute information throughout the company. This allows for the sharing of resources, programs, and data to become available to everyone in the network, regardless of physical location. For instance, a group of office employees can share a common printer, which is often cheaper, faster, and easier to manage than individual printers. Most businesses, regardless of size, are heavily reliant on computerized data, such as customer information, product details, inventory, financial statements, and tax information. Even larger businesses with multiple offices and plants across many countries can access data from different locations. The networks, the so-called virtual private networks (VPN) can be used, the different networks in different parts of a large network. In other words, the mere fact that a user is about

15,000 km should not prevent its information on the database, as if they were local.

In simple terms, we can imagine an information society, which is composed of one or more databases containing information on the company and several employees need to remotely access it. In this model, the data is stored on a powerful PCs called a server. Often, they are managed by a system administrator. On the contrary, employees use a simple machine called clients to remotely access the data.

The server and client computers that are connected to a network are shown in the figure.

The database application is the most popular of a Web application, in which the server generates Web pages from your database in response to requests from clients.

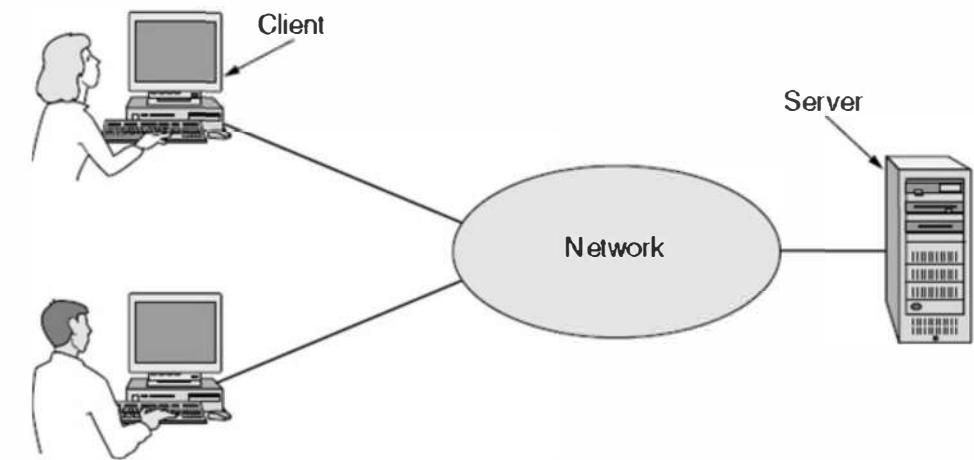


Figure 1-1. A network with two clients and one server.

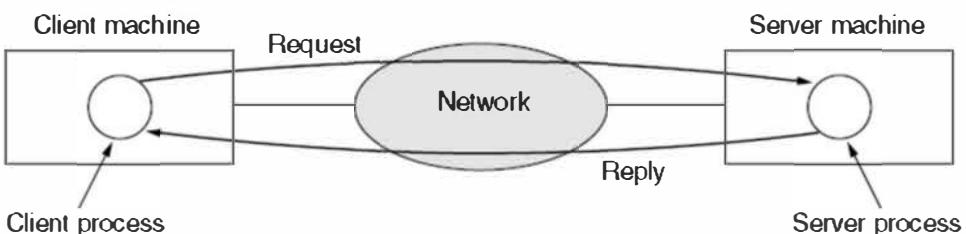


Figure 1-2. The client-server model involves requests and replies.

A network of computers is an effective tool for employee communication. Companies with computers and email can use the network for daily contact. IP telephony or Voice over IP (VoIP) allows phone calls to be made through the Internet, saving companies money on phone bills. Remote workers can also use computer network technology for

video and audio communication, eliminating the need for travel and improving collaboration.

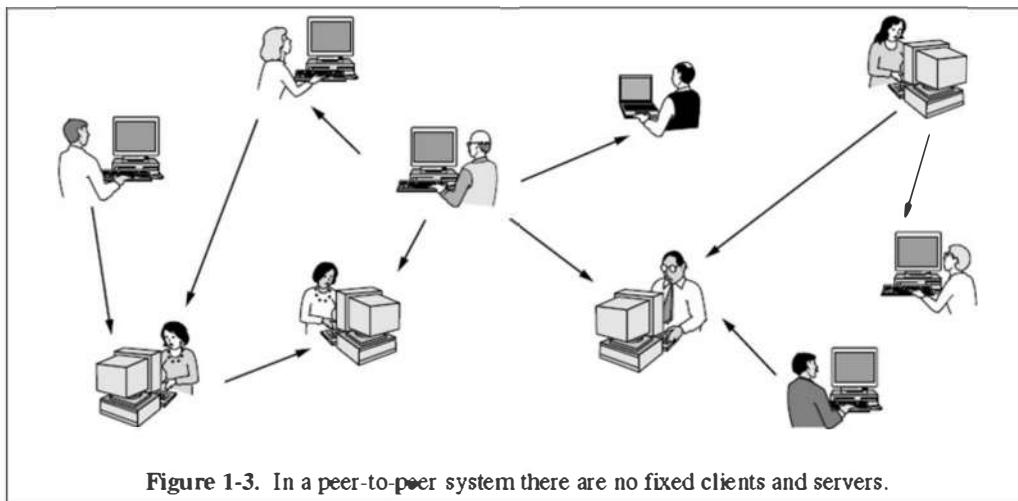
Home Applications:

In the past, people mainly bought PCs for text processing and gaming. Nowadays, computers are primarily used for internet access. Electronic devices like decoders, gaming consoles, and radios are equipped with computers and computer networks. Wireless networks, in particular, are commonly used for entertainment, including listening, watching, and creating music, photos, and videos. AS with the companies of the private sector, users can have access to information, to talk with other people, and pay money for the products and services of e-commerce.

The internet offers a wealth of information for both educational and leisure purposes. This includes topics

such as the arts, business, cooking, government, health, history, recreation, science fiction, sports, travel, and more. Additionally, newspapers are available online and can be personalized to avoid certain topics or preferences. The next step is the online digital library. With online libraries, you can read printed books. Much of this information needs a client-server model.

Another model is peer-to-peer which you can communicate with other people in the group, as shown in the figure. Each person can communicate with one or more people; there is no connection between the clients and the servers.



Much peer-to-peer, as a torrent, there is no central database. However, each user manages its database on the local system and provides a list of other persons in the vicinity, the members of the system. Let's look at each of the current members to see what he has and can obtain the names of the other members.

The Internet can be used by audio applications (for example, Internet radio stations) and videos (YouTub5). In addition to a good market, it is a means of distant friends.

Facebook is a popular social networking site where users can update their profiles and connect with friends. Collaborative websites like Wikipedia allow communities to

produce content. E-commerce includes online shopping, auctions, and payment of invoices. Smart homes can be equipped with sensors for energy consumption and smoke detection, and photographers can send photos in real time.

Mobile Users:

Mobile devices like laptops and portable computers account for the fastest growth in the IT sector. Sales have surpassed those of desktop computers. People on the go use their cell phones for emails, movies, music, games, and browsing.

Connectivity:

The convenience of wireless networks makes them essential for mobile users, including those in cars, ships, and aircraft. Wireless LAN Access Points based on 802.11 allow laptops to connect from coffee shops, hotels, airports, schools, trains, and aircraft as if on a wired network. Wireless networks are important for truck, taxi, and delivery fleets, and taxi drivers can receive call information on a screen. Although wireless networks and mobile technology

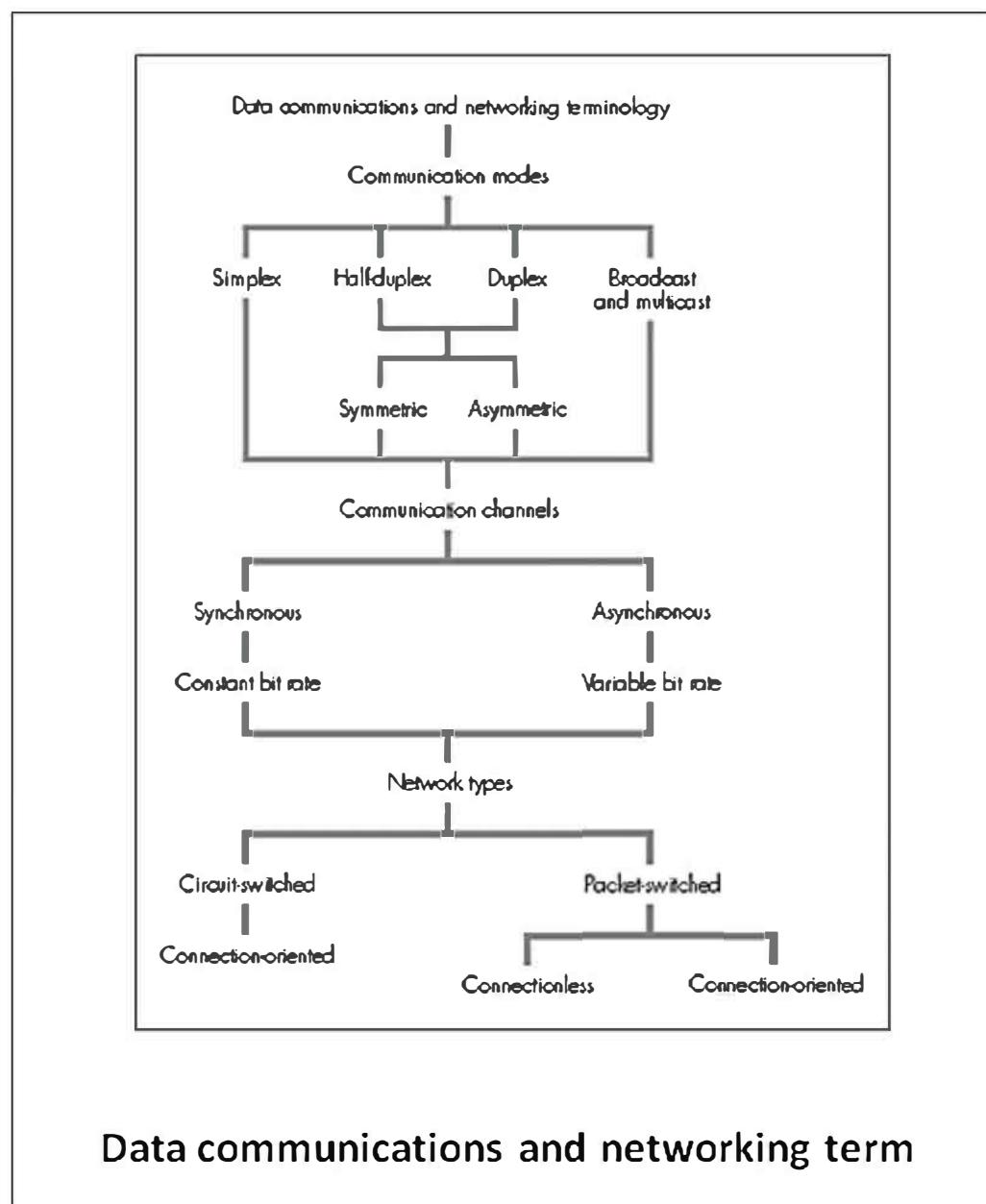
are often associated with informatics, they are not the same. In homes, offices, and hotels, wired connections are acceptable, but wireless technology is more comfortable.

Chapter 2

Data Communication

A selection of terms and conditions for the transfer of data and computer networks is an essential problem.

The transfer of data flow associated with the type of applications, and can be done with one of the five modes of operation:



Simplex:

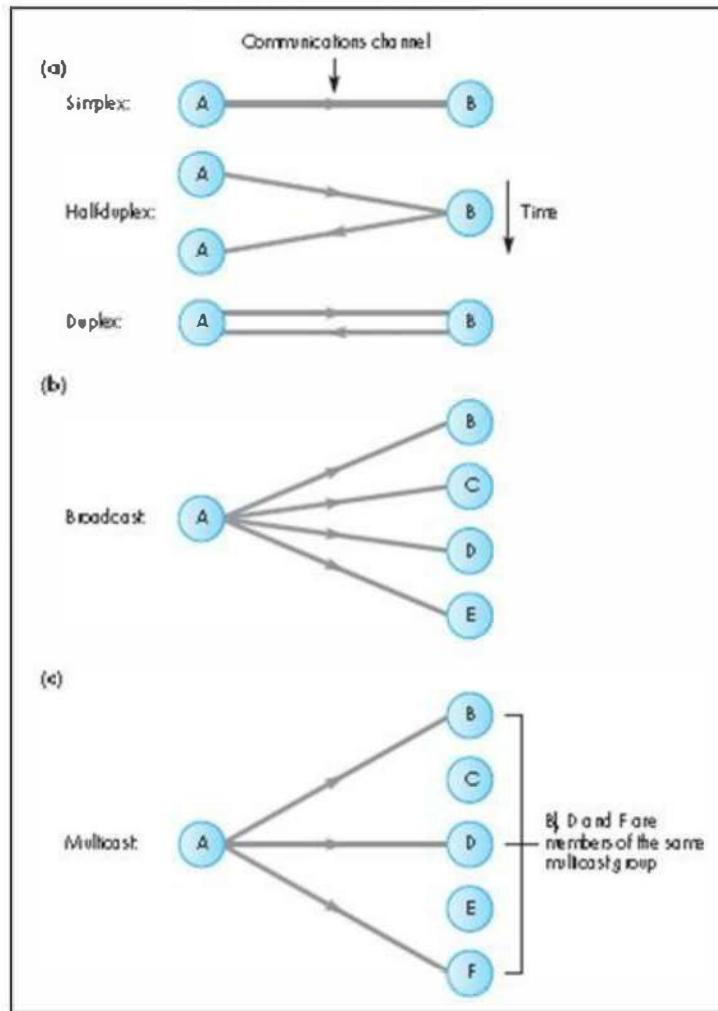
The data relating to the request flows in one direction only. An example is the transmission of photographic images from a space probe. This implies a unidirectional stream of data from the probe to an earth station.

Half Duplex:

The data travels in both directions, but alternately. This mode can be called a **two-way alternate** and an example is a user who performs a request for some of the data from a remote server and the last to return the requested data.

Full Duplex:

The data flows in both directions at the same time. An example is the two-way flow of digitized speech associated with a telephony application.



Communication modes: (a) unicast; (b) broadcast; (c) multicast

Broadcast:

The output of data from the sender is received from all other receivers; an example is the production of a television program on a network of cables,

Multicast:

It is a broadcast, but the performance of the data by the sender is received by only a specific subset of the receiver.

Video conferencing involves a predefined group of devices connected to a network exchange of speech and video stream.

In semi-duplex and duplex algorithms, the amount of data in each Direction can be equal or different. The flow of data is **symmetrical** if the amount of data flow is equal and, if it is different called asymmetrically.

For example, an exchange of video telephone speech and video flows in both directions simultaneously.

Alternately, in a browser and a Web server, a low bit-rate come to the server and higher bit rate from the channel server for the subscriber.

Circuit Switching

A circuit-switching network includes the interrelated elements of a set of exchanges of switching into which the subscriber is connected to.

Before transmitting data, the sender begins to establish a connection via the network. Each device subscriber uses a network exclusive-large number/address associated with it.

The sender has between its phone number and the address of the communication partner proposed.

The local switching exchange then uses this to install a connection via the network.

Assuming that the destination is free and ready to receive a call, a message is returned to the sender demonstrating that he can now begin to carry data.

Circuit-switching network suffers from a delay

while a connection is established.

Two examples of networks that operate in this way are PSTN and ISDN.

In the PSTN, a delay can go from one part of a second to several seconds for an international call. In an ISDN network, the time can vary from a few tens of milliseconds to several hundred milliseconds.

Packet Switching

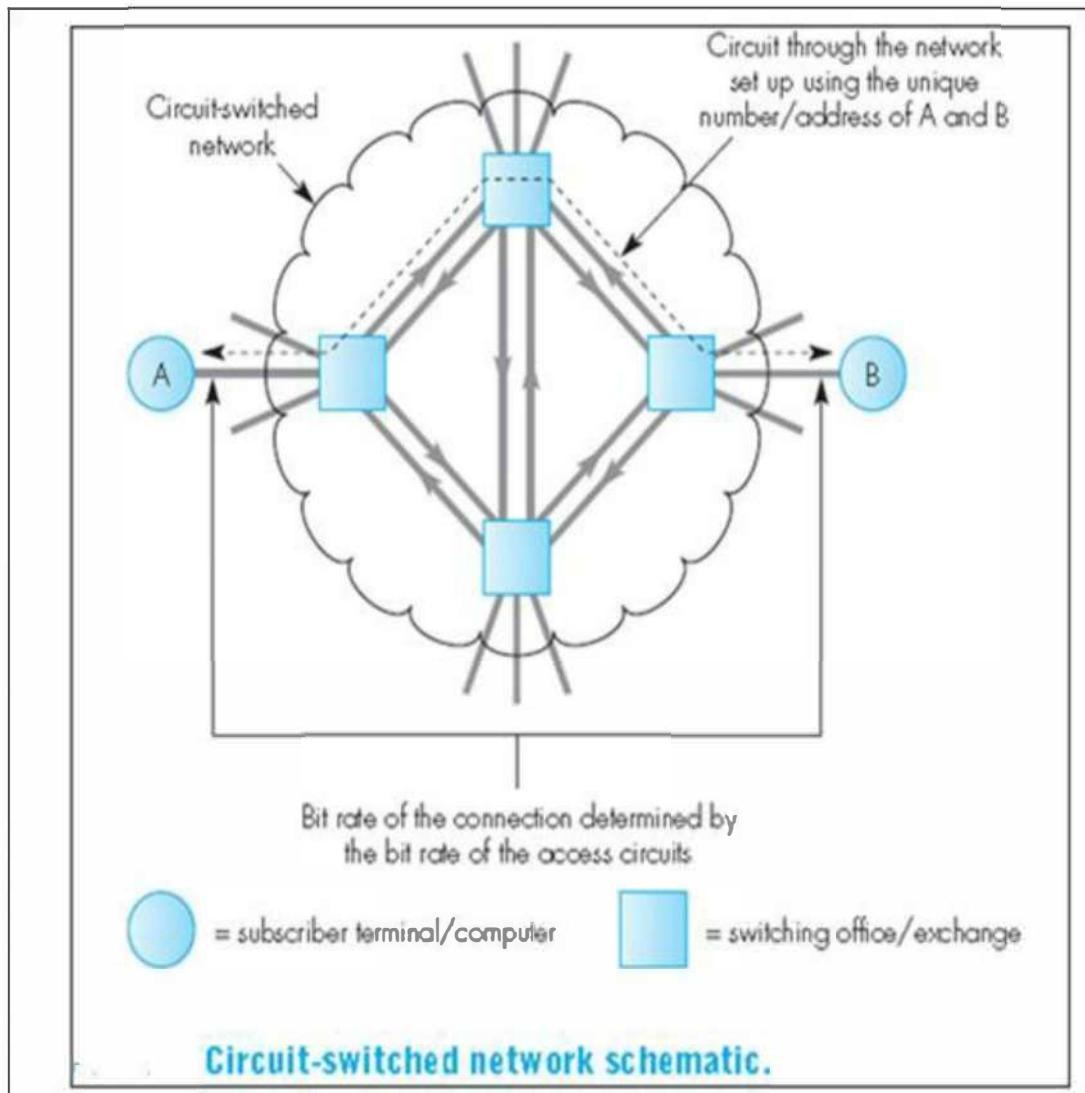
Packet-switched has two types:

The first one is connection-oriented (CO) and the second is connectionless (CL). The basis of a connection-oriented network comprises an interconnected set of packet-switching exchanges (PSEs).

A device that is connected to the network has an exclusive network-wide number/address correlated with it.

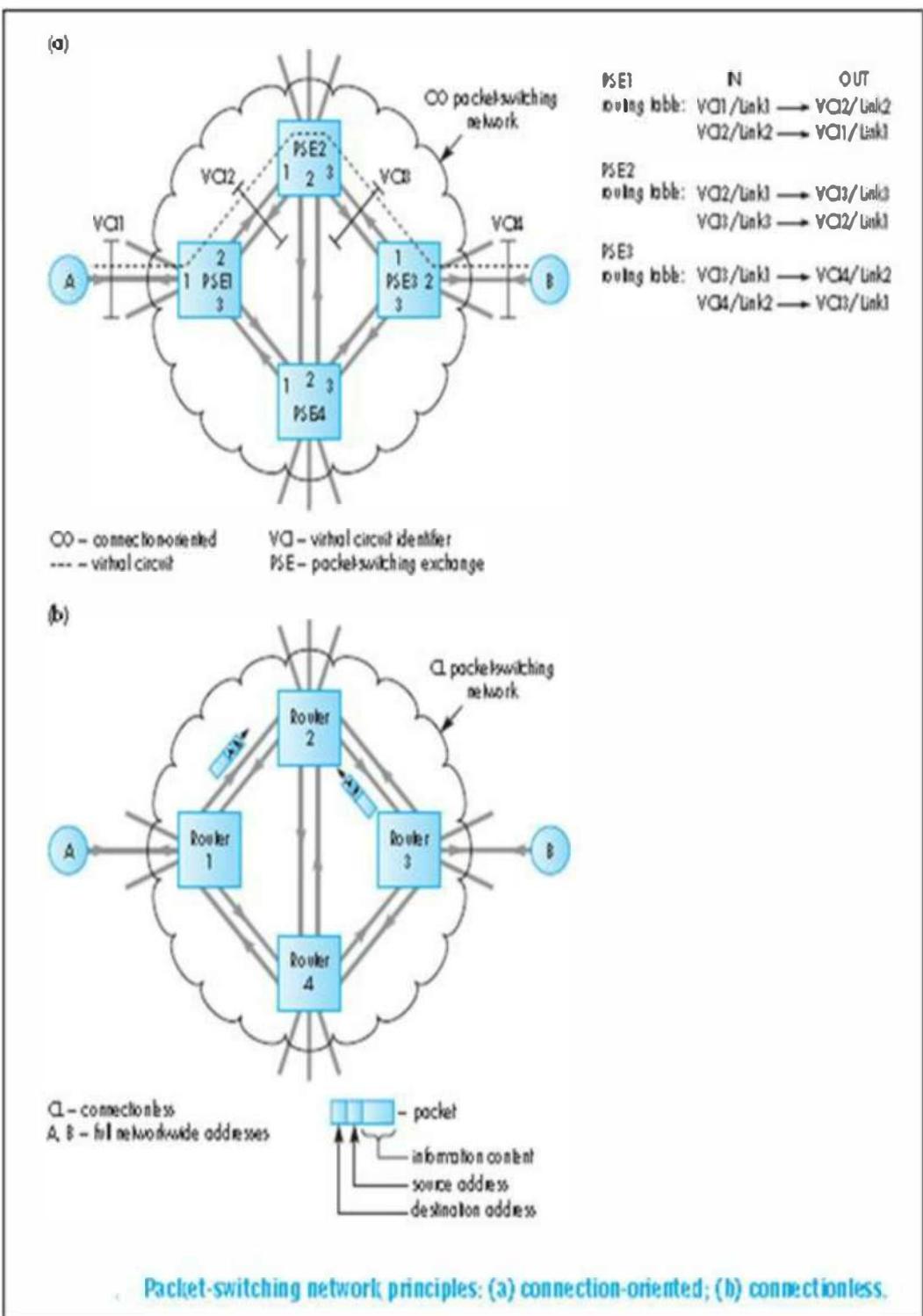
Connection Oriented Network implies, before any data

is sent, a beginning connection through the network of the sender address and terminals of destination.



In a packet-switching network, the connection/circuit is configured with only a part of the bandwidth of the connections.

The connection is called virtual circuit (V3).



On the other hand, uses a connectionless network, the connection is not required and the two communicating terminals/computers can exchange data and communicate if they wish. To do this, each packet must contain the full source and destination addresses in the header to route each PSE carrying the package to the appropriate outbound link.

Types of transmission media

The transmission of an electrical signal requires a physical environment.

This environment can be composed of a pair of conductors or cables. Other options are a ray of light through fiber or the transfer of electromagnetic waves through the free space.

The nature of the transmission is essential because the different types of media have bandwidths dissimilar that are associated with them.

The bandwidth determines the maximum flow rate that can

be used.

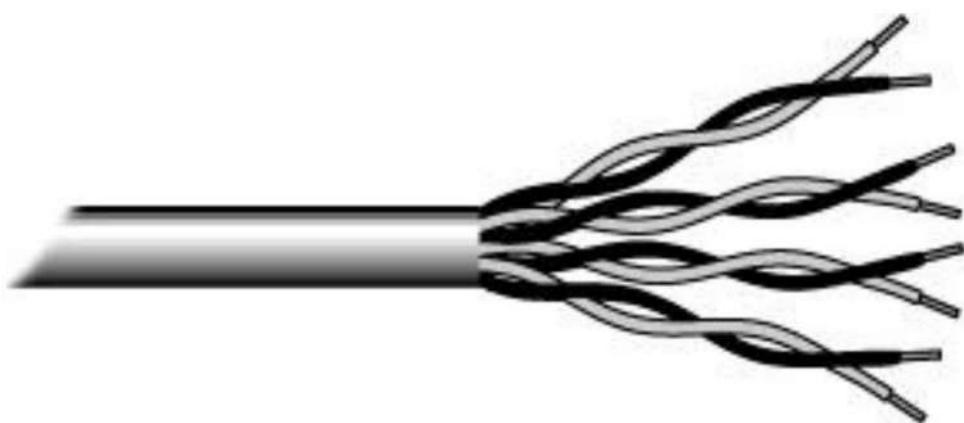
These are the common types of transmission media:

- Coaxial Cable
- Shielded twisted pair (STP) Cable
- Unshielded twisted pair (UTP)
- Fiber Optic Cable

Twisted pair cable has two types: unshielded cable and shielded cable.

Unshielded twisted pair (UTP)

Unshielded twisted pair (UTP) is primarily used in a cheap network.



Unshielded Twisted Pair

The class of the UTP varies from low-quality wire to high-quality cable. The cable is composed of four pairs of wires to the inside of the cover.

Each pair is twisted to eliminate the interference of neighboring pairs and other electronic devices.

The EIA/TIA put standards for UTP and its categories.

UTP Categories - Copper Cable				
UTP Category	Data Rate	Max. Length	Cable Type	Application
CAT1	Up to 1Mbps	-	Twisted Pair	Old Telephone Cable
CAT2	Up to 4Mbps	-	Twisted Pair	Token Ring Networks
CAT3	Up to 10Mbps	100m	Twisted Pair	Token Ring & 10BASE-T Ethernet
CAT4	Up to 16Mbps	100m	Twisted Pair	Token Ring Networks
CAT5	Up to 100Mbps	100m	Twisted Pair	Ethernet, FastEthernet, Token Ring
CAT5e	Up to 1 Gbps	100m	Twisted Pair	Ethernet, FastEthernet, Gigabit Ethernet
CAT6	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (55 meters)
CAT6a	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (55 meters)
CAT7	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (100 meters)



RJ-45 Connector

Shielded twisted pair (STP) Cable

The UTP is affected by radio frequency interference and electrical. STP is appropriate for the media with an electrical noise.

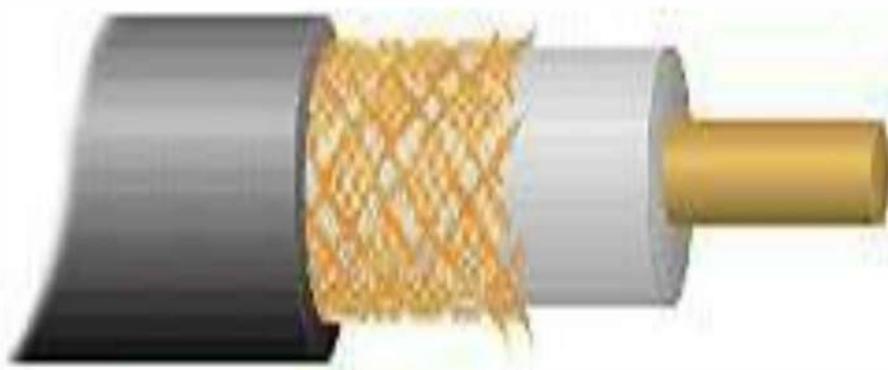
Shielded twisted pair used by the Token Ring networks.

Coaxial Cable

Coaxial cable consists of a copper conductor in its center.

Plastic provides isolation between the conductor and a metal shielding braid.

The metal shield prevents any outside interference from other devices.



Coaxial Cable

The coaxial cable is very resistant to interference so it supports the long cable.

There are two types of coaxial cable.

-Thick coaxial cable

-Thin Coax.

Thin coaxial cable 10Base2 code refers to a specification for coaxial cable end the Ethernet transport.

The 2 means that the segment length maximum length is 200 meters.

Coaxial cable is used essentially inexpensive networks, mainly the networks of the linear bus.

Thick coaxial cable called thicknet. 10Base5 designates the qualifications for thick coaxial cable transport Ethernet signals.

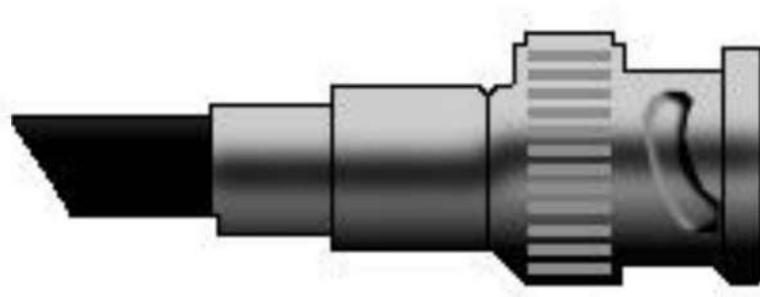
The 5 points to the maximum segment length are 500 meters.

Thick coaxial cable protected by the plastic cover to keep moisture away from the center conductor.

A thick coaxial cable is an excellent option when running long lengths in a network in the linear bus.

Coaxial cable connectors

The connector used with coaxial cable is the (BNC connector). Various types of adapters are available for the BNC connectors, for example, a T-connector, barrel connector, and the terminating resistor.



BNC Connector

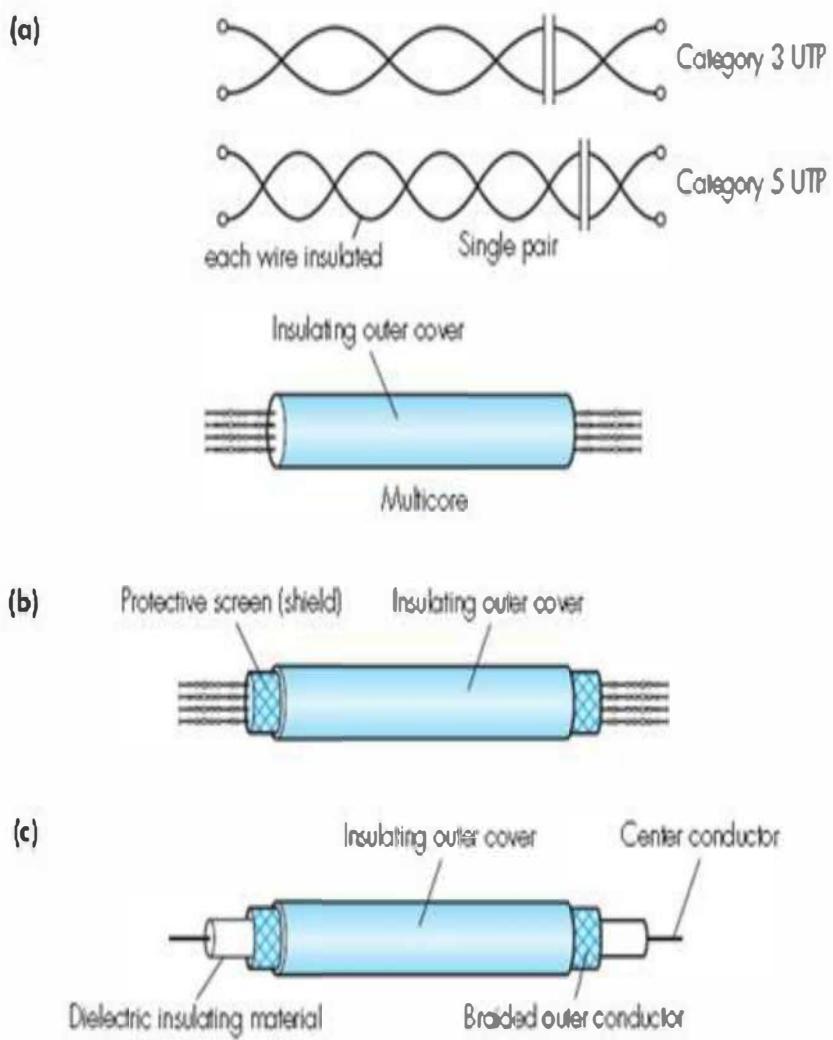


Figure 1.10 Copper wire transmission media: (a) unshielded twisted pair (UTP); (b) shielded twisted pair (STP); (c) coaxial cable.

Optical Fiber Cable

Fiber optic cabling consists of a core of glass in the enclosed environment of multiple layers of defense equipment.

It carries light instead of electronic signals to eliminate the difficulty of electrical noise.

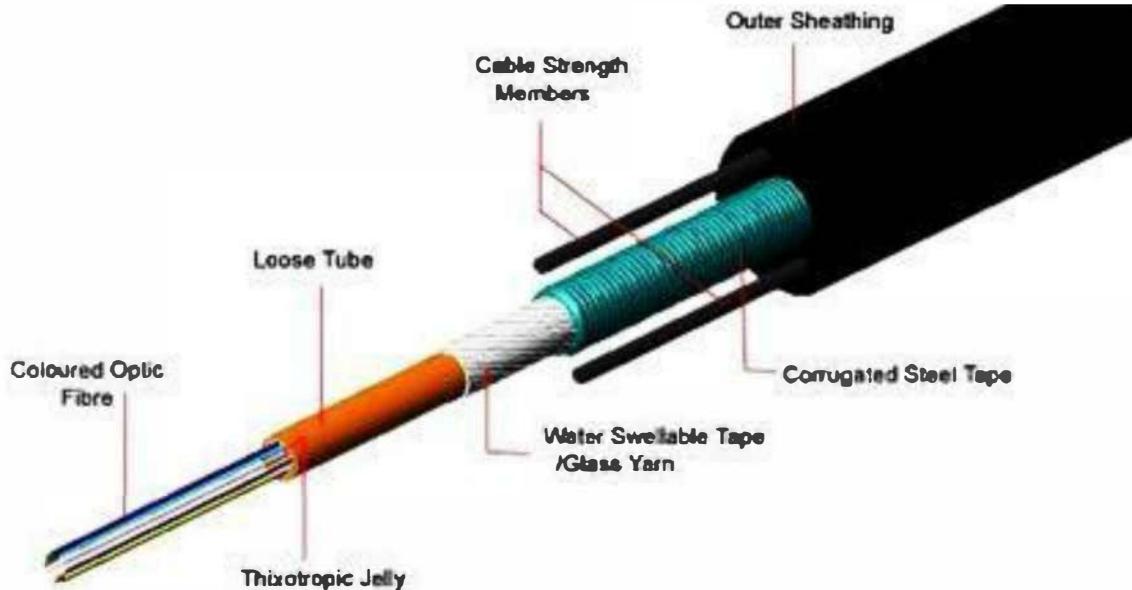
Optical fiber is the standard for environments that contain electrical interference.

It considers the connection of standard networks between buildings because of his immunity to the effects of moisture and light.

Fiber optic cable transmits signals at greater distances than a twisted pair and coaxial cables. It can take information at speeds much greater.

10BaseF designated the qualifications for fiber optic cable to transport Ethernet signals.

An optical receiver is used to make the rollover function at



the end of the reception. The transmitter uses a light-emitting diode (LED) or laser diode (LD) to make the conversion operation, while the receiver uses a light sensitive photodiode or phototransistor.

The fiber has two parts: an optical core and an optics coat with a low index of refraction. The light propagates along the core of the optical fiber in one of three ways depending on the type and width of the base material used.

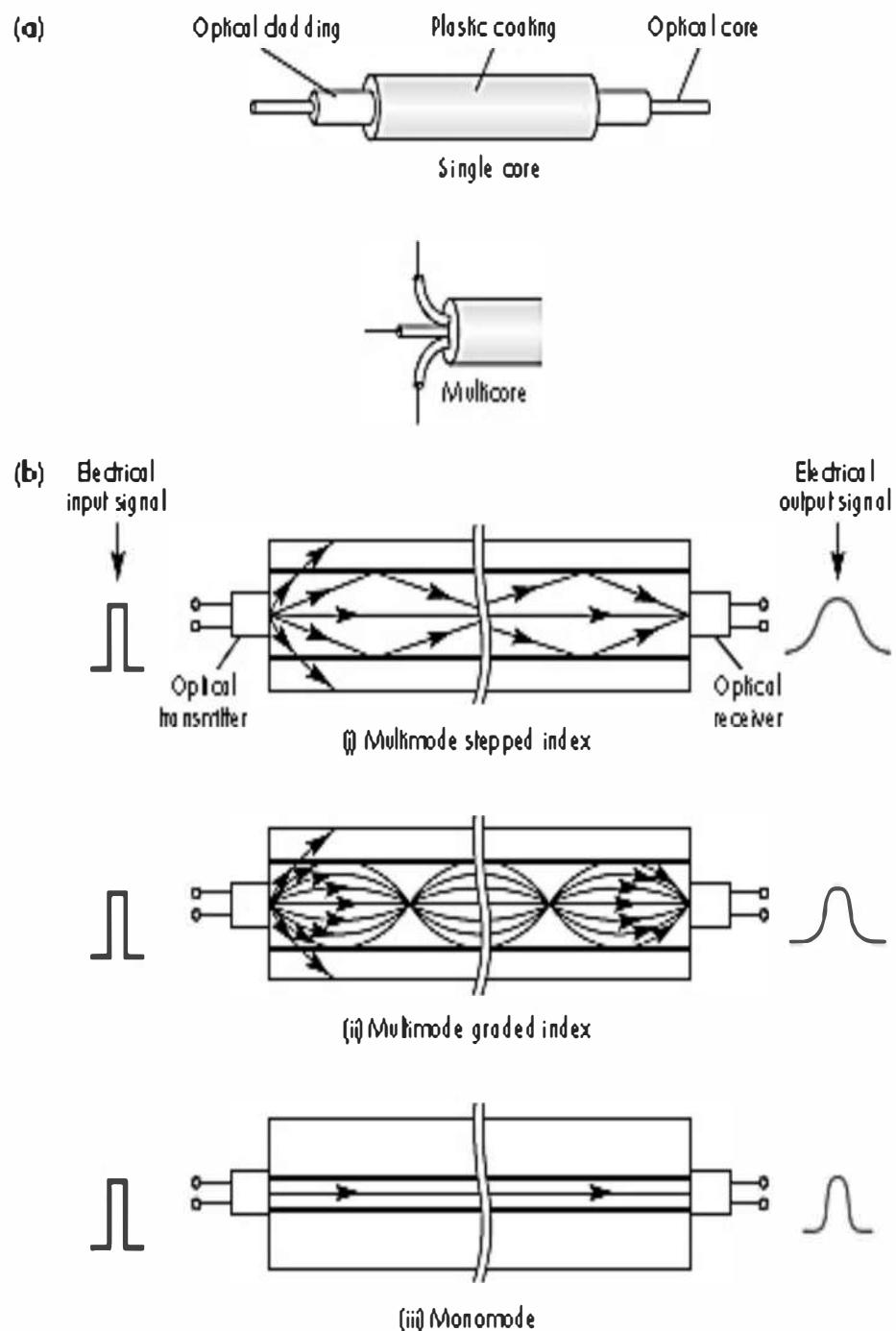
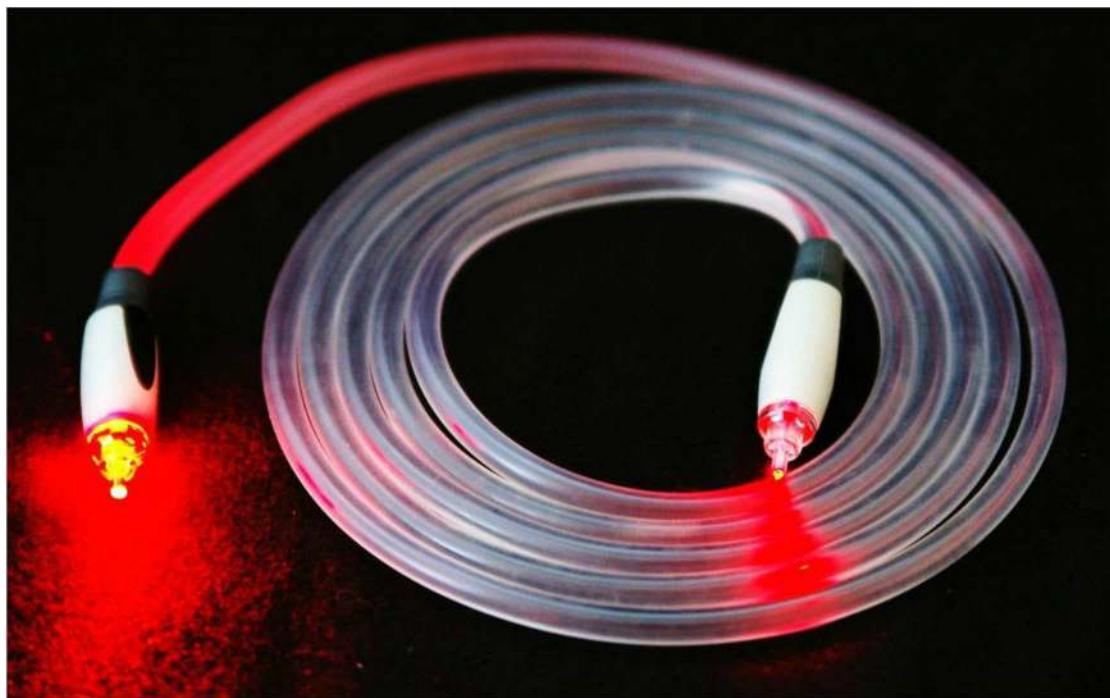


Figure 1.11 Optical fiber transmission media: (a) cable structures; (b) transmission modes.

In a Multimode optical fiber intensified index of the coating

material and the core of each have an index of refraction different but regular. All the light emitted by the light at an angle less than the critical angle is reflected at the level of the interface of coatings and is spreading along the heart through multiple reflections (internal). Depending on the angle at which it is emitted by the diode, the light will have a variable amount of time to spread along the cable.



Thus the received signal has a width wider than the input signal with a corresponding decrease in the maximum flow rate of the pulse. This effect is known as the dispersion of

means such as a cable is primarily used for rates of modest size LED with relatively inexpensive compared to laser diodes.

The dispersion can be reduced by using a base material having a variable (instead of constantly) the index of refraction. As shown in the figure in a fiber multi-mode index the light is refracted in a growing amount because it is away from the base. This has the effect of reducing the pulse width of the signal received by the report to the step index, allowing a fiber of a corresponding increase in the maximum flow.

The received signal is of a width comparable to the input signal and is called single-mode fiber. It is normally used with LDs and can operate at hundreds of Mbits/s.

In addition, several channels of transmission of high flow can be derived from the same fiber by using different parts of the bandwidth optical for each channel. This mode of operation is called wavelength division multiplexing (WDM) and, when this option is used, the flow rates are more than

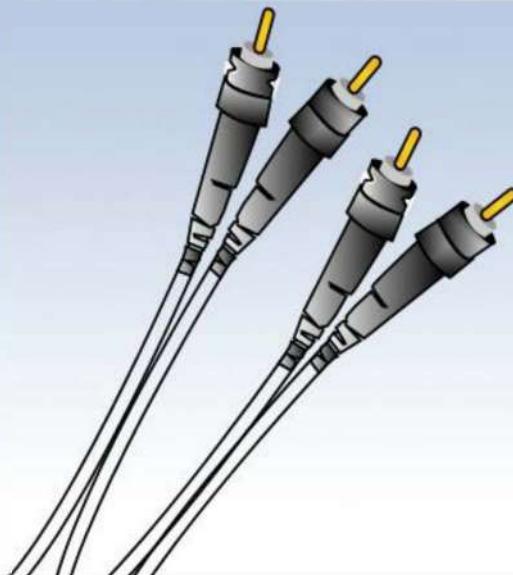
tens of GB/ s can be achieved.

"The Optical fiber connector

A fiber optic cable connector is an ST connector like a BNC connector. A connector more recently, the SC is more and more popular. It has a place in front, and it is easier to connect in a confined space.



STRAIGHT TIP (ST) CONNECTOR



Satellites

The data can be transmitted by radio (electromagnetic waves through space and TV A microwave beam climate is transmitted to the satellite from the ground.

This beam is received and relayed to the specified destination (s) using a circuit card known as a transponder. A satellite has several transponders, each covering a band of particular frequencies.

A satellite channel typically has a bandwidth,

extremely high (500 MHz), and can provide several hundred high-speed links of data using a technique known as the name of time-division multiplexing (TDM).

Microwave

Microwave Links are widely used to establish communication links when it is unreasonable or too costly for the configuration of transmission medium physical.

Ethernet Cables

The Ethernet cable types available are:

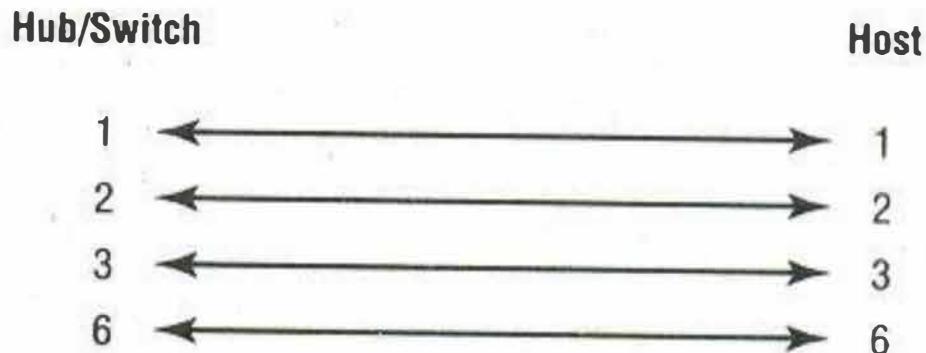
- Rolled cable.
- Crossover Cable
- Straight-through cable

Straightforward cable

It is used with Ethernet, Token Ring, ISDN, etc.

The cable used to connect the Router to switch or hub

The host to the switch or hub

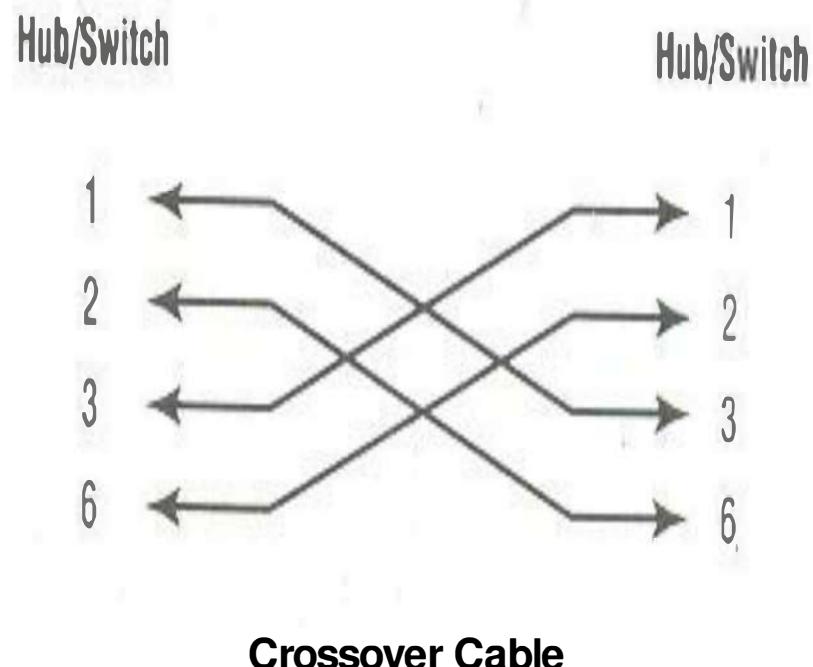


Straightforward cable

Crossover Cable

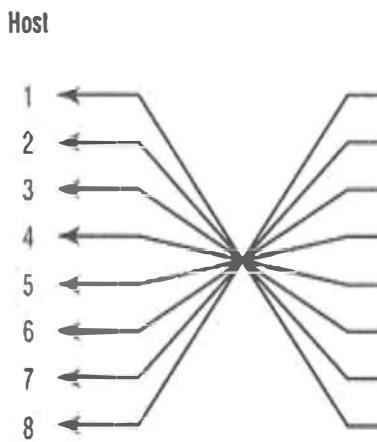
This type of cable is used to connect:

- Hub / Switch
- Router directly to the host
- Switch to switch
- Hub to hub
- Host-to-host
- Hub / Switch
- Router directly to the host



Rolled Cable

**Rolled Ethernet cable is perhaps connecting a host to
a router console serial communication port (com).**



Ethernet Cable Summary Table

Maximum length	Cable Type	Specification
100meters	Unshielded Twisted Pair	10BaseT
185Meters	Thin Coaxial	10Base2
500Meters	Thick Coaxial	10Base5
2000Meters	Fiber Optic	10BaseF
100Meters	Unshielded Twisted pair	100BaseT
220Meters	Unshielded Twisted Pair	100BaseTX