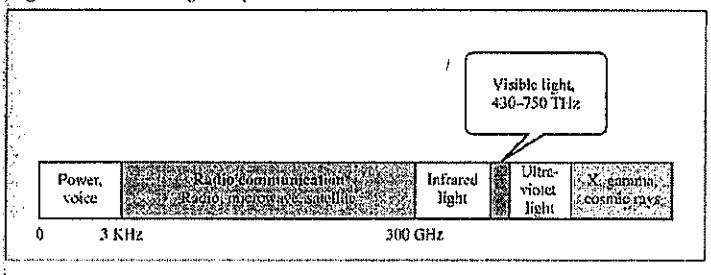
Transmission Media

- The transmission medium is the physical path by which a message travels from sender to receiver.
- Computers and telecommunication devices use signals to represent data.
- These signals are transmitted from a device to another in the form of electromagnetic energy.
- Examples of Electromagnetic energy include power, radio waves, infrared light, visible light, ultraviolet light, and X and gamma rays.
- All these electromagnetic signals constitute the **electromagnetic spectrum**

Figure 7.1 *Electromagnetic spectrum*



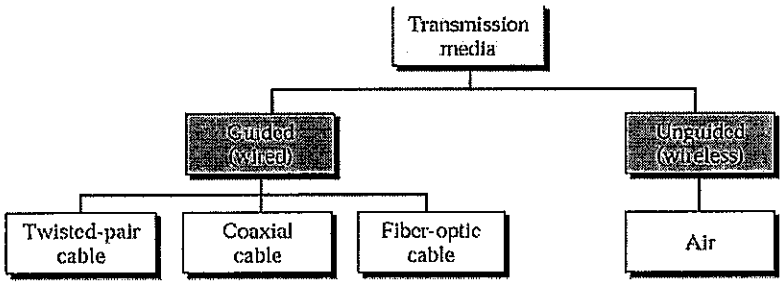
•Not all portion of the spectrum are currently usable for telecommunications

•Each portion of the spectrum requires a particular transmission medium

Signals of low frequency

- Signals of low frequency (like voice signals) are generally transmitted as current over metal cables. It is not possible to transmit visible light over metal cables, for this class of signals is necessary to use a different media, for example fiber-optic cable.

Classes of transmission media



Transmission Media

- Guided media, which are those that provide a conduit from one device to another.
- Examples: twisted-pair, coaxial cable, optical fiber.
- Unguided media (or wireless communication) transport electromagnetic waves without using a physical conductor. Instead, signals are broadcast through air (or, in a few cases, water), and thus are available to anyone who has a device capable of receiving them.

Guided Media

There are three categories of guided media:

1. Twisted-pair cable
2. Coaxial cable
3. Fiber-optic cable

Twisted-pair cable

- Twisted pair consists of two conductors (normally copper), each with its own plastic insulation, twisted together.
- Twisted-pair cable comes in two forms: unshielded and shielded
- The twisting helps to reduce the interference (noise) and crosstalk.

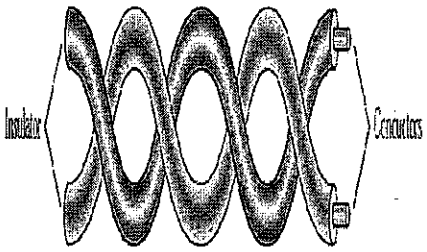


Figure 7.4 *Frequency range for twisted-pair cable*

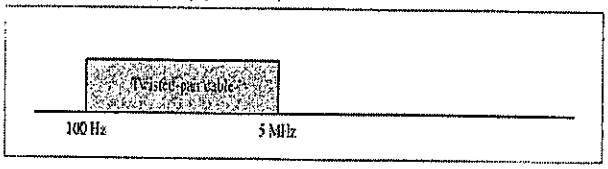
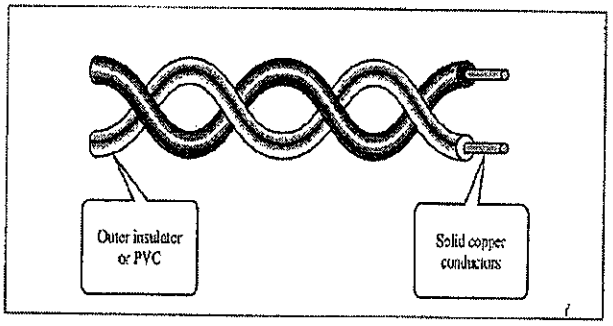
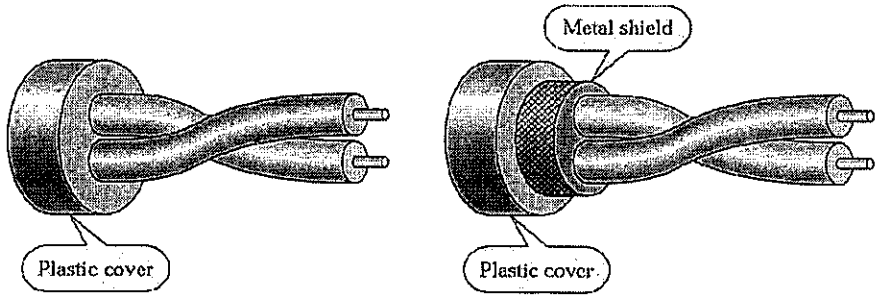


Figure 7.5 *Twisted-pair cable*

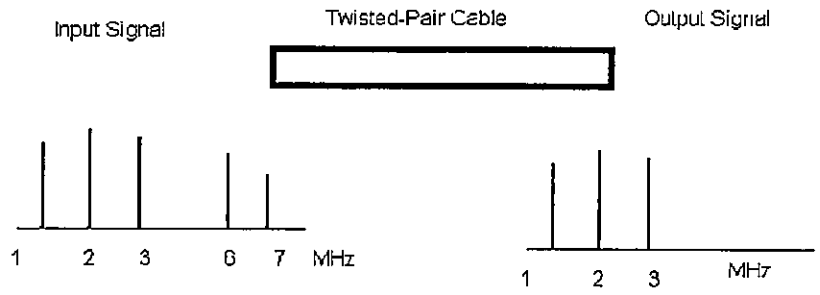


UTP and STP



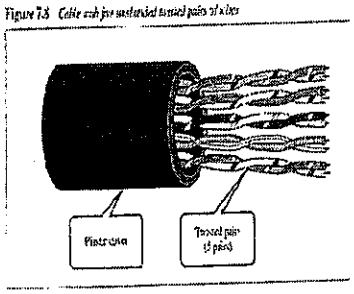
a. UTP b. STP

Frequency range for twisted-pair cable



Unshielded Twisted-pair (UTP) cable

- Any medium can transmit only a fixed range of frequencies!
- UTP cable is the most common type of telecommunication medium in use today.
- The range is suitable for transmitting both data and video.
- Advantages of UTP are its cost and ease of use. UTP is cheap, flexible, and easy to install.



The Electronic Industries Association (EIA) has developed standards to grade UTP.

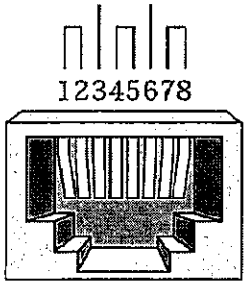
1. Category 1. The basic twisted-pair cabling used in telephone systems. This level of quality is fine for voice but inadequate for data transmission.
2. Category 2. This category is suitable for voice and data transmission of up to 2Mbps.
3. Category 3.This category is suitable for data transmission of up to 10 Mbps. It is now the standard cable for most telephone systems.
4. Category 4. This category is suitable for data transmission of up to 20 Mbps.
5. Category 5. This category is suitable for data transmission of up to 100 Mbps.

Table 7.1 Categories of unshielded twisted-pair cables

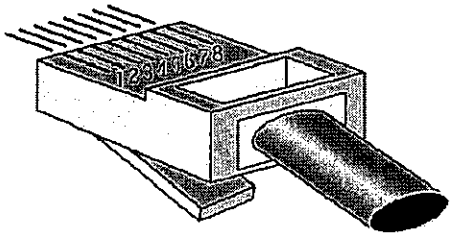
Category	Bandwidth	Data Rate	Digital/Analog	Use
1	very low	< 100 kbps	Analog	Telephone
2	< 2 MHz	2 Mbps	Analog/digital	T-1 lines
3	16 MHz	10 Mbps	Digital	LANs
4	20 MHz	20 Mbps	Digital	LANs
5	100 MHz	100 Mbps	Digital	LANs
6 (draft)	200 MHz	200 Mbps	Digital	LANs
7 (draft)	600 MHz	600 Mbps	Digital	LANs

UTP connectors

The most common UTP connector is RJ45 (RJ stands for Registered Jack).



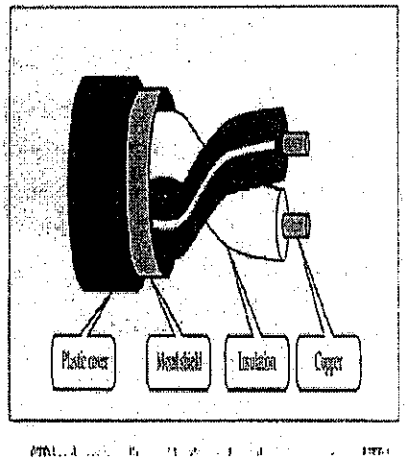
RJ-45 Female



RJ-45 Male

Shielded Twisted (STP) Cable

- STP cable has a metal foil or braided-mesh covering that enhances each pair of insulated conductors.
- The metal casing prevents the penetration of electromagnetic noise.
- Materials and manufacturing requirements make STP more expensive than UTP but less susceptible to noise.



Applications

- Twisted-pair cables are used in telephones lines to provide voice and data channels.
- The DSL lines that are used by the telephone companies to provide high data rate connections also use the high-bandwidth capability of unshielded twisted-pair cables.
- Local area networks, such as 10Base-T and 100Base-T, also used UTP cables.

Coaxial Cable (or coax)

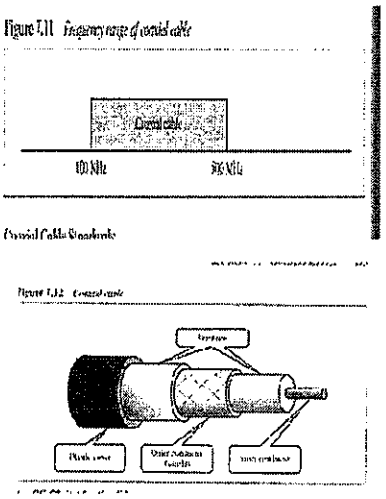
- Coaxial cable carries signals of higher frequency ranges than twisted-pair cable.

- Coaxial Cable standards:

RG-8, RG-9, RG-11 are used in thick Ethernet

RG-58 Used in thin Ethernet

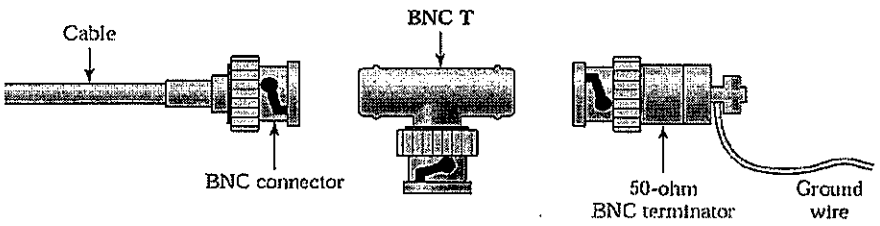
RG-59 Used for TV



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.

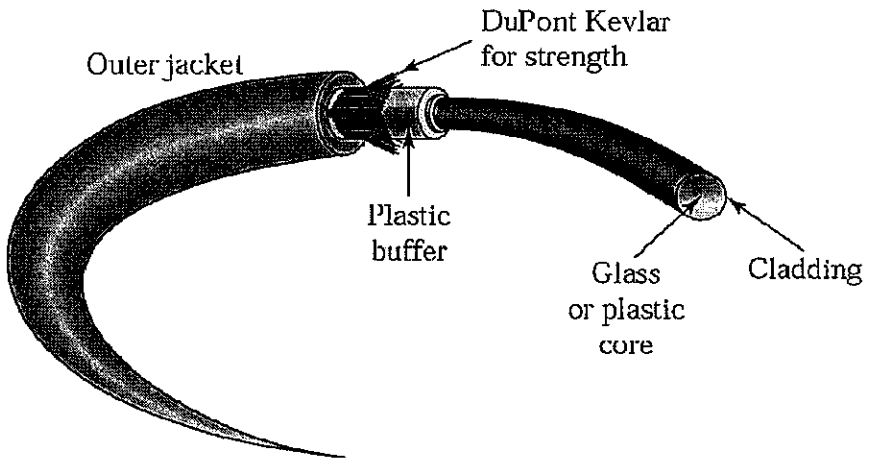
Applications include cable TV networks, and some traditional Ethernet LANs like 10Base-2, or 10-Base5.



Optical Fiber

- Metal cables transmit signals in the form of electric current.
- Optical fiber is made of glass or plastic and transmits signals in the form of **light**.
- Light, a form of electromagnetic energy, travels at 300,000 Kilometers/second (186,000 miles/second), in a vacuum.
- The speed of the light depends on the density of the medium through which it is traveling (the higher density, the slower the speed).

Fiber construction

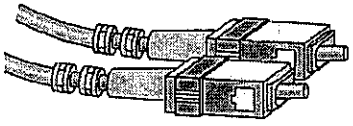


Types of Optical Fiber

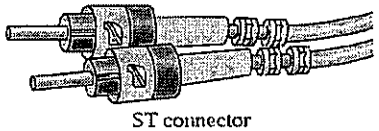
- **There are two basic types of fiber: multimode fiber and single-mode fiber.**
- **Multimode fiber is best designed for short transmission distances, and is suited for use in LAN systems and video surveillance.**
- **Single-mode fiber is best designed for longer transmission distances, making it suitable for long-distance telephony and multichannel television broadcast systems.**

Fiber-optic cable connectors

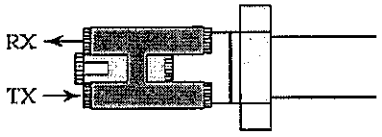
The subscriber channel (SC) connector is used in cable TV. It uses a push/pull locking system. The straight-tip (ST) connector is used for connecting cable to networking devices. MT-RJ is a new connector with the same size as RJ45.



SC connector



ST connector



MT-RJ connector

Advantages of Optical Fiber

- The major advantages offered by fiber-optic cable over twisted-pair and coaxial cable are **noise resistance, less signal attenuation, and higher bandwidth**.
- **Noise Resistance**: Because fiber-optic transmission uses light rather than electricity, noise is not a factor. External light, the only possible interference, is blocked from the channel by the outer jacket.

Advantages of Optical Fiber

- **Less signal attenuation**

Fiber-optic transmission distance is significantly greater than that of other guided media. A signal can run for miles without requiring regeneration.

- **Higher bandwidth**

Currently, data rates and bandwidth utilization over fiber-optic cable are limited not by the medium but by the signal generation and reception technology available.

Disadvantages of Optical Fiber

- The main disadvantages of fiber optics are **cost, installation/maintenance, and fragility**.
- Cost. Fiber-optic cable is expensive. Also, a laser light source can cost thousands of dollars, compared to hundreds of dollars for electrical signal generators.
- Installation/maintenance
- Fragility. Glass fiber is more easily broken than wire, making it less useful for applications where hardware portability is required.