Computer Networking & Communication

[4th Class....]

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Introduction:

Communication is the activity of conveying information through the exchange of thoughts, messages, or information, as by speech, visuals, signals, writing, or behavior. It is the meaningful exchange of information between two or more living creatures.

One definition of communication is "any act by which one person gives to or receives from another person information about that person's needs, desires, perceptions, knowledge, or affective states". The methods that we use to share ideas and information are constantly changing and evolving. Whereas the human network was once limited to face-to-face conversations, media breakthroughs continue to extend the reach of our communications. From the printing press to television, each new development has improved and enhanced our communication. Early data networks were limited to exchange character-based information between connected computer systems. Current networks have evolved to carry voice, video streams, text, and graphics between many different types of devices.

The immediate nature of communications over the Internet encourages the formation of global communities. These communities foster social interaction that is independent of location or time zone.

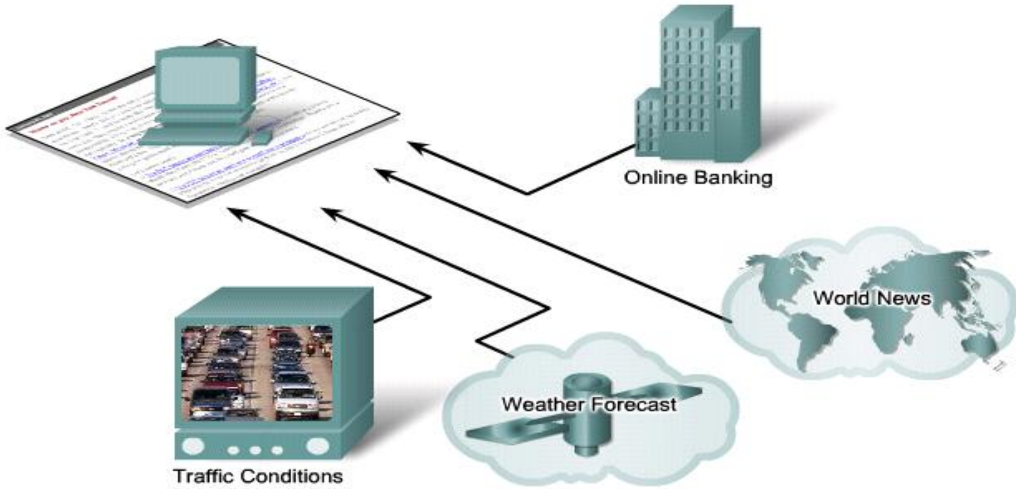

Figure 1: General network behavior

Network:

A network is a group of interconnected systems (devices) sharing services and interacting by means of a shared communications link. A simple idea is shown in figure 2

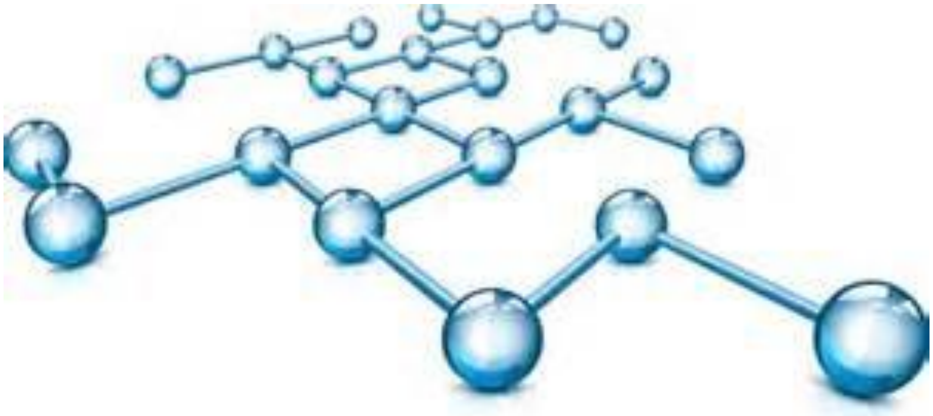

Figure 2 : General network

In general, all networks must have the following basic elements:

- Something to share (messages),

- A physical pathway (transmission medium),
- Rules of communication (protocols),
- Devices (computers, printers …), as in figure 3.

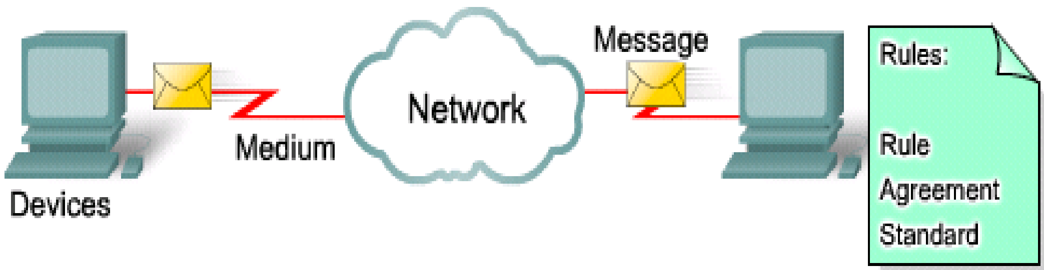

Figure 3: Four elements of network

A Computer Network or Data Network

Is a telecommunications network that allows computers to exchange data. In computer networks, networked computing devices (network nodes) pass data to each other along data connections. The connections (network links) between nodes are established using either cable media or wireless media. The best-known computer network is the Internet.

Why Networking PCs ?

- Sharing files,
- Sharing printers and other devices,
- Enabling common administration and security,

- Supporting network applications such as electronic mail and database services.

Quality of Communications:

As a message moves through the network, many factors can prevent the message from reaching the recipient or distort its intended meaning.

- External Factors:
  - ➢ The quality of the pathway between the sender and the recipient.
  - ➢ The number of times the message has to change form.
  - ➢ The number of times the message has to be redirected or readdressed.
  - ➢ The number of other messages being transmitted simultaneously on the communication network.
  - ➢ The amount of time allotted for successful communication.
- Internal Factors, figure4:
  - ➢ The size of the message.
  - ➢ The complexity of the message.
  - ➢ The importance of the message.

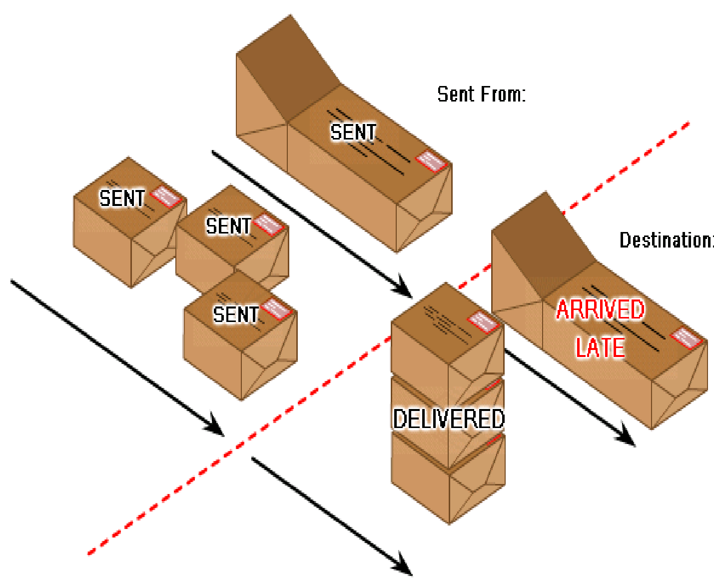

Figure 1.4: messages being sent and delivered

Transmission Media:

It's the physical medium that is used for physical communication between network devices.

Characteristics of Transmission Media:

Each type of transmission media has special characteristics that make it suitable for a specific type of service. These characteristics are:

- Cost.
- Installation requirements.
- Bandwidth. It refers to the measure of the capacity of the medium to transmit data. It's measured in bit per second (bps), or Byte per second (Bps).
- Band Usage (Baseband or Broadband). Figure 1.5.

Baseband devotes the entire capacity of the medium to one communication channel. (LAN). While **Broadband** enables two or more communication channels to share the bandwidth of the communications medium. (TV)

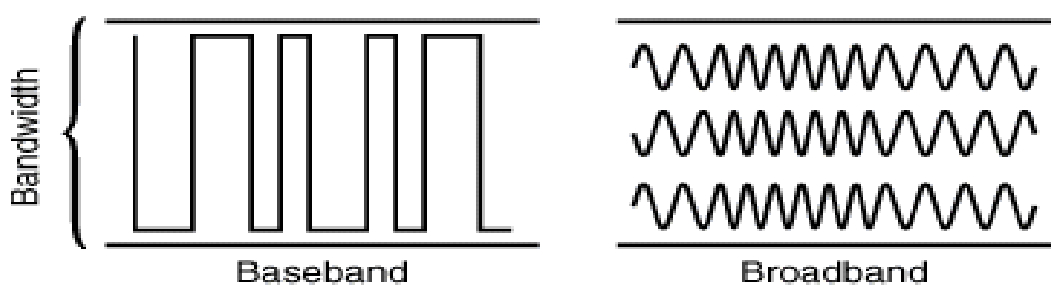

Figure 4: Baseband and broadband transmission modes.

Multiplexing:

Multiplexing is a technique that enables broadband media to support multiple data channels.

Demultiplexing:

Refers to recovering the original separate channels from a multiplexed signal, Multiplexing and Demultiplexing are performed by a multiplexor (also called MUX), which usually has both capabilities.

Frequency-Division Multiplexing (FDM):

Figure 1.5 illustrates (FDM). This technique works by converting all data channels to analog form. Each analog signal can be modulated by a separate frequency (called a carrier frequency) that makes it possible to recover that signal during the demultiplexing process. At the receiving end, the demultiplexor can select the desired carrier signal and use it to extract the data signal for that channel. One advantage of FDM is that it supports bidirectional signaling on the same cable.

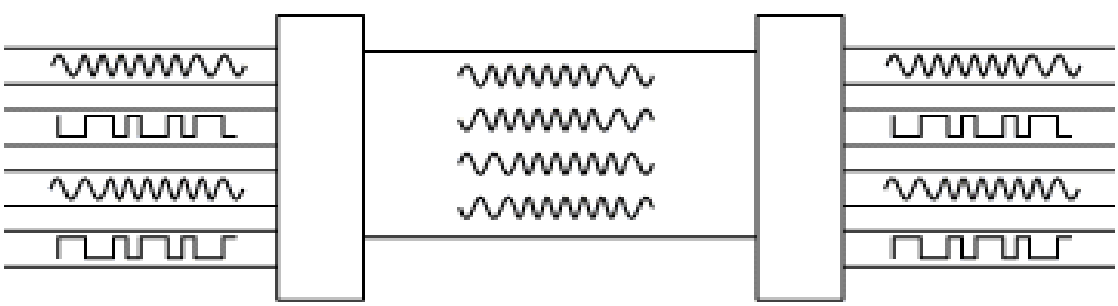

Figure 5: Frequency-division multiplexing.

Time-Division Multiplexing (TDM)

TDM divides a channel into time slots that are allocated to the data streams to be transmitted, as illustrated in figure 6. If the sender and receiver agree on the time-slot assignments, the receiver can easily recover and reconstruct the original data streams. In Statistical time-division multiplexing (StatTDM), a Stat-MUX uses the time-slot technique but allocates time slots based on the traffic demand on the individual channels as can be seen in figure 7.

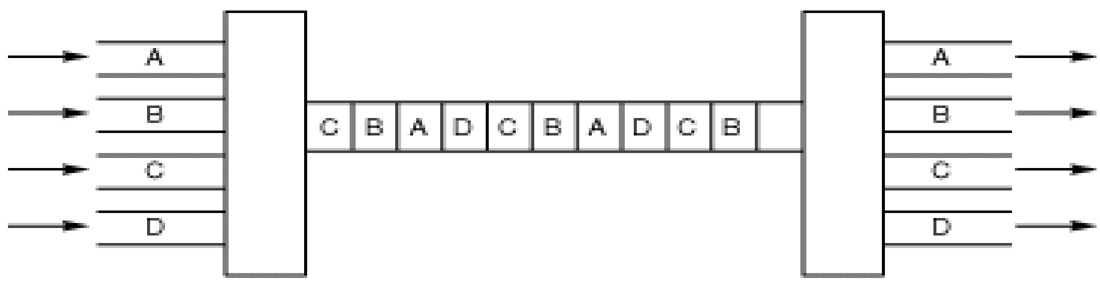

Figure 6: Time-division multiplexing creates time slots within the channel for the data streams.

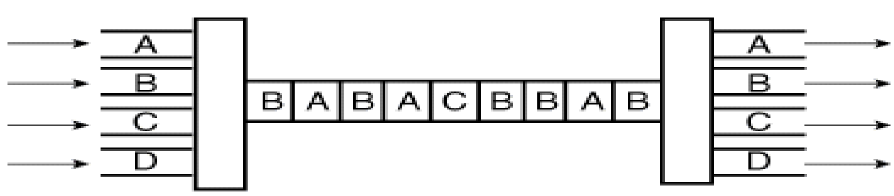

Figure 7: Statistical time-division multiplexing allocates time slots based on channels' traffic demand.

⇒ **Attenuation:**

It's a measure of how much a signal weakens as it travels through a medium. When signal strength falls below certain limits, the electronic equipment that receives the signal can experience difficulty in isolating the original signal from the noise present in all electronic transmissions.

⇒ **Electromagnetic Interference (EMI):**

EMI consists of outside electromagnetic noise that distorts the signal in a medium. Crosstalk is a special kind of interference caused by adjacent wires.

Types of Transmission Medium:

There are three main types of transmission media:

1- Copper media (voltages),

2- Optical media (lights),

3- Wireless media (radio frequencies).

1- Copper media:

⇒ **Coaxial:**

Coaxial cable consists of a copper conductor surrounded by a layer of flexible insulation, as shown in figure 8.

Over this insulating material is a woven copper braid, or metallic foil, that acts as the second wire in the circuit and as a shield for the inner conductor. This second layer, or

shield, also reduces the amount of outside electromagnetic interference. Covering the shield is the cable jacket. Coaxial cables are used to attach antennas to wireless devices.

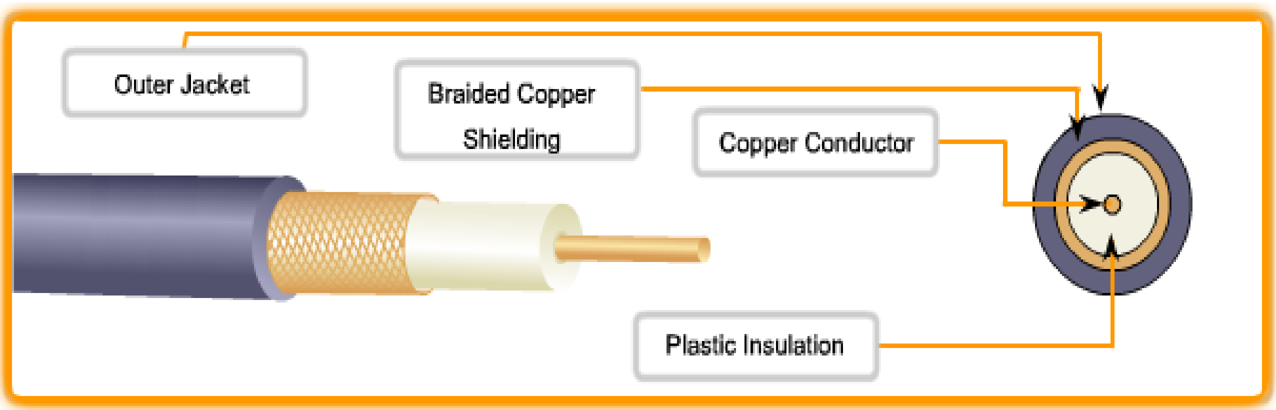

Figure 8: Coaxial Cable Design

There are two types of coaxial cable:

- **Thinnet 10Base 2**: 10 Mbps for about 185 meters.
- **Thicknet 10Base 5**: 10 Mbps for about 500 meters.

2- Twisted Pair:

A basic twisted-pair cable consists of two strands of copper wire twisted together as in figure 1.9.

✓ This twisting reduces the sensitivity of the cable to EMI.

✓ Reduces the tendency of the cable to radiate radio frequency noise that interferes with nearby cables and electronic components.

✓ Twisting also controls the tendency of the wires in the pair to cause crosstalk.

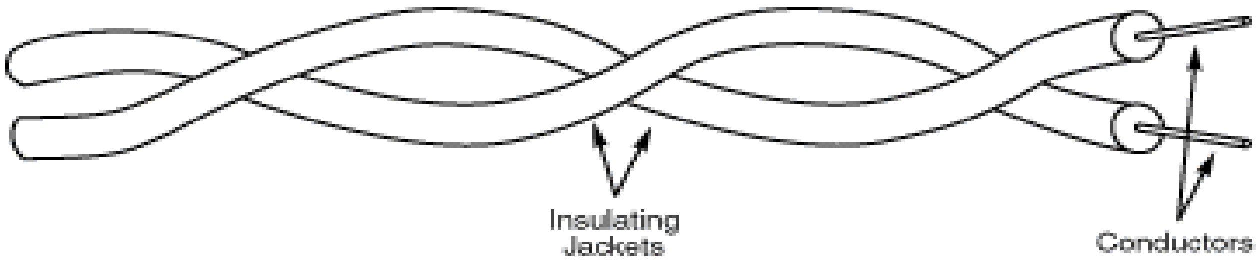

Figure 9: Twisted-pair cable.

There are two types of Twisted-pair cable:

i. **Unshielded Twisted Pair (UTP):**

Unshielded twisted-pair (UTP) cabling consists of four pairs of color-coded wires that have been twisted together and then encased in a flexible plastic sheath. As seen in figure 1.10, the color codes identify the individual pairs and wires in the pairs and aid in cable termination.

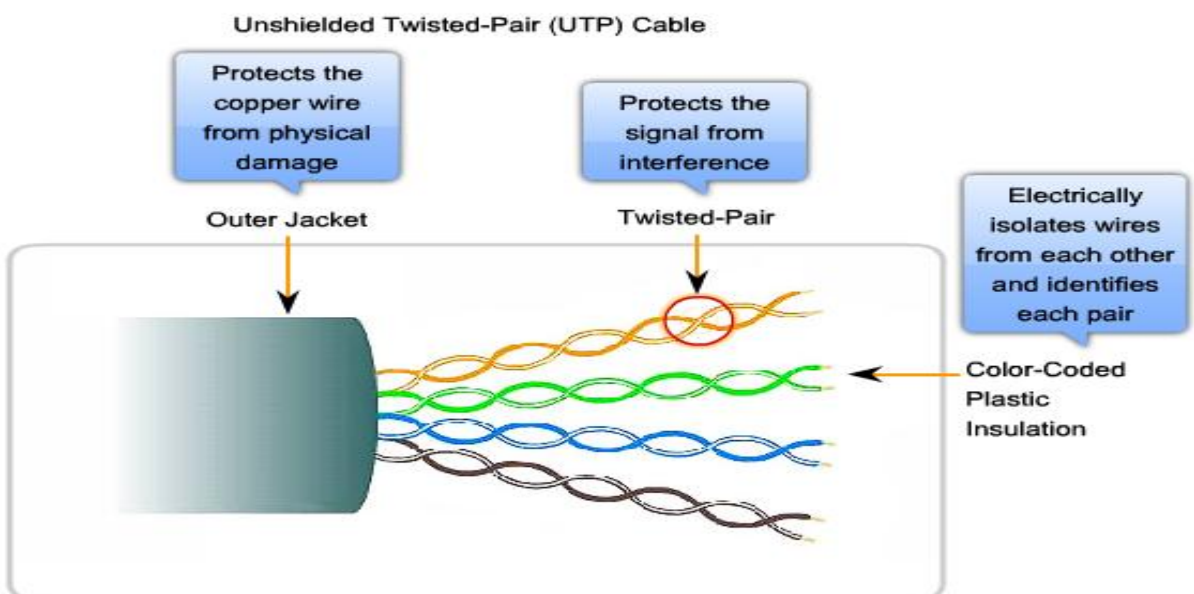

Figure 10: Unshielded Twisted Pair

UTP Cable is Available in the Following Categories:

- ✓ Cat 1 and 2. (Below 4 Mbps).
- ✓ Cat 3. This type of cable generally is suited for data rates up to 10 Mbps.
- ✓ Cat 4. Is suitable for data rates up to 16 Mbps.
- ✓ Cat 5. Is suitable for data rates up to 100 Mbps.
- ✓ Cat 5e. Is suitable for data rates up to 1000 Mbps (1Gbps).
- ✓ Cat 6. (1Gbps).

For UTP, 100m is the maximum allowed length.

Connectors of (UTP):

RJ-45 is the popular connector used with UTP cable as shown in figure 11. Figure 12 shows the pinout of UTP.

Figure11: RJ-45 Connector

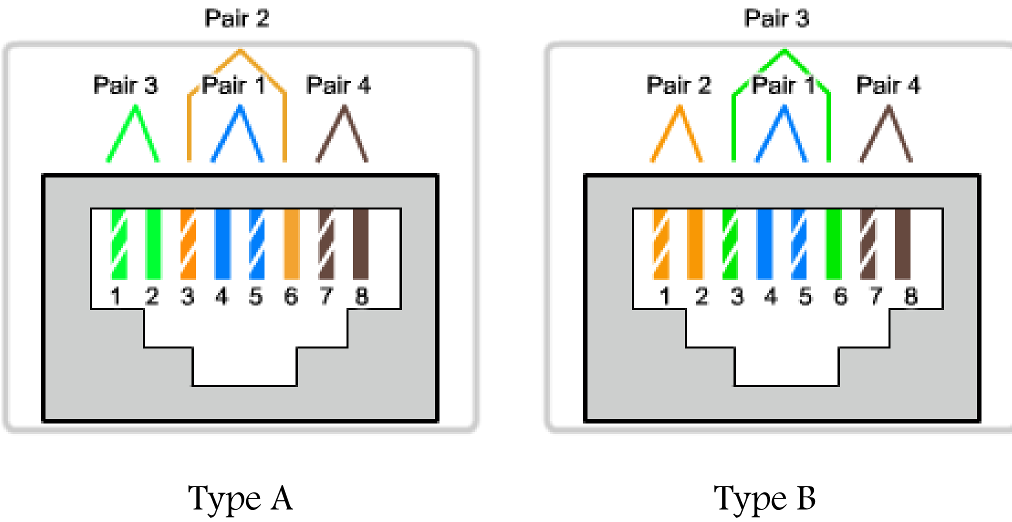

Figure 12: Different pinouts of RJ-45 with UTP cabling

Cabling of (UTP):

Different situations may require UTP cables to be wired according to different wiring conventions. The following are main cable types that are obtained by using specific wiring conventions:

- **Ethernet Straight-through**: both ends are either type A or type B. (different devices).
- **Ethernet Crossover**: one end is type A and the other end is Type B. (similar devices)

ii.Shielded Twisted Pair (STP).

STP uses two pairs of wires that are wrapped in an overall metallic braid or foil as in figure 13. STP cable shields the entire bundle of wires within the cable as well as the individual wire pairs. STP provides better noise protection than UTP cabling, however at a significantly higher price.

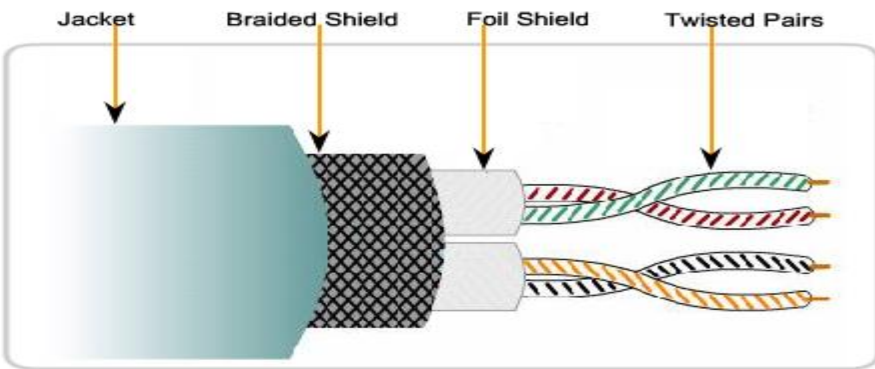

Figure 13: STP cable

Optical Fiber

Fiber-optic cabling uses either glass or plastic fibers to guide light impulses from source to destination. The bits are encoded on the fiber as light impulses. Fiber-optic cables can transmit 100 Mbps signals for several kilometers.

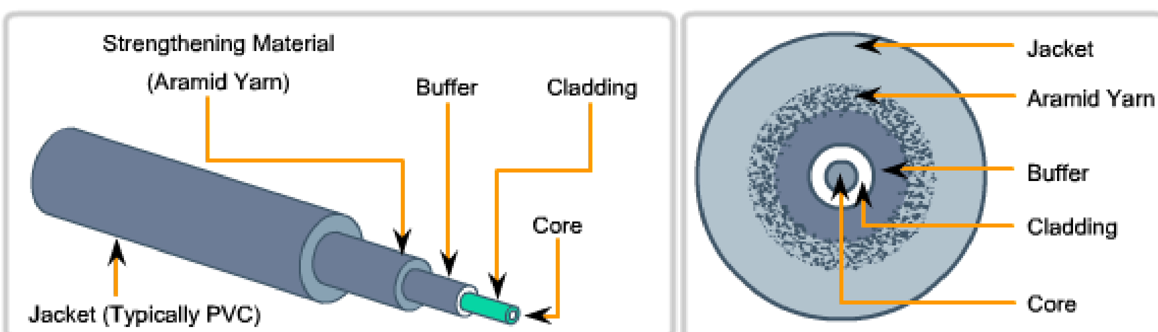

Figure14: Fiber Media Cable Design