MODULE-2: PHYSICAL LAYER

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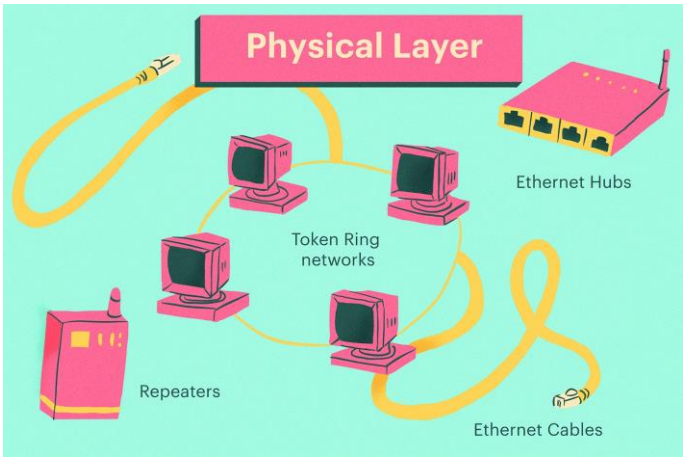

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Module 2 Physical Layer

Definition of Transmission Media

Transmission media are actually located below the physical layer and are directly controlled by the physical layer. You could say that transmission media belong to layer zero. Figure shows the position of transmission media in relation to the physical layer.

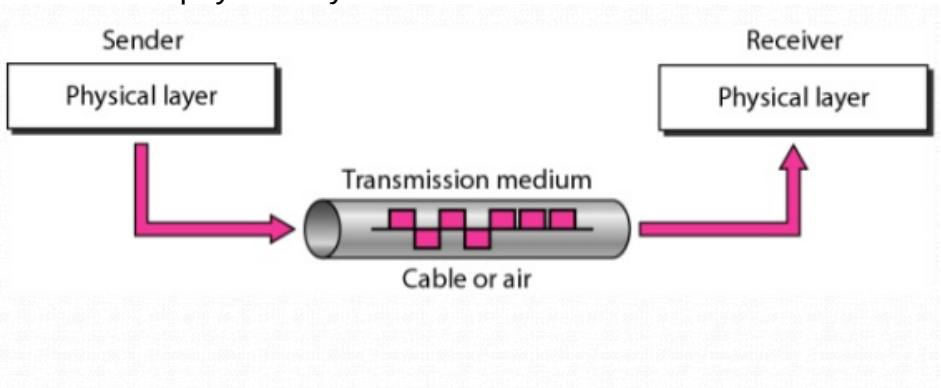


Figure: Transmission Media

Types of Transmission Media

Transmission Media is broadly classified into the following types:

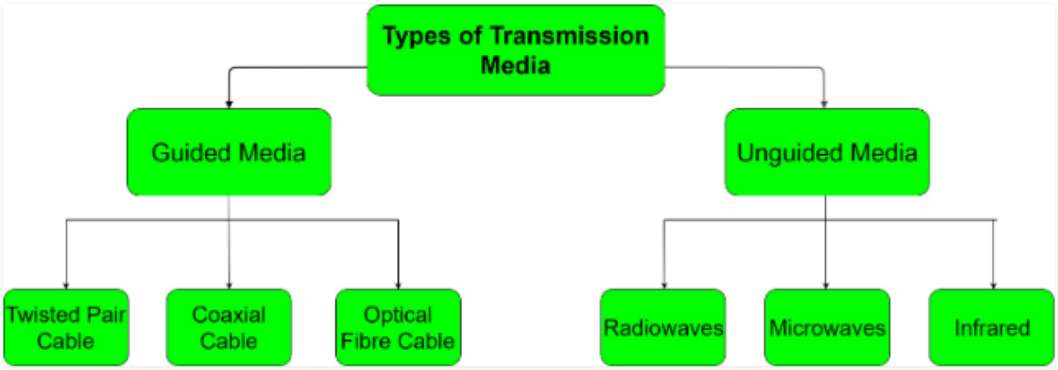


Figure: Types of Transmission Media

Guided Media:

It is also referred to as Wired or Bounded transmission media. Signals being transmitted are directed and confined in a narrow pathway by using physical links.

Features:

- High Speed
- Secure
- Used for comparatively shorter distances

Twisted Pair Cable

A twisted pair consists of two conductors (normally copper), each with its own plastic insulation, twisted together, as shown in Figure below :

Figure : Twisted-pair cable

1. One of the wires is used to carry signals to the receiver, and the other is used only as a ground reference. The receiver uses the difference between the two.
2. In addition to the signal sent by the sender on one of the wires, interference (noise) and crosstalk may affect both wires and create unwanted signals.
3. If the two wires are parallel, the effect of these unwanted signals is not the same in both wires because they are at different locations relative to the noise or crosstalk sources (e,g. one is closer and the other is farther). This results in a difference at the receiver.
4. By twisting the pairs, a balance is maintained. For example, suppose in one twist, one wire is closer to the noise source and the other is farther; in the next twist, the reverse is true.
5. Twisting makes it probable that both wires are equally affected by external influences (noise or crosstalk). This means that the receiver, which calculates the difference between the two, receives no unwanted signals. The unwanted signals are mostly canceled out..

Unshielded

This type of cable has the ability to block interference and does not depend on a physical shield for this purpose. It is used for telephonic applications.

Advantages:

- Least expensive
- Easy to install
- High speed capacity

Disadvantages:

- Susceptible to external interference
- Lower capacity and performance in comparison to STP
- Short distance transmission due to attenuation

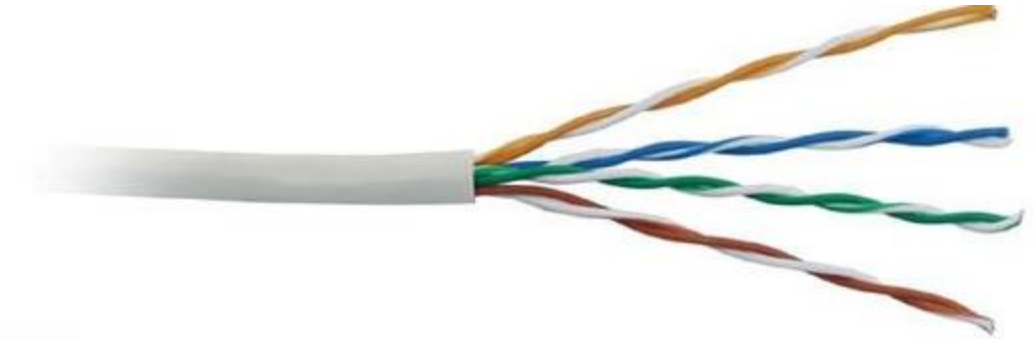


Figure: UTP

Shielded

This type of cable consists of a special jacket to block external interference. It is used in fast-data-rate Ethernet and in voice and data channels of telephone lines.

Advantages:

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

Disadvantages:

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

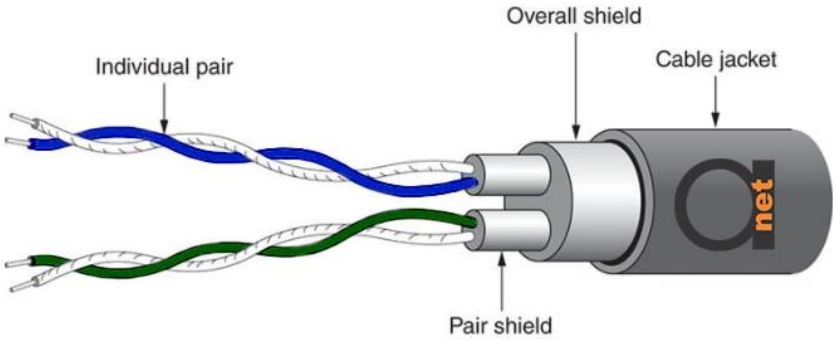
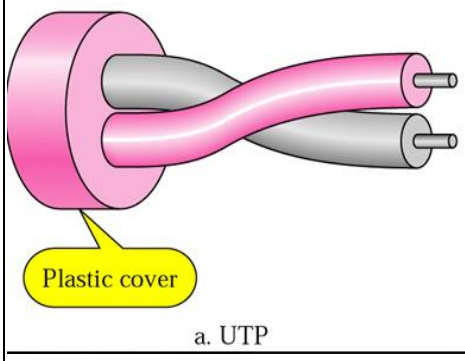
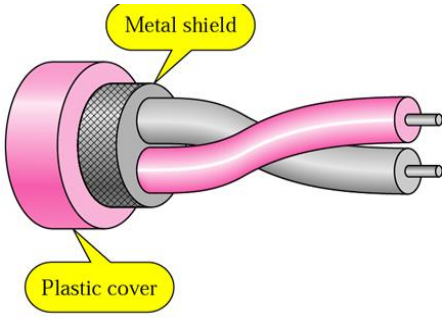


Figure: STP

The Difference

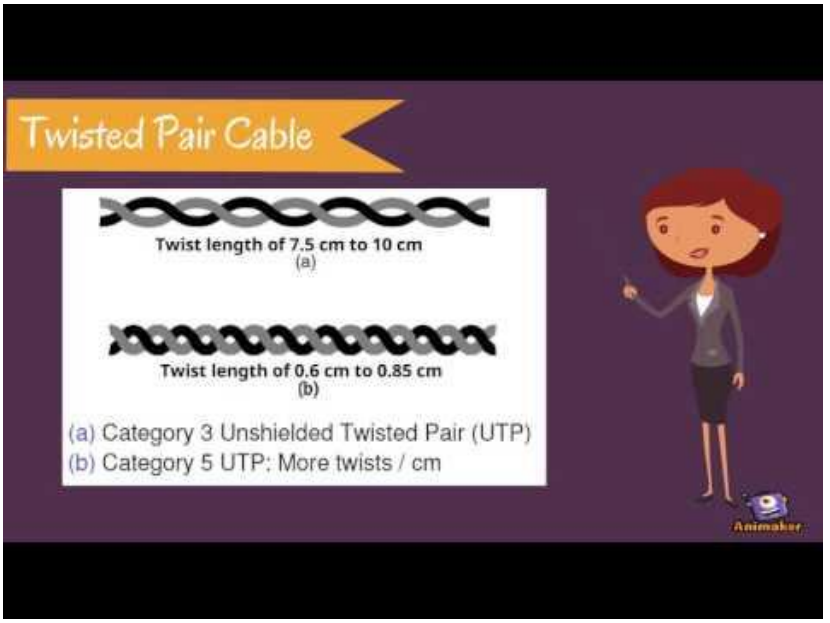
	Unshielded Twisted Pair (UTP)	Shielded Twisted Pair (STP)
1)	 a. UTP	 b. STP
2)	Bandwidth capacity is 1-155 mbps (typically 10 mbps)	Bandwidth capacity is 1-155 mbps (typically 16 mbps)
3)	UTP cables are very cheap and easy to install.	STP cables are bulky and expensive.
4)	They are badly affected by the noise interference.	Metal Shield reduces interference of noise.

Applications of Twisted-Pair Cables :

- In Telephone lines to carry voice and data channels
- In the local loop
- In the DSL line (ADSL)
- Local area networks such as 10 Base-T and 100 Base-T use the twisted pair cables
- In the ISDN (Integrated Services Digital Network)

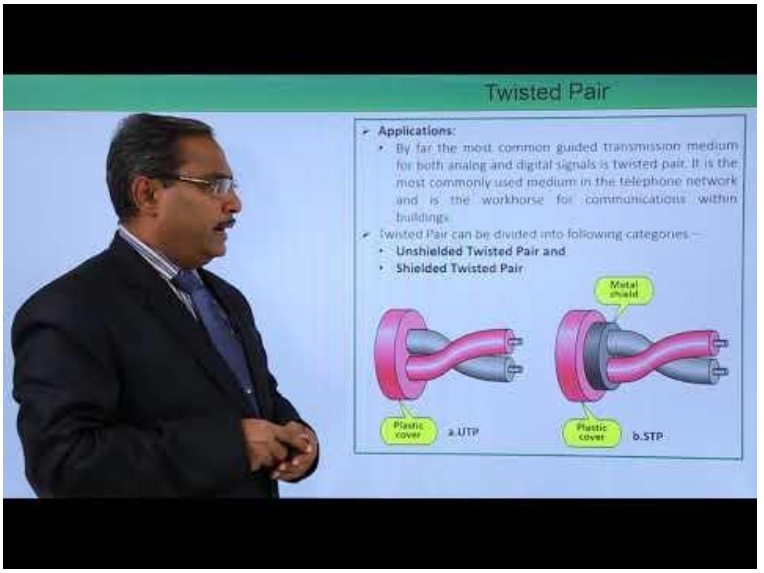
Videos

Guided Medium(Twisted Pair Cable)



Videos

Guided Medium(Twisted Pair Cable)



Coaxial Cable

Coaxial cable (or coax) carries signals of higher frequency ranges than those in twisted pair cable, in part because the two media are constructed quite differently. Instead of having two wires, coax has a central core conductor of solid or stranded wire (usually copper) enclosed in an insulating sheath, which is, in turn, encased in an outer conductor of metal foil, braid, or a combination of the two. The outer metallic wrapping serves both as shield against noise and as second conductor which completes the circuit. This outer conductor is also enclosed in an insulating sheath, and the whole cable is protected by a plastic cover.

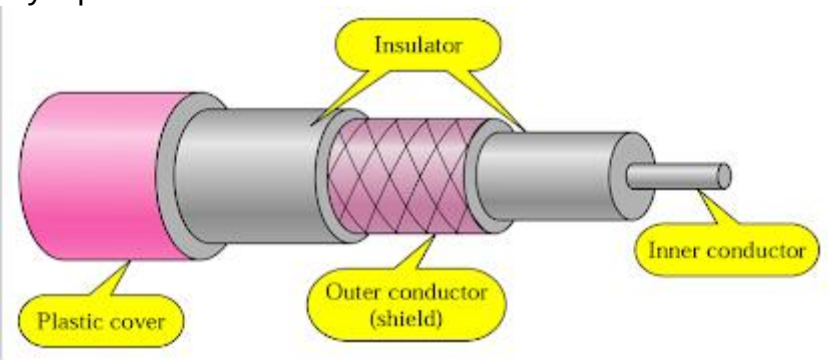


Figure : Coaxial cable

Characteristics of a co-axial cable:

•Due to the shield provided, this cable has excellent noise immunity.

•It has large bandwidth and low losses.

•This cable is suitable for point to point or point to multipoint applications. This is the most widely used medium for local area networks.

•These cables are costlier than twisted pair cables but they are cheaper than the optical fiber cables.

•It has a data rate of 10 Mbps which can increased with the increase in diameter of the inner conductor

Advantages

1. Superior bandwidth and data rate compare to twisted pair (350Mhz – 500Mbps)
2. Shielded against crosstalk and external noise without the need for twists

Disadvantages

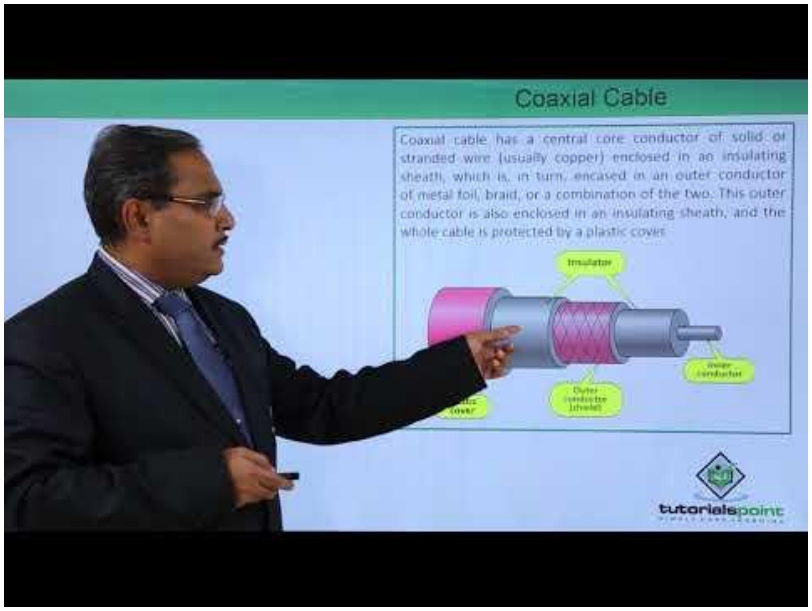
1. Susceptible to thermal noise and intermodulation noise
2. Rigid and heavy Cable
3. Higher attenuation compared to twisted pairs.

Applications :

- Analog telephone networks
- Digital telephone networks
- Cable T.V
- Traditional Ethernet LANS
- Digital transmission

Video:

Coaxial Cable



Optical Fiber

A fiber-optic cable is made of glass or plastic and transmits signals in the form of light. Optical fibers use reflection to guide light through a channel. A glass or plastic core is surrounded by a cladding of less dense glass or plastic. The difference in density of the two materials must be such that a beam of light moving through the core is reflected off the cladding instead of being refracted into it.

One of the most significant technological breakthroughs in data transmission has been the creation of the fiber-optic cable. It allows data rate of up to 1600Gbs using WDM. 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. The fiber-optic cable transmits electromagnetic signals known as visible light.

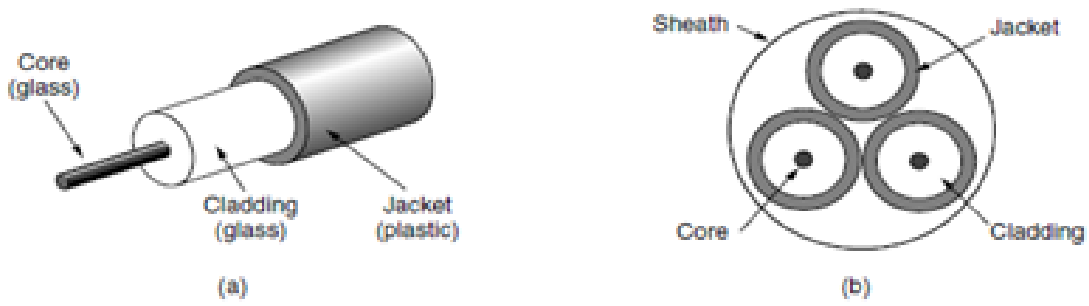


Figure: (a) Side view of a single fiber.
Figure: (b) End view of a sheath with three fibers.

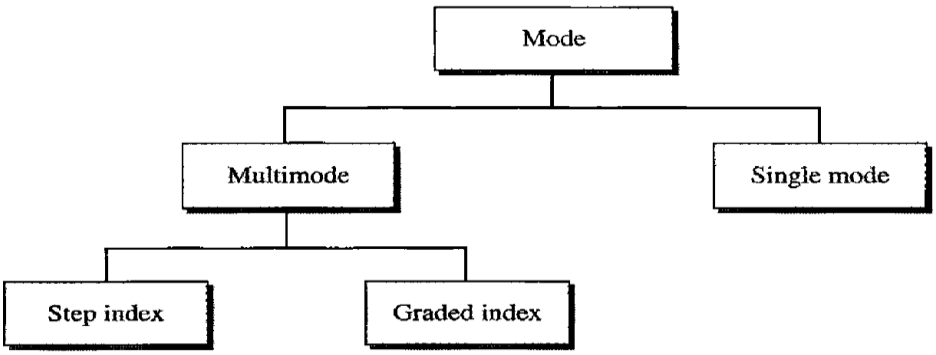
A fiber-optic cable has a cylindrical shape and consists of three concentric sections: the core, the cladding and the jacket. The core is made up of dense plastic or glass and it is here that the light travels. The cladding is made up of less dense material which reflects the light signals back to the core instead of absorbing it. The jacket surrounds one or more cladded cores to protect against environmental dangers.

Characteristics of Optical Fiber Cables :

1) Fiber optic cabling can provide extremely high bandwidths in the range from 100 mbps to gigabits because light has a much higher frequency than electricity.
2) The number of nodes which a fiber optic can support does not depend on its length but on the hub or hubs that connect cables together.

3) Fiber optic cable has much lower attenuation and can carry signal to longer distances without using amplifiers and repeaters in between.
4) Fiber optic cable is not affected by EMI effects and can be used in areas where high voltages are passing by.
5) The cost of fiber optic cable is more compared to twisted pair and co-axial.
6) The installation of fiber optic cables is difficult and tedious.

Propagation Modes



Multimode

Multimode fiber-optics transmits multiple light signals. How the beam travel depends on the density composition of the core.

Multimode step-index
The core is evenly dense. The light travels straight until it reaches the interface of the core and cladding. The abrupt change causes it to be reflected back to the core. Step-index refers to the abrupt change of direction of the light.

Multimode graded-index.
The core is densest at the center and the density decreases gradually towards the edge of the core. This varying density allows the light to bend. This allows focusing the signals more efficiently than step-index.

Single-mode

Single mode uses step-index fiber and a highly focused light source that limits the light beam to a small range of angles close to the horizontal. The core itself has a small diameter and lower density making the path of the light almost horizontal. The propagation time for all signals are almost equal. Delays are negligible. This is the most expensive propagation mode for fiber-optics commonly used for long distance telecom lines.

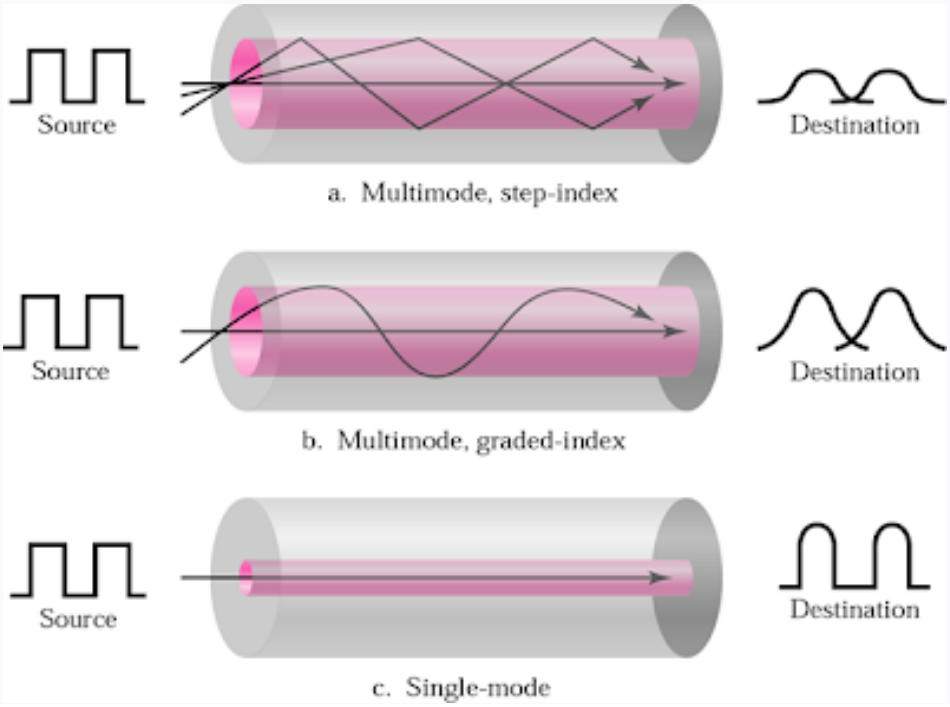


Figure: Propagation Modes

Advantages

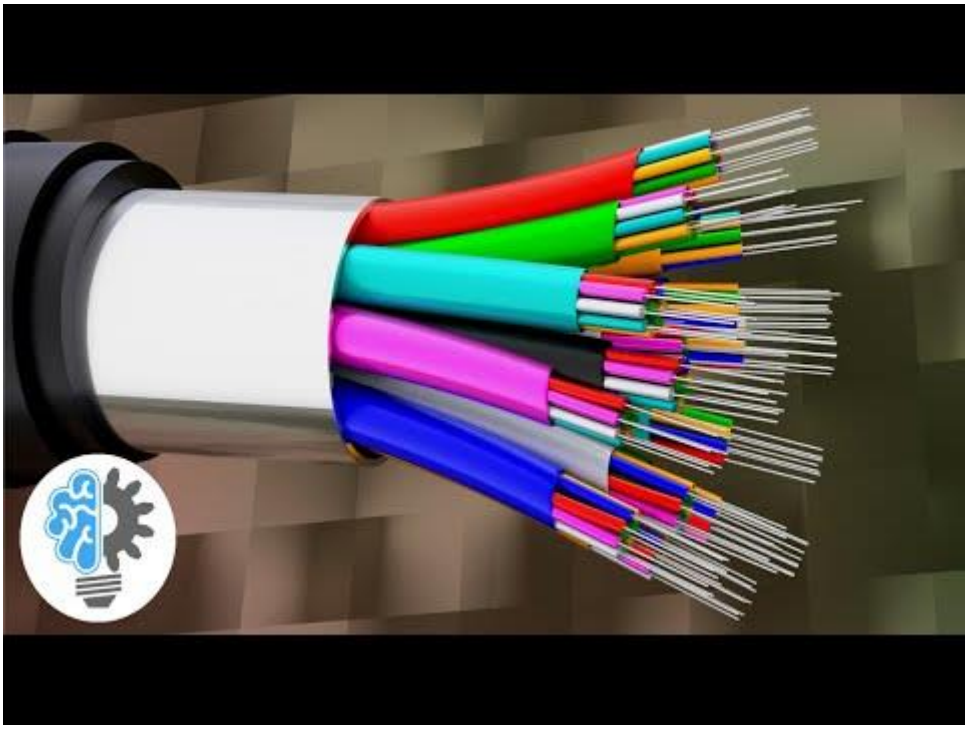
1. Very high bandwidth and data rate
2. Less signal attenuation
3. Immunity to electromagnetic interference
4. Resistance to corrosion
5. Light weight
6. Difficult to tap

Disadvantages

1. Installation/maintenance
2. Unidirectional
3. Cost

Video:

Optical fiber cables, how do they work?



Comparison of Wired Media.

	Twisted Pair Cable	Co-axial Cable	Optical Fiber
1	Transmission of signals takes place in the electrical form over the metallic conducting wires.	Transmission of signals takes place in the electrical form over the inner conductor of the cable	Signal transmission takes place in an optical form over a glass fiber.
2	Noise immunity is low, Therefore more distortion.	Higher noise immunity than the twisted pair cable due to the presence of shielding conductor.	Highest noise immunity as the light rays are unaffected by the electrical noise.
3	Affected due to external magnetic field.	Less affected due to external magnetic field.	Not affected by the external magnetic field.
4	Short circuit between the two conductors is possible.	Short circuit between the two conductors is possible.	Short circuit is not possible.
5	Cheapest	Moderately expensive	Expensive
6	Can support low data rates	Moderately high bandwidth	Very high bandwidth
7	Power loss due to conduction and radiation.	Power loss due to conduction.	Power loss due to absorption, scattering, dispersion and bending.
8	Low Bandwidth	Moderately high bandwidth	Very high bandwidth
9	Node capacity per segment is 2	Node capacity per segment is 30 to 100.	Node capacity per segment is 2
10	Attenuation is very high	Attenuation is low	Attenuation is very low
11	Installation is easy	Installation is fairly easy	Installation is difficult
12	Electromagnetic Interference (EMI) takes place.	EMI is reduced due to shielding.	EMI is not present.

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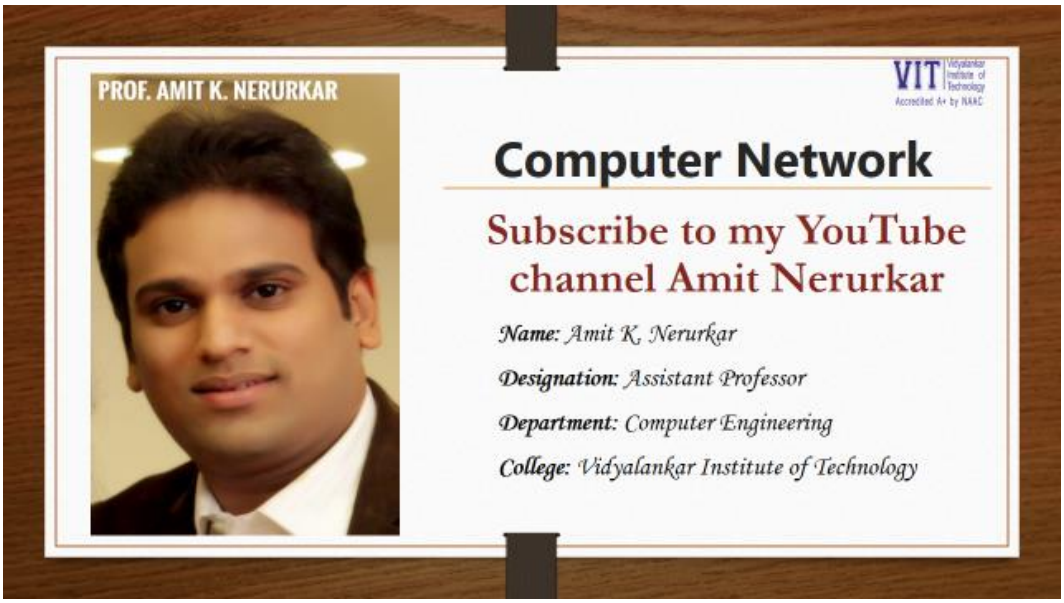

Subjects Taught by Amit K. Nerurkar

1. C programming
2. Data Structure
3. Computer Network
4. Network Security
5. Artificial Intelligence
6. Soft Computing
7. Distributed Systems
8. Internet of Things
9. Linux Administration
10. Database Management System