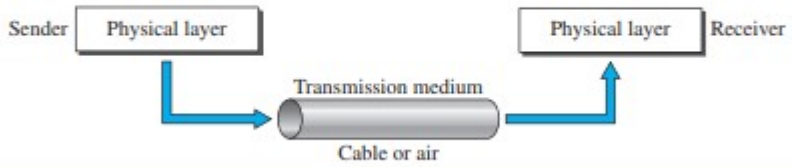
Transmission Media

Introduction

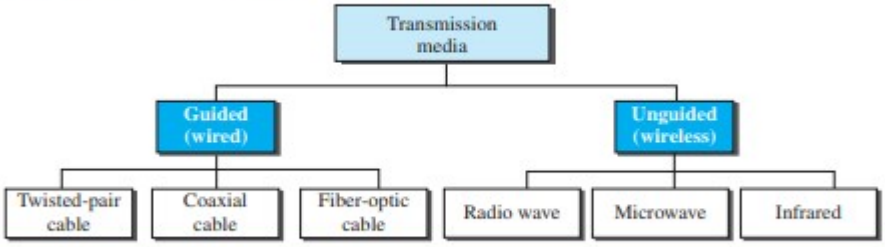
- Transmission media are actually located below the physical layer and are directly controlled by the physical layer. We could say that transmission media belong to layer zero.
- The below figure shows the position of transmission media in relation to the physical layer.

Figure 7.1 *Transmission medium and physical layer*



- A transmission medium can be broadly defined as anything that can carry information from a source to a destination.
- In data communications the definition of the information and the transmission medium is more specific.
- The transmission medium is usually free space, metallic cable, or fiber-optic cable. The information is usually a signal that is the result of a conversion of data from another form.
- In telecommunications, transmission media can be divided into two broad categories: guided and unguided. Guided media include twisted-pair cable, coaxial cable, and fiber-optic cable. Unguided medium is free space

Figure 7.2 *Classes of transmission media*



GUIDED MEDIA

- Guided media, which are those that provide a conduit from one device to another, include twisted-pair cable, coaxial cable, and fiber-optic cable.
- A signal traveling along any of these media is directed and contained by the physical limits of the medium.
- Twisted-pair and coaxial cable use metallic (copper) conductors that accept and transport signals in the form of electric current.
- Optical fiber is a cable that accepts and transports signals in the form of light.

Twisted-Pair Cable

A twisted pair consists of two conductors (normally copper), each with its own plastic insulation, twisted together.

Figure 7.3 *Twisted-pair cable*

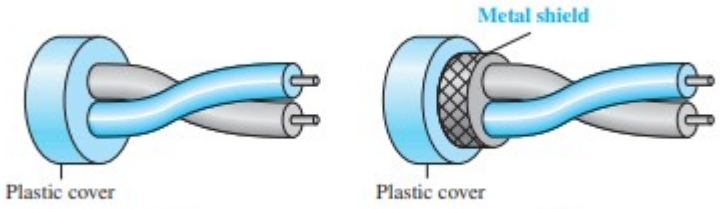
- One of the wires is used to carry signals to the receiver, and the other is used only as a ground reference.
- The receiver uses the difference between the two. In addition to the signal sent by the sender on one of the wires, interference (noise) and crosstalk may affect both wires and create unwanted signals.
- 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.
- By twisting the pairs, a balance is maintained.

Unshielded Versus Shielded Twisted-Pair Cable

- The most common twisted-pair cable used in communications is referred to as unshielded twisted-pair (UTP).
- IBM has also produced a version of twisted-pair cable for its use, called shielded twisted-pair (STP).

- STP cable has a metal foil or braidedmesh covering that encases each pair of insulated conductors. Although metal casing improves the quality of cable by preventing the penetration of noise or crosstalk, it is bulkier and more expensive.

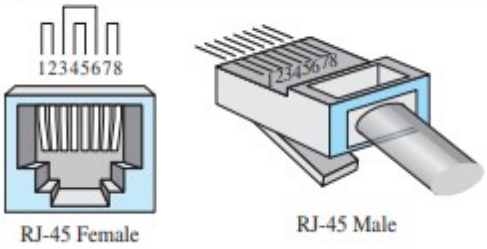
Figure 7.4 *UTP and STP cables*



Connectors

- The most common UTP connector is RJ45 (RJ stands for registered jack).
- The RJ45 is a keyed connector, meaning the connector can be inserted in only one way.

Figure 7.5 *UTP connector*



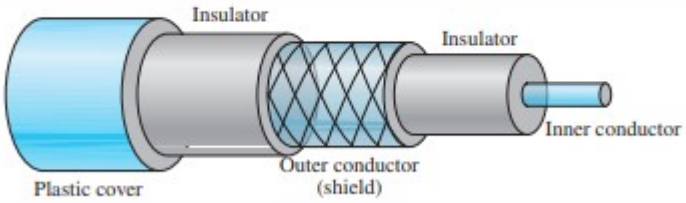
- One way to measure the performance of twisted-pair cable is to compare attenuation versus frequency and distance.
- A twisted-pair cable can pass a wide range of frequencies.
- Applications: Twisted-pair cables are used in telephone lines to provide voice and data channels.

Coaxial Cable

- Coaxial cable (or coax) carries signals of higher frequency ranges than those in twistedpair 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 a shield against noise and as the 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 7.7 *Coaxial cable*



- To connect coaxial cable to devices, we need coaxial connectors. The most common type of connector used today is the Bayonet Neill-Concelman (BNC) connector.

Table 7.2 *Categories of coaxial cables*

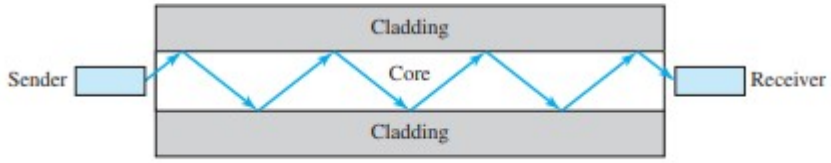
Category	*Impedance*	*Use*
RG-59	75 Ω	Cable TV
RG-58	50 Ω	Thin Ethernet
RG-11	50 Ω	Thick Ethernet

- The attenuation is much higher in coaxial cable than in twisted-pair cable. In other words, although coaxial cable has a much higher bandwidth, the signal weakens rapidly and requires the frequent use of repeaters.
- Traditional Ethernet LANs, digital telephone networks, Cable TV networks also use coaxial cables.

Fiber-Optic Cable

- 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.

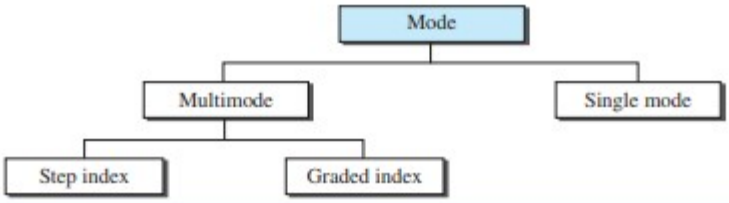
Figure 7.11 *Optical fiber*



Propagation Modes

- Current technology supports two modes (multimode and single mode) for propagating light along optical channels, each requiring fiber with different physical characteristics.
- Multimode can be implemented in two forms: step-index or graded-index.

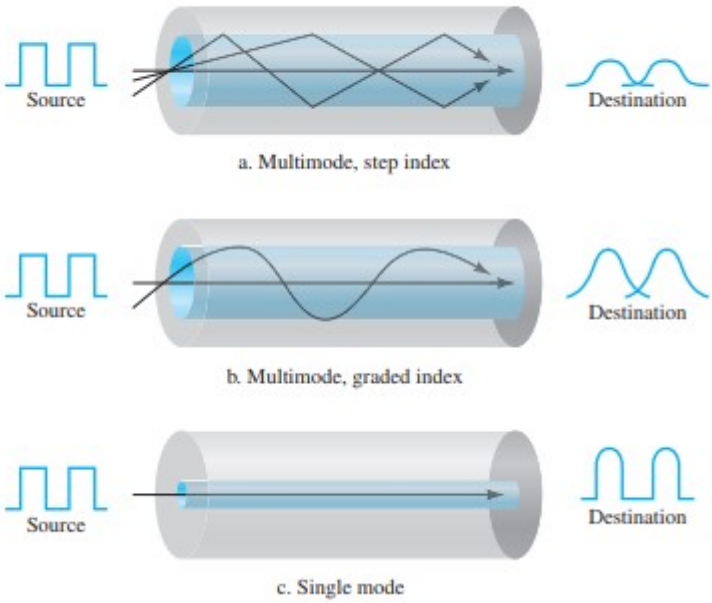
Figure 7.12 *Propagation modes*



Multimode

- Multimode is so named because multiple beams from a light source move through the core in different paths. How these beams move within the cable depends on the structure of the core.

Figure 7.13 *Modes*



- In multimode step-index fiber, the density of the core remains constant from the center to the edges. A beam of light moves through this constant density in a straight line until it reaches the interface of the core and the cladding
- A second type of fiber, called multimode graded-index fiber, decreases this distortion of the signal through the cable. The word index here refers to the index of refraction.
- Single-mode uses step-index fiber and a highly focused source of light that limits beams to a small range of angles, all close to the horizontal.

Fiber-Optic Cable Connectors

- There are three types of connectors for fiber-optic cables
- The subscriber channel (SC) connector is used for cable TV. It uses a push/pull locking system.
- The straight-tip (ST) connector is used for connecting cable to networking devices. It uses a bayonet locking system and is more reliable than SC.
- MT-RJ is a connector that is the same size as RJ45.
- Fiber-optic cable is often found in backbone networks because its wide bandwidth is cost-effective.
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Advantages and Disadvantages of Optical Fiber

Advantages

Fiber-optic cable has several advantages over metallic cable (twisted-pair or coaxial).

❑ Higher bandwidth.

Fiber-optic cable can support dramatically higher bandwidths (and hence data rates) than either twisted-pair or coaxial cable. 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.

❑ Less signal attenuation.

Fiber-optic transmission distance is significantly greater than that of other guided media. A signal can run for 50 km without requiring regeneration. We need repeaters every 5 km for coaxial or twisted-pair cable.

❑ Immunity to electromagnetic interference.

Electromagnetic noise cannot affect fiber-optic cables.

❑ Resistance to corrosive materials.

Glass is more resistant to corrosive materials than copper.

❑ Light weight.

Fiber-optic cables are much lighter than copper cables.

❑ Greater immunity to tapping.

Fiber-optic cables are more immune to tapping than copper cables. Copper cables create antenna effects that can easily be tapped.

Disadvantages

There are some disadvantages in the use of optical fiber.

❑ Installation and maintenance.

Fiber-optic cable is a relatively new technology. Its installation and maintenance require expertise that is not yet available everywhere.

❑ Unidirectional light propagation.

Propagation of light is unidirectional. If we need bidirectional communication, two fibers are needed.

❑ Cost.

The cable and the interfaces are relatively more expensive than those of other guided media. If the demand for bandwidth is not high, often the use of optical fiber cannot be justified.


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