DATA COMMUNICATIONS AND NETWORKING

Transmission Media

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BIT 2nd Year, 2nd Semester

Outline

- Guided Media
- Unguided Media
- Summary

Transmission Media

- A transmission medium can be broadly defined as anything that can carry information from a source to a destination.

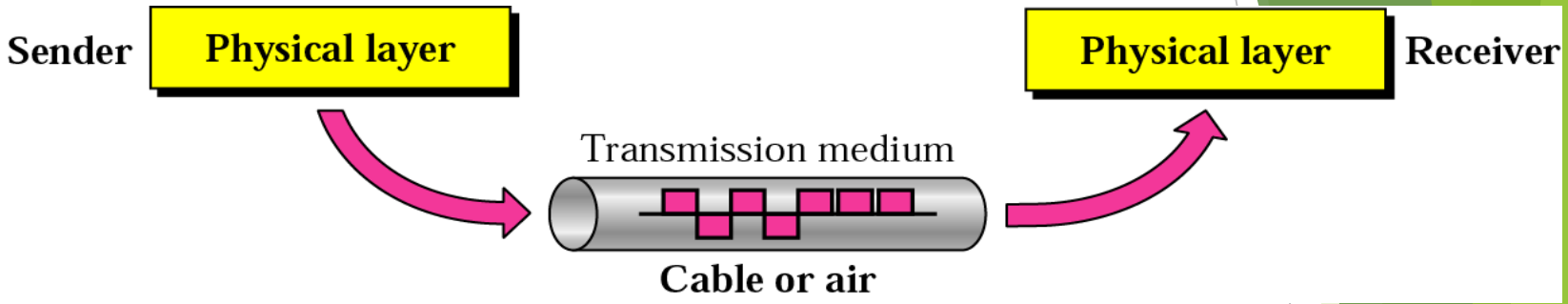


Figure 1. Transmission medium and physical layer

- Computers and other telecommunication devices use signals to represent data. These signals are transmitted from one device to another in the form of electromagnetic energy, which is propagated through transmission media.
- Electromagnetic energy, a combination of electric and magnetic fields vibrating in relation to each other, includes power, radio waves, infrared light, visible light, ultraviolet light, and X, gamma, and cosmic rays. Each of these constitutes a portion of the electromagnetic spectrum.
- 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.

Transmission Media (continue…)

- A transmission medium can be broadly defined as anything that can carry information from a source to a destination.

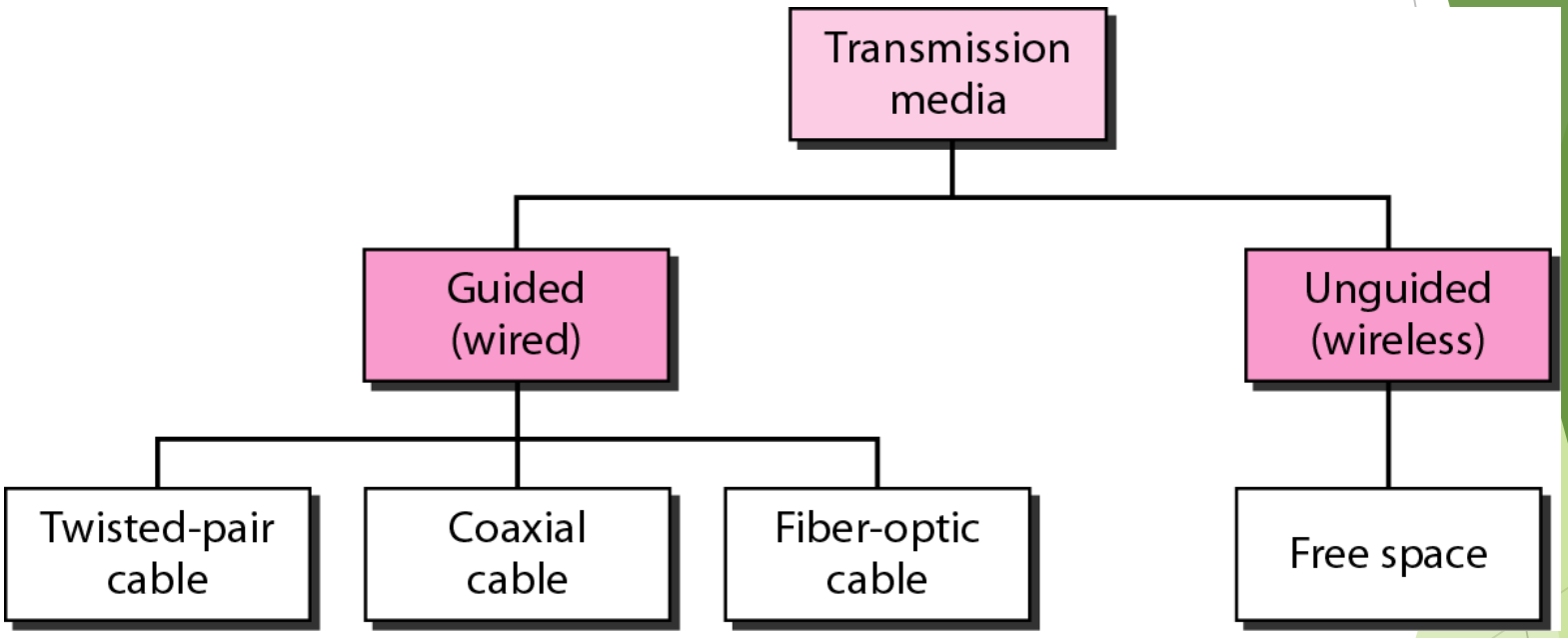


Figure 2. Classes of transmission media

GUIDED MEDIA

- A transmission medium can be broadly defined as anything that can carry information from a source to a destination.
- Guided media, which are those that provide a conduit from one device to another, include twisted-pair cable, coaxial cable, and fiber-optic cable.
- 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,

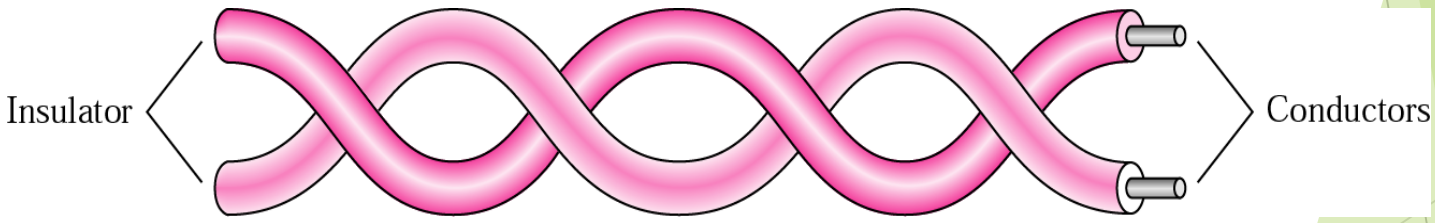


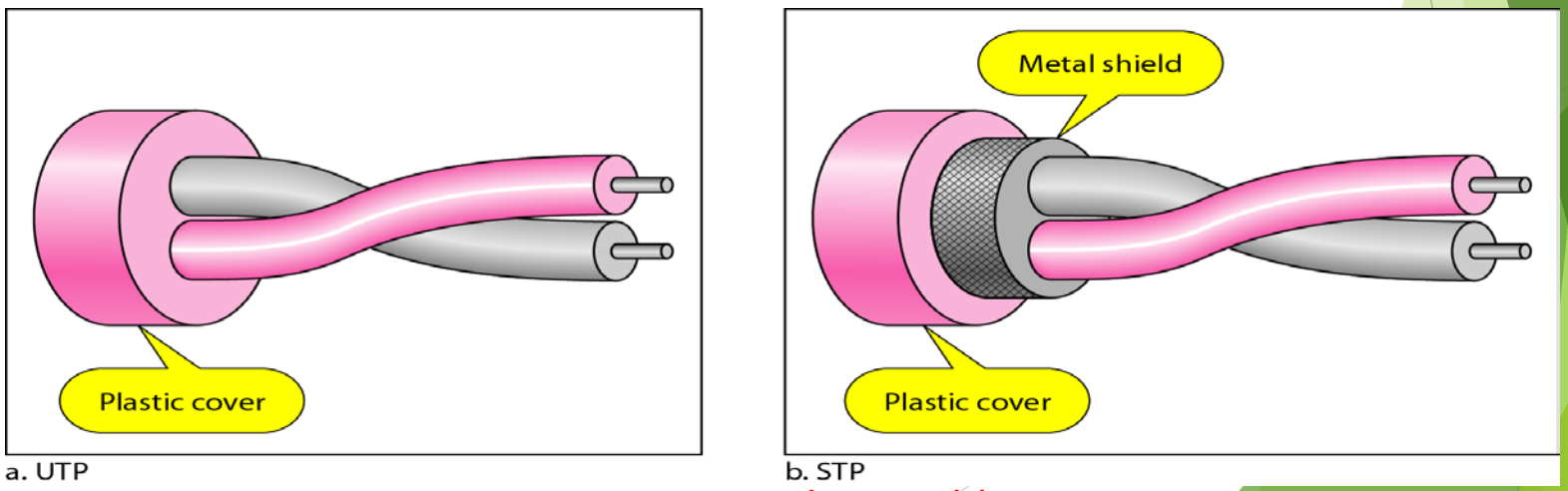
Figure 3. Twisted-pair cable

- 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

GUIDED MEDIA (continue…)

- Twisted-Pair Cable (continue…)

- 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. 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.
- 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).



a. UTP b. STP

Figure 4. UTP and STP cables

GUIDED MEDIA (continue…)

- Twisted-Pair Cable (continue…)

- Categories :- The Electronic Industries Association (EIA) has developed standards to classify unshielded twisted-pair cable into seven categories. Each EIA category is suitable for specific uses, as shown in Table 1.
- Connectors:- The most common UTP connector is RJ45 (RJ stands for registered jack), as shown in Figure 5. The RJ45 is a keyed connector, meaning the connector can be inserted in only one way.

Table 1. Categories of unshielded twisted-pair cables

Category	*Specification*	*Data Rate (Mbps)*	*Use*
1	Unshielded twisted-pair used in telephone	< 0.1	Telephone
2	Unshielded twisted-pair originally used in T-lines	2	T-1 lines
3	Improved CAT 2 used in LANs	10	LANs
4	Improved CAT 3 used in Token Ring networks	20	LANs
5	Cable wire is normally 24 AWG with a jacket and outside sheath	100	LANs
5E	An extension to category 5 that includes extra features to minimize the crosstalk and electromagnetic interference	125	LANs
6	A new category with matched components coming from the same manufacturer. The cable must be tested at a 200-Mbps data rate.	200	LANs
7	Sometimes called SSTP (shielded screen twisted-pair). Each pair is individually wrapped in a helical metallic foil followed by a metallic foil shield in addition to the outside sheath. The shield decreases the effect of crosstalk and increases the data rate.	600	LANs

GUIDED MEDIA (continue…)

- Twisted-Pair Cable (continue…)

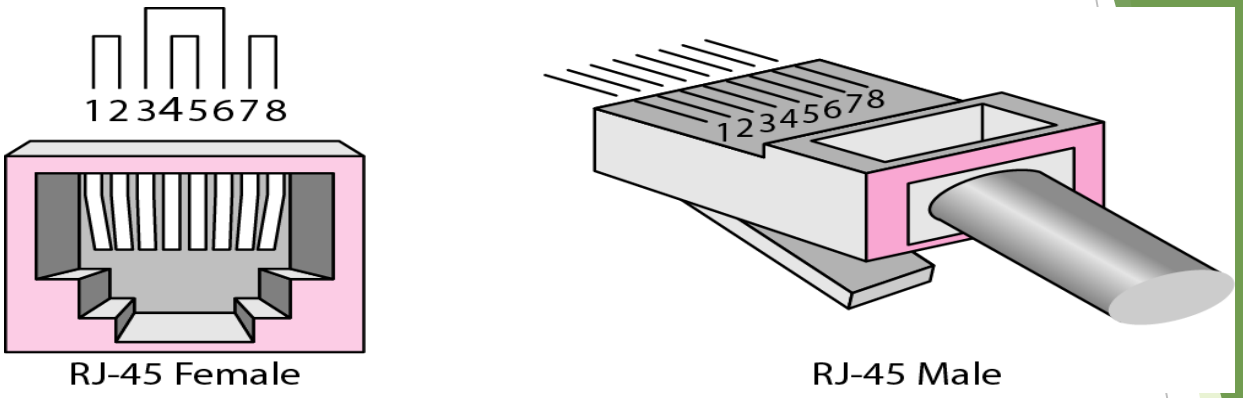


Figure 5. UTP Connector

- Performance
- 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. Figure 6. shows that with increasing frequency, the attenuation, measured in decibels per kilometer (dB/km), sharply increases with frequencies above 100 kHz.
- Note that gauge is a measure of the thickness of the wire

GUIDED MEDIA (continue…)

- Twisted-Pair Cable (continue…)
- Performance (continue…)

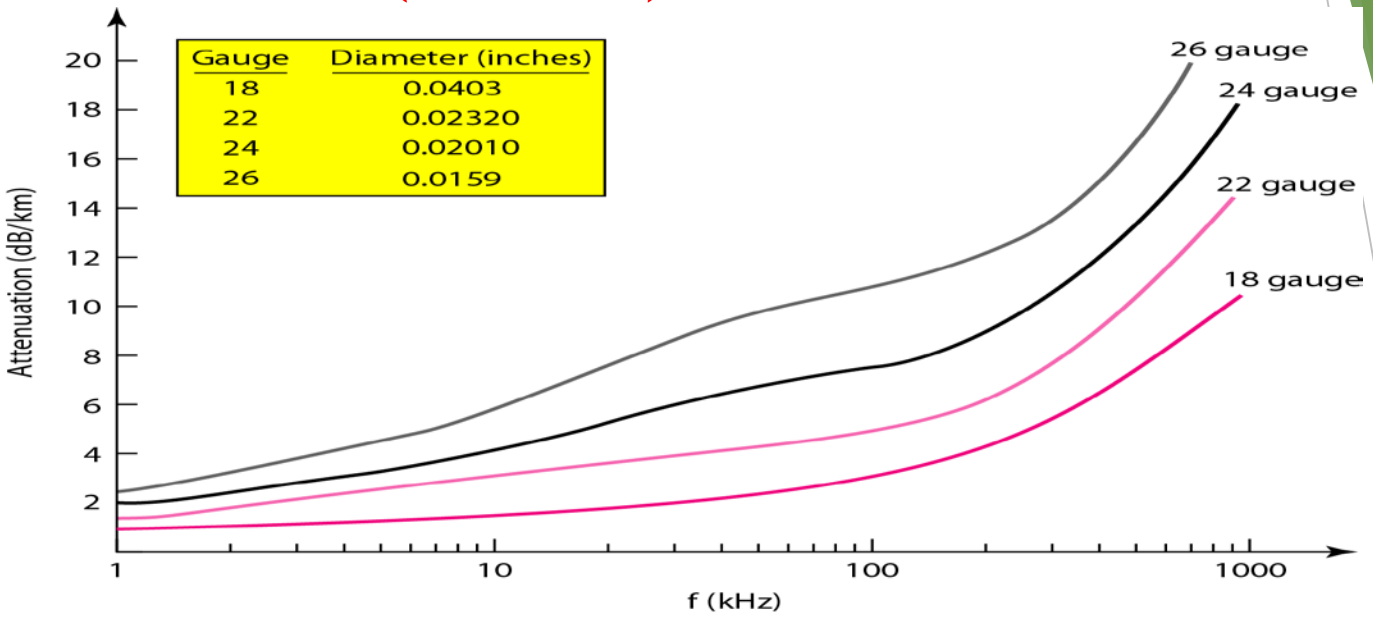


Figure 6. UTP performance

- Applications
- Twisted-pair cables are used in telephone 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 lOBase-T and lOOBase-T, also use twisted-pair cables.

GUIDED MEDIA (continue…)

- Twisted-Pair Cable (continue…)

- Parallel Flat Wire :- Electromagnetic interference can create noise. The noise over parallel wires results in an uneven load and a damaged signal.

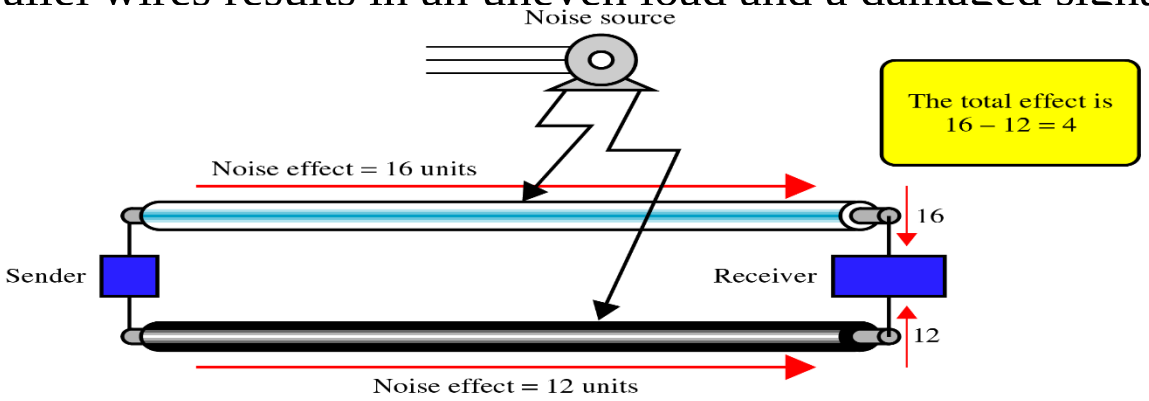


Figure 7. Parallel Flat Wire

- Noise Effect on Twisted-Pair: Cumulative effect of noise is equal on both sides. Twisting does not always eliminate the noise, but does significantly reduce it.

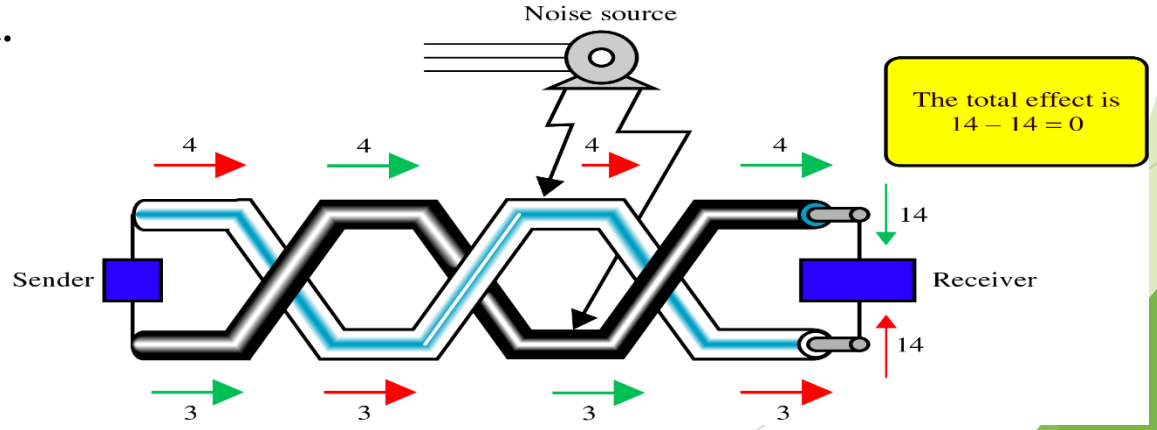


Figure 8. Noise Effect on Twisted-Pair

GUIDED MEDIA (continue…)

➢ 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 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, as shown in figure 9.

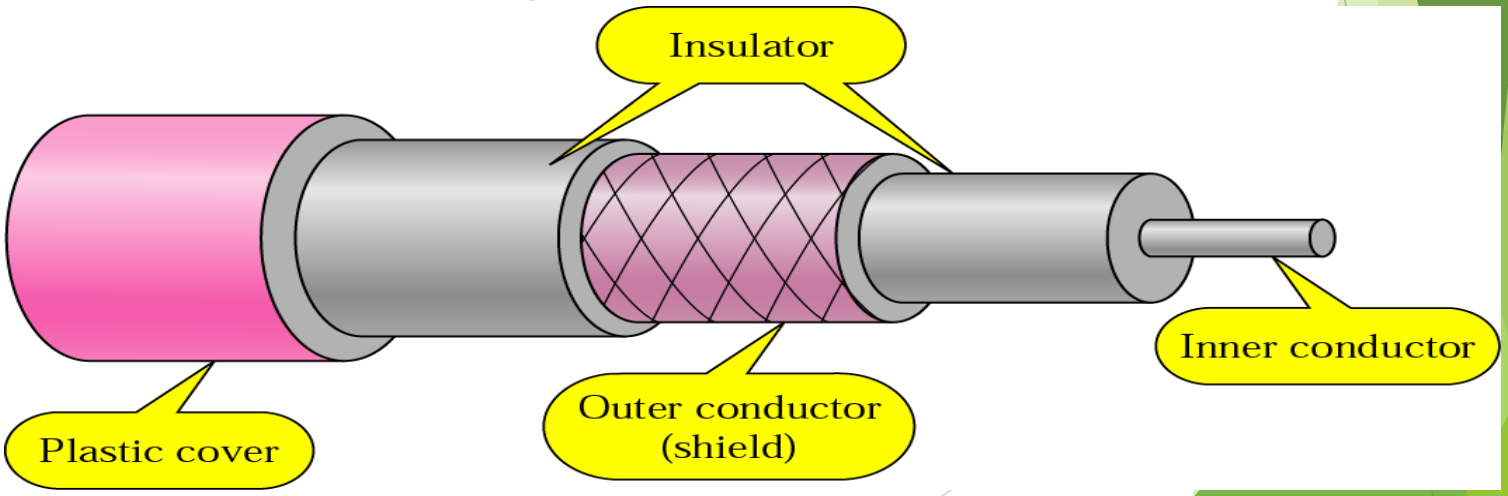


Figure 9. Coaxial cable

GUIDED MEDIA (continue…)

Categories of Coaxial Cables

- Coaxial cables are categorized by their radio government (RG) ratings. Each RG number denotes a unique set of physical specifications, including the wire gauge of the inner conductor, the thickness and type of the inner insulator, the construction of the shield, and the size and type of the outer casing.

Table 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

- Coaxial Cable Connectors
- To connect coaxial cable to devices, we need coaxial connectors. The most common type of connector used today is the Bayone-Neill-Concelman (BNC), connector. Figure 10. shows three popular types of these connectors: the BNC connector, the BNC T connector, and the BNC terminator.
- The BNC connector is used to connect the end of the cable to a device, such as a TV set. The BNC T connector is used in Ethernet networks to branch out to a connection to a computer or other device. The BNC terminator is used at the end of the cable to prevent the reflection of the signal.

GUIDED MEDIA (continue…)

- Categories of Coaxial Cables (continue…)

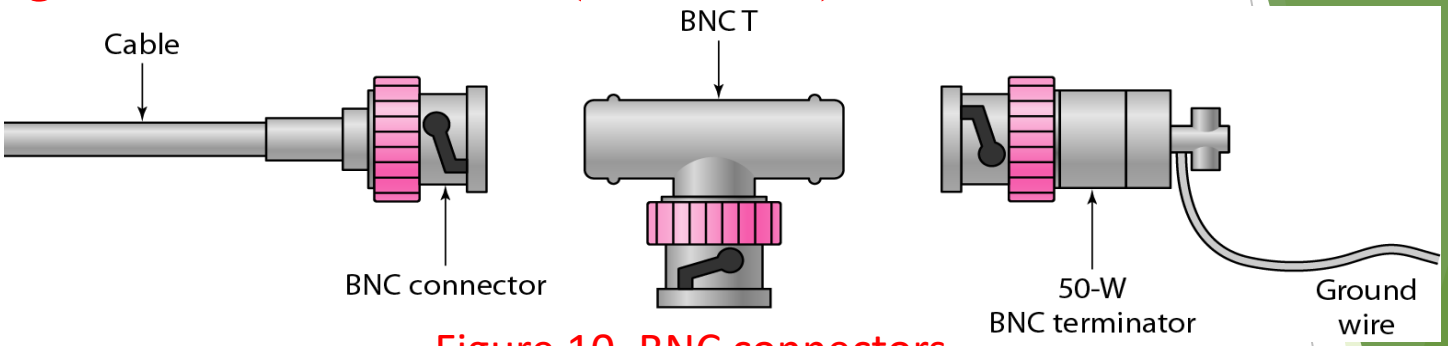


Figure 10. BNC connectors

- In Figure 11. we notice the attenuation is much higher in coaxial cables than in twisted-pair cable. In other words, although coaxial cable has a much higher bandwidth, signal weakens rapidly and requires frequent use of repeaters.

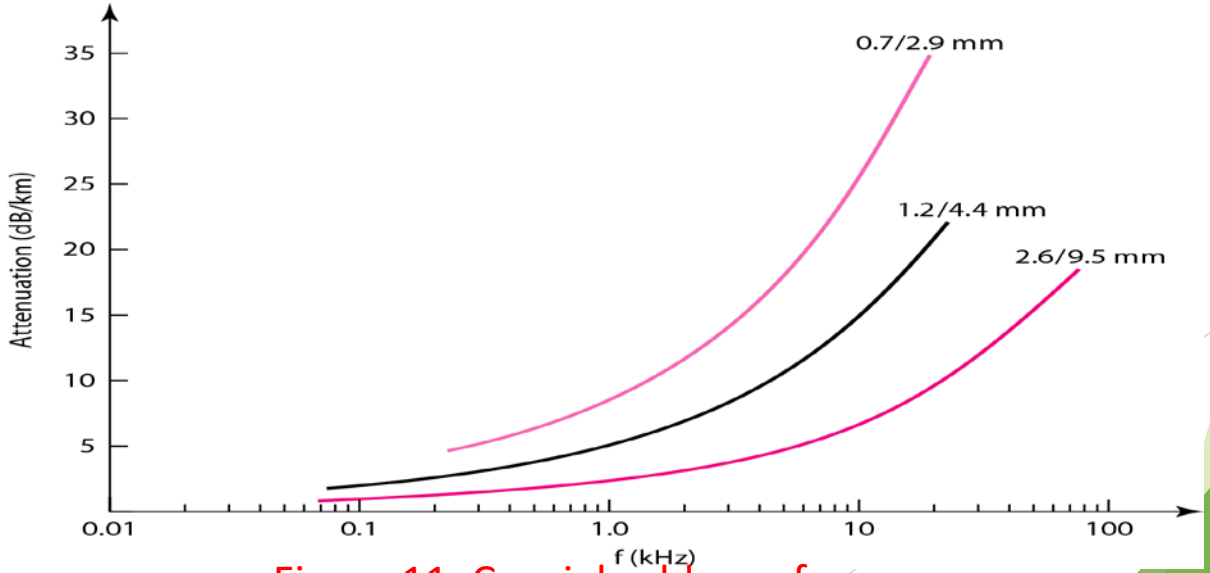


Figure 11. Coaxial cable performance