Data Communications

Digital Transmission

Digital Encoding

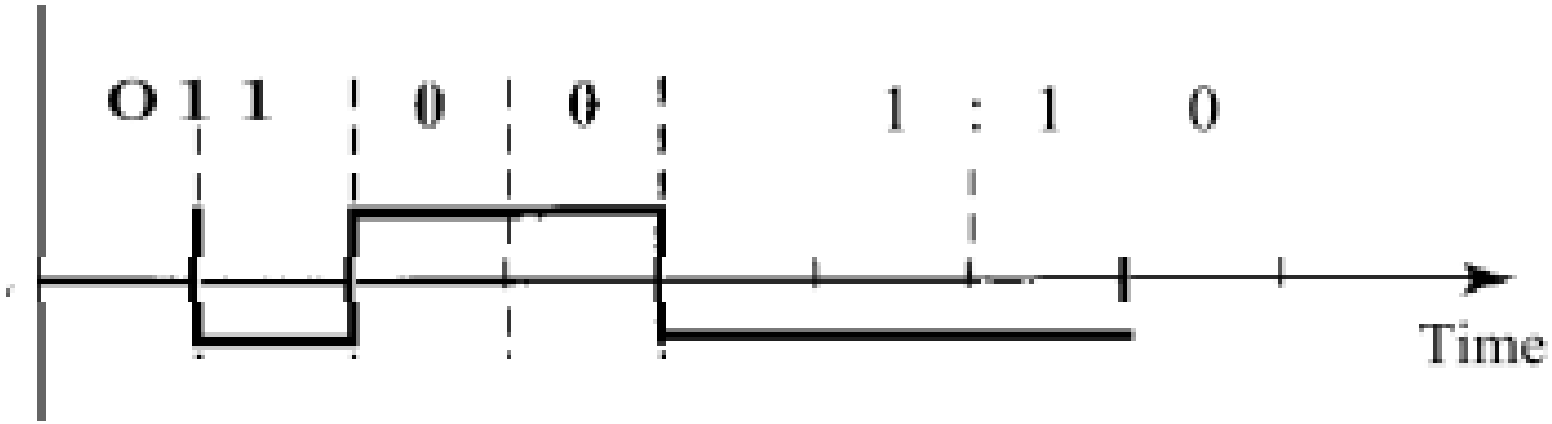
- To transmit digital data it should be converted into digital signals
- At the sender, digital data are encoded into a digital signal
- At the receiver, the digital data are recreated by decoding the digital signal

Digital Coding Schemes

- Unipolar Scheme
  - NRZ (Non-Return-to-Zero) : the positive voltage defines bit 1 and the zero voltage defines bit 0

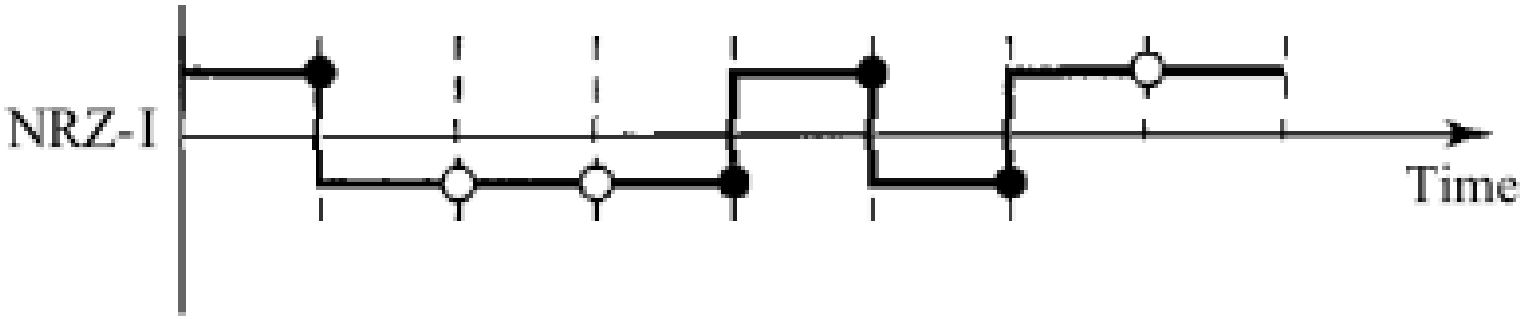
Digital Coding Schemes

- Polar Schemes
  - Non-Return-to-Zero (NRZ) In polar NRZ encoding, we use two levels of voltage amplitude.



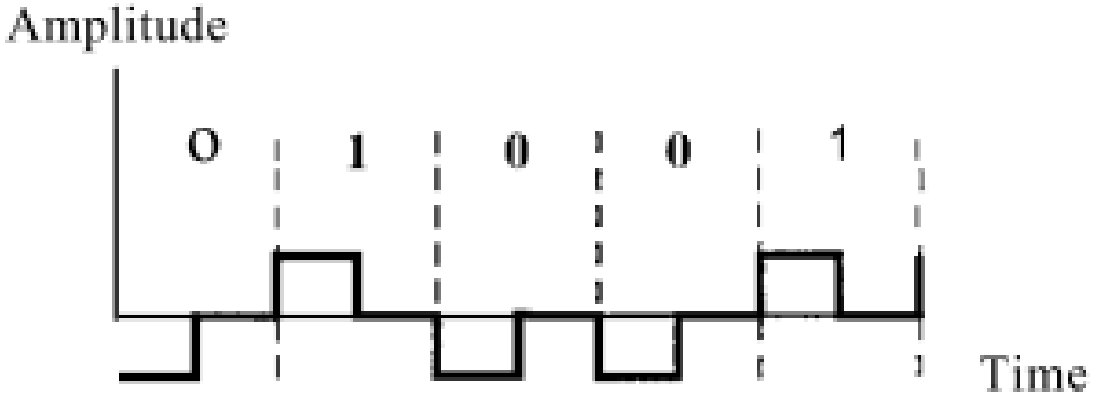
Digital Coding Schemes

- Polar Schemes
  - Non-Return-to-Zero –Inverted (NRZ-I)
  - In polar NRZ-I encoding, the change or lack of change in the level of the voltage determines the value of the bit. If there is no change, the bit is 0; if there is a change, the bit is 1.



Digital Coding Schemes

- Polar Schemes
  - Return to Zero (RZ): In RZ, the signal changes not between bits but during the bit.

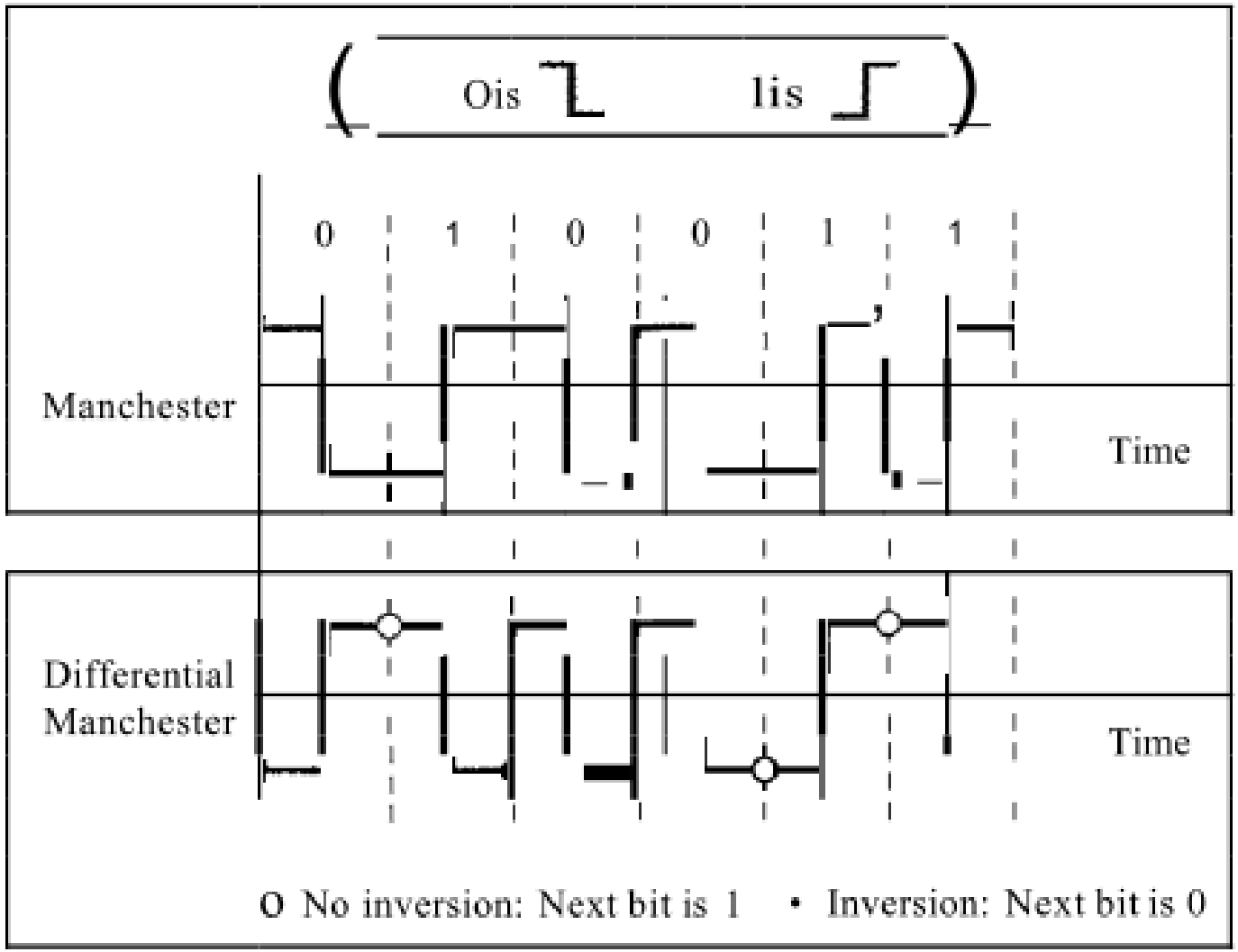


Digital Coding Schemes

- Biphase:
  - Manchester
  - Differential Manchester

    In Manchester and differential Manchester encoding, the transition at the middle of the bit is used for synchronization.

Digital Coding Schemes

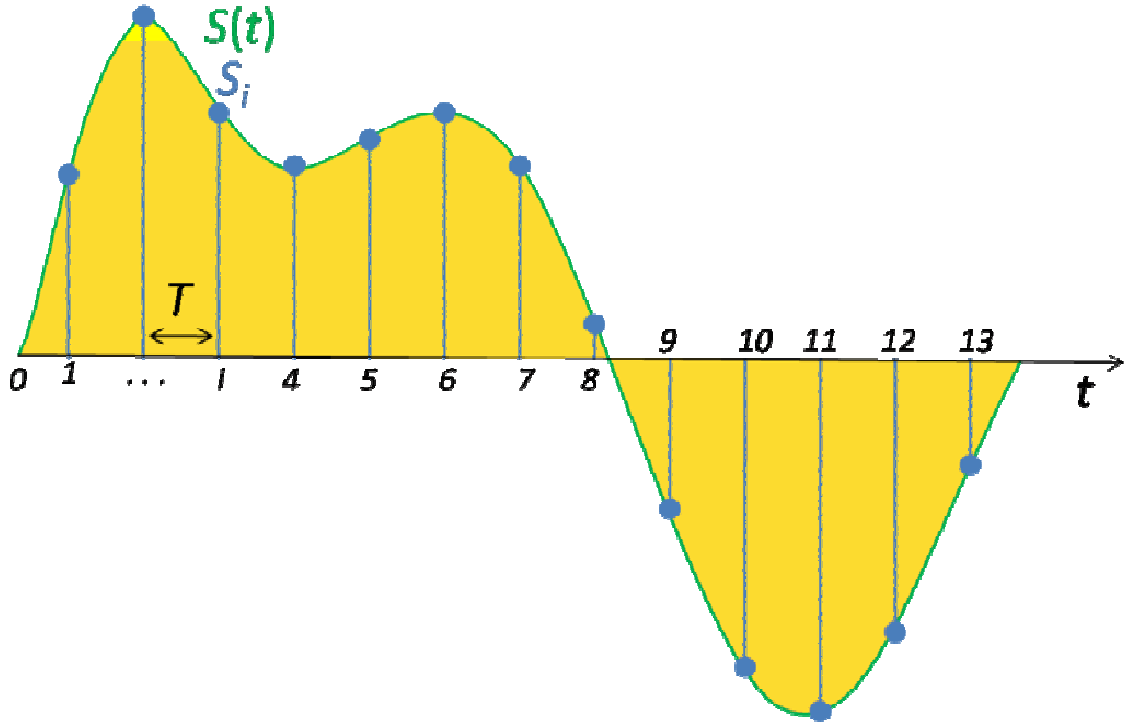


Analog to Digital Conversion

- Pulse Code Modulation (PCM)
  - The analog signal is sampled.
  - The sampled signal is quantized.
  - The quantized values are encoded as streams of bits.

Sampling

- The result of sampling is a sequence of samples that retains the shape of the analog signal.



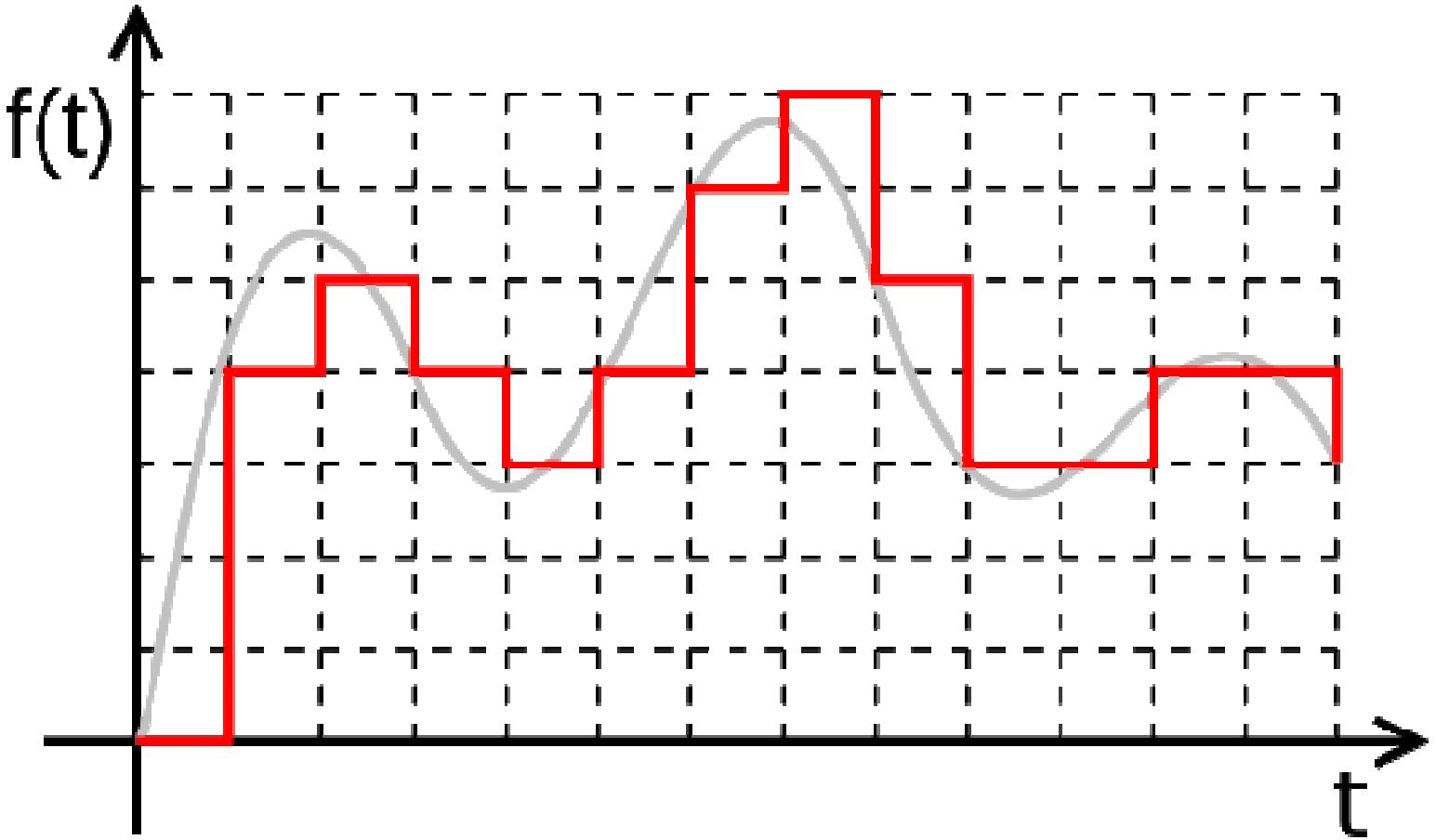
Sampling Rate

- Sampling Rate : According to the Nyquist theorem, to reproduce the original analog signal, one necessary condition is that the sampling rate be at least twice the highest frequency in the original signal.

Quantization

- The result of sampling is a series of pulses with amplitude values between the maximum and minimum amplitudes of the signal.
- The range of signal values is divided into L zones
- The values are assigned to the midpoint of each zone.

Quantization



Transmission Media

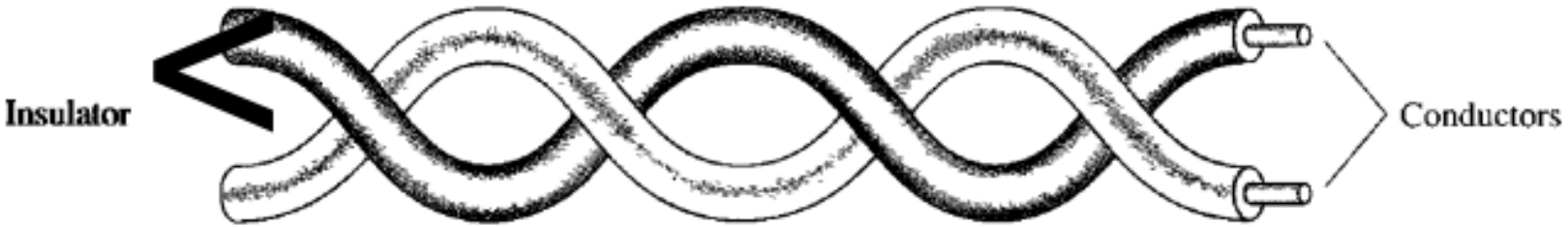
- A transmission medium can be broadly defined as anything that can carry information from a source to a destination.
- The transmission medium is usually free space, metallic cable, or fiber-optic cable.
- Transmission media can be divided into two broad categories: guided and unguided.

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.

Twisted-Pair Cable

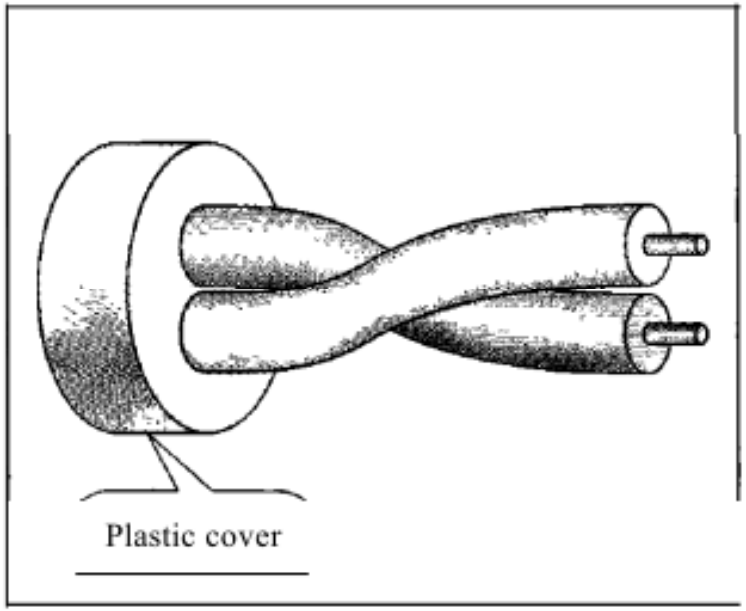
- A twisted pair consists of two conductors (normally copper), each with its own plastic insulation, twisted together
- One of the wires is used to carry signals to the receiver, and the other is used only as a ground reference.



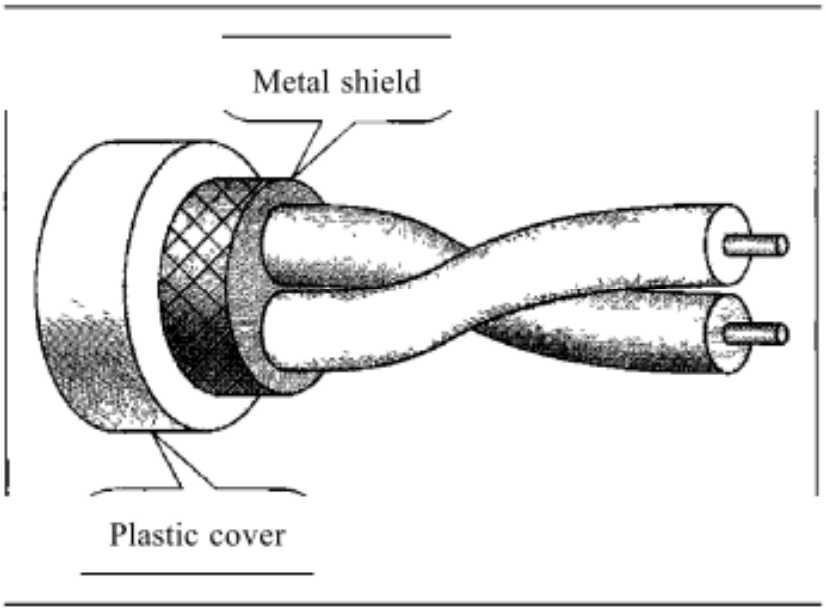
Unshielded Versus Shielded Twisted-Pair Cable

- 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 braided-mesh covering that encases each pair of insulated conductors.

Unshielded Versus Shielded Twisted-Pair Cable

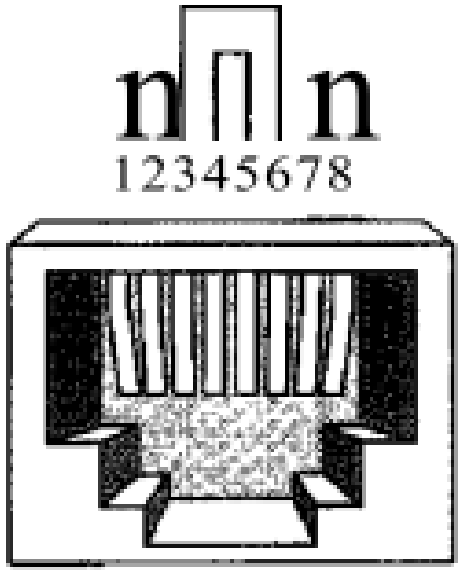


a.UTP

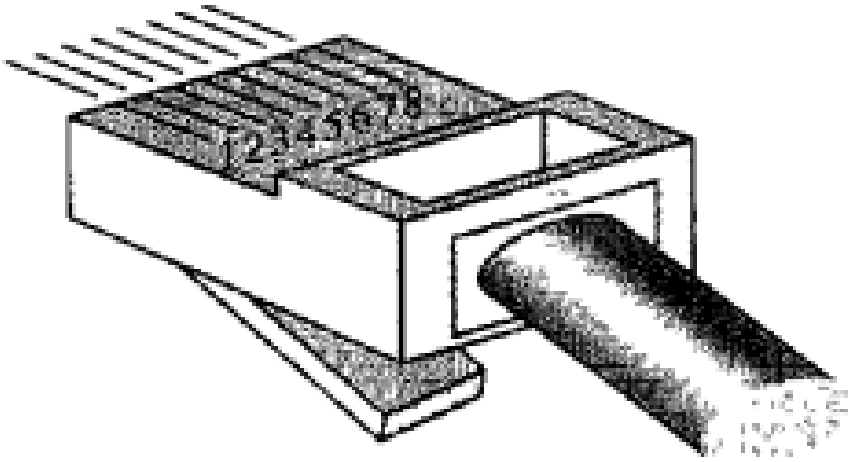


b.STP

UTP Connectors



RJ-45 Female

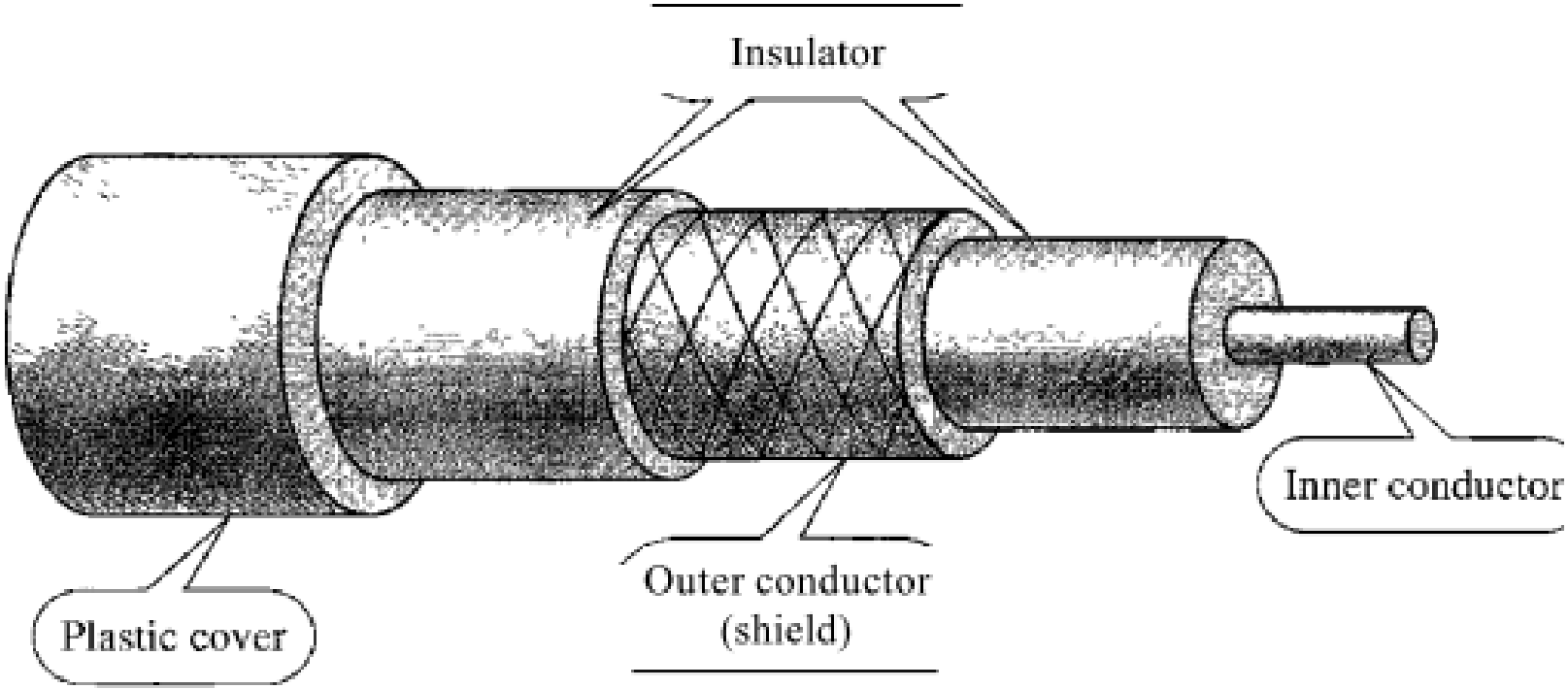


RJ-45 Male

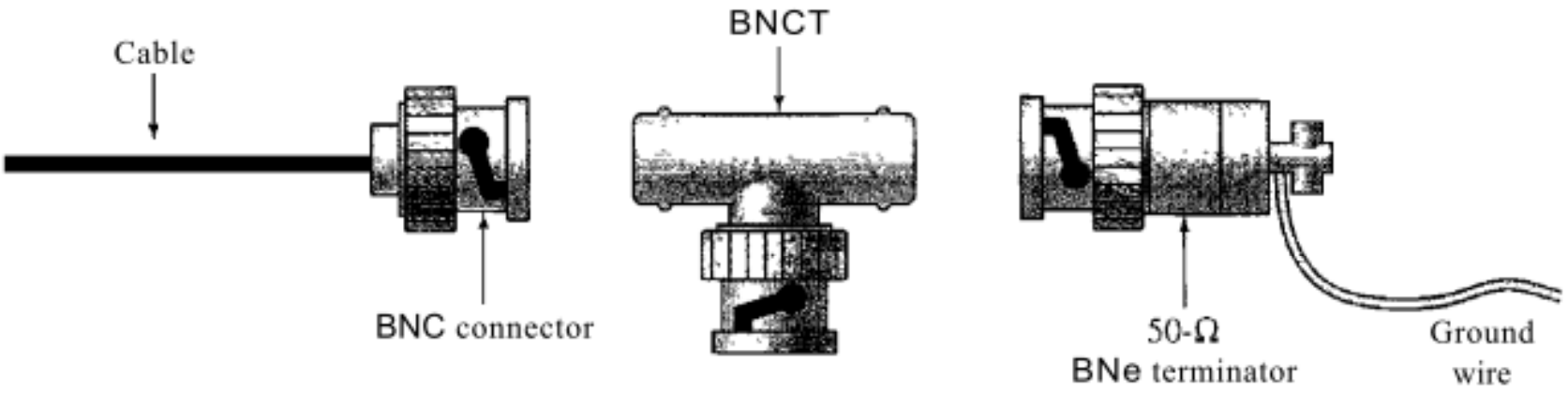
Coaxial Cable

- Coaxial cable (or coax) carries signals of higher frequency ranges than those in twisted-pair cable.
- Coax has a central core conductor of solid 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.

Coaxial Cable



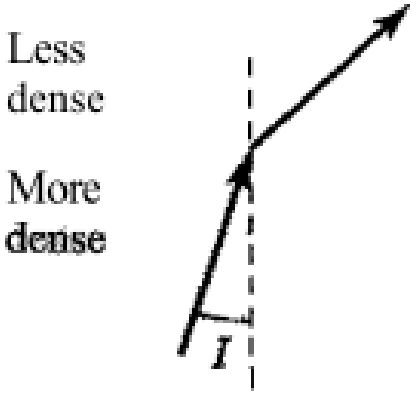
Coaxial Cable Connectors



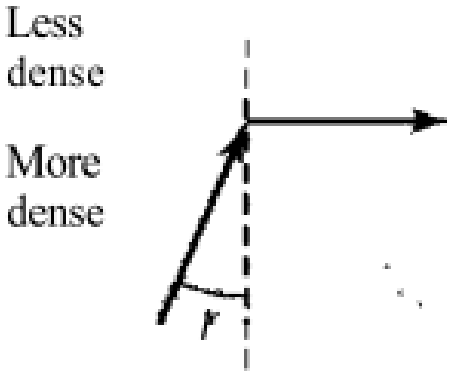
Fiber-Optic Cable

- A fiber-optic cable is made of glass or plastic and transmits signals in the form of light.
- If a ray of light traveling through one substance suddenly enters another substance (of a different density), the ray changes direction.

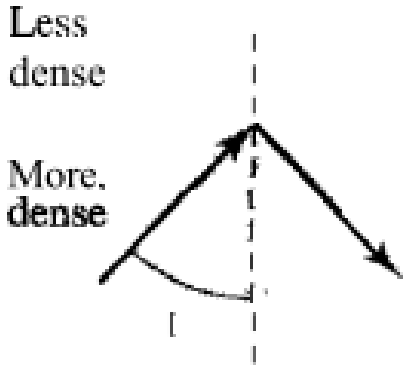
Fiber-Optic Cable



I < critical angle,
refraction

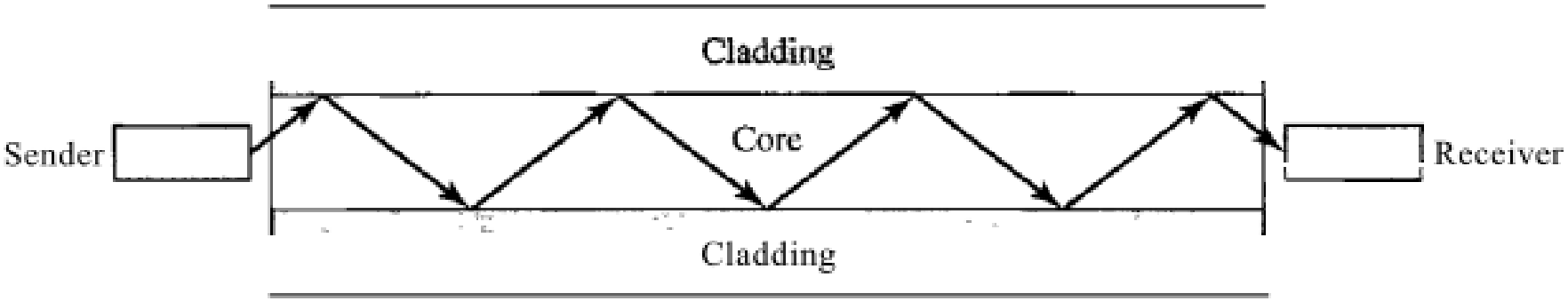


I = critical angle,
refraction

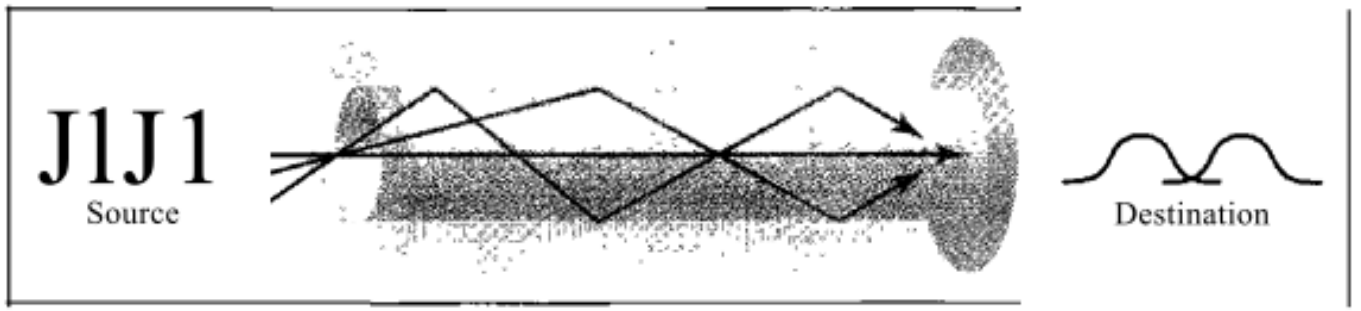


I > critical angle,
reflection

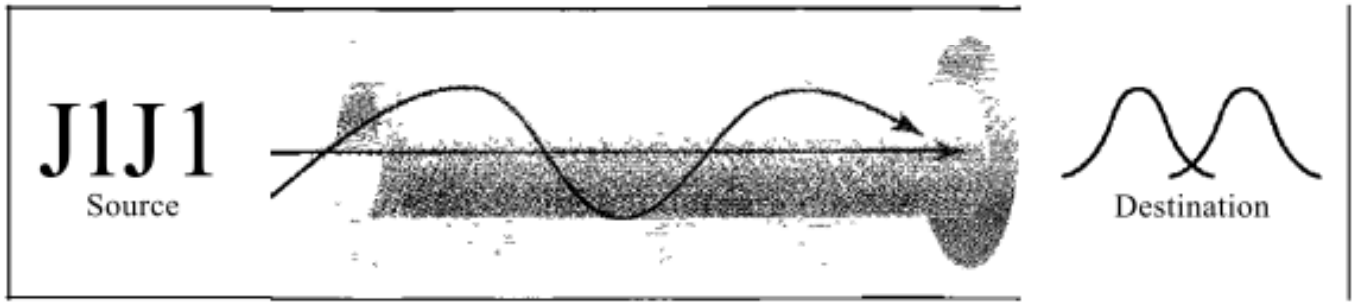
Fiber-Optic Cable



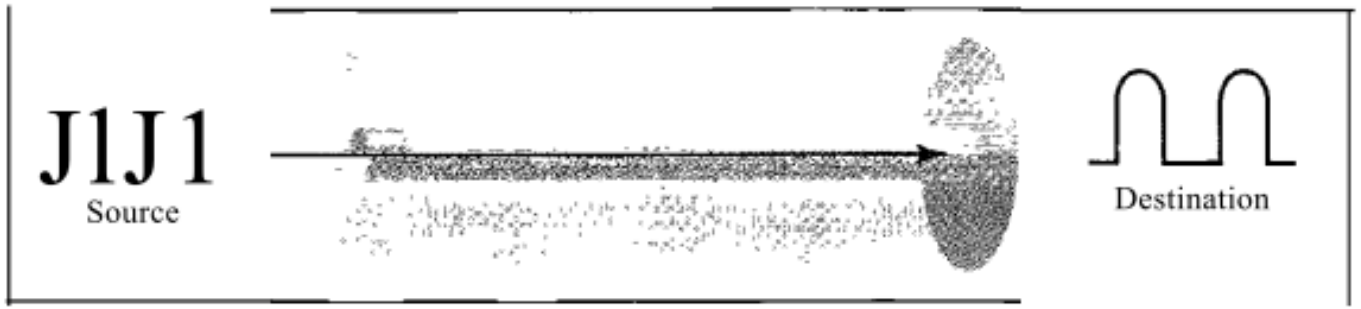
Propagation Modes



a. Multimode, step index



b. Multimode, graded index



c. Single mode