Guided and unguided media

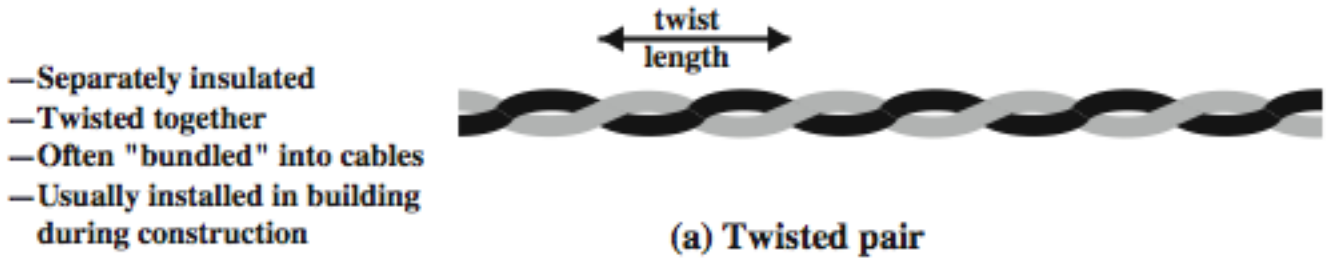
- guided - wire / optical fibre
- unguided – wireless

- Guided – Makes use of cables
  - Twisted wire pair, coaxial cable, fiber optic

- Unguided – is “In the Air”
  - Terrestrial microwave, satellite, radio, infrared

- characteristics and quality determined by medium and signal
  - in unguided media - bandwidth produced by the antenna is more important
  - in guided media - medium is more important
- key concerns are data rate and distance
- the greater the data rate and distance the better.

Twisted Pair



A twisted pair consists of two insulated copper wires arranged in a regular spiral pattern. A wire pair acts as a single communication link. Typically, a number of these pairs are bundled together into a cable by wrapping them in a tough protective sheath. The twisting tends to decrease the crosstalk interference between adjacent pairs in a cable.

Twisted Pair - Transmission Characteristics

- analog
  - needs amplifiers every 5km to 6km
- digital
  - can use either analog or digital signals
  - needs a repeater every 2-3km
- limited distance
- limited bandwidth for a point to point analog signaling(1MHz)
- For a long-distance digital point to point signaling data rates up to a few Mbps are possible.
- for very short distances, data rates of up to 10 Gbps have been achieved in commercially available products.
- susceptible to interference and noise

Advantages and Disadvantages of TP

Advantages:

The most common guided transmission medium for both analog and digital signals.

It is the most commonly used medium in the telephone network, and for communications within buildings (for LANs running at 10-100Mbps).

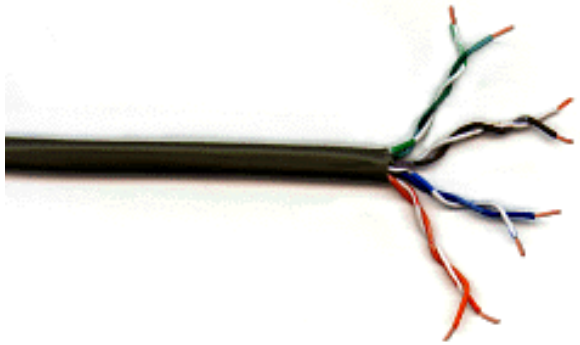
Twisted pair is much less expensive than the other commonly used guided transmission media (coaxial cable, optical fiber) and is easier to work with.

Disadvantages:

- Sensitive to EMI (Electro Magnetic Interference) and eavesdropping, especially unshielded.
- Unsuitable for very high-speed data transmission.
- Some data networking standards for TP are new and not entirely stable.

Unshielded vs Shielded TP

- category 5, UTP wire pair



- unshielded Twisted Pair (UTP)
  - ordinary telephone wire
  - cheapest
  - easiest to install
  - suffers from external EM interference
- shielded Twisted Pair (STP)
  - metal braid or sheathing that reduces interference
  - This shielded twisted pair provides better performance at higher data rates.
  - more expensive
  - harder to handle (thick, heavy)

Crosstalk

- **Coupling of signal from one pair to another.**
- **Occurs when transmit signal entering the link couples back to receiving pair.**

  ie. near transmitted signal is picked up by near receiving pair

Five categories of Unshielded TP (UTP)

- UTP cable is rated according to its data-carrying capacity.

Category 1: For analog and digital voice (telephone) and low speed data applications.

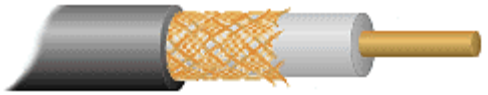
Category 2: For Integrated Services and Digital Network (ISDN) and medium-speed data applications.

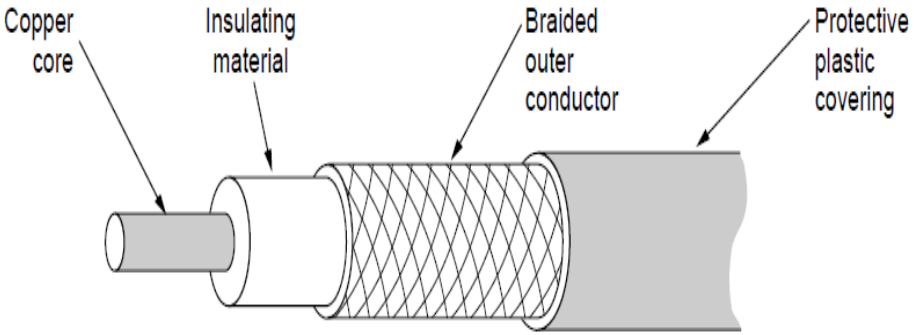
Category 3: For High-speed data and LAN traffic up to 10 Mbps.

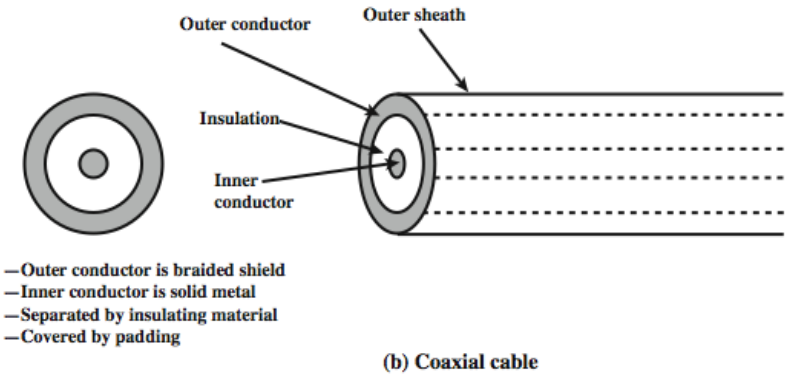
Category 4: For LAN traffic up to 16 Mbps.

Category 5: For LAN technologies such as 100 Mbps Ethernet.

Coaxial Cable







- Superior frequency characteristics than TP
- performance limited by attenuation & noise
- analog signals
  - amplifiers every few km
  - closer if higher frequency
  - up to 500MHz
- digital signals
  - repeater every 1km
  - closer for higher data rates

A coaxial cable

Coaxial Cable-Advantages and Disadvantages

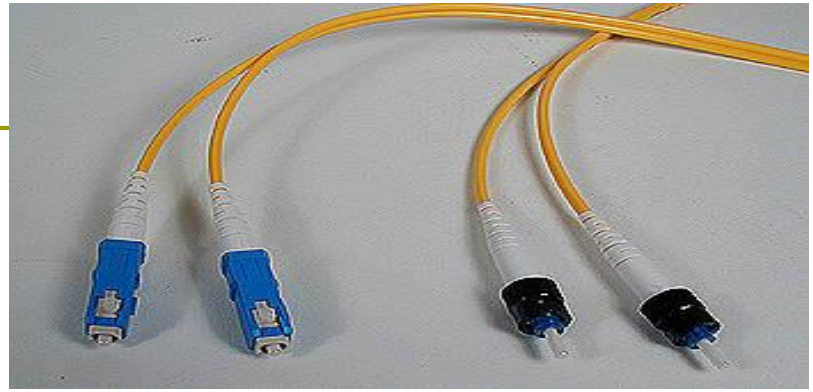
Advantages:

- Technology and standards are mature, which promotes compatibility and interoperability of different vendors' equipment.
- Resists EMI better than bandwidths than twisted pair.
- Supports higher bandwidths than twisted pair.
- Heavier coax cable is relatively sturdy and resists rough treatment.

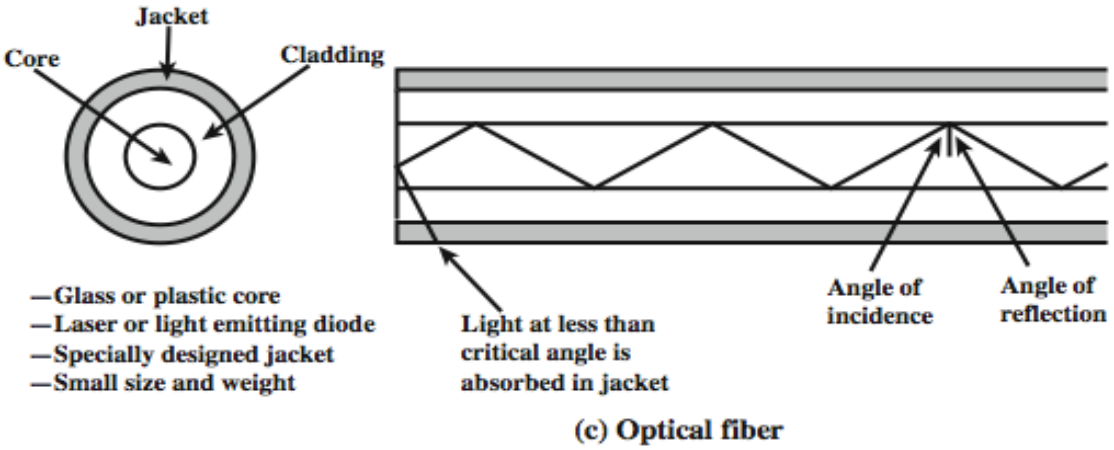
Disadvantages:

- Coax cable, like TP, is susceptible to EMI and eavesdropping.
- Some coax cables are heavy, bulky, or expensive.

Optical Fiber - Benefits



- Greater capacity
  - data rates of hundreds of Gbps over tens of km.
- smaller size & weight
- lower attenuation
- electromagnetic isolation
- greater repeater spacing
  - 10s of km at least

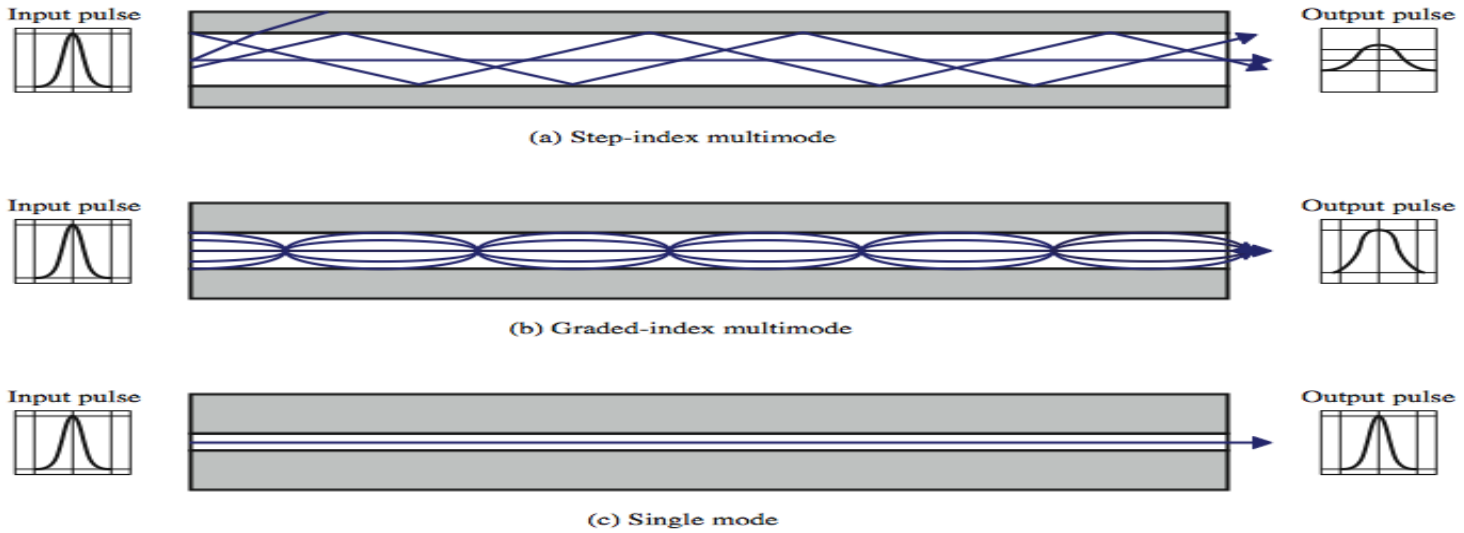


(c) Optical fiber

Optical Fiber - Transmission Characteristics

- uses total internal reflection to transmit light
  - effectively acts as wave guide for 10^{14} to 10^{15} Hz
  - this covers portions of the infrared and visible spectra
- can use several different light sources
  - Light Emitting Diode (LED)
    - cheaper, wider operating temp range, lasts longer
  - Injection Laser Diode (ILD)
    - more efficient, has greater data rate
- relation of wavelength, type & data rate

Optical Fiber Transmission Modes



- Light from a source enters the cylindrical glass or plastic core. Rays at shallow angles are reflected and propagated along the fiber; other rays are absorbed by the surrounding material.
- This form of propagation is called **step-index multimode**, referring to the variety of angles that will reflect.
- With multimode transmission, multiple propagation paths exist, each with a different path length and hence time to traverse the fiber.
- This causes signal elements (light pulses) to spread out in time, which limits the rate at which data can be accurately received. This type of fiber is best suited for transmission over very short distances.

Advantages and Disadvantages

Advantages:

- Immune to interference or detection outside the cable, so fiber optic cable is an extremely reliable and secure transmission media.
- Supports very high bandwidths.

Disadvantages:

- Network interfaces and cables are relatively expensive.
- Connections require high- precision manufacturing and careful handling.
- Relatively complex to configure and install.