Computer Networks

Transmission Media (Guided)

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Guided Transmission Medium

- Guided medium:
  - Twisted pair, coaxial cable, optical fiber
  - 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

❑Twisted pair cable:

- A twisted pair consists of two conductors (normally copper), each with its own plastic insulation, twisted together
- Two wires carry signals of opposite polarities
- The receiver uses the difference between the two

Twisted pair cable

❑Twisted pair cable:

- Twisting makes sure that both wires are equally affected by external influences (noise or crosstalk)
  - Converse is also true

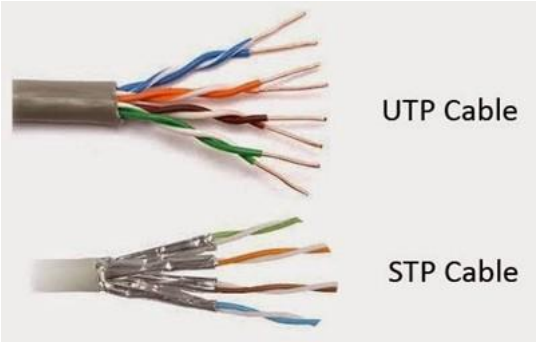
Twisted pair cable

- Twisted pair cable:
  - Unshielded Twisted pair
    - ordinary telephone wire
    - cheapest
    - easiest to install
    - suffers from external electromagnetic interference

Src:https://commons.wikimedia.org/wiki/File:UTP_cable.jpg

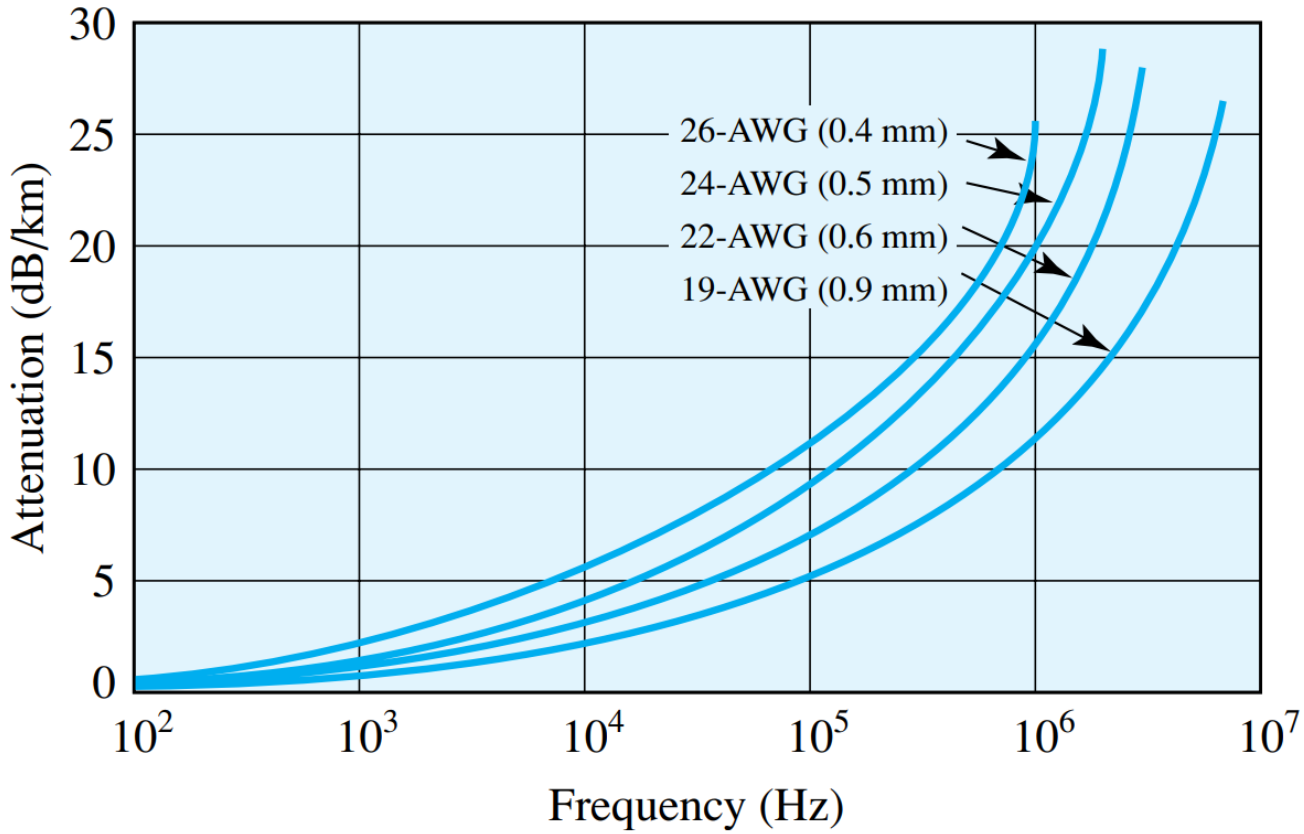
  - Shielded Twisted pair:
    - Has a metal foil or braided mesh covering that encases each pair of insulated conductors
    - Improves the quality of cable by preventing the penetration of noise or crosstalk
    - Bulkier and more expensive

  - Used in telephone lines and LANs



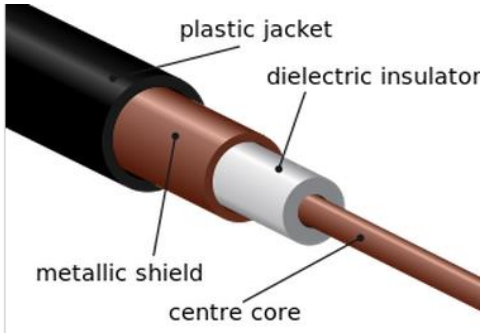
Src: https://medium.com/@bilby_yang/comparison-between-utp-and-stp-27f7ac1d61aa

Twisted Pair Cable Performance

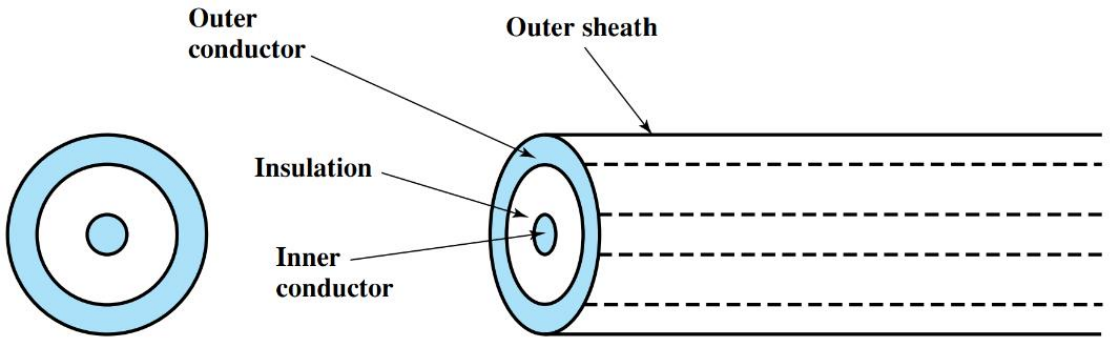


Coaxial Cable

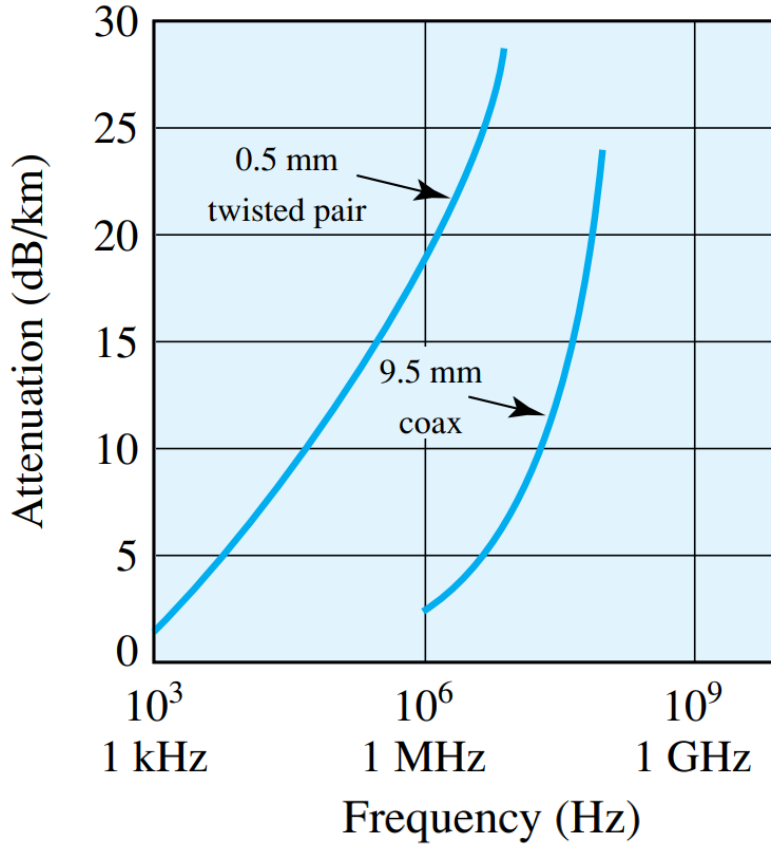
- Coaxial cable can be used over longer distances
- Supports more stations on a shared line than twisted pair
- Consists of a hollow outer cylindrical conductor that surrounds a single inner wire conductor
- Used for TV distribution, long distance telephone transmission and LANs



Src:https://commons.wikimedia.org/wiki/File:Coaxial_cable_cutaway.svg

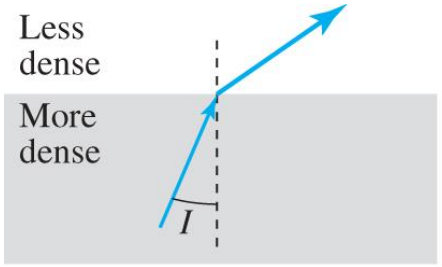


Coaxial Cable Performance

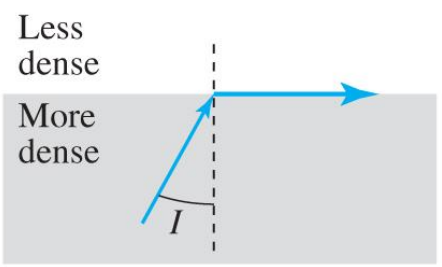


Optical Fiber

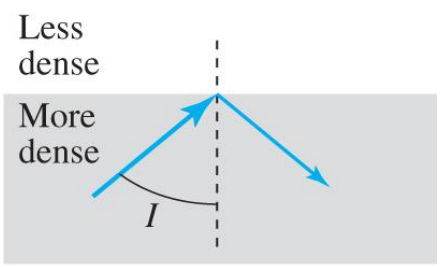
- Uses total internal reflection to transmit light
  - When waves are refracted from a dense medium to a lighter medium the angle of refraction is greater than the angle of incidence
  - As the angle of incidence approaches a certain threshold (called the critical angle), the angle of refraction approaches 90° → the refracted ray becomes parallel to the boundary surface
  - As the angle of incidence increases beyond the critical angle, the conditions of refraction can no longer be satisfied, so there is no refracted ray, and the partial reflection becomes total



$I <$ critical angle, refraction



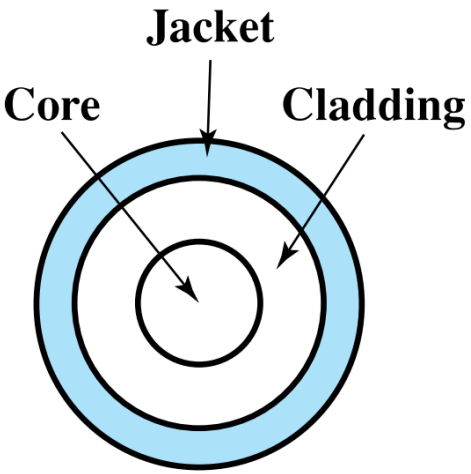
$I =$ critical angle, refraction



$I >$ critical angle, refraction

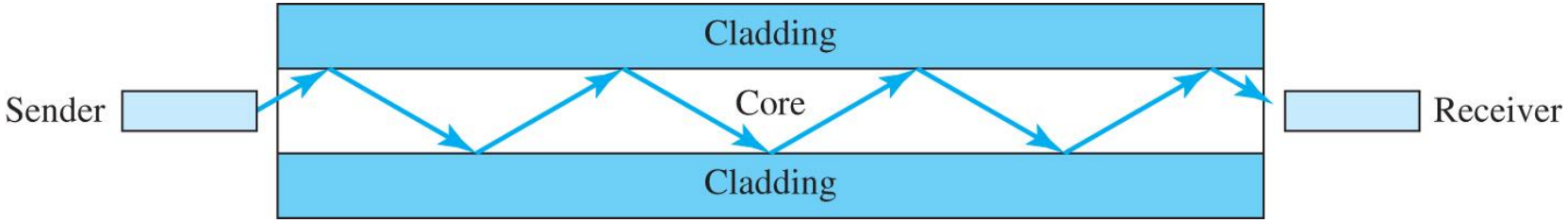
Optical Fiber

- Optical fiber is a thin flexible medium capable of guiding an optical ray



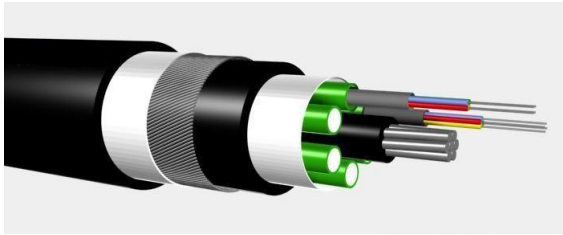
- Various glasses and plastics can be used to make optical fibers

- Has a cylindrical shape with three sections
  - Core, cladding, jacket



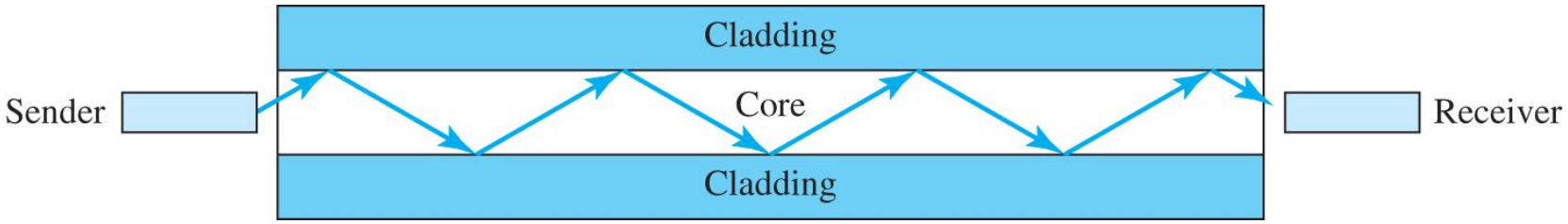
Optical Fiber

- Light sources used:
  - Light Emitting Diode (LED)
  - Cheaper, operates over a greater temperature range, lasts longer

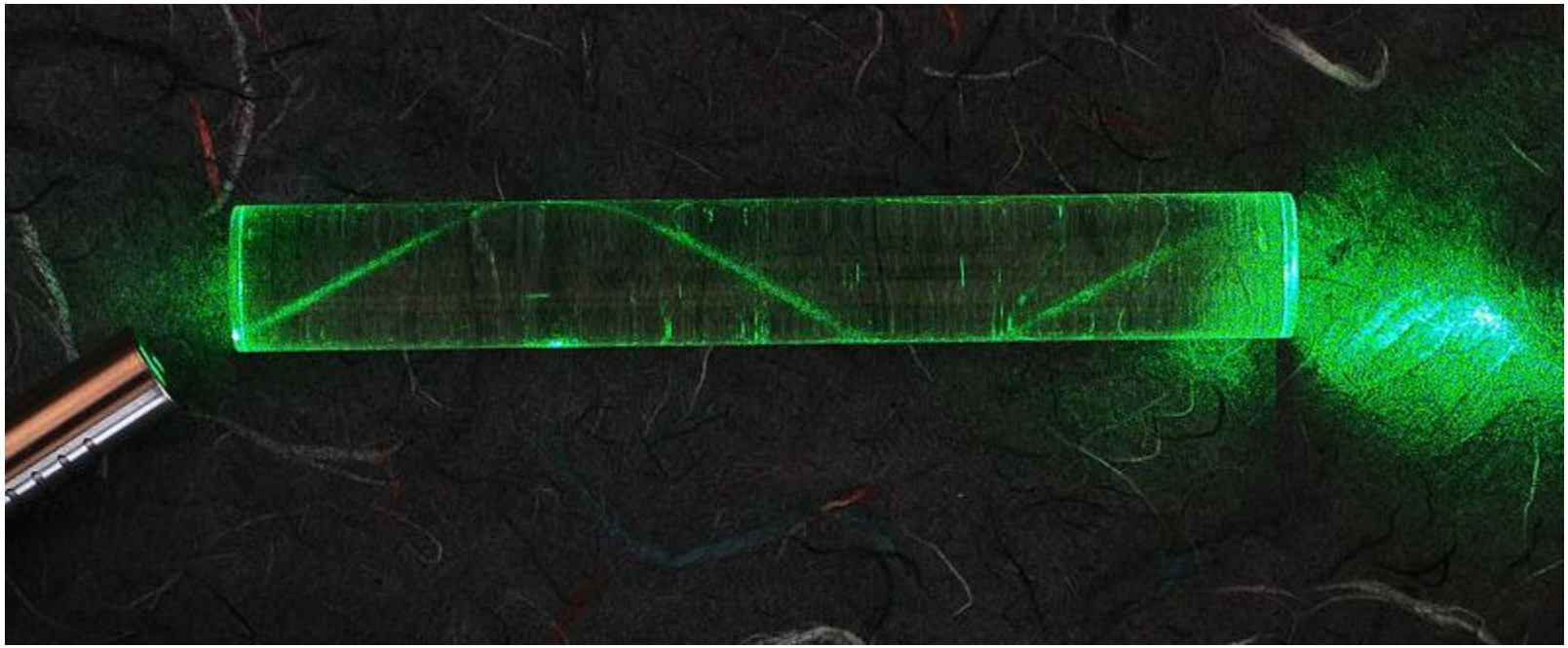


Src:https://commons.wikimedia.org/wiki/File:Optical_fiber_cable.jpg

- Injection Laser Diode (ILD)
  - More efficient, has greater data rates

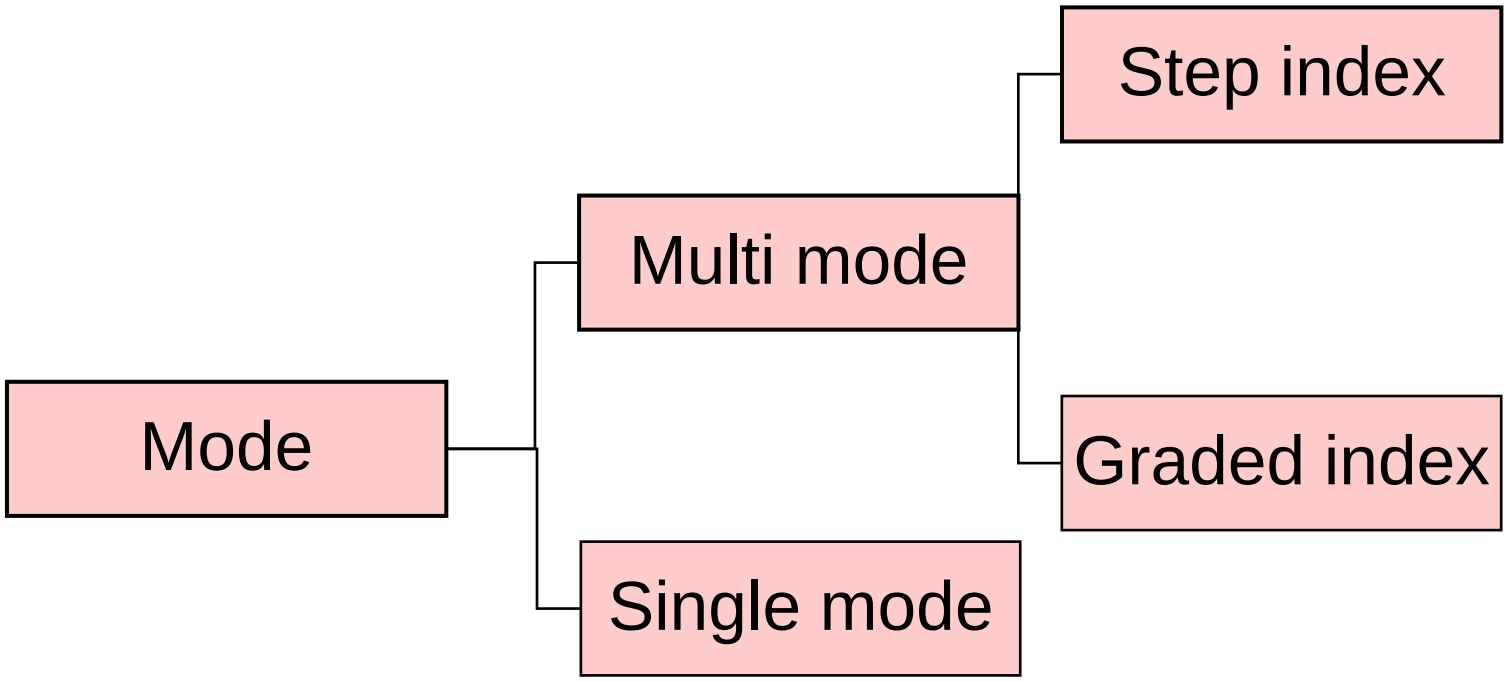


Optical Fiber

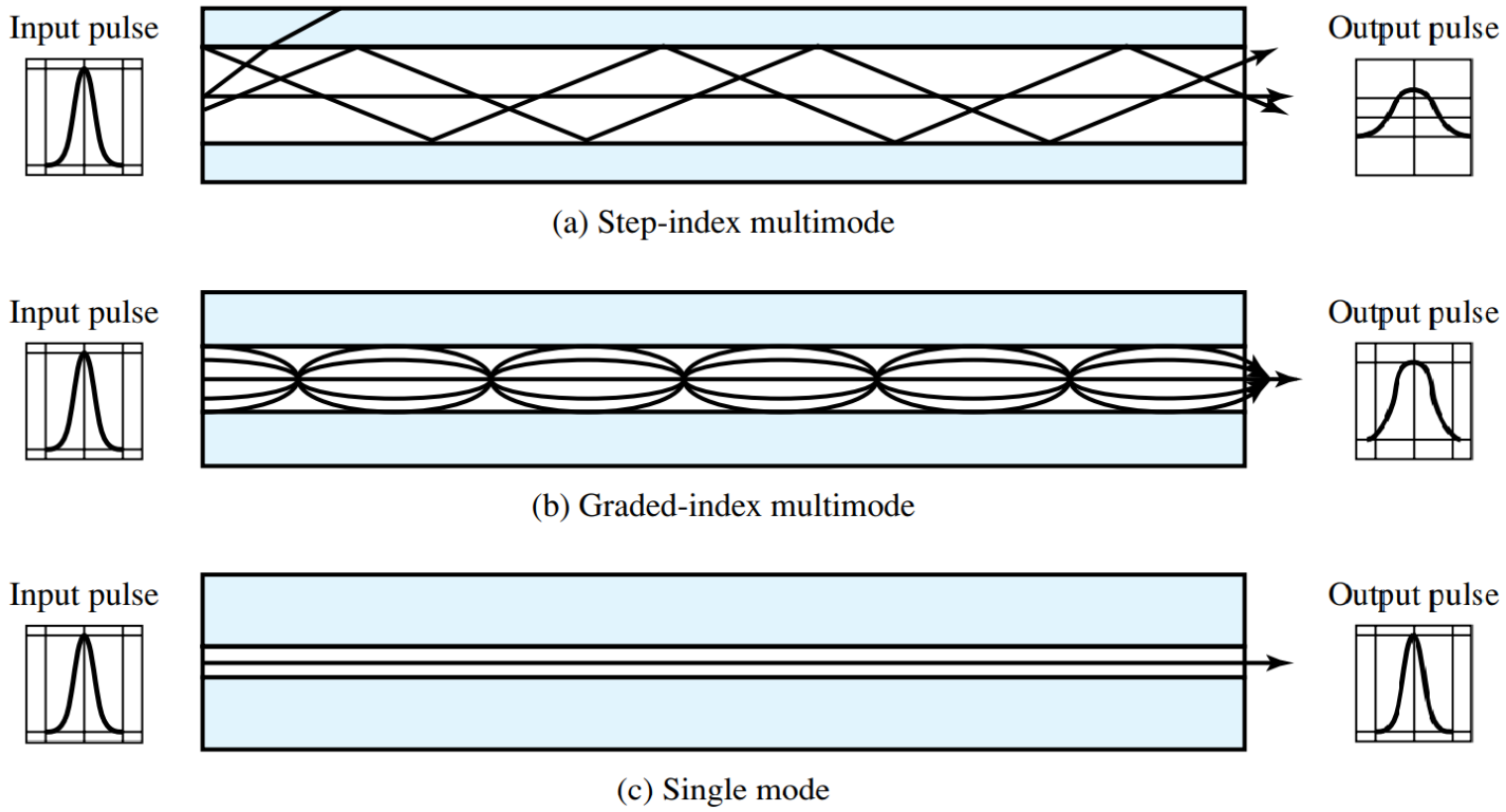


Src: https://commons.wikimedia.org/wiki/File:Laser_in_fibre.jpg

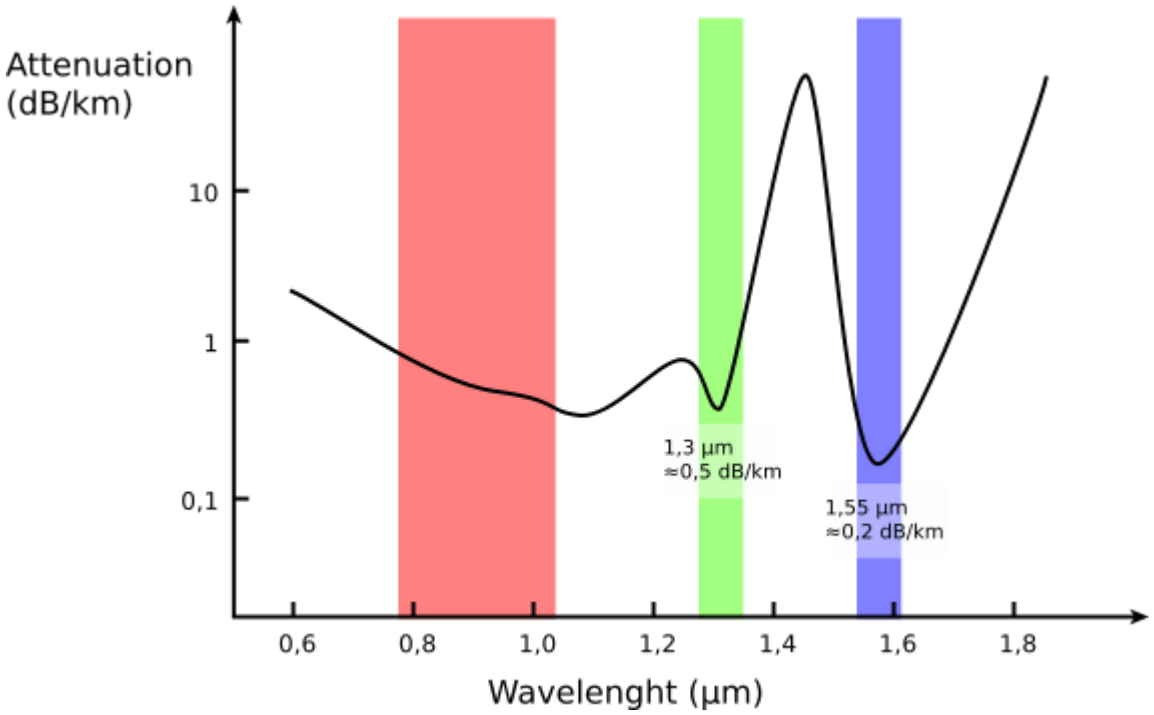
Optical Fiber



Optical Fiber Transmission Modes

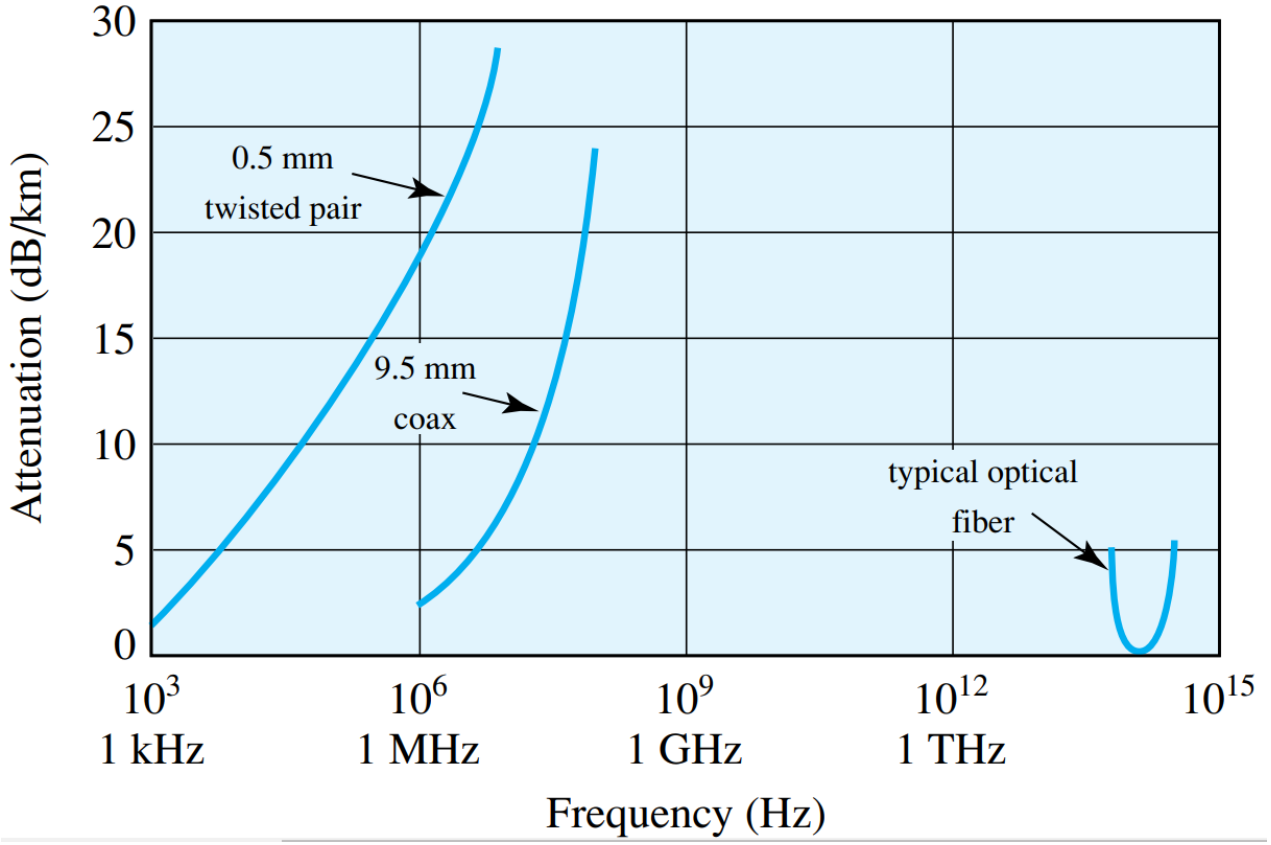


Optical Fiber Performance



Src: https://commons.wikimedia.org/wiki/File:Optical_fiber_transmission_windows.svg

Attenuation Comparison



Optical Fiber - Benefits

- Greater capacity
  - Data rates of 100 Gbps+ (as compared to 1 Gps with electrical cables)
- Smaller size and lighter weight
  - Considerably thinner than coaxial or twisted pair cable
- Lower attenuation
  - Maximum distance is 40 km → as compared to 2 km (twisted pair) and 10 km (coaxial cable)
- Greater repeater spacing
  - Lower cost and fewer sources of error
- Electromagnetic isolation
  - Not vulnerable to interference, impulse noise, or crosstalk
  - High degree of security from eavesdropping

Summary

- Wired transmission medium:
  - Twisted pair cable
  - Coaxial cable
  - Optical fiber