Guided Transmission Media

- Magnetic Media
- Twisted pair
- Coaxial cable
- Fiber Optics

Magnetic Media

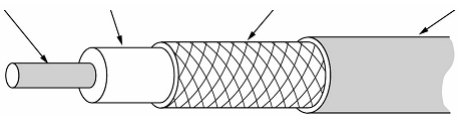
- Physical transport
  - e.g. Floppies, DAT, DLT, etc
- Example
  - Ultrium tape: Capacity 200GBytes, 800GByte compressed
  - 60cm x 60cm x 60cm Box would hold about 1000 tapes
    - Capacity 200TBytes or 1600 Terabits
  - DHL overnight service
    - Data rate: If it takes 1 day, then 19Gbps
- Motto: "Never underestimate the bandwidth of a station wagon full of tapes hurtling down the highway"

Twisted Pair

- Construction: consists of 2 insulated copper wires wrapped in double helix fashion
- This reduces electrical interference from similar pairs
  - Note: Straight copper wires act as antennas and pick up extraneous signals,
- Usage: Telephones, PBX and also ADSL
- Distance: Run for several km without amplification
- Types
  - Shielded Twisted Pair (STP): uses foil shield to reduce interference and crosstalk. Expensive and able to handle high-speed tx.
  - Unshielded Twisted Pair (UTP): no shielding, used in 10/100/1000BaseT ethernet
    - Cat 3: Bandwidth 16MHz, 2 insulated wires twisted together
    - Cat 5: Bandwidth 100MHz+, More twists per cm than Cat 3.

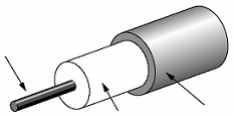
Coaxial Cable

- Shielding: Improved shielding over twisted pair, minimizes attenuation at high frequencies,
- Speed: Operates at speeds up to 100 Mbps-1Gbps. Bandwidth of up to 1GHz depending on cable quality,
- Distance: Faster speeds over larger distances,
- Usage: Used for trunk cables in the telephone system. Now in Cable TV and some LANs,
- Construction: Copper core, surrounded by insulating material, surrounded by a braided outer conductor, surrounded by a protective shield.

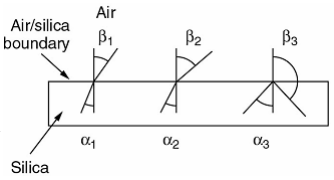


Fiber Optics (1)

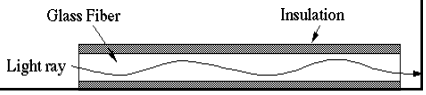
- Components
  - Source: LED or a laser diode
  - Fiber: an ultra thin fiber of glass. Fiber cable consists of a central glass core, surrounded by glass cladding of lower refractive index, surrounded by a thin plastic jacket.
  - Detector: a photo-sensitive diode



- Principle behind fiber optics:
  - **Total internal reflection:** is an optical phenomenon, where the light reflects back to the boundary surface.

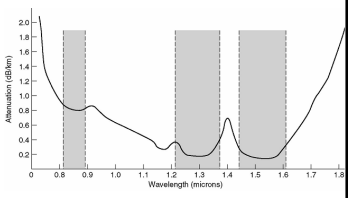


- Multimode, light is reflected to a range of possible angles
- Single mode, diameter of the fiber is thin, the light propagates on straight line.



Fiber Optics (2)

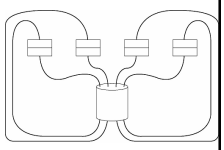
- Properties
  - Uni-directional and fragile
  - Secure: Not easy to tap into data stream,
  - Error Rate: Low error rates
  - Bandwidth: High signal rate => High data rates (Gbps)
  - Attenuation: Low Attenuation, repeaters every 100km
- Attenuation: Light is attenuated as it is passed through different mediums

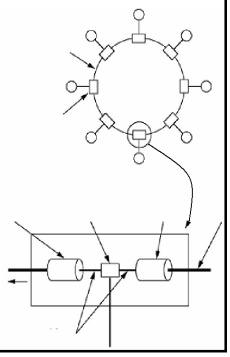


- Three bands typically used
  - 1.30μ, 1.55μ good attenuation, < 5% per km.
  - 0.85μ Higher attenuation, but easier to make laser and electronics

Fiber Optic Networks

- LANs
  - Passive Star: Each computer has a transmitter and a receiver. Everything is transmitted to a central hub and then broadcasted on to all receivers.
  - Ring: Each computer contains a T-junction tap for each computer.
- Taps
  - Passive: 2 taps fused onto main fiber. One contains a photodiode for rx; the other a LED or laser diode for tx. Reliable, because a broken receiver does not break the ring.
  - Active: Incoming light converted to electrical signal, regenerated and transmitted as light. If active repeater fails, ring is broker and network fails.





Fiber vs. Copper

- Bandwidth: Fiber handles much higher bandwidths,
- Attenuation: Repeaters needed every 50km for fiber, every 5 km for copper,
- Interference: Fiber unaffected by power surges, electromagnetic interference, power failures, corrosive chemicals. Copper is.
- Weight: 1000 TP is approximately equivalent to 2 fibers. 1Km copper would weigh 8tons, whereas fiber weighs 100kg,
- Security: Fiber much harder to tap,
- Familiarity: Fiber is unfamiliar to engineers,
- Breakability: Fiber is much easier to break,
- Cost: Fiber is much more expensive in terms of components.