William Stallings Data and Computer Communications

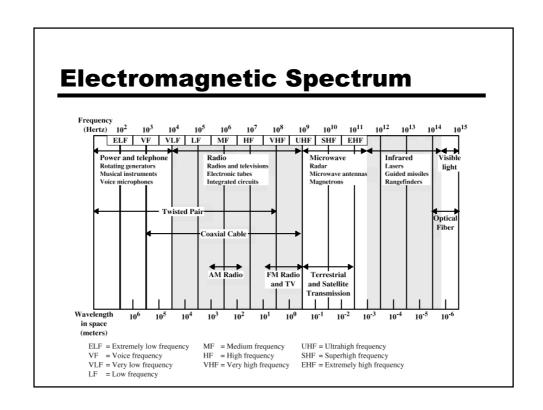
Chapter 4 Transmission Media

Overview

- Guided wire
- Unguided wireless
- Characteristics and quality determined by medium and signal
- For guided, the medium is more important
- For unguided, the bandwidth produced by the antenna is more important
- Key concerns are data rate and distance

Design Factors

- Bandwidth
 - Higher bandwidth gives higher data rate
- Transmission impairments
 - Attenuation
- **■** Interference
- Number of receivers
 - I In guided media
 - More receivers (multi-point) introduce more attenuation



Guided Transmission Media

- Twisted Pair
- Coaxial cable
- Optical fiber

Twisted Pair -Separately insulated -Twisted together -Often "bundled" into cables -Usually installed in building during construction (a) Twisted pair

Twisted Pair - Applications

- Most common medium
- Telephone network
 - Between house and local exchange (subscriber loop)
- Within buildings
 - To private branch exchange (PBX)
- For local area networks (LAN)
 - 10Mbps or 100Mbps

Twisted Pair - Pros and Cons

- Cheap
- Easy to work with
- Low data rate
- Short range

Twisted Pair - Transmission Characteristics

- Analog
 - Amplifiers every 5km to 6km
- Digital
 - Use either analog or digital signals
 - repeater every 2km or 3km
- Limited distance
- Limited bandwidth (1MHz)
- Limited data rate (100MHz)
- Susceptible to interference and noise

Unshielded and Shielded TP

- Unshielded Twisted Pair (UTP)
 - Ordinary telephone wire
 - Cheapest
 - Easiest to install
 - I Suffers from external EM interference
- Shielded Twisted Pair (STP)
 - I Metal braid or sheathing that reduces interference
 - More expensive
 - Harder to handle (thick, heavy)

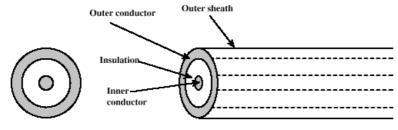
UTP Categories

- Cat 3
 - up to 16MHz
 - Voice grade found in most offices
 - Twist length of 7.5 cm to 10 cm
- Cat 4
 - up to 20 MHz
- Cat 5
 - up to 100MHz
 - Commonly pre-installed in new office buildings
 - Twist length 0.6 cm to 0.85 cm

Near End Crosstalk

- Coupling of signal from one pair to another
- Coupling takes place when transmit signal entering the link couples back to receiving pair
- i.e. near transmitted signal is picked up by near receiving pair

Coaxial Cable



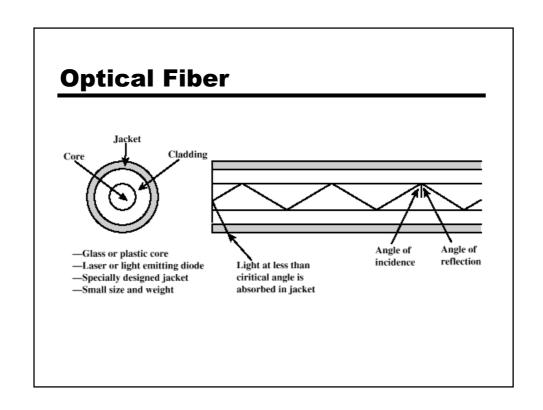
- -Outer conductor is braided shield
- -Inner conductor is solid metal
- -Separated by insulating material
- -Covered by padding

Coaxial Cable Applications

- Most versatile medium
- Television distribution
 - Ariel to TV
 - Cable TV
- Long distance telephone transmission
 - Can carry 10,000 voice calls simultaneously
 - Being replaced by fiber optic
- Short distance computer systems links
- Local area networks

Coaxial Cable - Transmission Characteristics

- Analog
 - Amplifiers every few km
 - Closer if higher frequency
 - Up to 500MHz
- Digital
 - Repeater every 1km
 - I Closer for higher data rates



Optical Fiber - Benefits

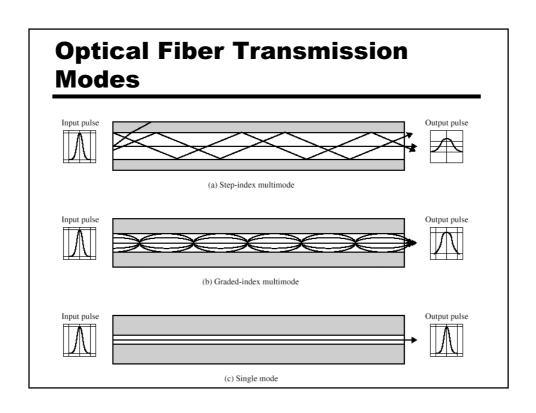
- Greater capacity
 - Data rates of hundreds of Gbps
- Smaller size & weight
- Lower attenuation
- Electromagnetic isolation
- Greater repeater spacing
 - 10s of km at least

Optical Fiber - Applications

- Long-haul trunks
- Metropolitan trunks
- Rural exchange trunks
- Subscriber loops
- **LANs**

Optical Fiber - Transmission Characteristics

- Act as wave guide for 10¹⁴ to 10¹⁵ Hz
 - I Portions of infrared and visible spectrum
- Light Emitting Diode (LED)
 - I Cheaper
 - Wider operating temp range
 - Last longer
- Injection Laser Diode (ILD)
 - More efficient
 - I Greater data rate
- Wavelength Division Multiplexing



Wireless Transmission

- Unguided media
- Transmission and reception via antenna
- Directional
 - Focused beam
 - I Careful alignment required
- Omnidirectional
 - Signal spreads in all directions
 - Can be received by many antennae

Frequencies

- 2GHz to 40GHz
 - Microwave
 - Highly directional
 - Point to point
 - Satellite
- 30MHz to 1GHz
 - I Omnidirectional
 - Broadcast radio
- 3×10^{11} to 2×10^{14}
 - Infrared
 - Local

Terrestrial Microwave

- Parabolic dish
- Focused beam
- Line of sight
- Long haul telecommunications
- Higher frequencies give higher data rates

Satellite Microwave

- Satellite is relay station
- Satellite receives on one frequency, amplifies or repeats signal and transmits on another frequency
- Requires geo-stationary orbit
 - Height of 35,784km
- Television
- Long distance telephone
- Private business networks

Broadcast Radio

- Omnidirectional
- FM radio
- UHF and VHF television
- Line of sight
- Suffers from multipath interference
 - Reflections

Infrared

- Modulate noncoherent infrared light
- Line of sight (or reflection)
- Blocked by walls
- e.g. TV remote control, IRD port

■ Stallings Chapter 4