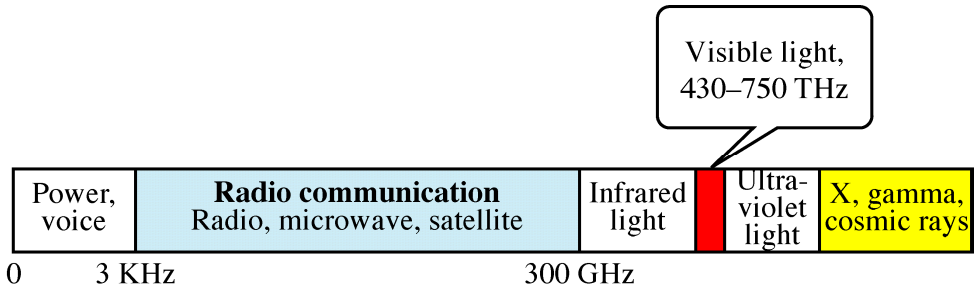
School of Computer Science

Winter Term 2000

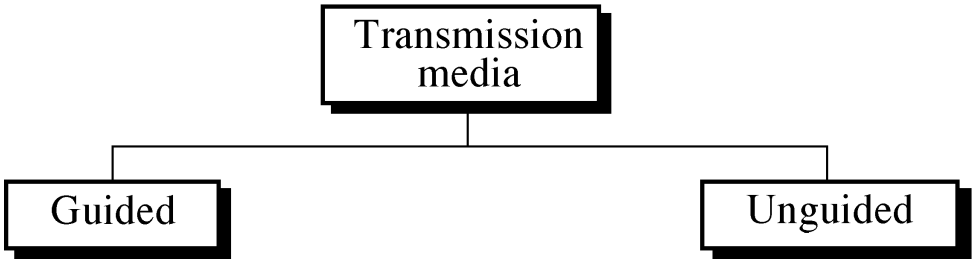
CS 308-435
Basics of Computer Networks

Hans Vangheluwe

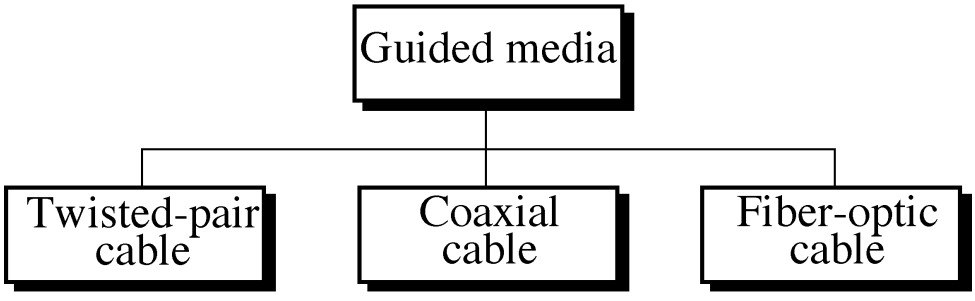
The Electromagnetic Frequency Spectrum



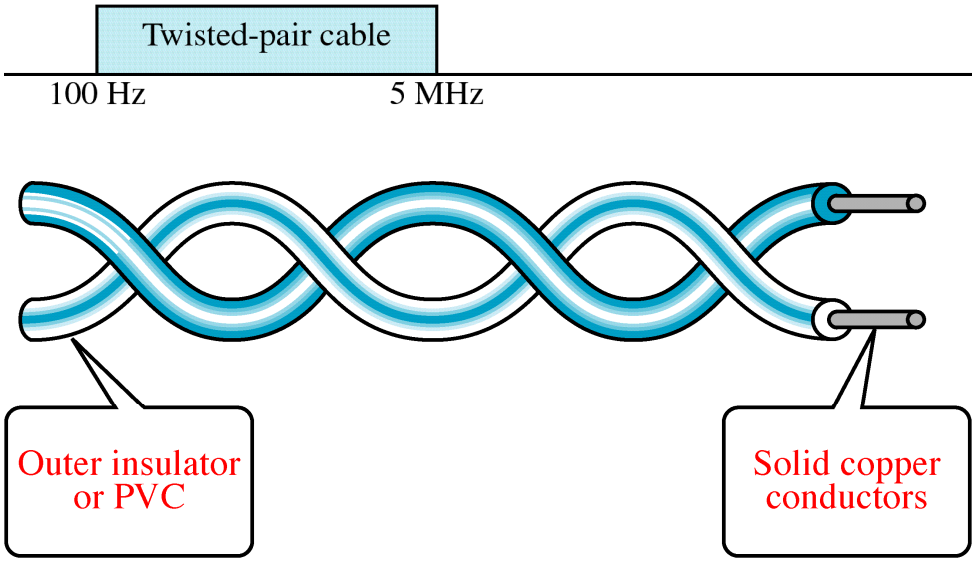
Types of Transmission Media



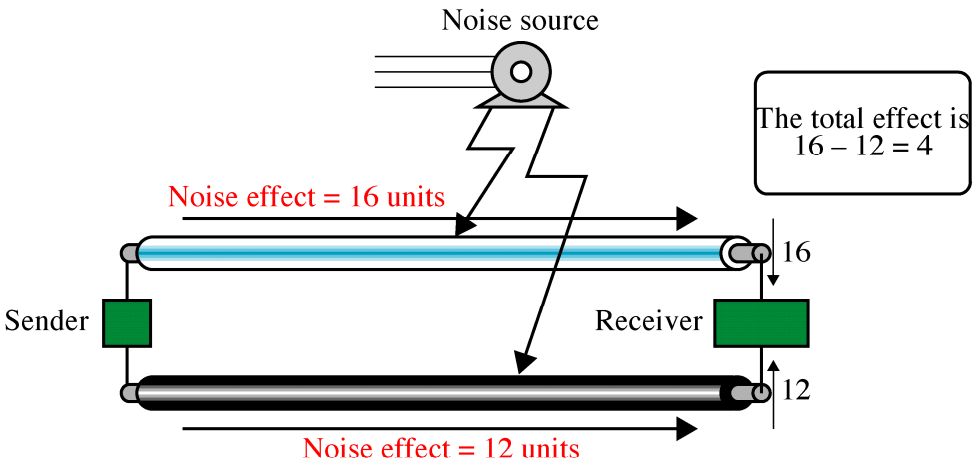
Guided Transmission Media



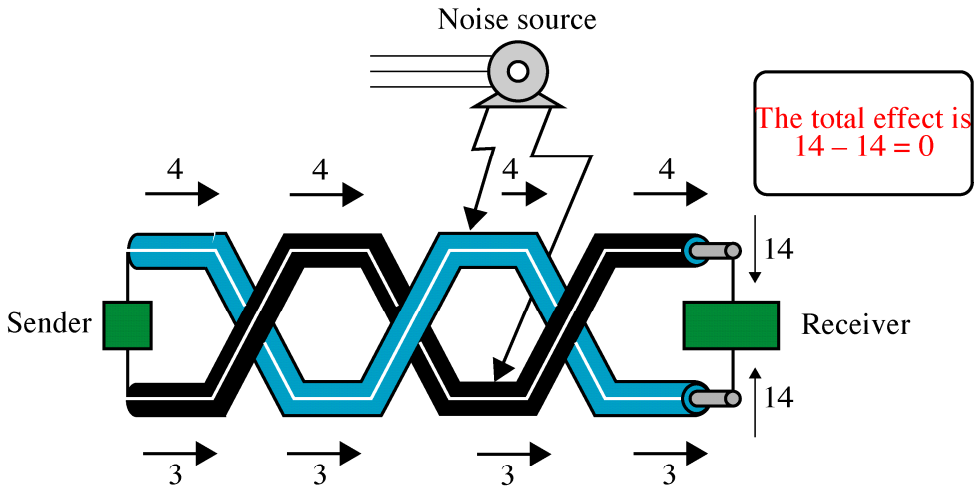
Twisted-pair Cable



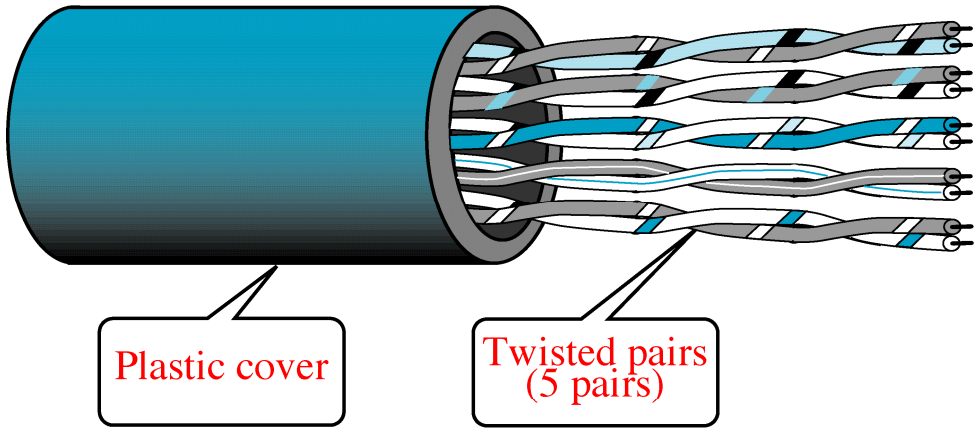
Noise on Parallel Lines



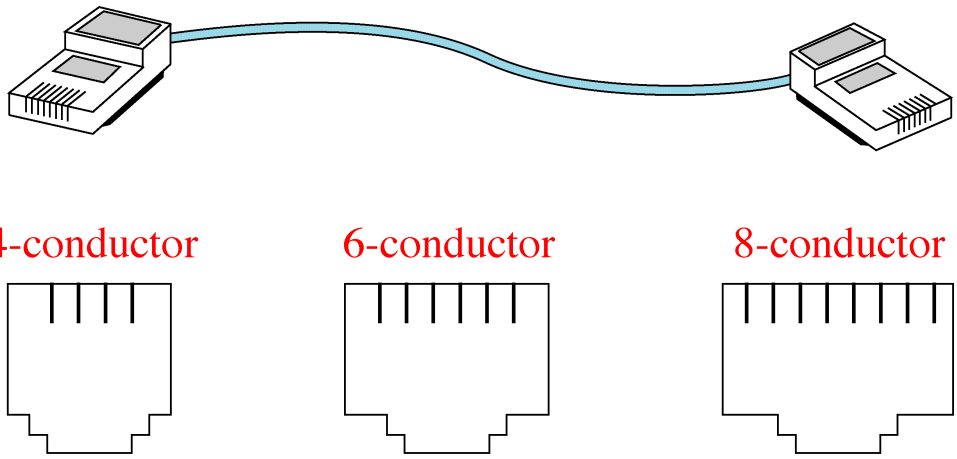
Noise on Twisted-pair Lines



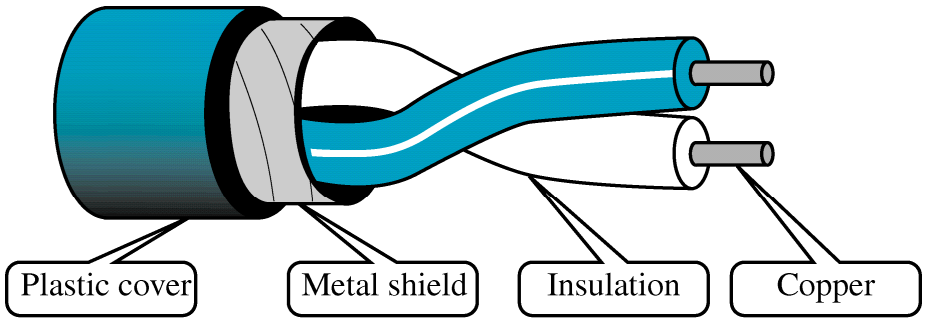
Twisted-pair Cable



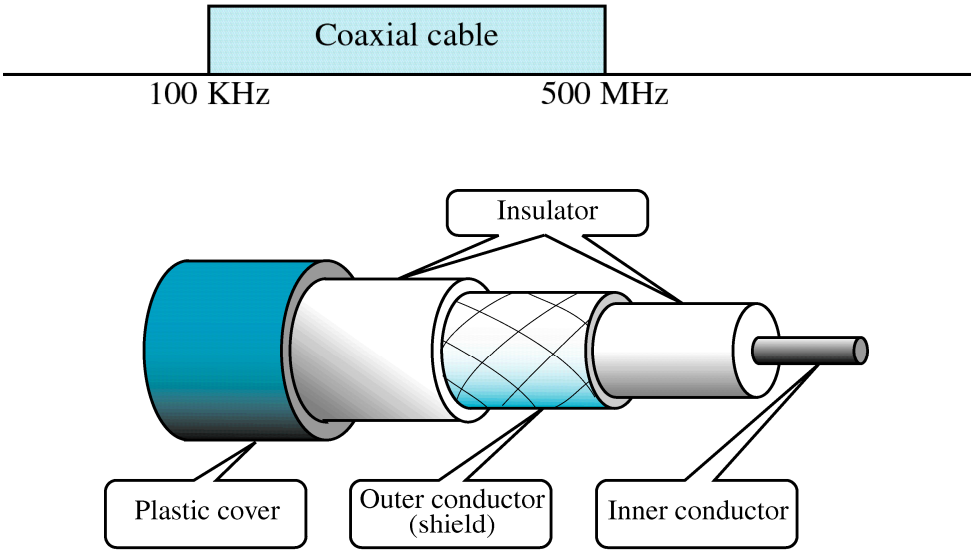
Unshielded Twisted-Pair (UTP) Connectors



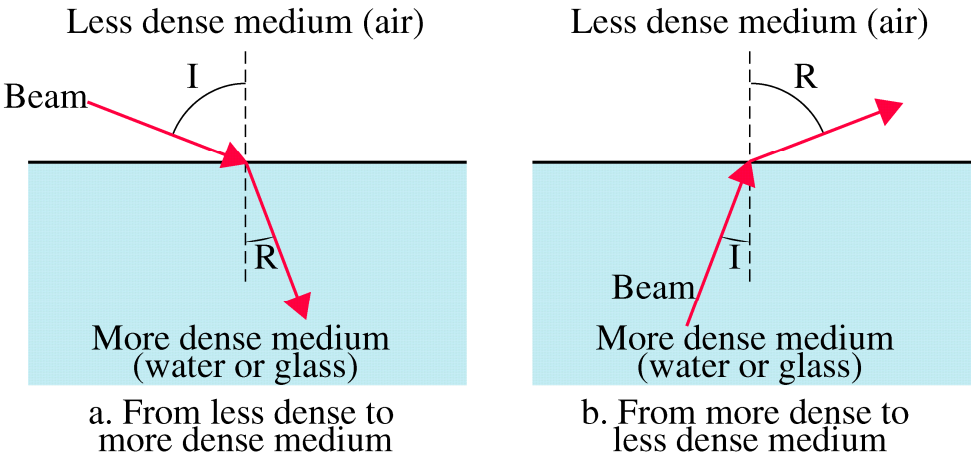
Shielded Twisted-Pair (STP)



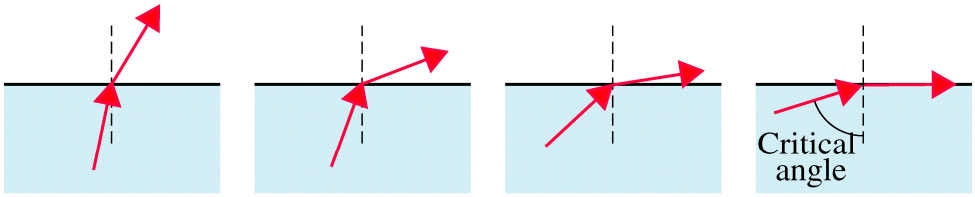
Coaxial Cable



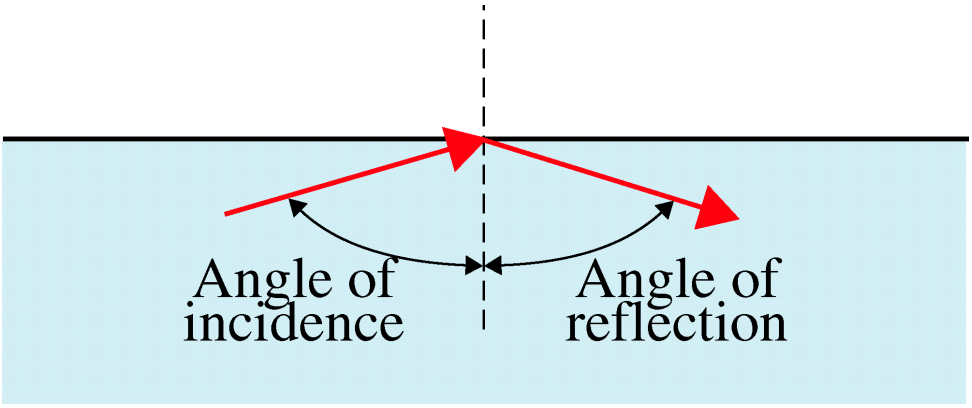
Refraction



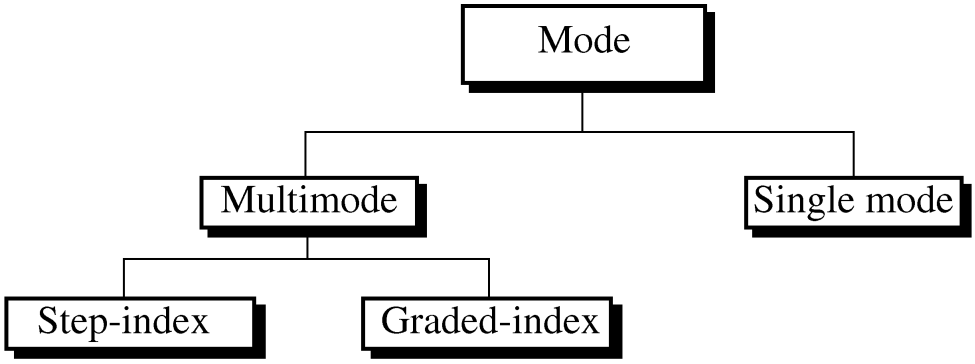
Critical Angle



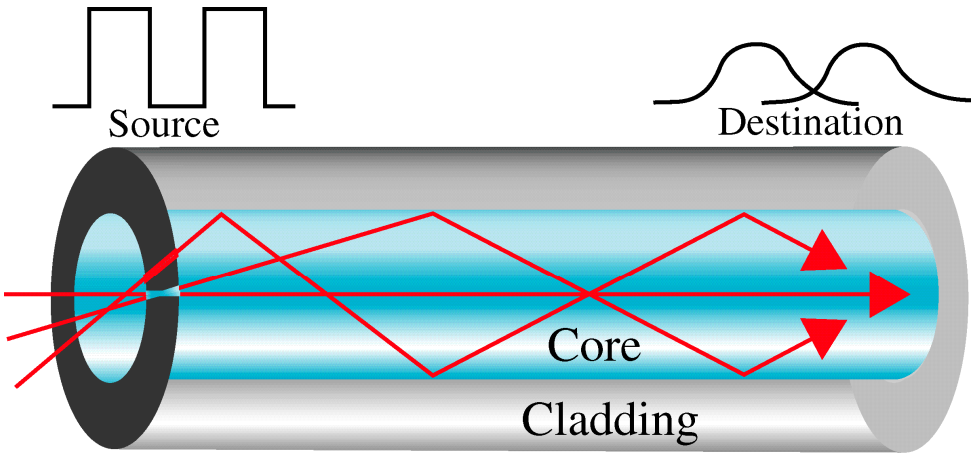
Reflection



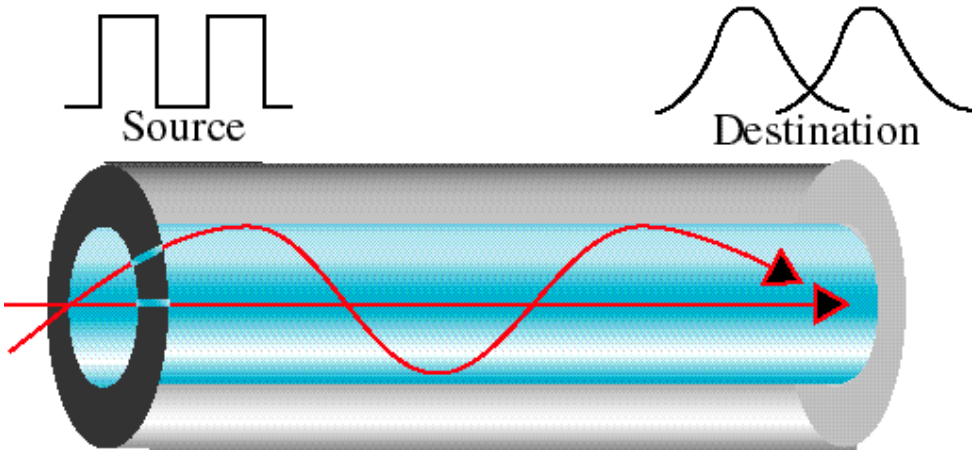
Propagation Modes



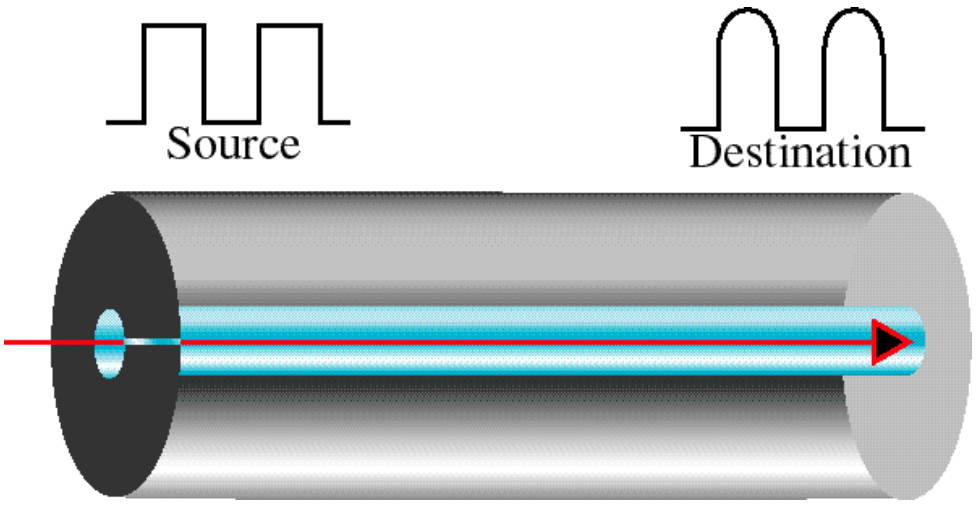
Multimode Step-index Fiber



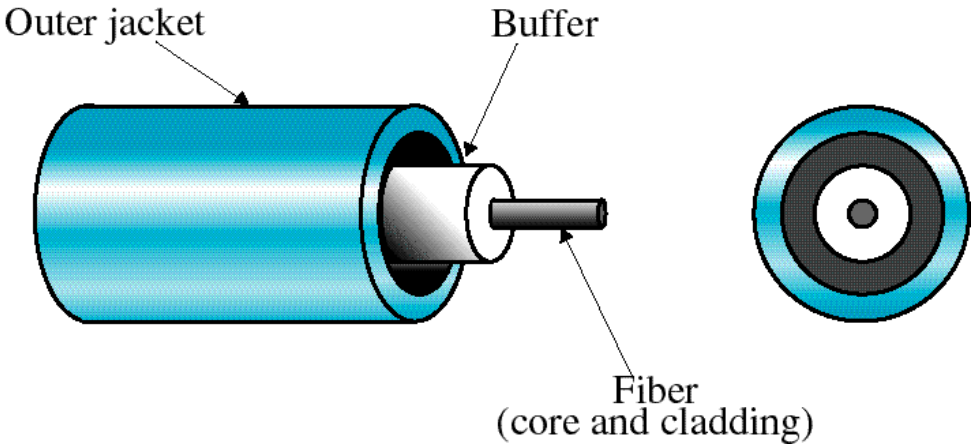
Multimode Graded-index Fiber



Single-mode Fiber

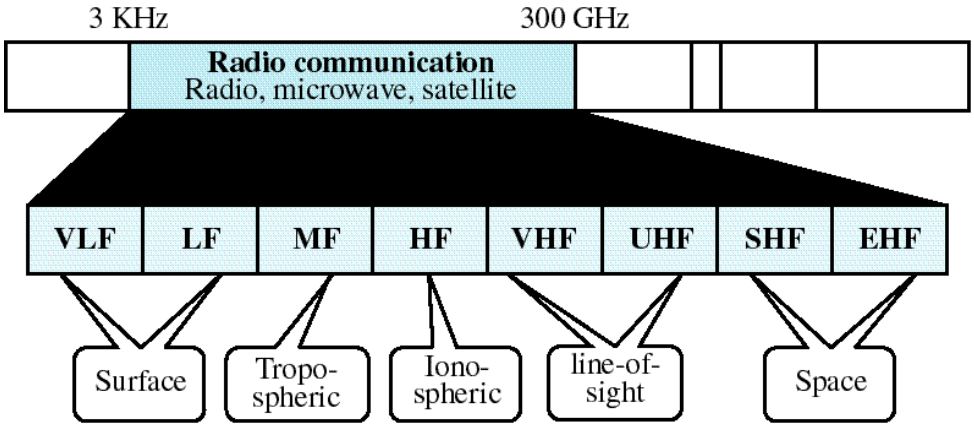


Fiber Construction

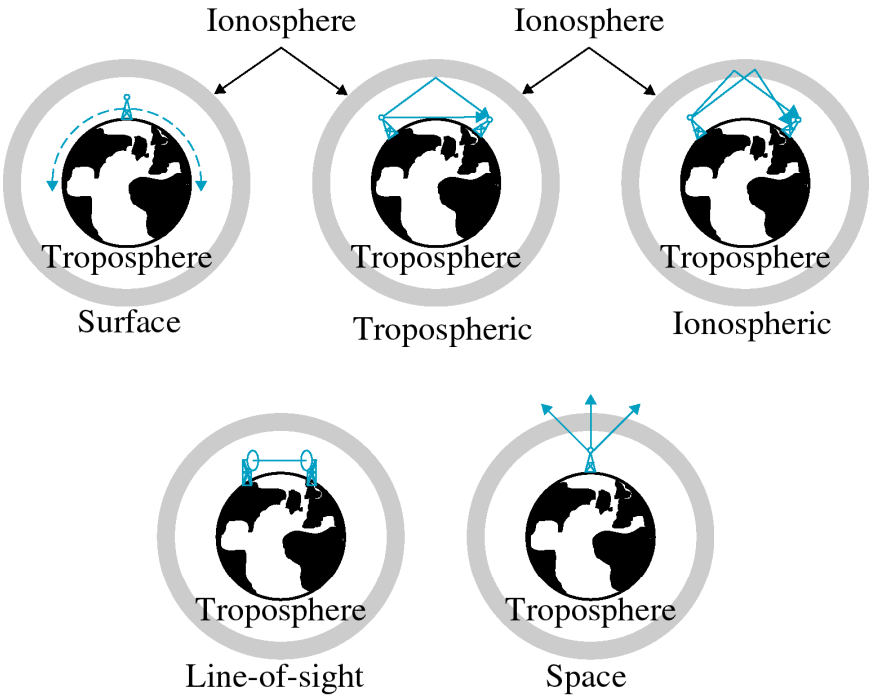


Radio Communication Band

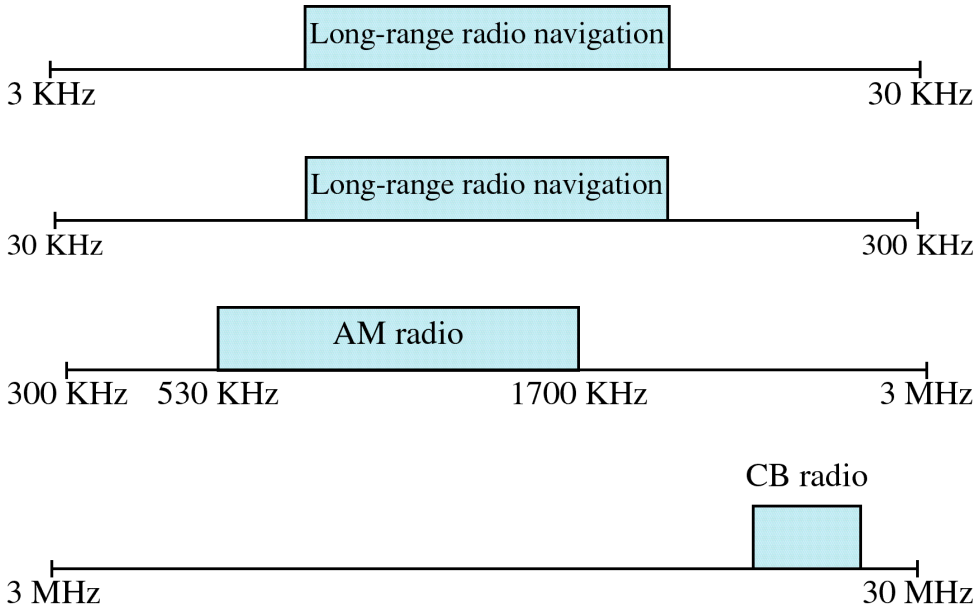
VLF	Very low frequency	VHF	Very high frequency
LF	Low frequency	UHF	Ultra high frequency
MF	Middle frequency	SHF	Super high frequency
HF	High frequency	EHF	Extremely high frequency



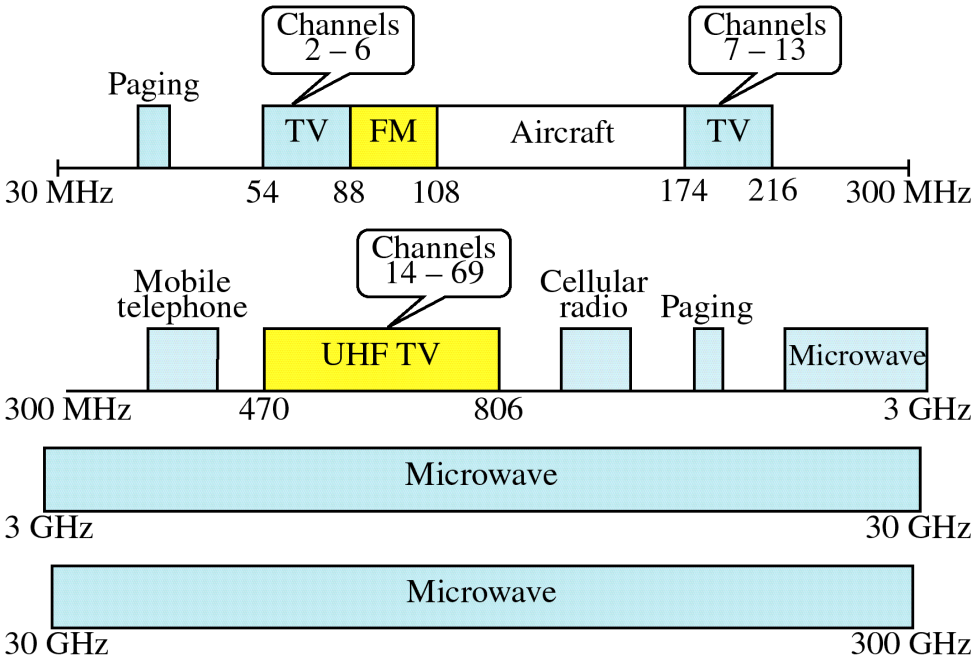
Types of Propagation



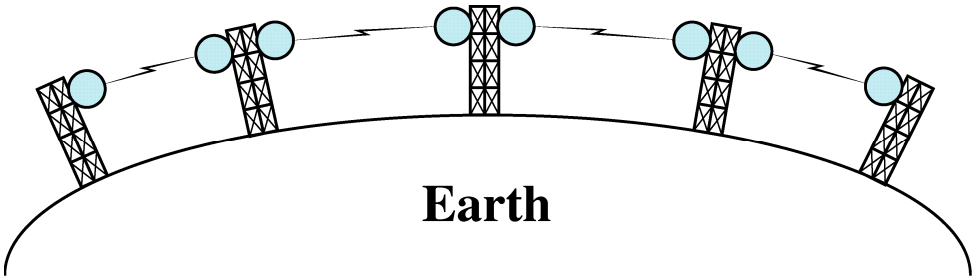
VLF, LF, MF, HF



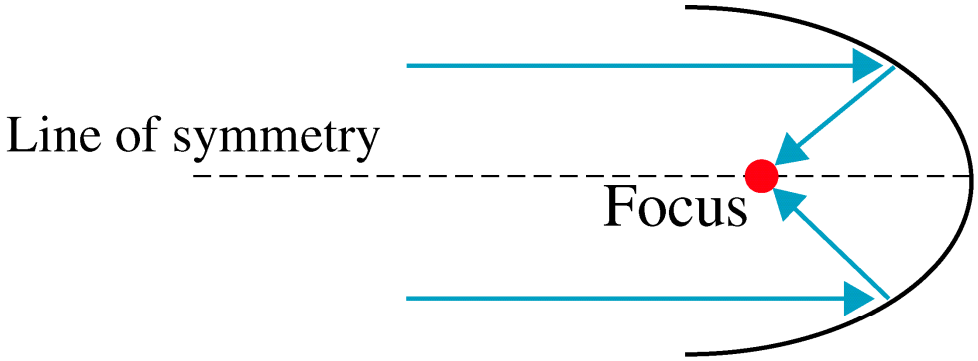
VHF, UHF, SHF, EHF



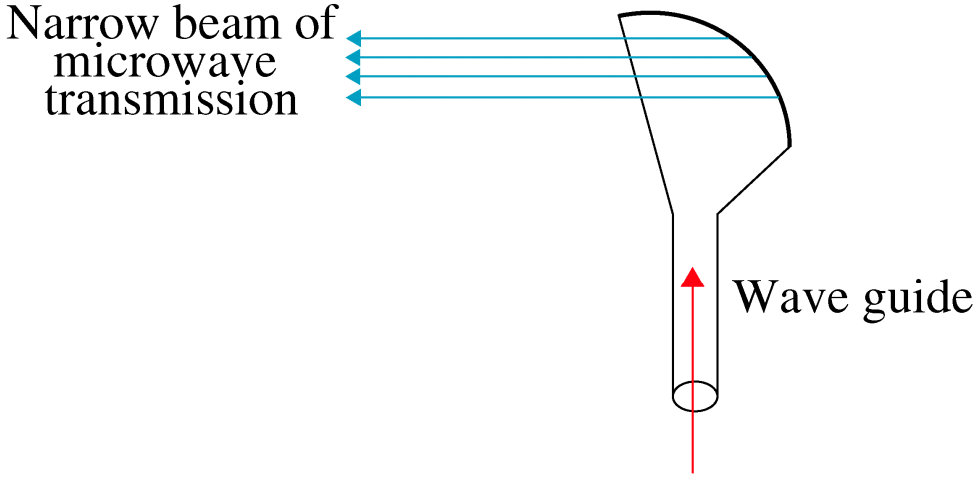
Repeaters for Terrestrial Microwave



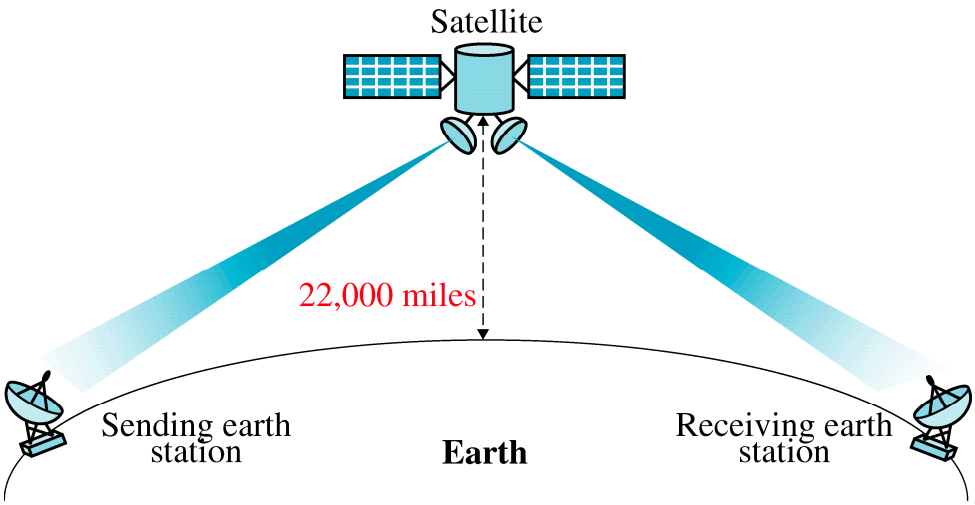
Parabolic Dish Antenna



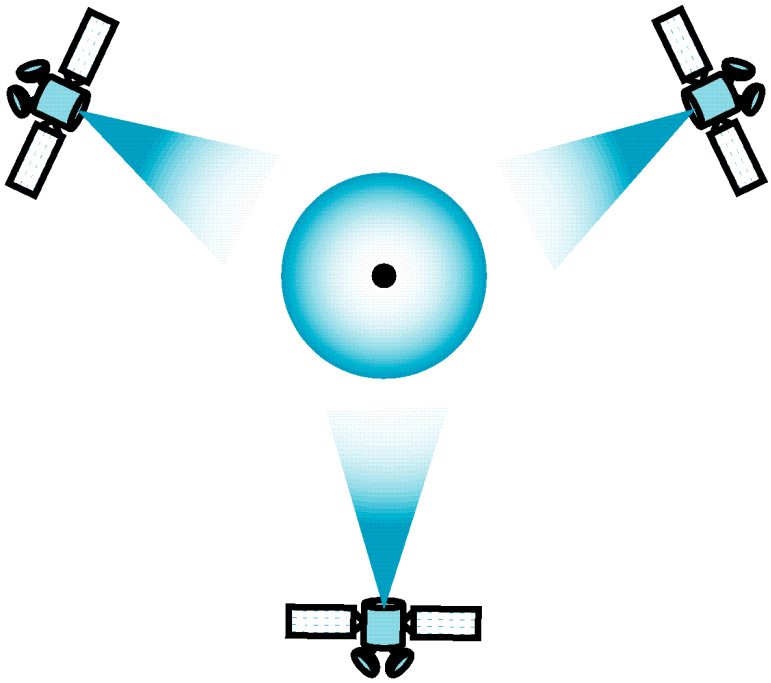
Horn Antenna



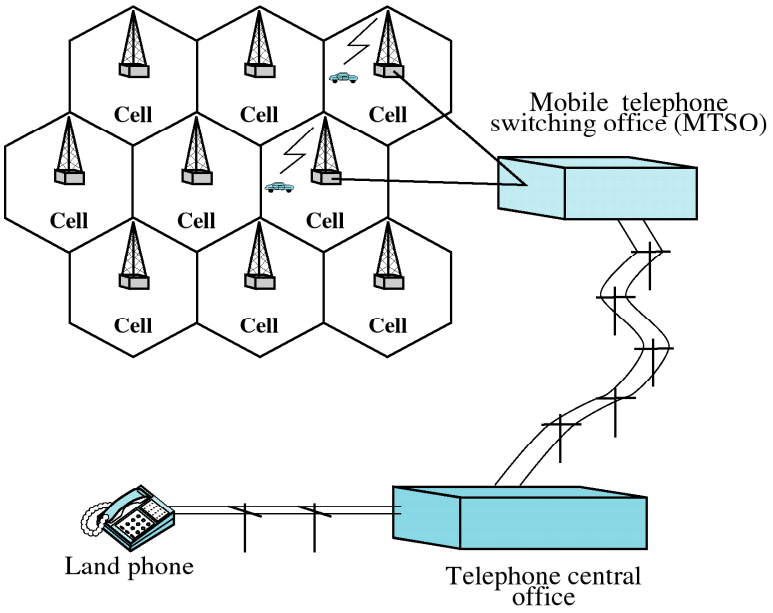
Satellite Communication: Line-of-sight



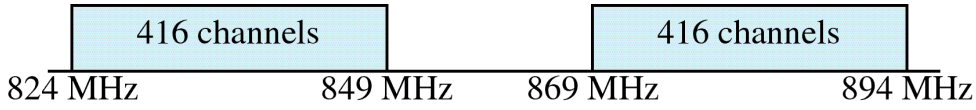
Geosynchronous Orbit



Cellular Communication (transmit, receive, handoff)



Cellular Bands



- FM communication between mobile phone and cell office
- 824 MHz – 849 MHz: calls from mobile phone
- 869 MHz – 894 MHz: calls from fixed phone
- Carrier frequencies 30 KHz apart $\rightarrow$ 833 channels per band
- Full duplex communication $\rightarrow$ 416 channels per band
- Control channels, alternating frequencies, ... $\rightarrow$ 40 channels per cell

Transmission Impairment

- Attenuation

$$dB = 10\log_{10}(P_2/P_1)$$

$$P_2 = P_1/2 \rightarrow 10\log_{10}(P_2/P_1) = 10\log_{10}(0.5) = -3dB$$

$$P_2 = 10P_1 \rightarrow 10\log_{10}(10) = 10dB$$

  Additive:

$$dB = dB_1 + dB_2 + \ldots$$

- Distortion: multiple frequencies, different propagation speeds
- Noise (transmission medium acts as antenna)

Performance

- Throughput: how fast data can pass through a medium ?
- Propagation speed (c): $3 \times 10^8 m/s$
- Propagation time $p = d/c$

$$p = 1000\ m/(3 \times 10^8 m/s) = 3.33\ \mu s/km$$

Wavelength

- The distance a simple signal travels in one period in a medium

$$\lambda = c \times period$$

$$\lambda = c / f$$

Shannon Capacity

- Highest data rate for a channel

$$C = B\ log_2(1 + S/N)$$

- Noisy channel:

$$S/N = 0 \rightarrow C = B\ log_2(1) = 0$$

- Phone line:

$$S/N = 3162,\ B = 3300Hz - 300Hz \rightarrow$$

$$C = 3000\ log_2(1 + 3162) = 34,860\ bps$$