TCOM 370 NOTES 99-3

TRANSMISSION MEDIA

Communication links use physical media such as wire or cable, or free space, to transmit electrical signals to enable data transmission.

Frequencies:

A sine or cosine function of time, $\cos(2\pi ft)$, with f=1 cycle/sec has a frequency of 1 Hertz (Hz).

10^3 Hz = 1 KHz 10^9 Hz = 1 GHz (Giga Hz)

10^6 Hz = 1 MHz 10^{12} Hz = 1 THz (Tera Hz)

- For propagation of frequencies in free space (radiation) or in any physical medium (guided waves) for which speed of propagation is c m/s, the *wavelength* λ is related to the frequency f by

$$c = f\lambda$$

- Wavelength is a spatial parameter. A sinusoidal propagating time waveform produces in the medium at any time instant a sinusoidal spatial variation of the electric or magnetic field. The wavelength is the distance between maxima in this spatial field pattern along the medium. The significance of the wavelength is that it dictates the physical size of the radiating and receiving antennas, and the diameter of waveguides and fiber media.

- In free space (e.g. radio) $c=3 \times 10^8$ m/s, the speed of light.

- The wavelength at f=1 GHz in free space is approximately 0.3 meters. (In a cable or fiber the speed is a little less than the speed of light.)

- At f=300 GHz and $c=3 \times 10^8$ m/s, the wavelength $\lambda=10^{-3}$ m or 1 mm

(Note: 1 μm = 10^{-6} m, 1 nm=10^{-9} m)

Typical Frequency Range	Application	Comments
100 KHz - 1 GHz	Radio	Below 30 MHz, ionosphere reflections
1 GHz - 300 GHz	Microwave, Radar Satellite and Terrestrial Links	
$\lambda=10^{-3}$ m - 10^{-6} m (1000 nm)	Infrared, Lasers	Optical Fiber at $\lambda \approx 10^{-6}$ m
$\lambda <$ 1000 nm	Visible light	$\lambda =$ 300 - 700 nm

Guided Propagation and Data Rates

Typical transmission media for this are:

Open Wire, Twisted Pair	max. data rate = a few Mbps; repeaters every few Km (e.g. PSTN connections, LANs)
Coaxial Cable	max. data rate = a few hundred Mbps; repeaters every few Km (e.g. cable systems for TV, Ethernet LANs)
Optical Fiber	max. data rate = a few Gbps; repeaters every few tens of Km (e.g. LANs, PSTN)

Wireless Transmission and Frequencies

	Frequency of Operation
Terrestrial Microwave	between 2 and 40 GHz, mainly 4-12 GHz Used for long distance telephone and data networks; Line-of-sight transmission with repeaters every 10-100 Km
Satellite	4/6 GHz, 12/14 GHz (up/down links) are popular
Broadcast Radio/TV	Few hundred KHz to few hundred MHz
Cellular Telephone	1-2 GHz
Wireless LANs	A few GHz
Infrared	(direct/reflected radiation for short distances)