

MOBILE COMMUNICATION – AN OVERVIEW

Lesson 02

Propagation of Signals and need of modulation

WIRELESS PROPAGATION OF SIGNALS

- Faces many complications
- Mobility renders reliable wireless transmission much more difficult
- Antenna height and size at mobile terminals generally quite small

PROPAGATION PROPERTIES

- Obstacles in the vicinity of the antenna, significant influences propagated signals
- Influence vary with place, mobile terminal and time

LINE-OF-SIGHT PROPAGATION

- Between the transmitter and receiver
- Transmission without refraction, diffraction, or scattering

SPHERICAL RADIATION PATTERN AND LINE OF SIGHT SIGNAL STRENGTH

- Decreases as square of the distance from transmitter assuming free space (space without consideration of medium characteristics)
- Radiated power distributed over larger spherical surface area at larger distances

SIGNAL STRENGTH

1. Decreases due to attenuation
2. When size of obstacles present in path of signal greater than the wavelength

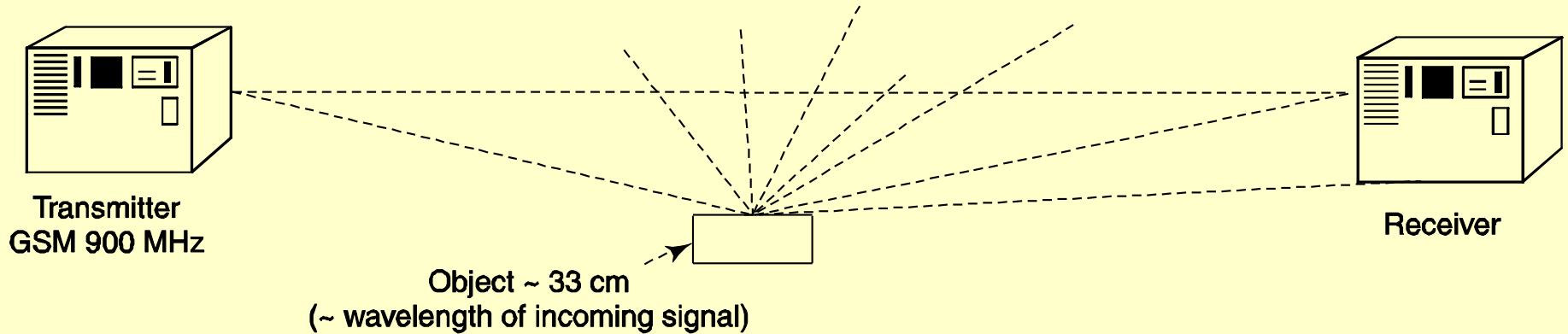
SIGNAL STRENGTH ATTENUATION

1. FM band signal transmitter 90 MHz ($\lambda = 3.3$ m)— faces attenuation of in objects of size 10 m and above
2. GSM 900 MHz ($\lambda > = 33$ cm) signal— then it will face attenuation in objects of size > 1 m (means $\gg \lambda \sim 33$ cm)

SCATTERING OF SIGNAL

- Decreases signal strength greatly
- Scattering from an obstacle of size equal to or less than the wavelength
- GSM signal, about 33 cm in wavelength, scattered by an object of 30 cm or less

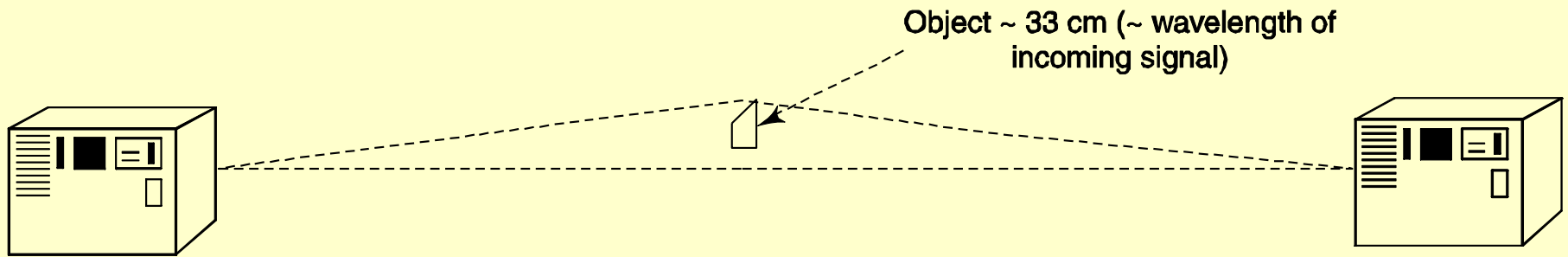
SCATTERING OF SIGNALS



DIFFRACTION OF SIGNALS

- Bending of signals as a result of **diffraction** from the edges of an obstacle of size equal to or less than the wavelength.
- GSM signal of wavelength 33 cm will diffract from an object of 33 cm or less.

DIFFRACTION OF SIGNALS

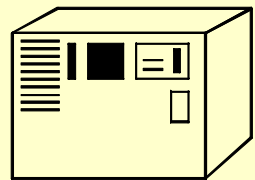


REFLECTION OF SIGNALS

- Signal *reflected* from the surface of an obstacle, the earth's surface, or a water body of size greater than the wavelength of the signal.
- GSM 900 MHz ($\lambda = 33$ cm) signal the transmitter signals reflect from an object of size 10 m and above (much greater than λ)

REFLECTION OF SIGNALS

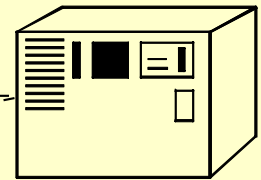
GSM 900 MHz



Transmitter
GSM 900 MHz

$$t_{\text{direct}} = 1000 \text{ m} / (3 \times 10^8 \text{ m s}^{-1}) = 3.33 \mu\text{s}$$

$$t_{\text{indirect}} = 1000 \text{ m} / (\sin 60^\circ \times 3 \times 10^8 \text{ m s}^{-1}) = 3.85 \mu\text{s}$$



Receiver

120°

Building or lake > 10 m
(wavelength of incoming signal)

DELAYED REACH OF REFLECTED SIGNALS

- Delay more pronounced in case of multi-hop paths.
- Distorts waveforms
- Causes misrepresentation of information which encode the signals

ELIMINATION OF SIGNAL DISTORTIONS DUE TO DELAYS

- Use digital signal processing techniques
- Recovers original signal

CHARACTERISTICS OF RADIATED SIGNALS FROM ANTENNAE

- Power radiated proportional to the signal frequencies
- Sizes of antennae required for wireless transmission *inversely proportional* to the frequencies

LOW FREQUENCY RANGE SIGNALS

- Requirement of abnormally large sized antennae
- Moreover, properties medium (air or vacuum)— such that ultra low frequency signals can't be transmitted across long distances without significant loss of signal strength

VOICE AND MUSIC SIGNALS

- Voice signals very low frequencies between 0.1 kHz to 8 kHz
- Music-signal frequencies lie between 0.1 kHz to 16 kHz.
- Ranges unsuitable for wireless transmission

MODULATION

- Makes wireless transmission of low frequencies and very low frequencies practical
- Increases the compatibility of transmitted signal and transmission medium

SUMMARY

- Propagation of signals
- Line of sight propagation
- Attenuation in obstacles in the path of the signals if obstacle sizes greater than radiated wavelengths
- Scattering from obstacles of sizes equal to or less than the wavelength

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- Diffraction from the edges of an obstacle of size equal to or less than the wavelength
- Reflection from the surface of an obstacle, the earth's surface, or a water body of size greater than the wavelength of the signals

... SUMMARY

- Properties medium (air or vacuum)—such that ultra low frequency signals can't be transmitted across long distances without very high loss in signal strengths at the receivers
- Modulation of signals with the very high-frequency carriers must

End of Lesson 02

Propagation of Signals and need of Modulation of the signals