



# **SNS COLLEGE OF TECHNOLOGY**

Coimbatore – 35

**An Autonomous Institution**

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai



## **DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

19ECT311 / Wireless Communication

**III ECE/ VI SEMESTER**

**Unit II - MOBILE RADIO PROPAGATION**

**Topic 9 : Small Scale fading- Types**



# Factors Influencing

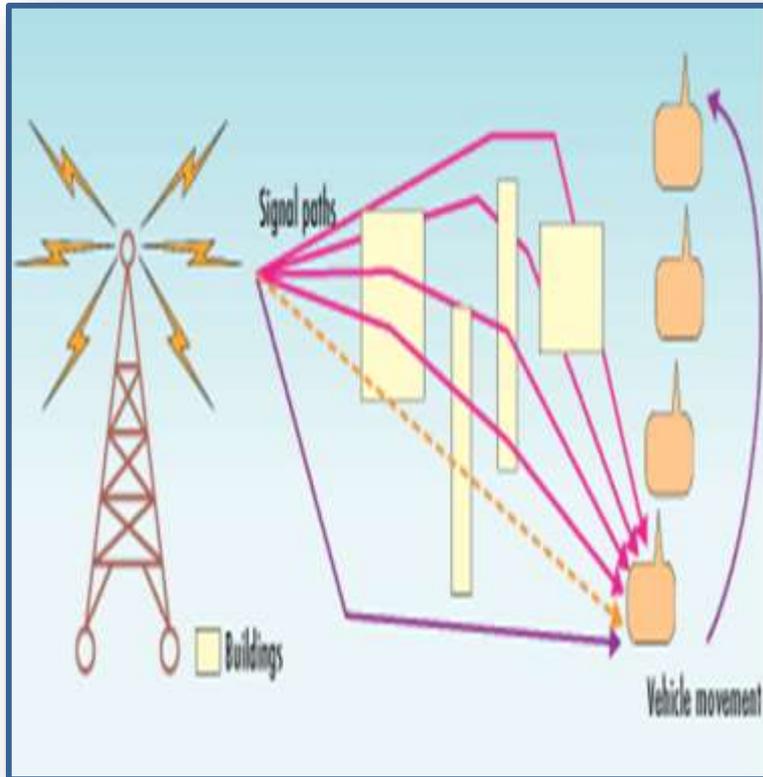
## Factors influencing small-scale fading

- Multipath propagation: reflection objects and scatters
- Speed of the mobile: Doppler shifts
- Speed of surrounding objects
- Transmission bandwidth of the signal





# Multipath fading

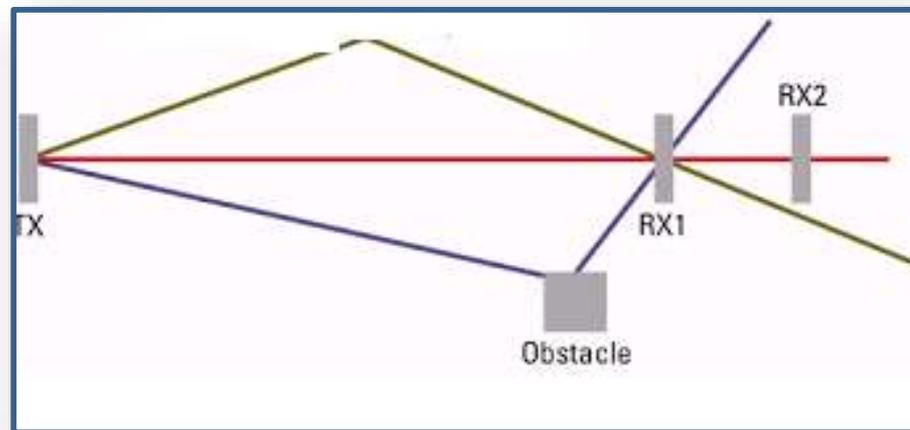


- **Fading** is variation of the attenuation of a signal with various variables
- These variables include **time, geographical position, and radio frequency**
- Fading is often modelled as a **random process**
- When a signal takes multiple paths from transmitter to receiver due to obstacles in the path, it is called **Multipath fading**



# Types

Small scale fading(Based on Multipath time delay spread)



Multipath Time delay Spread



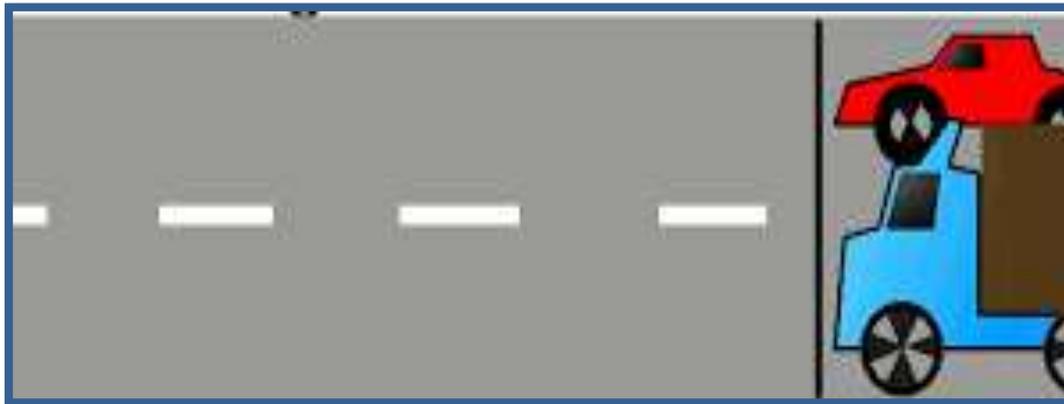
# Based on Multipath time delay spread

## Flat fading:

- The mobile radio channel has
  1. Bandwidth of the Signal  $<$  Bandwidth of the channel

## Frequency selective fading:

- The mobile radio channel has
  1. Bandwidth of the Signal  $>$  Bandwidth of the channel





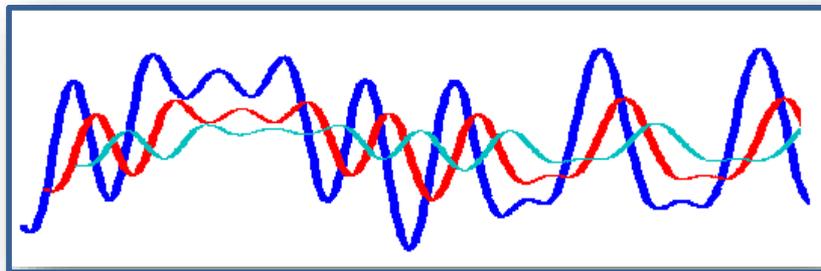
# Based on Multipath time delay spread

## Flat fading:

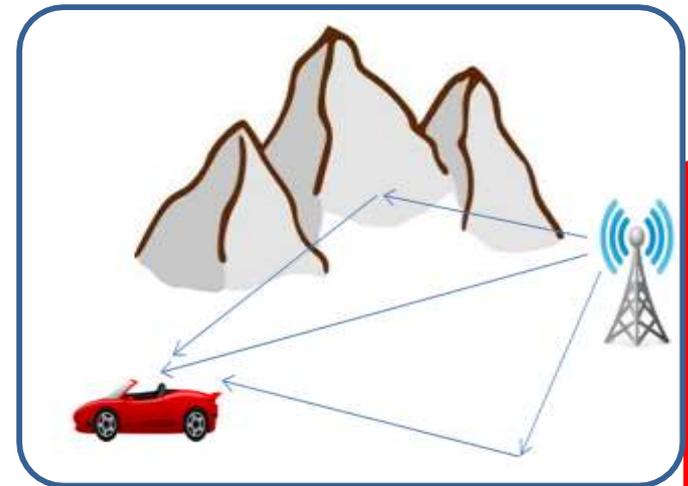
- The mobile radio channel has
  1. Doppler Spread  $<$  Symbol Period

## Frequency selective fading:

- The mobile radio channel has
  1. Doppler Spread  $>$  Symbol Period



Symbol Period



Doppler spread



# ACTIVITY



Activity: Draw a logo which may describe your character or things you like.



# Flat fading

- The wireless channel is said to be flat fading if it has constant gain and linear phase response over a bandwidth which **is greater** than the bandwidth of the transmitted signal
- All the frequency components of the received signal fluctuate in **same** proportions simultaneously
- It is also known as non-selective fading
  - **Signal BW  $\ll$  Channel BW**
  - **Symbol period  $\gg$  Delay Spread**
- The effect of flat fading is seen as decrease in SNR
- These flat fading channels are known as amplitude varying channels or narrowband channels



# Frequency Selective fading

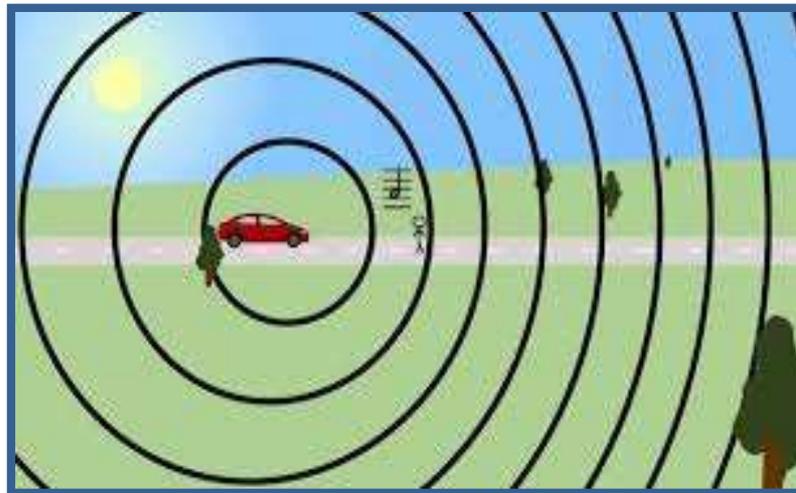


- If the channel possesses a constant-gain and linear phase response over a bandwidth that is **smaller** than the bandwidth of transmitted signal, then the channel creates frequency selective fading on the received signal
- It affects different spectral components of a radio signal with **different** amplitudes. Hence the name selective fading
  - **Signal BW > Channel BW**
  - **Symbol period < Delay Spread**
- The received signal includes multiple versions of the transmitted waveform which are attenuated (faded) and delayed in time, and hence the received signal is distorted
- Frequency selective fading channels are much more difficult to model



# Types

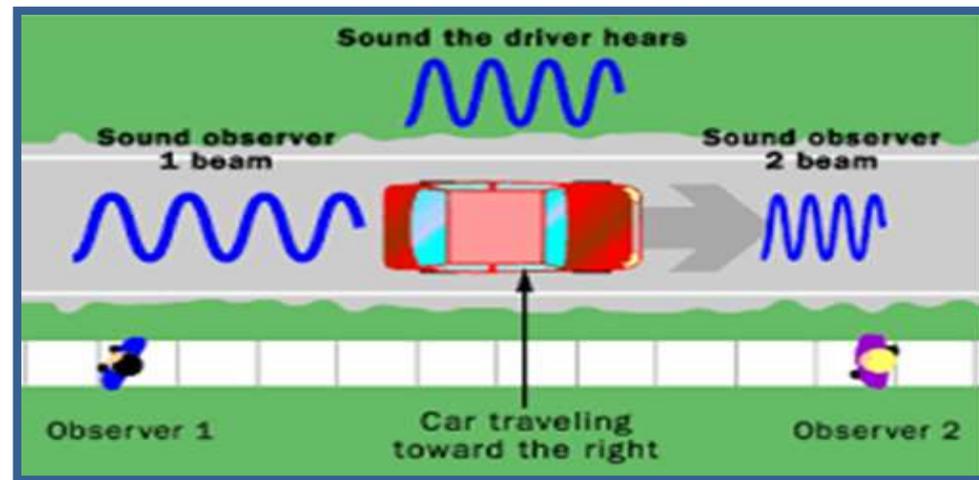
Small scale fading(Based on Doppler spread)





# Based on Doppler Spread

- **Fast Fading:**
  1. High Doppler Spread
- **Slow Fading:**
  1. Low Doppler Spread





# Fast Fading

- In a fast fading channel, the coherence time of the channel is **smaller** than the symbol period of the transmitted signal
- This causes frequency dispersion due to Doppler spreading, which leads to **signal distortion**
- Viewed in the frequency domain, signal distortion due to fast fading increases with increasing Doppler spread relative to the bandwidth of the transmitted signal
- Therefore, a signal undergoes fast fading if

$$T_s > T_c$$

$$B_s < B_D$$



# Slow Fading

- In a slow fading channel, the channel impulse response changes at a rate much slower than the transmitted baseband signal  $s(t)$ .
- In this case, the channel may be assumed to be static over one or several reciprocal bandwidth intervals.
- In the frequency domain, this implies that the Doppler spread of the channel is much less than the bandwidth of the baseband signal.
- Therefore, a signal undergoes slow fading if

$$T_s \gg T_c$$

$$B_s \ll B_D$$



# Assessment

- **Small scale propagation model is also known as \_\_\_\_\_**
  - a. Fading model
  - b. Micro scale propagation model
  - c. Okumura model
  - d. Hata model
- **Flat fading or frequency nonselective fading is a type of**
  - a. Multipath delay spread small scale fading
  - b. Doppler spread small scale fading
  - c. Both a) and b)
  - d. None of the above
- **Types of small scale fading, based on Doppler spread are**
  - a. Fast fading
  - b. Frequency non selective fading
  - c. Flat fading
  - d. Frequency selective fading





# Thank you