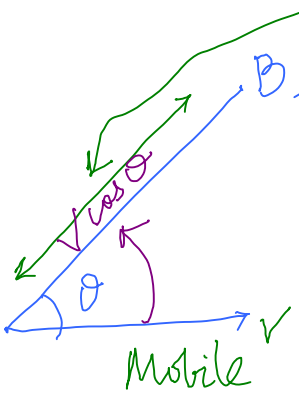
Impact of Doppler on Wireless Channel:

Recall that the fading coefficient is,

$$h = \sum_{i=0}^{L-1} a_i e^{-j2\pi f_c \tau_i}$$

Consider the i^{th} path



Distance between mobile and base station is decreasing.

Therefore delay τ_i is changing.

$$\tau_i(t) = \tau_i - \frac{v \cos\theta\, t}{c}$$

Therefore,

$$h = \sum_{i=0}^{L-1} a_i e^{-j2\pi f_c \left(\tau_i - \frac{v\cos\theta\, t}{c}\right)}$$

$$= \sum_{i=0}^{L-1} a_i e^{-j2\pi f_c \tau_i} e^{j2\pi \boxed{f_c \frac{v\cos\theta}{c}} t}$$

f_d

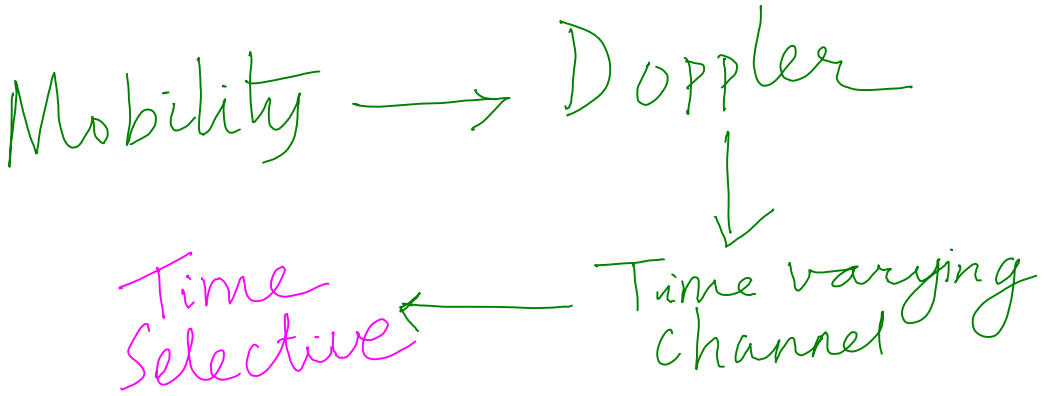
$$h = \sum_{i=0}^{L-1} a_i e^{-j2\pi f_c \tau_i} \underbrace{e^{j2\pi f_d t}}$$

f_d = Doppler Freq

Changing with respect to time.

Therefore, the channel coefficient h is time varying.

Such a time varying channel is also known as a time Selective channel.



consider the phase factor

$$e^{-j2\pi F_d t}$$

at $t = 0$, phase $= 0$

$t = \frac{1}{4F_d}$, phase $= 2\pi F_d \cdot \frac{1}{4F_d}$

$= \frac{\pi}{2}$

Channel has changed significantly From $t = 0$ to $t = \frac{1}{4F_d}$.

$$T_c = \frac{1}{4F_d}.$$

T_c: Coherence Time of Channel.

Channel changes significantly during T_c.

or Channel is approximately constant for T_c.

$$T_c = \frac{1}{4 f_d}$$

Example: Consider $f_d = 143\,Hz$

What is T_c?

$$T_c = \frac{1}{4 f_d}$$

$$= \frac{1}{4 \times 143}$$

$$T_c = 1.7\,ms$$

Channel is approximately constant for 1.7ms

or channel is changing after 1.7ms.