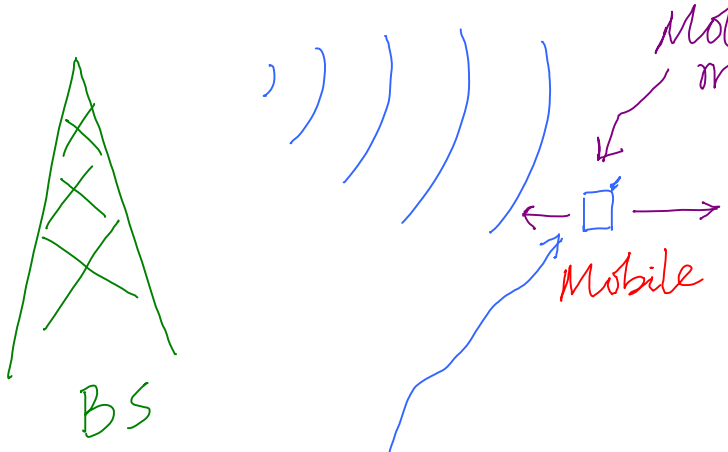
Doppler Effect:

Consider a scenario in which the mobile is moving i.e. user is in motion.



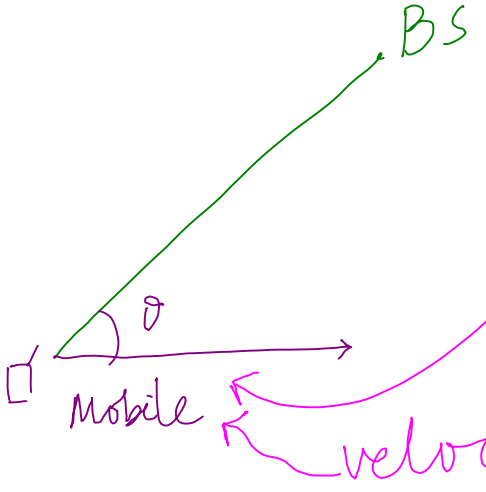
This leads to a change in the frequency of the wireless signal received at Mobile.

This is Doppler Effect

Doppler Effect:

Change in frequency of received signal due to motion between Transmitter and Receiver.

Calculation of Doppler:



Mobile moving at an angle of θ with respect to the Base station.

velocity = V

Doppler shift $F_d = \frac{V \cos\theta}{c} F_c$

$$F_d = \frac{V \cos\theta}{c} \cdot F_c$$

c : speed of light

F_c = carrier frequency.

Frequency F_r, of Received signal,

$$F_r = F_c + F_d.$$

$$F_r = f_c + \frac{V\cos\theta}{C} F_c$$

F_r — received frequency

f_c — carrier freq.

$\frac{V\cos\theta}{C} F_c$ — Doppler shift

If $0 \leq \theta \leq \pi/2$, then $\cos\theta \geq 0$

Therefore,

$$f_r = f_c + \frac{v\cos\theta}{c} f_c$$

$$\geq f_c$$

Received Freq $\geq$ Carrier Freq.

$\Rightarrow$ Mobile is moving towards Base Station

If $\frac{\pi}{2} < \theta \leq \pi$, then

$\cos\theta < 0$

$$f_r = f_c + \frac{v\cos\theta}{c} f_c$$

$$< f_c$$

$\Rightarrow$ Received Freq $<$ Carrier Freq.

$\Rightarrow$ Mobile is moving away from Base station.

Example: consider $f_c = 1.85$ GHz

vehicle moving at 60 mph

$\theta = 30^\circ$.

— What is the Doppler Shift?

— What is Received Freq?

$$V = 60 \text{ mph}$$

$$= 60 \times 1.6 \text{ Kmph}$$

$$= 60 \times 1.6 \times \frac{1000}{3600}$$

$$= 26.8 \text{ m/s}$$

$$f_{d.} = \frac{V\cos\theta}{C} \times f_c$$

Doppler shift

$$= \frac{26.8 \times \cos 30^{\circ}}{3 \times 10^{8}} \times 1.85 \times 10^{9}$$

$$= \frac{26.8 \times \sqrt{3}/2}{3 \times 10^{8}} \times 1.85 \times 10^{9}$$

$$\boxed{f_{d.} = 143\ Hz}$$

$$f_r = f_c + f_d$$

$$= 1.85 \times 10^9 + 143$$

Received Freq.