Multipath & Fading

- W/L channel is multipath channel there are several path – multipath.

- Multipath is the radio channel causes rapid fluctuation of signal amp. called small scale fading or simply fading. (temporary effect much more frequent)

- Fading is caused by destructive interference of two or more versions of the transmitted signal arriving at receiver at slightly different times.

Multiple copies of transmitted signal with different amplitude and random phase due to different path-length. (Most received are much lower in amplitude)

It can be modeled as a multiplicative number, R_x signal = $\alpha e^{j\theta}$

Delayed signals are result of refraction/scattering from terrain features such as trees, hills, mountains or objects such as people, vehicle, building.

- The received signal may vary widely in amplification and phase over a short period of time or travel distance.

- Note that R_x may be stationary or mobile.

Ex. (LAN) T_x and R_x are fixed movement of people can cause fading.

Multipath Propagation Fading
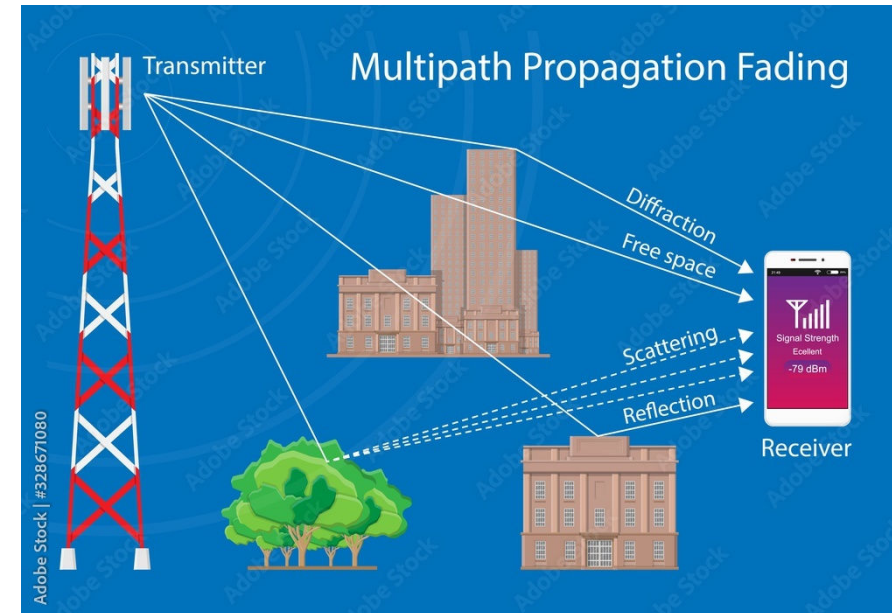
Radio waves generated from same transmitted signal may come :

- From different directions

- With different propagation delay (random)

- With different amplitude (random)

- With different phases (random)

- With different angle of arrival (random)

These multipath components combine vectorially at R_x antenna and cause total signal,

➢ To fade

➢ To distort

Effects of fading/multipath:

Results in

- Rapid changes in signal strength over small travel distance or short time intervals.
- Random frequency modulation due to varying doppler shift on different multipath signal.
- Time dispersion (echoes) due to multipath propagation.

(narrow pulse, T_x → several copies at narrow pulse, R_x)

Mobility in control of fading:

- When R_x is mobile, Other object may be mobile or stationary.
- If other objects are stationary , Motion is only due to mobile R_x.

Fading is purely a spatial phenomena.

(Occurs only when mobile R_x moves)

Factors influencing small scale fading:

1. Multipath propagation -

Presence of reflecting objects and scatter causes a multipath versions of signal.

2. Speed of mobile -

- Causes doppler shift at each multipath component.

- Causes random frequency modulation.

- Doppler shift will be positive or negative depending on weather mobile is moving towards or away from base station.

3. Speed of surrounding objects -

(Static environment → How fast people/fan spinning)

- Causes timing doppler shift on multipath components.

- If source object moves at a greater rate than mobile this effect dominates the small scale fading.

- If move at much slower than mobile then effect can be ignored.

- The term coherent time determine how static the channel is.