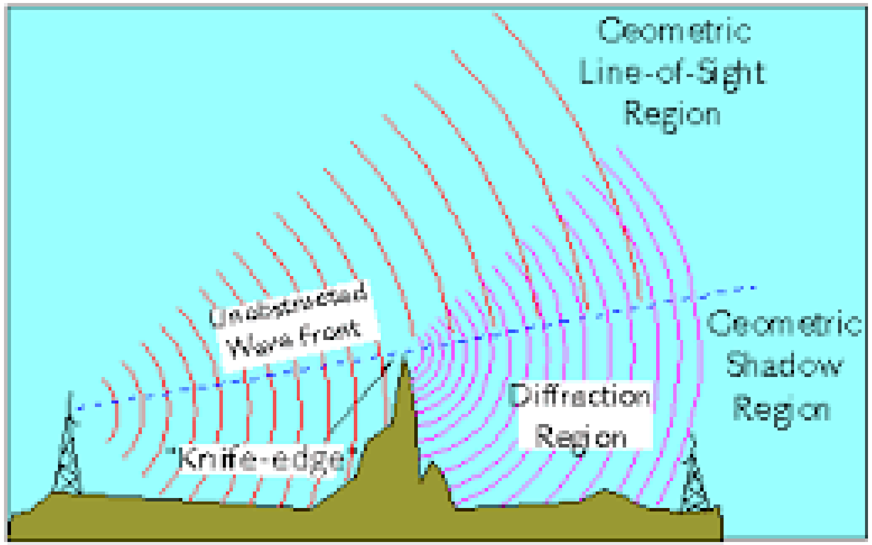
19EC601 – Wireless Communication

Unit -2
Mobile Radio Propagation

Knife Edge Diffraction Model

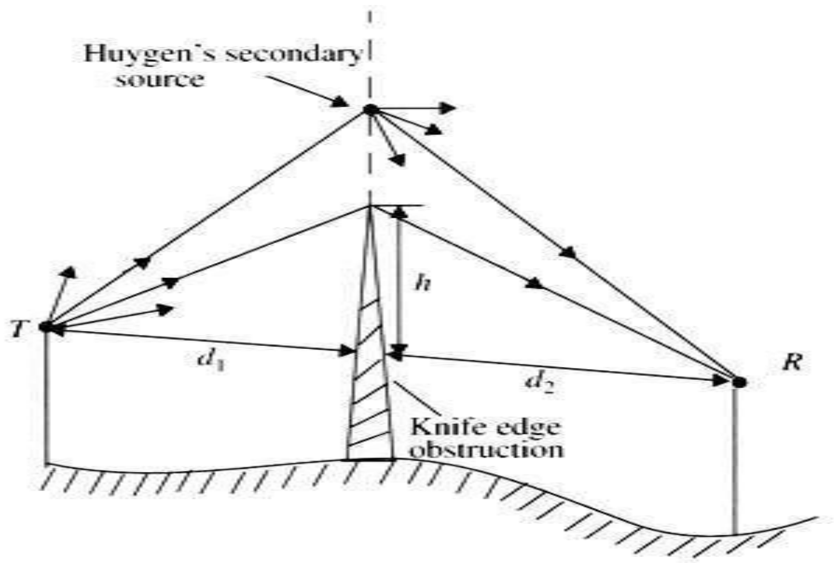


Knife-edge Diffraction Model

- Estimating the signal attenuation caused by diffraction of radio waves over hills and buildings is essential in predicting the field strength in a given service area.

- As a starting point, the limiting case of propagation over a knife edge gives good in sight into the order of magnitude diffraction loss.
- When shadowing is caused by a single object such as a building, the attenuation caused by diffraction can be estimated by treating the obstruction as a diffracting knife edge

Consider a receiver at point R located in the shadowed region. The field strength at point R is a vector sum of the fields due to all of the secondary Huygens sources in the plane above the knife edge.



- The difference between the direct path and diffracted path, call *excess path length*

$$\Delta \approx \frac{h^2}{2}\frac{(d_1 + d_2)}{d_1 d_2}$$

The corresponding phase difference

$$\phi = \frac{2\pi\Delta}{\lambda} \approx \frac{2\pi}{\lambda}\frac{h^2}{2}\frac{(d_1 + d_2)}{d_1 d_2}$$

- *Fresnel-Kirchoff* diffraction parameter is used to normalize the phased term and given as

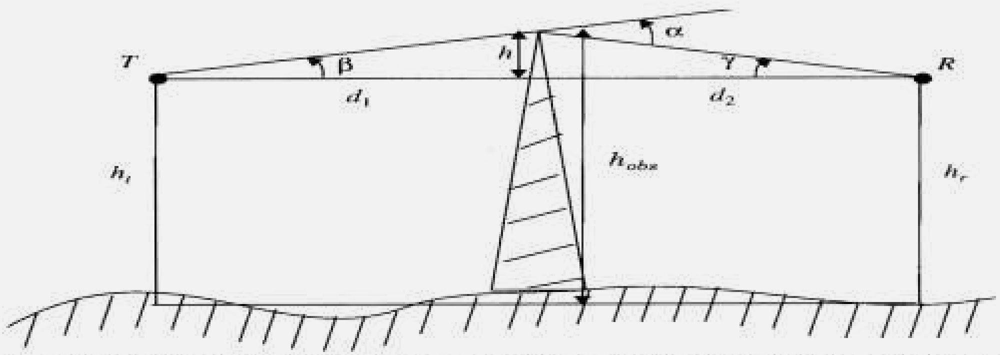
$$v = h\sqrt{\frac{2(d_1+d_2)}{\lambda d_1 d_2}} = \alpha\sqrt{\frac{2d_1 d_2}{\lambda(d_1+d_2)}}$$

Which gives

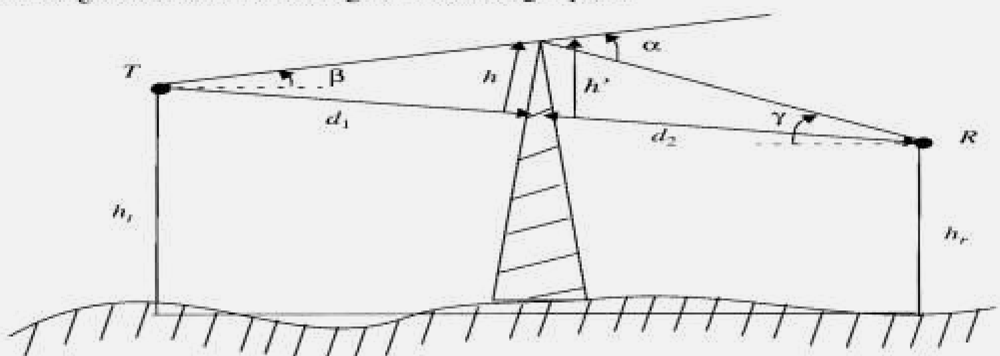
$$\phi = \frac{\pi}{2}v^2$$

- where $\alpha = h(^{d1+d2/d1d2})$

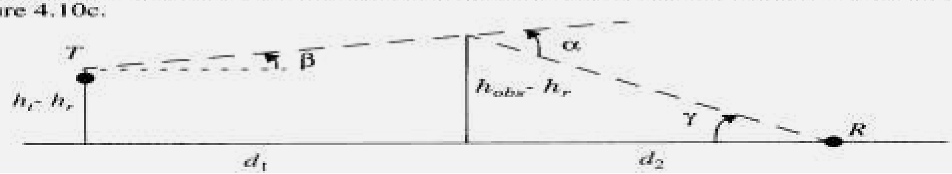
Knife-edge Diffraction Model



(a) Knife-edge diffraction geometry. The point *T* denotes the transmitter and *R* denotes the receiver, with an infinite knife-edge obstruction blocking the line-of-sight path.

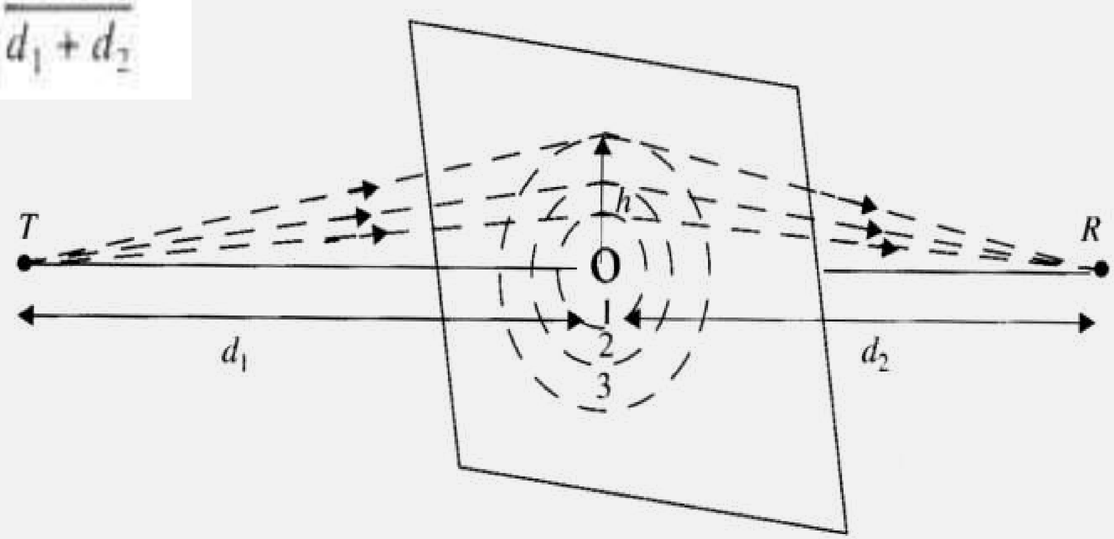


(b) Knife-edge diffraction geometry when the transmitter and receiver are not at the same height. Note that if α and β are small and $h << d_1$ and d_2, then h and h' are virtually identical and the geometry may be redrawn as shown in Figure 4.10c.

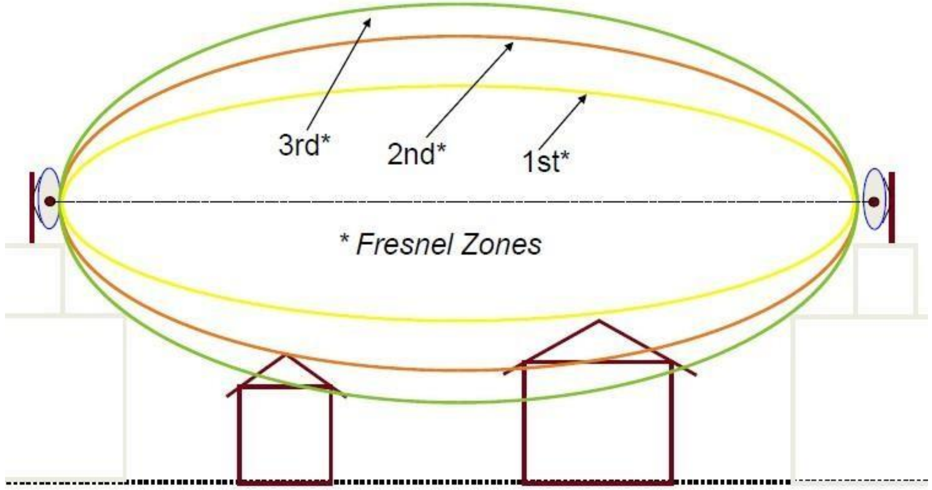


Fresnel zones

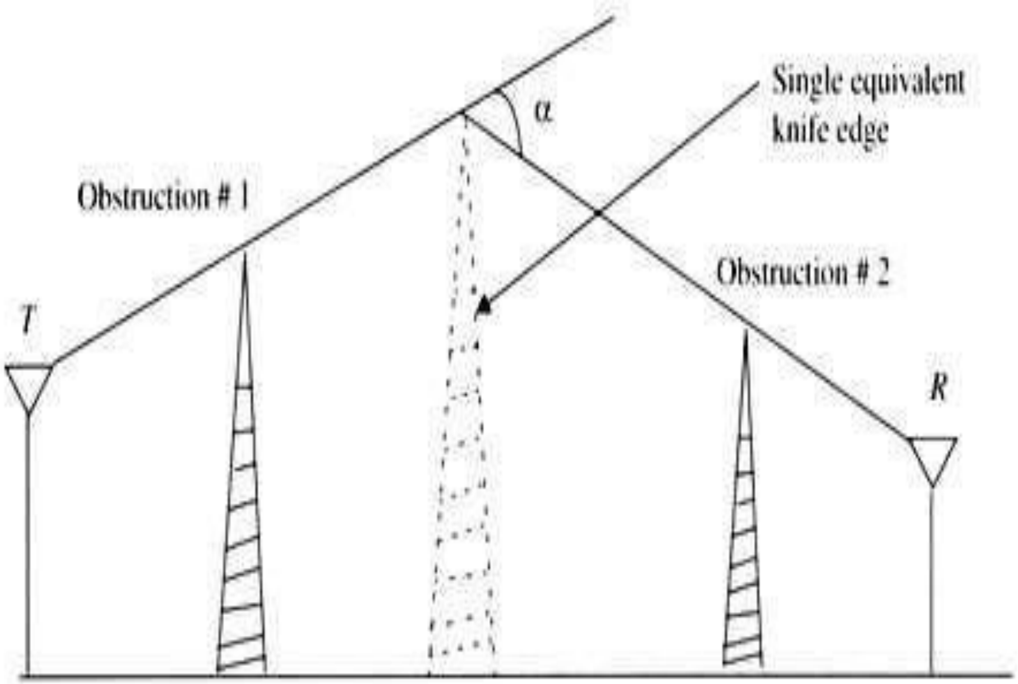
$$r_n = \sqrt{\frac{n\lambda d_1 d_2}{d_1 + d_2}}$$



Fresnel zones represent successive regions where secondary waves have a path length from the TX to the RX which are $n\lambda/2$ greater in path length than of the LOS path. The plane below illustrates successive Fresnel zones



Multiple Knife Edge Diffraction



Scattering

- Scattering occurs when the medium through which the wave travels consists of objects with dimensions that are small compared to the wavelength, and where the number of per unit volume is large.

➢ Scattered waves are produced by rough surfaces, small objects,

or by other irregularities in the channel.

➢ Scattering is caused by trees, lamp posts, towers, etc.

- Received signal strength is often stronger than that predicted by reflection/diffraction models alone

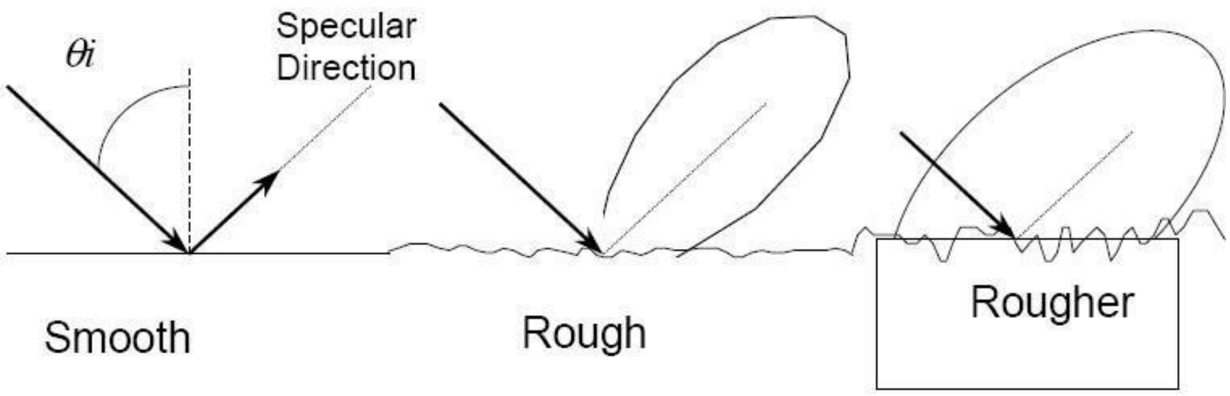
- The EM wave incident upon a rough or complex surface is **scattered** in **many** directions and provides more energy at a receiver

  energy that would have been absorbed is instead reflected to the Rx.

- flat surface → EM reflection (one direction)
- rough surface → EM scattering (many directions)

Scattering

Rough Surface Scattering



Roughness depends on :

- Surface height range
- Angle of incidence
- Wavelength

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Thank you