Vertical and lateral propagation

A 1800 MHz radio link operates in a Manhattan-like scenario shown in the figure, with uniform building height (=20 m) street-width equal to 20 m and building-side length also uniform and equal to 100m (figure non to scale). Let's assume that coverage is guaranteed in NLOS locations through street-corner diffraction(s). Let's also assume that n-times-diffracted rays (rays undergoing n successive diffractions) are always negligible w.r.t. (n-1)-times-diffracted ones. Both terminals are at a height of 1.7 m and while the Rx is fixed the other can be in Tx1 of in Tx2 (see figure).

Neglecting ORT propagation, determine:

a) what street sections can be covered with LOS, with 1 diffraction and with 2 diffractions for each Tx position.

Consider now Tx2 and both LP and VP propagation. In the vertical plane the link profile can be obtained by representing each building with a knife edge in the middle of the block and assuming it orthogonal to the radial line (see figure). VP attenuation can be computed using the Epstein-Peterson method (see attached single knife-edge attenuation formulas). LP attenuation can be computed applying the Berg's method (see attached formulas) to the single-diffracted ray and assuming the angle equal to 90^o and the q parameter equal to 0.5.

Question:

b) what contribution between LP and VP is dominant in terms of Rx power?

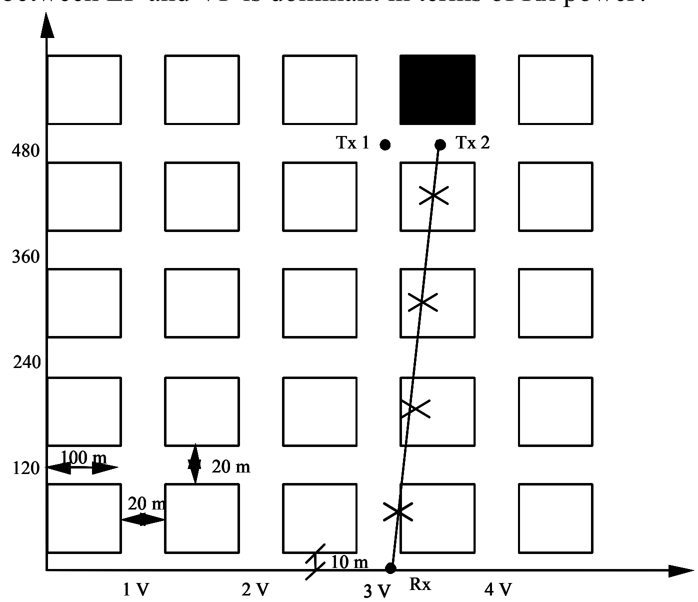


Figure 1

Lee's formula:

$$As(dB) = 6.4 + 20 * \log\left(\sqrt{\nu^2 + 1} + \nu\right)$$ (single diffraction attenuation)

Berg's model formulation

$$A_L\,(\mathrm{dB}) = 20 * \log_{10}\left(\frac{4\pi * d_n}{\lambda}\right)$$

where d_n is derived from:

$$\begin{cases} k_j = k_{j-1} + d_{j-1} \cdot q_{j-1} \\ d_j = k_j \cdot s_{j-1} + d_{j-1} \end{cases} \quad \text{with } k_0 = 1,\ d_0 = 0$$

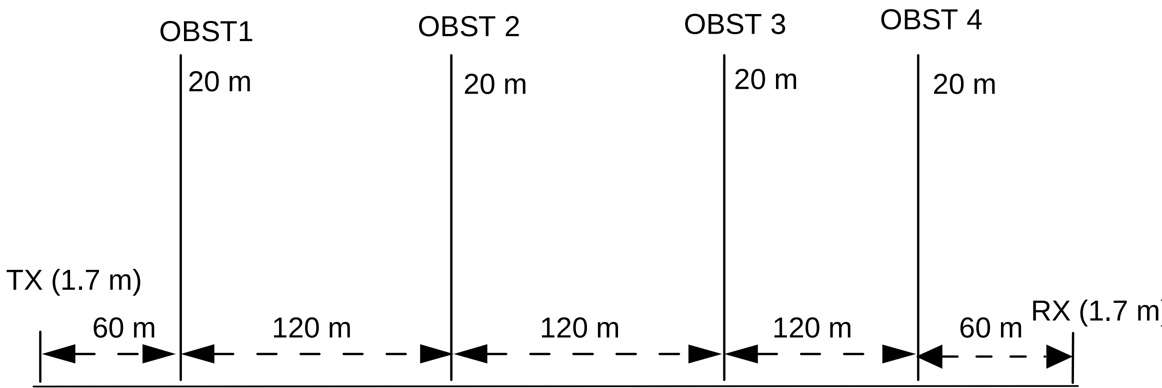
Solution

Question a)

With Tx1, the streets tagged by 3V and 4O can be covered with LOS, while all the other locations can be covered with only 1 diffraction. With Tx2, only 4O can be covered with LOS, vertical street with 1 diffraction and horizontal streets with 2 diffractions.

Question b)

The resulting VP profile is shown in the figure herebelow:



Applying Epstein-Peterson the total excess attenuation is:

L_{tot} = A1+A2+A3+A4= 70.8 dB

where :

A1= 29 dB (OBST1 → ν=6.7)
A2= 6.4 dB (OBST2 → ν=0)
A3 = 6.4 dB (OBST3 → ν = 0.0)
A4 = 29 dB (OBST4 → ν = 6.7)

Applying Berg to the only single-diffracted path the total attenuation results:

$$L_{LP} = 20\log\left(\frac{4\pi d_2}{\lambda}\right) = 121 \text{ dB}$$

where d_2 between Tx_2 and Rx is:

$d_n = (1+s_0*q_{90})*s_1+s_0$

$s_0 = Tx_2 - Tx_1 = 60$ m
$s_1 = Tx_1 - Rx = 480$ m
$q_{90} = 0.5$

The total VP attenuation must be computer by adding to diffraction-loss free-space loss for a distance of approximately 480 m. We have therefore:

A_{VP} = 70.8 + 91.2 = 162 dB

Therefore the LP contribution to Rx power is greater than the VP one.