ABS Seminar no.5

WiFi

T.1

Calculate the maximum theoretical data rate for:

a) LTE if 10MHz bandwidth is used, the system uses 4 x 4 MIMO configuration and SNR in the receiver is 13 dB.
b) WCDMA uses a bandwidth of 5 MHz, the received SNR after despreading is 26 dB and the spreading factor: SF = 16.

In case b) it is necessary to include spreading factor in channel capacity:

$$C = W \times \log_2\left(1 + \frac{SNR}{SF}\right)$$

T.2

We have a mobile WiMAX system. We assume a data rate of 5.75Mb / s and a cell radius of 400m. Average losses are modeled as:

$$L(d) = 137,4 + 35,2\log(d)\ \ [dB]$$

, where d is distance in km.

We assume that the standard deviation of the attenuation caused by shading is 9dB and we consider 3 different performance requirements at the cell edge:

1. 50% probability of outages
2. 10% probability of outages
3. 1% probability of outages

a) Calculate the maximum allowable loss $L_{\max}$ for the 3 considered probabilities of outages.
b) Calculate the radius of the cell d for the 3 considered probabilities of outages if we assume a max. allowed loss 135.3 dB.

The average loss taking into account the standard deviation due to shading is:

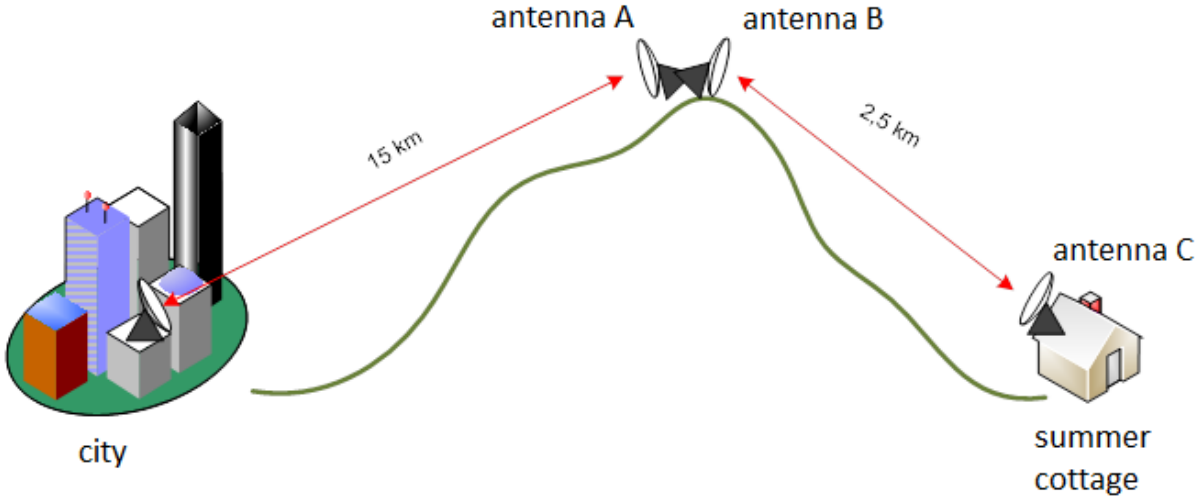
$$L(d) = L_{\max} - \sigma_s Q^{-1}(P_{out})\ \ [dB]$$

, where: σ_s is the standard deviation caused by shading, $Q^{-1}()$ is inverse Q function, P_{out} is the probability of outages.

T.3
WiFi - antennas

We have a fixed WiFi communication system with two jumps, according to the picture, which connects the city and the summer cottage. A relay station is located in the mountains to ensure the connection. The system operates at a frequency of 2.45 GHz. All three antennas of the transmission system: A, B, C are the same parabolic antennas. The WiFi access point (AP) located in the city transmits with a power of 30dBm and uses an antenna with a gain of 5dBi. For optimal reception, a signal level of min. - 95 dBm has to be provided at the cottage. We assume propagation through ideally free space and the repeater works in the mode: 1:1. Calculate:

a) the minimum gain of all three antennas in dBi to ensure a minimum signal level in the cottage.
b) the necessary minimum diameters of parabolic antennas, if we assume their efficiency is 60%.



a)

power of the received signal on the cottage:
$P_r = P_t + G_t - L_1 + G_A + G_B - L_2 + G_C \ [dB]$

where:
P_t, G_t are the parameters of WiFi AP in the city
L_1 is the propagation loss between the AP and antenna A
L_2 is the propagation loss between antenna B and the cottage
G_A, G_B, G_C are antenna gains

$A_e = \eta A_p$ A_e is the effective area of the antenna, η is the antenna efficiency, A_e is the physical area of the antenna aperture

The relationship between the effective area of the antenna and antenna gain:
$G = \frac{4\pi A_e}{\lambda^2}$