Exercises 1: "Radio Channel"

Exercise 1.1: The range of a mobile communication system is assumed to be limited by the maximum allowed path loss of 140dB.
(height of the transmitting antenna: 30m, height of the receiving antenna: 1,5m)

a) Calculate the maximum range for f=900MHz in case of
   (1) free space propagation
   (2) plane propagation

b) How does the range change in case of free space propagation and f=1800MHz?

Exercise 1.2: The mobile communication system of exercise 1.1 is limited by a maximum path loss of 140dB. It is operated in an urban environment.

a) Calculate the range for f=900MHz based on the Okumura-Hata Model.

b) How high is the path loss at a distance of d=1km?

c) How does the range change in case of f=1800MHz?

d) Calculate the height of the transmitting antenna so that the range for f=1800MHz is equal to the range in a)?

Exercise 1.3: For the system of exercise 1.1/1.2 (with f=900MHz) the path loss due to slow fading can be assumed as log-normal distributed with a standard deviation of 6dB.

a) Calculate the probability that the path loss is less than 140dB at a distance of 1km.

b) Now the system should be dimensioned so that with a probability of 95% the path loss at the cell edge is less than 140dB. Calculate the maximum range under this constraint.

Exercise 1.4: A second base station is added to the system of exercise 1.3. The two base stations are assumed to have the same configuration and are placed at a distance of 2km. Calculate the probability that a mobile station which is placed in the middle of the two base stations can served by

a) both,

b) exactly one,

c) none

base station(s) assuming that the propagation paths to the base stations are not correlated.

Exercise 1.5: A GSM system with 15W transmission power per channel and Δf=200kHz channel bandwidth should be dimensioned. The noise factor of a mobile station is assumed to be F=7 (receiver temperature = 293K) and interferences are neglected.

a) Calculate the average SNR for d=1km, G_t=10dB (antenna gain of the base station) and the same propagation conditions like in exercise 1.2 (f=900MHz). The antenna gain of the mobile station is G_r=0dB.

b) Calculate the range for a required SNR of 9dB, a service probability of 98% assuming that the influence of fast fading is neglected.
   (G_t=10dB, G_r=0dB, σ_t=10dB)