Exercise 2 in SSY135 Wireless Communications

January 30, 2020

1. Consider a cell with log-distance path loss, log-normal shadowing, and Rayleigh fading. The base station uses 16QAM modulation with 1Mbit/s bit rate and transmits with the power 10 W and carrier frequency is 900 MHz. The path loss exponent is 3.7 and the constant K in the simplified pathloss model is -109.53 dB. Assume that the transmit and receive antennas are omnidirectional.
   Consider a vehicle that travels with 36 km/h at a distance of 4 km from the base station. Suppose the shadow fading introduces a fixed extra path loss of 10 dB. Assume that the small-scale fading has Clarke's power spectrum.

   (a) Compute the level crossing rate at 15 dB below the average received power.

   (b) Compute the average deep fade duration. Does the system experience burst errors?

2. Consider a wireless system for which the bit error probability averaged over the small scale fading is denoted by $\overline{P}_b$. Suppose the path-loss follows a log-distance path loss model with path-loss exponent 2. The shadow fading and time dispersion are assumed to be negligible. If the data rate is $R_b = 1$ Mbit/s, then $\overline{P}_b = \overline{P}_{b,\text{target}} = 10^{-3}$ when the distance between the transmitter and receiver is 1000 m. That is, the maximum transmission range is 1000 m.

   Consider the log-normal shadow fading with mean 0 dB and standard deviation 6 dB is added to the propagation model. We declare outage when the average bit error probability exceeds $\overline{P}_{b,\text{target}}$. What is the maximum transmission range if the outage probability must be less than 2%?