Exercise 4 in SSY135 Wireless Communications: Performance in fading

February 7, 2020

1. [G-6.12] Consider a system where the distance between the transmitter and the receiver is $100\sqrt{26}$. Assume the signal follows a free space path loss model with no multipath fading or shadowing. The transmitted signal has a carrier frequency of 900 MHz and a bandwidth of 10 KHz. The receiver has noise spectral density of 10^{-16} (total noise power is N_0B) mW/Hz. Assume nondirectional antennas (0 dB gain) at both the transmitter and receiver. Suppose the transmitter must support users at a BER of 10^{-6}.

   (a) For DBPSK modulation, what is the transmit power needed such that all users in the cell meet the 10^{-6} BER target? *Hint*: $P_b = \frac{1}{2}e^{-\gamma_b}$

   (b) Assume that the channel also experiences log-normal shadowing with $\sigma = 8$ dB. What is the average transmitted power to have $P_b = 10^{-6}$ (for each bit) with probability 0.9?

2. [G-6.16] Assume a cellular system with log-normal shadowing. The signal modulation is DPSK. The service provider has determined that it can deal with an outage probability of 0.01, i.e., 1 in 100 customers are unhappy at any given time. The average BER requirement is 10^{-3}, i.e., $\bar{P}_b = 10^{-3}$. Assume a noise power spectral density of $N_0 = 10^{-16}$ mW/Hz, a signal bandwidth of 30 KHz, a carrier frequency of 900 MHz, free space path loss propagation with nondirectional antennas, and shadowing standard deviation of $\sigma = 6$dB. Find the maximum cell size that can achieve this performance if the transmit power at the mobiles is limited to 100 mW.

3. [G-6.10] Consider a cellular system at 900 MHz with a transmission rate of 64 Kbps and multipath fading. Explain which performance metric, average probability of error or outage probability, is more appropriate and why for a user speed of 1 mph. (1mph $\approx$ 1.6 km/h)