Assignment 1: Analysis of Physical and Data Link Layers

Due on March 15, 2023

This assignment carries a total of 20 points. For each programming exercise (Exercises 1-3), you have to submit the code along with the output file. The code should have a couple of lines explaining the logic. For the numerical questions, you may either submit a single pdf or a text file. Please create separate directories named "Q<Number>" and zip the directories before submitting on Google Classroom.

Exercise 1

Assume that you are transmitting using a single antenna that is transmitting over a additive white Gaussian noise channel. Plot the BER's at SNR values of 0 dB, -20 dB and -60 dB using (i) BPSK, (ii) QPSK, (iii) 4-QAM, (iv) 16-PSK (v) 16-QAM and (vi) 32-QAM, all using simulation. The X-axis of the plot should contain the SNR in dB, and the Y-axis should have the BER. Based on the plot, can you say anything about which among (i) QPSK vs 4-QAM, and (ii) 16-PSK vs 16-QAM is preferred? (5 points)

Exercise 2

Assume that you have a center frequency of 1.5 GHz, and that you are in a area where there is a Rayleigh fading of (i) 10 independent sinusoids and (ii) 100 independent sinusoids. Plot the SNR received with respect to time. (3 points)

Exercise 3

Create a client and server program using sockets. The client should send a packet containing its own timestamp to the server. The server should in turn check its current time, and then print the packet latency in milliseconds. Now, move the server program to (i) a machine which is connected over a wired Ethernet network, and (ii) a machine which is connected over a WiFi network. Send a total of 100 packets for both the cases. Store the latency in each case in a file called 'wired.csv' and 'wireless.csv'. Note that NTP needs to be switched on for this program to work (4 points).

Exercise 4

Consider a case of a signal where 1 is denoted by +5V and -1 is denoted by -5V. The signal is corrupted by additive white Gaussian noise. What should be the threshold for classification at the receiver end, if 1 is 2 times more likely to be sent than 0? If the noise has a Gaussian distribution with zero mean and variance four, then what is the BER using this threshold? Use both simulation and analysis to compute it (4 points).

Exercise 5

Consider a case of a WiFi AP that sends packets to a user device at an SNR of -10 dB using CSMA/CA using 64-QAM modulation. The channel is busy due to other traffic (not from WiFi) 20% of the time with uniform probability. What is the probability of failure of a single transmission attempt? Would RTS/CTS mechanism reduce the probability of failure? (4 points)