Mobile Communication Networks
Understanding WLAN performance: Activities Part 1

*It is recommended to use MATLAB or OCTAVE:

1) Given a M/M/1/K queue with K=4, X=0.2 seconds/frame and \( \lambda = 4.5 \) frames / second:
   1. Draw the Markov chain which models the system.
   2. Compute the traffic load.
   3. Write the balance equations and find a close expression for the empty and blocking probabilities.
   4. Compute the probability of each state and the average number of frames in the queue (including the one in service).
   5. If \( \lambda \) ranges from 0.2 to 8, plot a) the Transmission Delay (Queuing + Service) and b) The Blocking Probability.

2) What is the main assumption which we use to model a WLAN node using a M/M/1/K queue?

3) Given three active nodes, each one with a constant traffic flow of bandwidth B bits/second. Regarding a node “i”:
   1. Write the expression for the transmission probability.
   2. Write the expression for the conditional collision probability.
   3. Write the expression for the average number of transmissions attempts (assuming a retry limit equal to infinity).
   4. Write the expression for the average duration of a slot when the “i” station is in backoff and compute the probability to find an empty slot, in a successful transmission or in a collision.
   5. Write the expression for the service time.
   6. Write the expression for the throughput, blocking probability and Delay (queuing + service).

3) A single-hop WLAN with \( n \) stations, ranging from 1 to 10. Each station selects the backoff from a uniform distribution with \( CW_{min} = CW_{max} = 32 \) and with a retry limit equal to infinity. Consider that all stations are saturated, this is: \( \rho = 1 \):
   1. Compute and plot the transmission probability for each value of “n”.
   2. Compute and plot the conditional collision probability for each value of “n”.
   3. Justify the results of 1. and 2.
   4. Compare previous results with the case of \( \rho = 0.4 \) (constant and independent of the value of “n”). Note that assuming that \( \rho = 0.4 \), we are considering that a rate-based mechanism regulates the traffic generated by the applications (reducing/increasing B to maintain \( \rho = 0.4 \) constant).

4) If the relation \( n \cdot B \), where “n” is the number of nodes and “B” the bandwidth required for each node remains constant for any “n” and “B” pairs (this is, for instance, the cases of \( [n=2, B=100 \text{ Kbps}] \) and \( [n=10, B=20 \text{ Kbps}] \)). Discuss about the impact on performance if we increase “n” (reducing “B” properly) or on the contrary, we increase “B” (reducing “n” properly).

5) How you can solve the non-linear set of equations that model the behavior of a CSMA/CA model?