Wireless Networking

Course code: CS4222/5422, Tutorial session: #9

Brief Instructions regarding the tutorial session

1. The attendance to tutorial sessions would contribute towards the determination of final grade
2. Please review the questions before coming to the tutorial session
3. Make an effort to solve the questions before attending tutorial. The teaching assistants will help in case of issues
4. The designated time for the tutorial session is one hour. Please contact the teaching assistants or the instructor if you need any further clarification regarding the tutorials outside the allocated period. Please send them an email.

Question 1: If you are deploying a network of air quality sensors in a city and need to make decisions regarding the selection of wireless networks, please answer the following questions:

- What data rate should be expected for these sensors? What could be packet structure?
- You are selecting between 2-FSK (narrow bandwidth transmitter) occupying 125 kHz bandwidth and the LoRa standard using the CSS modulation, consider the following: You have been allocated 3 MHz of spectrum in the unlicensed frequency band. What are the pros and cons of each option? How many air quality sensors can be supported using these standards?

Question 2: On the average, there are 17 students in a tutorial session. What is the probability that at least two students have the same birthday (assume 365 days)?

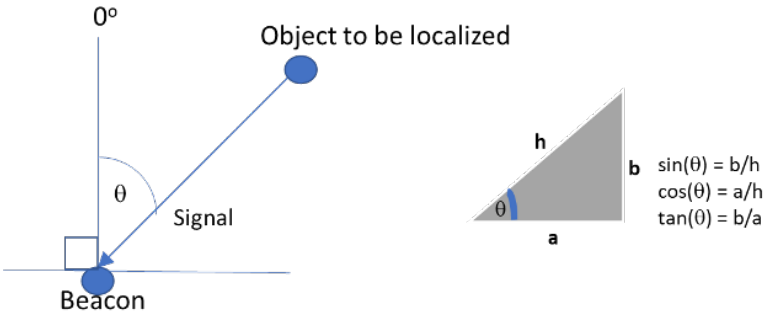
Question 3: We are using a time-slotted neighbor discovery mechanism. For this kind of neighbor discovery mechanism, please answer and reason the following questions:

- Let's assume that time is divided into slots of duration 200ms. In each time slot, a node wakes up with a probability of 0.1. What is the average time taken for two such nodes to select a common slot to wake up?

- In the project, beacon transmissions to announce a node's presence are transmitted once at the beginning and once at the end of an active time slot. Should transmissions be performed more often to improve chances of discovery?

Question 4: Localization can also be done by measuring the angle of (signal) arrival. In the left figure below, the signal angle of arrival is **q** degree. The right figure below provides reference for some basic trigonometric relationships.

Consider a 2-D plane with two beacons. Beacon 1 is located at (0,0) and beacon 2 at (10,0). Let the (unknown) position of the object to be localized be (X,Y). The angle of signal arrival from object to Beacon 1 is 40 degree and the signal angle of arrival from object to Beacon 2 is 300 degree. Write 2 equations that determines the unknown location (X,Y) and find values of X and Y.



Question 5: The figure represents an IoT network. The numbers presented on the edge indicates the link metrics represented as the number of packets that were lost for every 1000 packets that were sent over the link. Please answer the following question:

a) Calculate ETX of every link in the network?
b) What is the best path considering the following metric: ETX, hop-count?
c) If we assume that transmissions/receptions on Link 1 -> 4 requires 25 milliwatts, and on the Link 1 -> 6 requires 15 milliwatts of power. Furthermore, all other links in the network consume 10 milliwatts for transmissions/ receptions. If you want to spend least amount of energy to transmit a fixed number of packets from node 1 to 7, which path would you select ?