Internet of Things, June 26, 2017 **Total Available time: 1.45 hours**

1 – Exercise (7 points)

A IEEE 802.15.4 network is composed of a PAN Coordinator and five motes. Each motes is assigned two slots in the Collision Free Part, and each slot can carry packets of 128 [byte]. The nominal rate is R=250 [kb/s] and the active part is composed of the beacon slot and the CFP only. The network is operated with a duty cycle η=1%. The motes have the following traffic pattern:

- Mote 1 and mote 2 generate packets according to a Poisson process with parameter λ_1=0.5 [packets/s]
- Mote 3 and 4 generate packets according to a Poisson process with parameter λ_2 = 2 [packet/s]
- Mote 5 generate packets deterministically at a rate r=2[packets/s]

Find:

1. the duration of the Beacon Interval
2. the duration of a slot
3. the equivalent rate defined as "one slot per Beacon Interval"
4. the average energy consumed by the PAN Coordinator assuming E_{rx} = 1[uJ], E_{tx},=3 [uJ], E_{idle} = 0.5 [uJ] and E_{sleep} = 1[nJ] to be respectively the energy for receiving, transmitting (circuitry + emitted power) , being idle and sleeping in a slot.

2 – Exercise (5 points)

A localization system is composed of three anchor nodes with coordinates (x_1, y_1), (x_2, y_2,) (x_3, y_3). Assuming that the "measured" distances from the three anchor nodes at one unknown position (x*, y*) is d_1, d_2, d_3, write the expression of the cost function to be minimized when using gradient descent and the update step of the gradient descent algorithm.

3 – Exercise (6 points)

A COAP client operating with the Observe mode is registered to the topic /temp on a COAP server with the registration mode that forces the server to send a non-stimulated message every time a temperature reading is different than the previous one. Assuming that the COAP server mounts a temperature sensor that capture a temperature sample every 30[s] and knowing that the probability that two consecutive temperature samples are different is p=0.2, find the average energy consumed by the COAP client in a time period of 10 minutes in the two cases where the COAP server uses/does not use CONFIRMABLE messages to send the temperature samples to the COAP client. Energy for receiving a COAP message, E_{rx}=4[uJ], energy for transmitting a COAP message, E_{tx}= 10[uJ], energy for being idle E_{idle}=0[uJ].

3 – Questions (8 points)

1. Four RFID tags are arbitrated by Dynamic Frame ALOHA. Tell if the following statements are true or false. **MOTIVATE THE ANSWER. UNMOTIVATED ANSWER WILL NOT BE CONSIDERED**
    a. The higher the dimension of the first frame the higher the efficiency of the arbitration process.
    b. The higher the dimension of the first frame, the higher the average throughput after the first frame
2. A link A-B is characterized by a ETX_1=3 and a link B-C is characterized by ETX_2=2.5. What is the ETX of the end-to-end link A-C?
3. Briefly explain the use of RETAIN FLAG in MQTT transactions.
4. What is the average throughput of a single frame Frame-ALOHA with N=3 tags and r=4 slots?