

1 – Exercise (8 points)

A personal area network (PAN) is composed of 50 motes and a PAN Coordinator. The PAN works in beacon-enabled mode. 25 motes of Type 1 are equipped with light sensors that require a deterministic communication channel to the PAN Coordinator of 100 [bit/s]; 20 motes of Type 2 are equipped with accelerometers and require to report deterministically to the PAN coordinator an acceleration sample at 500 [bit/s]; 5 motes of Type 3 which have statistical (non-deterministic) traffic towards the PAN coordinator characterized by the following probability distribution: $P(\text{required rate}=0)=0.4$, $P(\text{required rate}=100 \text{ [bit/s]})=0.5$, $P(\text{required rate}=1 \text{ [kbit/s]})=0.1$.

Assuming that the active part of the Beacon Interval (BI) is composed of Collision Free Part only, the motes use 127 [byte] packets to communicate with the PANC which fit exactly one slot in the CFP, and the duty cycle is 5%, find: (i) the nominal transmission rate, (ii) the duration of the single slot, (iii) the duration Beacon Interval (BI), (iv) the duration of the CFP and the duration of the inactive part.

Find then the average energy consumption in a BI for a mote of Type 3 if the energy for receiving/transmitting in a slot is $E_{tx}=3 \text{ [mJ]}$, the energy of being idle in a slot is $E_{idle} = 1.5 \text{ [mJ]}$ and the energy for sleeping is $E_{sleep} = 1.5 \text{ [uJ]}$. **Assume that motes of type 3 are in range only among themselves (they do not overhear transmissions from motes of type 1 and 2).**

2 – Exercise (6 points)

A RFID system operated according to Frame ALOHA is composed of $n=4$ tags; assuming that the first frame has size $r=3$, find the probabilities that after the first frame 0, 1, 2, 3 and 4 tags are resolved. Find then the average throughput after the first frame.

3 – Questions (12 points)

1. Given a single-frame Frame ALOHA system with $n=10$ tags to be resolved, tell which of the following statements are true or false **MOTIVATING YOUR ANSWER**
 - a. **The maximum throughput is achieved with frame size $r=9$**
 - b. **If the frame size is $r=3$, then the expected throughput is 0**
 - c. **The shorter the frame size, the lower the expected throughput**
2. Briefly compare the AODV-based routing in Zigbee and the RPL discussing similarities, differences, advantages/disadvantages.
3. Briefly compare the error recovery mechanisms implemented by COAP and MQTT.
4. Briefly describe the two approaches to localization: model-based and fingerprinting.