***Internet of Things,  September 2, 2021***

## *1 – Exercise (6 points)*

A IEEE 802.15.4 network is composed of a PAN Coordinator and five motes. Each mote is assigned 2 slots in the Collision Free Part, and each slot can carry packets of 128 [byte]. The nominal rate is R=125 [kb/s] and the active part is composed of the beacon slot and the CFP only. The network is operated with a duty cycle $\eta$=0,1%. The motes have the following traffic pattern: mote 1 and mote 2 generate packets according to a Poisson process with parameter $\lambda_1$=0.2 [packets/s], mote 3 and mote 4 generate packets according to a Poisson process with parameter $\lambda_2$ = 0.5 [packet/s], mote 5 generates packets deterministically at a rate r=2[packets/s]
Find: the duration of the Beacon Interval, the duration of a slot, the equivalent rate defined as "one slot per Beacon Interval", the average energy consumed by one mote 1 assuming that it is not in range of the other motes.

Ts=8.192[ms]
$N_{cfp}$=10
$N_{active}$=11
$T_{active}$=90.112[ms]
BI=90.112[s]
$R_{eq}$=11.36[bit/s]
$E1=E_{rx}+2P0E_{idle}+P1(E_{idle}+E_{tx})+2P>=2E_{tx}+8E_{idle}+N_{sleep}E_{sleep}$

## *2 – Exercise (6 points)*

Find the average efficiency of multi-frame Dynamic Frame ALOHA collision resolution protocol with an initial population of n=4 tags. and an initial frame size r=4. Assuming that:
-tags 1 and 2 choose slot 1 of the first frame,
tags 3 and 4 choose slot 2 of the first frame,
-the size of the second frame is set according to Schoute's estimate,
find the average throughput at the end of the second frame.

The size of the second frame is set according to r2=round(2.39 c) with c=2. So r2=5.
The throughput after the second frame is $E[S]=4(1-1/5)^3$

## *3 – Exercise (4 points)*

A COAP client (Client 1) is interested in retrieving the resource /motex/temperature.txt available at a COAP server. The resource reflects temperature readings at the COAP server which get updated with frequency f=15[Hz]. Find the average energy consumed by the COAP client Client 1 in a time period of 15 minutes in the two cases where COAP Observe mode is not adopted, and COAP Observe mode is adopted with the option of receiving every new sample of temperature reading. Use the following parameters: energy for sending/receiving COAP requests messages, Ereq=10[uJ], energy for sending/receiving COAP response messages, Eresp=15[uJ].

Total number of transactions
N=15[Hz] x 60[s/minute] x 15 [minutes]

Non observe mode
$E=N\ (E_{req}+E_{resp})$

Observe mode
$E=E_{req}+E_{resp}+(N-1)\ E_{resp}$
Accepted also
$E=N\ E_{resp}$

## *4 – Questions (9 points)*

1. Three 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 lower the dimension of the first frame the higher the efficiency of the arbitration process. F If the first frame is set to the real backlog, then the efficiency is for sure larger.
b. The optimal size of the first frame is 2 F

2. Briefly describe COAP block transfer mode See slides
3. A MQTT Broker receives a subscription message with the following content: what is the action of the Broker? See slides

| | |
|---|---|
| packeId | 2 |
| topicName | “matteo/temp” |
| QoS | 0 |
| retainFlag | false |
| Payload | “temperature:30” |
| dupFlag | false |