TP Internet of Things :
IEEE 802.15.4 a low-Rate low-Power WPAN standard

IEEE 802.15.4 is a standrad that defines a wireless personal area networks and a wireless sensor network. It targets low data rate, low power consumption and low cost wireless networking.

Many applications can benefit from this standard, such as those using sensors that control lights or alarms, wall switches that can be moved at will, wireless computer peripherals, controllers for interactive toys, smart tags and badges, tire pressure monitors in cars, inventory tracking devices … etc

802.15.4 allows two wireless medium access methods for beacon-enabled nodes: CSMA/CA (as in Wi-Fi) or slotted CSMA/CA (see Figure 1). Using slotted CSMA/CA, more than one station can use the medium at the same time. Nevertheless, collisions still occur ; stations have to contend to access the wireless medium - using exponential back-off algorithm.

Using NS2 - Network Simulator 2, you will be analyzing performance in a 802.15.4 network along with the energy constraints.

In the given simulation scenario "*wpan_demo2.tcl*", the network has a star topology and is composed of 7 nodes with one coordinator in the center. Nodes generate constant uplink trafic.

Exercice 1 : Delivery Rate vs Traffic Load

The goal is to produce a graph demonstrating how packet delivery Rate varies for different trafic loads.

$$Packet\ Delivery\ Rate = \frac{nb\ of\ received\ pkts}{nb\ of\ sent\ pkts}$$

- Modify the interval between two consecutive packet transmissions in order to change the trafic load.

- Compute delivery ratio using :

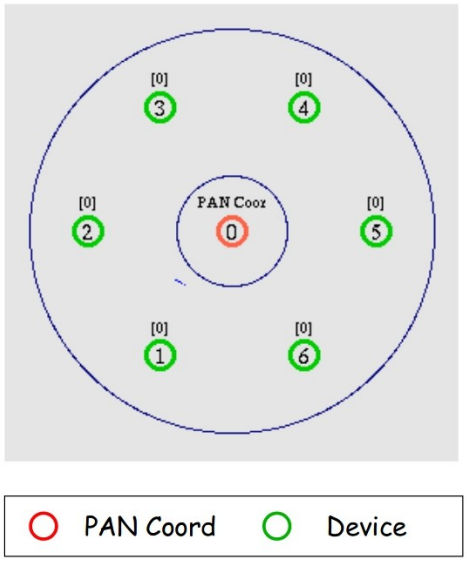
```
~$ ./simu -traffic -interv <seconds>
```

- Use the following values for `-interv`: 0.005, 0.001, 0.5, 1, 2, 3, 4, 6, 10, 14, 15, 18, 19 and 20 seconds.

- **Q1** : What is the relation between the trafic load and the interval between two consecutive packet transmissions ?

- **Q2** : Produce a graph of the number of sent packets as a function of trafic load.

- **Q3** : Produce a graph of the packet delivery rate as a function of trafic load.



- **Q4** : Produce a graph of the packet error rate as a function of trafic load

- **Q5** :Explain the *observed* relation between packet delivery rate and trafic load.

Exercice 2 : Duty Cycle vs Beacon Order

Duty cycle is a measure of the node's activity : sending/receiving frames, sensing the medium.

Beacon Order (**BO**) is a parameter defined by 802.15.4 standard that affects how many opportunities (time slots) stations have for using the wireless medium (see fig.1):

- When BO is low, nodes tend to have collisions.
- When BO is high, nodes have more opportunities to use the medium and thus collide less.

In IEEE 802.15.4 nodes use slotted CSMA/CA to access the medium by contending over a limitted number of time slots

The goal of this section is to analyze the impact of Beacon Orders (BO) values on the energy consumption of one of the nodes (node _3_).

- Compute duty cycle of node _3_ for different BO values using :

```
~$ ./simu -dutycycle -BO <BO-VALUE>
```

- Use the following BO values : 1, 2, 3, 4, 5, 7, 9, 11, 12 and 13.

- **Q1** : What is the relation between duty cycle and enregy consumption ?

- **Q2** : Explain the *observed* relation between duty cycle and Beacon Order (BO)

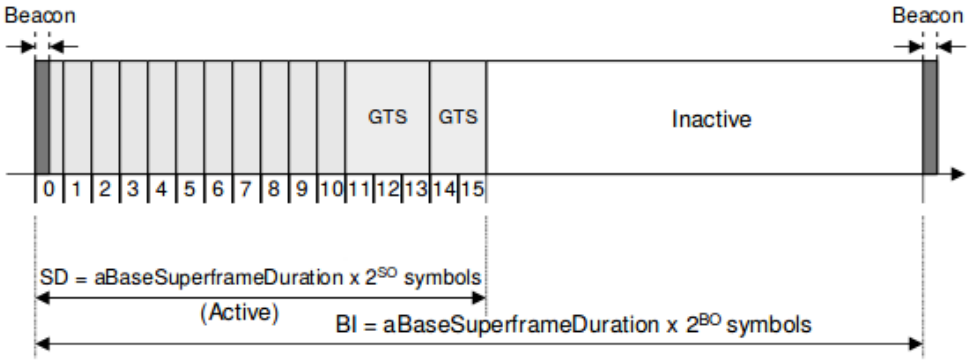


Figure 1: Superframe structure