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Evaluation of Sigfox LPWAN technology for autonomous sensors in coastal applications

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I. ABSTRACT

A low-power wide-area network (LPWAN) is a wireless communication network designed to send low bit rates in a long-range communication. SigFox is a LPWAN technology that uses Ultra Narrow Band to communicate packages of 12 bytes at a very low byte rate (<100 bits/s) and up to 140 messages/day per device. It is a payable service that includes the Base Stations and the Backend Services and works at 868 MHz (ISM band). These characteristics are attractive for IoT applications as it allows to send small packages at long distances at very low power range.

The TD1205P module features the SIGFOX Gateway and includes GNSS and Accelerometer sensors for tracking applications in 30x38x10.5 mm size. As a low power and compact solution that includes sensing, processing and transmitting units, it is suitable for Energy Harvesting Autonomous Sensor applications.

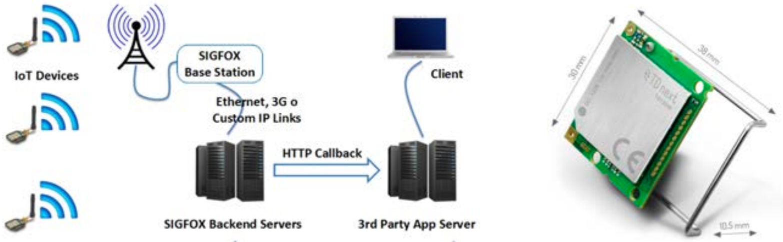

Fig 1. At left, Sigfox technology scheme and at right, TD1205P module

UPC is designing a drifter with a kinetic energy harvester, the electronics to adequate the power, the batteries to storage it and a TD1205P module as a tracker. It is going to be deployed at coastal areas to provide information of the surface currents for a long period hence, the power auntonomy has to be assured through the harvesting system. The aim of this study is to determinate the consumption of this module in his different modes of operation.

Two modules were set with different configuration and his power were compared, then in future studies, EH generation will be modelled in order to determine the autonomy of the buoy. The software is designed to minimize the consumption so it keeps the TD1205P sleeping during long periods, spending a few amount of energy. At some interval, the modules will wake up, fix the GPS position, take the measurements of battery voltage and temperature, send the data thought Sigfox coverage and they will go back to sleep. Two modes were configured, called mode 0 and mode 1. The difference between them is that the first do not save any data of the satellite constellation and the second does, so differences were appreciated at fixing GPS time and at sleeping consumption.

At figure 2 consumption of both modes is plotted with a symbolic working interval of 120 seconds. Table 1 shows the data plotted, being mode 0 segments from 1 to 6 and mode 1 segments from a to f. In one cycle, the module gets up and starts fixing the GPS position a taking the sensor measurements (2 – b) and then it sends the data (3 – c). This is pretty much the same for both modes but, when the module goes to sleep (4 –d), mode 1 keeps some memory alive for saving GPS constellation information so consumption is 5 times higher. Nevertheless, when the cycle starts the GPS fixing time (5 – e) is strongly different, being 8 times more at mode 0 because it has to start from nothing.

In addition, in both modes, it is easy to appreciate how SigFox technology sends each package of 12 bytes 3 times, at 3 pseouranom frequencies on the UNB modulation of the ISM band (3, 6, c and f).

To sum up, substantial consumptions were appreciated at different modes of work, some in the range of mA for short intervals and some at uA level for long ones. To determine the best option, a long-term study was simulated with intervals of 2 hours each output package.

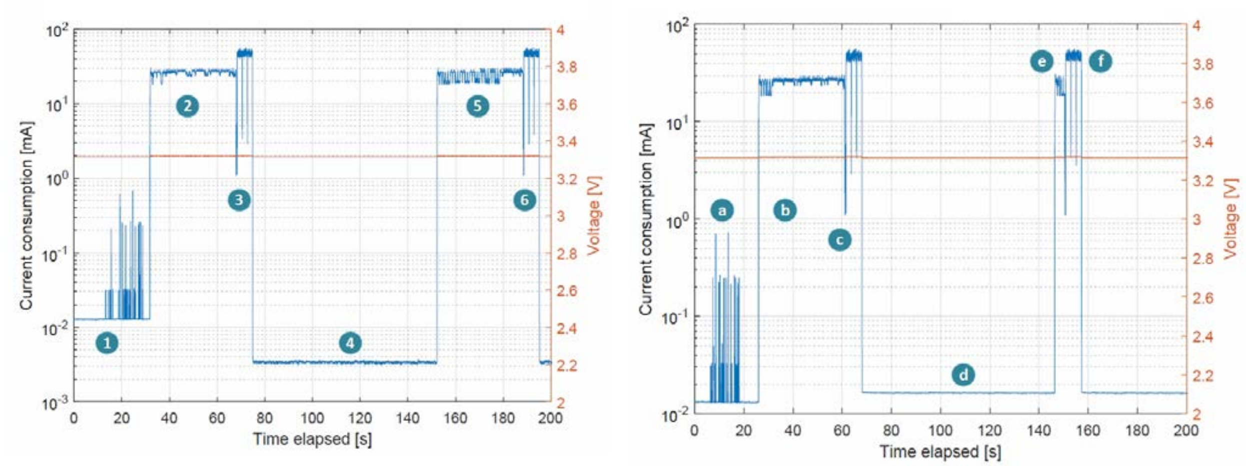

Fig 2. At left, mode 0 of TD1205P consumption, at right mode 1

Reference	Current (_A)	Power (_W)	Time (s)	Energy (J)
1	12.94 u	42.96u	Indiferent	-
2	26.01m	86.35m	36.58	3.159
3	45.94m	152.52m	6.56	1.001
4	**3.39u**	11.25u	7150	0.081
5	24.01m	79.71m	**36.39**	2.901
6	46.11m	153.08m	6.57	1.006
a	13.04u	43.29u	0	-
b	24.94m	82.80m	35.52	2.941
c	45.62m	151.45m	6.61	1.001
d	**16.31u**	54.15u	7190	0.389
e	21.31m	70.74m	**4.39**	0.311
f	46.04m	152.85m	6.58	1.006

Table 1. Consumption of both modules. [1-6] mode 0. [a-f] mode 1.

Formulas below are used to calculate the energy consumption of one day. For 2 hours interval, 12 cycles will be performance. Notice that Duty Cycle change from one to the other because mode 1 is awake for shorter periods.

$$\overline{P_{cycle}} = P_{sleep} + D \cdot \overline{P_{active}} \quad ; \quad E_{cycle} = \overline{P_{cycle}} \cdot T \quad ; \quad E_{day} = E_{cycle} \cdot 12$$

In conclusion, mode 1 spend around 18 J in one day while mode 0 spend 48. Table 2 shows this conclusions and determines mode 1 as the best option for for Energy Harvesting Autonomous Sensor applications.

Mode	Duty Cycle (%)	P_{sleep} (_W)	P_{active} (_W)	P_{cycle} (_W)	E_{cycle} (J)	E_{day} (J)
0	0.60	11.25u	90.84m	0.56m	4.00	48.06
1	0.11	54.15u	137.12m	0.21	1.49	17.84

Table 2. Energy and Power comparison between mode 0 and mode 1 operation for one-day deployment with 2 hours interval.

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