Demo Abstract: Multi-source energy management for Long Range IoT nodes

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***Abstract*— Energy harvesters are used in Internet of Things (IoT) networks to provide more energy to the nodes and enhance their autonomy. However, the nodes must adapt their consumed energy to variable energy harvesting conditions. Typically, an energy budget estimation (EBE) algorithm is used to calculate an energy budget based on the current energy capabilities. In this demonstration, we show an implementation and a comparison of multiple EBE algorithms on a real world LoRaWAN platform powered by different energy sources.**

I. Introduction

IoT networks are usually powered by non rechargeable batteries, which limit their autonomy and require maintenance. As an alternative, the use of energy harvesting devices has been considered, which enables each node to scavenge its energy from its environment.

Most energy harvesting sources are variable, which requires the node to manage its energy to avoid power failure. To this purpose, energy management algorithms have been developed. These can be divided in two units : an EBE which calculates the best energy budget based on the node energy capabilities, and an energy allocator which decides how to spend this energy. In particular, model-free EBE algorithms, such as LQ-tracker [1] or Fuzzyman [2], are generic and can be used regardless of the energy source.

In this demonstration, we show a comparison of such algorithms, implemented on a real-world LoRaWAN IoT node powered by a multi-source energy harvesting board [3]. All algorithms are implemented in a cross-platform library, which enables both real-world implementation and simulation.

II. Testbed and Demonstration

This demonstration is implemented on a LoRaWAN node platform, shown in Fig. 1, composed of a STM32L0 micro-controller and a SX1272 LoRa transceiver. The node is powered by a solar panel which provides up to 5 V and 40 mA. The solar energy is harvested by a multi-source energy harvesting board which can accept up to three simultaneous energy sources. This board uses SPV1050 converters from STmicroelectronics, and is used to charge a 7.5 F super-capacitor.

Four algorithms are compared in this demonstration. LQ-tracker takes the residual energy in storage E_R as input, and determines the best energy budget E_B using a linear regression algorithm. Fuzzyman takes E_R and the harvested energy E_H as inputs, and uses fuzzy logic to determine E_B. In this demonstration, E_R variation is used to estimate E_H, and an adapted rule-set has been designed. Moreover, we designed Linear_T and Linear_E algorithms, which respectively deliver a delay D and E_B proportional to the super-capacitor state of charge.

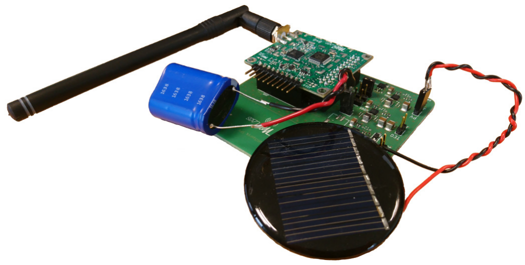

Fig. 1: Hardware evaluation platform.

This demonstration uses four nodes, each running a different EBE algorithm. All nodes are connected to a remote LoRa-WAN application server through a LoRa gateway. Periodically, each node wakes-up, sends the previously measured and calculated E_R, E_B, D to a remote server, along with the number of passed transmissions. The node then calculates its new E_B and goes in deep-sleep until it has to send a new transmission. The data from the nodes are fetched from the server and displayed.

III. Conclusion

This document presents a demonstration of a real-world implementation of energy budget estimation algorithms. These algorithms are used to control the duty cycle of LoRaWAN IoT nodes, and enable a theoretically infinite battery life. Future work will focus on improving the energy allocation, especially in the context of multiple tasks.

References

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