UWE Bristol University of the West of England

UFCFXK-30-3: Digital Systems Project

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Project Title: Creating an Offline LoRaWAN Gateway

Abstract:

LoRaWAN is a long range, low bandwidth communication protocol with many potential applications in the IoT. This project aims to utilise this technology to provide wearable trackers that can operate over long distances (>10 miles) with a view to providing hikers and mountaineers with a cheap and effective option for SOS-style signalling. By covering the area with a net of LoRaWAN gateways, a wearable gps-enabled node can ensure that users would not need to worry if an accident happens.

LoRaWAN gateways can be found relatively cheaply, these tend to run on a raspberry pi and some flavour of linux and often rely on internet connections to function. However, for this project it is preferable to create a gateway that needs no internet connection and uses either a more lightweight OS or even none at all to allow it to run on a battery for extended periods of time. As a result, I have selected the STMicroelectronics Nucleo f411RE as my platform and will be focusing development around this.

Research:

Augustin *et al.* (2016) alongside Adelantado *et al.* (2017) agree that the advantages of LoRaWAN, namely its long range and high degree of reliability, are due to a combination of the use of spreading factors and the modified CSS chirping modulation used for transmissions. However, Augustin *et al.* (2016) found that increasing the transmission payoad of a LoRa network had a significant effect on its reliability and likens it to a similar technology, ALOHA, in this regard.

Battery life of a LoRa device can vary with a number of different factors. The LoRaWAN specification designates three classes of LoRa devices: A, B and C. Cheong *et al.* (2017) examined classes A and C on a device capable of both of these and found that a battery life of 10 years could be expected of a class A device running in ideal conditions. Khutsoane, Isong and Abu-Mahfouz (2017) also evaluated a class A device and concluded that it could run for up to 10 years on a single battery. These conclusions are merely estimates though as the technology has not been around for long enough to draw from real-life data and they do not take into account hardware or battery degredation over the period.

Key requirements:

Functional

2. The board must be able to communicate with the LoRaWAN module (ic880A concentrator board)

- The LoRaWAN gateway must be able to receive LoRa packets from at least one LoRa node
- The LoRaWAN gateway must function offline
- The LoRaWAN nodes must be able to transmit GPS data to the LoRaWAN gateway
- The LoRaWAN gateway must be able to store rececived LoRa packets.

Non-functional

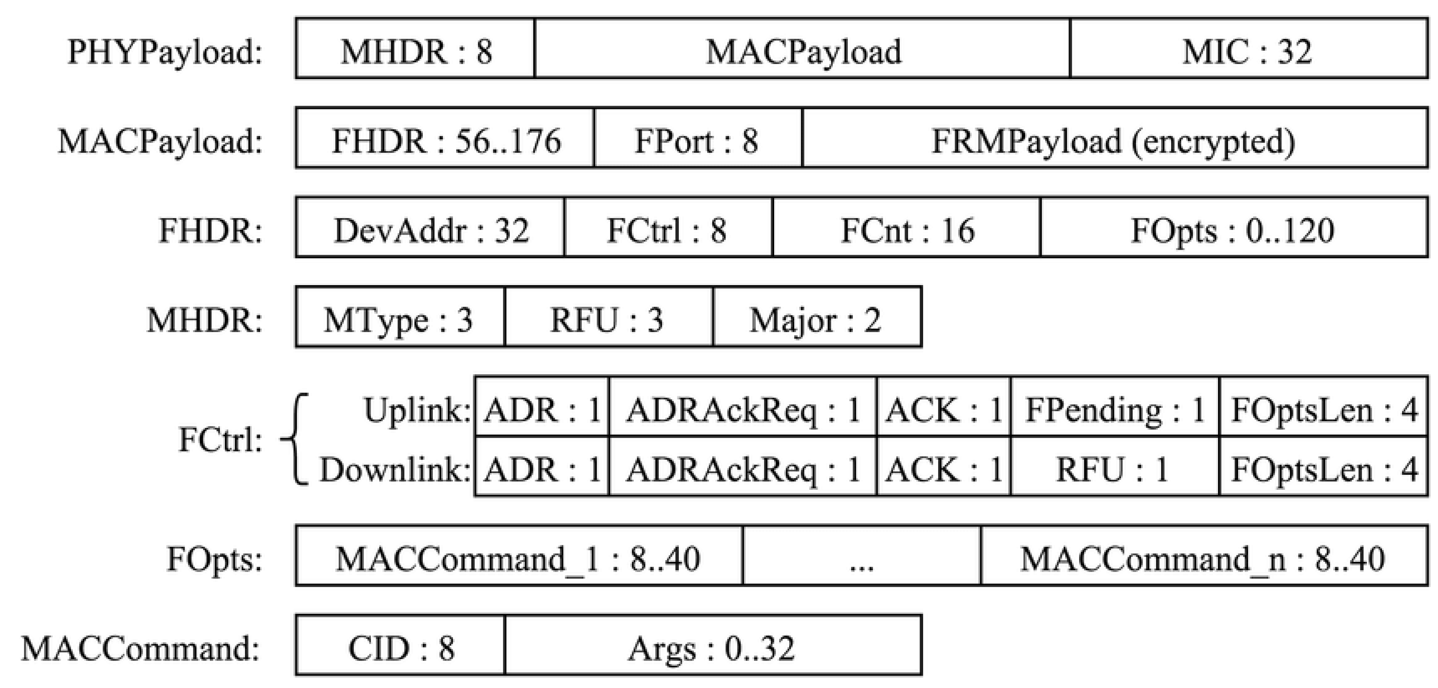
- The LoRaWAN gateway assembly should be weatherproof
- The LoRaWAN gateway should operate for at least 72 hours on a single battery charge
- The LoRaWAN node should be weatherproof
- The LoRaWAN node should be lightweight enough to carry
- The LoRaWAN node should be sturdy enough to survive several days of jostling movement (any wires should be secure and not liable to fall out during transit)

Aims and objectives:

The project objectives are:

- To port the ic880-A HAL to the STNucleo platform
- To create a LoRaWAN gateway that will function without an internet connection
- To allow communication between this gateway and a series of GPS enabled LoRaWAN nodes
- To store communications received by the gateway in some easily parsable format eg. CSV file

LoRa Payload Breakdown



Augustin *et al* (2016)

Design and implementation

Due to the nature of the project, development progress will be in terms of functional sections of the HAL. This is not yet at a state where any progress can be shown.

Planning and Management:

Contact time with supervisor consists of regular weekly group meetings on Thursday mornings. Further meetings can be organised at the discretion of the supervisor and project student.

Completion of the HAL port should be by the end of January, after this the next task is to successfully receive LoRa packets sent from a LoPy node. This should hopefully be done by mid February.

Report progress is ongoing.

References:

Adelantado. F., Vilajosana, X., Tuset-Peiro, P., Martinez, B., Melia-Segui, J. and Watteyne, T. (2017) Understanding the limits of LoRaWAN. *IEEE Communications Magazine.* 55 (9), pp. 34-40

San Cheong, P., Bergs, J., Hawinkel, C. and Famaey J. (2017) Comparison of LoRaWAN classes and their power consumption. *2017 IEEE Symposium on Communications and Vehicular Technology (SCVT).* Leven, Belgium. 14 November 2017. IEEE

Khutsoane, O., Isong, B. and Abu-Mahfouz, A. (2017) IoT devices and applications based on LoRa/LoRaWAN. *Industrial Electronics Society, IECON 2017 - 43rd Annual Conference of the IEEE. Beijing, China. 29 October - 1 November 2017. IEEE*

Augustin, A., Hide Clausen, T., Yi, J., Mark ownsley, W. (2016) A Study of LoRa: Long Range & Low Power Networks for the Internet of Things. *Sensors* 16(9), *1466*