Implementing NB-IoT: Communication with a Load Cell

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Abstract

The purpose of this project is to establish a line of communication between a loading cell and the internet. This will be done through the NB-IoT technology, and the data being sent is produced by the loading cell. Using a micro-controller from PyCom and a SIM-card from Telia as the network service provider, [...]

Contents

Chapter 1

Introduction

Vetek is a Swedish scale supplier located in Väddö, situated approx. 100 kilometers north of Stockholm. Vetek constructs their own scales and weighing systems, as well as reselling products from other manufacturers.[7]

Vetek aims to improve their services, and as such are interested in the possible use cases of IoT (Internet of Things) technology, and ultimately see how that can be applied to their own products. In this paper,the term IoT will simply mean "(a) device(s) connected to the internet"[3]. In a pilot project, Vetek wants to see how this connectivity can be implemented in a energy-efficient and effective manner. This would entail investigating factors such as power consumption, range and data rate. NB-IoT (Narrowband-IoT), a new and emerging radio technology, encapsulates some principles suitable for this type of endeavor, such as wide coverage, low power consumption and low complexity.[1] Using some form of NB-IoT compatible micro-controller and hooking it up to a basic load cell should provide sufficient testing grounds to see how this new functionality could improve existing products.

According to Swedish telecom company Telia, they were the first to introduce the NB-IoT technology in Sweden, as well as the Nordic countries overall[5]. They further claim that their network will be in range for over 99.9% of Sweden's population, as well as provide a speed of 200 kb/s in more than 95% of the country.[4] The grand opening of the network was on the 24th of May, and pilot projects were conducted as early as a year before this, in multiple locations across the country, such as Västerås and Lund. Telia currently offers a starter kit for any actor interested in the technology, with a trial period of 6 months that includes access to Telia's IoT portal and APIs as well as 5 SIM cards, each with a 30MB data cap per month.

The only other competing telecom companies in Sweden dealing in NB-IoT is Tele2 who have partnered up with Nokia to deliver a ...

[TODO: How much description of the market is needed?]

1.1 Purpose and Goals

NB-IoT is a relatively new technology, and as such, implementations and documentations remain sparse.[1] However, even a small project such as this can serve as a guiding post for future work. The goal of this project is to establish a working internet connection with a load cell through the NB-IoT technology. The data sent from the load cell should be functionally identical to the data produced if the load cell was offline. Disregarding problems due to a internet service provider, data speeds and losses should not be abnormal. Using the same components, replication of the project should be feasible with the documentation provided in this thesis, assuming similar software and service providers remain.

The end-goal can be divided into two sub-goals.

- Enable internet communication via NB-IoT from the microcontroller.
- Enable data transfer from the load cell to the microcontroller.

This paper will outline and describe the process from start to finish. Problems and challenges that arise in the implementation will be investigated and analyzed. An agile workflow will be prioritized in the implementation, with small increments of work being added and tested before moving on to the next part. The workflow will flow this rough outline.

1. Enable communication from the microcontroller via another common protocol, such as WiFi.
2. Enable the reading of data from the load cell via the microcontroller.
3. Upload the data to a suitable online platform.
4. Enable communications from the microcontroller via NB-IoT.

The reason for enabling communications via WiFi is to ensure a functioning channel via a more common and well-documented protocol that's easier to setup. Once this is functional at the same time as the data upload of the load cell data, the move to NB-IoT can be done. This setup is due to the aforementioned agile workflow.

The final implementation will be evaluated by measuring uptime $\vee$ energy consumption $\vee$ packet transmission time.

[TODO: Finalize what parameter(s) should be used in an evaluation]

1.2 Delimitations

The end goal of the paper is to document and outline the steps needed to implement a functioning data upload from a load cell to the internet via NB-IoT. The final implementation will not be a functional product ready to be taken into commercial use. Any extra improvements upon a NB-IoT enabled load cell will only be done if time remains after the implementation and the completion of the thesis. The reason for this is due to a limited time budget, since this project is done within the framework for a bachelor's thesis.

When starting this project, several factors motivated the choice for hardware (which will be described in greater detail in the following chapter). Since existing work on NB-IoT at Uppsala university has been done on the microcontroller FiPy, and the available expertise would make troubleshooting simpler, a FiPy was chosen for this project as well. Furthermore, since the Computer Communications group at Uppsala University have an ongoing contract(**wording?**) to use Telia's NB network, the choice for which tele-carrier to use was also quite simple. The load cell, a Tedea

Huntleigh - Model 1022 was provided by Vetek, as it was deemed a simple and basic model which would be suitable for this kind of pilot project. Since the output of a load cell is measured in mV/V[6], some form of mediator is needed between the microcontroller and the load cell. A similar implementation made at KTH [2] used a load cell amplifier, HX711, to convert the data to a digital format. After some research online, no alternatives were cheap or simple enough to warrant a different purchase. The readily available documentation and tutorials were also a compelling argument for using the HX711.

Chapter 2

Definitions

2.1 Components

- FiPy: a development board that gives access to all major LPWAN technologies. FiPy is developed by PyCom and equipped with an expansion board to enable integration with other components via GPIO pinouts, as well as an LTE-antenna to enable LTE CAT M1 or NB1. MicroPython is enabled on the board, and as such is programmed via the Python programming language (Version 3.5). The available protocols on the FiPy are:
  - WiFi
  - Bluetooth
  - LoRa
  - SigFox
  - Dual LTE-M (LTE CAT M1 / NB1)
- Tedea Huntleigh - Model 1022: a single point load cell ideally suited for low cost weighing platforms. This specific model has the capacity of 30 kg, which should be more than enough to run tests of data transfer from the load cell via the FiPy.
- HX711: a breakout board that amplifies the signal from a load cell so that the data can be read more easily. Several libraries are readily available online, including some MicroPython variants.

2.2 Applications & Services

Chapter 3

Methodology

3.1 Preparation

Chapter 4

Results

4.1 Discussion

Chapter 5

Conclusions

5.1 Future Work

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