Technical Specification

Group: I-TT-4N2, I-IT-4N2

Version	Date	Author	Change
1.0	7.12.2017	Apurva Ganoo	-
1.1	15.12.2017	Apurva Ganoo	Additions

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Introduction

This technical specification is designed to provide a concise overview of the City Atmospheric Measurement System (CAMS) Project that was undertaken by the Information Technology students from the Finnish and English side at the Vaasa University of Applied Sciences. The goal of the project was to deliver a working prototype, or a node, which was capable of measuring at least 3 environmental variable using different sensors, which would then push data using the LoRaWAN network to The Things Network gateway which was hosted at our university.

Purpose and Scope

The purpose of the CAMS project was to design a modular, scalable, system that allowed for the monitoring of the Vaasa City environment. The idea is based on The Things Network which aims to create an IoT platform where the network allows nodes to send data to a centralized location using LoRaWAN technology. The project was designed to create nodes that were scalable, in terms of the number of sensors attached, and modular in the sense that those sensors could be attached with as little effort/time required as possible ("plug and play" capabilities).

The goal of this project is to create an eco-system of various nodes, stationed all around the city of Vaasa, providing key environment-related data automatically, and periodically to a fixed Gateway which is then able to store the data in a secure database. The database, in the future, will have an application layer attached onto it, allowing for easy access from users and other interested parties. The end goal is to create a system onto which more and more nodes can be added in, whenever necessary, and with as little effort as possible. In essence, the idea is to build a small, working network, but to also put in an infrastructure that allows for more nodes and larger scopes.

The scope for the project was defined as to have a minimum of 3 sensors attached to a single node, with the maximum being around 9 to 10 sensors for a single node. The scope of the project was purposefully kept vague, in order to first build a working prototype with the minimum specifications, which could then be used as a reference for future iterations.

Item	Minimum Number	Maximum Number (Theoretical)
Sensors per Node	3	10
Nodes	1	NA

Definitions, Notations, and Abbreviations

LoRaWAN Network: "LoRaWAN is a media access control (MAC) protocol for wide area networks. It is designed to allow low-powered devices to communicate with Internet-connected applications over long range wireless connections. LoRaWAN can be mapped to the second and third layer of the OSI model.[1]"

[1] Definition derived from The Things Network Website

Node: In our case, a node has been defined as one, self-sufficient, device with at least 3 monitoring sensors, with the capabilities of handling more sensors with minimal effort from the end-user. In our case, the nodes should be designed in a scalable manner.

The Things Network: "The Things Network is building a network for the Internet of Things by creating abundant data connectivity, so applications and businesses can flourish.[2]"

References

Definitions for The Things Network related terms were obtained from the official Things Network website. The website can be accessed from: https://www.thethingsnetwork.org/

General Description of the System

The general system has been divided into 2 main parts, the hardware, and the software. As such, the hardware deals with the Printed Circuit Board (PCB) designs, the electronic configurations, and the components needed. The software side mainly consists of 3 individual parts: the networking configurations, the scheduler system, and the application functions; designed to obtain values from the sensors, and later to be pushed through to The Things Network Gateway.

Description of Application Area

The application area consists mainly of the Things Network Gateway and its application platform. The user case diagram can be seen below (see fig.1).

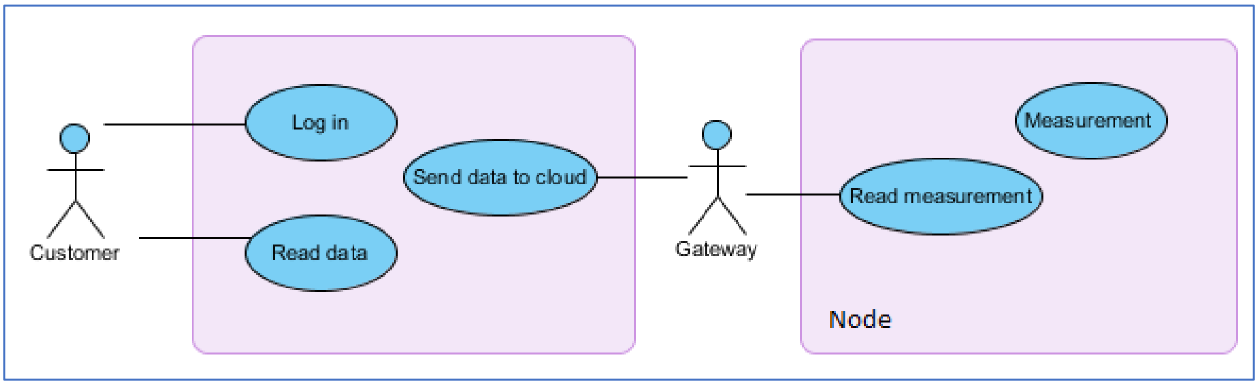

Fig.1 – User Case Diagram

System interfaces to its environment

The application area consists of multiple nodes which shall push data through to the main gateway using LoRaWAN. As such, the system architecture can be seen below (see fig.2).

[2] Definition derived from The Things Network Website

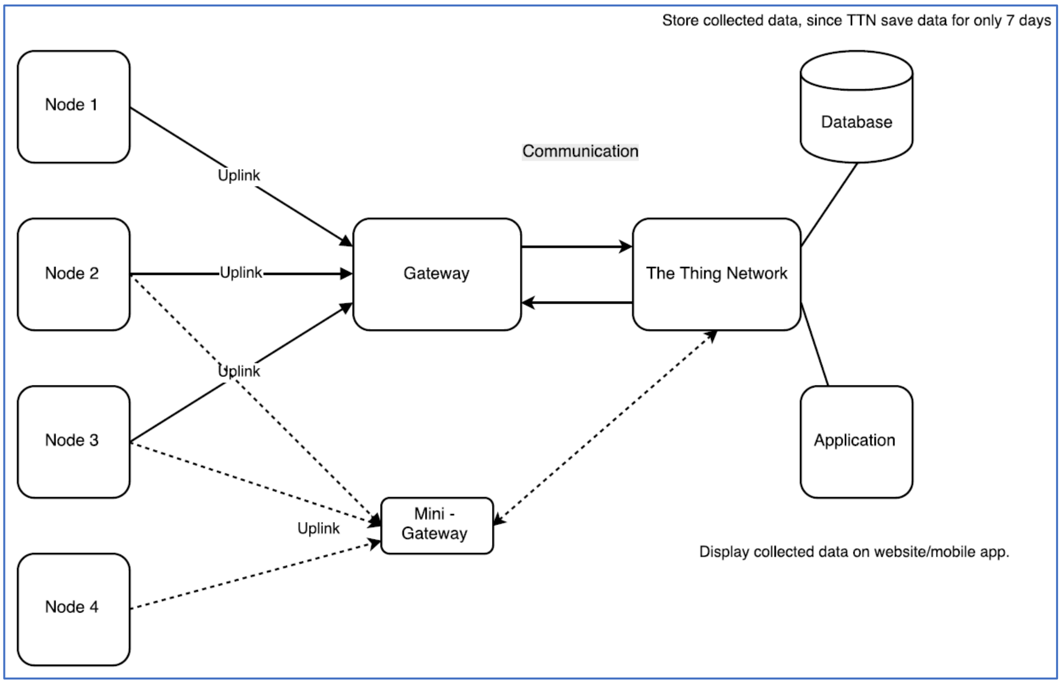

Fig.2 – System Architecture

Hardware Environment

The hardware consists of a mainboard which shall host the main processing unit of our node, as well as the LoRa chip which is needed to communicate with the Things Gateway.

As such, the processor to be utilized for our node is the ATMEGA 128/L microcontroller which is produced by the Atmel Corporation. This microcontroller contains 128Kbytes of in-system programmable flash and is an 8-bit configuration.

The first, testable node to be designed by our group is to be one with 3 peripheral sensors, one mainboard, and will be given power using stored energy sources (i.e. batteries). The 3 peripheral sensors will be monitoring: temperature, humidity, wind direction, wind speed, and traffic monitoring. Both, temperature and humidity will be measured by 1 sensor. Likewise, wind direction and wind speed shall also be measured by one sensor. Lastly, the traffic will be monitored by an infrared sensor which shall work on the principle of a simple counter. Furthermore, a GPS shall also be placed onto each node, providing the coordinates of where the node has been stationed.

The whole node system shall be powered by batteries, or stored sources of power, as opposed to a running source. This is mainly to allow the nodes to be stationed in remote locations, where running power may be scarce and difficult to be obtain. Secondly, due to the nature of the nodes themselves, there will not necessarily be a need for a constant source of power. These nodes are designed to consume as little power as possible, with the majority of the consumption coming from the LoRa chip which is used to transmit data over large distances, directed towards the Things Gateway.

Software Environment

The software environment consists of 3 main parts: the network configuration, measurement functions, and the scheduler system. As such, we shall now provide a concise summary of each of the parts.

The network configuration pertains to the programming and configuration related to the LoRa chip and the ability of the nodes to successfully send data packets, using LoRaWAN technology, to the Things Gateway. Furthermore, the network configuration should also guarantee that the information received on the Things Gateway can be read clearly and easily by the user, with the data being formatted correctly.

The measurement functions pertain to the functions designed by the Software team to help measure the data from the sensors attached to the node. The measured data should then either be pushed forth in the right data format, or used to create certain calculations. The calculations only pertain to the traffic sensor.

The scheduler system was designed by the Software team to ensure that the measurements are done correctly and in a timely manner, without compromising the microcontroller's processing power.

Agreements and Standards

All the functions and libraries utilized in our project were designed by the student themselves apart from the LMIC library, used in part to configure the LoRa Chip on the node. This library was obtained as it was free to use and openly sourced.

Some standards or regulations that had to be followed in the design or the implementation of the node include:

- An antenna with a transmission frequency of less than 900 MHz
- A maximum of 1% uplink time in the transmission of data from the node to the Gateway
- The node should have a rating of IP66
- The node should offer ESD Protection