Università degli Studi di Padova

Department of Mathematics "Tullio Levi Civita"

Master Thesis in Computer Science

Supporting tools for Agile software development: experience from a real use case

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Accademic Year 2018 - 2019

This is a very
meaningful dedication

Abstract

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Sommario

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1 Introduction

1.1 Contributions

1.2 Document outline

The document is organized in the following chapters as such:

1. **Introduction**:
2. *Background*:
3. *Technologies*:
4. *Related work*:
5. *Conclusions*:

2 Background

This chapter introduces the background knowledge that necessary to understand the project and why it has been developed. It first establishes the concept of Internet of Things, which is at the base of this thesis, afterwards, it describes the problem statement and gives an overview on the background work and state of the art present at the moment of writing.

2.1 Internet of Things

The *Internet of Things*, abbreviated with *IoT*, has a longer history than many people know.

One of the first technologies that can be associated to IoT is the "*Universal Product Code*", or *UPC*. This was issued to inventors Joseph Woodland and Bernard Silver on October 7, 1952, and can be described as a "bull's eye" symbol, made up of a series of concentric circles [1].

Due to the large size of equipment and the scarse reliability, it has not been immediately introduced to the public.

The barcode was first used commercially in 1966, however, it was soon realized that there would have to be some sort of industry standard set.

The first appearance of the Universal Product Code (UPC) that is known to the public and has become widespread, is the one developed in 1971 by George Laurer at IBM. [2].

Adoption relied on emergence of laser optics, developed around the same time, as these offered compact reading technology

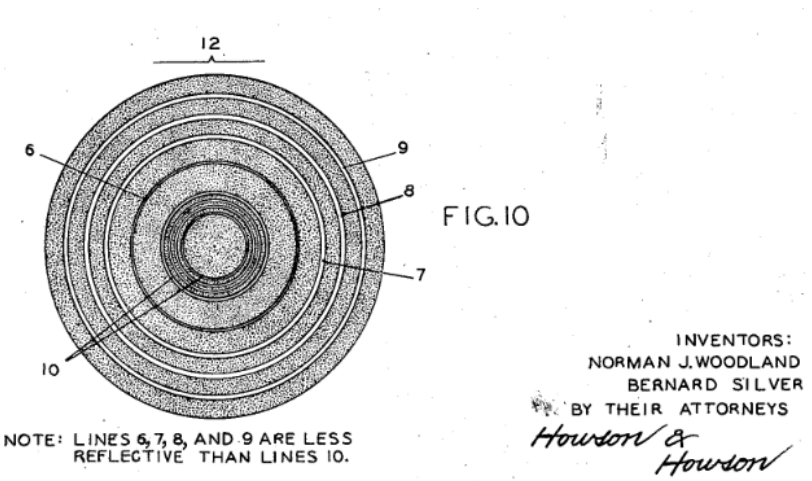

Figure 2.1

Although, printers used to generate barcodes were vulnerable to smudge è design coped with errors as ink bleeding would result in taller bars. Offered the first way to track products and address them!

Visto che le stampanti hanno cominciato ad essere vendute in larga scala e le stampe dunque costavano poco, l'adozione dell'UPC è stata addottata su larga scala. GUARDARE SLIDE ECONOMIA DELL'INNOVAZIONE

It may come as a surprise, but connecting everyday objects has started in 1980 - mid 90s. One of the most famous and most quoted as the is the first IoT device, is the Carnegie Mellon University (CMU) coke machine at the Computer Science Department.

This used sensors to detect whether shelves have bottles. Simple algorithms used to track status of coke bottles (warm, cold, empty). Allow remote access to check status of machine. Communication took place through Arpanet at CMU as the system predated the Internet.

The term "*Internet of Things*" which is now know all around the globe, has been attributed to *Kevin Ashton*, who used it in a presentation at *Protector & Gamble* in 1999 [3] to describe the network connecting objects in the physical world to the Internet.

IOT TRENDS AND FORECASTS

Another important definition of IoT is IIoT, which stands for Industri 4.0 IoT.

2.2 Air quality

The solution this thesis focuses on is MegaSense

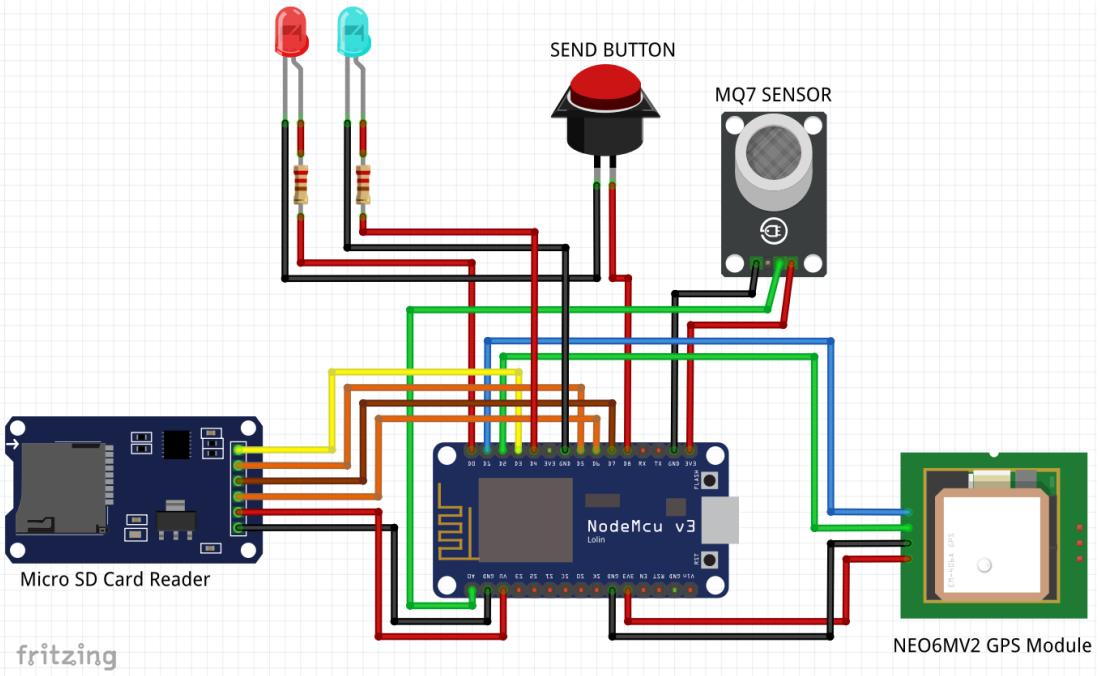

Figure 2.2

2.3 Solutions to detect air pollution

ArduECO

2.4 Megasense

https://www.megasense.org/

Describe the consortium

HOPE and Megasense

The calibration of the megasense device is made via

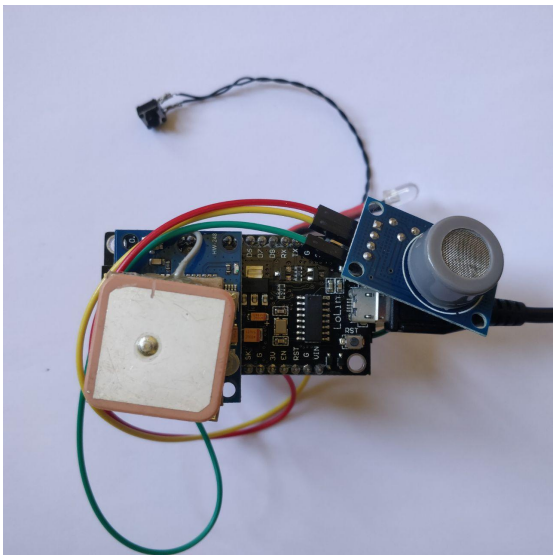

Figure 2.3

3 Technologies

To fully understand the project and the choices behind it, is worth taking a look at some backgrounds technology which can be useful to know before proceeding further into this thesis. In this chapter we describe DTNs, the notion of peer-to-peer and overlay networks.

3.1 Radio technologies

3.1.1 LoRa

https://lora-alliance.org/
https://www.semtech.com/lora

3.1.2 LoRaWAN

3.1.3 Bluetooth

3.1.4 WiFi

IEEE 802.11, better known in the public as WiFi, short for wireless fidelity

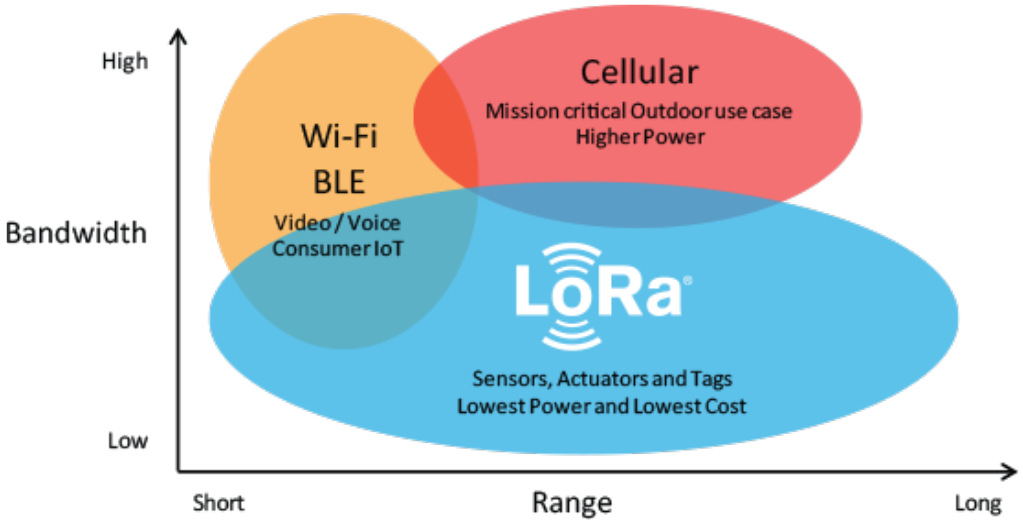

Figure 3.1

3.1.5 LTE

3.2 LoRa and LoRaWAN

3.3 Hardware (Microcontrollers)

3.3.1 Arduino

3.3.2 Raspberry Pi

3.3.3 Pycom

4

Related work

To better understand the proposed solution in this thesis, this chapter better describes the state of the art and the related work that has been done in this field, both commercially and in research.

5

Proposed solution

5.1 Idea

5.2 Architecture

5.3 Hardware

5.4 Software

5.5 Use cases

6

Results and experimentation

6.1 Experiments

6.2 Expected results

6.3 Results

7 Conclusions

7.1 Improvements

7.2 Future work

7.3 Personal considerations

Acknowledgments

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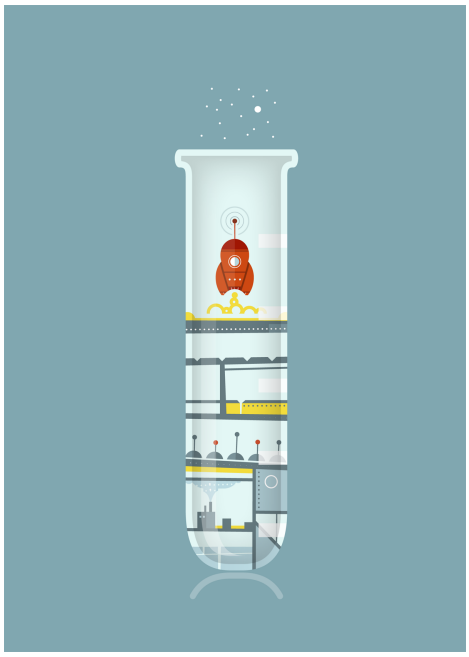
References

[1] W. E. A. N. J., "Classifying apparatus and method," Patent US2 612 994A. [Online]. Available: https://patents.google.com/patent/US2612994A/en

[2] D. Savir and G. J. Laurer, "The characteristics and decodability of the universal product code symbol," *IBM Systems Journal*, vol. 14, no. 1, pp. 16–34, 1975.

[3] K. Ashton. That 'internet of things' thing. [Online]. Available: https://www.rfidjournal.com/that-internet-of-things-thing



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