FACULTY OF ENGINEERING TECHNOLOGY
– GENT –

MOBILE COMMUNICATIONS

LAB

BOEIend!
INTERMEDIATE REPORT

GROUP 2

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1 Description of the problem

'BOEIend!' is a project about giving buoys the ability to communicate with each other, to make them 'smart', so they can **automatically detect and report if they are adrift**. They can also periodically report other useful data such as **wave amplitude and water temperature**.

The goal of the project (and the lab sessions) is to **develop the design and specifications for the communication element of such a 'smart' buoy**, and to **build and test a prototype**. Buoys generally have a lifespan of **5-10 years** so the design must be **energy efficient** and possibly make use of some energy-harvesting methods.

Since the scope of the lab is more about the communication-side, the low-power aspect should rather be kept in mind than to actively pursued. We know however that due to the limited energy budget of some of the buoys, continuous collecting GPS measurements is unfeasible. It is thereby imperative that low-energy strategies are employed to ensure a long lifespan. We can also see that we need to look more into other localization or proximity-based mechanisms.

2 Breakdown in smaller sub-problems

2.1 Types of buoys

We can divide our problem in smaller sub-problems by distinguishing two types of buoys:

Master buoy These buoys will be equipped with the technology required to communicate with both the mainland and the other (slave) buoys. It is important to use a technology that is capable of communicating over rather long distances for the connection to the mainland.

These larger buoys will be equipped with larger batteries. For the scope of this coarse we can assume they have 'unlimited power', so they can be used to do more energy-heavy tasks.

Slave buoy These buoys need to be energy-efficient and could generate their own energy. They don't need to communicate over long distances.

On figure 1 we see a diagram of the general problem. In this project, we assume the following distances:

- Coast ↔ Master buoy (A): 100 m – 1 km
- Neighboring (slave) buoys (B): 10 m
- Immobile buoy ↔ drifting buoy (C): > 20 m

A buoy is considered **out of place** when the distance to his original location is lager than a certain predefined threshold, which is in this case **20 meters**.

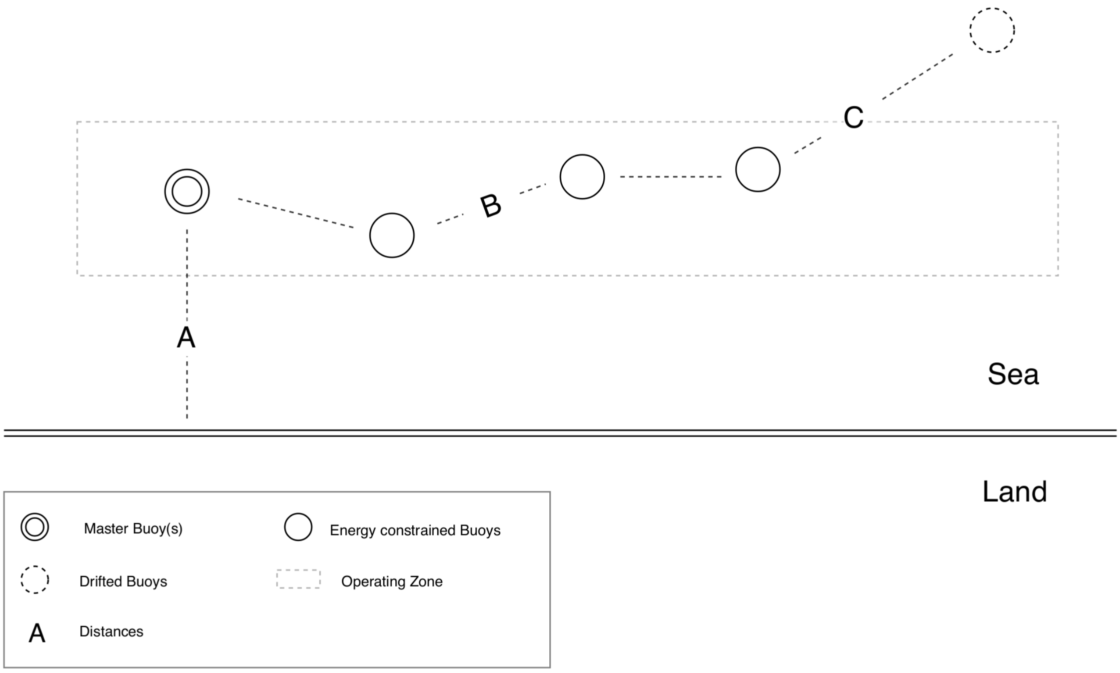

Figure 1: Visualization of the project.

2.2 Communication to the mainland

Communication **between the mainland and the 'master' buoys** will be established using a **LoRa-connection**. Reasons to choose for LoRa in our case include the great range and the low power-consumption. On the master buoys we theoretically have an 'unlimited' amount of power, but a low power design is always preferred.

The LoRaWAN network by Proximus [1] covers almost the whole area of Belgium, as depicted on Figure 2. We can see that the network reaches a few kilometers in to the North Sea. This makes it a perfect candidate for our connection between the master buoys (equipped with a LoRa-module) and the mainland. The data coming from the master buoys will be transmitted over the LoRa network to 'the cloud', where it can be collected and further analyzed.

In the lab sessions we will experiment with a `EMF32 Happy Gecko` development-board with a `DRAMCO LoRaWAN RN2483` modem addon board.

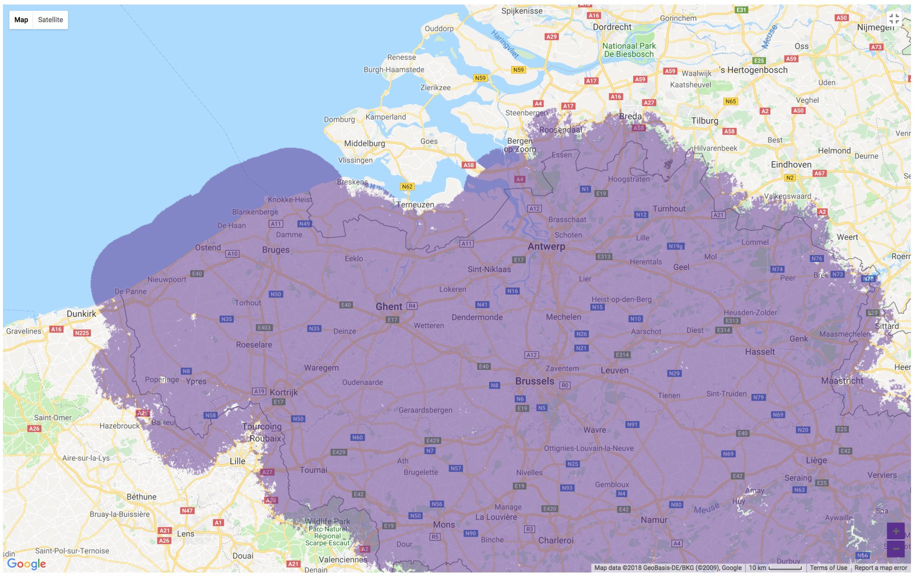

Figure 2: Coverage of the LoRaWAN-network by Proximus.

2.3 Communication between buoys

Starting with the data given in our assignment (also depicted on figure 1) we can see that each buoy and the next will be **10 meters** apart. If we determine that **every 15 buoys a master buoy** is needed, we can see that the master buoy needs a communication protocol which is able to communicate in a **star-network of up to 70 meters**. This means that every master buoy needs to communicate with 7 buoys to the left and 7 buoys the right. An overview of this proposed implementation is shown in Figure 3.

A communication technology that can handle these distances is `Zigbee`. With this technology every 'slave' buoy will communicate with the master in a star topology. When all the buoys are in the right position and the distance between every master buoy is 150 meters, each slave buoy within a distance of maximum 70 meters (if he is at his correct position) can communicate with his designated master buoy. This also means that **a drifting buoy** can communicate with the master buoy **if it stays at a distance of maximum 100 meters**, which corresponds to **30 meters drifting**.

To realize this we will be using a `DRAMCO ZigBee` Arduino Shield.

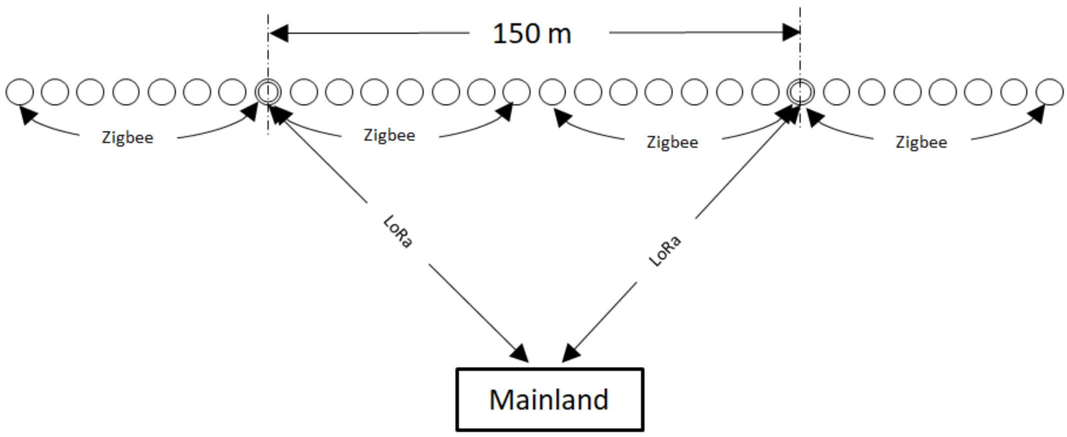

Figure 3: The overview of the proposed implementation.

3 Technologies

3.1 LoRa

LoRa is a communication technology developed by SEMTECH. By using sub-Gigahertz radio band frequencies, this technology has a very wide range with limited power consumption. Because they work on lower frequencies the error-bit rate is significantly lower, but this will also result in a lower data-bit rate. All of these features make LoRa a suitable communication protocol for the connection between the master buoys and the mainland.

3.2 ZigBee

ZigBee is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios. Use-cases can be found in home automation, medical device data collection and other low-power low-bandwidth needs. This communication technology can communicate between 10 and 100 meters with a bit rate of approximately 0,12 Mbit/s.[2]

References

[1] Proximus, *LORAWAN*,
https://www.proximus.be/en/id_cl_iot/companies-and-public-sector/solutions/connected-business/internet-of-things.html

[2] Wikipedia, *ZIGBEE*,
https://en.wikipedia.org/wiki/Zigbee