Haute Ecole ICHEC - ECAM - ISFSC

Designing an Internet of Things device to geolocate people outside a perimeter in the NeoFinder startup project frame.

Master's Thesis Presented by

Sam BERTRAND

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DESIGNING AN INTERNET OF THINGS DEVICE TO GEOLOCATE PEOPLE OUTSIDE A PERIMETER IN THE NEOFINDER STARTUP PROJECT FRAME.

Master's Thesis

Author

Sam Bertrand

Master student at ECAM Industrial Engineering Sciences with a computer science orientation

15027

15027@ecam.be

Supervision

ECAM

School supervisor: Ing. Clémence Flemal

CERDECAM

Technological supervisor: Dr Ir. Sébastien Combéfis

Entrepreneurial supervisor: Ms. Queenie Halsberghe

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SPECIAL CONTEXT

The Thesis took place from November 2019 until June 2020. This means that the Covid-19 pandemic, that hit Belgium in March 2020, influenced the outcome of the project.

The CERDECAM shut its doors down on the 16th of March 2020 and all the employees worked from home. I was able to retrieve all the hardware of the project and kept working from home.

Regrettably, the pandemic blocked the advancements of the project in two ways. There was no possible access to electronic equipment to measure the chip's consumption. During the end of the project's development there was a need to order a new LoRa chip and an Arduino. The arrival of this hardware was delayed due to the current state of the world, it did not arrive on time to be in the thesis.

The project was about to be finalized but given the circumstances the thesis is considered presentable in June 2020.

ABSTRACT

This master's thesis is related to the entrepreneurial project called NeoFinder. Currently, the number of Alzheimer cases is growing, and the number of caretakers remains the same. NeoFinder is a company project that uses IoT geolocation to allow a caretaker to locate where lost people are, on a map, if they go beyond a certain defined perimeter. NeoFinder develops a geolocation device to find a helpless dependent person, thanks to notifications sent to the web/phone app of the caretaker. The contribution of this master's thesis to the porject is the development of the IoT device, more specifically the electronics aspects. This work presents the design of a working prototype of the device. It is traceable after the device gets out of a set up perimeter. The device sends GPS information through the LoRa services of communication. That information will be forwarded to cloud services which send it to the caretaker. The second part of this thesis concerns every entrepreneurial aspect of the project. It describes the actions initiated for the development of the future company, from the Innoviris spin-off application to the trainings followed at the StartLab ICHEC.

1. TABLE OF CONTENTS

2. INTRODUCTION

NeoFinder is a company project that uses IoT geolocation. The goal is to offer a solution for companies and institutions that care about the well-being of their less autonomous customers or members. NeoFinder is a geolocation device that allows you to find a lost dependent person. This can apply to elderly people with dementia who may get lost as well as groups of young children (such as Scouts for example). Connecting to a simple web/phone app, a caretaker will be able to locate on a map where the lost person is if they leave a certain definable perimeter. The geolocation chip will be in a small container that can take an appropriate shape depending on the target customers, such as a bracelet, a badge or even other forms.

The idea first came to the team during the HackToStart challenge organized by the StartLab and the CERDECAM in March 2019. The Idea, having a geolocation device for people who are not comfortable with a smart phone, won the challenge primarily when focused on seniors. A party of students and project carriers came together in September 2019 to form a group of student entrepreneurs to carry out the project. Martin Degeldt and I both included this project into our school cursus. It was included in our Internship and our master's thesis. The goal of these two activities is to develop the company, mainly the technology of the project. The Internship was a preparation phase that took place from September to November 2019. The preparation consisted of a state of the art, a choice of technologies and entering the StartLab's program. The internship report can be found on Teams which is linked in the appendices.

The Thesis has two goals, the main goal is to develop the technology of the company and the second one is to develop the entrepreneurial side of the company. To have more information on this aspect of the project, a document was made and is attached in the appendices. This document focuses on the technological aspect. The technology developed in this thesis is the device itself and its communication platform. For the web app and the project's software, please refer to Martin Degeldt's thesis.

The project took place at the CERDECAM in the student entrepreneur program. The workplace was an open space with other workers. This created a work environment encouraging mutual help.

This thesis's organization was held by a Gantt chart, which was made in the beginning of the project. The technological Gantt summarizes what is explained in this thesis. A second Gantt was made for our entrepreneurial advancements. This one is explained in the entrepreneurial document. Link to the technological Gantt in the appendices.

After the exposition of the design brief, the current essay explains the work environment in which the thesis took place. After that, the technology choices followed by the development are described. Before concluding it discloses the improvements that can be made to the project.

3. DESIGN BRIEF

The objective of the working prototype of the connected bracelet is to be able to check, every fifteen minutes, if the subject is still in the defined area. If it is not in the area, the prototype must communicate its position for the next four hours unless it comes back into the defined area, the position will be accurate to the nearest meter.

The prototype must be autonomous for one week and rechargeable.

The working prototype must communicate with the IoT platform, getting an answer in less than one minute.

As for the creation of the spin-off, the objective is to complete the application form and follow the Startlab ICHEC entrepreneurial program.

Main steps:

- The prototype of the connected bracelet:
  - Confirming the choice of technology made during the internchip.
  - Choice of architecture and ordering of the appropriate chips.
  - Study of the operation and communication of these chips.
  - Choice of battery and monitoring system.
  - Design of the battery system.
  - Wiring of the working prototype on breadboard and microchip coding.
  - Implementation of the communication with the IoT platform.
  - Testing and validation of the prototype.
- Entrepreneurship:
  - Training and business creation work at Startlab ICHEC
  - Drafting of the grant application file for the creation of a spin-off.

4. CERDECAM & STARTLAB

CERDECAM

The CERDECAM is ECAM’s research and development unit. The team consists of a manager, a couple of researchers and four students completing their master’s thesis. The members of the institution are:

- Queenie Halsberghe: manager
- Sébastien d’Oreye: researcher
- Manoel Da Silva: researcher
- Fatima Nouhi: master’s thesis student entrepreneur
- Louis de Cockborne: master’s thesis student entrepreneur
- Martin Degeldt: master’s thesis student entrepreneur
- Sam Bertrand: master’s thesis student entrepreneur

Mr. Da Silva's project is to create a wireless charging station for medium power. Since February, he does not work at CERDECAM anymore. Mr. Da Silva was our technical advisor for the first part of the year.

Mr. d'Oreye's project’s goal is to create a computer tool to visualize the entourage of people with psychiatric problems, aiming at their reintegration into society.

Fatima Nouhi's thesis is on the implementation of a functionality for a surgical assistant robot.

Louis de Cockborne's thesis is working on the prototyping of his company's product.

Martin Degeldt’s thesis is in collaboration with this thesis. His goal is to develop the software side of our company’s product, the website application, the data base and the IoT management platform.

During the thesis, Mrs. Halsberghe is my supervisor and gives advice from an entrepreneurial point of view, while Mr. Da Silva and then Mr. Combéfis gives advice from a technical point of view.

The goals of CERDECAM in the large scope of ECAM's strategy are:

Applied research

Researchers are hired to work on research projects in collaboration with companies and universities.

Technological service to businesses

Some companies do not have the resources or the technical capacity to develop their own projects. CERDECAM can provide teachers or students doing their internship or thesis to be able to meet their demands.

Continuous education

CERDECAM offers continuous education for companies. Professors or researchers offer their expertise in specific fields such as MOD BUS, 3D printing or industrial communication. The training courses are currently all responses to specific company requests, so the courses are custom made. The aim in the future is to offer generic continuous education for any company.

Support for entrepreneurship and innovative projects

CERDECAM offers selected students the opportunity to become “entrepreneur students”. Selected students can then can slightly modify their courses to develop their business. The projects must meet a technological challenge.

The institution’s office is located on the upper floor of the “Vinci 1” building at ECAM. Researchers and interns work in an open space, which allows for good communication. Mrs. Halsberghe has her own office that is easily accessible to other members of the company.

On a day-to-day basis work was mostly done in the open space on Thursdays and Fridays from 9 am to 5 pm. Martin and I Sometimes had meetings at StartLab ICHEC. When Covid-19 locked down Belgium, work was done from home.

STARTLAB ICHEC

The ICHEC StartLab is a structure that aims to raise awareness and provide support in setting up a business for students and young graduates in Brussels. Its mission is to reveal, accompany and develop talented students who have a company project. To perform this mission every year, the StartLab opens for applications to allow the young project bearers to register. After a selection, a cohort is created and enters their program.

The program consists of two and a half years of formations toward the creation of a company. There is a check in every June to see if the project keeps going.

The goal of the internship that prepared this thesis was to enter the StartLab’s program. And it was achieved while starting in February the NeoFinder project entered the StartLab’s program.

The main actors running the StartLab are:

- Hélène Cochaux: project manager
- Nathalie Degroote: academic advisor
- Aurélie Mulowa: communication and community manager
- Xavier De Poorter: NeoFinder’s coach

All the details about the Start Lab’s curriculum and the entrepreneurial advancements can be found in the appendix.

5. TECHNOLOGIES

As mentioned in the design brief and the introduction, the thesis's goal is to develop a device that can get geolocation information. And It is going to transmit this information to an IoT reception platform. The device also must be able to measure fifteen minutes to get a new geolocation information. The bracelet also needs a battery.

The device needs to be able to do the following:

- Geolocation
- Communication
- Processing
- Be autonomous
- Receive IoT information from ma platform

This chapter explains the reason and the choices of each aspect mentioned as well as the technologies considered.

SPECIFICATIONS

To make the needed technology choices some constraints need to be placed.

The goal of the device is to be wearable, meaning it need to be as big as a watch. Chips and hardware must be chosen accordingly.

The systems, as said in the design brief need to be able to have a week's battery. To have the longest possible battery life the chosen hardware must consume the least energy possible.

The device must be able to send information through a network towards a web page and a phone application from anywhere in Belgium therefore good coverage is needed.

The data sent from the device towards the website must be secure as it is sensitive data.

GEOLOCATION

Geolocation is the center of the device's purpose. The system needs to be able to fit in a watch sized device, not to consume too much energy and to be precise. This point will first look into technologies considered then explain why GNSS (Global Navigation Satellite System) is the best option. For more information and an in-depth study of the matter, please refer the internship report (p.14) mentioned in the introduction

EXISTING SYSTEMS

The Global Navigation Satellite System (GNSS) employs a grid of satellites spread over a certain number of orbits in such a way that four satellites are always visible at any point on the globe. The device system will subsequently use triangulation to know exactly where it is in latitude, longitude and altitude. The main GNSS are GPS, Galileo, GLONASS and BeiDou, they all apply the identical principle but vary in number of satellites and orbits.

The advantage of the GNSS technology is that it can be employed anywhere on the globe, and that its precision can be up to the meter. The consumption of a GNSS chip depends on its activation time but on average it is 70mW.[4]

Global System for Mobile Communications (GSM) localization works through triangulation depending on the relay antennas to which the Sim card is connected. The antenna can know how far away from the tower the chip is thanks to a response time calculation system. By examining the information of several towers, the position can be defined precisely.[9]

The maximum accuracy is 90 meters under the best conditions and can lose precision very quickly if the GSM coverage is not perfect. The consumption of a GSM chip used for geolocation is 5mW.[9]

There are other existing geolocation systems, the four dominant ones are Wi-Fi, IP address, RFID, Loran-C.

Wi-Fi and IP geolocation systems consists of locating someone via their IP address when they are connected to a router. Some WI-FI triangulation is possible for a more accurate result.[10]

It is possible to locate RFID sensors with detectors at strategic locations.[2]

Loran-C is a geolocation system exploiting radio waves.

GNSS

GNSS is technology selected for this device. It was adopted for its ability to geolocate anywhere for a low energy cost and chip size. All these criteria are related to the application in which the device will be used. The only downside to this choice is that the device must be outdoors for the GPS to function.

The most relevant chips in term of consumption, size and ease of use were compared in a table available in the appendix, figure 7. The Ublox chip was selected because its consumption is small, its size is adequate, and it especially had an Upotronics development board. This board helps for development because it has integrated antenna and communication pins.

COMMUNICATION

Communication is required to send the geolocation information towards the web application. The communication must cope with certain constraints of design. The device needs to have a good network coverage, moderate consumption and a sufficient data rate. Those constraints come from the device's purpose explained in the introduction. Considering the application, the communication chip chosen must be small enough to fit in the device's desired size. It must have, on top of that, an encryption system to transfer information securely. For more information and an in-depth study of the matter, please refer the internship report (p.14) mentioned in the introduction

EXISTING COMMUNICATION SYSTEMS

Zigbee is a communication based on radio waves. It needs to maintain a point to point connection with no coverage, only beacons.

Bluetooth, like Zigbee is a point to point communication with no large-scale coverage.

Wi-Fi is similar to Bluetooth and Zigbee as it needs a beacon to function but there is coverage mostly in the cities. This is not a reliable possibility because coverage is still extremely small.

"Mobile internet" like 3 or 4G, has good coverage but its energy spending is bigger than manageable with our constraints. The biggest issue with this technology is that it is bound to a sim card which increases the complexity of the device.

LoRa follows the identical principle as GPRS but is reserved to "Internet of things". This technology is optimized for moderate consumption and the coverage is as good as 4G thanks to Proximus which, In Belgium owns LoRa. [6] This means there is a cost to constitute a business around this technology, but not nearly as expensive as a classic GPRS. LoRa moreover has an integrated cryptology system.

Sigfox looks like LoRa in many ways. It is developed by Engie at an European level. The coverage is almost the same.[7] The most considerable difference between the two is that Sigfox has a small data rate (100 bps).[8]

In the appendix, there is a comparative table in which you may see all the technologies cited and their specifications.

After working all year with LoRa, the technology is unperfect and it needs more documentation. It is constructed for business projects which makes finding information quite difficult. Considering that LoRa is the choice of technology because it surpasses Sigfox

.

MICROCONTROLLER

The microcontroller used in the device should have a low consumption and an adequate size. For more information and an in-depth study of the matter, please refer the internship report (p.14) mentioned in the introduction. The Pic by Microchip has a couple of good designs for this device's architecture, its competitor Texas Instrument also has good designs. The research stopped at a Pic because it was practiced during the Ecam's curriculum. The Pic24FJ128GB204 is the best microcontroller to use for this device. Information about the Pic chip can be found in the appendices.

BATTERY

The Battery is under two obligations: an appropriate size and a capacity to function for one weeks while checking every fifteen minutes if the device is in its zone. The device also needs available battery for tracking at any time.

A first calculation was performed during the internship. It was theoretical for a two-week period, and the calculation maintained some energy for the tracking. A battery that has a capacity of 500 mAh should hypothetically be enough for a two-week period. The calculations can be referred to in the internship report, which can be found in the project's Teams.

The goal of the thesis was to confirm these theoretical calculations. Unfortunately, In March 2020 the Covid-19 outbreak hit Belgium and it was not possible to do the battery measures. The way it would have been done was by measuring the consumption of the prototype's chips separately. Then computing them with the theoretical consumption of the Pic chip, it would have been exploited with and not the Arduino.

IOT

The goal of the IoT is to have a platform that can revive the information broadcast with LoRa and forward it to the web application's data base. Which can be found in Mr. Degeldt's thesis.

After research, the Proximus platform LoRa for Markers was chosen during the internship. It was selected for two reasons:

- Thanks to our partnership with Proximus, the platform which is costly but could be cheaper for the project.
- The platform is specific to LoRa and made for development.

SPECIFICATION CHANGES

Some changes had to be made to the constraints in place as they were too restrictive to have results in the given time period.

- The chosen microprocessor needs a library development for the two chips chosen. Since the goal is to develop a prototype, it was decided, even though it is not optimized, to use an Arduino for the development in this thesis. It was chosen because the working prototype would be unfinished if the libraries used in the chips needed to be developed as well.
- The LoRa for makers platform is not constructed for prototyping and does not offer proper development tools for personal creations. The platform is designed for business development. The most fundamental problem is that it needs a Mac address to connect a device to the platform. The three LoRA chips used during the thesis's development did not come with the MAC address information. To work around this issue, a second receptor was used. This receptor is connected to a computer and will forward the information sent by the device to the project's data base. Unfortunately, the device did not arrive on time to test the communication.

IN SHORT

To provide an overview of the device designed in this thesis here is a summary of the technologies used.

- A GNSS chip for geolocation: Chosen for its precision and coverage. May absorb a lot of power and is only available outdoors
- A LoRa chip for communication: Chosen for the small consumption and broad coverage.
- The Arduino to control the geolocation and communication chips: Worse than a Pic chip but made for development of a working prototype.
- A second receptor connected to internet for communication to the project's data base: LoRa for Makers is unfortunately unusable yet

6. DEVELOPPEMENT

PROTOTYPE

ARCHITECTURE

The code's objective is to obtain a position every quarter of an hour and send it to the IoT platform. The platform checks if the person is in its area previously set up and confirms back the status to the device. The device finally starts tracking or not depending on the platform's answer.

The following description is an explanation of the code's flowchart, which can be seen here under.

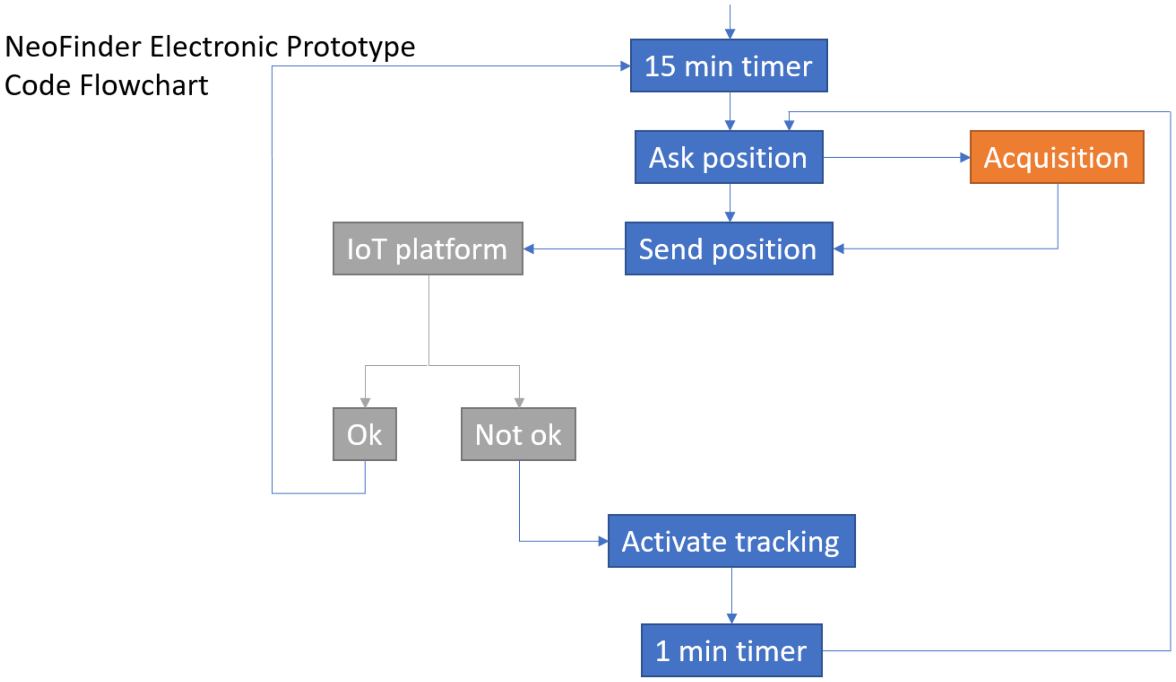

Figure 1 NeoFinder prototype: code flow chart

- 15 minutes timer: This section is timing 15 minutes while setting the other functionalities to sleep. It is constructed to save power. It was determined that one check every 15 minutes is enough for this application.
- Ask position: This section turns the GPS on.
- Acquisition: The GPS gets a location and conveys it via transmitter/receiver communication to the Arduino. After the acquisition the Geolocation chip is turned off.
- Send position: the Arduino sends the location obtained from the geolocation chip to the LoRa chip for transmission to the IoT platform, after turning it on.

- Receive position: The IoT platform receives and translates the information.
- Data base check: The information is cross checked with the data base.
- OK/Not OK: The IoT platform forwards information to the device saying if the coordinates sent are in or out of the zone set up. Refer to Martin Degeldt's thesis for this part in detail.
- Activate tracking: The tracking is activated and consists of every minute check for four hours instead of every 15 minutes.
- 1 min timer: simple timer that acts like the 15-minute timer but is shorter for tracking purposes.

WIRING

The physical device consists of the Arduino, two integrated circuits (geolocation and LoRa), two transistors to turn them on or off and two buttons to emulate the answer form the IoT platform. The image here under shows the project's wiring

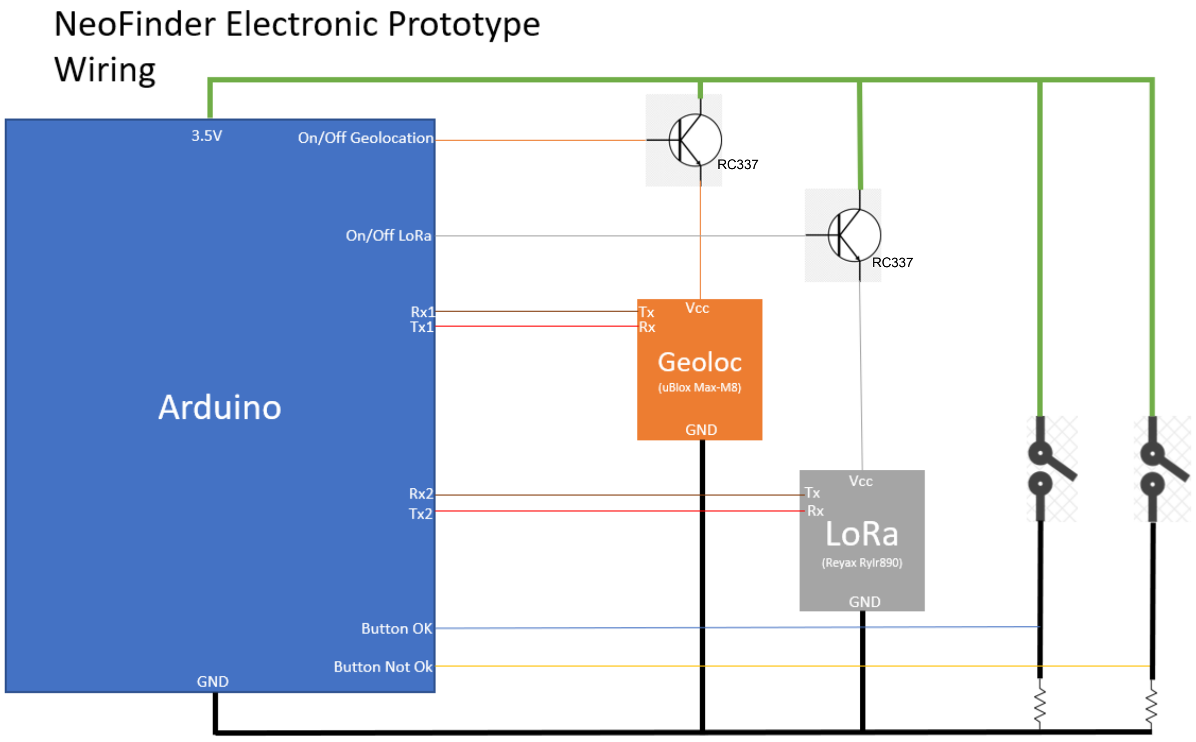

Figure 2 NeoFinder prototype: wiring

The Arduino includes ten wires. They function in pairs described here after:

- On/Off pins are two wires that manage the on and off set of the transistors who control the energy input of the chips.
- Rx/Tx 1 is the communication between the geolocation chip and the Arduino.
- Rx/Tx 2 is the communication between the LoRa chip and the Arduino.
- Button ok and not ok are analog pin to read if the button is pressed or not.
- 3.5V and GND are the alimentation wires for the whole circuit.

COMMUNICATION PROTOCOLS

Both the chips communicate with the UART protocol which enables direct communication between two devices. The data is communicated asynchronously thanks to a transceiver wire and a receiver wire. The data is sent in bytes.

The geolocation chip's sent bytes are translated by the TinyGPS++ library into usable functions. The functions can communicate the information the chip is able to get. `gps.altitude.value()` will give the chips altitude for example.

The LoRA chip is set up thanks to AT commands which are serial printed to the chip's receiver wire. When receiving information, the chip forwards it automatically on the UART transceiver wire.

CODE

The code produced for this application is readable on GitHub in the Arduino_Neofinder file. The code follows a classic Arduino architecture.

The first part is the instantiation that sets up all the variables needed for the code.

The second part is the setup. In this part, the pins are set up as in or output, the LoRa chip is configured and the Serial communications are started. There are three different serial communications: one for communication with the geolocation chip, one for communication with the LoRa chip and one to show message for demonstration and testing. The switcher variable is also set to one. The switcher represents the case tracker.

The third part is the loop code. The loop code is divided in states which represent part of the architecture. The switcher variable will maintain track of the case. Every case fulfils a specific role:

- Case 1: 15 minutes timer; this case will sleep all the external chips and time 15 minutes.
- Case 2: ask position; this case will turn the geolocation chip on.
- Case 3: wait position; this case will wait for the geolocation chip to obtain a position then write it down in variables.
- Case 4: send position; this case will turn on the LoRa chip and transmit the information received.
- Case 5: wait for LoRa's answer; this part will receive the information from the IoT platform with the decision to start tracking or not. In this application and via two buttons, one to tell the Arduino the chip is in the zone and the other to say it is not. If the tracking is unnecessary, the switcher will go back to case 1. In the other outcome it will continue to case 6.
- Case 6: activate tracking; this case will start timing a 4-hour tracking, while the person is out of the zone.
- Case 7: 1-minute timer; this case times 1 minute between acquisitions instead of case 1 when the device is tracking.

the code has been adapted for a presentation this means the third serial part is applied only to allow a visual aid of which case the code is in. The timers are also not set properly, this is to support a smooth demonstration where timing is not overly long.

GEOLOCATION

The chip used for geolocation is the Ublox Max-M8 set on an Upotronics board for development. References to the chip and its data sheet can be found in the appendices.

When powered, the chip searches for satellites. Using the TinyGPS++ library, it is possible to acquire the information transmitted from the chip via the UART protocol. Case 3 in the prototype's code displays how the library is used to get latitude, longitude and altitude details from the chip while waiting for it to receive the position.

The library will translate the information by parsing NMEA data streams provided by the GPS module. NMEA is a data format standardized by the marine. Each sentence is up to 80 characters long. [3] It is used in most GNSS chips to communication geolocation information. After including this library functions are offered to the code to use this parsed data.

COMMUNICATION

LoRa communication is allowed using the REYAX RYLR896. References to the chip and its data sheet can be found in the appendices. During the internship a chip was selected because it fit the size and had a small consumption. This chip was not used seeing as it did not function correctly. Later the Reyax chip was preferred because it is designed for Arduino development.

The Chip functions via AT commands over Transmitter/receiver. There is a set up phase in which the chip is configured to function and a communication phase. These are the elements to set up:

- IPR establishes the baud rate for communication.
- ADDRESS provides the device an address.
- NETWORKID choses a network id to use.
- MODE sets the device in sending or receiving mode.
- BAND chooses the RF frequency in which the communication will be allowed.
- PARAMETER supports three elements: the spreading factor, the bandwidth and the coding rate.

After configuration a communication will purely be used to send information as a string.

The goal was to connect the chip to the LoRa for Makers by Proximus IoT platform which, as explained in the technology point it was not possible, unfortunately.

To address this issue, a second Reyax chip was included. The second chip is also connected to an Arduino and functions as a receptor thanks to the reception code on GitHub. The Arduino is connected to a computer which will transmit information to project's data base. To enable this to function two codes were used. One for Arduino reception and a Python code for sending. Both can also be found on GitHub. The python code was made with the help of Mr. Degeldt.

The Arduino reception code can be found on GitHub as well. The variables are a data string and an id. The Chip is set up with a different mode than the sending chip, otherwise the setup is the same. The chip is in reception instead of sending mode. Once the chip receives information, it is sent to the serial output of the Arduino with the id.

The Python sending code uses the serial library to read the information forwarded by the Arduino. To acquire the information properly, a baud rate and the port need to be set up. The main code sends a json post to the platform. The json contains the details needed to update the devices status. To communicate the information securely the code firstly asks for a token from the platform with its name and password. The token sent as a header to the payload will authorize the information to be used by the data base.

The reception code needs to have the right id for a given device. The right id is necessary to identify it in the applications database. To do that a python script which transforms the address of the device is used. First, the configuration file is loaded to access the data base and retrieve the device's id for a given account. The code uses the safe_substitute function to change the device id to the appropriate one.

TESTING

The code evolved during the thesis's duration. The first tests were created to make the geolocation chip function. Figure 8, 9 and 10 show the way the geolocation's information was displayed. On GitHub the code named *UBlox_GNSS_Parse_Test* was used to figure the geolocation chip out. In this code the smart delay function was discovered. This function is also used in the device's code and very important. Its purpose is to wait until the information sent from the geolocation chip was received before continuing the code. A way to wait a certain time is also added to the function.

In the main code was tested thanks to serial prints in the code. These serial prints become the presentation code later. Figure 11, 12 and 13 shows the code's main functions. It shows which case the code in on and the relevant variables that go with it.

As said before the communication chip's testing could not be done yet.

The working prototype's state can be seen in a picture here under

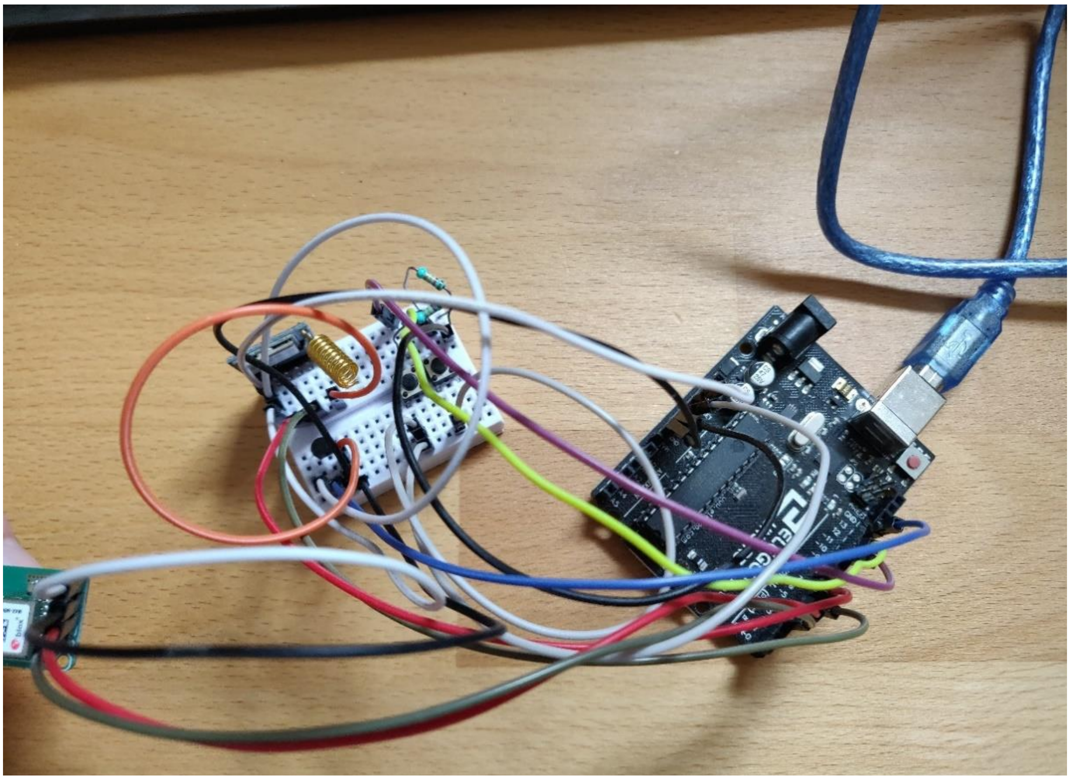

Figure 3 NeoFinder prototype

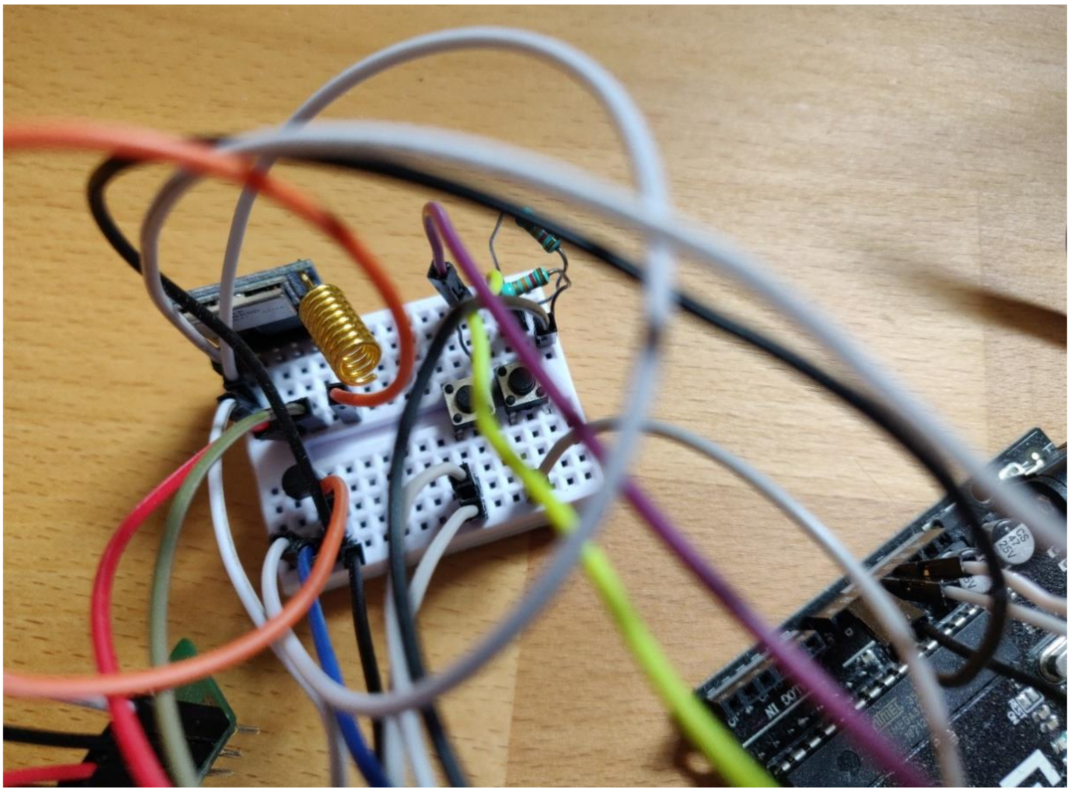

Figure 4 NeoFinder prototype: zoom on the board

For testing purposes, the Ublox's transistor was removed. Otherwise the working prototype follows the wiring set in the wiring figure.

To improve testing, a testing protocol can be set in place. This should evaluate every aspect of the prototype separately and evaluate the whole product in integrated tests.

Global testing can be implemented to test real-life situations once the prototype is completed. Hereunder is a list of scenarios that absolutely must be tested to confirm proper functioning:

- Test the prototype functions properly:
  - Move around inside the zone for the whole battery life and check that the tracking doesn't start.
  - Cross out of the zone and be sure the tracking starts after 15 minutes maximum.
  - The battery is correctly managed and when it is low it shows.
- Test timings:
  - Time the time between checks of position to be sure it's 15 minutes.
  - Time the time between checks of position on tracking to be sure it's 1 minute.
  - Time the tracking to be sure it lasts 4 hours.
- Test communication between the LoRa reception chip and the platform:
  - Verify if the platform receives information.
  - Check what information the platform gets and its accuracy.
  - Check that the platform can tell if the device is in the zone or not.
- Test communication between LoRa Chips:
  - Test if information is transmitted between the chips.
  - Check if this information is accurate.
  - Test how far apart the two chips can be (they should not have a limit).
- Test communication between the geolocation chip and the LoRa chip:
  - Verify the information acquired by the geolocation chip is accurate.
  - Verify if this information is properly communicated to the LoRa chip.
  - Check that movement is accurate.

Performance testing additionally also be done. This is the way these tests will be conducted to measure performance accurately:

- Battery life:
    - Measure how much battery is left when it requests a recharge. To be sure the battery possesses enough capacity left for tracking at any time.
    - Leave the device in tracking mode to see how long battery lasts on tracking.
    - Leave the device in position check mode to see how long it lasts.
- Signal quality:
    - Measure how the number of satellites varies over time in tracking mode and checking mode.
    - Measure the LoRa signal quality in diverse locations.
- Precision:
    - Walk around the perimeter to determine the accuracy of the device and how precise we can go in establishing the zones.
- Ease of use and comfort:
    - Make a study on elderly people to know if the design fits and is usable.
    - Check with institutions if the use of the device is as easy as intended.
- Consumption of each element:
    - Check the consumption of each element separately to know where improvements are possible.

7. PERSPECTIVES

To finalize the prototyping three elements are needs:

- Set up the new communication Arduino which receives the information and forwards it to the application.
- Test the communication between the two LoRa chips.
- Change the timing chosen for presentation to the temporal arrangement selected for functioning (15 minutes checks and 4 hours of tracking). These timings can change to fit the clients demands via variables in the code.

IMPROVEMENTS

The project is still in its development phase. Many improvements can be introduced in the future of this project.

The communication between the two LoRa chips could not be tested. Theoretically, the codes should communicate properly. But the Covid-19 outbreak prevented the second LoRa chip ordered to arrive on time for this thesis as said before.

Battery calculations were only made theoretically. A measure of consumption in real working conditions can be made. It is already possible to measure the consumption of the geolocation and LoRa chip.

Replacing the correspondence between two LoRa chips by communication with the LoRa for makers platform represents an improvement that could further be made.

ADDITIONS

Some minor and major additions can be considered to do on this working prototype in the future to better match the company's product idea.

Use a microchip instead of the Arduino and develop the adequate libraries for the use of the chosen chips. This would enable the creation of a considerably smaller prototype.

As said in the entrepreneurial appendix the goal of the company shifted these last weeks. The new goal is to develop a device that can geolocate indoors as much as outdoors. To do this LoRa technology may be used with beacons. These beacons are able to triangulate a chip's positioning thanks to signal strength and time of arrival. More information can be retrieved in this thesis.[1]

8. CONCLUSION

To conclude this thesis, we have seen that the device can geolocate and communicate with the web application. The project's current state is not what was predicted during the internship or when making the design brief. Choosing to develop on an Arduino was mandatory as the microchip did not include the adequate libraries. Development of these libraries would be out of this thesis's scope. Nonetheless for future projects, it is important to check libraries and available development tools before adopting a technology.

The end of the project with battery estimations and testing the reception code could not be done because of the actual pandemic which is quite unfortunate.

The separation between the company's vision and the thesis's design brief increased over the months of the project. This renders what was done in this thesis less useful than expected for the company. If another project of this type is initiated for the company, it should have a more flexible design brief and day-to-day advancement.

This thesis allowed me to acquire many entrepreneurial skills as well as ability on how to research and design an electronic, IoT focused, project. It's fascinating to discover how a project, especially one linked to the creation of a company, evolves over time. With all its uncertainties, it proves how an engineer must learn to adapt and find solution to any kind of problem.

To conclude, my personal goal for the future is to keep working on the company and follow the StartLab's cursus. I also intend to spend next year at ICHEC to develop my marketing skills which could assist the company.

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10. APPENDICES

Project Links and online data

GitHub

This GitHub repository contains every code mentioned in the thesis.

https://github.com/Sambertrand/NeofinderDemonstartor

Teams

The following link redirects to the teams of the NeoFinder project. If you don't have access send a mail to sam.bertrand@gmail.com and access will be given.

https://teams.microsoft.com/l/team/19%3a57d7ec4568c449a0a891f3a145271507%40thread.skype/conversations?groupId=b93d567e-8190-417a-b2da-f6e7512b5021&tenantId=e3d6f09e-9ba9-4a36-ad75-d9039be4fe29

Products references and data sheets

Electronics chip: PIC24FJ128GB204
https://www.microchip.com/wwwproducts/en/PIC24FJ128GB204

LoRa for makers platform:
https://proximusapi.enco.io/asset/lora4maker/documentation

Geolocation chip: Ublox Max-M8
https://www.u-blox.com/en/product/max-m8-series puce
geolocation chip development board : uBLOX MAX-M8C Pico Breakout with Chip Antenna

https://store.uputronics.com/index.php?route=product/product&path=64&product_id=72

LoRa communication chip : reyar ryrl896 data sheet and communication sheet
https://fccid.io/QLYRYLR896/User-Manual/Manual-3990611

http://reyax.com/wp-content/uploads/2018/01/REYAX-Lora-AT-COMMAND-GUIDE_EN.pdf

Arduino library for geolocation – Arduino communication: tiny GPS ++ library

http://arduiniana.org/libraries/tinygpsplus/

Other Appendices

The two following images are the Gantt charts that organized the project.

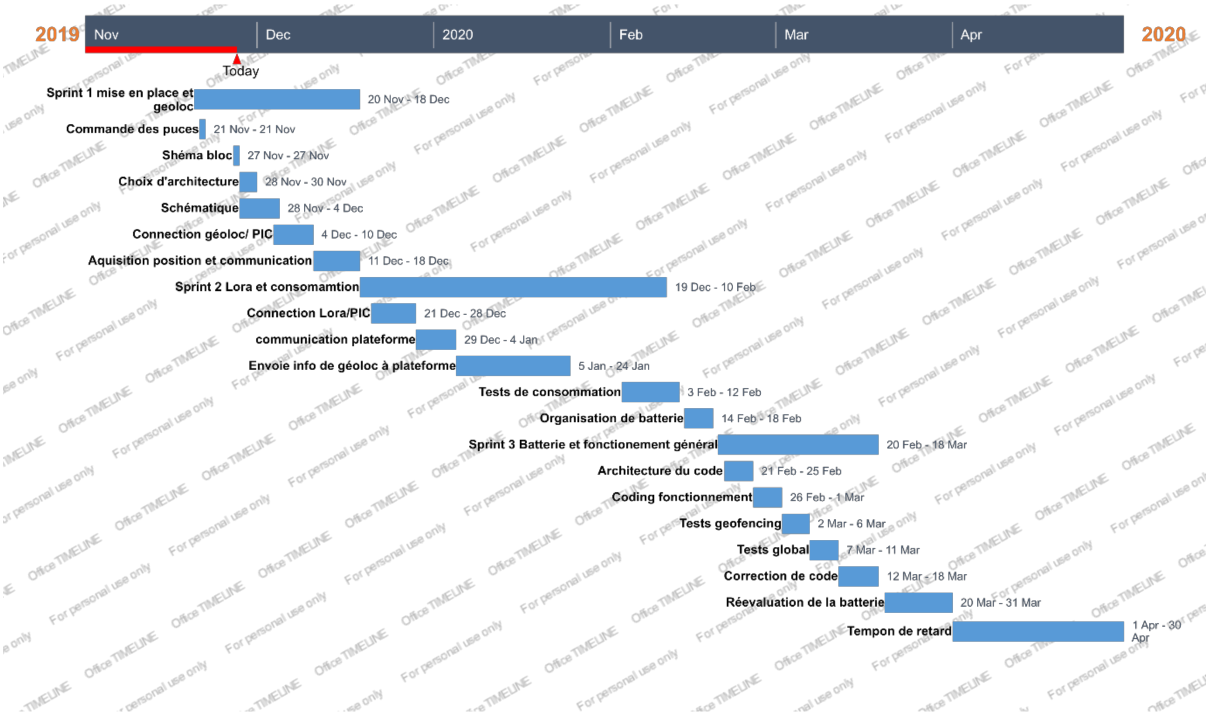

Figure 4 Technical Gantt chart

The following table compares the different communication systems considered:

Paramètres	ZigBee	Bluetooth	Bluetooth LE	Wifi	GPRS	LoRa	Sigfox
Bande de fréquences	868/915 MHz et 2.4GHz	2.4GHz	2.4GHz	2.4GHz	900-1800 MHz	869/915 MHz	868/915 MHz
Bande passante	2 MHZ	1 MHz	1 MHz	22 MHz	200 kHz	<500kHz	
Consommation (Emission)	40 mW	215 mW	10 mW	835 mW	560 mW	100 mW	122 mW
Vitesse de donnés	20 40 et 250 kbps	1-3 Mbps	1 Mbps	150 Mbps	170 kbps	290bps - 50kbps	100 bps
Latences	20 ms	100 ms	6 ms	50 ms	< 1s	-	-
Portée	100m	10-50m	10m	100m	1 - 10 km	2-5 km en zone urbaine	10km
Cout	Bas	Bas	Bas	Haut	Moyen	Bon marché	Bon marché
Possibilités de sécurité	AES-128	AES-128 ou 64	AES-128 ou 64	AES-128		AES-128	AES-128
Limitations	Convient peu pour la ville	Portée très courte	Portée très courte	Haute consommation et temps de connexion	Haute consommation	Data rate, message capacity	Data rate
Déploiement	Réseau local	Réseau local	Réseau local	Hot-Spot disponible	Réseau déployé mondialement	Réseau déployé	Réseau déployé

Information from bibliography 5.

COMPARATIF DES PUCES GNSS

Chips	L70B-M39	L76-M33	L86-M33	ADAFRUIT 1059	A2200-A	TESEO-LIV3R	NV08C-CSM	UBLOX MAX-M8
Lien	https://befr.rs-online.com/web/p/gps-chips-gps-modules/1709178/	https://befr.rs-online.com/web/p/gps-chips-gps-modules/1709179/	https://befr.rs-online.com/web/p/gps-chips-gps-modules/1709180/	https://befr.rs-online.com/web/p/gps-chips-gps-modules/9054637/	https://be.farnell.com/fr-BE/maestro-wireless-solutions/a2200a/module-gps-rom-based-mini-outline/dp/2281694	https://be.farnell.com/fr-BE/stmicroelectronics/teseo-liv3r/module-tiny-rom-gnss-lcc-18/dp/3132401	https://be.farnell.com/fr-BE/nvs-technologies/nv08c-csm/receiver-sat-navigation-smt/dp/1902504	https://store.uputronics.com/index.php?route=product/product&product_id=71
Prix €	16,628	18,8644	20,66	34,22	15,75	13,17	51,09	23,43
Taille (mm)	10,1x9,7x2,5	10.1 × 9.7 ×2.5	18.4 x 18.4 x 4.0	30.5x 5,9	14 x 10.2 x 2.5	10.1 × 9.7 ×2.5	26,6x20x3	9.6x14.0x1.95
Tension (V)	3,3	3,3	3,3	3,3	3,3	3,3	3,3	3,3
Consommation acquisition	18mA	21mA	26mA	20mA	69mA	70mA	55mA	26mA
Consommation idle	200uA	500uA	1mA		25uA	17uA	100uA	
Antenne	Non	Non	Oui	Oui	Non	Non	Non	Oui
Channels	66/22	99/33	99/33	66/22	48/16		32/32	
Commentaire				Portable		Geofencing	Galileo	Galiléo, Geofencing

Figure 5 Comparative table of GNSS chips

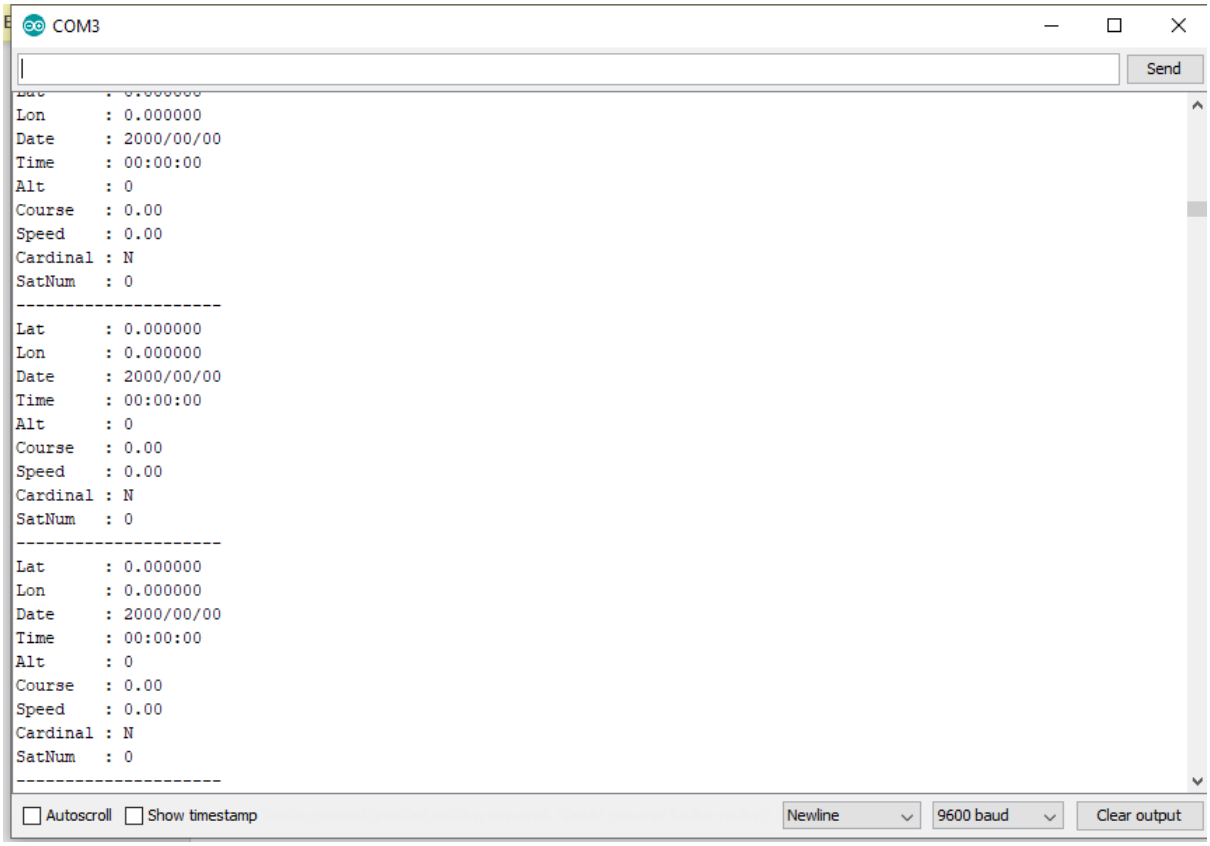

Figure 6 Geolocation chip debugging: no information

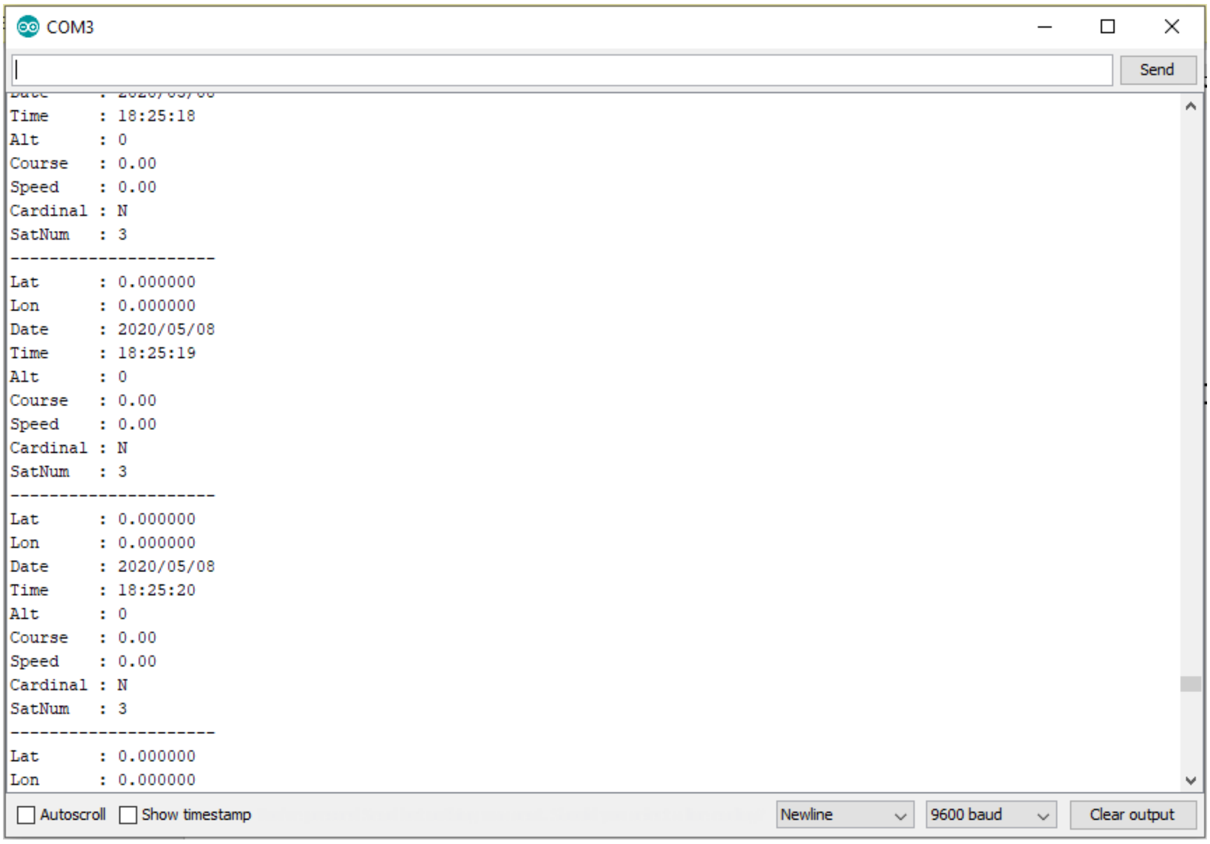

Figure 7 Geolocation chip debugging: First satellites found

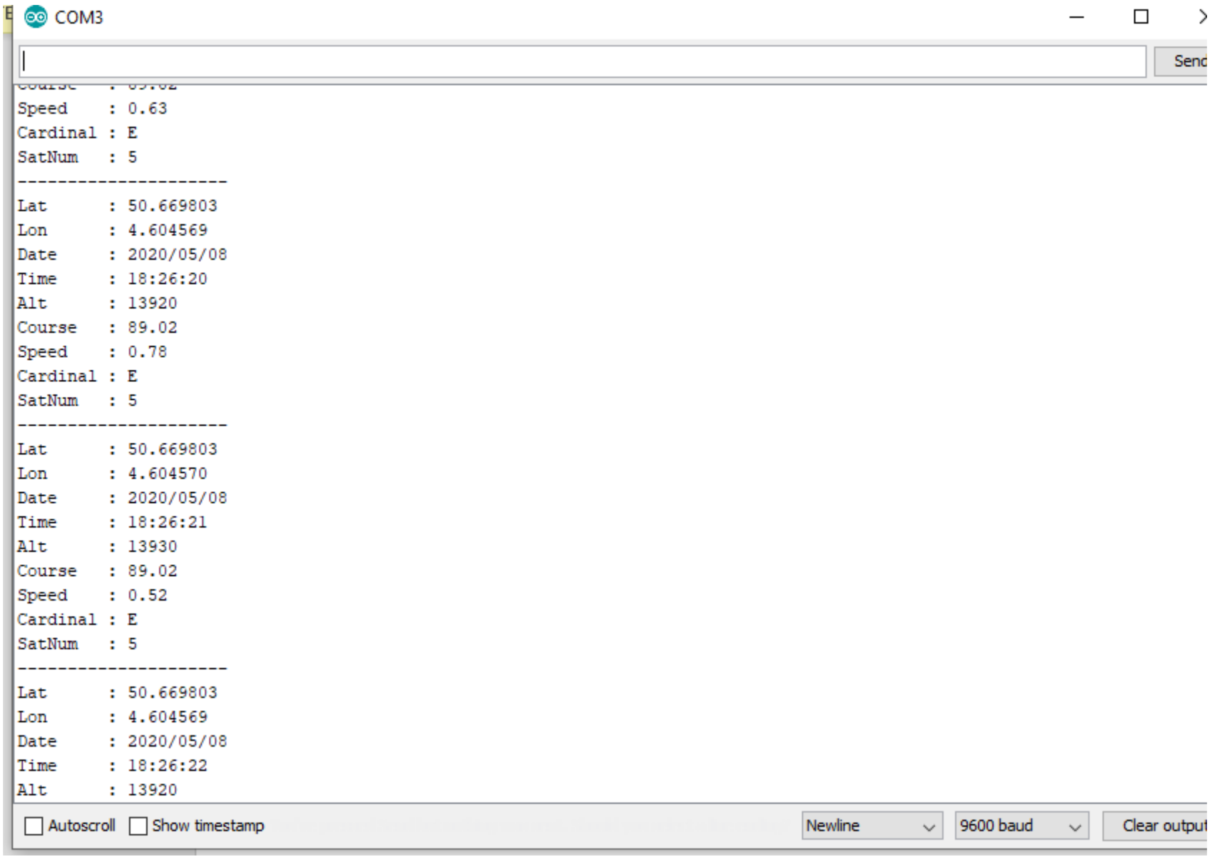

Figure 8 Geolocation chip debugging: position found

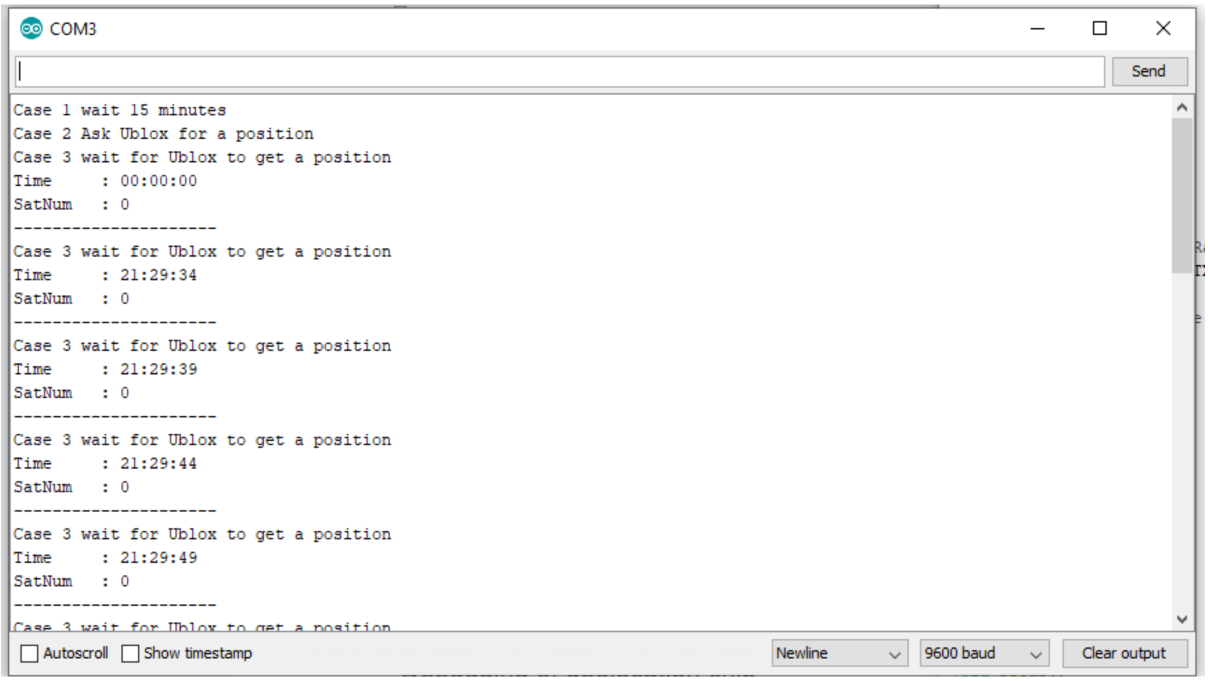

Figure 9 code testing: firsts cases

```
---------------------
Case 3 wait for Ublox to get a position
Time     : 21:31:17
SatNum   : 5
---------------------
Lat : 50.67
Long : 4.61
Alt : 15920.00
Case 4 Send position via LorA
message sent
Case 5 Wait for LoRa's awnser
00Case 5 Wait for LoRa's awnser
00Case 5 Wait for LoRa's awnser
```

Figure 10 code testing: Geolocation found

```
00Case 5 Wait for LoRa's awnser
10OK the person is in the zone let's start over
Case 1 wait 15 minutes
```

Figure 11 code testing: LoRa is ok

```
00Case 5 Wait for LoRa's awnser
01NOT OK the person is not the zone let's start tracking!
Case 6 tracking starts for 4 hours
tracking count = 60
Case 7 we wait only a minute for the next aquisition
Case 2 Ask Ublox for a position
Case 3 wait for Ublox to get a position
Time     : 21:37:32
SatNum   : 7
---------------------
Lat : 50.67
Long : 4.60
Alt : 14680.00
Case 4 Send position via LorA
message sent
Case 5 Wait for LoRa's awnser
```

Figure 12: code testing: LoRa is not ok

Entrepreneurial report

Haute Ecole ICHEC - ECAM - ISFSC

NeoFinder startup entrepreneurial Report

Master's Thesis Presented by

Sam BERTRAND & Martin DEGELDT

For graduation in

Master's degree in Industrial Engineering Sciences with a computer science orientation

Academic year 2019-2020

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We would like to thank Houda Hannouni for her participation in the teamwork and the energy she brings to the project.

We would also like to thank Quentin Vandenborre for managing the team and his strategic work during the decision-making process.

Many thanks to Cyril Le Ray, who oversees the mechanical design, for his help with the project.

Thanks to Raissa Kasenga Mania for her help with the work and her good mood.

We would also like to acknowledge the efforts of Mr. Combéfis and Ms. Flémal for their supervision and technical assistance to the project.

We would like to express our thanks to the whole support team of the StartLab ICHEC, and especially to Hélène Chochaux for the incredible work behind the incubator, Aurélie Mulowa for maintaining us informed of the latest news from the community and Xavier de Poorter, our coach, who guides us throughout our adventure.

Finally, thank you to all the ICHEC StartLab supporters for the atmosphere during the training sessions!

CHANGES DUE TO COVID-19

In the context of the coronavirus crisis, the Belgian government established social distancing. The measures implemented in hospitals and retirement homes limit contact with medical staff and carers on the front line.

These people are defending the lives of our forefathers, and we have chosen not to disturb them. Our marketing contacts had to stop prematurely due to this issue. We moved forward with the information we had gathered beforehand. Strategic questions were proposed to best respond to this crisis.

This break also made it possible to develop the idea of the pivot.

Because of the social distancing, the calendar of the last Startlab ICHEC's training sessions have been modified and these are given remotely until further notice.

ABSTRACT

This document is related to the NeoFinder entrepreneurial project. Cases of Alzeimer's disease are increasing every year and the number of caregivers remains the same. In view of this situation, the idea of NeoFinder was born. The company's goal is to create a geolocation bracelet connected via IoT (Internet of Things) to a web and mobile platform. This application will allow the staff of establishments caring for demented or disoriented people to be notified when these individuals leave a predefined area. The purpose of this document is to share the entrepreneurial progress of the project, as opposed to the master’s thesis of Martin Degeldt and Sam Bertrand to whom this document is linked. The report communicates the advancement achieved within the StartLab ICHEC, in terms of funding applications and the concrete evolution of the idea in recent months. The progress made at the StartLab is divided into "winning paths", training and coaching. During the academic year 2019/2020 two demands for funding have been submitted, the application at Innoviris Brussels and the application for access to the Albert Vanhée grant.

TABLE OF CONTENTS

INTRODUCTION

On Friday, March 15th, 2019, the first edition of Hack2Start, a hackathon organized by the StartLab ICHEC and the ECAM research and development center (CERDECAM) took place. The case study was relatively simple:

"How can we find lost individuals, such as children in a supermarket, joggers in a park and elderly persons leaving their retirement home. The aim is neither to track them nor to clutter them up. The solution is intended to be independent of a mobile phone."

After 3 days of reflection, debates and calculations, a jury decided on the winning idea of the competition: a specialized solution for retirement homes, allowing to find residents who get lost. This solution would be proposed directly to the homes, so that they could set up the infrastructure necessary for the safety of their residents.

Wishing to follow up on the ideas put forward during the hackathon, CERDECAM proposed to the weekend's participants to pursue the adventure. ECAM students who accepted would be considered as student entrepreneurs. Three of us answered this call: Sam Bertrand, Houda Hannouni and Martin Degeldt.

In September 2019 we were joined by 3 other members: Cyril Le Ray, Raissa Kasenga and Quentin Vandenborre.

The objective of the project is, on the one hand, to develop the entrepreneurial part of the idea and, on the other hand, to realize the technical part of the solution.

We are carrying out this work after 5 years at ECAM. The following work focuses on the entrepreneurial proportion of the project.

We collaborated throughout the year to give life to our project. We organized ourselves and divided the tasks to move forward efficiently, while being a group of several people.

First of all, we will begin by setting the context of our entrepreneurial journey, describing our objectives. We will then review the various actions we have undertaken to move our project forward, as well as the training and coaching we have undergone. Finally, we will discuss the state of the project before concluding.

CONTEXT

ENTREPRENEURIAL CONTEXT

Six members are embarking on the entrepreneurial project in September 2019. This requires a commitment from each one for communication and the functioning of the venture. The first step of the project was to know the involvement of everyone. This was done to divide the tasks as best as possible according to each person's abilities and time. Meetings were scheduled as frequently as possible to be informed of the progress of each person in the various activities that the project entails. The activities consist of the technical progress, the follow-up of the trainings and the actions which result from them.

In order to organize the work in the best possible way, each member of the project has a role to play. This role is a supervisory responsibility. The job is carried out by all on all elements of the project but the person in charge oversees organizing the work in this area. Martin Degeldt and Sam Bertrand are responsible for the technical side. Houda Hannouni is accountable for marketing with Cyril Le Ray and Raissa Kasenga Mania as primary helpers. Quentin Vandenborre is responsible for management.

Meeting roles have been created to allow for a smooth workflow. Sam Bertrand oversees time and is the meeting secretary. He takes notes, publishes CVs and refocuses the subject when necessary. Notes are published on Teams in the meeting file. Quentin Vandenborre oversees animation; he is the one who solicits the people who speak rarely to make sure we have the opinion of all the participants of the meeting. Houda Hannouni is an ambient maker, i.e. she pays attention to team cohesion and resolves disputes within the group.

The project is supervised so that it can be carried out successfully. Queenie Halsberghe oversees CERDECAM, she helps in her areas of expertise, especially with grant applications. Xavier De Poorter is our coach assigned by the StartLab. He helps with his expertise and his extensive knowledge in the field of entrepreneurship. Hélène Cochaux and Aurélie Mulowa, the StartLab staff, are of considerable help in terms of networking and organizing training.

For the organization of communications, tools have been put in place. The primary means of communication is Teams, Microsoft's professional platform. This platform makes it possible to organize the work via a KANBAN, a file manager and a calendar. Messenger by Facebook is employed for day-to-day communication. Communication with peers is mainly via e-mail. The Wikipreneur platform is utilized for the StartLab.[2]

OBJECTIVES

The purposes of the entrepreneurial work to carry out this project are multiple and different for each member. Hereunder are described the objectives of the team. We can identify three core objectives:

- A business creation plan

This is the general aim of entrepreneurial work. This goal includes various sub-objectives. They can be divided into three dominant categories: Management objectives, marketing objectives and technical objectives. The list of all the steps is provided in the appendix "Winning path".

- A learning purpose

As students, the objective is to acquire knowledge and skills valuable in the professional world.

This project has expanded our field of learning. It consists of training courses, coaching sessions, reflections and questioning, but also reviews and retrospectives on successful and unsuccessful actions.

- A fundraising objective

Fundraising is necessary in order to achieve the technical goals, as well as to make the project sustainable. CERDECAM explicitly asked to apply for the Innoviris Spin-off grant, which was the first objective of this category.

JOURNEY

WINNING PATH

The "winning path" is a tool provided by the StartLab ICHEC. This tool allows you to list the actions to be taken to develop an idea for a solution or service into a company.

These actions are divided into different stages. Each step has been specified in the Kanban backlogs. These backlogs are then divided into two-week sprints.

At the beginning of each sprint, the tasks are separated. This method has been followed up to containment. The list of tasks is present in the appendix.

These actions were our daily business routine. All these tasks have been documented and are available on the Teams.

The first section of tasks allowed us to examine the motivations and involvement of the team members. This brought the team together and helped to identify the objectives of each member for the experience.

The second sprint made it possible to determine the desirability of the project. This section allowed the formulation of the problem that the solution could be expected to solve, the differentiation and a value proposition of the project. During the second section, a study of the competitors was also carried out. It is during this sprint that the societal impact of the project began to evolve. It comes to be one of the deep motivations to introduce the service to market.

The third section determined the feasibility of the project. Tools were completed such as the Lean canvas, the Value Business Model Canvas (BMC) and the Riskiest Assumption Test (RAT).

At the end of the third sprint, the market study began. Calls to residences were made. This made it possible to identify the usefulness of the solution. The value proposition that was offered was not sufficient but important enough to arouse the interest of the interlocutors.

An idea for a pivot or an increase in the value proposition was discussed. Based on the first feedbacks of the market research, the idea of geolocation also inside the buildings appeared.

The fourth sprint established the viability of the project. In this section, a creation equation was quantified. After some assumptions, this creation equation allowed to confirm the viability of the model.

It was approximately after the fourth section that the work began to encounter difficulties due to COVID-19.

In containment, a pitch was produced and filmed. It was published within the ICHEC StartLab community and was correctly received.

Work on the choice of technology for the pivot idea was also carried out during the confinement period. Subsequently, a strategic reflection was conducted to find out the position of the future company on various points.

This represents our progress from February to May 2020.

FORMATIONS

Beginning in February 2020, the StartLab ICHEC training courses have enabled the team to grasp the basics of entrepreneurship. The training is divided into workshops that take place between February and May 2020. You can find the training courses in the appendices.

Below are detailed all the trainings and their contents in short. The complete notes composed during the trainings are available on the Teams.

Appropriating the Lean canvas (positioning on its market) took place on February 8, 2020. A first introduction to the Lean canvas took place. The team was capable to start filling it out to establish the NeoFinder value proposition.

"Organizing the management of my project" (managing an entrepreneurial project) took place on February 11, 2020. Employing the agile method to work as a team like a KANBAN and iterative evolution is important. Allocating tasks and structuring meetings makes them more efficient.

"Establishing its creation equation" (finance) took place on February 18, 2020. The creation equation is theoretical and modular, so you should not hesitate to modify it to evaluate hypotheses. There are three ways to set a cost:

- By cost.
- By competition.
- By the value estimated by the customer.

One should not hesitate to put a high product price to stay on course even if it means going down in price for the first customers.

The "Appropriation of the Lean canvas (continued)" (positioning in its market) took place on March 3, 2020. An introduction to the RAT ("Riskiest Assumption Test") was shared and the Tam Sam Som rules were explained and understood.

The meeting "Increasing the positive societal impact of my project" (co-development) took place on March 7, 2020. The purpose of the training was to explain and implement the societal problem tree. This helps to identify the societal impact of the project.

The training session "Making my project known (communication)" took place on March 10, 2020. Corporate identity is essential to establish the vision, values, emotional and functional benefits and brand attributes.

The following formations had to be adapted to the confinement following the Covid-19.

"The basics of intellectual property rights" (legal) helped to understand what judicial choices to make when setting up a company.

"Challenging my hypotheses" (testing your market) took place online on 21 and 28 March 2020. It is crucial to segment the customers surveyed. The customer represents the center of the project, if he doesn't like it, he won't buy.

"Pitching my project with confidence (communication) " took place online in early April 2020. In order to pit your project correctly, you must keep in mind the expectations of the public. The training also insisted on repetition so that the pitch statement becomes automatic.

"Retrospective on the pitch (co-development)" has been moved to September.

"Understanding my financial needs (finance)" took place online on April 25, 2020. The theme of the training was building a budget and what tools to use to do so. Fixed costs should be limited for more flexibility on how to use the budget.

The training session "Putting in place your first management tools" (finance) was moved to September.

"Choosing my legal structure" (legal) took place online on April 28, 2020. This training focused on the concrete steps of setting up a business at the legal level. It is extremely crucial for all the legal steps of commencing a business to construct a financial plan that makes sense.

"Me in your place & evaluation" (co-development) was moved to September.

COACHING

Coaching meetings with Xavier De Poorter were held every month since the start of the StartLab in February. He helps in the creation of the project and adds an external and professional vision. Xavier De Poorter possesses a degree in commercial engineering. He is the founder of ICHEC-PME and has spent his entire career in the world of entrepreneurial activity. And is reliable to help the realization of the project.

A monthly coaching meeting was held to share the progress of NeoFinder and get feedback from Mr. De Poorter. The reports of the gatherings are readable in full on Teams.

The first meeting took place on January 28th. After a brief overview and presentation of the project, the basics of NeoFinder were set up and the upcoming goals were discussed.

On February 21st, the second coaching meeting took place. The session allowed to assign roles and functions while clarifying personal and global objectives. An in-depth questioning of the idea helped to clearly define the project. The current objective was defined: analyse the market.

The meeting of 27/03 took place remotely following the isolation due to Covid-19. We shared the first results of our market study. The subject of the evolution of the project was discussed. The new goal is to take the time to continue to develop the technology to be able to geolocate inside as well as outside. The team's work over the next month will be to clearly define this pivot.

The meeting of April 24th also took place remotely. The meeting started by sharing the choice of technology for indoor geolocation as well as the general strategy choosing for the company. The conclusion reached was that, in order to progress in the creation of the company, it is necessary to try to find the first customer and the partner to develop the technology.

The last meeting before the end of this year's trainings will take place on May 29th.

GRANT RESEARCH

This paragraph details the application process for the two grants for which we have applied: the SPIN-OFF grant from Innoviris and the Albert Vanhee grant from the Foundation for Future Generations.

INNOVIRIS

The SPIN-OFF program supports the creation of new companies in the Brussels-Capital Region in order to develop economic use of the results of scientific research. It allows the financing of projects with the following objectives:

- To finalize the development of an innovative product, process or service based on results acquired during prior research;
- To explore the conditions for the industrial and commercial exploitation of the results obtained with as goal the creation of a new economic activity in the Brussels-Capital Region.

The projects financed must still present experimental development issues at the time of their start-up. They must have a favorable impact on the economy, employment and the environment of the Brussels-Capital Region.[3]

As part of the application of this grant, a search for sponsors has begun. In addition to the StartLab ICHEC, which is helping the project from a marketing point of view, Proximus has agreed to aid us with the technical aspects, as they are the operators of the LoRaWAN network.

A description of NeoFinder has been written. It covers the origin of the project and its evolution.

A two-year budget was also drawn up. This includes an engineer working on the development of the project and the equipment it needs.

This research duty was planned over the two years and divided into Work Packages (WP), either for the technical or for the creation of the company.

Work on the potential for realization and the valorization strategy was carried out. This allowed to understand the market in which the project will evolve and how it will fit into this market.

The objective of the application of this subsidy is multiple. This is the first work that the team has done collectively. It allowed the different members of the team to be coordinated and create group cohesion. On the other hand, it enabled us to answer many questions left unanswered, mainly those concerning market demand. Ultimately, if the idea was promoted, CERDECAM could have hired an engineer to work on the design of the project.

Regrettably, the application was not selected, as NeoFinder was is not a research project in the sense of Innoviris.

ALBERT VANHEE

In 2019, the Foundation for Future Generations initiated a new program to support student-entrepreneurs who develop a product, service or technology that produces a positive societal impact.[1]

Technical innovation must include a beneficial impact on at least two dimensions of sustainable development - People, Planet, Prosperity, Participation.

- **Planet**: the impact on the planet, its biodiversity, its climate and its natural resources (e.g. dynamic waste management, pollution reduction, rational use of space, resources, energy, etc.).
- **People**: the impact on the well-being and equity of human beings, whether here or elsewhere (e.g. strengthening social ties, health, solidarity, cohabitation, contribution to skills and knowledge, etc.).
- **Prosperity**: the economic impact and effective management of the initiative (e.g. promoting autonomy and transparency, good financial management of available means, the initiative contributes to the prosperity of society, develops an alternative economic model, etc.).
- **Participation**: good governance and stakeholder involvement (e.g. fostering democratic functioning, new partnerships, co-management, peaceful conflict resolution, etc.).

In order to carry out the application of this grant, the project description was taken from the SPIN-OFF grant. The societal issues to which the product responds have been included.

The Foundation for Future Generations asked about the progress and future prospects of the project. This summarized the work completed on the technical side and a marketing strategy.

Next, the prototyping plan was described. It includes a budget for the creation of prototypes and the various elements for their successful completion.

Finally, the positive and negative societal impacts were described, explaining what effect our solution would have on the various societal dimensions.

This grant would allow, on the one hand, to make progress on the design of a prototype and, on the other hand, to create initial commercial contacts for the creation of the final solution.

The idea was awarded the grant, and we received €5,000 to continue developing the prototype, which we will be apt to do at CERDECAM.

DISCUSSION

RÉSULTS

This document was composed in May 2020 and the project started in September 2019. During this period the following tasks were accomplished:

- The ICHEC StartLab application form was completed, and the project was accepted.
- An application document to Innoviris Brussels for the creation of a Spin-off was handed in.
- The follow-up of the StartLab's start-test program training courses took place. This covers entrepreneurship in all its aspects and was shared with the whole team. From how to prepare and manage a budget to how to communicate properly personally, with a pitch, or globally, through corporate communication.
- The "Winning Path" offered by the StartLab enabled the company to make concrete progress. These elements include a creation equation and a market analysis.
- An application file for the Albert Vanhée scholarship for the financing of projects with a beneficial impact has been submitted. A €5,000 grant for the creation of the prototype was awarded to the project following this application.

A sound basis for the creation of NeoFinder has been set. The team became tightly knit and dedicated over the months. Despite the unsuccessful application to Innoviris, the team received encouraging and formative feedback on the project. This allowed the creation of a better application for the Albert Vanhée grant, thus releasing a base budget for prototyping. NeoFinder has a sound foundation for further business development.

PERSPECTIVES

NeoFinder and its team have an ambitious outlook. Nevertheless, we must remain realistic and overcome the obstacles one by one. The perspectives are in short, medium and long term. They represent current goals and may change in the future.

The short-term objectives are primarily to complete the market study once the current health crisis is over. Then complete the first prototype and with it acquire a pilot customer to assist in the finalization of the product. The team also wants to move on to the next step in the StartLab journey and evolve in their training program to the best of their ability.

In the medium term, develop the technology of the bracelet so that it also works inside. The team hopes to be able to enter the Belgian market and start making the company profitable.

In the long term the objectives are to continue research and development to constantly produce the best possible product. NeoFinder also hopes to expand into the international market. Finally, why not, to develop the customer base towards private clients.

CONCULSION

Here is a review of the progress made in achieving the goals

- The objective of business creation

This objective has not been fully achieved. The creation of the company as such has not been achieved, but the actions carried out bring us closer to the goal. Thanks to the work completed on grant applications and the calls made in nursing homes, an image and structure of the market has been outlined and our understanding of this market has developed. In addition, with the help of the coaching sessions, ideas were challenged, and this helped to prepare a core of our value proposition.

- A learning goals

This was achieved on the one hand through the StartLab training courses, which contributed to entrepreneurial learning. On the other hand, the group work on the various funding schemes enabled us to improve our teamwork.

- A fundraising aim

The project was awarded the Albert Vanhee Fellowship from the Foundation for Future Generations, which raised funds for the creation of the prototype. Despite the rejection of Innoviris's SPIN-OFF grant, there is a motivation to repeat the application. The topic could be the indoor geolocation technology to be developed.

Although the marketing work was complicated, given our lack of expertise in this field, the team succeeded in most of the objectives by maintaining cohesion and developing good synergies.

All things considered, it was a very enriching experience and an extraordinary first entrepreneurial adventure.

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