Software Requirements Specification

IoTracking

5ISS

Abstract: The purpose of this document is to give a detailed description of the requirements of the IoTracking project. This project aim is to deploy an ad-hoc LoRa network from scratch and develop a user-friendly web application to allow people to follow the evolution of boat regattas in real time.

Keywords: LoRa, GPS, boat regattas, deployment of an ad-hoc network, hardware, web application.

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Revision History

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Section 1. INTRODUCTION

Purpose

The purpose of this document is to give a detailed description of the requirements of the IoTracking project. It will illustrate the purpose and complete declaration for the development of the system. It will also explain the system's constraints, it's interface and the interactions between all the components.

This document is primarily intended to be proposed to our client, CVRL Sailing Ships Club. Upon its approval, this document will be used as a reference for developing the first version of the system for the development team.

In order to make the reading of this paper easier for the readers, we will consider that our main user is a man, which eliminates the future need to precise the user's gender.

Scope

The system described in the following sections is aimed at providing spectators of a boat regatta organized by CVRL and their members a way of viewing the position, trajectory, speed, and direction of the boats participating in a race, both in real time and in differed time.

The system shall :

- Collect and store data from the race (GPS position of the boats).
- Display the race data to users during the race and after the race.

The system shall not :

- Collect personal data from its users.

This document covers four main parts of the system :

1. The Devices collecting the data from the boats.
2. The Network allowing the devices to send and receive data.
3. The Network Server collecting and processing (deduplication, integrity check, etc…) data from the network and sending it to the application server.
4. The Application server collecting data from the network and serving the application used to configure the system and display the races data.

Overview

The General Description chapter gives an overview of the product's functionalities. It describes the whole system, and is used to establish a context for the technical requirements in the chapter that follows it.

The Specific Requirements chapter covers the functional and quality requirements of the system. It describes the functionality of the system in technical details.

Definitions, Acronyms, and Abbreviations

Term/Acronym	Definition
User	The one who uses the application
App	The application/the system itself
CVRL	*Club de Voile des Rives de Léran* Association

References

The references below are the other parts of our documentation:

- Final paper
- SRS
- SDD
- Abstract
- Final presentation

Section 2. General Description

There are several general factors that will affect the requirement of our solution.

1. The system will be implemented in an area where there is no network coverage (2G, 3G, 4G, LoRa).
2. There is no Internet access or WiFi at the base station.
3. The network has to cover a big surface without the possibility to place fixed repeaters (difficulties placing repeaters on the lake).
4. The device will be mounted on a sailboat, far from an external power supply source, for several hours.
5. The device will be exposed to water.
6. The sailboats can move with a speed up to 20-25 km/h.
7. For most of the time of the regatta, the sailboats are not visible from the shore.

Product Functions

This subsection provides an overview of the functionality provided by the four main parts of the project. The full details of the functions will be covered later in this document.

Collecting Device

Function	**Description**
Get GPS coordinates	The device, placed on the boat, will collect the GPS coordinates.
Calculation of the relative GPS coordinates	To limit the number of bits of the GPS coordinates without losing precision, we will use a reference area to calculate the relative GPS coordinates before sending them.
Send GPS coordinates	The device will transmit its GPS coordinates to the server via the LoRa network.
Activate sleep mode	The device will enter sleep mode when no movement has been detected over a longer period of time.
Deactivate sleep mode	The device will go out of sleep mode when a movement is detected.
Measure battery level	The device will measure its battery level, so that the user can determine whether or not to charge the device.

Network gateway

Receive information	The gateway will receive the information from the device.
Data processing and forwarding	The gateway encapsulates the data by adding headers and forward it to the network server.

Network server

Registering a node	To receive data from a device we need to register it in the Lora application server which integrates a database. The device must have a device address, a DEVEUI, a network key, and an application key to be registered.
Receive information	The Lora server will receive the information from all the registered devices via the gateways. The communication is enabled by MQTT subscribe/publish messaging protocol thanks to the lora gateway bridge.
Data processing	The Loraserver duplicates the packets received by several Network Gateways, check the integrity of the packets and if it's from one of our network devices, adds it to the queue data and forward it to the web application server.

Application server

Register staff members and other members	The application server comes with an administrator account. The **administrators** can register CVRL's staff members and regular members. Those users will be asked to choose a unique username. The account type can be one of : Administrator, Staff member, Member. The users should NOT provide personal information such as name or e-mail addresses.
Register devices hardware IDs	**Staff members** can register new devices by giving the device's unique hardware identifier. They can associate this identifier to a shorter name of their choice which can be printed on the device. For example "DEV-0054".
Configure the system for a race	**Staff members** can associate devices to boats. Boats can be associated with users (it is not required) and to a team name.

Display live race data.	**All users** (even anonymous) can access live race data.
Display past races data.	**All users** (even anonymous) can access past race data. **Members** can filter past races to only include the races they or their team participated in.

User Characteristics

There are three different group of users of our product, each with their own use case.

Association/Management of the regatta:
The association will be able to do a part of the management of the regatta through the web application, and they will have their own login access. They will be given the possibility to add new regattas, edit the ones that already exist, and to delete a regatta from the system. The system will be developed to be easy to understand and use, but some level of experience might be necessary in order to do this properly.

Participants of the regatta:
The participants can use the application to evaluate their performance in the race after it has finished, in order to do so all the data will be saved for a certain amount of time. This use of the application will not require any level of education.

Spectators:
The spectators can access the web application with their smartphone. They will be given the possibility to follow in real time the current regatta. They can chose what boats to follow, and whether or not they want their trajectory to be drawn on the map. Everyone that owns a smartphone should be able to connect to the web application and understand its functionalities. This will require no level of experience.

General Constraints

According to the regulations in Europe, the frequency that is allocated for LoRa is 868MHz. Therefore, we may only use hardware that contains a LoRa module that respects this regulation to avoid unnecessary problems.

There is a limited number of times that one can send and receive a packet when using LoRa. This is due to the various factors such as the spreading factor, the nature of the transmission which is narrow band, the frequency used and the density of devices that will be transmitting simultaneously.

The temperature may vary quite aggressively at the lake. The hardware that will be used may not be able to operate normally at extreme temperatures. They may also be limited by the type of battery that will be used because different types of batteries may have different levels of tolerances to temperature.

There is no personal information that will be transmitted by the application, and therefore there is no real risk for outsiders exploiting the data communicated by the network. There is still a possibility that the system will evolve in the future, and that the level of security will have to become more significant, and in order to make the future versions of the system easier to develop, we will still take this into consideration when deploying the first version of the network.

Assumptions and Dependencies

1. The system should be transferable to other lakes and/or environments, where the level of connectivity and size of the area may differ.
2. The duration of the regatta may evolve in the next years.
3. The number of sailboats that participates in a regatta may evolve.
4. There may be deployment of different networks (4G, LoRa) by official operators in the future.

Section 3. Requirements

This section covers the functional and quality requirements of the system. It describes the system in detail, including the features of the application.

Functional Requirements

Use Case

This section describes specific features of the software project and includes the requirements that specify all the fundamental actions of the software system.

The use case schema below illustrates the different services the system offers. It shall be responsive to any of these requests from the user application.

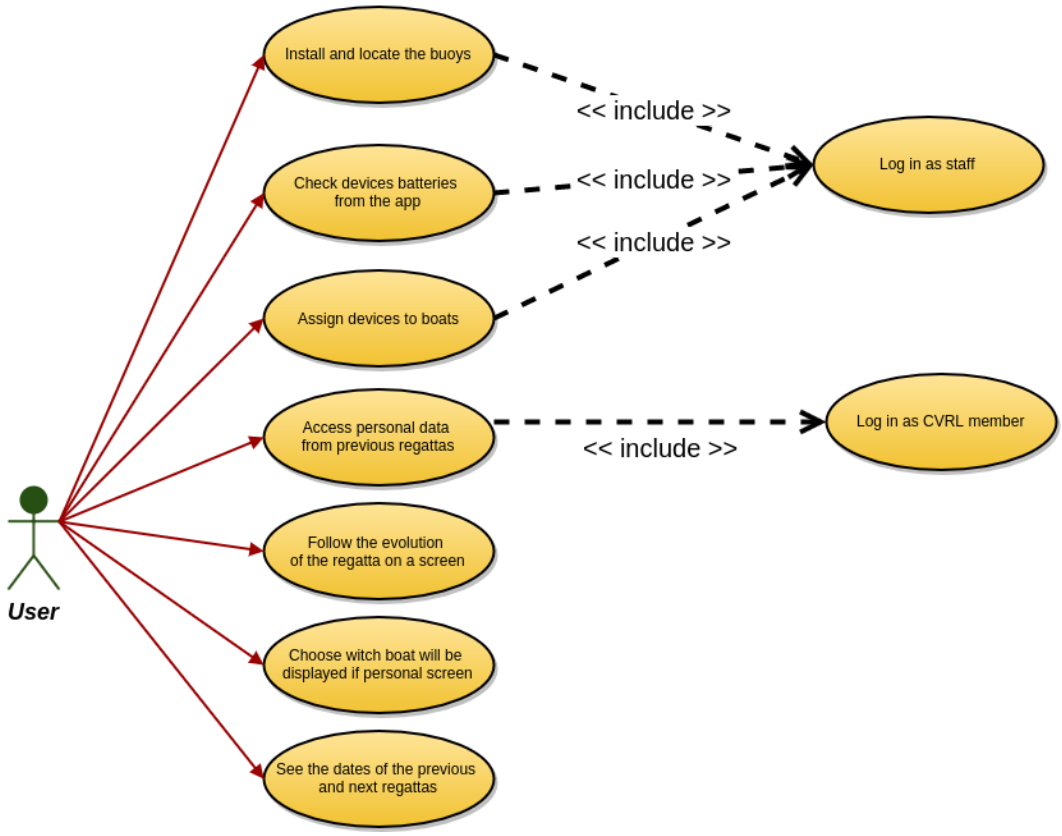

Figure 1: Use Case Diagram

The system shall allow the user to log in and access different types or services according to his profile. This profile can take three (3) values : anonymous (no login), member (adhering to the association), and staff. To access to specific services, the user must be identified as a member or staff with a username and a password.

As described in the use case diagram above, an “anonymous” user will access to some specific services, a “member” user will access all the services offered to “anonymous” users, in addition to

other services, and a “staff” user will access all the services offered to “member” users, in addition to some others services designed for the organization of the races.

The software system will be considered as the application in the following parts. This system communicates with several interfaces:

- The database
- The LoRa appServer
- The Android application
- The web application

Software system inputs

The software system inputs are:

- Text inputs
- CSV files
- PNG, JPG images
- GPS coordinates
- MQTT topics
- Data from the database
- Requests of regattas and races lists

Text inputs shall be provided to allow the user to modify, delete and create new regattas, races, racers, devices and race maps. A text-input-checking system shall be implemented to force the user to enter a valid text input before allowing them to validate their modification.

CSV files shall be imported to parse information about regattas and racers (exported from another software the client uses). The system shall check that the CSV structure matches the structure required. Otherwise, the system shall return an error to alert the user to the fact the its file does not correspond to what it should.

PNG and JPG images shall be imported to set new race maps. The system shall not provide any verification of the nature of this image.

GPS coordinates shall be sent from the Android application to the application server. This coordinates correspond to the positions of buoys. The system shall not provide any verification of the bits received from the Android application.

MQTT topics shall be sent to the application server from the LoRa appServer, which check the integrity of the data it sends to the application server.

Data from the database shall be sent in response of requests. The system shall provide simple verifications such as null parameters.

Requests of regattas and races lists shall be sent from the Android application to allow the user to choose which race they are installing buoys for. The system shall not provide special verifications concerning these requests.

Overflow

The system shall be able to support up to 10 requests per second from devices, which corresponds to a transmit frequency average of one packet each 10 seconds for 100 devices, because each device shall transmit one packet randomly during an interval of 10 seconds. In the same time, it shall support requests from the application to allow the users to navigate comfortably, up to 15 requests per second.

Software system outputs

The software system outputs are:

- Application views
- Requests to the database
- Regattas and races lists

Relationship of outputs to inputs

The following table lists the different inputs, their origin, and the output provided.

Input	***From***	***Output***
Text inputs	Web application	Request to database Application view
CSV files	Web application	Request to database Application view
PNG, JPG images	Web application	Request to database Application view
GPS coordinates	Android application	Request to database
MQTT topics	LoRa server	Request to database Application view
Data from the database	Database	Application view
Requests of regattas and races lists	Android application	Regattas and races lists

External Interface Requirements

Our application has two external interfaces:

- The user interface described in the following part after the table.
- The interface with the FREG software provided by the French sailing federation.

This FREG software, provided the following inputs to our application :

	Sailing number	Name	First Name
Name of item	REG_CAT_VO	NOM_1	PRENOM_1
Relationships to other inputs/outputs	none	Linked to PRENOM_1	Linked to NOM_1
Description of purpose	The unique identifier of a regata	The surname of the team leader	The first name of the team leader
Data formats	Alphanumeric	String	String

User Interfaces

The user shall be able to access the web application through any type of device that has a web browser. The web application's display will be adapted according to the characteristics of the device. As the application is accessed through the web browser, there is no need for a specific mobile operating system to be used.

Performance Requirements

Even if our solution must be low cost, the system we propose shall respect many performance requirements.

The network infrastructure must able to simultaneously handle 100 devices. It has to be long range by covering the entire lake (approximately 9 km^2). It also has to correctly capture the data sent from devices, moving at a maximum speed of 30 km/h.

Each device must be able to send 3 bytes every 10 seconds and needs to consume a very low amount of energy. They shall last at least 10 hours.

Design Constraints

Constraints limit the action of the users. For our project, user satisfaction is very important. That is why we have identified the constraint from the very beginning of our software development. This will help us to address these constraints and we can then try to minimize their impact on the final product. Firstly, it must be noted that there will be no network coverage at the site. Secondly, there might not be any Internet connection. So our application must be operational locally. Thirdly, we do not have much time to implement our solution as there are many aspects to consider. Our solution involves integrating many different types of technologies of which we may not have the expertise required in the beginning. Fourthly, the association that we are working with are on a very limited budget so we must ensure that our final solution is within their budget. Finally, the end users of our application will not be aware of the complexity of our system. This means that they might not deploy everything as they should.

Standards Compliance

The system that we will implement will respect all the regulations that have been imposed. We will do regular tests to see if our LoRa modules and our WiFi modules transmit on the right frequency. This is to ensure that we do not interfere with other types of communications. We also will use standard GPS capabilities. This means our GPS module and the information retrieved will also respect normal GPS standards.

A budget has been allocated to us by INSA Toulouse. We can only buy some of the hardware to be used in our proof of concept. Each purchase shall be justified and a record will be kept of the purchase.

A report of our work will be done following the format required by our lecturers. As this is a collaboration between CVRL and INSA Toulouse. The report must mention both entities as it was the project was the idea of CVRL and it was financed by INSA Toulouse.

Hardware Limitations

We will be working in an environment that may be exposed to water and harsh conditions. Therefore, we must try to protect our system at all times. It is noted that our equipment should be at least rated IP66. The area that we will be covering is very big. To be able to cover such an area, we may need to use equipments that consume more energy. We also need to consider public safety because using an antenna that emits with a lot of power is dangerous. Moreover, a more powerful antenna will be expensive. For this reason, we must find the right balance for our solution. We are also aware that our solution requires that a user must have a smartphone. This is a constraint because not everyone owns a smartphone and neither is it cheap to acquire. Specifically, we will only cater to Android smartphones. Moving on, our GPS module has to be out in the open to be able to receive a good signal otherwise it would cease to work appropriately.

Attributes

For our project, it is important or even essential, to determine a certain number of attributes and to guide their verification in the most objective way possible. Thus the following attributes were identified.

Availability

The system should be easily deployable during a regatta and available until the end of the regatta. The devices should be continuously transmitting their location after being assigned to a boat. The gateways should continuously be active to receive data from these devices during the regatta. This means the devices should have sufficient energy to fully operate while the gateways must be supplied with energy by a reliable source. The server should be running at all times during the regatta to ensure the users can access it to follow the race.

Security

The system will not be fully protected against software or network attacks.

The information that can be found in our system is not sensitive and does not contain any element that violates anybody's privacy. The only security measure needed is the physical security of the all the equipments as to avoid theft, rebooting and the transmission of erroneous data.

Maintainability

The system is made up of different parts and modules that are independent from one another. This means that updates, repairs and bug corrections can be done without having to change other parts of the system. It is even possible to change a technology of a certain module. They only need to respect the interfaces that have been defined between the modules.

Transferability/Conversion

The system will be designed to be portable and deployable elsewhere. The devices, gateways and the various servers are not dependant on the location to operate. The devices and the gateways used may change and this should not affect the system in any way. Only a gateway that is able to communicate with the network server is required and there is no specific gateway required. The devices can be of any type, as long as they use LoRa to communicate and is able to retrieve GPS coordinates.