

Software Requirements Specification

for

Salish Sea Water Weather Station

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Version 1.0
2019-05-24

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Revision History

Authors	Date	Description	Version
RL, SV, MG, KS	2018-5-24	Document Created	1.0

1 Introduction

1.1 Purpose

The purpose of this document is to report the software requirement specifications for the Salish Sea Water Weather Station. This document will contain detailed descriptions of the buoy system's hardware, the mobile phone data collection application, the data deposition website, and storage database.

1.2 Document Conventions

Term	Definition
WWXS	Water and Weather Station. Used as abbreviation for the project name
Buoy	The water and weather data collection system that will be placed in the Salish Sea
BLE	Bluetooth Low Energy, an efficient communications protocol
GPIO	General Purpose Input and Output

1.3 Intended Audience and Reading Suggestions

The intended audience for this document includes individuals interested in the underlying structure of the code base or hardware. This includes individuals who wish to refine the current implementation or extend the capabilities of the WWXS. System examiners will find utility in this document as a list of functionalities for future testing. Students and teachers at the cybersecurity sea discovery camp can benefit from the information presented in this document, however the level of depth presented is more than what would be required to facilitate the use of this system.

1.4 Project Scope

The scope of this project will be the extension of the buoy, android app, website, and database implementation provided by the previous group. Specifically the main area of focus will be on extending each buoys ability to communicate with not just one, but any number of authorized devices while visualizing key concepts of cybersecurity. Once that has been completed the next phase will be to increase the number of sensors on the buoy. These changes will require performing updates to the android application, website, and database as they are all active participants in the collection and transfer of data. The change in buoy accessibility will include the creation of a secure key system for linking more than one user to be able to access a buoy as well as updated to the rolling updates system for the data deposition from multiple sources. At the time of this documents creation the types of new sensors to be added have yet to be selected but possible options include accelerometers for monitoring waves, more salinity and

turbidity sensors, and barometric pressure. Once the decision on which sensors will be added is finalized, this document will be updated correspondingly.

1.5 References

Due to this project being the third iteration of a continuous development cycle by senior project groups, the other projects will be referenced but not described in depth. The previous groups software requirement specifications can be found via the following links. [Iteration 1](#). [Iteration 2](#).

2 Description

2.1 Product Perspective

At the camp, students will learn about various cyber security and marine science concepts. The buoy will serve as a real-life example of several of these concepts in use. Each camper and assistant will receive one to deploy in the Salish Sea, to help keep them engaged with these concepts after the camp ends. The hardware and app will maintain security in a way visible to the user. The gathered data will be visualized to help engage the users, as well as provide useful data for researchers.

2.2 Product Features

The buoy will have various sensors for monitoring the environment; our version will have a few more than the previous. The chip installed on the buoy will be able to store at least one month's worth of data, and be able to transfer this data to an Android app via bluetooth. The mobile application will be able to demonstrate data encryption to the user, as well as other cyber security concepts; additionally, it will reliably send data to the web server. The web server will be able to register users and their devices. The server will store the gathered data, as well as visualize it for any visitors. It will also allow researchers to download this data in a convenient format.

2.3 User Classes and Characteristics

User Type	Characteristics
Camper	Middle School students who are learning about cyber security and environmental science. Will be the main group interacting

	with the stations.
Camp Staff	High School students assisting the camp. Will need to understand the stations enough to assist the Campers.
Maintenance	People in charge of maintaining the website, database, buoys, and other things as needed.
Researchers	Will download bulk data from the website in a usable format.
Public	Members of the general populace who wish to look at the data gathered on the website.

2.4 Operating Environment

The buoy is a SparkFun ESP32 Thing, held inside a buoyant waterproof container, which gathers data from an array of sensors. It communicates with the user's Android device via bluetooth. The Android app receives data via bluetooth, and sends it to the website via a mobile data connection. The website stores data in a MySQL database, and runs on the Django framework.

2.5 Design and Implementation Constraints

The total cost of each buoy needs to be kept down, so the camp can provide one to each camper, as well as hopefully some extras in the case of hardware failure. The hardware needs to fit inside a waterproof and durable container; likely the established Nalgene water bottle. To ensure that the product is suitably waterproof, it will need to be relatively easy to assemble to minimize errors. As the battery will be sealed in the waterproof container and therefore difficult to access, the program running on the hardware needs to be designed such that the battery will last for at least a year, while still gathering uninterrupted data.

2.6 Assumptions and Dependencies

This project operates under the assumption that it will only need to provide an Android app, hosted on the Google Play store. We also assume that the website will continue to be hosted and maintained by the Poulsbo satellite campus' Cyber Range. This project requires that we have the previous team's work off of which we can build. We also require enough of a budget to fund the purchase of the required electronics to assemble the product.

3 Features

3.1 Access to Gathered Data

3.1.1 Description

Data stored on the website should be accessible to both members of the public and participants in the data collection program. Data should be presented in a graphical manner and be available for download.

3.1.2 Priority

Necessary for product function.

3.1.3 Stimulus and Response

Users of the WWXS want to view or download data collected and uploaded to the website database.

The website will query the database and display data in a visualized format that can be also be downloaded.

3.1.4 Functional Requirements

- The system shall allow users to specify the date, time, and area they want to view data from.
- The system shall allow users to filter the displayed data.
- The system shall present the data in a visualized manner.
- The system shall allow users to download data in a usable file format.

3.2 Hardware Registration

3.2.1 Description

Users working with WWXS will be able to register and manage their assigned buoys through the WWXS website.

3.2.2 Priority

Necessary for product function.

3.2.3 Stimulus and Response

A user with a buoy wants to register or remove a station.

The website registers the buoy or removes it from th

3.2.4 Functional Requirements

- The system shall allow a user to register a new buoy to their account.
- The system shall allow a user to remove an existing station from their account.

3.3 Account Registration and Management

3.3.1 Description

In order to register buoys and upload collected data, users of the WWXS will need to create accounts via the website.

3.3.2 Priority

Necessary for product function.

3.3.3 Stimulus and Response

A new user wants to create an account.

The website creates a new account with appropriate credentials for that user.

3.3.4 Functional Requirements

- The system shall allow a users to create a new account.
- The system shall allow a users to set and modify information in their account.

3.4 Data Upload to Website

3.4.1 Description

Users need to be able to upload data that is collected from buoys to the website database. They will use the mobile app to do so.

3.4.2 Priority

Necessary for product function.

3.4.3 Stimulus and Response

The users collects data from a buoy and requests the data to be uploaded.

The website receives the upload request, validates the data, and inserts the new data into the database with proper formatting.

3.4.4 Functional Requirements

- The system shall receive user upload requests.
- The system shall receive and parse the data from the mobile app and insert it into the database.
- The system shall verify that the data being received is from a legitimate source and is not corrupted.

3.5 Device Control

3.5.1 Description

Users of the WWXS will need to be able to control the functionality of their assigned buoy from the mobile app.

3.5.2 Priority

Necessary for product function.

3.5.3 Stimulus and Response

User of the buoy wants to change the state of the device. For instance, the user wants to change a buoy from an idle state to a collecting state.

The buoy is now in the state desired by the user, or reports an appropriate error message if unable to do so.

3.5.4 Functional Requirements

- The system shall present the user with all options they can use to change the state of the buoy.
- The system shall accept user requests to change the state of the buoy.
- The system shall transmit commands to change the state of the buoy.

3.6 Data Collection from Buoy

3.6.1 Description

Users of the WWXS will need to be able to retrieve data from the buoy using the mobile app.

3.6.2 Priority

Necessary for product function.

3.6.3 Stimulus and Response

The user connects to the buoy and transmits a request for collected data.

The buoy transmits the data it has collected to the mobile app and the device stores the data locally.

3.6.4 Functional Requirements

- The system shall accept user requests to upload data.
- The system shall transmit a command to the buoy to send data to the mobile phone.
- The system shall accept data sent by the station and store the data locally.

3.7 Data Security

3.7.1 Description

A secondary goal of the product is to introduce users to cyber security concepts. In order to do that, data transmitted from the buoy will be encrypted and must be decrypted with the mobile app. The system will give a visualization and walk the user through the steps of encryption/decryption.

3.7.2 Priority

Important for product goal but not necessary to its functionality.

3.7.3 Stimulus and Response

User wants to get data from a buoy.

The mobile app retrieves data and decrypts it using the key set by the user.

3.7.4 Functional Requirements

- The system shall decrypt data when received from the buoy.
- The system shall present a visualization of the decryption process.

3.8 In-App Data Storage

3.8.1 Description

The mobile app will need to be able to store data retrieved from the buoys. The app should be able to store multiple data uploads from multiple different buoys.

3.8.2 Priority

Necessary for product function.

3.8.3 Stimulus and Response

The mobile app receives data from a buoy.

The mobile app stores the data locally on the device, keeping track of the metadata associated with the stored data.

3.8.4 Functional Requirements

- The system shall store received data locally after reception from a buoy.
- The system shall be able to store data from multiple uploads.
- The system shall be able to store data from multiple buoys.

3.9 Account Authentication

3.9.1 Description

In order to ensure that only users who are authorized to collect data from and control the settings of buoys can access them, the app must be able to authenticate user credentials.

3.9.2 Priority

Important to ensure data integrity and security but not necessary for product function.

3.9.3 Stimulus and Response

A user opens the app and their device.

The app prompts the user for login credentials and verifies them with the database server.

3.9.4 Functional Requirements

- The system shall require the user to provide login credentials when the app is opened.
- The system shall verify given credentials with the web server and verify which buoys the user has permission to access.

3.10 Environmental Data Collection

3.10.1 Description

The buoys must have the ability to collect environmental data continuously and store the data locally until it can be sent to a user's mobile app.

3.10.2 Priority

Necessary for product function.

3.10.3 Stimulus and Response

The hardware timer indicates it is time to collect data from the sensors.

The buoy reads from each of its sensors and stores the data locally.

3.10.4 Functional Requirements

- The system shall keep track of the time in order to record data at precise intervals.
- The system shall read from each of its sensors once at each time cycle.
- The system shall store all data locally until it can be uploaded.
- The system shall overwrite the oldest data if there is not enough memory left to record new sensor readings.

3.11 Group Account Management

3.11.1 Description

In order to facilitate the use of the WWXS with classrooms and other educational groups, user accounts must be able to be managed at a group-level.

3.11.2 Priority

Not necessary for product function but useful for administrative purposes.

3.11.3 Stimulus and Response

A user group must be added, removed, or modified.

The website allows a user to create a new group, modify or remove an existing group, or add users to a group.

3.11.4 Functional Requirements

- The system must keep track of all groups and their members using the database.
- The system must allow for the modification of existing groups or the creation of new groups.

3.12 Mass-Produced Device Hardware

3.12.1 Description

In order to ensure that the buoys will be available for use in future camps and group activities, the hardware must be designed in such a fashion that it is easy mass-produced.

3.12.2 Priority

Necessary for product goals.

3.12.3 Stimulus and Response

More devices need to be produced.

The documentation is available to easily reproduce the hardware and circuitry to create a functional buoy.

3.12.4 Functional Requirements

- The system shall be affordable to keep product costs down.
- The system shall be made from parts that are easily obtainable.
- The system shall have documentation that allows for easy reproduction of buoys.

4 External Interfaces

4.1 User Interfaces

In our system the main user interface will be the mobile phone application. The mobile application will be used for the creation of new accounts, establishing links to new buoys, communicating with the database to authentic other phones to connect to a linked buoy, telling the buoys to start and stop data collection, and the transmission of recorded data from the buoy to the database. To accomplish this the application the application must be able to confirm that all commands and data during the collection and deposition phases has completed successfully as well as the the creation of new links for users to buoys. The secondary user interface will be the database website, which will offer a front-end environment for users to see visual representations of the collected data.

4.2 Hardware Interfaces

The main hardware component in this project will be the buoy minicomputer. The minicomputer stored in the nalgene bottle will interface with the data collection sensors via the systems GPIO pins located on the sides of the chip. The buoy will also receive power via a set of AA batteries which will be wired to the power IO for the chip. Once the buoy is set up and placed in the bottle, no further hardware interaction will be required.

4.3 Software Interfaces

There are two main software interfaces used in this system. The first interface will be between the buoy and the mobile application, which requires the buoy and phone to perform a key handshake before giving the app access to control the buoy's operations. Once authenticated these systems will then have to facilitate the transfer commands or encrypted data from the buoy to the phone storage system. The second interface is the interface between the mobile application and the website which will be used for the creation and linking of accounts to buoys, as well as the transfer and verification of valid data being deposited into the database.

4.4 Communications Interfaces

The phone application and buoy interface must utilize the BLE communication protocol alongside a specific data transmission format such that battery usage on the

buoy is minimized. The communication between the application and the website's database will use the RESTful API transfer protocol to ensure encrypted data transfer over HTTPS or cellular connection.

5 Nonfunctional Requirements

5.1 Performance Requirements

- Battery must have sufficient battery capacity to run for four weeks of collecting and storing data, as well as uploading data via Bluetooth
- Device must be available for polling via Bluetooth between the hours of 6 a.m. to 9 p.m.
- Device must have a storage capacity to save at least four weeks of sensor data

5.2 Safety Requirements

- Final assembly of the device must be safe for middle school students, precluding risk of electric shock or minor skin punctures, or similar minor injuries
- The inclusion of a tether attaching the device to the dock precludes the risk of drowning for those placing and retrieving the device in or from the water

5.3 Security Requirements

- Data being fetched from the device via Bluetooth must be encrypted
- Requests sent to the device via Bluetooth to retrieve data must be encrypted
- Access to the device must have proper authentication to prevent unauthorized attempts to request data
- Data sent to the website server from the phone app must be authentic and unaltered
- Website must keep user data secure
- Website must not accept data from unauthenticated sources

5.4 Software Quality Attributes

- Availability
 - The website shall have at least a 95% uptime
 - The station shall be accessible to Bluetooth polling between 6 a.m. to 9 p.m. at 60 second intervals at least 95% of the time
 - The app shall remain available on the Google Play Store

- Efficiency
 - Data sent between the device and the app shall take no longer than 30 seconds
 - Data sent from the app to the website shall take no longer than 30 seconds
- Integrity
 - Users shall not be able to access devices not registered to their account
 - Website and app shall not accept fraudulent data
- Portability
 - Website shall be able to run on Firefox and Chrome
- Robustness
 - The station shall have a lifetime at least equal to four weeks
 - The buoy shall be able to withstand turbulence or related unpredictable movement from the water or from transportation
 - The buoy shall be waterproof for at least its lifetime
 - Loss of one sensor on the station shall not affect the rest of the station's functionality
- Usability
 - Middle school campers shall be able to complete the assembly of the devices in a reasonable time frame
 - Campers shall be able to connect to their assigned device via the Android app and Bluetooth
 - Data shall be accessible to view on the website