Software Requirement Specification
for
Salish Sea Data System

Created by Erik Kellogg, Gus Cramer, and Nick DeYoung
Advised by Dr. Erik Fretheim
Western Washington University

Version 1.0
2018-11-09

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Revision History

Name	Date	Reason for Changes	Version
Full group	2018-11-09	Initial document	1.0

1 Introduction

1.1 Purpose

This document will cover the specifications and requirements for the Salish Sea Data System. This includes specifications of the system hardware, the website and associated database, and the mobile application.

1.2 Conventions

Term	Definition
SSDS	Salish Sea Data System. An abbreviation of the project name
Station	A shorter name for the full sensor package deployed in the water
BLE	Bluetooth Low Energy, a communications protocol
GPIO	General Purpose I/O

1.3 Intended Audience

The primary audience of this document will be anyone who is interested in utilizing the full hardware and software suite. Specifically, anyone who wishes to understand the full design of the project will be able to do so with this document, such as future development teams or camp staff. Anyone who is asked to test the system will benefit from this document as a source of criteria to test by. Campers and student teachers can also gain information from this, but their use of the system does not require the depth of understanding that this document will provide.

1.4 Project Scope

The goals of this development effort will be to add new sensors to the system, improve the system's size and housing, add a visible element of data encryption to the mobile app, and to have a fully functional app in the app store. To improve the range of data being collected, several new sensors will be added to the system, primarily salinity, turbidity, and insolation sensors. If time permits, other environmental sensors, such as Ph levels, are also within the scope of the project. Reducing the size of the system to be able to fit into a Nalgene water bottle, a more robust housing than the current tupperware, is also a goal of the project. The mobile app will be updated so that users can see the encrypted data being received from the sensor system being decrypted on their device. Finally, having a fully functional app hosted on the app store prior to the camp's start date is a goal of the project.

1.5 References

Because our project is a continuation of an existing senior project, we will inevitably make reference to their development efforts. The previous group's software requirements specification, which this document is based off of, can be accessed here.

2 Overall Description

2.1 Product Perspective

This project is intended to serve as a real world example of both cyber security and environmental science concepts that summer camp students have spent the week learning. Each camper will be provided with a station to deploy in the Salish Sea near their homes. The goal of providing campers with these stations is to keep campers engaged with the concepts they have learned after the camp ends. Having a mix of hardware and software that must maintain its security in a transparent manner to the camper provides engagement with cyber security concepts such as data encryption. The data that the sensors are collecting serve both to engage students further with environmental science, as well as provide valuable data to researchers studying the Salish Sea.

2.2 Major features

- Additional sensors will be added to the existing device to gather data about the water and environment around the package.
- The on-board chip will be capable of recording and storing at least four weeks of continuous data.
- The on-board chip will support seamless transfer of the collected data to a mobile device via an Android application.
- The mobile application will include visualization of related cyber security concepts, including a visual demonstration of data decryption.
- The mobile application will reliably send data to the web server.
- An accompanying website will store collected data and present interactive visualizations for users.
- The website will be able to register users and their associated devices.
- The website allows for downloading of data in a commonly accepted data format.

2.3 User classes and characteristics

User Class	Characteristics
Campers	Middle school students who are learning about cyber security and environmental science concepts.
Camp staff	High school students brought in to asoasist at the summer camp. Will have to understand the stations enough to assist campers in building and using the stations.
Researchers	Need to be able to download data in a usable file format from the website.
Maintainers	Maintain the website, database, app, and physical stations as applicable.
General public	View visualizations of the data on the website.

2.4 Operations Environment

The station will be controlled by a SparkFun ESP32 Thing, which gathers data about the water from an array of sensors. The station will communicate with an Android mobile app using the BLE protocol to aid in power saving. The mobile app will be a custom written app designed for use on Android mobile phones. The mobile app will send the data to a web server hosted at the Poulsbo satellite campus. The website runs on the Django framework and stores data in a MySQL relational database. The stations will be partly assembled by the development team, with final assembly being performed by the campers.

2.5 Design and Implementation Constraints

The cost of each station should remain low enough to allow the camp to purchase the supplies for at least one station per camper and student staff with some leftovers to accommodate any hardware failures. The hardware design must be able to fit in a suitably durable waterproof container such as a Nalgene bottle. The hardware must be programmed in a manner that allows for its battery to power it for up to a year of continuous data collection without intervention. The board powering the station has limited storage capacity, so the data being collected must be stored in an intelligent manner. The hardware design must also be easy to assemble, both for initial assembly by the development team and for final assembly by the campers.

2.6 Existing user documentation

The SparkFun ESP32 Thing has board specific documentation available on the product page. In addition, the ESP32 chip itself is heavily documented online on the manufacturers site. There is also existing documentation of the website and app provided by the previous senior project group to work on this project.

2.7 Assumptions and Dependencies

The SSDS website will rely on the continued hosting of the site on the servers owned and operated by the Cyber Range at Western's Poulsbo satellite campus. This project also assumes that the mobile application will be limited to the Android operating system, and hosted on the Google play store. This project will also require access to the work of the prior team both for reference and to introduce the aforementioned additions of this project. Additionally, the project is dependent on a budget sufficient to purchase the requisite number of sensors and boards.

3 System Features

Feature Name: Public Data Access

- Description: Members of the public should be able to access and view data on the SSDS website in a graphical manner and be able to download data files in a useable format.
- Stimulus: Users of the SSDS website want to view or download data collected by the system.
- Response: The website will present data in a visualized format that an average person can understand or create a file for download that can be parsed by another program.
- Functionality:
    - The system shall allow users to select the area they want to view data from.
    - The system shall allow users to filter what kinds of data they view.
    - The system shall present the data in a visualized manner.
    - The system shall allow users to download selected data in a parseable file format.

Feature Name: Hardware Management

- Description: Users working with SSDS data collection will be able to register and manage their assigned hardware through the SSDS website.
- Stimulus: A user with a data collection unit(s) needs to register or remove a station.
- Response: The website registers the station to that user or removes it from their account.
- Functionality:
    - The system shall allow a user to register a new station to their account.
    - The system shall allow a user to remove an existing station from their account.

Feature Name: Account Creation

- Description: Users of the SSDS will need to create accounts in order to register stations and upload collected data.
- Stimulus: A new users wants to create an account with the SSDS.
- Response: The website creates an new account with appropriate credentials for that user.
- Functionality:
    - The system shall allow a user to create a new account in the system.
    - The system shall allow a user to set and modify information in their account.

Feature Name: Data Upload to Website

- Description: Users working with the SSDS need to be able to upload data, collected by the stations, from their phone to the website's database.
- Stimulus: The user completes collecting data from a sensor unit or the user manually requests for data to be uploaded.

- Response: The website receives the app's request to upload data, validates said data, and adds the new data to its own database.
- Functionality:
    - The system shall receive requests from user apps to upload data.
    - The system shall receive data from user apps and correctly insert the data into its own database.
    - The system shall verify that the data being received is from a legitimate source and is not corrupted.

Feature Name: Device Control

- Description: Users of the SSDS will need to be able to control the functionality of their stations from their phone's app. Primarily, they will need to be able to start and stop data collection on the station.
- Stimulus: Users of the station need to change the state of the device.
- Response: The station is now in the state desired by the user.
- Functionality:
    - The system shall present the user with all options they can use to change the state of the station.
    - The system shall accept user requests to change the state of the system.
    - The system shall transmit commands to change state to the station.

Feature Name: Data Upload to App

- Description: Users of the SSDS will need to be able to request that data collected by the stations be uploaded to their mobile phone.
- Stimulus: The user connects to the station and requests for data to be uploaded.
- Response: The station transmits the data it has collected to the mobile phone and the phone stores the data locally.
- Functionality:
    - The system shall accept user requests to upload data.
    - The system shall transmit a command to the station to send data to the mobile phone.
    - The system shall accept data sent by the station and store the data locally.

Feature Name: Decryption Visualization

- Description: In order to introduce users of the SSDS to concepts of computer security, the decryption of the data received from the station will be displayed in a visual way that a new user can understand.
- Stimulus: Data is uploaded from the station to the mobile phone.
- Response: Data is decrypted and the process is visualized for the user in an easy to understand way.
- Functionality:
    - The system shall decrypt data when received from the station.
    - The system shall present a visualization of the decryption process.

Feature Name: Data management

- Description: The mobile app will need to be able to store data received from the stations. It is possible that no internet connection is available at the time of receipt, so the mobile device may need to store the data for some time- possibly storing multiple data uploads from the station.
- Stimulus: The mobile app receives data from the station.
- Response: The mobile app stores the data locally on the mobile phone.
- Functionality:
    - The system shall store received data locally after reception from the station.
    - The system shall be able to store data from multiple uploads.

Feature Name: App Login

- Description: In order to ensure that only users who are authorized to collected data from and control the settings of stations can access them, the app must be able to authenticate user credentials.
- Stimulus: A user opens the app.
- Response: The app prompts the user for login credentials and verifies them.
- Functionality:
    - 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 stations the user has permission to access.

Feature Name: Data Collection

- Description: The core element of the SSDS is the ability of stations to collect environmental data continuously and store the data locally until it can be sent to a user's mobile app.
- Stimulus: The hardware timer indicates it is time to collect sensor data.
- Response: The device reads from each of its sensors and stores the data locally.
- Functionality:
    - 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.

Feature Name: Device Communication

- Description: In order for the data recorded by the device to be useful it must be able to be transmitted to a users mobile app so it can be stored and viewed.
- Stimulus: The device receives a request from the mobile app over BLE to upload data or to change state.

- Response: The station uploads data via BLE to the mobile device or changes its state.
- Functionality:
    - The system shall be able to connect with the mobile app over BLE.
    - The system shall be able to receive requests from the app.
    - The system shall be able to transmit stored sensor data to the app.
    - The system shall be able to change its state (recording or not recording) upon receiving a request to do so from the mobile app.

Feature Name: Data Encryption

- Description: In order to ensure that only authorized users are receiving data from the station, and in order to introduce users to cyber security concepts, the sensor data to be sent from the station to the mobile app shall first be encrypted.
- Stimulus: The station receives a request to transmit data to the mobile app.
- Response: The data is encrypted.
- Functionality:
    - The system shall encrypt all sensor data prior to transmitting it to the mobile app.

Feature Name: Resource Conservation

- Description: In order for the station to function for its intended one year of operation, careful attention will have to be paid to maximize efficiency to reduce power and memory usage.
- Stimulus: The station is operational.
- Response: The station uses its resources in an efficient manner to make its battery and memory last as long as possible.
- Functionality:
    - The system shall be able to remain on and functional for one year without needing to replace or recharge the battery.
    - The system shall be able to collect data for four weeks without running out of memory.

4 External Interfaces

4.1 User

The website will be serving as a front end for the users to interact with the database. Users must be able to interact with the data, both in the form of visualizations and downloadable datasets. The app will need to enable the user to see which devices they can connect to, and support users interacting with the device they are connected to. The app must also support confirmation of data being downloaded from the station and being uploaded to the website, with the additional step of showing the decryption process when being downloaded from the station.

4.2 Hardware

Because of the physical nature of our project, there is a large hardware component. The board powering the station will communicate with all of its sensors using the general GPIO pins available to the chip. The board will also receive battery power from a power plug built into the PCB.

4.3 Software

The data uploaded from the app must be verified when it reaches the website to make sure that it is authentic data before being added to the database. Both the app and website must support secure user sign-in and sign-out to prevent any malicious activity from occurring.

4.4 Communication

The data collection station shall use BLE to communicate with and transfer data to the app. To transmit the large quantity of data collected, the station and app shall communicate with each other using a well defined protocol for data transmission. When transferring data from the phone to the website, the app shall communicate with the website using a publicly facing and secure RESTful API, while data is transferred between the app and the website over HTTPS.

5 Non-Functional Requirements

5.1 Performance

Battery life of the device is sufficient to store and collect four weeks data, sampled at five minute intervals.
Battery life of the device balanced with storage and data collection

5.2 Safety

The assembly of the device can be performed by a middle school student without risk of exposure to electrical current, punctures in the skin, or other potentially injury-inducing situations. The device itself is properly sealed from water, and security tethered to a solid attachment point to avoid potential environmental impact. The use of a rope and inclusion of a rope attachment point on the device will also minimize the likelihood of accidents and injuries that could take place when the device is placed into water.

5.3 Security

Encrypt/decrypt data going from device to phone
Ensure that the data being sent to the website from the app is authentic and unaltered data
Make sure you can't access a device that isn't yours
The station will be floating about in public, so reasonable precautions should be made to ensure sure that it can't be tampered with
Ensure that the website keeps user data safe and secure

5.4 Quality Attributes

- Availability
    - The website shall accept requests and present data 95% of the time
    - The stations shall be accessible 95% of the time from 6 a.m. to 9 p.m. at 60 second intervals
    - The app shall remain available on the app store 95% of the time
- Efficiency
    - Data should be read from the device to the app in the order of seconds, 30 seconds at most
    - Similar time frame for app to website transfer
    - Keep website responsive and lightweight in the face of a large dataset
    - App should be responsive to user interaction
- Flexibility
    - How quickly the hardware can be modified

    - How easily can another team send their data to the website
        - Documentation of API, data format, etc
    - How easily the app can be adapted to a new device
- Integrity
    - You can't access devices that aren't registered to your account
    - Users can't modify each others devices
    - Website and app prevent false data from being accepted
    - Basic user and data security procedures
- Interoperability
    - Data that can be downloaded can be parsed by R
    - App and device don't modify the BLE protocol
    - Website maintains best practices for the API
- Maintainability
    - Any software bugs should be addressable within a manner of days by someone familiar with the system, and within two weeks by someone new to the system
    - Repair of the hardware could potentially involve replacement of large parts of the station as repairability is sacrificed for reliability
    - There should be a developed maintenance procedure to keep the devices in full working order
- Portability
    - Website runs on reasonable set of browsers
    - App is restricted to Android, but must support the broadest range of devices possible
- Reliability
    - Minimizing data loss over BLE
    - Sensors should have known accuracy ranges
    - Website maintains backups of the database
- Robustness
    - Station will not have any recovery methods for data
    - Durability of the station should at least match the battery life, around 1 year
    - Hardware should be able to survive being shaken around without loss of functionality
    - Station should be completely waterproof
    - Loss of one sensor shouldn't cause a loss of other functionality
    - Website should have enough backups in enough places to maintain data continuity
    - App should be able to maintain data integrity under unexpected circumstances such as sudden power loss
- Testability
    - Must have code to run hardware through its paces
    - App and website have known testing procedures to check functionality of features
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- Usability
    - Campers are able to assemble the devices within the allotted time frame
    - Campers should be able to register the device, connect through the phone, and collect data easily and reliably
    - End users should be able to find the data they want on the website

6 Other Resources

None at this moment