CS Capstone Design Document

December 7, 2018

Slide Sentinel

Prepared for

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Group 29

The Slide Sentinel

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Abstract

This document outlines the requirements for the Slide Sentinel 2018-19 senior capstone project. This document includes both the requirements for the Slide Sentinel and ONE hub projects this team will be working on. Outlined below is the requirements of the projects software for both hubs and the online client.

CONTENTS

1 INTRODUCTION

1.1 Purpose

The documents purpose is to provide an outline of the design going into the software components of the Slide Sentinel and ONE hub projects.

1.2 Scope

Slide Sentinel project consists of a central hub, an array of sensors, and an online mapping visualization. Sensors will collect positional data whenever a change is detected, and sends that data to the central hub. Sensors will collect data on position, orientation, time, and status. The central hub is set to communicate with around 20 sensors in total. Data collected by the central hub will be stored locally for redundancy and sent to an online database using either 4G NB-IoT or satellite communication where it can be analyzed and viewed in a map.

ONE hub project consists of only a hub and the necessary antennae to communicate over the specified radio technology. ONE hub can communicate with other LOOM sensor over either nRF, LoRa, or WiFi. Outgoing data collected by the ONE hub can be sent over either WiFi, 4G NB-IoT, or satellite communication to some cloud storage provider where it can then be sent to a location of the users specification.

1.3 Intended Audience

The Slide Sentinel project intended for Weyerhauser and the ONE hub project is intended for the OPEnS lab headed by Chet Udell.

1.4 Definitions and Abbreviations

- IoT - Internet of Things
- LoRa - Long Range
- nRF - (Nordic) Radio Frequency
- GPS - Global Positioning System
- RTK - Real Time Kinematic (GPS)
- WAN - Wide Area Network
- LPWAN - Low Power WAN
- LTE - Long-Term Evolution
- NB-IoT - Narrow Band IoT

1.5 References

[1] G. L. Marissa Kwon, “Project description for capstone,” document hosted on OPEnSLab google drive.

[2] G. Lund, “Landslide monitor development targets,” document hosted on OPEnSLab google drive.

[3] M. Wright, “The open sound control 1.0 specification,” *OpenSoundControl*, 2002.

1.6 Document Overview

Each of the components listed below is focused on the software side of the component. Some components listed such as those referring to the hubs themselves have some substantial hardware design behind them outlined in other documents for the project. For Slide Sentinel, the components are the enclosure, online visualization, and the software running on the hub itself. The ONE hub components consist of the software running on the hub itself as well as the code to be incorporated into the LOOM library.

2 System Overview

The Slide Sentinel system will provide a way to monitor landslide-prone areas. In addition to passive monitoring, Slide Sentinel will report when conditions indicate that a landslide is occurring. Slide Sentinel will be a specialized use case of the ONE Hub. The ONE Hub will integrate with the OPEnS Lab's LOOM software. The ONE Hub will be able to communicate with other LOOM sensors and report the data collected from them to a cloud storage location.

3 System Architecture

Slide Sentinel has a total of 4 components in total with 3 of them being focused on by the capstone team for design. There are the many sensors collecting positional data, the hub collecting all the data, the weather-resistant enclosure for the hub, and a Google maps visualization build from data stored in a Google sheets page. Below is a diagram of the components are their relationships to each other.

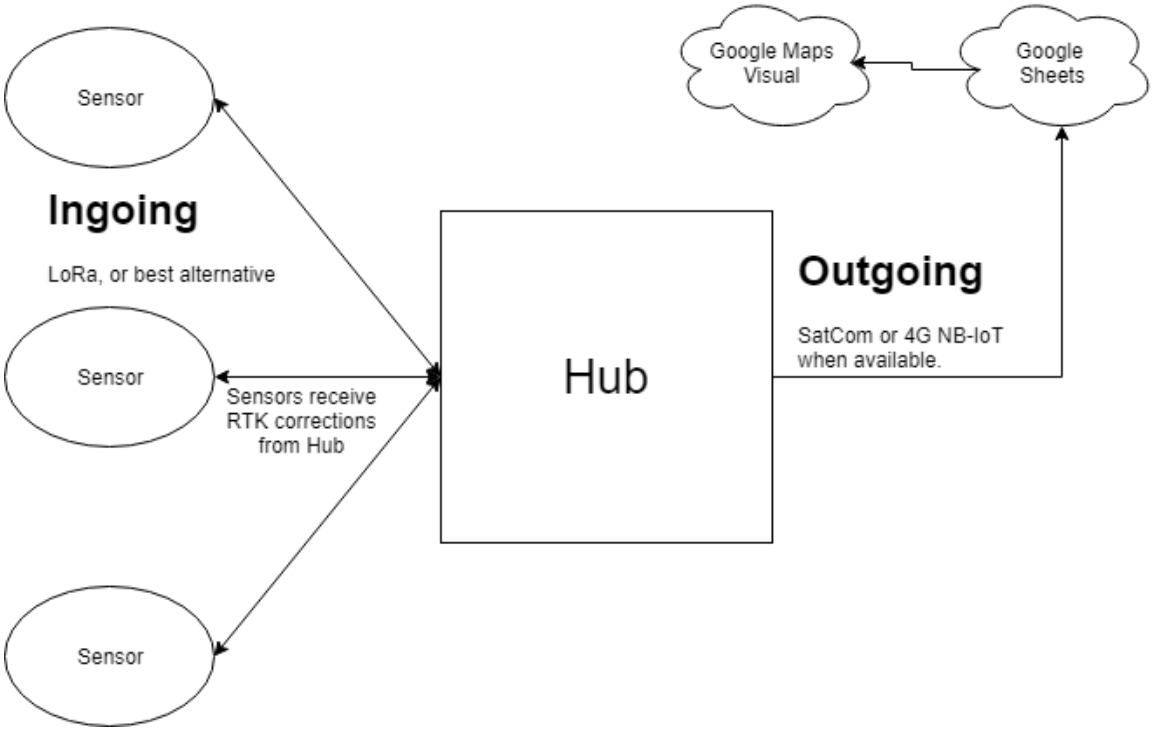

Fig. 1. Relational Diagram of the Slide Sentinel project

The ONE hub project is broken up into 2 components. One of the components is the hub itself and another is the LOOM interpreter. The LOOM interpreter is responsible for correctly configuring the ONE hub from the LOOM software

to the hub will work according to the users specifications in the software. Below is a diagram of the hub and how it will interact with various elements.

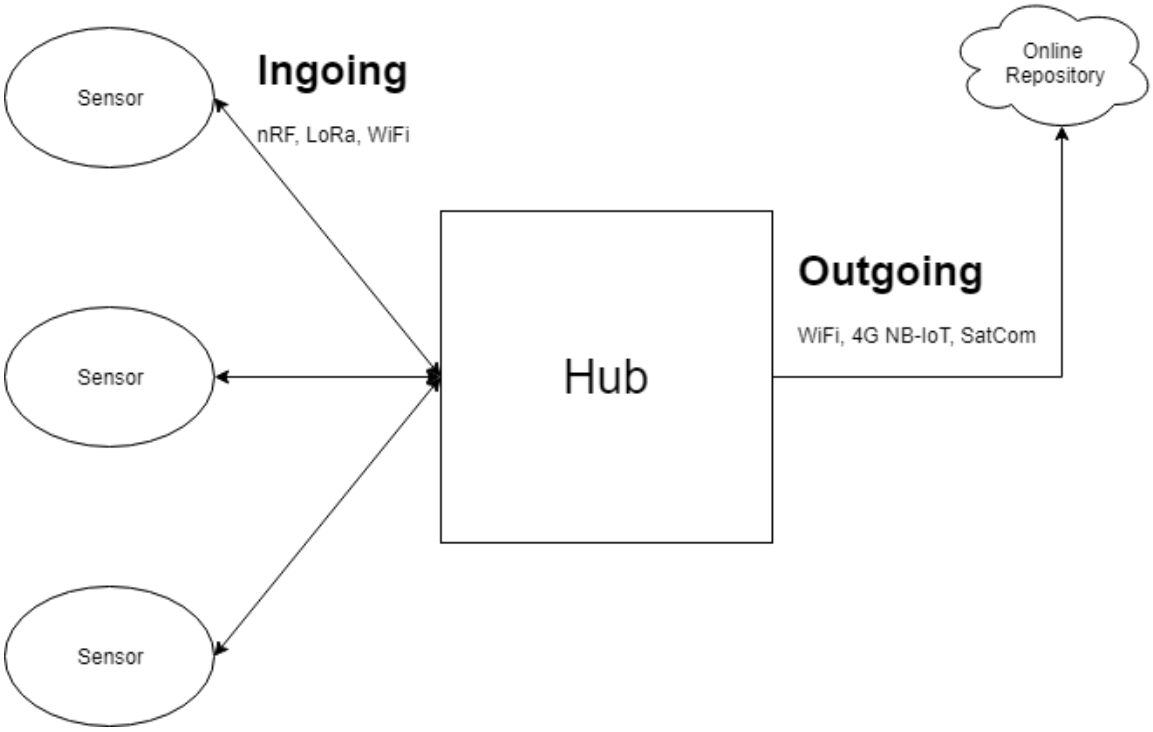

Fig. 2. Relational Diagram of the ONE hub project

4 Major Design Components

The following is a component overview of the components in the Slide Sentinel and ONE hub projects. Slide Sentinel and ONE hub have their own separate sections going over their own components.

5 Slide Sentinel

5.1 Slide Sentinel Hub

The Slide Sentinel Hub will collect data from an array of nodes that report positional data whenever a positional change is detected. The Slide Sentinel Hub will receive data with the nodes over LoRa and communicate RTK correctional data for 1cm precise positioning. The data will then be stored locally on an SD card and also sent to the online visualizer via satellite communication or 4G NB-IoT. Technicians will be able to access the data stored on the SD card if the wireless communications fails. The Slide Sentinel Hub will be based on a Pycom FiPy which runs on Micropython.

5.2 Slide Sentinel Visualization

The Slide Sentinel Visualization will be the only user interface designed by the capstone team. It will be a web page that will be portable to most web browsers. It will display the data that is reported by the Hub on a projection of the area that the sensor nodes are located using the Google maps API. The visualizer will be able to show how the sensor nodes have shifted over time at certain time stamps. In addition to displaying the data visually, the web client will make the raw data available for inspection through the Google sheets API.

5.3 Slide Sentinel Enclosure

There is no software component to the Slide Sentinel Enclosure. However, it is important to mention as it will protect the Slide Sentinel Hub from the elements. The Slide Sentinel Hub enclosure will be 3D printed to allow for quick replacement of broken pieces as well as reducing the overall cost. The enclosure will protect the Hub from water, dust, and small impacts. The enclosure will be printed in ABS and painted to improve its weather resistance. Work on the enclosure will proceed once the final decisions on the hardware elements of the Slide Sentinel hub have been finalized.

6 ONE HUB

6.1 ONE Hub Software

The hub will provide a means for LOOM system users to have multiple sensors communicate over either nRF, LoRa, or WiFi to the central hub to collect data. This data can then be sent over WiFi, 4G NB-IoT cellular, or satellite communication to another repository or service of the users specification such as Pushingbox. Due to the similar nature of the ONE hub and the Slide Sentinel hub, code will be shared between the two where they intersect. The hub will interface with the LOOM library allowing users easy configuration and installation of the ONE hub. Data will also be stored on a local SD flash memory in case the hub is not capable of communicating over its outgoing connection or the user specifies for no offloading of data. The will be powered by a Pycom FiPy similar to that of Slide Sentinel. A typically sequence of operations the hub may take would look like:

1) Hub boots and may read a configuration file for user specific instructions.
2) Hub then goes into a sleep state where the power draw is dramatically less.
3) The hub is woken periodically to send data to either an online repository or a service such as Pushingbox which can route the data elsewhere.
4) The hub is woken when a sensor radio signal is picked up and will either provide the sensor with RTK correctional data or receive data from the sensor on its position and status.
5) After the hub has done the work it needs it will go back to sleep to conserve power use.

6.2 ONE Hub Interpreter

The ONE interpreter is to be an extension of the LOOM library that works to incorporate the ONE hub into the LOOM library of sensors. This piece of software will work in a similar fashion as to those in the LOOM library which will read the user specifications from a configuration file and set up their LOOM system to their liking. This will load all of the necessary scripts and files needed for the ONE hub to properly run, communicate with other sensors, and do any customize actions based on the users input.