Av-Alert: Avalanche Risk Analysis System
Client: Steep Mountaineering

Requirements Specification Document 3.0

Snowlutions

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Revision History

Name	Date	Reason for Changes	Version
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Chua, Jerusha / Eng, Andrew / Joy, Samuel / Schell, Alexander / Siemens, Derek / Voorthuyzen, Sho Ya / Yang, Charles	Sept 26, 2019	Filled out each section from initial outline.	RD 0.8
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Chua, Jerusha / Eng, Andrew / Joy, Samuel / Schell, Alexander / Siemens, Derek / Voorthuyzen, Sho Ya / Yang, Charles	Nov 14, 2019	Edited UI slides to match use cases, created UI storyboards. Edited document for consistency and according to feedback.	RSD 2.3
Chua, Jerusha / Eng, Andrew / Joy, Samuel / Schell, Alexander / Siemens, Derek / Voorthuyzen, Sho Ya / Yang, Charles	Nov 15, 2019	Final content additions, final resolution of outstanding comments and issues, final edits, formatting, and update to Table of Contents.	RSD 3.0

1 Introduction

1.1 Purpose

This document outlines the requirements specifications necessary for version 1.0 of Av-Alert, a new Avalanche Risk Analysis System for the client Steep Mountaineering. Steep Mountaineering's current system relies on manual collection and analysis of snow pit data, which makes real-time risk analysis impossible. Av-Alert's objectives are to make avalanche risk analysis available to each Administrator and Public User in real-time, and to replace manual data collection and analysis with an automated system.

1.2 Project Scope

There are three major objectives for Av-Alert. Av-Alert's first objective is to automate the collection of Avalanche Risk Analysis Data required to track and analyze potential avalanche conditions. Steep Mountaineering's current system requires multiple snow pits to be dug and data to be manually recorded for later analysis. Av-Alert will remove the need for manual data collection, reduce cost and time spent doing so, and improve Resort Staff safety. Av-Alert's second objective is to provide frequent updates and Alerts about the risk factor of an avalanche occurring. Av-Alert will eliminate manual analysis and will update the calculated risk factor when new Avalanche Risk Analysis Data becomes available, increasing safety by allowing Public Users to make informed decisions. Av-Alert's third objective is to create an interface for viewing the Avalanche Forecasts. By creating an interface that can display current Avalanche Forecasts, Steep Mountaineering will be able to reach a wider user base with a product that requires no specialized knowledge for analyzing Avalanche Risk Analysis Data.

1.3 Glossary of Terms

API	Abbreviation for Application Programming Interface. An API specifies how software components will interact.
Administrative Portal	A website that is designed for Administrators to complete tasks and functions related to Av-Alert.
Administrator	System Administrator or Resort Administrator.
Advisory	An Advisory is authorized when a Slope is forecasted as having a medium risk of avalanches. By default it is made up of 2 components: 1. An indication in Av-Alert to each Public User whose Specified Resort is within 50km of the at-risk Slope. 2. A radio broadcast covering 50km from the Resort closest to the at-risk Slope. These conditions can be modified by a Resort Administrator.

Alert	An Alert is authorized when a Slope is forecasted as having a high risk of avalanches. By default it is made up of 3 components: 1. An indication in Av-Alert to each Public User whose Specified Resort is within 50km of the at-risk Slope. 2. A notification sent out to each Public User whose Specified Resort is within 50km of the at-risk Slope. 3. A radio broadcast covering 50km from the Resort closest to the at-risk Slope. These conditions can be modified by a Resort Administrator.
Avalanche Forecast	Risks calculated for Slopes within 50km of a Resort using Av-Alert. The risks are summarized as a Low, Medium, or High Risk of an avalanche for each Slope. Risks are calculated for the next three days.
Avalanche Risk Analysis Data	The correlated and analyzed data from Topological Maps, Remote Sensing Instruments, and Meteorological Data [A-1.6].
Avalanche Risk Analysis Data Set	A collection of Avalanche Risk Analysis Data for a specific date, time and Resort.
Cloud Storage	A service in which data is maintained, managed, and backed up remotely and made available to users over a network (typically the Internet).
Consumer Environment	The public, front facing interface of Av-Alert.
Data Sources	The sources from which data is collected to form the Raw Avalanche Data, these sources are specified for each Resort.
Educational Material	A detailed description of avalanche Educational Material learning objectives to allow all users to learn through videos and text articles.
Emergency Services	Organizations that provide safety and rescue services, such as Search and Rescue. They may be specifically associated with a Resort.
Forecasting Agencies	Weather stations providing data on weather conditions at a location.
High Risk	Equivalent to a considerable danger warning level or higher on the European avalanche danger scale. “A considerable, high, or extreme danger warning level is risk factor 8, 16, or 32 respectively. An avalanche can already be triggered with low additional load (one person), especially on indicated steep slopes. Sometimes and spontaneously, some medium, occasionally also large avalanches are possible.” [8]

Historical Data	Data taken from past events over a long period of time. This data can be used to inform predictive modelling.
Low Risk	Equivalent to a low danger warning level on the European avalanche danger scale. “A low danger warning level is assigned a risk factor of 2. An avalanche can generally only be triggered with high additional loads (groups of people, snow groomer, avalanche dispersion) at isolated points on extremely steep terrain. Spontaneously, only slides and small avalanches are possible. Generally safe conditions.” [8]
Medium Risk	Equivalent to a moderate danger warning level on the European avalanche danger scale. “A moderate danger warning level is risk factor 4 (twice as much as a low danger). An avalanche can be triggered particularly with high additional loads (a group of people, snow groomer, avalanche dispersion), especially on indicated steep slopes. Large spontaneous avalanches are not expected. Mostly favourable conditions. Careful route selection, especially on steep slopes of indicated exposure and altitude.” [8]
Meteorological Data	Information about wind, temperature, air density and humidity.
Mobile Interface	A touch sensitive display for Av-Alert on mobile devices.
Predictive Models	Statistics are used to predict outcomes. Training data is modelled and adjusted to output the best prediction. The predictive models become more accurate as more training data is run through.
Public Users	Users who use Av-Alert but are not employed by Steep Mountaineering or a Resort utilizing Av-Alert.
Push Notification	A notification that appears at the system level of a mobile device, often accompanied with a sound or other notification method.
Radio Broadcasting Equipment	The hardware required to transmit a radio signal. Minimally consisting of: a transmitter, an antenna, and an audio processor.
Radio Equipment	Electronics and software capable of receiving and decoding radio frequencies. Consisting of handheld radios as well as larger units.
Raw Avalanche Data	The uncorrelated and unanalyzed data collected by Avalanche Risk Analysis Data sources for a Resort.

Remote Sensing Instruments	Devices installed into multiple Snow Pit locations at individual Resorts. Data about the Snow Pit is sent to that Resort's Av-Alert system.
Resort	A commercial establishment created for skiing, snowboarding and other winter activities.
Resort Administrator	A subset of Resort staff with privileged access to Av-Alert for administrative tasks related specifically to their Specified Resort.
Resort Profile	A Resort Profile is made up of a collection of Resort specific information such as name, location, Resort Administrators and data sources.
Resort Staff	Individuals employed at a specific Resort.
Risk Analysis Update Intervals	Updates will take place at the following times daily: 6am, 12pm and 6pm [A-1.5].
Risk Factor	Low, Medium, or High Risk
Slope	A surface or area within 50km [A-1.2] of a Resort which can be skied or snowboarded upon.
Snow Pit	A snow pit is a trench exposing a flat, vertical snow face from the snow surface to the ground. It allows people to study the characteristics of the different layers of the snowpack that have developed as the snow has changed due to compaction and weather changes [1].
Specified Resort	The Resort chosen by a Public User for which they want Avalanche Forecasts.
System Administrators	People who are responsible for managing, maintaining, and configuring the reliability of multiple systems.
Topological Maps	A detailed description of the natural and artificial features of an area.
User	One of System Administrator, Resort Administrator, or Public User
Verified Data Source	A data source that has been approved for use in Av-Alert by a System Administrator.
Web Browser Interface	A method of interacting with Av-Alert through a web browser.

1.4 References

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1.5 Overview

This document contains eight sections plus an appendix. The second section describes Av-Alert, including an overview of current systems, major features, user classes, operating environment, as well as constraints to design and implementation. Following that, the third section provides in-depth descriptions of the major system features required by Steep Mountaineering. Next, the fourth section outlines the interfaces required by Steep Mountaineering for user interaction with Av-Alert. The fifth section outlines any non-functional requirements that Av-Alert must meet. The sixth section specifies any additional requirements necessary for Av-Alert. In the seventh section, each of the Use Cases are outlined, and summarized in a Use Case diagram. The Use Cases which are related to high priority system features include a system sequence diagram and a UI flow mock-up. Additionally, Use Cases which are important to client group required features include a UI flow mock-up. The eighth section offers further analysis of Av-Alert, including an Entity-Relationship Diagram, Data Dictionary, and Data Flow Diagrams. The appendix contains a list of clarifications made with the client group.

2 Overall Description

2.1 Product Perspective

Av-Alert is a replacement for Steep Mountaineering's current system of manual data collection for avalanche risk analysis. Manual data collection techniques for avalanche risk analysis are subjective, time-intensive, can put data collectors at risk, and are not able to provide real-time data [2][5]. Av-Alert will replace manual data collection with Remote Sensing Instruments on Slopes within 50km [A-1.2] of a Resort using Av-Alert. These Remote Sensing Instruments will provide objective, safe, and up-to-date Avalanche Risk Analysis Data. Figure 1 represents Steep Mountaineering's current system.

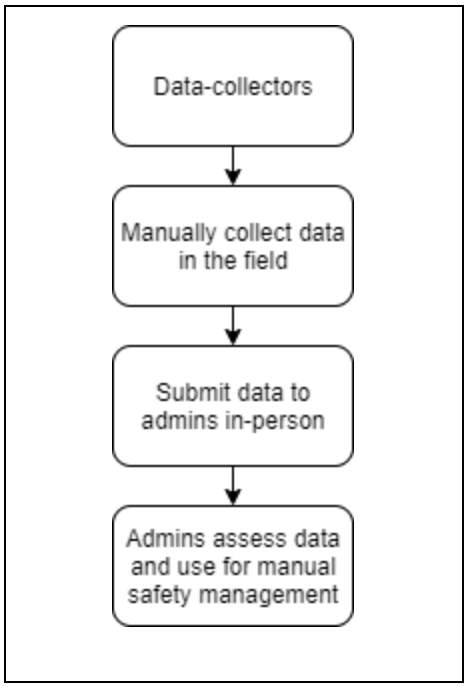


Figure 1: Steep Mountaineering's current system.

2.2 Product Features

Av-Alert consists of six main features. First, the Av-Alert Data Collection feature collects information from Remote Sensing Instruments, weather institutions, and topological maps, to create Avalanche Risk Analysis Data which Av-Alert will use to base its Avalanche Forecast on. Second, the Avalanche Risk Analysis feature uses Predictive Models to create Avalanche Forecasts on Slopes within a 50 km radius of each Resort using Av-Alert. Third, the Alert and Advisory feature delivers Resort specific Alerts and Advisories based on the Avalanche Forecasts to Resort Staff, Emergency Services and Public Users. Alerts and Advisories are delivered through Push Notifications in Av-Alerts Mobile Interface and through radio broadcasts. Fourth, the Topological Avalanche Map feature displays the terrain around a Public User's location with its current Avalanche Forecast. The Topological Avalanche Map and the current

Avalanche Forecast is also downloadable by each Public User. Fifth, the Avalanche Training feature provides Educational Material regarding avalanche safety, and what to do if caught in one. Finally, Av-Alert provides an Administrative Portal feature which allows each Administrator to manage Av-Alert and each Resort on a system wide and Resort level.

2.3 User Classes and Characteristics

Av-Alert has three user classes: System Administrators, Resort Administrators, and Public Users.

2.3.1 Administrators

2.3.1.1 System Administrators

System Administrators have high privilege access on Av-Alert. With high privilege access, System Administrators have full access across Av-Alert and are able to create, delete, or edit Resorts and Resort Administrators, as well as manage Educational Material. Additionally, they are able to edit the Avalanche Risk Analysis Data Sources used at a Resort. The primary tasks of each System Administrator is to ensure the availability of Av-Alert to Public Users. Each System Administrator manages and maintains each Resort Administrator, each Resort Profile, and each Data Source that contributes to Avalanche Risk Analysis Data. In order for System Administrators to access Av-Alert, they must be authenticated through the Administrative Portal.

2.3.1.2 Resort Administrators

Each Resort Administrator is experienced in analyzing Avalanche Risk Analysis Data. Each Resort Administrator has medium privilege access to Av-Alert and these privileges are limited to their assigned Resort. In order for each Resort Administrator to access Av-Alert, they must be authenticated through the Administrative Portal. Within their assigned Resort, each Resort Administrator is able to add other Resort Administrators, monitor mountain conditions, alert Resort Staff and Resort guests of potential avalanches, and manage Educational Material. Each Resort Administrator may update Av-Alert with an Alert or Advisory based off of an Avalanche Forecast and may also update Av-Alert with an Alert or Advisory if they receive information through pre-existing local communication channels outside of Av-Alert, such as Resort Staff communicating an observed change in avalanche conditions over radio.

2.3.2 Public Users

Each Public User does not require any technical knowledge and have low privilege access on Av-Alert. Each Public User does not need to be authenticated and has read-only access to a Topological Map interface showing Avalanche Forecasts, Alerts, Advisories, Avalanche Risk Analysis Data [A-1.3] and Educational Material.

2.4 Operating Environment

Av-Alert will receive information from Topological Maps, Remote Sensing Instruments, and Meteorological Data. Meteorological Data will be retrieved through APIs provided by Forecasting Agencies. Avalanche Risk Analysis Data is stored on Av-Alert's cloud storage. Av-Alert will analyze, correlate, and map the Avalanche Risk Analysis Data to produce a Topological Map interface displaying the Avalanche Forecast. Av-Alert will receive an updated Avalanche Risk Analysis Data Set during the Risk Analysis Update Intervals. The updated Avalanche Risk Analysis Data Set will be analyzed, correlated, and mapped to update the existing Topological Map interface displaying the Avalanche Forecast for the corresponding region.

Av-Alert contains two separate user interfaces, a Mobile Interface and a Web Browser Interface. The Mobile Interface of Av-Alert must support iOS 12.4.3 (last supported version for iOS) on the Apple iOS platform and support Android 7.1.1(last supported version of Android) on the Android platform.

Public Users will be accessing Av-Alert through the Mobile Interface. The Mobile Interface is not required to authenticate Public Users. Administrators must access Av-Alert through the Web Browser Interface. Administrators will be prompted to authenticate with their credentials.

Av-Alert will allow Administrators to broadcast Alerts and Advisories in audio format via Radio Broadcasting Equipment. The audio format Alerts and Advisories will be transmitted through a line out audio port to the Radio Broadcasting Equipment. The audio format Alerts and Advisories will be kept up to date and broadcast on a repeating loop.

2.5 Design and Implementation Constraints

There are four major design and implementation constraints on Av-Alert:

Due to the nature of the environment that Av-Alert will be deployed in, it is required that Av-Alert be able to provide Avalanche Risk Analysis Data for a minimum of 72 hours without primary power.
C-1: Remote Sensing Instruments must be able to maintain full functionality for 72 hours without access to their primary battery power source [A-1.7].

C-2: Av-Alert must stay within the implementation budget of four million CAD [A-1.1].

C-3: Each Administrator must be able to access the Administrative Portal through a Web Browser Interface.

C-4: Each Public User must be able to access public system features through a mobile application.

2.6 Assumptions and Dependencies

The following sections, 2.6.1-2.6.2, outline the assumptions and dependencies of Av-Alert.

2.6.1 Assumptions

Steep Mountaineering will be receiving and collecting Avalanche Risk Analysis Data from weather forecasters, government agencies, and research groups regarding avalanche reports and historical data. If Avalanche Risk Analysis Data received from a source external to Av-Alert contains inconsistencies or is erroneous, such as contrasting data types, measurement units, or values outside of a reasonable range, incorrect analysis of the current conditions may occur. All values will be checked to see if they are metric, and if not, they will be converted into metric.

A-1: Avalanche Risk Analysis Data is standardized and is free of inconsistencies and errors.
A-2: The Avalanche Risk Analysis Data is not required to be stored in a single physical location.
A-3: The Meteorological Data received from the Forecast Agencies API is compatible with Av-Alert.

2.6.2 Dependencies

The alert and Avalanche Risk Analysis Data transmission of Av-Alert is dependent on a multimodal data transmission model. The transmission model attempts to send alerts and Avalanche Risk Analysis Data through cellular towers and radio transmissions.
D-1: Av-Alert must have a data transmission model available at all times.

Remote sensors must have at least two power supplies as a precaution. When a power outage occurs, remote sensors must be powered by a secondary power supply.
D-2: Remote sensors must have a secondary battery power supply [A-1.7].

3 System Features

The following section outlines the core features of Av-Alert with a description of each feature and the feature's functional requirements. Each System Feature description includes a priority ranking the importance of that feature to the core functionality of Av-Alert.

3.1 System Feature 1 - Data Collection

3.1.1 Description and Priority

The Data Collection feature collects Raw Avalanche Data from multiple Data Sources, such as Remote Sensing Instruments, Topological Maps, and weather stations. After collection, this feature turns the Raw Avalanche Data into Avalanche Risk Analysis Data. The Data Collection feature is of high priority as the Raw Avalanche Data collected by the Data Collection Feature provides the basis for Av-Alert's Avalanche Risk Analysis feature.

3.1.2 Functional Requirements

As Data Sources become available or obsolete for a particular Resort, the System Administrator must be able to modify the sources which make up the Raw Avalanche Data for that Resort.

DC-1: Each System Administrator must be able to modify each Data Source for each Resort.

3.2 System Feature 2 - Avalanche Risk Analysis

3.2.1 Description and Priority

The Avalanche Risk Analysis feature is passed the Raw Avalanche Data for each Resort collected by the Data Collection feature mentioned previously. The Avalanche Risk Analysis feature then uses predictive modelling to create Avalanche Risk Analysis Data and the corresponding Avalanche Forecasts. The Avalanche Risk Analysis feature does this for each individual Slope within the 50km range from a Resort which Av-Alert is deployed at. This feature is of high priority as it is imperative that Avalanche Forecasts are accurate, as an inaccurate Avalanche Forecast could result in the injury or death of misinformed Public Users who may be relying on the Avalanche Forecast.

3.2.2 Functional Requirements

In order to allow for further analysis and observations based on more than just the most recently available Avalanche Risk Analysis Data, Av-Alert will provide the option to view each set of previously available Avalanche Risk Analysis Data for each Resort.

ARA-1: Each System Administrator must be able to download each previously stored Avalanche Risk Analysis Data Set.

ARA-2: Each Resort Administrator must be able to download each previously stored Avalanche Risk Analysis Data Set.

ARA-3: Each Public User must be able to download each previously stored Avalanche Risk Analysis Data Set.

3.3 System Feature 3 - Alert and Advisory

3.3.1 Description and Priority

The Alerts and Advisory (AA) feature delivers Alerts and Advisories based on current Avalanche Forecasts to Resort Staff, Emergency Services, and Public Users with access to the Av-Alert app or Radio Equipment. The AA feature has two main methods of transmitting Alerts and Advisories: Push Notifications and Radio Alerts. Alerts and Advisories for a Resort are authorized manually by a Resort Administrator. The AA feature is high priority as it provides actionable information to each Public User, and without it, their lives may be at risk.

3.3.2 Functional Requirements

AA-1: Each Public User must be able to check for each Alert at their Specified Resort.
AA-2: Each Public User must be able to check for each Advisory at their Specified Resort.
AA-3: Each Resort Administrator must be able to authorize each Alert for the Resort they administer.
AA-4: Each Resort Administrator must be able to authorize each Advisory for the Resort they administer.
AA-5: Each Public User must be able to receive each radio alert within the 50km radius around Resort location.

3.4 System Feature 4 - Topological Avalanche Map

3.4.1 Description and Priority

The Topological Avalanche Map feature visualizes the Avalanche Forecast [A-1.4] made by the Avalanche Risk Analysis feature. The Topological Avalanche Map feature overlays the Avalanche Forecast onto a topological map of the selected area, colour coding the Slopes with the computed Risk Factor of an avalanche occurring, from green (Low Risk) to red (High Risk). The Topological Avalanche Map feature is of high priority as it is one of Av-Alert's main components.

3.4.2 Functional Requirements

TAM-1: Each Public User must be able to search for each resort location.
TAM-2: Each Public User must be able to view the Avalanche Forecast of their Specified Resort.
TAM-3: Each Public User must be able to update to the most recent Avalanche Forecast for their Specified Resort.
TAM-4: Each Public User must be able to download the current Topological Avalanche Map with the associated Avalanche Risk Analysis Data Set used to create its Avalanche Forecast.

3.5 System Feature 5 - Avalanche Training

3.5.1 Description and Priority

The Avalanche Training feature provides each Public User with Educational Material such as how to identify Slopes at High Risk of avalanches and what to do during an avalanche. Public Users are able to access and download Educational Material on their mobile device. The Avalanche Training feature is of medium priority as it is not essential to core functionality of Av-Alert, however, it is still important as it provides possibly life-saving information for Public Users.

3.5.2 Functional Requirements

AT-1: Each Administrator must be able to create new Educational Material.
AT-2: Each Administrator must be able to edit each Educational Material.
AT-3: Each Administrator must be able to delete each Educational Material.

AT-4: Each Public User must be able to access each Educational Material.
AT-5: Each Public User must be able to download each Educational Material for offline usage.

3.6 System Feature 6 - Administrative Portal

3.6.1 Description and Priority

The Administrative Portal feature provides an interface for Administrators to manage Av-Alert on a system wide and Resort level. The Administrative Portal is of high priority as it is essential in the management of Av-Alert, its Resorts and Administrators by providing an interface for activities such as creating, editing or deleting a Resort or Resort Administrator, as well as changing the information found in a Resort Profile.

3.6.2 Functional Requirements

AP-1: Each System Administrator must be able to create a new Resort Profile.
AP-2: Each System Administrator must be able to edit each pre-existing Resort Profile.
AP-3: Each System Administrator must be able to delete each pre-existing Resort Profile.
AP-4: Each System Administrator must be able to create a new Resort Administrator for any Resort.
AP-5: Each Resort Administrator must be able to create a new Resort Administrator for their specified Resort.
AP-6: Each System Administrator must be able to edit each Resort Administrator's first name, last name, and the assigned resort.
AP-7: Each Administrator must be able to sign in to the Administrative Portal.

4 External Interface Requirements

4.1 User Interfaces

4.1.1 Public Interface

The public interface is accessed by Public Users and is used to access the front-facing features of Av-Alert, such as the Topological Avalanche Map and Educational Material. Additionally, through the public interface Public Users will receive Alerts and Advisories.

PI-1: Av-Alert must present each Avalanche Forecast as a Topological Map.
PI-2: Each Avalanche Forecast on the Topological Map must be colour coded.

4.2 Hardware Interfaces

The following sections describe the hardware interfaces which Av-Alert will interact with and the requirements for those interactions.

4.2.1 Weather Collection Stations

Av-Alert will collect Meteorological Data from the BC Ministry of Environment Meteorological Data collection stations. The BC Ministry of Environment Meteorological Data collection stations remotely sense snow and provide Meteorological Data that is uploaded in near real-time [3]. The Meteorological Data is uploaded hourly and transmitted through a geostationary satellite network. The Meteorological Data is freely available to download in csv format.

WCS-1: Av-Alert must collect data from the BC Ministry of Environment Meteorological Data collection stations.

4.2.2 Remote Sensing Instruments

Remote Sensing Instruments are capable of acquiring snow depth data over large spatially continuous areas. Land-based laser scanning has already proven its ability to monitor the spatial distribution of snow depth in subsets of single alpine catchments [4]. Air-borne or spaceborne sensors, cover several hundreds of square kilometers in one data acquisition.

RSI-1: Av-Alert must collect data from Remote Sensing Instruments.

4.3 Software Interfaces

SI-1: Each Public User must be able to access and view the Av-Alert mobile application on their mobile device.
SI-2: Each Public User must be able to see the most up-to-date Avalanche Forecasts at all times.
SI-3: Each Administrator must be able to see the most up-to-date Avalanche Forecasts at all times.

As the Data Collection feature fetches information from its Data Sources, the information will naturally come in different forms. To prevent errors during the creation of Avalanche Forecasts, data types and measurement units should be standardized to metric.
SI-4: The Data Collection feature must standardize each data type and measurement unit it collects from varying information sources.

Av-Alert's data must be stored remotely and accessible via the internet to ensure data reliability and security.
SI-5: All Resort data must be stored in cloud storage.
SI-6: All Administrator data must be stored in cloud storage.
SI-7: All Alerts and Advisories data must be stored in cloud storage.
SI-8: All Educational Material must be stored in cloud storage.

4.4 Communications Interfaces

For radio communications, Av-Alert is to convert Alerts and Advisories to an audio format, similar to NOAA's Weather Radio [7]. Audio format Alerts and Advisories will then be transmitted by a Resort Administrator using the Administrative Portal through the line out audio port to their Resort's Radio Broadcasting Equipment. Transmission of the audio format Alerts and Advisories is the responsibility of each Resort Administrator.

CI-1: Av-Alert must convert Alerts and Advisories to a standard audio format.

CI-2: Audio format Alerts and Advisories must be transmitted via radio to at least 50km around the Resort to which they pertain.

5 Other Non-Functional Requirements

5.1 Safety Requirements

If misinformation is spread to Resort staff, misunderstanding will occur. Misunderstandings can result in unsatisfactory safety precautions taking place such as not closing off a high-risk Slope, and can result in Public User injury or death.
SAR-1: Av-Alert must alert Resort staff of every potential avalanche.

Av-Alerts Public Users require Avalanche Forecasts to be regularly updated at precise times each day so that they may make educated decisions about their present and future activities at their Specified Resort.
SAR-2: Av-Alert must update the Avalanche Forecast for each Resort at precise intervals: 6:00am, 12:00pm, and 6:00pm [A-1.5].

5.2 Security Requirements

Integrity of Avalanche Risk Analysis Data is important. If Avalanche Risk Analysis Data is tampered with, it could result in misinformation or false forecasts leading to user injury and loss of life.
SER-1: Incoming Raw Avalanche Data must be encrypted after entering Av-Alert.

SER-2: Each System Administrator must have high privilege access in order to manage and maintain Av-Alert, each Resort, each Data source, and each other Administrator.
SER-3: Each Administrator must be authenticated to use Av-Alert.
SER-4: Each Public User must not be able to gain privileged access to Av-Alert.

5.3 Reliability Requirements

Due to the extreme cold, heavy snow and freeze-thaw cycles found in the problem domain and importance that Av-Alert must be reliable, the hardware must be able to function in any weather condition.

RR-1: Av-Alert's hardware, such as Remote Sensing Instruments, must work in all weather conditions.

As aspects of any system can temporarily go down, it is important to ensure that in such an event the Data Collection feature continues to function as normal.
RR-2: The Data Collection feature must not halt if one of the Data Sources is unreachable.

5.4 Testability Requirements

TR-1: Av-Alert's Radio Alert feature must be tested daily to ensure it stays operational.

5.5 Software Quality Attributes

SQR-1: Av-Alert's Avalanche Forecasts must be presented in ways that adhere with UI/UX best practices to ensure readability and clarity [6].

The terrain of the problem domain could prevent ease of access to both Resort Staff and Resort Administrators, making maintenance tasks more complex. Therefore it is important to maximize maintainability.
SQR-2: Av-Alert must be developed as a series of independent subsystems.

SQR-3: Av-Alert must be capable of receiving and processing Avalanche Risk Analysis Data inflows from in-field sensors.

6 Other Requirements

In the unfortunate event of an avalanche, it is important that no liability is held by Snowlutions or the Resort using Av-Alert. Av-Alert only provides the risk analysis of an avalanche based on the available Avalanche Risk Analysis Data. It serves only as an approximation of the risk Public Users are exposed to as they make choices for themselves.
OR-1: All Public Users must agree to the Terms and Conditions of using Av-Alert.
OR-2: Av-Alert's Terms and Conditions must include that Av-Alert is not held liable in the event of injury or loss of life due to an avalanche.
OR-3: Av-Alert's Terms and Conditions must include that Av-Alert is not held liable in the event of misinformation stemming from Avalanche Risk Analysis Data.

7 Use Case Diagram

Below, through a Use Case Diagram, is displayed how users will interact with Av-Alert.

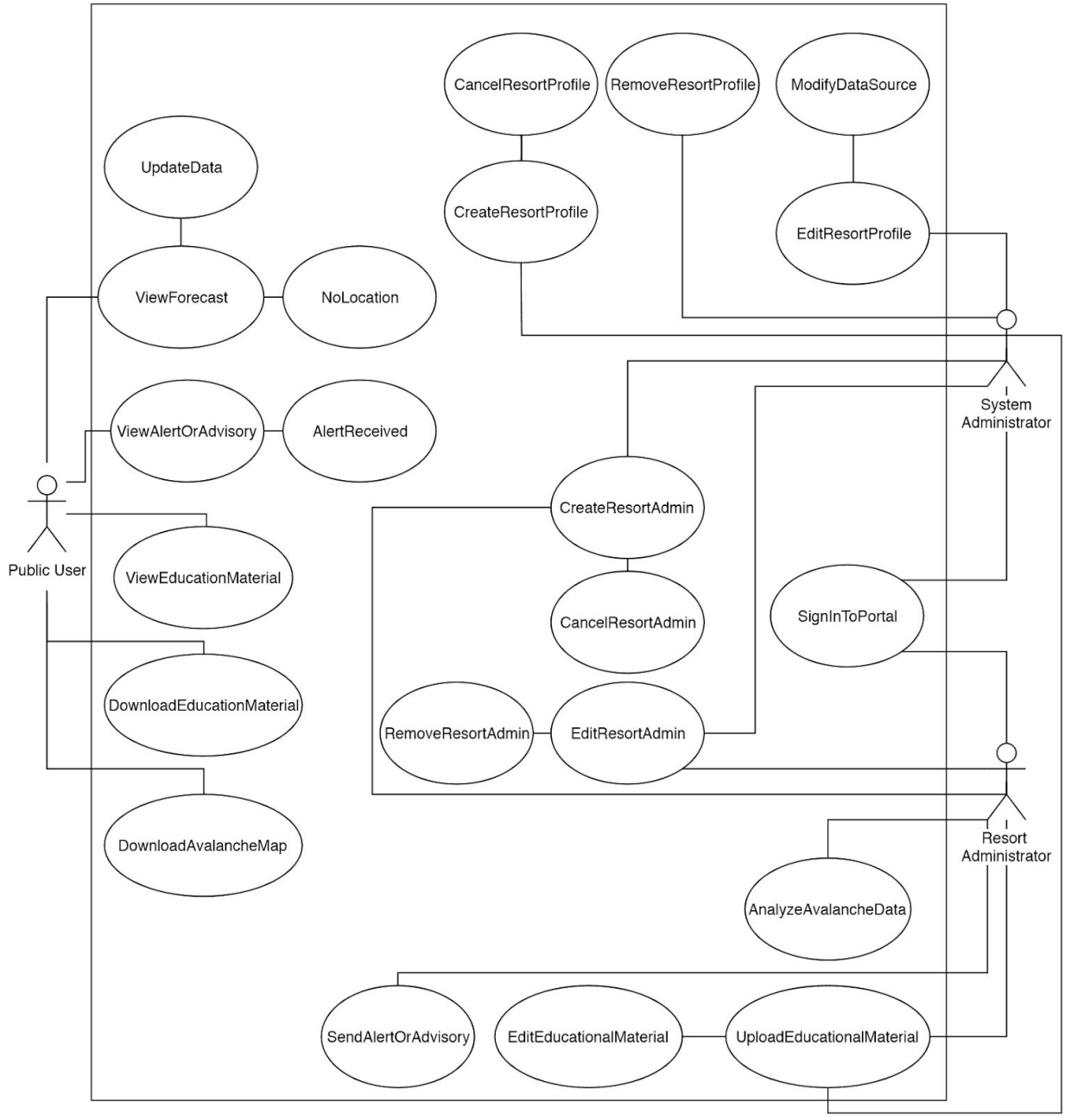


Figure 2: Use Case Diagram.

7.1 Use Cases

The following section outlines the different use cases that a Public User or Administrator may follow. Use Cases regarding high priority system features are followed by a System Sequence Diagram. Use Cases regarding high priority system features and Use Cases which are important to client specified system features are followed by a User Interface Storyboard. System Sequence Diagrams and User Interface Storyboards are not included for the high priority Use Cases: CreateResortProfile, EditResortProfile, and RemoveResortProfile. This exclusion is due to their close similarity with the Use Cases: CreateResortAdmin, EditResortAdmin, and RemoveResortAdmin.

Use Case: ViewForecast	
ID:	1
Brief description:	The Public User views Avalanche Forecast through the Topological Map.
Actor(s):	Public User.
Preconditions:	1. The Public User has low privilege access to Av-Alert. 2. The Public User has GPS location provided to Av-Alert.
Main flow:	1. The Public User selects the Topological Map. 2. If the Public User has not provided a location to Av-Alert then: 2.1. The Public User manually selects a Resort as their Specified Resort. 3. If the Public User adjusts the view of the Topological Map then: 3.1. Public User sees an updated view of the Topological Map. 4. The Public User selects a Slope of the Topological Map. 5. The Public User sees the Forecast for that area.
Postconditions:	1. If the Public User selected a Specified Resort then: 1.1. Av-Alert has cached the Resort on the Public User's mobile device.
Alternative flow(s):	UpdateData

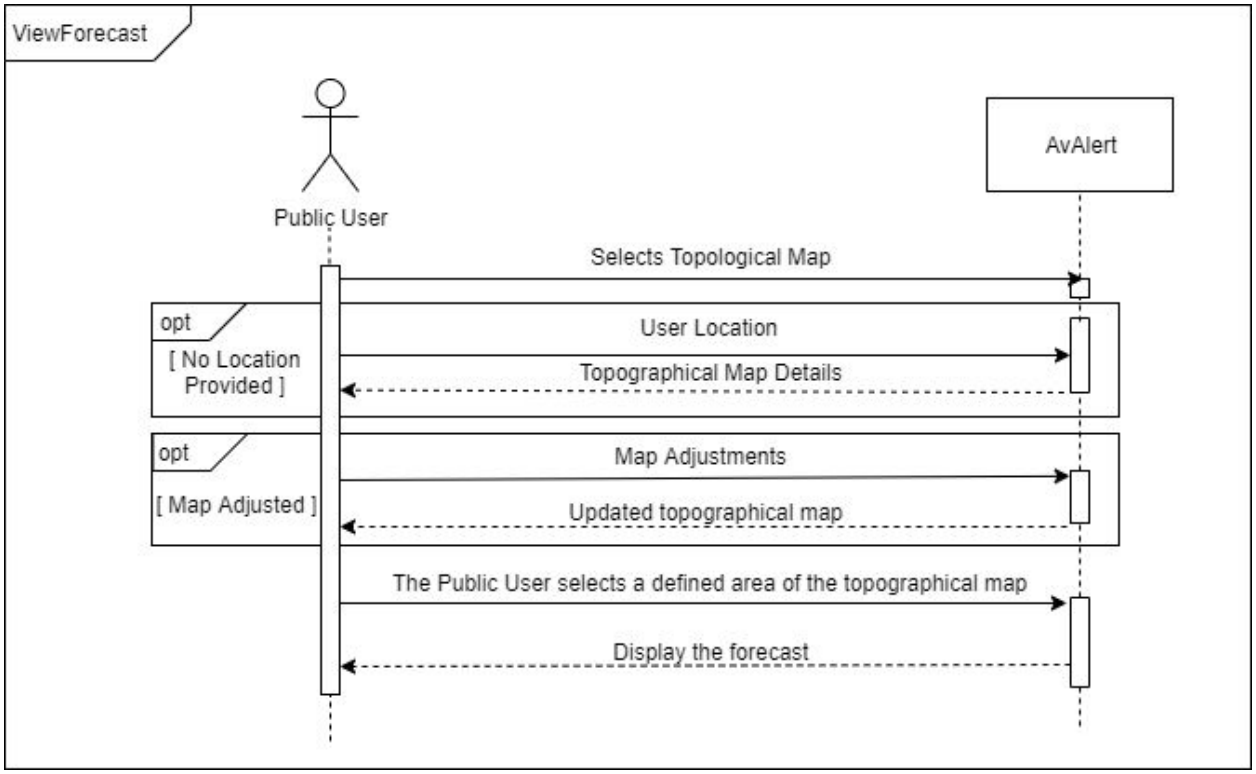
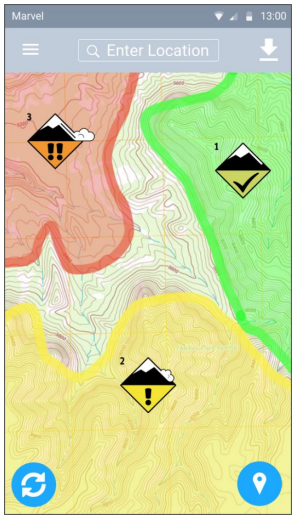
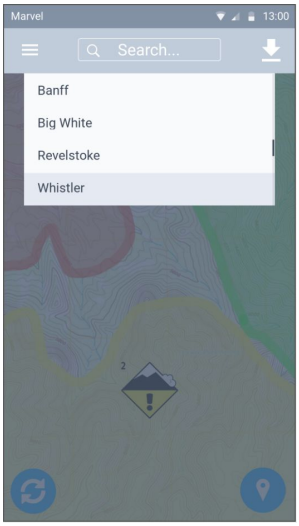
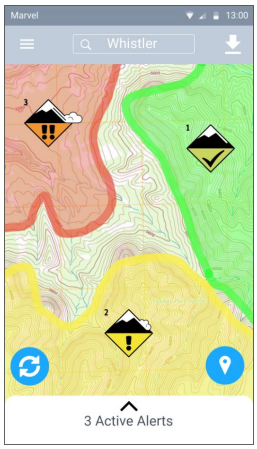
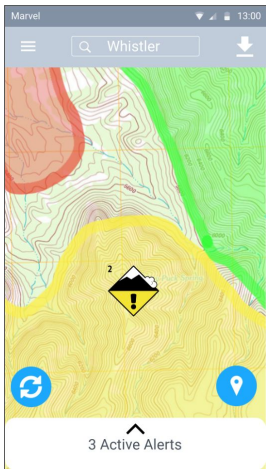


Figure 3: System Sequence Diagram - Use Case 1.

<table>
<tr><td colspan="3">The Public User Without a Specified Resort Views Forecast</td></tr>
<tr><td>1. The Public User is viewing the Topological Map.</td><td colspan="2">2. After selecting “Enter Location”.</td></tr>
<tr><td> 
</td><td colspan="2"> 
</td></tr>
<tr><td>3. After selecting a Resort from the list of Resorts.</td><td>4. After adjusting the map by zooming map into a Medium Risk Slope.</td><td>5. After selecting the Medium Risk Slope.</td></tr>
<tr><td> 
</td><td> 
</td><td> 
</td></tr>
</table>

Alternative Flow: ViewForecast: UpdateData	
ID:	1.1
Brief description:	The Public User updates the Avalanche Risk Analysis Data on the Topological Map.
Actor(s):	Public User.
Preconditions:	None.
Alternate flow:	The alternate flow begins at any time. 1. The Public User updates the information on the map by selecting the refresh option. 2. If Av-Alert is able to retrieve Avalanche Risk Analysis Data on the Topological Map which is newer than the current Avalanche Forecast loaded on Av-Alert then: 2.1. The Public User's view of the Topological Map is updated with the new Avalanche Risk Analysis Data. 3. Else the Public User sees that no new Avalanche Risk Analysis Data is available.
Postconditions:	None.

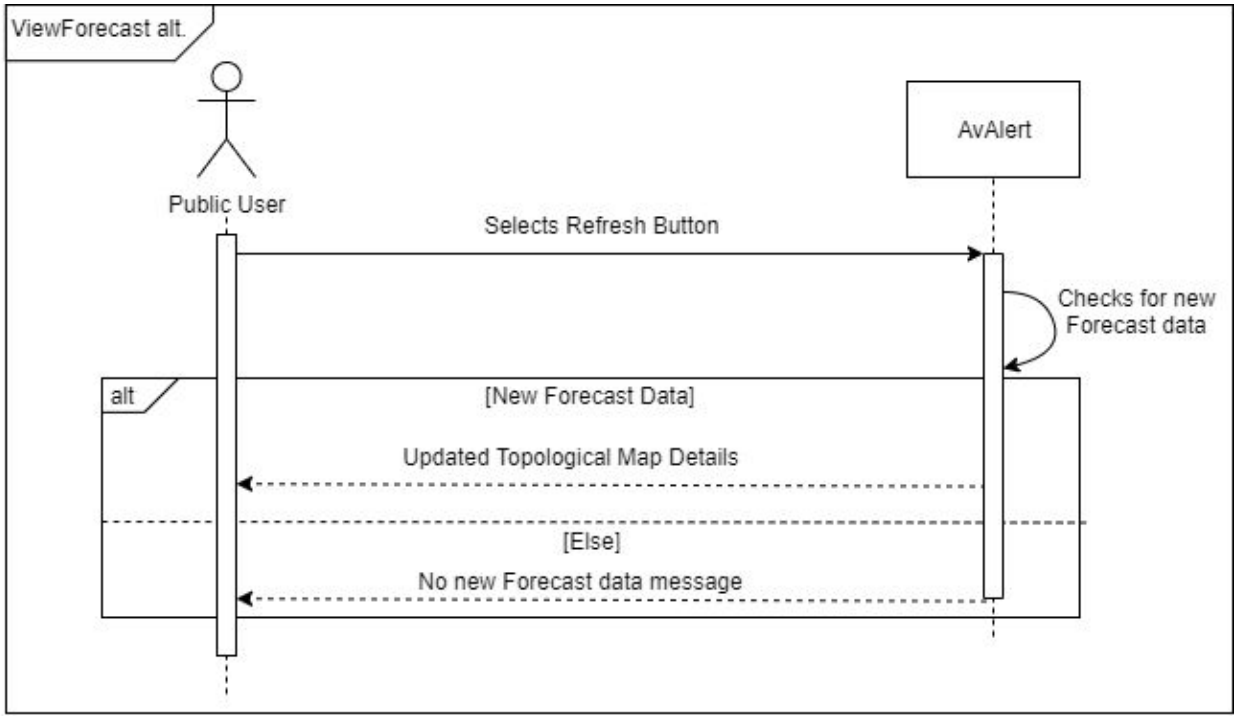
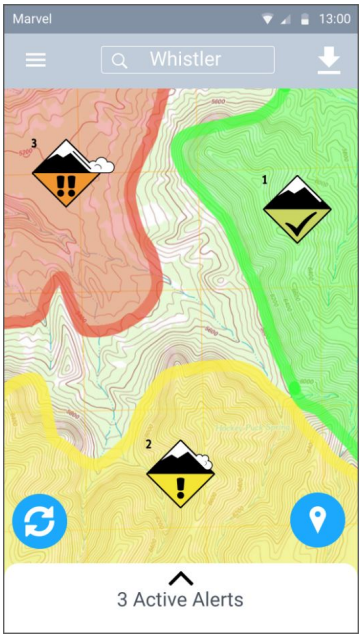
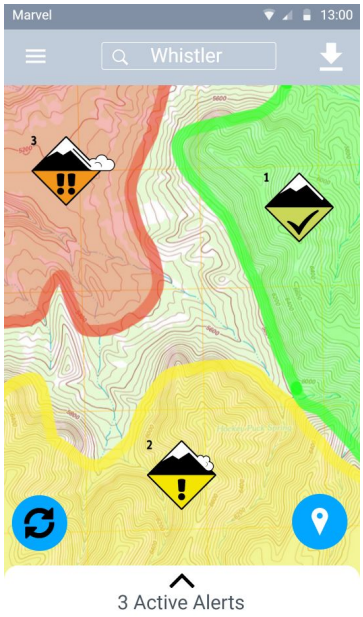


Figure 4: System Sequence Diagram - Use Case 1.1.

<table>
<tr><td colspan="2">The Public User Updates Map Data</td></tr>
<tr><td>1. The Public User has previously selected “Whistler” as their Specified Resort.</td><td>2. After selecting update button in the bottom left corner.</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td colspan="2">3. After the Public User is notified that the Topological Map has been updated.</td></tr>
<tr><td colspan="2"> 
</td></tr>
</table>

Use Case: DownloadAvalancheMap	
ID:	2
Brief description:	The Public User downloads the Topological Map for offline use.
Actor(s):	Public User.
Preconditions:	1. The Public User has read-only access to Av-Alert. 2. The Public User has cell service or Wi-Fi connection. 3. The Public User has selected their Specified Resort.
Main flow:	1. The Public User selects the Topological Map. 2. The Public User selects the option to download the map.
Postconditions:	1. The map is downloaded to the Public User's mobile device and stored in the application memory.
Alternate flow:	None.

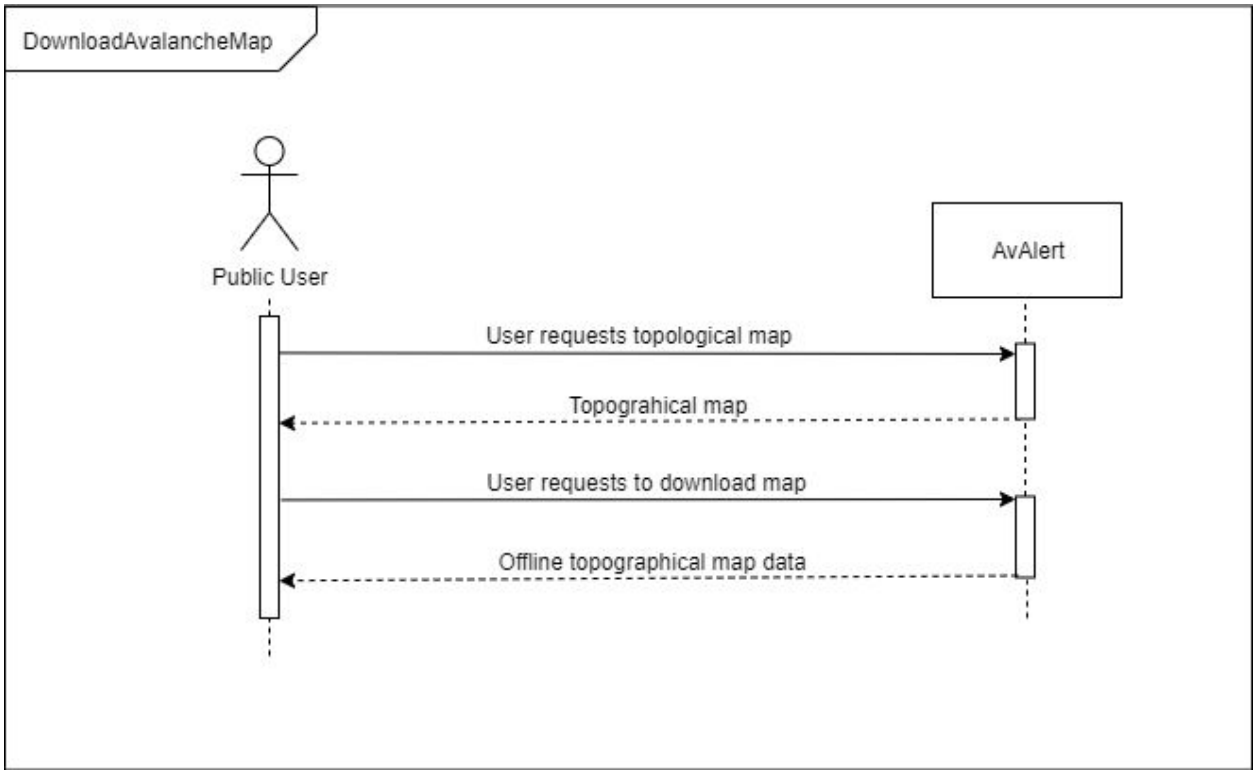
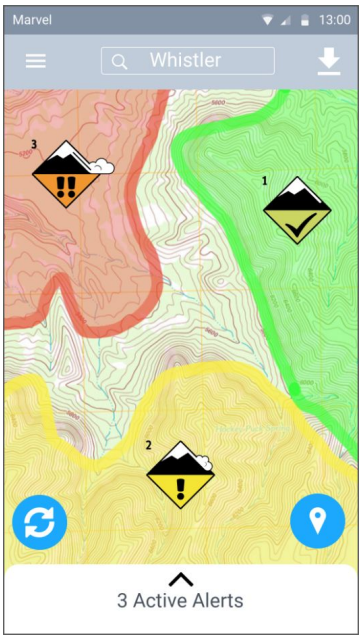
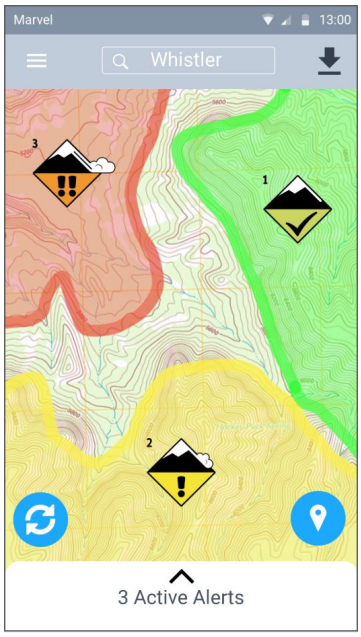
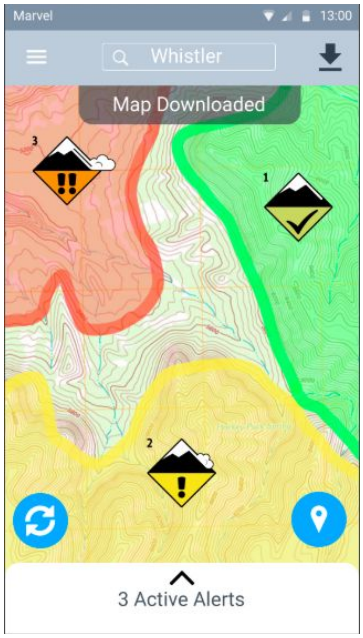


Figure 5: System Sequence Diagram - Use Case 2.

<table>
<tr><td colspan="2">The Public User Downloads Map to their Device</td></tr>
<tr><td>1. The Public User is at the Topological Map screen.</td><td>2. After selecting the download button in the top right corner.</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td colspan="2">3. After the Public User is notified that the Topological Map has been downloaded.</td></tr>
<tr><td colspan="2"> 
</td></tr>
</table>

Use Case: ViewAlertOrAdvisory	
ID:	3
Brief description:	The Public User views an Alert or Advisory pertaining to an avalanche forecast.
Actor(s):	Public User.
Preconditions:	1. The Public User has read-only access to Av-Alert.
Main flow:	1. The Public User navigates to the list of Alerts and Advisories. 2. The Public User sees the list of Alerts and Advisories, sorted in order of most recently received. 3. The Public User selects an item from the list of Alert and Advisories 4. The Public User sees the expanded view of the selected Alert or Advisory.
Postconditions:	None.
Alternative flow(s):	AlertReceived.

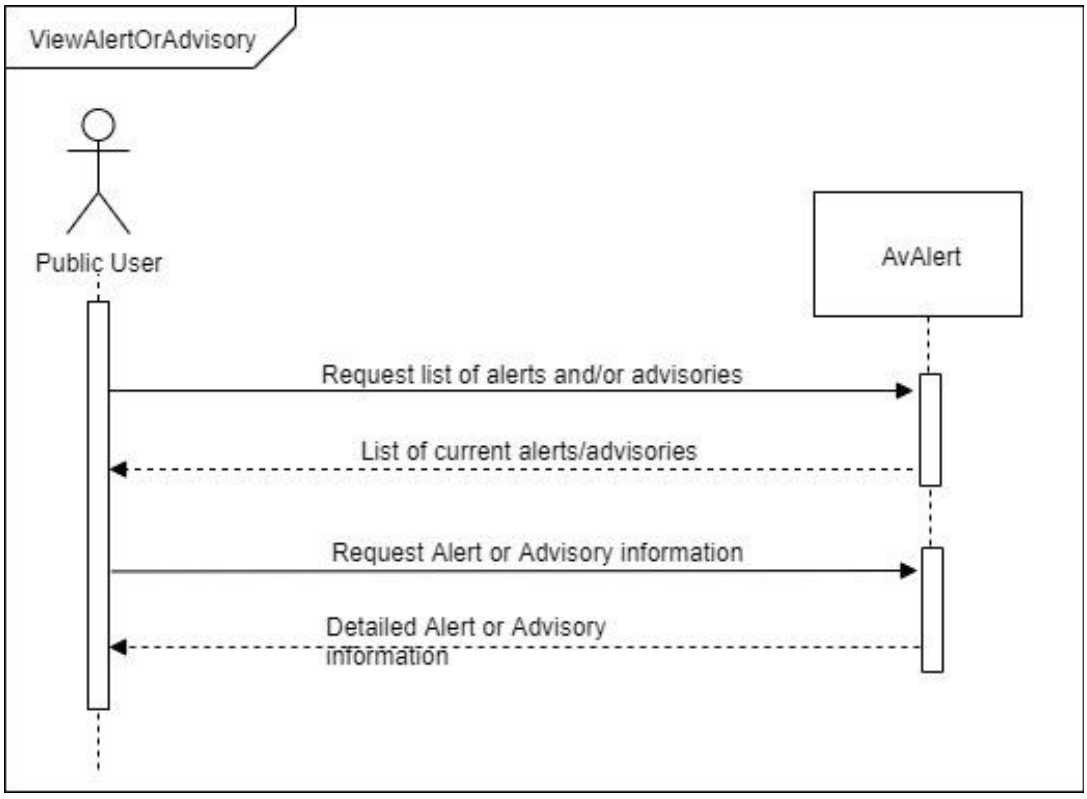
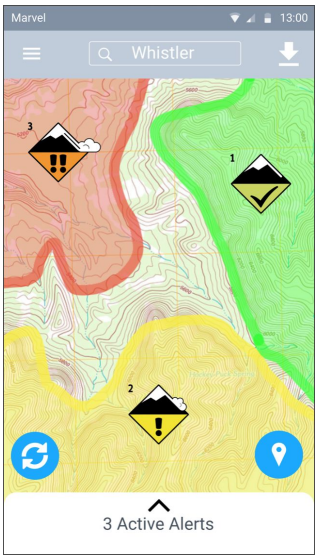
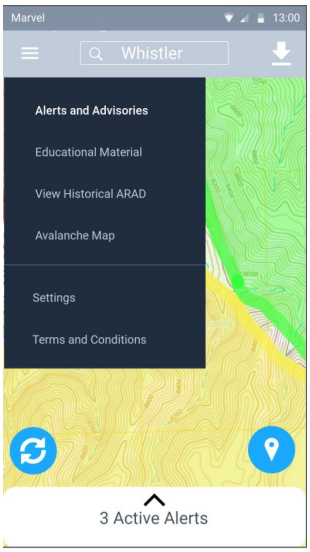
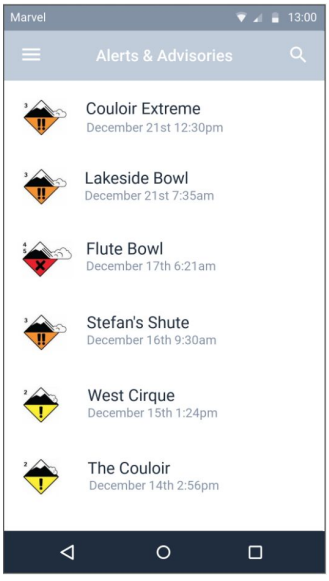
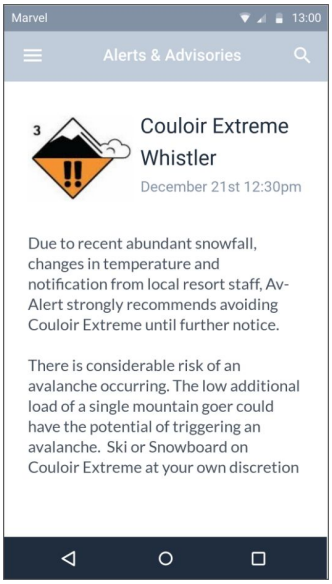


Figure 6: System Sequence Diagram - Use Case 3.

The Public User Views a Specific Slope Alert	
1. The Public User is at the Topological Map screen.	2. After selecting the hamburger button in the top left corner.
	
3. After selecting "Alerts and Advisories" from the list of options.	4. After selecting the first Alert in the list of Alerts and Advisories.
	

Alternative Flow: ViewAlertOrAdvisory: AlertReceived	
ID:	3.1
Brief description:	The Public User opens a received Alert.
Actor(s):	Public User.
Preconditions:	1. The Public User has read-only access to Av-Alert. 2. An Alert has been sent out to the Resort which matches the Specified Resort of the Public User.
Alternate flow:	1. The Public User has received a push notification on their mobile device notifying them of an Alert. 2. The Public User selects the notification. 3. The Public User is directed by Av-Alert to the received Alert. Main flow is entered at step 4.
Postconditions:	1. Alert is now marked as read but remains available for viewing.

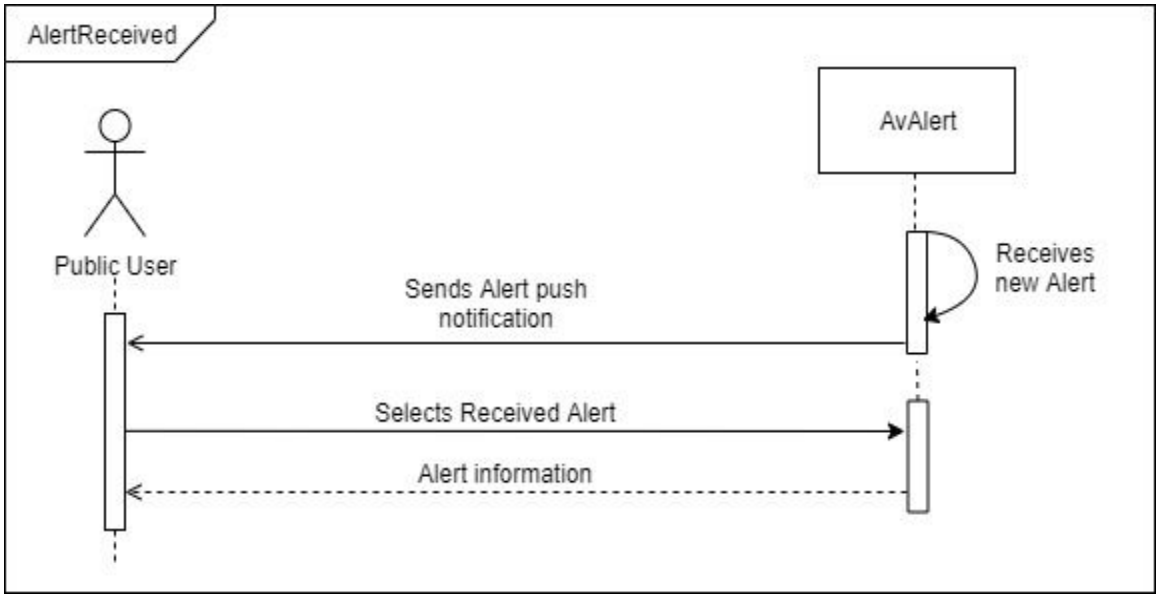
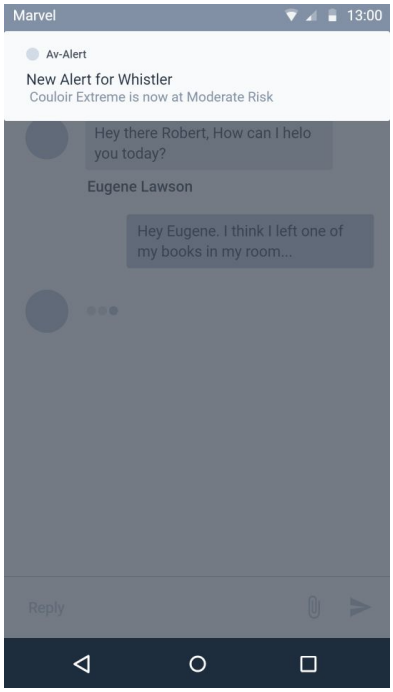
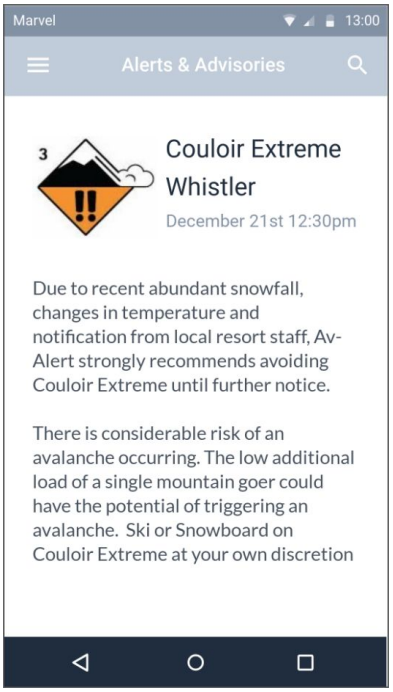
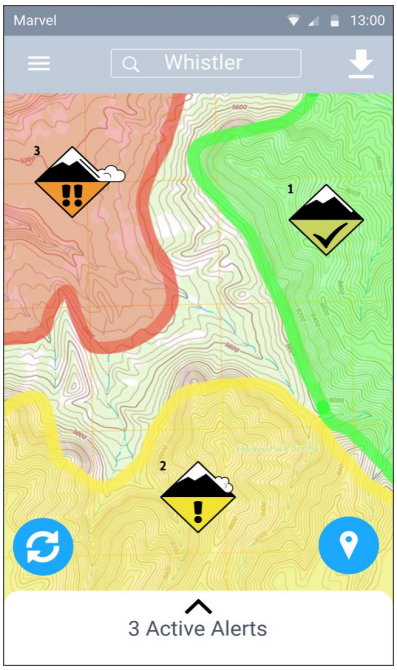
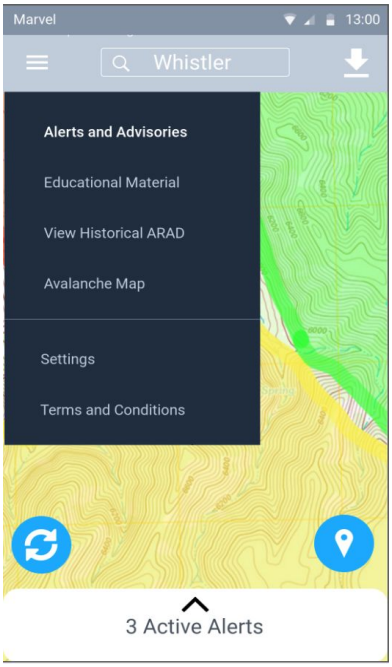
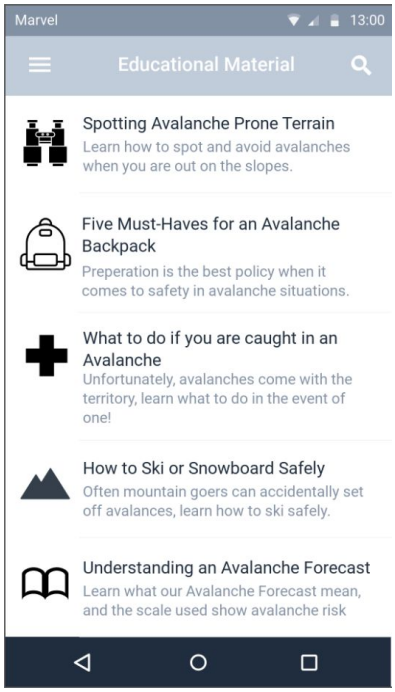
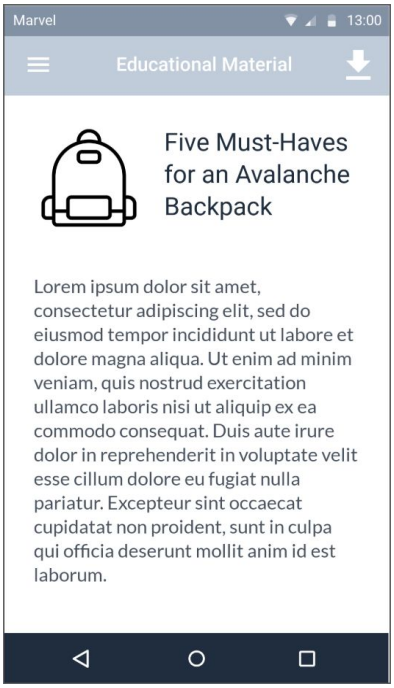


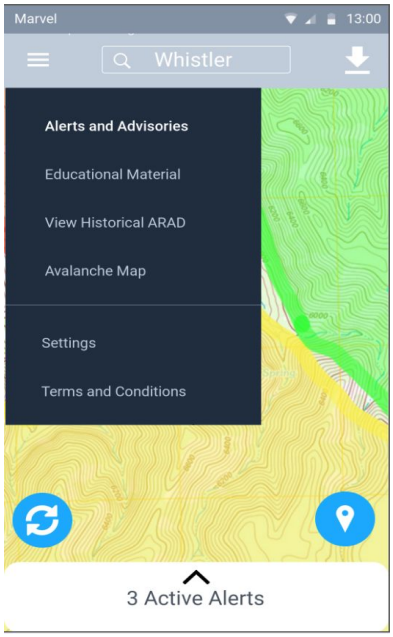
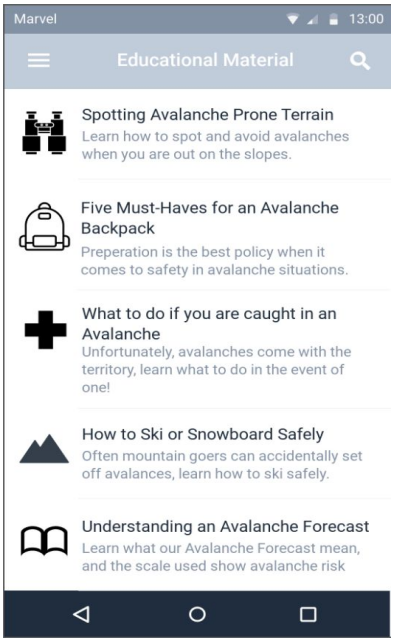
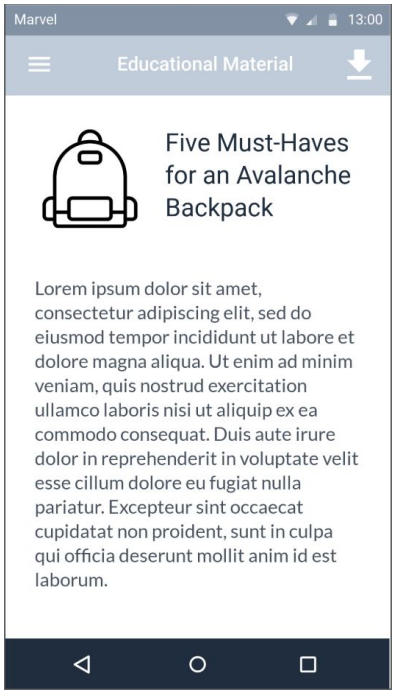
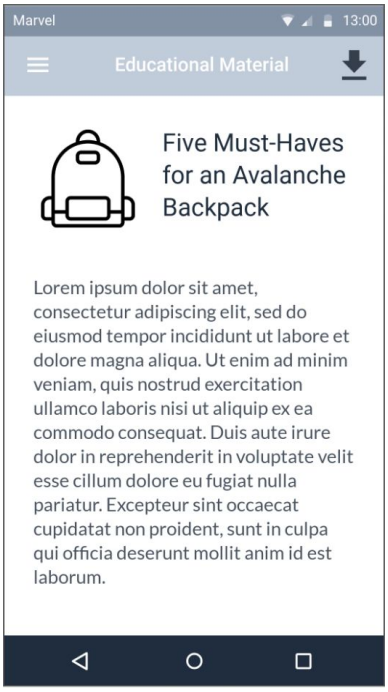
Figure 7: System Sequence Diagram - Use Case 3.1

The Public User Receives an Alert While Outside of Av-Alert App	
1. The Public User is notified of an Alert using a Push Notification.	2. After selecting the Push Notification the Av-Alert application is opened directly to the Alert.
	

Use Case: ViewEducationalMaterial	
ID:	4
Brief description:	The Public User views Educational Material information relevant to avalanche risk.
Actor(s):	Public User.
Preconditions:	1. The Public User has read-only access to Av-Alert.
Main flow:	1. The Public User navigates to the Educational Material section. 2. The Public User sees a list of Educational Material materials sorted in order of most recently published. 3. The Public User selects a piece of content. 4. The Public User sees the expanded view of the selected safety or training content. 5. If the selected content contains video content then: 5.1. The Public User presses the play button to start the video content. 5.2. The Public User views the video content.
Postconditions:	None.
Alternative flow(s):	None.

Public User Views a Specific Piece of Educational Material	
1. The Public User is at the Topological Map screen.	2. After selecting the hamburger button in the top left corner.
	
3. After selecting “Educational Material” from the list of options.	4. After selecting the second piece of content from the list of Educational Materials.
	

Use Case: DownloadEducationalMaterial	
ID:	5
Brief description:	The Public User downloads a piece of Educational Material information.
Actor(s):	Public User.
Preconditions:	1. The Public User has read-only access to Av-Alert. 2. The Public User has cell service or Wi-Fi connection.
Main flow:	1. The Public User navigates to the Educational Material section. 2. The Public User sees a list of Educational Material materials sorted in order of most recently published. 3. The Public User selects a piece of content. 4. The Public User sees the expanded view of the selected safety or training content. 5. The Public User selects the download option for that piece of content.
Postconditions:	1. The selected content is downloaded to the Public Users mobile device and stored in the application memory.
Alternative flow(s):	None.

<table>
<tr><td colspan="2">The Public User Downloads a Specific Piece of Educational Material</td></tr>
<tr><td>1. The Public User is at the options menu.</td><td>2. After selecting “Educational Material” from the list of options.</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>3. After selecting the second piece of content from the list of Educational Materials.</td><td>5. After selecting the download button in the top right corner.</td></tr>
<tr><td> 
</td><td> 
</td></tr>
</table>

Use Case: SignInToPortal	
ID:	6
Brief description:	The Administrator wants to sign in to the Administrative Portal.
Actor(s):	System Administrator or Resort Administrator.
Preconditions:	1. The Administrator has previously created an account.
Main flow:	1. The Administrator opens the Administrative Portal 2. The Administrator enters their username and password. 3. While the username and password are incorrect then: 3.1. The Administrator is prompted to enter their credentials again. 4. The Administrator is verified and signed into their account.
Postconditions:	1. The Administrator is now signed into the Administrative Portal.
Alternative flow(s):	3.1 b) Username not recognized. 3.1 c) Password incorrect.

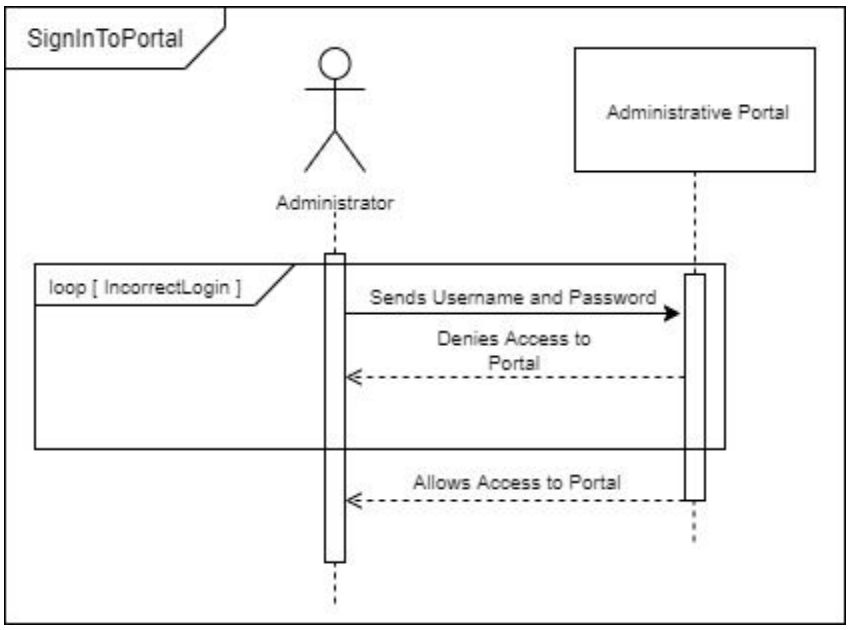
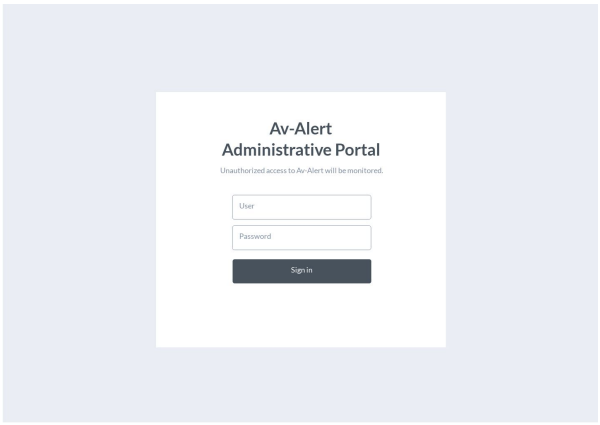
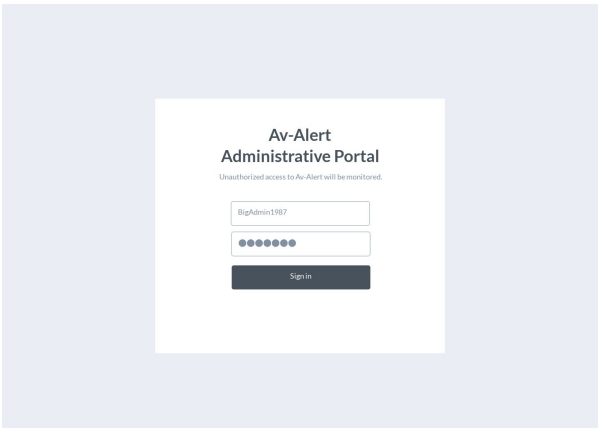
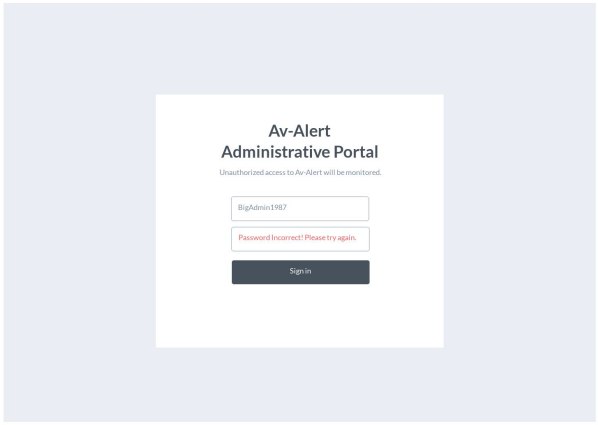
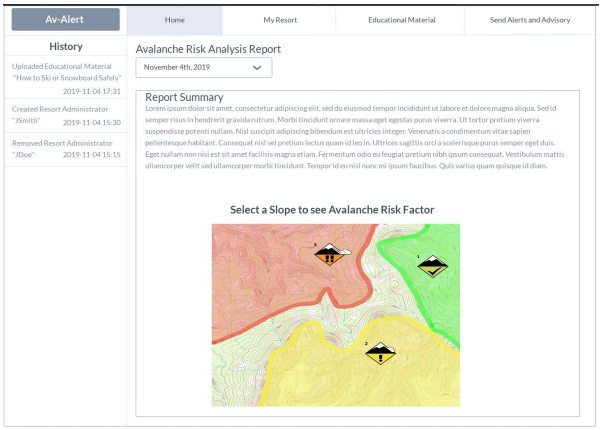


Figure 8: System Sequence Diagram - Use Case 6.

The Administrator Signs in to the Administrative Portal	
1. The Administrator is at the sign in screen of the Administrative Portal.	2. The Administrator enters their username and password into the appropriate fields.
	
3. a) After clicking the “Sign in” button with incorrect username or password.	3. b) After clicking the “Sign in” button with the correct username and password.
	

Use Case: SendAlertOrAdvisory	
ID:	7
Brief description:	The Resort Administrator decides the need for an Alert or an Advisory for a Slope.
Actor(s):	Resort Administrator.
Preconditions:	1. The Resort Administrator has processed the latest Avalanche Risk Analysis Data and identified a medium or greater Risk Factor for a Slope within the 50km radius of the Resort. 2. The Resort Administrator is signed into the Administrative Portal.
Main flow:	1. The Resort Administrator sees the latest colour-coded Avalanche Forecast for the surrounding Slopes on the Topological Map. 2. The Resort Administrator selects a Slope of the Topological Map for detailed information on Avalanche Risk Factor. 3. If the Resort Administrator decides the Risk Factor is great enough to warrant an Alert to be sent out then: 3.1. The Resort Administrator authorizes an Alert for that Slope. 3.2. The Resort Administrator sees that Av-Alert has sent the Alert to each Public User who has set their specified Resort to the Resort Administrator's Resort. 3.3. The Resort Administrator sees that Av-Alert has begun broadcasting the authorized Alert over the local radio channel reserved for Alert and Advisory information. 4. Else if the Resort Administrator decides the Risk Factor is enough to warrant an Advisory then: 4.1. The Resort Administrator authorizes an Advisory for their Resort. 4.2. The Resort Administrator sees that Av-Alert has set an Advisory for the specified Slope. 4.3. The Resort Administrator sees that Av-Alert has begun broadcasting the authorized Advisory over the local radio channel reserved for Alert and Advisory information.
Postconditions:	1. If an Alert has been sent out for a Slope then: 1.1. The Alert has been recorded in Av-Alert. 1.2. Each Public User with their Specified Resort set to a Resort within 50km of the Slope will receive an Av-Alert notification. 2. Else if an Advisory has been sent out for a Slope then: 2.1. The Advisory has been recorded in Av-Alert. 2.2. Each Public User with their Specified Resort set to a Resort within 50km of the Slope will see the Advisory if they select that area of the Topological Map.
Alternative flow(s):	None.

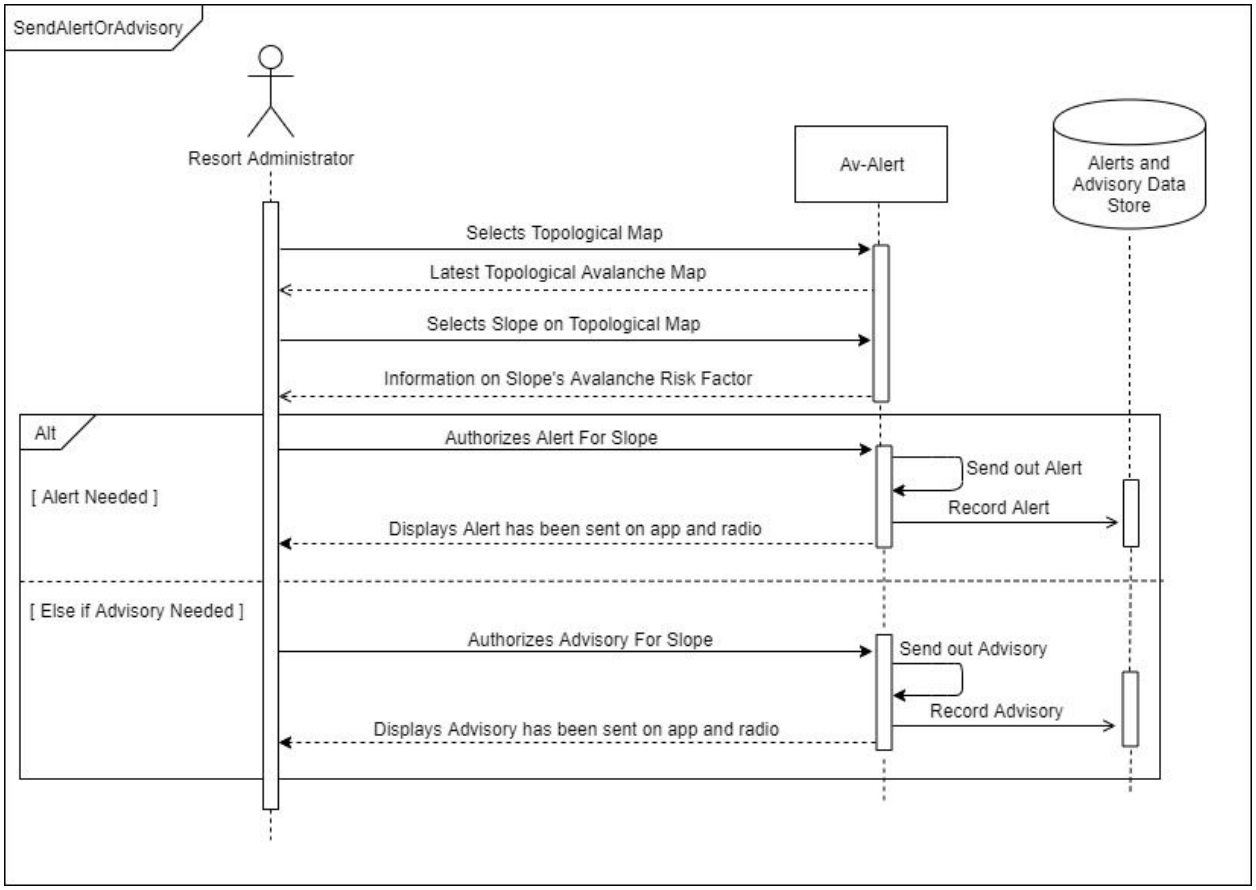
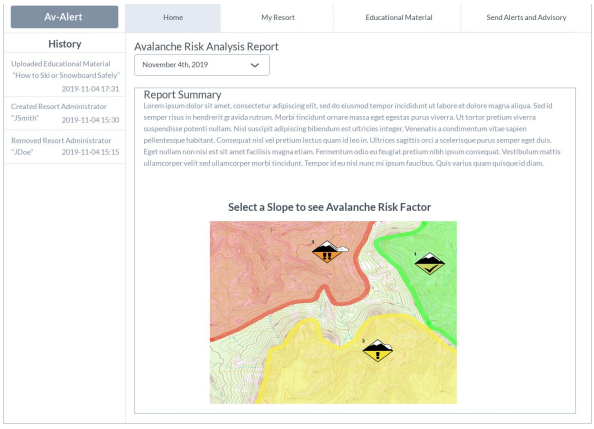
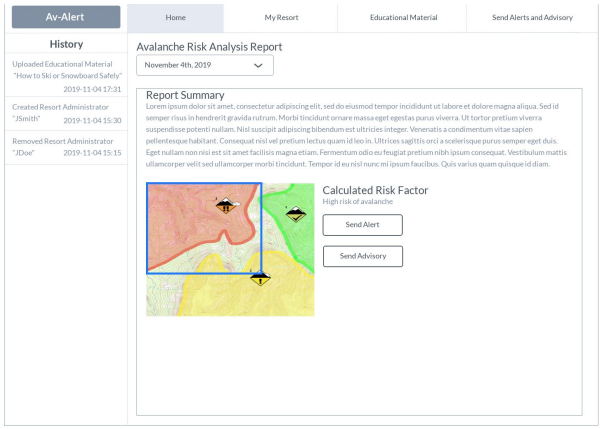
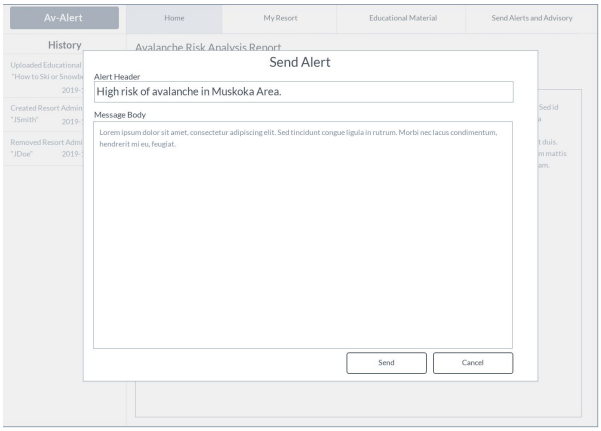
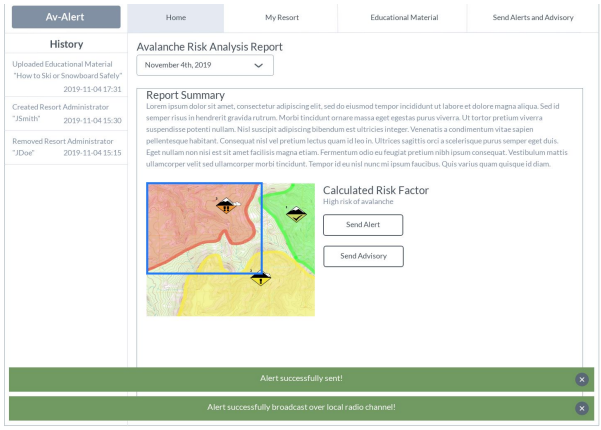
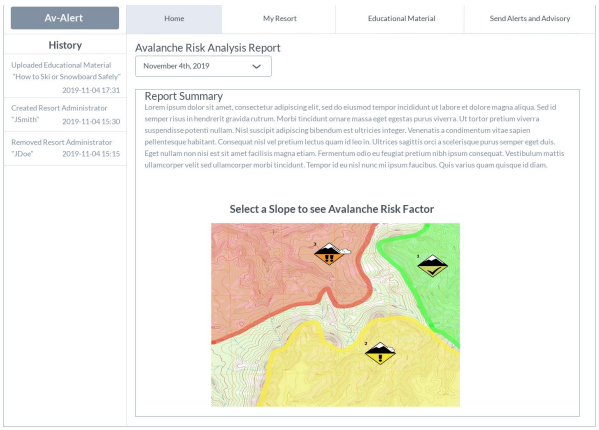
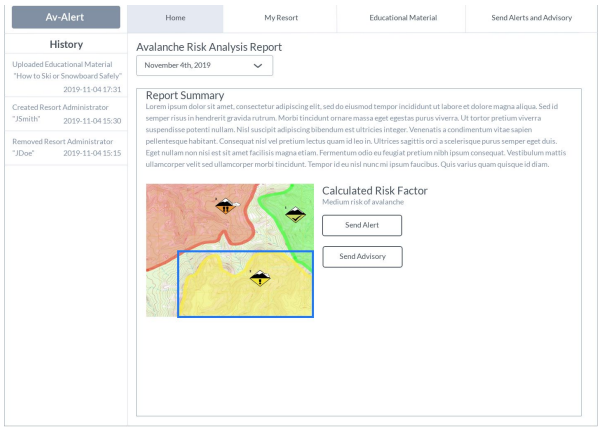
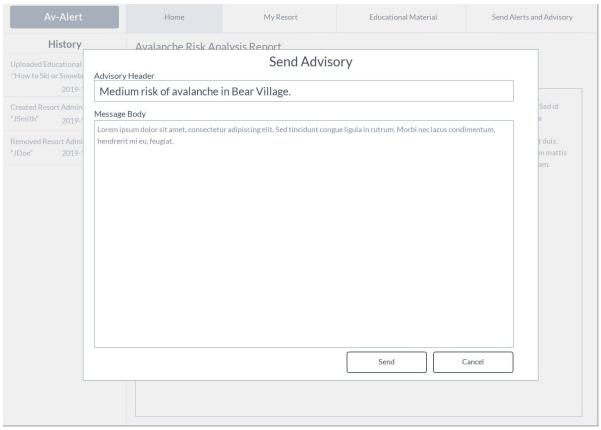
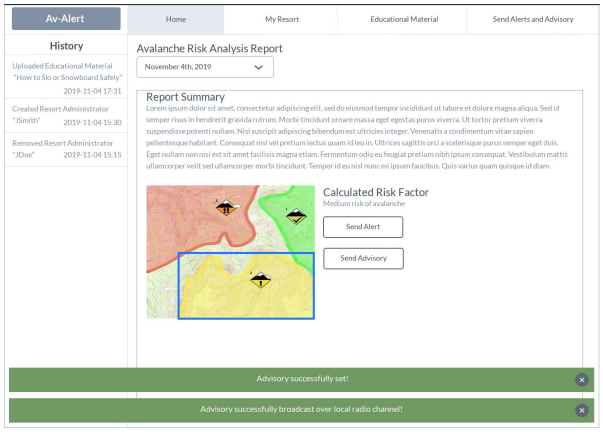


Figure 9: System Sequence Diagram - Use Case 7.

The Resort Administrator Sends Alert	
1. The Resort Administrator is viewing the latest Forecast.	2. The High Risk Slope is selected.
	
3. After selecting “Send Alert”, the Alert is ready to be authorized.	4. After selecting “Send” on the Alert
	

The Resort Administrator Sends Advisory	
1. The Resort Administrator is viewing the latest Forecast.	2. The Medium Risk Slope is selected.
	
3. After selecting “Send Advisory”, the Advisory is ready to be authorized.	4. After selecting “Send” on the Advisory.
	

Use Case: UploadEducationalMaterial	
ID:	8
Brief description:	The Administrator wants to upload or edit Educational Material content.
Actor(s):	System Administrator or Resort Administrator.
Preconditions:	1. The Administrator is signed into the Administrative Portal.
Main flow:	1. The Administrator selects the Educational Material page.. 2. The Administrator sees a list of any previously uploaded Educational Material. 3. The Administrator selects add new Educational Material. 4. The Administrator uploads new Educational Material to Av-Alert.
Postconditions:	1. The Educational Material has been uploaded to Av-Alert.
Alternative flow(s):	EditMaterial.

Use Case: EditEducationalMaterial	
ID:	8.1
Brief description:	The Administrator wants to edit pre-existing Educational Material.
Actor(s):	System Administrator or Resort Administrator.
Preconditions:	1. Educational Material has been previously uploaded to Av-Alert. 2. The Administrator is signed into the Administrative Portal.
Main flow:	1. The Administrator selects the Educational Material page. 2. The Administrator sees a list of any previously uploaded Educational Material. 3. The Administrator selects an item from the list of Educational Material. 4. The Administrator selects edit Educational Material. 5. The Administrator makes modification to the selected Educational Material. 6. The Administrator selects save changes.
Postconditions:	1. The edits made to the selected Educational Material has been recorded.
Alternative flow(s):	None.

Use Case: AnalyzeAvalancheData	
ID:	9
Brief description:	The Actor analyzes the trend in Avalanche Risk Analysis Data that were collected over a period of time.
Actor(s):	Resort Administrator, System Administrator, or Public User.
Preconditions:	1. If the Actor is an Administrator then 1.1. The Actor is signed into the Administrative Portal
Main flow:	1. The Actor selects the list view of Avalanche Risk Analysis Data. 2. The Actor sees each Avalanche Risk Analysis Data Set, which is sorted by most recently recorded. 3. The Actor selects an Avalanche Risk Analysis Data Set from the list. 4. The Actor sees a detailed view of the Avalanche Risk Analysis Data for the selected time period.
Postconditions:	None.
Alternative flow(s):	None.

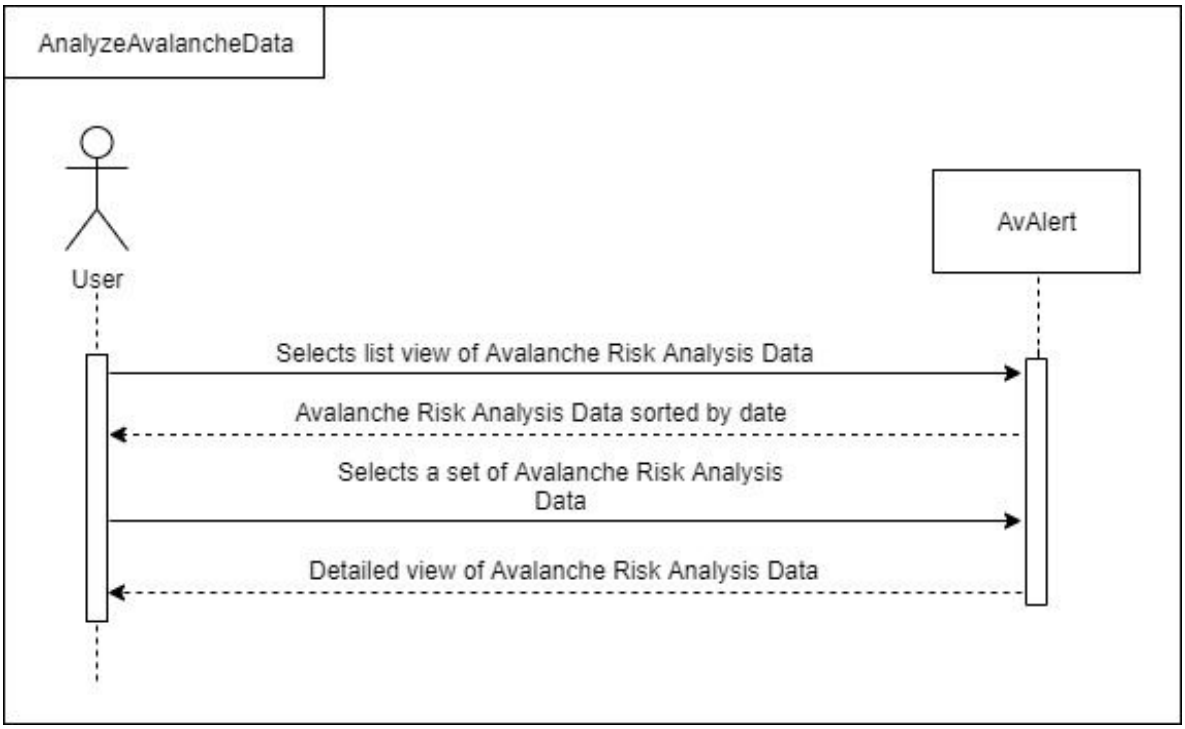
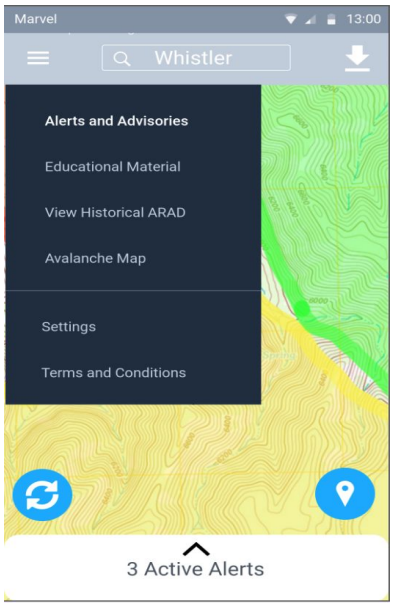
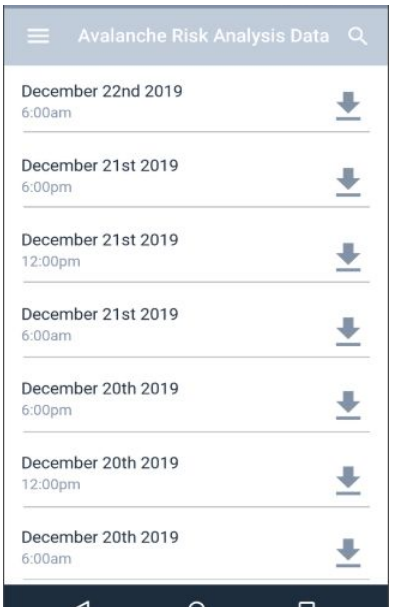
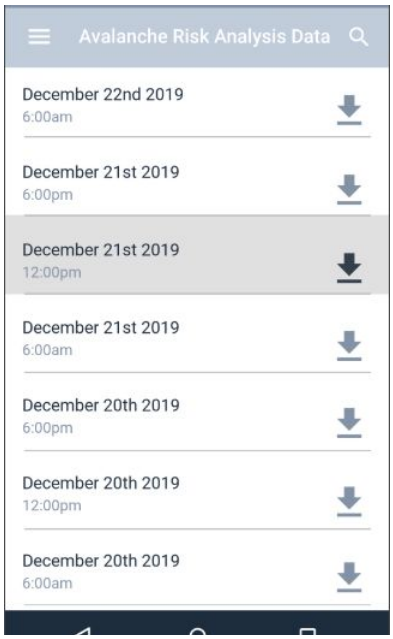
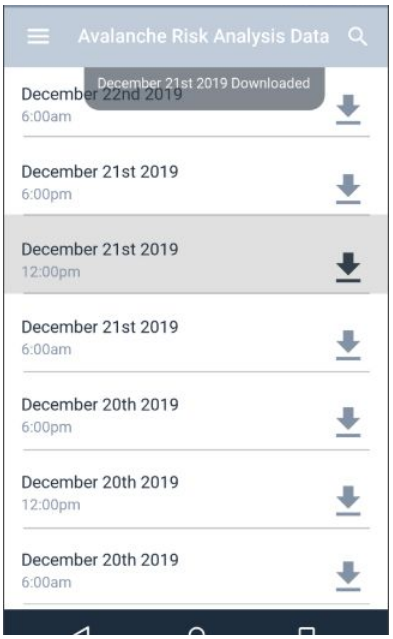


Figure 10: System Sequence Diagram - Use Case 9.

The Public User views Avalanche Risk Analysis Data	
1. After the Public User opens the options menu.	2. After the Public User navigates to the list of sorted Historical Avalanche Risk Analysis Data.
	
3. After the Public User selects a set of Avalanche Risk Analysis Data to download.	4. After the Avalanche Risk Analysis Data Set has been downloaded to the Public User's device.
	

Use Case: CreateResortProfile	
ID:	10
Brief description:	The System Administrator wants to create a new Resort Profile instance.
Actor(s):	System Administrator.
Preconditions:	1. The System Administrator is signed into the Administrative Portal. 2. The System Administrator has the information to fill out the Resort Profile.
Main flow:	1. The System Administrator selects the option to create a Resort Profile. 2. The System Administrator sees a prompt to input Resort information. 3. The System Administrator inputs the Resort information into the respective fields. 4. The System Administrator submits the Resort information. 5. The System Administrator sees that the Resort Profile was successfully created.
Postconditions:	1. A Resort Profile has been created.
Alternative flow(s):	CancelResortProfile.

Alternative Flow: CreateResortProfile: CancelResortProfile	
ID:	10.1
Brief description:	The System Administrator cancels the creation of a Resort Profile.
Actor(s):	System Administrator.
Preconditions:	None.
Alternate flow:	The alternate flow begins at any time. 1. The System Administrator cancels the creation of a new Resort Profile.
Postconditions:	1. A new Resort Profile is not created.

Use Case: EditResortProfile	
ID:	11
Brief description:	The System Administrator wants to edit a pre-existing Resort Profile.

Actor(s):	System Administrator.
Preconditions:	1. A Resort Profile has been previously created. 2. The System Administrator is signed into the Administrative Portal. 3. The System Administrator has the information to fill out the Resort Profile.
Main flow:	1. The System Administrator selects a specific Resort Profile from a list of Resorts. 2. The System Administrator selects the option to edit the Resort Profile. 3. The System Administrator sees a prompt to edit the fields for the Resort Profile. 4. The System Administrator makes modifications to the Resort Profile information. 5. The System Administrator submits the modified Resort information. 6. The System Administrator sees that the Resort Profile was successfully modified.
Postconditions:	1. The modified Resort Profile has been updated.
Alternate flow(s):	None.

UseCaseName: RemoveResortProfile	
ID:	12
Brief description:	The System Administrator wants to remove a pre-existing Resort Profile.
Actor(s):	System Administrator.
Preconditions:	1. The System Administrator is signed into the Administrative Portal. 2. A Resort Profile has been previously created.
Main flow:	1. The System Administrator selects a specific Resort Profile from a list of Resorts. 2. The System Administrator selects the option to edit the Resort Profile. 3. The System Administrator selects the option to delete the Resort Profile. 4. The System Administrator selects the option to confirm the deletion of the Resort Profile
Postconditions:	1. The modified Resort Profile has been deleted.
Alternative flow(s):	None.

Use Case: ModifyDataSource	
ID:	13
Brief description:	The Administrator wants to modify the Data Sources which contribute to the Avalanche Risk Analysis Data for a Resort.
Actor(s):	System Administrator or Resort Administrator.
Preconditions:	1. The Administrator is signed into the Administrative Portal.
Main flow:	1. If the Administrator is a System Administrator then: 1.1. The Administrator selects a specific Resort Profile from a list of Resorts. 2. The Administrator selects a Resort Profile. 3. The Administrator selects the option to view Data Sources. 4. The Administrator sees the Data Sources available to use at the selected Resort. 5. The Administrator selects a Data Source. 6. If the Data Source is not being used at the selected Resort then 6.1. The Administrator selects the option to add the specific Data Source to the Resort Profile. 7. Else the Data Source is being used at the selected Resort then: 7.1. The Administrator selects the option to remove the specific Data Source to the Resort Profile. 8. The Administrator sees the the updated set of Data Sources in use at the selected Resort.
Postconditions:	1. The Data Sources for the selected Resort has been updated. 2. If a Data Source has been added to a Resort Profile: 2.1. The Avalanche Risk Analysis now includes the Data Source. 3. Else a Data Source has been Removed from a Resort Profile: 3.1. The Avalanche Risk Analysis no longer includes the Data Source.
Alternative flow(s):	None.

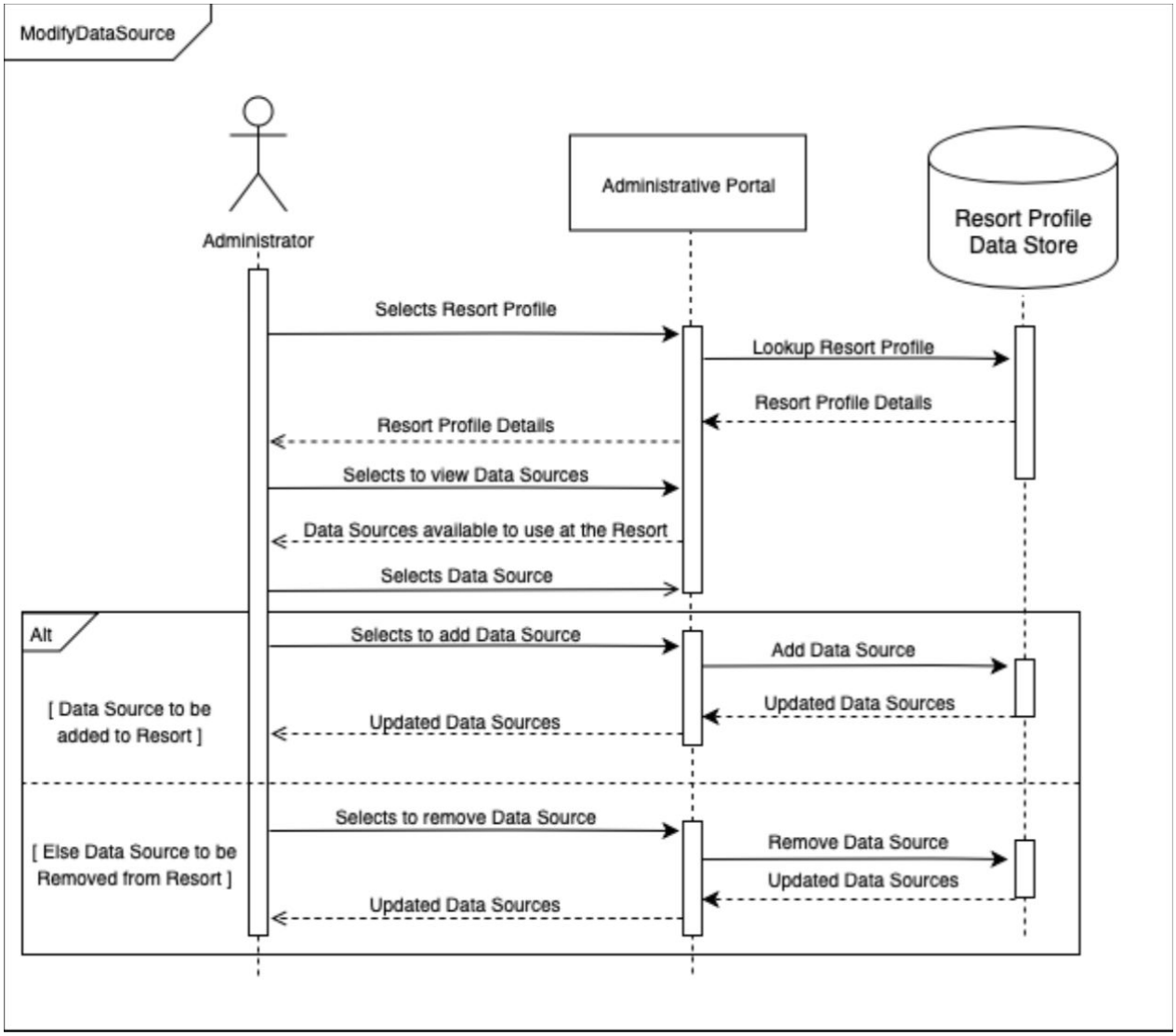
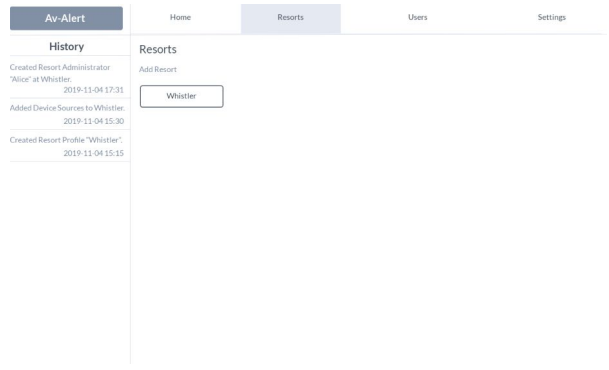
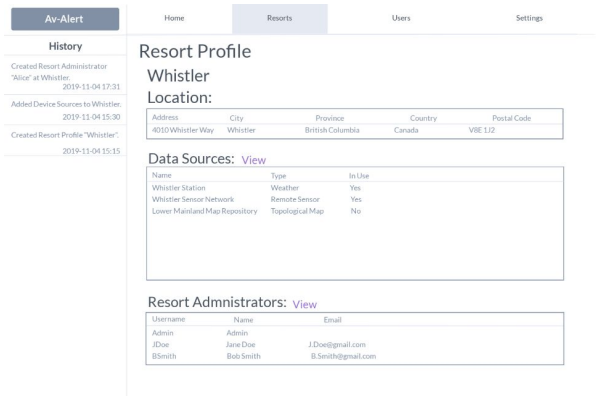
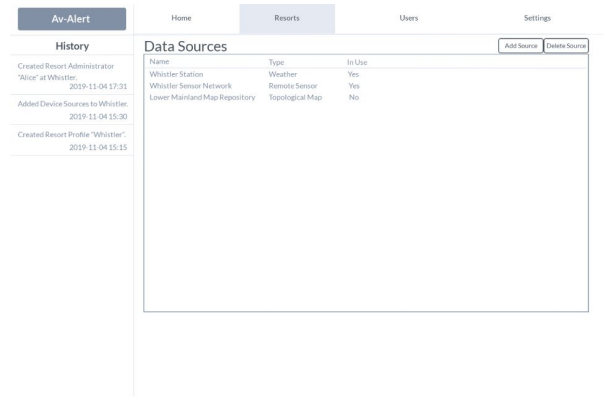
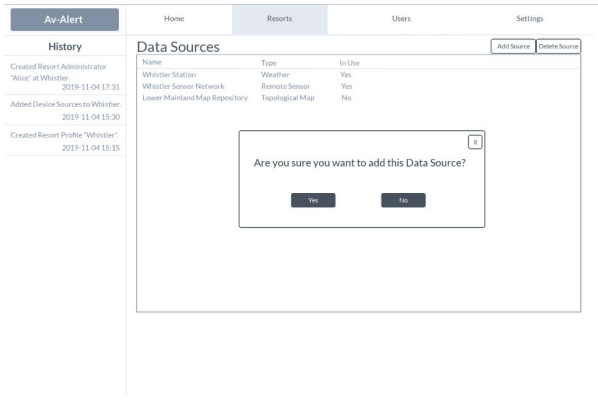
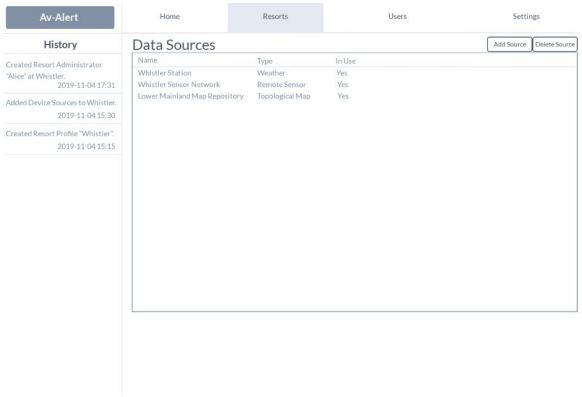
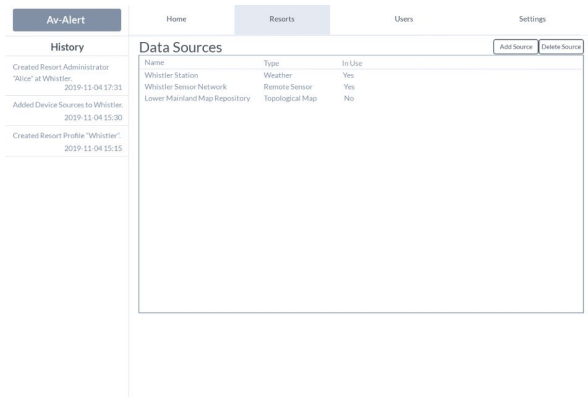
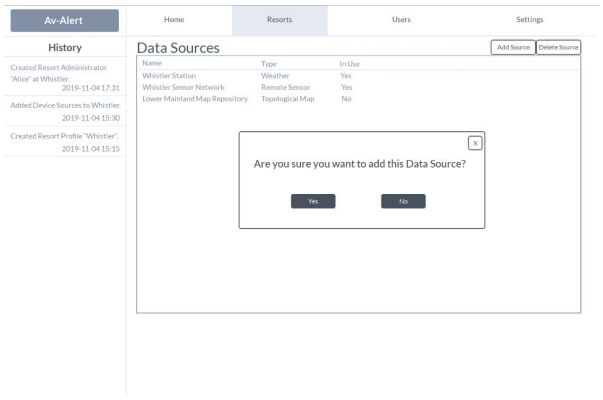
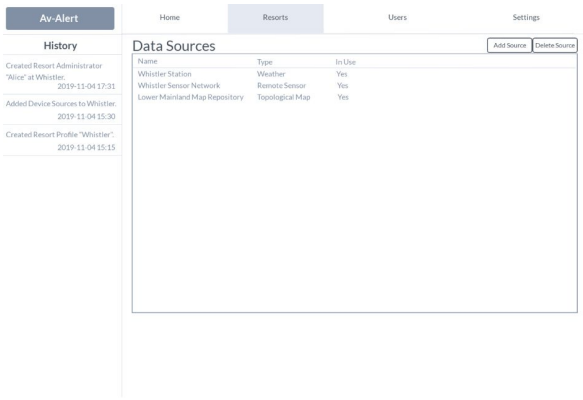
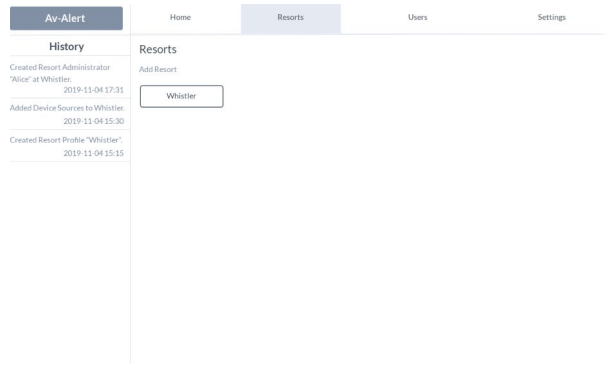
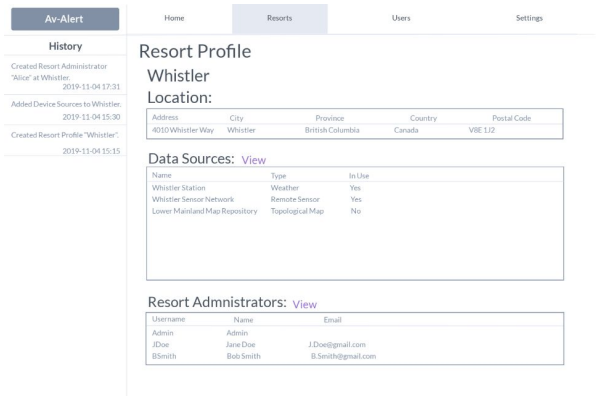
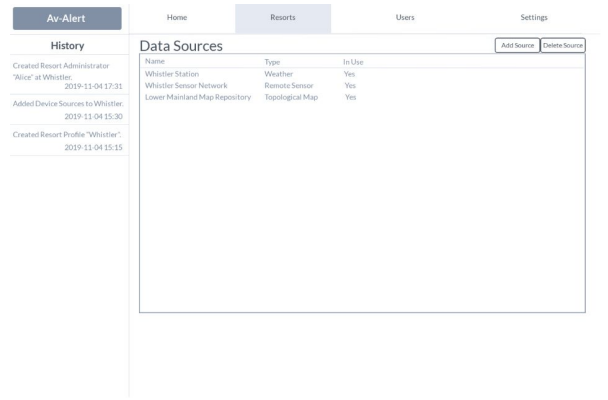
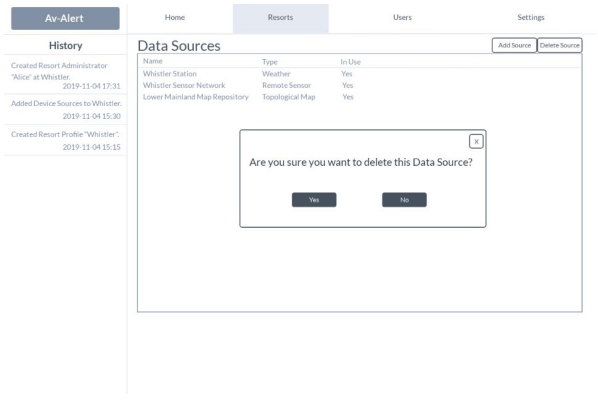
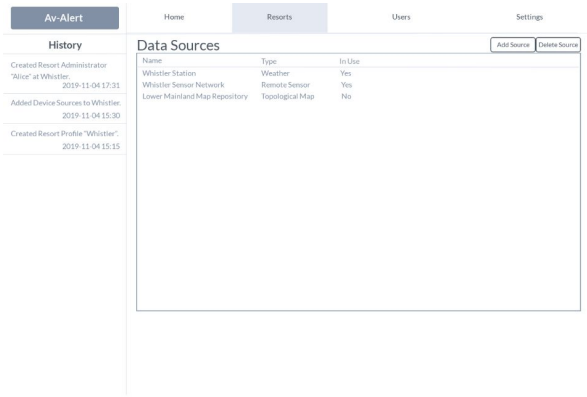
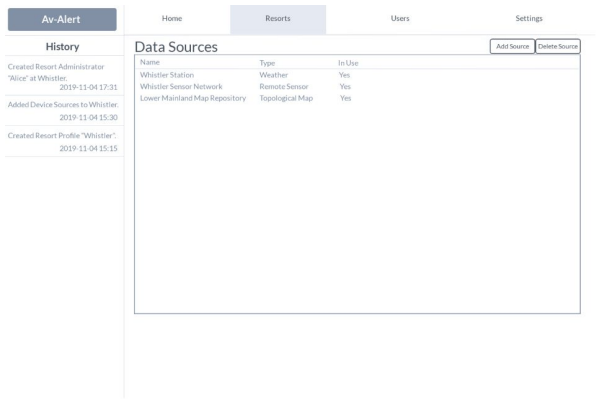
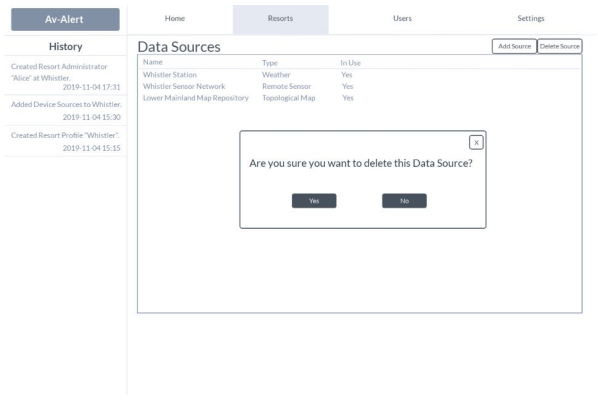
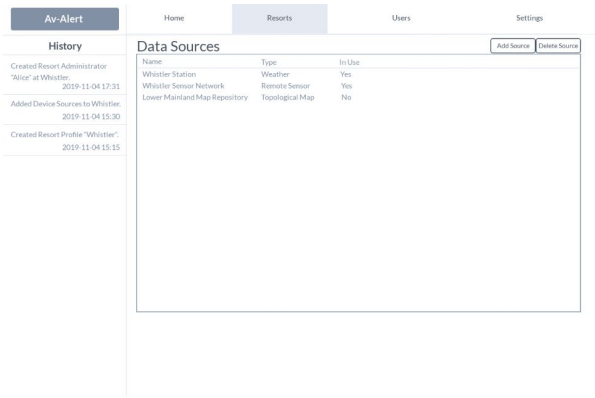


Figure 11: System Sequence Diagram - Use Case 13.

The System Administrator adds a Resort Data Source	
1. The System Administrator sees each Resort under the “Resorts” tab.	2. After selecting a Resort from the list of Resorts to see the Resort Profile.
	
3. After selecting to view Data Sources.	4. After selecting a Data Source and selecting the “Add Source” option, a window will pop up to confirm their selection.
	
5. After confirming their selection, updated Data Sources will be displayed.	
	

The Resort Administrator adds a Resort Data Source	
1. After selecting to view Data Sources.	2. After selecting a Data Source and selecting the “Add Source” option, a window will pop up to confirm their selection.
	
3. After confirming their selection, updated Data Sources will be displayed.	
	

The System Administrator removes a Resort Data Source	
1. The System Administrator sees each Resort under the “Resorts” tab.	2. After selecting a Resort from the list of Resorts to see the Resort Profile.
	
3. After selecting to view Data Sources.	4. After selecting a Data Source and selecting the “Delete Source” option, a window will pop up to confirm their selection.
	
5. After confirming their selection, updated Data Sources will be displayed	
	

The Resort Administrator removes a Resort Data Source	
1. After selecting to view Data Sources.	2. After selecting a Data Source and selecting the “Delete Source” option, a window will pop up to confirm their selection.
	
3. After confirming their selection, updated Data Sources will be displayed.	
	

Use Case: CreateResortAdmin	
ID:	14
Brief description:	The Administrator wants to create a new Resort Administrator for a Resort.
Actor(s):	System Administrator or Resort Administrator.
Preconditions:	1. The Administrator is signed into the Administrative Portal.
Main flow:	1. If the Administrator is a System Administrator then: 1.1. The Administrator selects a specific Resort Profile from a list of Resorts. 2. The Administrator sees each Resort Administrator for that Resort. 3. The Administrator selects the option to create a new Resort Administrator. 4. The Administrator is prompted to enter the Resort Administrator' details. 5. The Administrator inputs the Resort Administrator details into the respective fields. 6. The Administrator submits the Resort Administrator. 7. The Administrator sees that the Resort Administrator has been created.
Postconditions:	1. A new Resort Administrator has been created.
Alternative flow(s):	CancelResortAdmin.

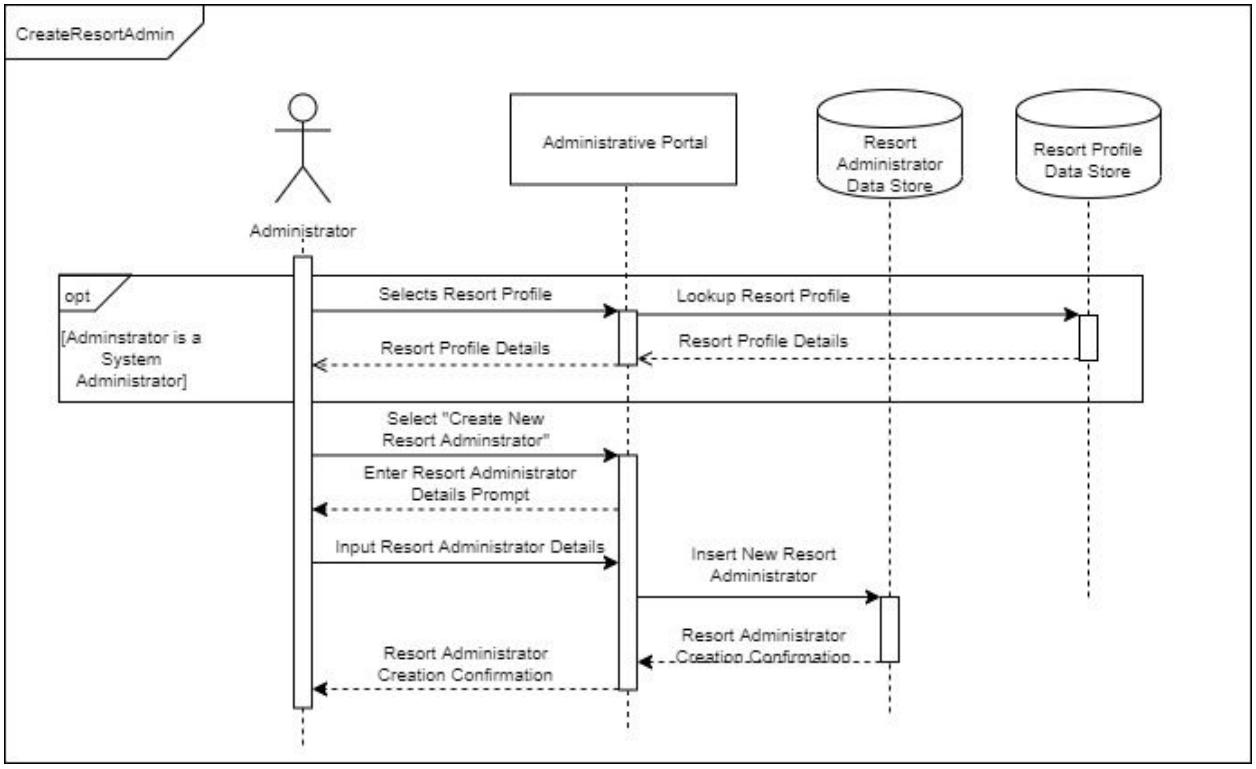
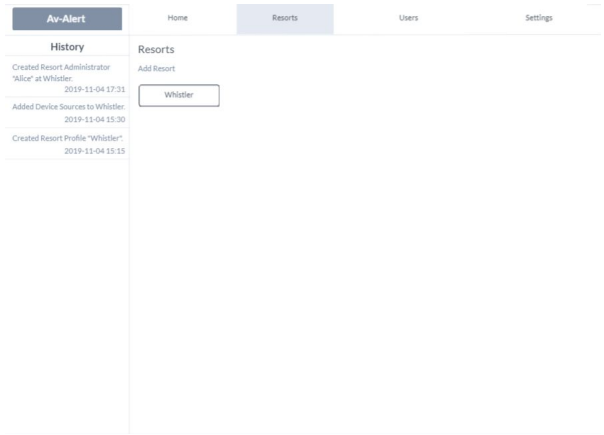
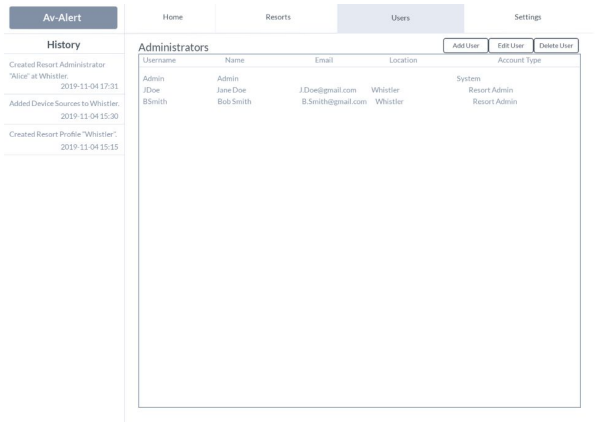
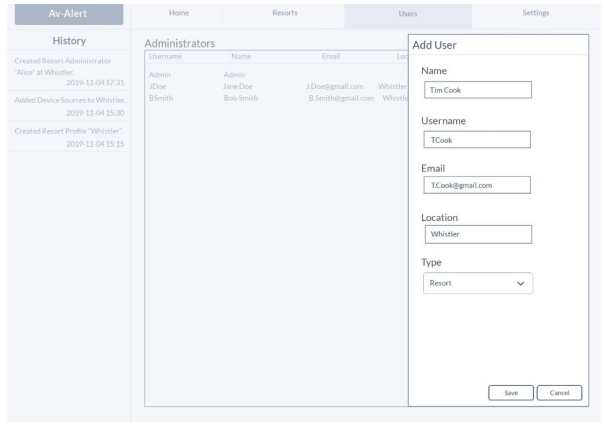
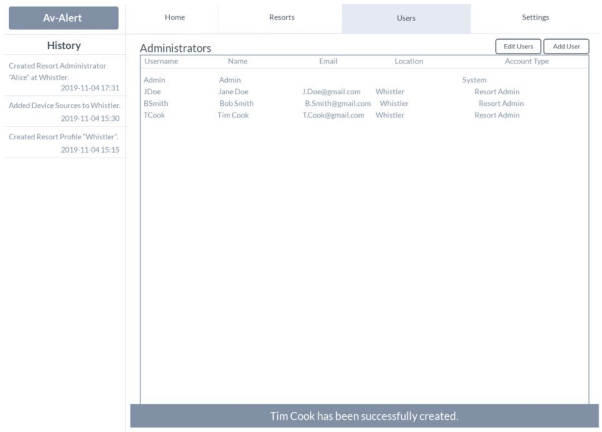
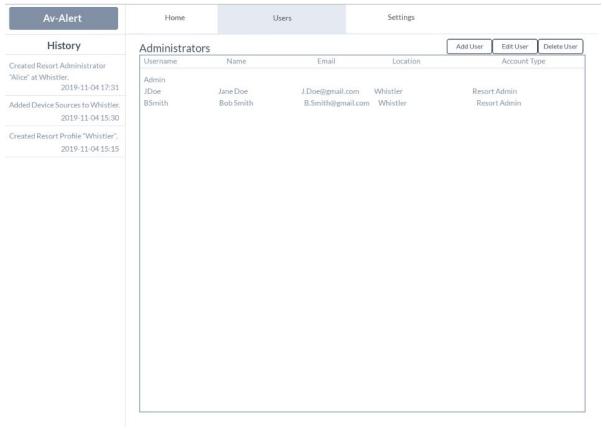
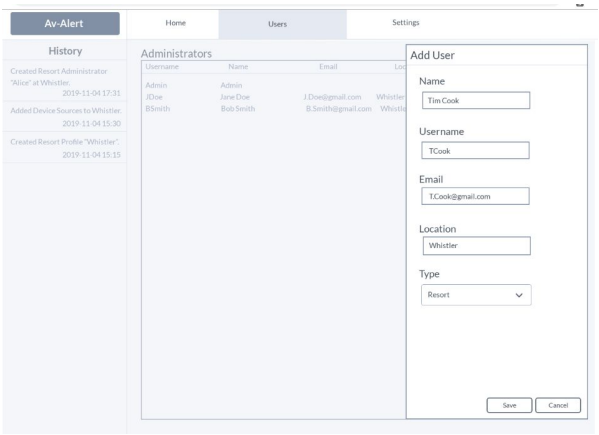
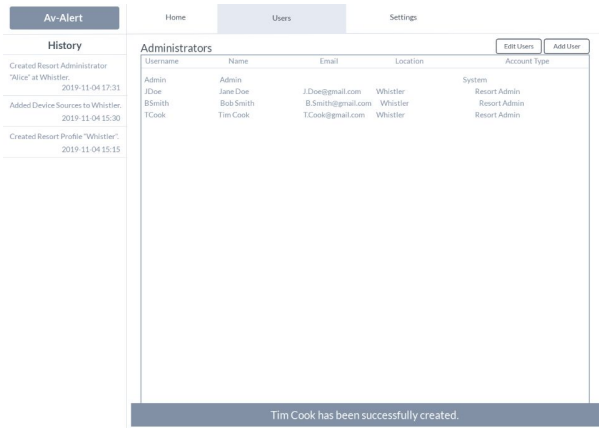


Figure 12: System Sequence Diagram - Use Case 14.

The System Administrator Creates a Resort Admin	
1. The System Administrator sees each Resort under the “Resorts” tab.	2. After selecting a Resort from the list of Resorts and selecting the “Users” tab.
	
3. After selecting “Add User”, a window will pop up providing user information fields to be filled.	4. After entering the Resort Administrator’s details and selecting “Save”.
	

The Resort Administrator Creates a Resort Admin	
1. After the Resort Administrator selects the “Users” tab.	2. After selecting “Add User”, a window will pop up providing user information fields to be filled.
	
3. After entering the Resort Administrator’s details and selecting “Save”.	
	

Alternative Flow: CreateResortAdmin: CancelResortAdmin	
ID:	14.1
Brief description:	The Administrator cancels the creation of a Resort Administrator.
Actor(s):	System Administrator or Resort Administrator.
Preconditions:	None.
Alternate flow:	The alternate flow begins at any time. 1. The Administrator cancels the creation of a new Resort Administrator.
Postconditions:	1. A new Resort Administrator is not created.

Use Case: EditResortAdmin	
ID:	15
Brief description:	The Administrator wants to edit a pre-existing Resort Administrator's details.
Actor(s):	System Administrator or Resort Administrator.
Preconditions:	1. A Resort Administrator has been previously created. 2. The Administrator is signed into the Administrative Portal.
Alternate flow:	1. If the Administrator is a System Administrator then: 1.1. The System Administrator selects a specific Resort Profile from a list of Resorts. 2. The Administrator sees each Resort Administrator for that Resort. 3. The Administrator selects a Resort Administrator. 4. The Administrator is prompted to edit the selected Resort Administrators details. 5. The Administrator edits the Resort Administrators details. 6. The Administrator sees that the Resort Administrator has been updated.
Postconditions:	1. The Resort Administrator has been updated.

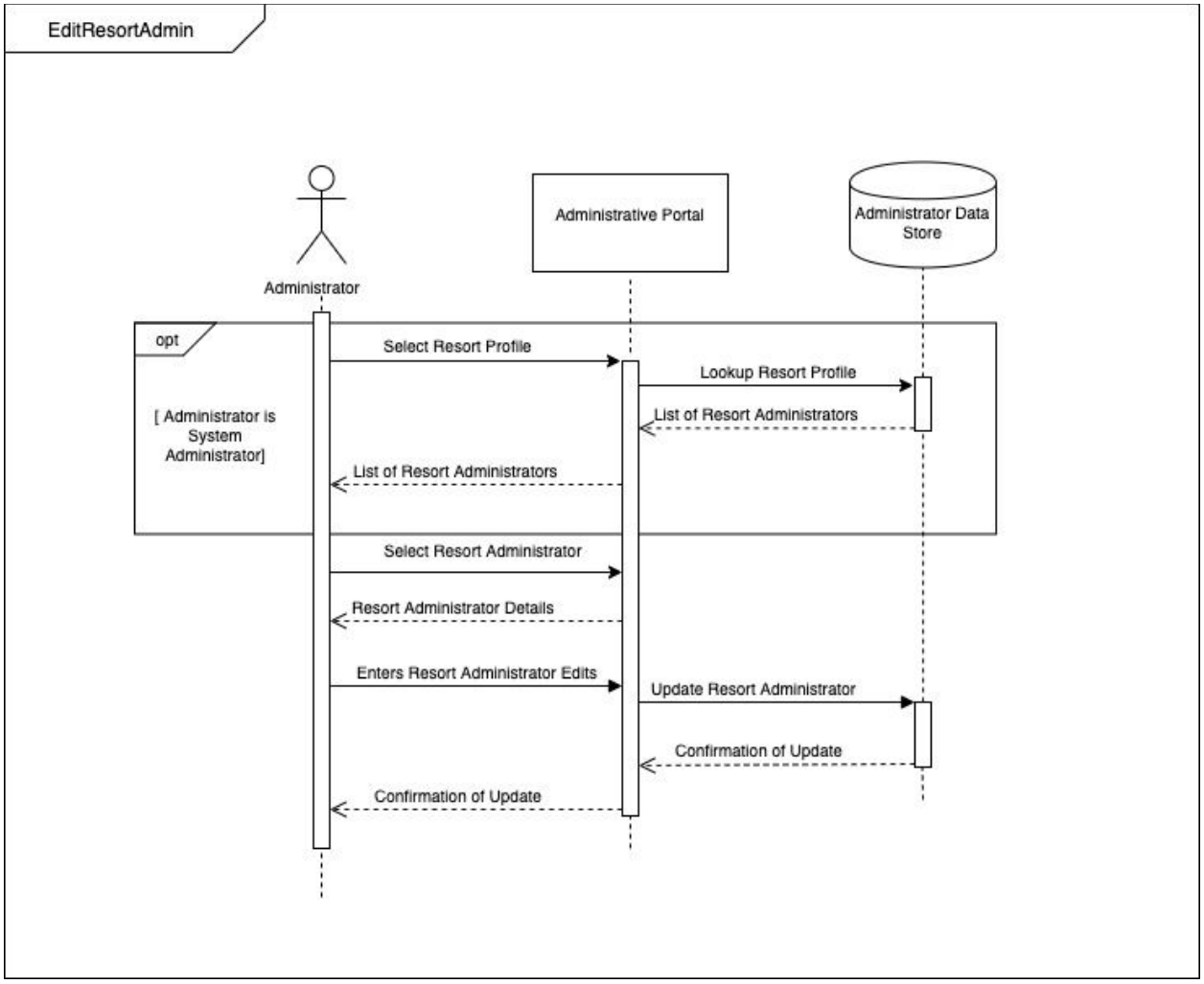
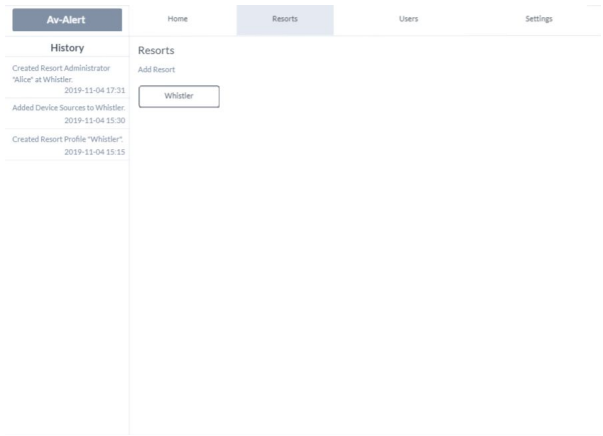
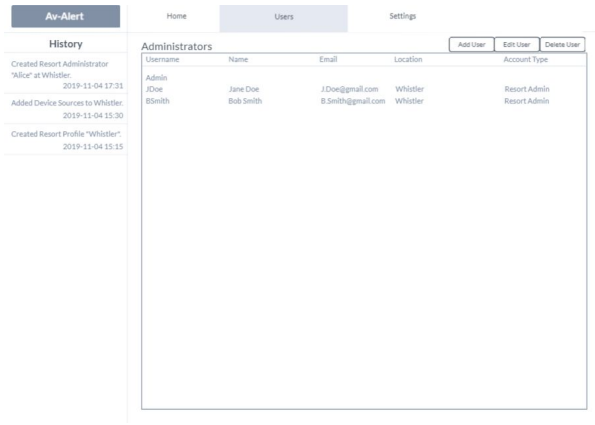
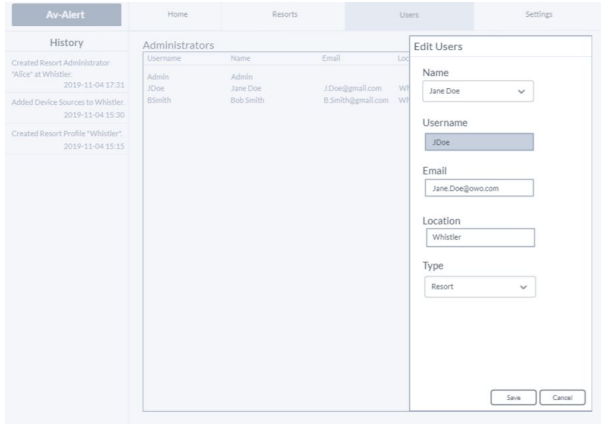
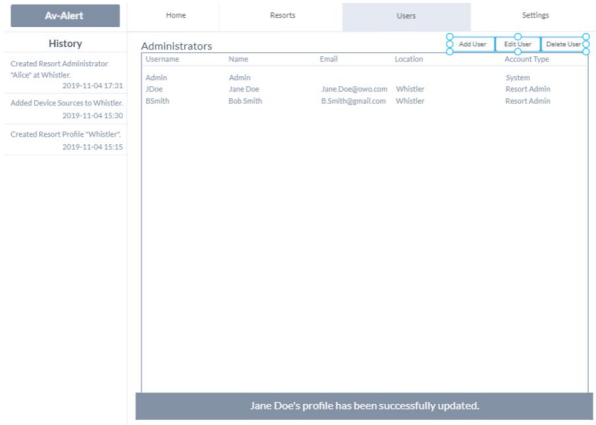
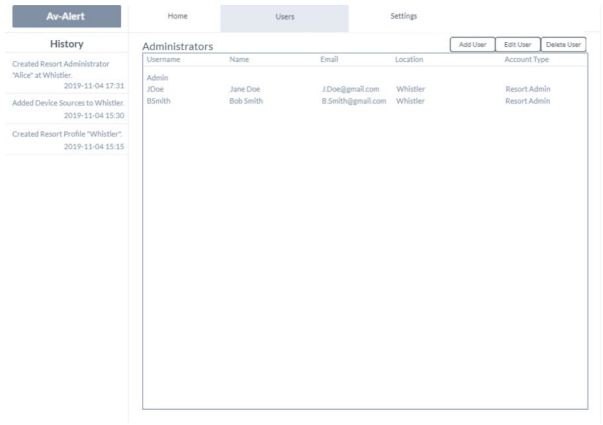
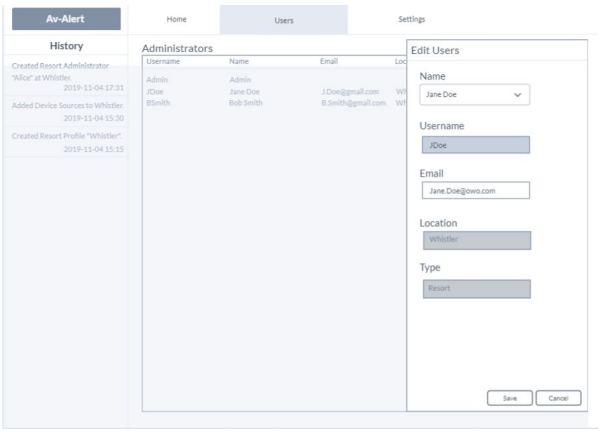
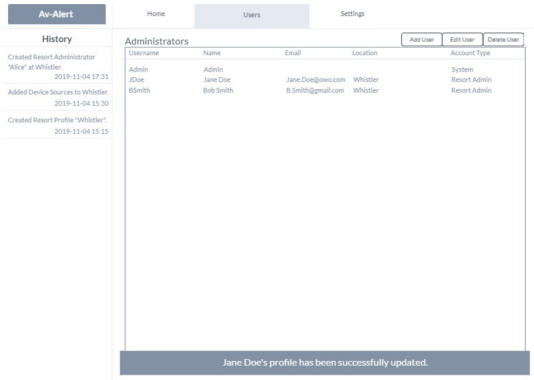


Figure 13: System Sequence Diagram - Use Case 15.

The System Administrator Edits the Details of a Resort Administrator	
1. The System Administrator sees each Resort under the “Resorts” tab.	2. After selecting a Resort from the list of Resorts and selecting the “Users” tab.
	
3. After selecting a Resort Administrator, a window will pop up providing options for what can be edited.	4. After editing the Resort Administrator’s details and selecting “Save”.
	

The Resort Administrator Edits the Details of a Resort Administrator	
1. Each Resort Administrator will see each current Resort Administrator for their Resort under the “Users” tab.	2. After selecting a Resort Administrator, a window will pop up with values that can be edited.
	
3. After editing the Resort Administrator’s details and selecting “Save”.	
	

UseCaseName: RemoveResortAdmin	
ID:	16
Brief description:	The Administrator wants to remove a pre-existing Resort Administrator from a Resort Profile.
Actor(s):	System Administrator or Resort Administrator.
Preconditions:	1. A Resort Administrator has been previously created. 2. A Resort Administrator has been previously assigned to a Resort.
Alternate flow:	1. If the Administrator is a System Administrator then: 1.1. The Administrator selects a specific Resort Profile from a list of Resorts. 2. The Administrator sees each Resort Administrator for that Resort. 3. The Administrator selects a Resort Administrator. 4. The Administrator removes that Resort Administrator's details.
Postconditions:	1. The Resort Administrator has been removed from the Resort.

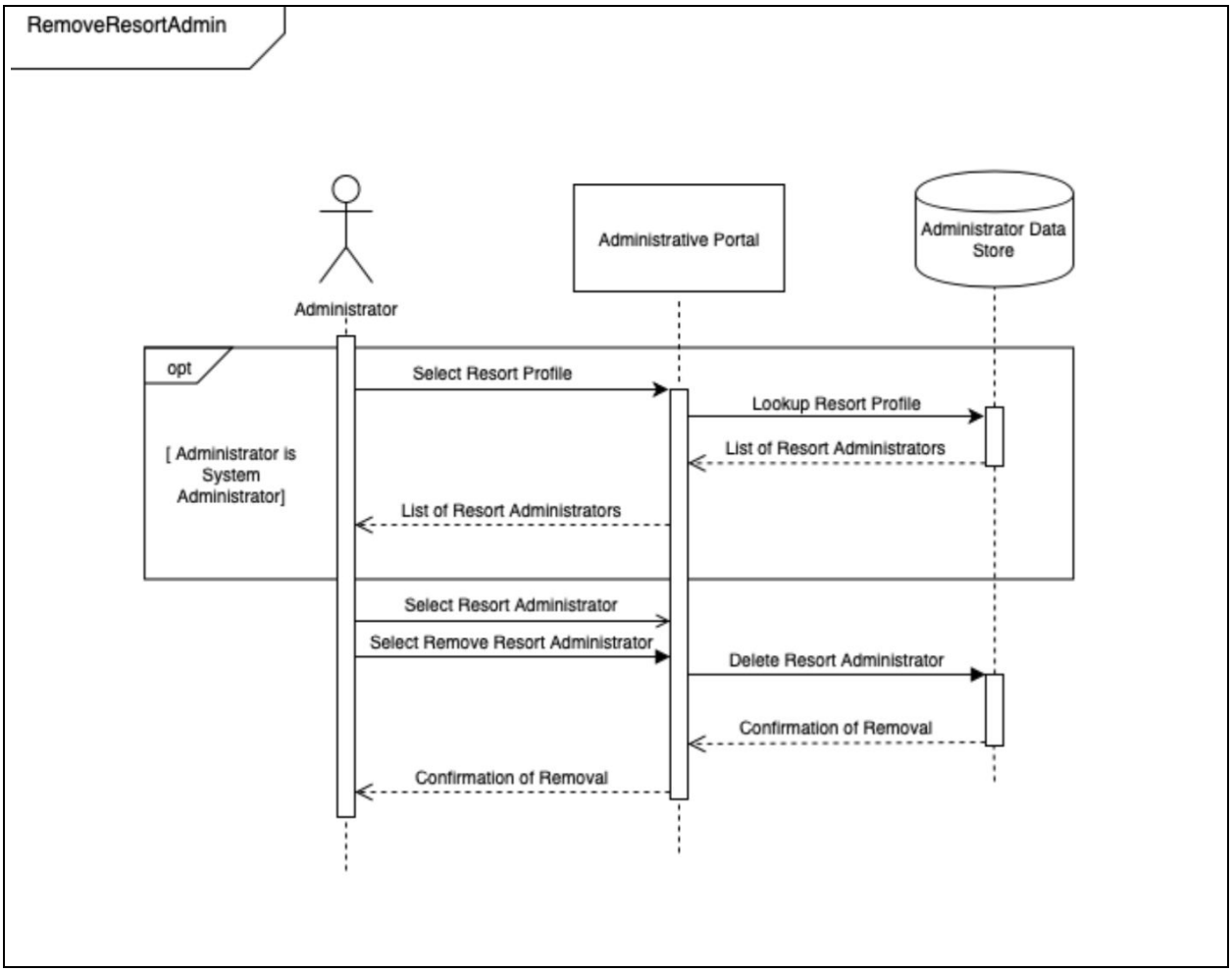
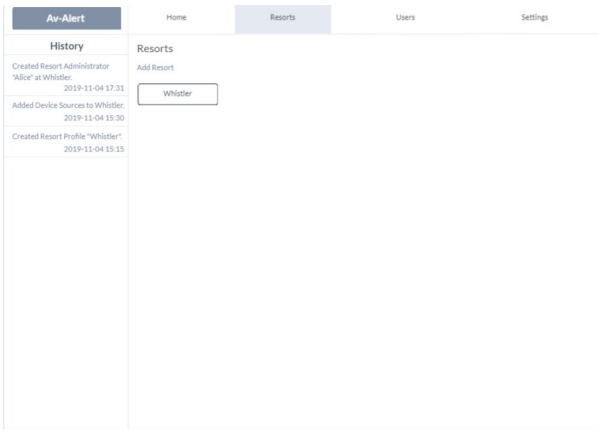
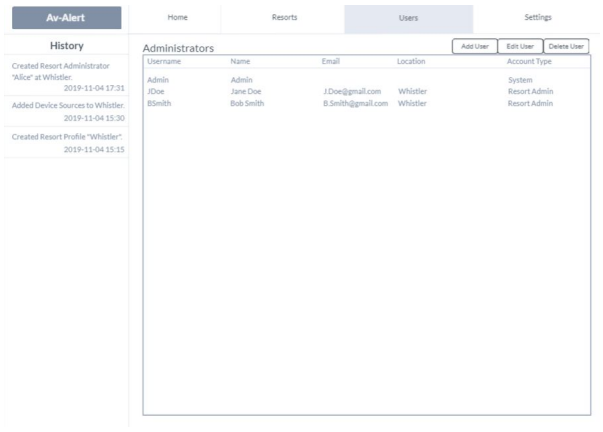
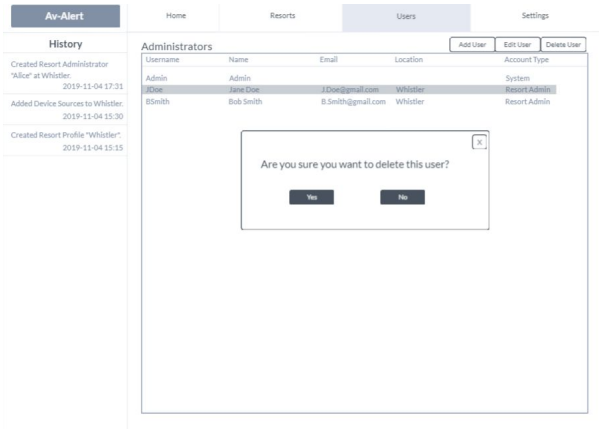
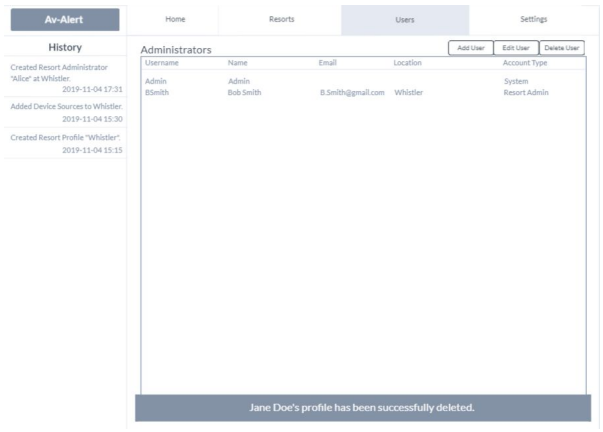
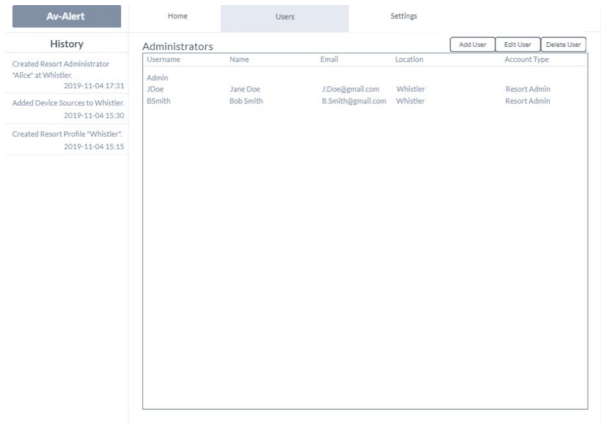
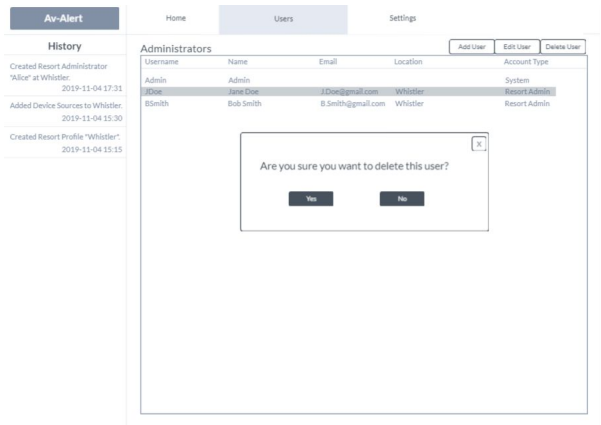
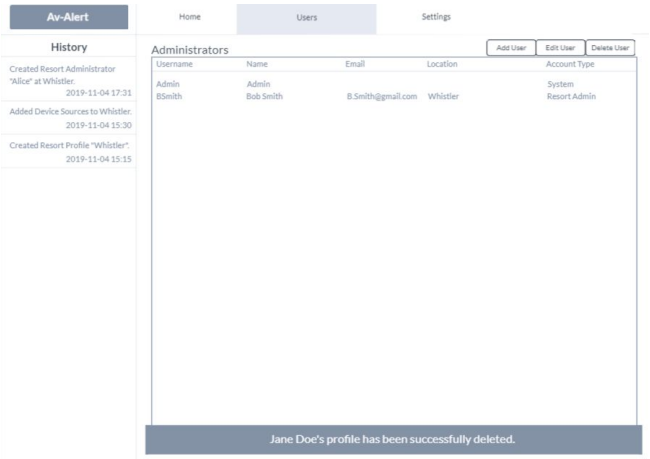


Figure 14: System Sequence Diagram - Use Case 16.

The System Administrator removes a Resort Administrator	
1. The System Administrator sees each Resort under the “Resorts” tab.	2. After selecting a Resort from the list of Resorts and selecting the “Users” tab.
	
3. After selecting a Resort Administrator and selecting the “Delete User” option, a window will pop up to confirm their selection.	4. After selecting “Yes” to delete the Resort Administrator.
	

The Resort Administrator removes a Resort Administrator	
1. Resort Administrators will see each Resort Administrator for their Resort under the “Users” tab.	2. After selecting a Resort Administrator and selecting the “Delete User” option, a window will pop up to confirm their selection.
	
3. After selecting “Yes” to delete the Resort Administrator.	
	

8 Analysis Model

This section displays a deeper analysis of Av-Alert, including an Entity-Relationship Diagram, Data Dictionary, and Data Flow Diagrams.

8.1 Entity Relation Diagram

Below is an entity-relation diagram, which displays how the various components of Av-Alert will interact with each other.

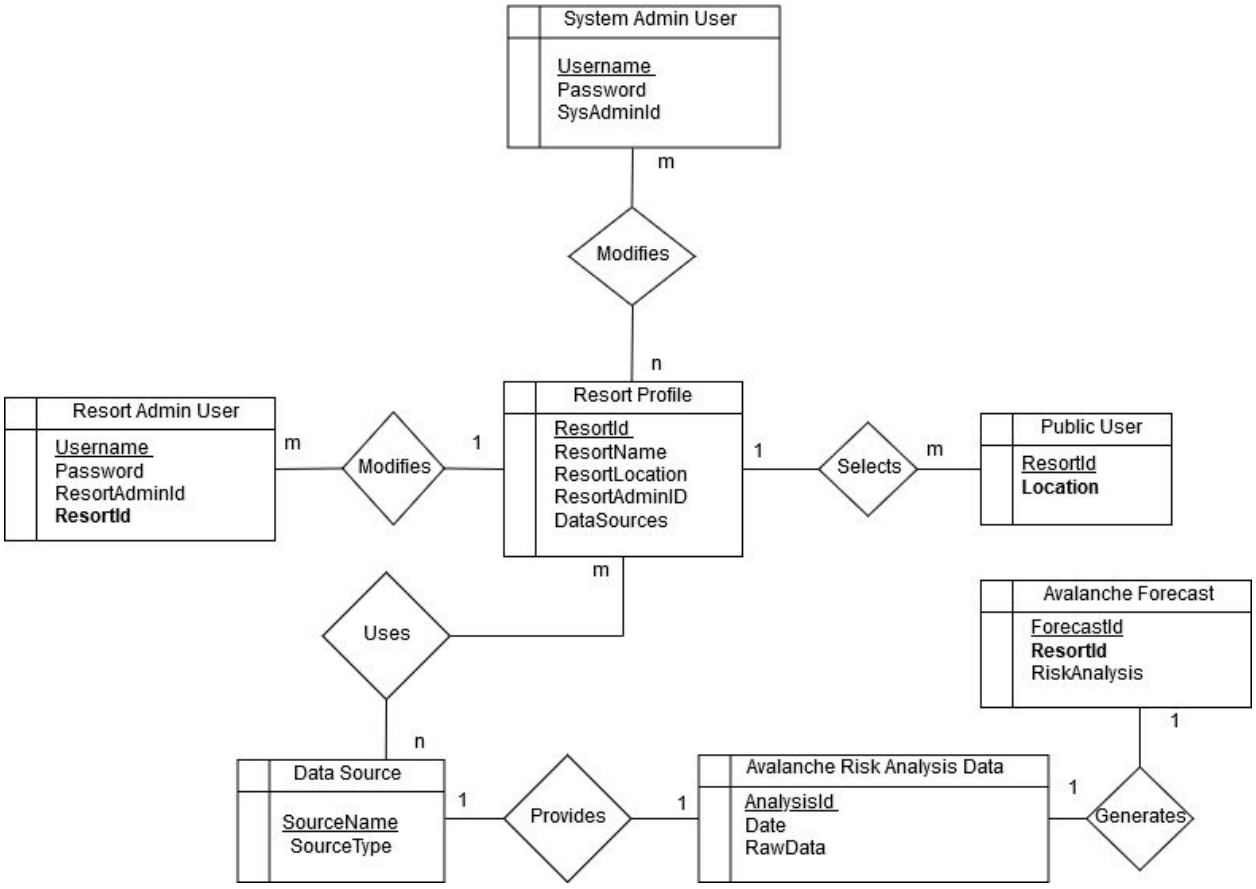


Figure 15: Entity Model Diagram.

8.2 Data Dictionary

The primary keys are denoted by underline and the **foreign keys** are denoted by bold text.

8.2.1 Resort Admin User

Field Name	Data Type	Data Format	Field Size	Description
ResortId	Integer	NNNN	4	A unique identifier for each Resort.
Username	Varchar	N^{16}	16	A unique string of letters and/or numbers. Used during the sign in flow.
Password	Varchar	N^{16}	16	A string of characters and/or numbers. Used during the sign in flow.
ResortAdminId	Integer	NNNN	4	A unique identifier for each Resort Administrator.

8.2.2 System Admin User

Field Name	Data Type	Data Format	Field Size	Description
Username	Varchar	N^{16}	16	A unique string of letters and/or numbers. Used during sign in flow.
Password	Varchar	N^{16}	16	A string of characters and/or numbers. Used during the sign in flow.
SystemAdminId	Integer	NNNN	4	A unique identifier for each System Administrator.

8.2.3 Public User

Field Name	Data Type	Data Format	Field Size	Description
Location	String	N^{17}	17	Latitude and longitude values.
ResortId	Integer	NNNN	4	A unique identifier for their Specified Resort.

8.2.4 Avalanche Risk Analysis Data

Field Name	Data Type	Data Format	Field Size	Description
AnalysisId	Integer	N^{6}	6	A unique identifier for an Avalanche Risk Analysis Data Set.
Date	Varchar	N^{19}	19	A string of letters and numbers that indicates when the report was generated. Format is ISO 8601: "YYYY-MM-DDThh:mm:ss".
RawData	Integer	$(NNNN)^{50}$	4^{50}	A unique list of integers.

8.2.5 Avalanche Forecast

Field Name	Data Type	Data Format	Field Size	Description
ResortId	Integer	NNNN	4	A unique identifier for each Resort.
ForecastId	Integer	N^{6}	6	A unique identifier for an Avalanche Forecast.
RiskAnalysis	Integer	NN,NN,NN	8	A unique list of integers indicating Low, Medium or High risk.

8.2.6 Resort Profile

Field Name	Data Type	Data Format	Field Size	Description
ResortId	Integer	NNNN	4	A unique identifier for each Resort.
ResortName	String	N^{16}	16	The public name for the Resort.
ResortLocation	Varchar	N^{17}	17	Latitude and longitude values.
ResortAdminId	Integer	NNNN	4	A unique identifier for an associated Resort Administrator.
DataSources	String	$(N^{30})^{3}$	30^{3}	A list of Data Sources.

8.2.7 Data Source

Field Name	Data Type	Data Format	Field Size	Description
SourceName	Varchar	N^{16}	16	A unique identifier for the data source name.
SourceType	String	N^{16}	16	The type of the Data Source.

8.3 Data Flow Diagram Level 0

Below, DFD 0 displays how users interact with Av-Alert, and how it interacts with Data Sources.

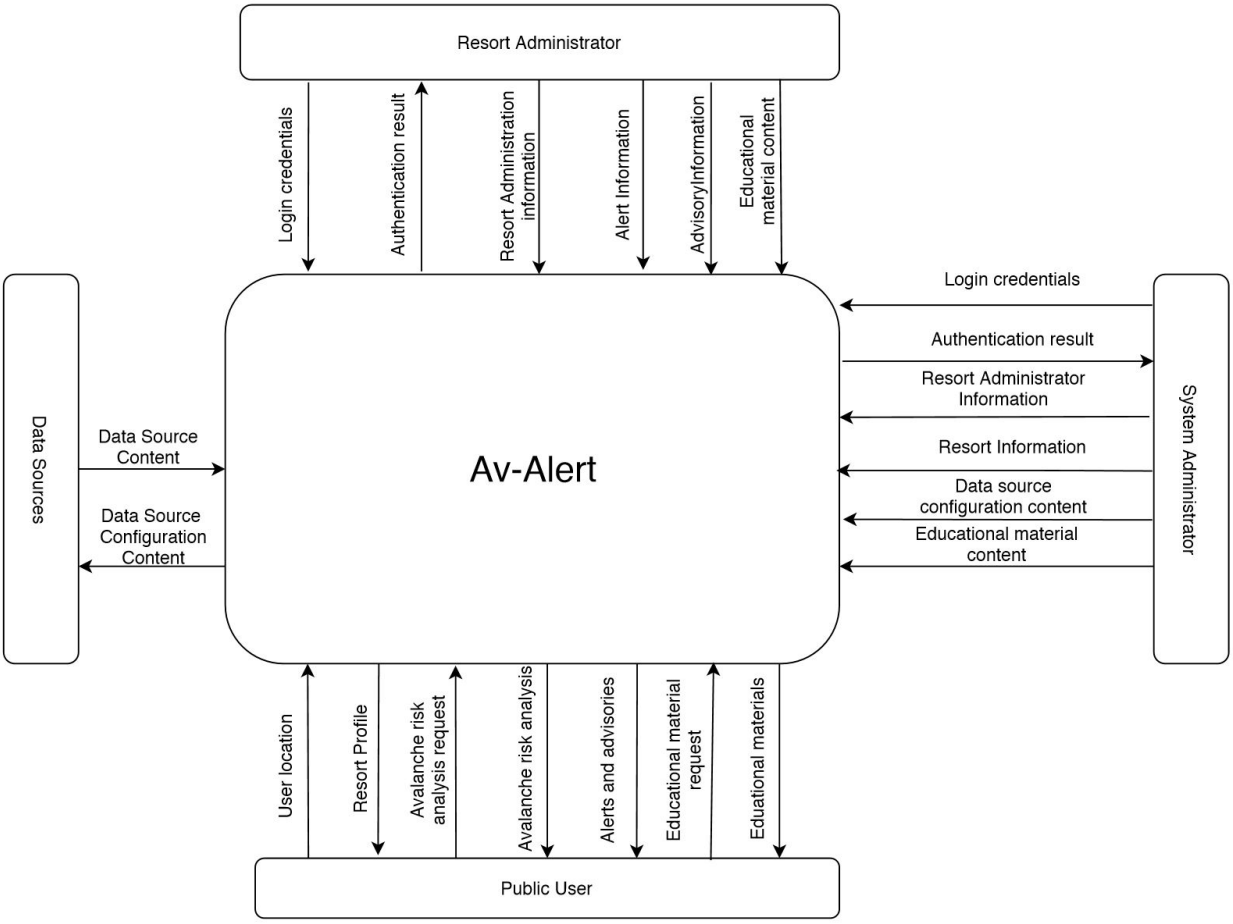


Figure 16: Data Flow Diagram Level 0.

8.4 Data Flow Diagram Level 1

Below, DFD 1 shows a more in-depth view of how users interact with the various processes of Av-Alert.

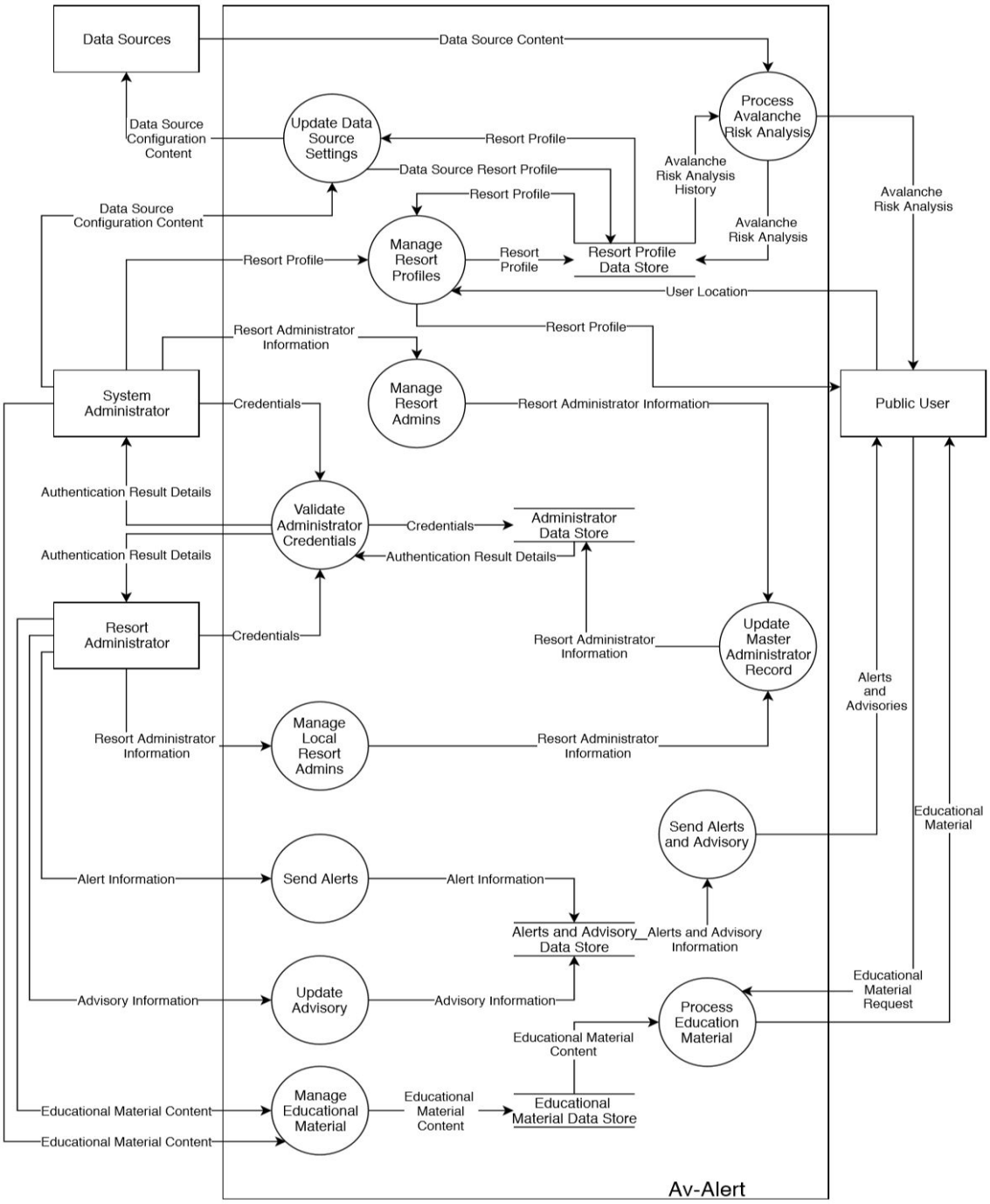


Figure 17: Data Flow Diagram Level 1.

8.4.1 Data Dictionary for Data Flow Diagram Level 1:

Data	Information encapsulated in the data.
Advisory Information	Identifying info (geographic location, name, etc.) for a Slope at Medium Risk of avalanches.
Alert Information	Identifying info (geographic location, name, etc.) for a Slope at High Risk of avalanches.
Authentication Result Details	A true or false value showing if a sign in attempt was successful.
Credentials	Sign in credentials of the administrator, comprising of username and password.
Data Source Configuration Content	Information used by a Data Source to set the format of future information passed from itself.
Data Source Resort Information	A list of Data Sources connected to a Specified Reps.
Educational Material Content	A text or video file that allow a user to gain knowledge towards the Educational Material learning objectives .
Educational Material Request	An Administrator query for a text or video file within the Educational Material Data Store.
Resort Administrator Information	Information such as ResortId, Username, ResortAdminId about a given Resort Administrator.

8.5 Data Flow Diagram Level 2

Process: Manage Resort Profile.

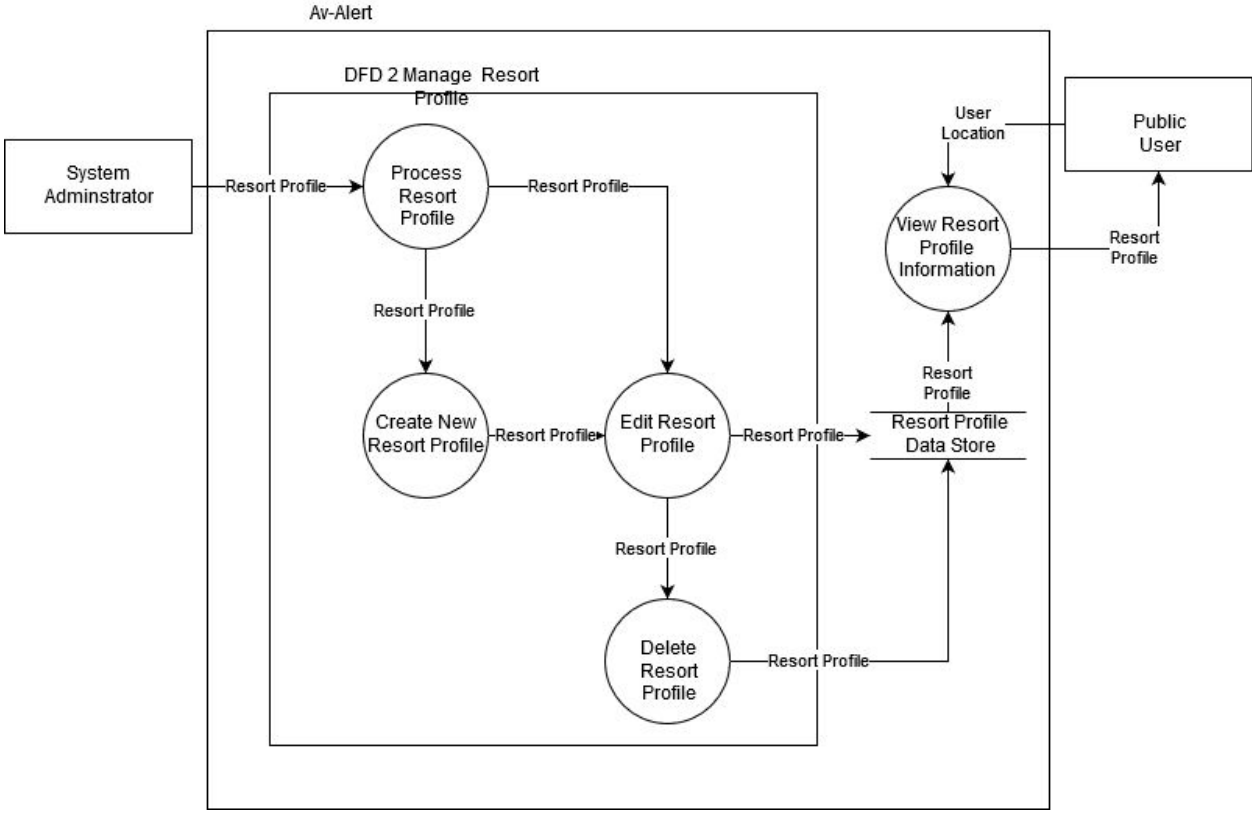


Figure 18: Data Flow Diagram Level 2.

Appendix: Issues List

A-1: Client Clarifications

A-1.1: The budget set by the client for Av-Alert is four million CAD, this was clarified during further elicitation with Steep Mountaineering during the lab.

A-1.2: The radius around each Resort needing to be covered by Av-Alert is 50 km, this was clarified during further elicitation with Steep Mountaineering during the lab.

A-1.3: Public Users will have access to Avalanche Risk Analysis Data. This was clarified with Steep Mountaineering over Slack.

The following clarifications were made with Steep Mountaineering after receiving feedback that the problem that Av-Alert was attempting to solve was a wicked problem.

A-1.4: Av-Alert will produce avalanche risk analysis in the form of an Avalanche Forecast, not a prediction.

A-1.5: Av-Alert will produce Avalanche Risk Analysis Data to create Avalanche Forecasts three times a day, at 6:00am, 12:00pm and 6:00pm instead of being real time as previously specified.

A-1.6: Av-Alert will only use three main data sources to create Avalanche Risk Analysis Data, they are as follows: Topological Maps, Remote Sensing Instruments, and Meteorological Data.

The following clarification was made in response to questions about primary and secondary battery power.

A-1.7: Remote Sensing Instruments are powered by battery, and can have a secondary battery unit to extend their running time in case of a failure of the first.