

Software Engineering Project Report



(Photo of Grand Teton National Park by Peerasith Patrick)

Park Pal Application

Prepared by
Michelle Baginski, Olesia Danchuk, Ryan Gaul, and Adwait Chavan
(GROUP # 28)
for CS 440

at the
University of Illinois at Chicago

Spring 2020

Table of Contents

| | |
|--|----|
| List of Figures | 9 |
| List of Tables | 10 |
| I Project Description | 11 |
| 1 Project Overview | 11 |
| 2 The Purpose of the Project | 11 |
| 2a The User Business or Background of the Project Effort | 11 |
| 2b Goals of the Project | 11 |
| 2c Measurement | 12 |
| 3 The Scope of the Work | 13 |
| 3a The Current Situation | 13 |
| 3b The Context of the Work | 13 |
| 3c Work Partitioning | 16 |
| 3d Competing Products | 18 |
| 4 The Scope of the Product | 18 |
| 4a Scenario Diagram(s) | 19 |
| 4b Product Scenario List | 19 |
| 4c Individual Product Scenarios | 19 |
| 5 Stakeholders | 20 |
| 5a The Client | 20 |
| 5b The Customer | 20 |
| 5c Hands-On Users of the Product | 21 |
| 5d Maintenance Users and Service Technicians | 22 |
| 5e Other Stakeholders | 22 |
| 5f User Participation | 23 |
| 5g Priorities Assigned to Users | 24 |
| 6 Mandated Constraints | 25 |
| 6a Solution Constraints | 25 |
| 6b Implementation Environment of the Current System | 26 |
| 6c Partner or Collaborative Applications | 27 |
| 6d Off-the-Shelf Software | 28 |
| 6e Anticipated Workplace Environment | 29 |
| 6f Schedule Constraints | 30 |
| 6g Budget Constraints | 31 |
| 7 Naming Conventions and Definitions | 31 |

| | | |
|-----------|---|----|
| 7a | Definitions of Key Terms | 31 |
| 7b | UML and Other Notation Used in This Document | 32 |
| 7c | Data Dictionary for Any Included Models | 33 |
| 8 | Relevant Facts and Assumptions | 34 |
| 8a | Facts | 34 |
| 8b | Assumptions | 34 |
| II | Requirements | 27 |
| 9 | Product Use Cases | 27 |
| 9a | Use Case Diagrams | 27 |
| 9b | Product Use Case List | 28 |
| 9c | Individual Product Use Cases | 28 |
| 10 | Functional Requirements | 32 |
| 11 | Data Requirements | 35 |
| 12 | Performance Requirements | 38 |
| 12a | Speed and Latency Requirements | 38 |
| 12b | Precision or Accuracy Requirements | 39 |
| 12c | Capacity Requirements | 39 |
| 13 | Dependability Requirements | 40 |
| 13a | Reliability Requirements | 40 |
| 13b | Availability Requirements | 40 |
| 13c | Robustness or Fault-Tolerance Requirements | 40 |
| 13d | Safety-Critical Requirements | 41 |
| 14 | Maintainability and Supportability Requirements | 42 |
| 14a | Maintenance Requirements | 42 |
| 14b | Supportability Requirements | 42 |
| 14c | Adaptability Requirements | 42 |
| 14d | Scalability or Extensibility Requirements | 43 |
| 14e | Longevity Requirements | 43 |
| 15 | Security Requirements | 44 |
| 15a | Access Requirements | 44 |
| 15b | Integrity Requirements | 44 |
| 15c | Privacy Requirements | 45 |
| 15d | Audit Requirements | 45 |
| 15e | Immunity Requirements | 46 |
| 16 | Usability and Humanity Requirements | 47 |

| | | |
|------------|---|----|
| 16a | Ease of Use Requirements | 47 |
| 16b | Personalization and Internationalization Requirements | 47 |
| 16c | Learning Requirements | 48 |
| 16d | Understandability and Politeness Requirements | 48 |
| 16e | Accessibility Requirements | 49 |
| 16f | User Documentation Requirements | 49 |
| 16g | Training Requirements | 50 |
| 17 | Look and Feel Requirements | 50 |
| 17a | Appearance Requirements | 51 |
| 17b | Style Requirements | 51 |
| 18 | Operational and Environmental Requirements | 52 |
| 18a | Expected Physical Environment | 52 |
| 18b | Requirements for Interfacing with Adjacent Systems | 53 |
| 18c | Productization Requirements | 54 |
| 18d | Release Requirements | 55 |
| 19 | Cultural and Political Requirements | 56 |
| 19a | Cultural Requirements | 56 |
| 19b | Political Requirements | 56 |
| 20 | Legal Requirements | 57 |
| 20a | Compliance Requirements | |
| 20b | Standards Requirements | 58 |
| 21 | Requirements Acceptance Tests | 58 |
| 21a | Requirements – Test Correspondence Summary | 59 |
| 21b | Acceptance Test Descriptions | 60 |
| III | Design | 60 |
| 22 | Design Goals | 60 |
| 23 | Current System Design | 60 |
| 24 | Proposed System Design | 61 |
| 24a | Initial System Analysis and Class Identification | 61 |
| 24b | Dynamic Modelling of Use-Cases | 62 |
| 24c | Proposed System Architecture | 62 |
| 24d | Initial Subsystem Decomposition | 63 |
| 25 | Additional Design Considerations | 64 |
| 25a | Hardware / Software Mapping | 65 |
| 25b | Persistent Data Management | 66 |

| | | |
|-----------|---|----|
| 25c | Access Control and Security | 66 |
| 25d | Global Software Control | 66 |
| 25e | Boundary Conditions | 66 |
| 25f | User Interface | 66 |
| 25g | Application of Design Patterns | 67 |
| 26 | Final System Design | 68 |
| 27 | Object Design | 68 |
| 27a | Packages | 68 |
| 27b | Subsystem I | 68 |
| 27c | Subsystem II | 69 |
| 27d | Subsystem III | 69 |
| IV | Project Issues | 80 |
| 28 | Open Issues | 70 |
| 29 | Off-the-Shelf Solutions | 71 |
| 29a | Ready-Made Products | 71 |
| 29b | Reusable Components | 72 |
| 29c | Products That Can Be Copied | 72 |
| 30 | New Problems | 72 |
| 30a | Effects on the Current Environment | 72 |
| 30b | Effects on the Installed Systems | 73 |
| 30c | Potential User Problems | 73 |
| 30d | Limitations in the Anticipated Implementation Environment That May Inhibit the New Product | 73 |
| 30e | Follow-Up Problems | 74 |
| 31 | Migration to the New Product | 74 |
| 31a | Requirements for Migration to the New Product | 74 |
| 31b | Data That Has to Be Modified or Translated for the New System | 74 |
| 32 | Risks | 75 |
| 33 | Costs | 75 |
| 34 | Waiting Room | 76 |
| 35 | Ideas for Solutions | 76 |
| 36 | Project Retrospective | 77 |
| V | Glossary | 77 |

| | | |
|------------|----------------------------------|----|
| VI | References / Bibliography | 78 |
| VII | Index | 79 |

List of Figures

| | |
|--|----|
| Figure 1 - The Context of the work Diagram | 12 |
| Figure 2 - Sample Use Case Diagram from Bruegge & DuToit (modified) | 37 |
| Figure 3 - Sample Use Case Diagram from Robertson and Robertson | 37 |
| Figure 4 - Use Case Diagram from Robertson and Robertson | 37 |
| Figure 5 - Class Diagram for Park Pal App | 61 |
| Figure 6 - Subsystem Decomposition of the Project | 63 |

List of Tables

| | |
|---|----|
| Table 1 - Event List | 13 |
| Table 2 - Requirements - Acceptance Tests Correspondence | 75 |

I Project Description

Park Pal is a mobile application that is to be used by national park visitors within the United States. It will allow visitors to plan their travel by using a map to view traffic and road conditions within and around the park as well as other events inside the park such as animal sightings, maintenance, closures, and warnings. These features will assist in elevating park safety. The markers on the map will be put in place by witnesses at the park and will be reflected on the map in real time. Additionally, the map will contain geographical information such as established hiking trails, water depth, and elevation.

1 Project Overview

Park Pal is slated to be the mobile application which would be utilized by tourists, visitors and trekkers visiting the National Parks for reporting any incidents, reports, animal activities and crimes that they spot or see at the National park. This app would serve as an helpful aid for the National Park officials to trace any unwanted activities and to tackle them efficiently. This app would also provide a platform for its users to submit photographs, videos and instances noted in the park, so that these can be used by future visitors for further reference and advertisements.

2 The Purpose of the Project

The purpose of this project is to create a mobile application that will be reliable and user friendly for all the parks visitors in the United States. This mobile app will help visitors plan their travels and have all needed resources in one mobile application such as: maps of parks, lists of restrooms nearby, water fountains, and also hiking trails. Park Pal will give visitors information about nearest trails, their length, level of difficulty, amount of time to finish the trail, and other tips and suggestions.

2a The User Business or Background of the Project Effort

The goal of mobile app Park Pal is to create a reliable and helpful application that will make National Park visitors experience better, easier and more memorable. This application is a solution for millions of people that visit those large parks and forests, it's supposed to help visitors know where they are and which way they want to go. The application will give visitors a menu and they can choose one out of the following

options: maps, hiking trails, list of food vendors, list of restrooms. The parks and forests will benefit from this application: more people will visit, and therefore more business. Park Pal will not only benefit the visitors but also employees of those parks. Since visitors will be able to post their location and destination, they will be able to get help or assistance in case it's needed.

Forests and parks are big chunks of natural resources. In the modern world people are exhausted and need getaways to rest and recharge, and forests and parks are perfect for it. The main motivation behind this project is to make people's experience in national parks great! This app is going to contain all needed resources for national park visitors, therefore it's going to solve lots of problems that people would encounter when they visit the park without the Park Pal application.

2b Goals of the Project

- Provide millions of national park tourists a map with real-time alerts and widgets that will display the occurrence of various events that can cause delays or inconveniences to travelers.
- Valuable for maintaining visitor safety and lessen preventable injury.
- Users may be notified of danger prior to park personnel resolving the problem, giving them an advantage to avoid certain areas.
- Park employees may monitor the map and see which events need further inspection or immediate action.
- No known app with many of these features is currently on the market.
- Provide useful insight about the terrain and surroundings.
- Encompass all 58 national parks in the United States.

2c Measurement

The amount of reports within the application can be measured for a certain time interval and be compared to the amount of reports received by park personnel. If the application ends up having more reports, it is likely that more areas of concern are being brought to attention.

The amount of injuries that occur within a park after the introduction of the application should be compared with the number of injuries prior to its use. If this number has declined, it is likely this was due to people taking precaution based on what they viewed on the map.

3 The Scope of the Work

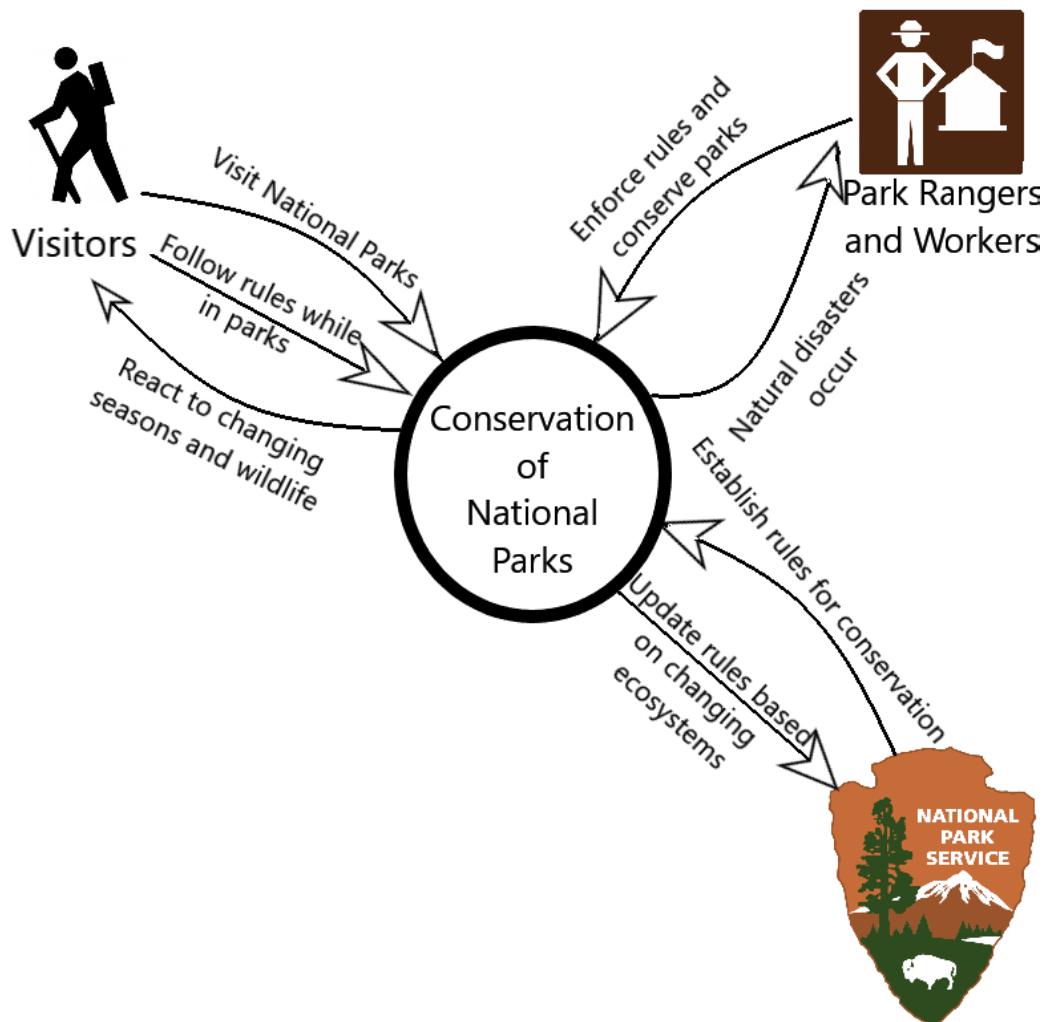
- We need to develop the application first.
- Then we need to get the data for the application from the park and store it.
- After that we put the information collected in the application.

3a The Current Situation

Currently, to report any problems within national parks, one would need to locate a phone number to the park or locate an employee. This may take considerable time to do and may end up as an inconvenience. In turn, problems are not brought to attention quickly and therefore take time to be resolved. Further, only the party who reported the problem and the employee may know about it and not the general public.

There exist various navigation and traffic maps that record traffic, but these are primarily used in urban locations. These applications include no accurate ways to report obstructions or natural events that may delay travel. None of these applications target national parks.

3b The Context of the Work



This diagram shows the relations between park visitors, park rangers and workers, and the NPS. (There is no significance in the curvature of the arrows or in the arrows being hollow.)

3c Work Partitioning

Event List

| Event | Input | Output | Summary |
|--|----------------------------------|---|--|
| Visitor reports a warning in the park. | Description of observed dangers. | Appropriate map tag and description of the warning. | Avoid injury and be cautious of the area. |
| Visitor reports traffic. | Description of causation. | Appropriate map tag at the location. | Visitors who were planning travel may avoid that area or leave at a different time to avoid traffic. |
| Employee reports construction. | Description of the area. | Appropriate map tag and duration. | Visitors who were planning travel to a specific area of the park that is now closed may reschedule their trip. |
| Visitor locates desired hiking trails. | Visitor views map. | Visitor chooses trail. | Convenient |
| Users of the app (visitors, personnel) report usage issues with the app. | Bug report. | Developers detect and fix problem. | After the bugs have been resolved by the development team, they should provide an updated version to the users and notify them of the resolutions. |

Table 1 – Event List

3d Competing Products

Waze is a navigation app that provides users with navigation, traffic alerts and construction. It allows the user to reroute in order to avoid inconveniences such as these. Park Pal is still beneficial because Waze tends to be of most use in urban areas and road traffic. Further, Waze does not directly target National Parks or provide any park-specific features such as reporting animals, information about hiking trails, elevations, or have the option to include images which will allow for mapping to the GPS location using image metadata and also the built-in GPS on phones.

REI National Park Guide & Maps focuses on providing detailed hiking trail information at major National Parks. It allows users to rate the difficulty of trails and a list of camping, lodging and tours. REI would not allow users to see live park updates and

warnings, which Park Pal offers and serves a huge advantage for visitors travelling long distances to the park. Park Pal's map would allow visitors to see if it would be fitting to make a trip out there that day.

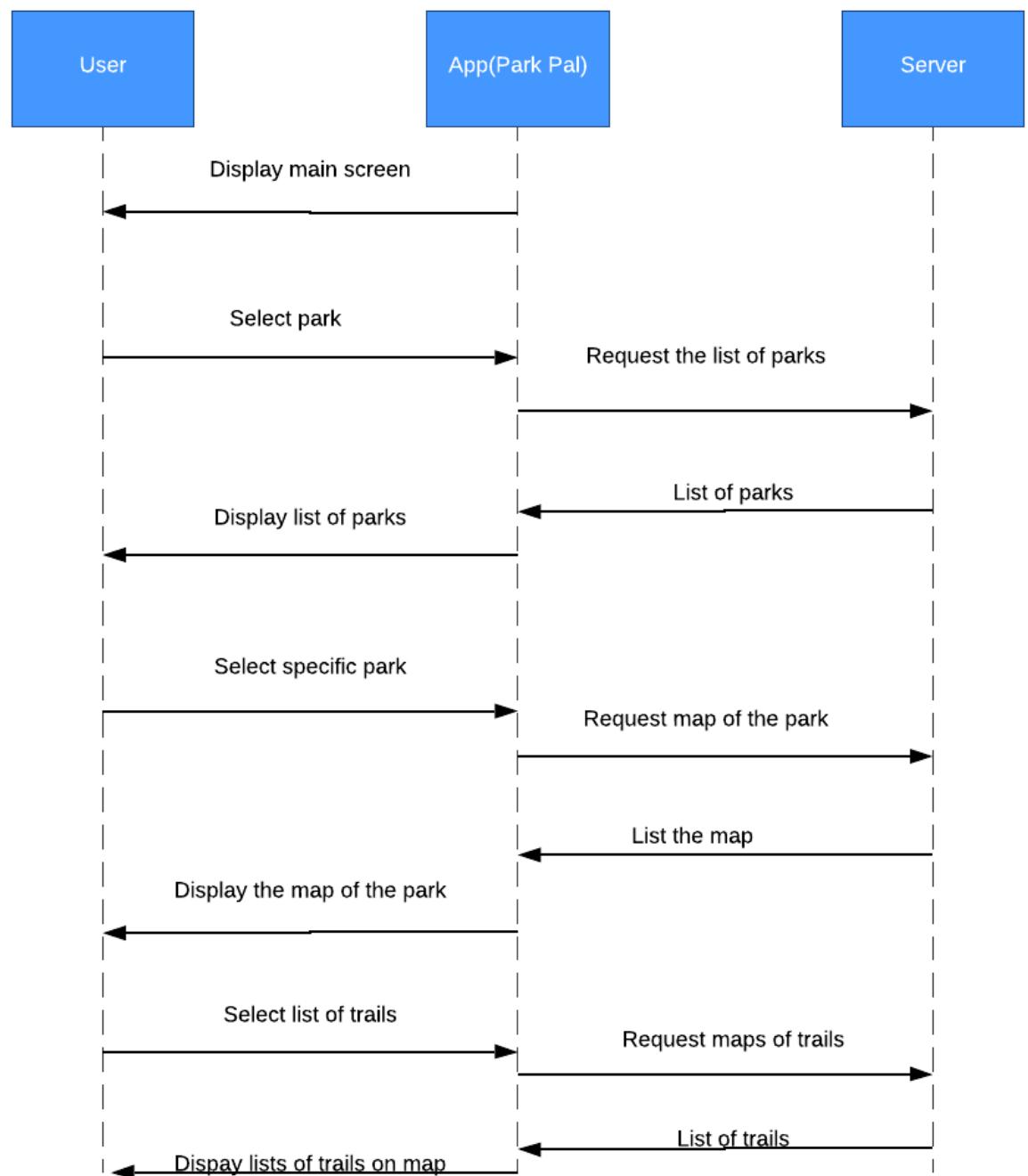
4 The Scope of the Product

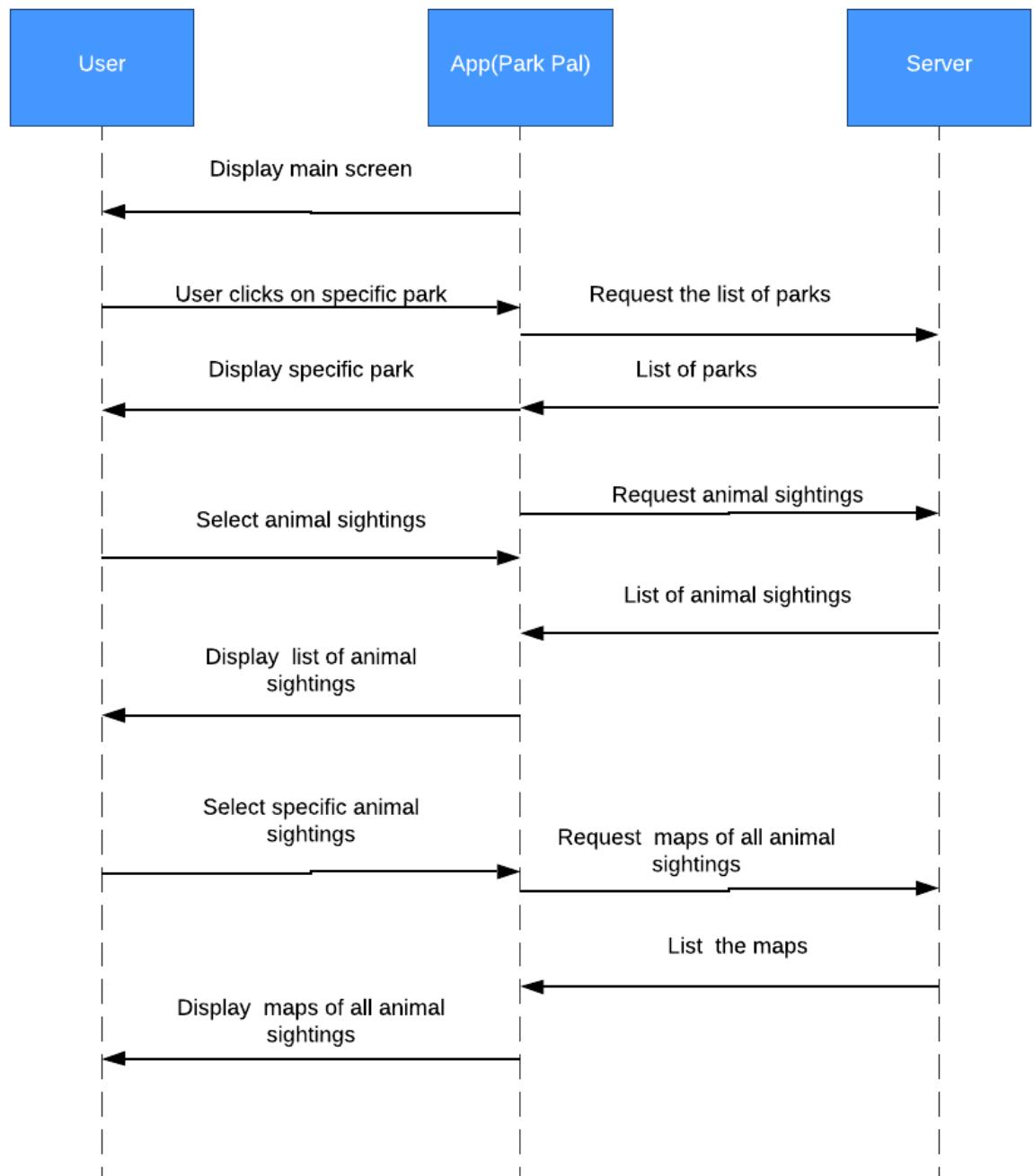
The application will be made available to everyone and will allow anyone to use it, such as any park staff or regular visitors. There will be no “master” users, or users with privileges. Below details some of the uses:

- Reporting traffic on the premises on the main travel routes to and from the park. Users will be directed to indicate if the traffic is light, moderate, or heavy.
- Reporting animal sightings.
- Reporting construction.
- Reporting littering and graffiti.
- Reporting closures within the park.
- Reporting maintenance operations and problems.
- Navigating and choosing desired hiking trails.

For tasks such as reporting construction, maintenance, or closures, this will ideally be foremost reported by maintenance personnel at the park since they will be the first to know of any problems.

4a Scenario Diagram(s)





4b Product Scenario List

1. Tourist
2. Park Personnel (first responders, park rangers, maintenance personnel)

4c Individual Product Scenarios

Tourist Scenario 1: A visitor making a trip that amounts to significant mileage will reference the map prior to leaving for the park. They are likely to have discovered this app while doing research on the official park website. The flow of traffic in areas within the bounds of the park as well as main routes surrounding the park will be marked with symbols representing potential delays or redirections, their causation, and their levels of severity. When planning to leave the park, the user will use this application for the same purposes to plan their travel back home. They will be able to choose ideal routes or avoid travel at peak times.

Tourist Scenario 2: When traveling through the park and coming across an animal, or other natural event that requires precaution, the tourist can report the sighting and tag that location on the map. This provides people with opportunities to see interesting animals (e.g., bison, moose) and their approximate last sightings, as well as warn people of animal presence.

Park Personnel: When becoming aware of any projects or operations that will interfere with tourist activity, the employee can tag the location on the map with an appropriate description of the event and closures if there are any. Users who are interested in this area of the park may look at the activity on the map and decide to plan the trip for another day if this activity was a large part of their plans.

5 Stakeholders

5a The Client

The Natural Park Service (NPS) is a federal government agency that manages natural parks. This agency has many divisions and works diligently to protect park resources and visitors, as well as provide their visitors with various services. They understand most about park maintenance and operations.

5b The Customer

National Parks will purchase this application for use by employees as well as the public.

5c Hands-On Users of the Product

Tourists will be the primary users of the product to gather information about park conditions.

- Age group: all ages
- Technological experience: novice to master (likely to travel in groups with at least one person familiar with the use of technology)
- Report park activities and animal sightings

Park staff concerned with visitor safety will be using the product to report any threats they find sufficient and which may be of interest to visitors.

- Age group: adults
- Technological experience: novice to master
- Role: monitor and report park activities

Park staff concerned with facility maintenance and operations will be using the product to report any park closure due to maintenance or construction.

- Age group: adults
- Technological experience: novice to master
- Report maintenance projects

5d Maintenance Users and Service Technicians

The team of developers will be in charge of maintaining the application whenever bugs have been reported, located, and fixed. Users should be notified of the changes and if any updates are required.

Additionally, maintenance users will be representatives from National Parks. As changes are made to the park, or reasons are found to introduce new features that have practical use, the representatives will make contact with the team of developers. The representatives will notify the developers of their wants and requirements. Work for the addition to the application will then begin. Users will also be notified of any changes and updates that are necessary once the addition has been made.

5e Other Stakeholders

First Responders

- No knowledge is needed by the project.
- Critical to the product because they will be called during emergencies and dangerous situations.
- Firefighters, police, rescuers, EMTs and other members from trained organizations will be called to locations to cease emergency situations.

System Designer

- No knowledge is needed by the project.
- Are to be called in if major issues arise in the use of the application to perform analysis on the problem, and to plan the development strategy and goals.
- Highly important for debugging, documenting and testing to come up with a development strategy and goals for the repair of the system.

Consultant

- Data, reports, and patterns must be recorded from users based on usage.
- Consultants will analyze the data in order to provide options and improvements for both users and the company.
- Positive implications for both users and the company in regards to performance and features.

5f User Participation

There will be a beta release of the application prior to the official launch date which will first be accessible exclusively to park employees. At this point in development, the main focus will be for testing, bug detection and resolution. Employees should be reporting real events, however mock events would be acceptable **only at this time** to cover more test cases.

The public should not have access to the application to avoid any misunderstanding of mock events. Employee testing should last one month. At the end of this testing period,

the testers should submit a report back to the engineers noting any major flaws, or suggestions for improvement, or new ideas to be introduced to the application.

After the employees have tested, the engineers should smooth any bugs and improve any functionality as necessary. The next group of testers will be to the public visitors. They will follow the same testing convention and will have a widget optional for submitting a report detailing their experience, just as the employees did.

5g Priorities Assigned to Users

Key users- National Parks maintenance workers/park rangers: their usage of the app will allow for a more streamlined workflow, as well as a way to interface with the general public easier. If the National Parks Service workers don't like the app, then the app may be discontinued, so it is key to make sure that this group of users like the app and find it to be useful.

Secondary users- Frequent visitors of parks: their usage of the app will allow for them to experience the parks better, or to help others experience the park better.

Secondary users- Infrequent visitors of parks: as most visitors are park don't go to parks very frequently, this large group of visitors can allow for a greater amount of data to be obtained by the app.

6 Mandated Constraints

Description: The application shall be designed for quick and straight to the point interaction with the user.

Rationale: It is still important for tourists to limit use of technology in the parks and take pleasure in the beautiful surroundings of nature.

Fit Criterion: The only features included in this project will be the ability to report various events within and around the park that will be represented by placing markers on a map and display relevant information about trails and geography.

Description: The application shall contain an emergency call button.

Rationale: In case of an emergency, there will be a quick access emergency number.

Fit criterion: This application promotes safety. On press, this will open up the built-in dialer application on their phone's mobile operating system and predial 911 for them.

Description: The design of the application shall be optimized to use as little phone battery as possible.

Rationale: Rural areas such as large parks tend to have poor signal, causing phone battery to be drained faster since it will more often be trying to locate signals.

Fit criterion: To maintain normal, expected battery drainage while using the application. If signal is not found for an extended period of time, the app will recommend that the user turn off mobile data in order to conserve battery.

Description: The application should be able to have some functionality while offline.

Rationale: Rural areas such as large parks tend to have poor signal, so it is important for there to be some functionality when the user does not have a constant internet connection.

Fit criterion: The app will be able to download maps for specific areas for offline usage, as well as have data such as path obstructions downloaded into the app's cache. This data can be set to get updated upon re-establishing an internet connection.

Description: The application should be usable in languages used commonly by tourists that don't have great English language skills.

Rationale: National Parks had around 15 million international visitors to the parks, and many of those visitors don't have a strong grasp of the English language.

Fit criterion: The app will be translated into languages that will reach most foreign visitors in order to make their visits to National Parks as great as possible.

6a Solution Constraints

Description: The application shall be able to run cross-platform on mobile devices such as iOS and Android.

Rationale: Many features of this application are to be used for navigation and while being present at the park, thus use on mobile devices is the most practical and convenient.

Fit Criterion: The application shall be available for download on the Apple App Store as well as the Google Play store.

Description: Any hiking trails or routes shown on this map should align with established routes confirmed to be true by travel guides or official park maps.

Rationale: Maintain and promote the safety of visitors on park property whenever possible.

Fit Criterion: The application is to be in accordance with existing park rules and safety guidelines.

Description: The finished product should be featured on the official website for the national park.

Rationale: While travelers are doing research about the park, they will be exposed to the application and more likely to use it.

Fit Criterion: The application will gain more exposure, resulting in more users and the best possible use out of the app with generating more reports.

Description: Specific tags on the map should be removed at certain time intervals.

Rationale: Users will not have the burden to focus on removing the tags after they have been added.

Fit Criterion: A timer will be set for every 4 hours. Unless a time interval for a specific event has been reported, the icons will disappear in order to avoid clutter and outdated events on the map.

6b Implementation Environment of the Current System

This application is intended to be developed and available for download on mobile phone operating systems. The application should be available on both the Apple App Store and Google Play for Android. It is a requirement for the user to either be on iOS 11.0 or later, or on Android 4.4 or later. Roughly 98% of iOS users and 96% of Android users globally would be able to run the app based only on OS version.

Motivation: Users will be using this application while walking around in the park, or on route to or from the park, therefore there is no need to make a desktop version.

Consideration: There should be a strong network connection and frequent updates to the map since connectivity in national parks may be scarce depending on location and surroundings.

6c Partner or Collaborative Applications

This application will not be using any partner software.

6d Off-the-Shelf Software

iOS mobile operating system

Apple App Store

Android mobile operating system

Google Play

Map API that encompasses the natural park

6e Anticipated Workplace Environment

There is a high chance this product may be used in areas far from cellular towers, so it must be made to consume as little battery as possible.

The user may be exhibiting poor signal depending on their location, so when reporting a problem, they may also be able to save an approximate location with image GPS coordinate metadata.

6f Schedule Constraints

This application would be utilized by the National Park Corporation to allow its users and tourists to report accidents and other significant events that they come across. Having said that, it would be extremely important for the park officials to have this application by the summer season. This is because the next major vacations would be in summer, and Park Pal would serve as a huge help and aid to the Park officials and tourists to manage the daily happenings of the park.

- If we don't build our product by the end of the spring season, it would be very inconvenient and difficult for Park employees and working staff to deal with the huge influx of the tourist population visiting the park.
- The financial impact of not having the product ready would be an added economic strain on the Park administration and government to pay for more forest officers to take care of the park and the nearby areas, as well as, take care of reported events and crimes.

6g Budget Constraints

There will be a team of 5 back-end developers working on this project, along with a quality assurance tester and a front-end developer. Additionally, there will be people from other professions such as geologists mapping trails, national park employees consulting with the development team to ensure specific areas of each individual park are targeted as necessary.

- Back-end developer: \$85,000 x 5 = \$425,000
- Front-end developer: \$75, 000
- Geologist: \$58,000
- Data Analyst: \$75,000

Estimated base cost: \$633,000

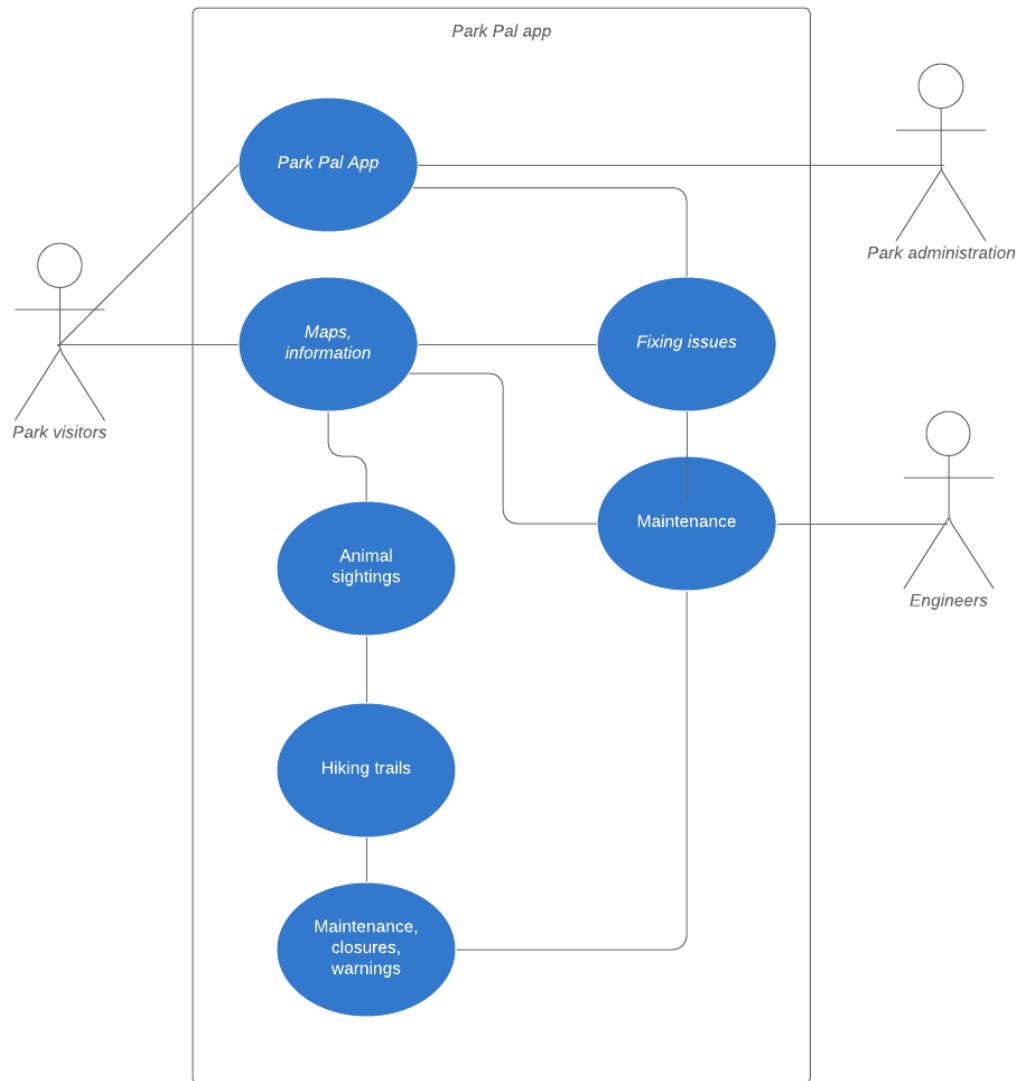
It is important to note that this cost may rise depending on how many parks will be built at the same time. There may be times where multiple geologists will need to collect data from different parks.

7 Naming Conventions and Definitions

7a Definitions of Key Terms

- Warning: A notice of cautionary advice for possibly impending danger.
- Obstruction: A blockage that prevents passage.
- Trail: An established route planned for a particular purpose, in this case hiking.
- National Park: An area protected by the federal government made for the enjoyment of the general public and the protection of wildlife.
- NPS (National Park Service): A United States agency that manages national parks, monuments, and historical and conservation properties.

7b UML and Other Notation Used in This Document



7c Data Dictionary for Any Included Models

Data structures and Data properties related to this project include GPS coordinates, ie., the latitudes and longitudes of the respective location related to the accident, where an unwanted activity has taken place. Also, data file formats would be of the form jpeg, to allow the use of pictures and photographs taken at the location of activity.

8 Relevant Facts and Assumptions

8a Facts

- National Parks are under the Department of Interior.
- The National Parks system has 84 million acres of land.
- The National Parks system also includes monuments, historical structures, monuments, and parkways.
- Extraction of natural resources is not allowed in national parks.
- The National Wilderness Preservation System protects land that includes some of that which falls under either the National Parks Service or the U.S. Forest Service.
- The National Wilderness Preservation System protects 111 million acres of land.

8b Assumptions

- All parks should have the same exact features and options for their users, only differing in their maps and geographical layouts.
- All users share the same abilities on this application, regardless of if they are park employees, authorities, or tourists.
- We assume that every park allows technology, meaning parks would not ban the usage of cell phones or other similar devices, and also parks allow photography of wildlife or locations inside the park.
- We also assume that the users would be able to navigate the app in one of the app's languages, and the user would also be capable enough to use their cell phones to tap pictures and photographs.

- Also, we assume that the Park Administration and Management would promote and advertise the usage of the app, and we also assume that at a time, at least one visitor of the park would have installed the mobile application.
- Finally, we assume that the Park Pal mobile application would serve as a means to report any unwanted wildlife sightings or natural hazards occurring in the park, but we also assume that the app would not be used as a means to request quick and urgent help from the Park officials, and in such a scenario of extreme danger and crime, calling the police would be suggested.

II Requirements

9. Product Use Cases

9a. Use Case Diagrams

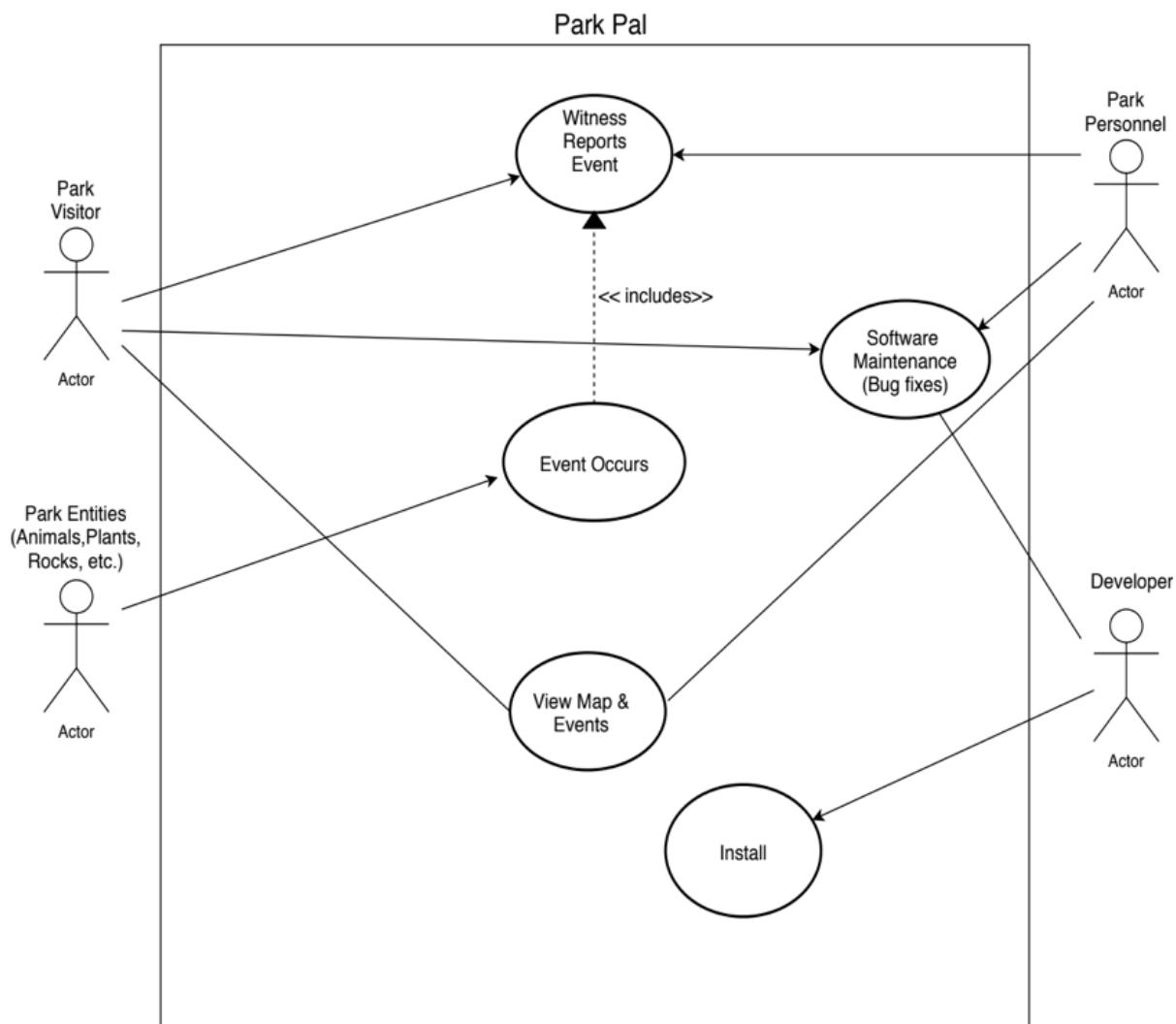


Figure 4 - Use Case Diagram

9b. Product Use Case List

Park employees:

Monitor the map

Add warnings to the map

Visitors:

See travel updates

Report maintenance operations

Check information about hiking trails

Report traffic

9c. Individual Product Use Cases

Use case ID: 1 **Name:** Report Event

pre-conditions: User witnesses something significant at the park.

post-conditions: Map will reflect the event occurrence.

Initiated by: Natural stimuli (weather, animals, natural elements), people

Triggering Event: Safety concern or warning occurs

Additional Actors: Park Personnel

Sequence of Events:

1. The user will witness a significant event of concern from a park entity.
2. The system will provide them the option to record the event on the map.
3. The user will be presented with a set of event categories and corresponding icons.
4. The system will allow the user to type in a short descriptor and assign the icon.
5. The user will select finish.

6. The system will tag the user's location and display the icon in the proper place on the map.

Alternatives: User contacts the park rangers or security staff.

Exceptions: Serious emergencies should contact 911.

Use case ID: 2

Name: Navigate Hiking Trail

pre-conditions: Displayed trails are based on established travel routes.

post-conditions: The user will be given directions to the nearest trail.

Initiated by: User

Triggering Event: User launches live map

Additional Actors: None

Sequence of Events:

1. The user will launch the application.
2. The system will find their location and update their display to their relative area.
3. The user will see hiking trails highlighted on the map.
4. The system will allow the user to click on one of the hiking trails and provide them with an outline on the map of how to get there from their current location.
5. The user will move towards the location.
6. The map will update the user's coordinates to display their current location relative to the desired trail.

Alternatives: Other map applications, paper maps. Although, alternative applications may not provide specific directions to trails.

Exceptions: Guided by a park ranger or tour guide

Use case ID: 3

Name: Travel Tracker

pre-conditions: The map will have a real time update of the current traffic conditions.

post-conditions: The user will be able to successfully plan a travel route.

Initiated by: User

Triggering Event: User types in a travel destination that is a national park.

Additional Actors: Other users who are reporting travel conditions near the park vicinity.

Sequence of Events:

1. The user will type in a travel destination that is a national park.
2. The system will determine the most efficient path of travel to the queried destination and contour the path on the map.
3. The user will select “Go”
4. The system will notify the user if there are any significant conditions that may prevent successful and efficient travel to the park area.
5. The user will move towards the location.
6. The map will update the user’s coordinates to display their current location relative to their destination and notify them once they have reached the destination.

Alternatives: Other map applications, paper maps. However, if the user is utilizing other map applications, they will not be able to get notifications regarding any park travel patterns.

Exceptions: The map must be able to successfully redirect the user if they stray from the provided route.

Use case ID: 4 **Name:** Capture Image

pre-conditions: The user will be in the process of reporting an event.

post-conditions: An image will be included with the report to aid other park goers in identifying an issue.

Triggering Event: Users will be asked if they want to include an image when they report an event.

Additional Actors: N/A

Sequence of Events:

1. The user will be at the last step of reporting an event.
2. The system will ask the user if they would like to include an image to the map.
3. If the user agrees, they will select “Yes.”
4. The system will ask the user for camera access.
5. If the user agrees, they will select “Allow.”
6. The built-in camera application on the phone will launch.
7. The user will capture an image.
8. The system will attach the image to the event report.
9. The user will publish the report.

10. The system will display the report on the map at the user's precise location and provide an image once the map icon is clicked.

Alternatives: User denies camera access and an image is not included.

Exceptions: N/A

Use case ID: 5 **Name:** GPS

pre-conditions: The application will be connected to a high-speed database.

post-conditions: GPS coordinates will be saved in five second intervals and sent to the database as well as updated on the live map.

Triggering Event: User has the map application launched in the foreground.

Additional Actors: N/A

Sequence of Events:

1. The user will have the live map open.
2. The application will retrieve the coordinate information of the user from built-in phone GPS that is pinged from satellites and relay it to the database.
3. The user will continue moving via walking or driving.
4. The system will relay the updated location of the user to the database and update the map to reflect their new location.

Alternatives: N/A

Exceptions: The GPS might not be able to deal with difficult situations like the user being deep underground or underwater.

10. Functional Requirements

Requirement #1

Description: The application traces the location of the user.

Rationale: This is important so forest officials can trace the location of important incidents and send help as well as tourists being alert of possible dangers.

Fit Criterion: The user will have their location recorded immediately upon filling out an event report.

Requirement #2

Description: The application will present the user with various categories and corresponding icons for reporting events.

Rationale: Each icon will correspond to a distinguishable event type.

Fit Criterion: There is a diversity of icons available for events pertaining to safety, animals, weather, natural disasters, danger and construction.

Requirement #3

Description: The application should remove each icon from the map every three hours unless an end-time is specified for that event.

Rationale: Events will expire and should not clutter the map with misinformation to viewers.

Fit Criterion: Timers are set for each icon as soon as it is placed and removes its reference from the map once the time has expired.

Requirement #4

Description: The system must provide users with travel directions via speech *only* if the user is gathering directions for driving purposes.

Rationale: Speech will not be enabled in main park areas to not disturb and provoke animals. People should refrain from staring at their phone while driving.

Fit Criterion: The application will enable this feature when a user is travelling on main roads or select they would like driving directions.

Requirement #5

Description: If an invalid action is completed by the user, the application should display text explaining the error.

Rationale: The application should not crash and instead aim to educate the user on how to successfully complete an action.

Fit Criterion: The test passes if there are sufficient error-handling mechanisms for invalid moves.

Requirement #6

Description: The system must have permissions granted by the user when accessing sensitive data such as camera or location.

Rationale: Sensitive user information must be kept secure.

Fit Criterion: The test passes if the code implements dangerous level permissions.

Requirement #7

Description: The system must relay GPS locations to the database in five second intervals.

Rationale: The user's location on the map must be updated as necessary and displayed accurately to ensure precise navigation.

Fit Criterion: Previous GPS coordinates are overwritten by new ones every five seconds.

Requirement #8

Description: The system must attach an image to the event report if the user has captured one.

Rationale: Other users will be able to click on the image to gain a better understanding or location of the event that was reported.

Fit Criterion: The test passes if the picture appears upon clicking the map icons.

Requirement #9

Description: When using the navigation feature, the system shall alert the user if there are significant travel delays on the route to their destination.

Rationale: This will provide flexibility for the user to choose an alternative route or reschedule their travel as well as save them time.

Fit Criterion: The test passes if warnings are displayed on the travel directions.

Requirement #10

Description: The system must display all hiking trails most relevant to the user's location.

Rationale: The user will be able to select one of the trails and have directions readily available.

Fit Criterion: The test passes if there is an algorithm designed to check for closest trails.

11. Data Requirements

Requirement #11

Description: The system must have permissions granted by the user when accessing sensitive data such as camera or location.

Rationale: Sensitive user information must be kept secure.

Fit Criterion: The test passes if the code implements dangerous level permissions.

Requirement #12

Description: The system shall not access user location services if the application has been killed.

Rationale: To lessen vulnerability and save battery. The location of the user should not be known if they do not have the application launched.

Fit Criterion: The test passes if location services are turned off when the application has been closed.

Requirement #13

Description: The system must use a high-speed database.

Rationale: There will be very frequent database transactions to obtain and update user locations. The database should not impede performance.

Fit Criterion: The test passes if the application uses a database with notoriety for its speed.

12 Performance Requirements

12a. Speed and Latency Requirements

Requirement #14

Description: The application should be able to load the map page in under three seconds.

Rationale: If the speed of the application is not fast enough, visitors of the park may choose not to use it.

Fit Criterion: New users shall be able to load a map of the park within five seconds from opening a specific park in the application.

Requirement #15

Description: Requests from the database should take no longer than three seconds.

Rationale: Users should not be waiting for noticeably long times that will take away from their park experience when trying to complete actions.

Fit Criterion: 90% of data requests have a response time of less than one second and 5% of data requests will have a response time of less than three seconds.

Requirement #16

Description: The application should continue to provide location tracking under poor network connectivity.

Rationale: Most national parks will be in remote locations away from towers. The user should still be able to see their location without a network connection.

Fit Criterion: Built-in phone GPS will be used because it is not reliant on any cell phone tower or network connectivity and operates through satellites in space.

12b. Precision or Accuracy Requirements

Requirement #17

Description: Users should be able to see their location on the map with a difference in accuracy of no more than 10 meters.

Rationale: Mobile devices have capabilities to be accurate within 10 meters with GPS turned on.

Fit Criterion: The test will pass if the user's true accuracy differs with the map accuracy by no more than 10 meters.

Requirement #18

Description: The application should still provide accurate location tracking under poor network connectivity.

Rationale: Most national parks will be in remote locations away from towers. The user should still be able to see their location without a network connection.

Fit Criterion: Built-in phone GPS will be used because it is not reliant on any cell phone tower or network connectivity and operates through satellites in space. The system will synchronize any necessary map updates when connection is available again.

12c Capacity Requirements

Requirement #19

Description: The application should be able to process the 1,000,000 visitors requesting the server per second.

Rationale: This application will be used in all National Parks across America.

Fit Criterion: Approximately 1,000,000 new visitors shall be able to use the application per second without any delays or performance disruptions.

13 Dependability Requirements

13a Reliability Requirements

Requirement #20

Description: The system should be able to handle many users at once in a given area.

Rationale: There may be multiple reports being input at the same time in close proximity to one another.

Fit Criterion: The server should be able to handle areas with lots of traffic and multiple requests at once.

Requirement #21

Description: The system should save and display the user's location every few seconds, with precision.

Rationale: GPS will save the user's location in short few-second intervals and then update the map with this view so that they can accurately navigate.

Fit Criterion: The map will depict an accurate location based on GPS coordinates.

Requirement #22

Description: Distance tracking features should be accurate.

Rationale: The app must be able to track movement and only be off by a relatively short distance.

Fit Criterion: This will be tested and verified with other applications such as step-tracking devices (Fit-bit, Apple Watch).

13b Availability Requirements

Requirement #23

Description: The map should be functional and use GPS location at **all** times.

Rationale: Many National Parks do not have signals in a lot of areas. GPS location should be used at all times to ensure the user can see their position relative to the map at all times.

Fit Criterion: All phones come with GPS tracking that does not require data.

Acceptance Tests: The test passes if the GPS phone tracker for the mobile device is turned on.

Requirement #24

Description: The product should be available for use 18 hours a day, 1 day a week and 24 hours a day the remainder of the 6 days in the week.

Rationale: National Parks are open to the public primarily for daytime hours.

Fit Criterion: The hours that the application will not be running will be used for updates and system maintenance.

Acceptance Tests: The test passes if all the bug-fixes have been resolved.

13c Robustness or Fault-Tolerance Requirements

Requirement #25

Description: The application should be able to work in the case when the internet is not available for use.

Rationale: A loss of internet will not allow visitors to enjoy their trip.

Fit Criterion: Every visitor of the park should be able to download and store maps locally on their mobile devices and use it while internet is not available

Requirement #26

Description: If the application detects that the user is in a sensitive area (high elevation, possibility of dangerous animals), the application should display a pop-up warning to the user.

Rationale: The user will be cautioned that they should limit their phone use as well as to remind them to be wary of their surroundings.

Fit Criterion: Their display will be partially obstructed with a warning message. The only way they may resume their use of the application is to acknowledge they have received the warning by a clickable button “Resume.”

13d Safety-Critical Requirements

Requirement #27

Description: Reports that are classified as dangerous *must* be displayed to reflect this on the map.

Rationale: Since this application promotes safety to a high degree, icons that indicate possible harm to tourists must be made more noticeable than other icons on the map.

Fit Criterion: The map will outline these icons in red, with bold and capitalized text and several exclamation marks, for those that may be colorblind.

Requirement #28

Description: Reports that are classified as cautious, or slightly dangerous must be displayed to reflect this on the map.

Rationale: Icons for these items must indicate that the area is mostly safe to be in, but users should still take precaution.

Fit Criterion: The map will outline these icons in yellow, with capitalized text and one exclamation mark, for those that may be colorblind.

Requirement #29

Description: Areas that are commonly known to inhabit animals that may be aggressive or pose a threat to travelers should be depicted on the map in the location in which they reside.

Rationale: The user should be cautioned of their presence and will become more alert of their surroundings and actions.

Fit Criterion: An icon with a picture of the animal will be displayed in areas where the animals are known to live.

14 Maintainability and Supportability Requirements

14a Maintenance Requirements

Requirement #30

Description: The Park Pal application must be available for maintenance by developers as well as park employees.

Rationale: Maintenance should be available for park employees as well because employees need to update content, for example closed roads or warnings.

Fit Criterion: Park employees shall be able to update content on a map of the park: closed roads, warning signs.

14b Supportability Requirements

Requirement #31

Description: The application should have the user manual for the park users and park employees.

Rationale: All the information will be provided in the user manual.

Fit Criterion: Park employees shall be able to easily understand the user manual and help visitors if any questions occur.

14c Adaptability Requirements

Requirement #32

Description: The application is expected to run on all platforms: Android and iOS.

Rationale: The application should function regardless of the operating system it is on.

Fit Criterion: The application will be developed in environments suitable for both Android and iOS.

14d Scalability or Extensibility Requirements

Requirement #33

Description: The application shall be capable of processing 1,000,000 visitors requesting the site per second, but there is an option to upgrade for a bigger throughput.

Rationale: Developers should keep in mind that depending on the season there could be more visitors, and also depending on the size of a National Park and popularity of the park there could be more visitors as well.

Fit Criterion: Developers should be able to scale the application based on the demand.

14e Longevity Requirements

Requirement #34

Description: The application is expected to operate without additional maintenance for at least one year.

Rationale: This application depends on the real data and requires updates; those updates depend on the season and size of the park.

Fit Criterion: The application is expected to function well within a year of purchase but will require updates depending on the season.

Requirement #35

Description: Developers and the NPS are open to collaborate with other companies to add new features to the application in the future.

Rationale: The NPS plans to expand features as necessary to provide a more memorable experience for users.

Fit Criterion: Users will be allowed to submit feedback reports and suggestions. Developers will also be open to inquiries from other companies.

15 Security Requirements

15a Access Requirements

Requirement #36

Description: Only software developers and park employees should have access to the database of the app.

Rationale: User locations and other sensitive information should be kept private.

Fit Criterion: Park employees and developers will be the only parties that have access to the database.

Requirement #37

Description: Visitors cannot view location of the other visitors, only software developers and park employees should be able to view visitor locations.

Rationale: Park employees should be able to view visitors' locations in case someone gets into trouble and needs assistance from park employees.

Fit Criterion: Park employees and developers shall be able to view visitor's locations on the park map.

15b Integrity Requirements

Requirement #38

Description: The application shall prevent incorrect data from being introduced, for example if a specific park has closed one or a couple of routes due to dangerous weather conditions.

Rationale: Visitors shall be able to see real time updates on the park map and shall be protected from incorrect data.

Fit Criterion: Park employees shall update the maps and post any changes in order to protect visitors from incorrect data.

15c Privacy Requirements

Requirement #39

Description: Users must consent to using location services before being allowed to utilize the map.

Rationale: User locations should be hidden from other applications or processes which try to access them.

Fit Criterion: Each user process will be private and not permitted to access information contained in other processes.

Requirement #40

Description: Users must consent to allowing the application to use photos before being allowed to take pictures.

Rationale: Pictures and camera roll should only be accessible if the user permits it and remain hidden from foreign processes.

Fit Criterion: Each user process will be private and not permitted to access information contained in other processes.

15d Audit Requirements

This application will not have any transactional data.

15e Immunity Requirements

Requirement #41

Description: No personal user data should be asked for or saved.

Rationale: Name, address, any contact information should not be asked for during use of the application by visitors.

Fit Criterion: All users will have the same privileges and therefore will not need accounts that ask for personal information fields.

16 Usability and Humanity Requirements

16a Ease of Use Requirements

Requirement #42

Description: The product must have an easy to use interface.

Rationale: The application should only provide quick options for reporting events and map usage so that people do not end up spending too much time on their phones.

Fit Criterion: The interface will be consistent, adaptable, and predictable.

Requirement #43

Description: The map should be simplistic and similar to those that people are likely familiar with prior use of (Google Maps, Apple Maps, etc.).

Rationale: The user should not spend needless time learning how to read a map and eliminates confusion with navigation.

Fit Criterion: Map API should be one that is not inundated with unnecessary clutter and includes all the essential features tourists may find useful.

Requirement #44

Description: The product must be usable for children and adults.

Rationale: The application should be simple enough to be used by visitors of any age group, inclusive of younger children and adults with basic smartphone experience.

Fit Criterion: People with novice to basic smartphone knowledge should be able to use the application.

Requirement #45

Description: The product must remember the permissions granted by the user.

Rationale: The application should be conscious of accessing sensitive information such as photos, camera, location. Unless permission has been granted by the user, the hardware and software components should be protected by default. If permission is granted, it should remain so unless the user disables this in the settings.

Fit Criterion: Permissions will be saved in the device's Settings application.

Requirement #46

Description: 99% of errors encountered during runtime should not crash the application.

Rationale: If the system detects an error, there should be proper exception handling and the user should not be kicked out of the application.

Fit Criterion: Quality assurance teams should provide the engineers with detailed reports of tests and edge cases that need patching prior to each large release.

16b Personalization and Internationalization Requirements

Requirement #47

Description: The product shall allow for language configuration changes in both English and Spanish.

Rationale: English and Spanish are the two most spoken languages in the United States.

Fit Criterion: English and Spanish will be the only languages this application utilizes.

Requirement #48

Description: The product shall work the same way for both portrait and landscape orientations of the mobile device.

Rationale: When rotating a device, the screen the user was on prior to the configuration change should relaunch in the same state.

Fit Criterion: Instances should be saved when the application is rebuilt on a configuration change.

Requirement #49

Description: Idioms should not be used in any language configuration.

Rationale: When translating between languages, the use of idioms may cause confusion between the two languages, and thus should be avoided.

Fit Criterion: Idioms will be prohibited.

Requirement #50

Description: The user should be able to change from light mode and dark mode.

Rationale: Depending on the light conditions outdoors, certain colors may be easier and more distinguishable to view than others.

Fit Criterion: There will be a feature in the application settings to customize the mode.

Requirement #51

Description: The user should be able to customize notification settings.

Rationale: The user may be able to choose which and if any notifications they would like to receive from the application.

Fit Criterion: The user will be able to customize this in the ‘Settings’ application of their mobile device.

Requirement #52

Description: The user should be able to customize location settings.

Rationale: The user must be able to turn their location settings off as desired.

Fit Criterion: The user will be able to customize this in the ‘Settings’ application of their mobile device.

16c Learning Requirements

Requirement #53

Description: The application should be easily learnable for the user.

Rationale: After a tutorial has been completed during the initial launch after download, the user should have all the required knowledge to properly use the application.

Fit Criterion: Both adults and children will be able to learn the basic functions of the application quickly if they have general smartphone knowledge.

Requirement #54

Description: The application should provide feedback during invalid actions.

Rationale: If the user enters invalid input or has not met all the steps to complete an action, the system should display an informative message to the user so they can complete the action successfully.

Fit Criterion: Input validation and error handling should be implemented anywhere that is necessary.

Requirement #55

Description: All interfaces for reporting errors should be consistent and uniform, no matter which category they fall under.

Rationale: The user will only need to adapt to one interface to perform a common function and will be able to quickly adapt to the application.

Fit Criterion: Font size, font type, buttons, and button positions should all be the same.

Requirement #56

Description: Once the user has learned how to use the application, submitting a report should take no longer than 30 seconds.

Rationale: The application will already have the user's location, and all they will need to do is include a short text, and optionally an image.

Fit Criterion: The interface must only ask for the type of event, optional text and an image.

16d Understandability and Politeness Requirements

Requirement #57

Description: The application shall use simple English, so it will be naturally understandable by the users of the application.

Rationale: By using simple English we will ensure that people from different backgrounds will understand instructions.

Fit Criterion: The application and manual shall use simple English.

16e Accessibility Requirements

There are no accessibility requirements for this product. Because this application is most likely to be used by people who are moving around, it is unsafe and not recommended that people with disabilities should be distracted with the use of technology in outdoor areas and the presence of unexpected wildlife conditions. In fact, it is highly recommended that people with disabilities are accompanied with an aid to the parks.

16f User Documentation Requirements

Requirement #58

Description: There should be a link in the app store as well as within the application to a website that will provide users with informative documentation.

Rationale: The link will supply them with a FAQ and other relative information for application usage.

Fit Criterion: The website with the display of this information will be created and displayed where the application is available for download on the market.

Requirement #59

Description: The NPS website should contain documentation detailing updates and changes for each release.

Rationale: Users should be informed of any deprecated features as well as new functionality.

Fit Criterion: The website with the display of this information will be updated upon each major release.

16g Training Requirements

Requirement #60

Description: The application manual should be available at the same time the product is released for all park users and park employees.

Rationale: Park visitors and park employees will be able to find answers to their questions in the manual, all the information about the product will be provided in the manual.

Fit Criterion: Park visitors and park employees shall be able to easily understand the manual, and it should be released when application is done.

17 Look and Feel Requirements

17a Appearance Requirements

Requirement #61

Description: Any user should be able to easily navigate through the application without any problems or concerns.

Rationale: The application shall be user friendly, and straightforward to use with an organized interface.

Fit Criterion: Any person given the application for first time use should be able to start using the product within the first 5 minutes without prompting or enticement.

17b Style Requirements

Requirement #62

Description: The application icon should be pleasant and address product branding. The application shall be posted on all of the platforms: Android and iOS.

Rationale: The application shall be nice and address product branding, therefore more potential park visitors would want to use it.

Fit Criterion: After their first encounter with the product, 70 percent of representative potential customers shall agree they feel they can trust the product.

18 Operational and Environmental Requirements

18a Expected Physical Environment

Requirement #63

Description: The product shall be used predominantly by users moving around.

Rationale: Visitors will be using this for travel and navigation purposes.

Fit Criterion: The user interface should be simplistic and not provide distractions during travel.

Requirement #64

Description: The product shall not allow for the use of any audio or make any sound.

Rationale: Visitors should not be distracted or startled as they may be in areas with high elevations and unexpected noise may cause them to be startled and possibly susceptible to injury or provoke any animals to be startled and aggressive.

Fit Criterion: The application will not provide any features that produce sound.

Requirement #65

Description: The product shall have a light-mode and a dark-mode.

Rationale: Depending on weather and location, different conditions will allow for different lighting. The application needs two modes that are suitable for any conditions.

Fit Criterion: The application should be tested in both modes to ensure that both of them are consistent and acceptable to use in various light conditions.

18b Requirements for Interfacing with Adjacent Systems

Requirement #66

Description: The product shall function with a map API.

Rationale: Visitors will be relying on the map for travel, park routes as well as live events noted on the map.

Fit Criterion: Google Maps or another API provider must be compatible with the mobile operating system.

Requirement #67

Description: The product shall use a database for information storage.

Rationale: Various information about updates and travel reports will be saved and then deleted once the events are obsolete.

Fit Criterion: There should be an automatic system timer set in place for each event.

Requirement #68

Description: The product shall use built-in phone GPS.

Rationale: The user will have an accurate display of their location whenever they launch the map on the application.

Fit Criterion: The GPS coordinates should be taken from the phone's internal GPS tracking system.

18c Productization Requirements

Requirement #69

Description: The product shall be compatible with mobile operating systems Android and iOS.

Rationale: These are the two most common mobile operating systems.

Fit Criterion: The requirement will be met when the application is thoroughly tested on both systems to ensure there are no system-related performance issues.

Requirement #70

Description: The product shall be available for download on Google Play and the Apple App Store.

Rationale: These are the corresponding app stores for both mobile operating systems the product will be available on.

Fit Criterion: The requirement will be met when the application is available for download on both stores.

18d Release Requirements

Requirement #71

Description: Each release should not reduce functionality of any previous features.

Rationale: New releases are intended to improve functionality and provide patches to pre-existing problems.

Fit Criterion: The requirement will pass when a new release does not cause pre-existing features to crash or perform worse than they were prior to the release.

Requirement #72

Description: Each release should provide the user with an update of what new features there are and any bug fixes.

Rationale: Users should be informed of new changes for each update. They should know of any patches as well as new features.

Fit Criterion: A message will be displayed once the new release has been downloaded to inform the user and include a tutorial if necessary.

Requirement #73

Description: Unless there is something urgent, smaller patches should be done once a week, every Sunday evening.

Rationale: This timing ensures there are no users that will have service disruptions during the update.

Fit Criterion: All updates will be scheduled for Sunday at 9:00 pm.

19 Cultural and Political Requirements

19a Cultural Requirements

Requirement #74

Description: The product must not offend any religious group or ethnicity.

Rationale: All content of the application should be strictly related to geography and safety.

Fit Criterion: There should be a list of blocked words, including offensive and racist terminology. This will not be allowed for display if a user tries entering it.

Requirement #75

Description: The product must have the same functionality no matter which language configuration is being used.

Rationale: All people should be able to get full and equal use out of the application regardless of which language they are using.

Fit Criterion: When rebuilding the application on a new language configuration change, the only thing that shall be altered is the translation of the language and text visible to the user.

19b Political Requirements

Requirement #76

Description: The application should be developed in one company and not outsourced.

Rationale: Since this has the possibility of being deployed to 58 National Parks, the client would like a single, uniform company procedure.

Fit Criterion: All work must be done internally by the same company.

20 Legal Requirements

20a Compliance Requirements

Requirement #77

Description: The application shall comply with state and local laws.

Rationale: The application shall be used in all National Parks that are located in different states and cities in America.

Fit Criterion: Legal counsel shall certify that application is compliant with all state, county and city laws.

20b Standards Requirements

Requirement #78

Description: The product shall comply with applicable Federal Communications Commission standards.

Rationale: The product shall comply with applicable Federal Communications Commission standards in order to ensure that mobile devices used in the United States work effectively without causing any harm to the users.

Fit Criterion: Legal counsel shall certify that the product is compliant with all the applicable laws: state and local.

21 Requirements Acceptance Tests

21a Requirements – Test Correspondence Summary

| Test | Requirements | | | | | | | | | | | | | | | | | | | | | | | | | |
|---------|--------------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--|--|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | | |
| Test 1 | x | | | | | | x | | x | x | | | | | x | x | x | | | x | x | x | | | | |
| Test 2 | | x | x | | | | | x | | | | | | | | | | | | | | | | | | |
| Test 3 | | | x | | | | | | | | | | | | | | | | | | | | | | | |
| Test 4 | | | | x | | | | | | | | | | | | | | | | | | | | | | |
| Test 5 | | | | | x | | | | | x | x | | | | | | | | | | | | | | | |
| Test 6 | | | | | | | | | | | x | | x | | | | | | x | x | | | | | | |
| Test 7 | | | | | | | | | | | x | | | | | | | | | | | | x | | | |
| Test 8 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Test 9 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Test 10 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Test 11 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Test 12 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Test 13 | | | | | | | | | | | | | | | | | | | | | | | | | | |

| T | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | | |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--|--|
| 1 | x | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | x | x | | | x | | x | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | |
| 5 | | | | | | | | | | | | | | | x | x | x | | | | x | | | | | | | | |
| 6 | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | x | | | | x | x | x | x | x | | | | | | | | | | | | | | | | |
| 8 | | | | | | x | x | | | | | | | | | | | | | | | | | | | | x | | |
| 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | x | | | | | | | |

21b Acceptance Test Descriptions

ID #1 - GPS & Navigation (Req 1, 7,9,10, 16,17,18,21,22,23, 25,26,27,28,29,43,66,68)

Description: Open the app, and check to see if GPS pings the user at the correct location and follows the user when they move, updating every five seconds, even with unreliable or no internet connection, with an accuracy of ± 10 meters. The navigation system should be simple, and give the user possible driving and hiking routes, as well as warnings and suggestions if there are safer or faster routes available.

ID #2 - Events (Req 2, 3, 8,56)

Description: Ensure that users can select a category and an icon that will describe their event type, and ensure events are usable and functional. An event being functional involves the event being chosen, showing up on the map, having a picture attached and associated with it, being removable, and automatically disappearing after a set amount of time.

ID #3 - Accessability & Ease of Use (Req 4,42,44,47,49, 53,57, 61,62,63,75)

Description: Ensure that the application has accessibility functionality, including speech control for navigation. Navigation of the application is easy and predictable, being usable by both children and adults, as well as English and Spanish speakers.

ID #4 - Errors (Req 5, 46,54,55)

Description: Attempt to do an invalid action, such as drive across the Pacific Ocean, and check to see if a proper error message is displayed for the problem and it is uniform. Errors should not crash the app most of the time.

ID #5 - Permissions & Privacy (Req 6,11,12,39,40,41,45)

Description: Open the app, attempt to take a picture and get location information, and check if the user is prompted to give the app permissions, and these permissions are remembered by the app. Make sure that the application is not updating GPS coordinates in the background, and user information is not stored. User location information should not be viewable by other users.

ID #6 - Database (Req 13,15,19,20,33,67)

Description: Check to make sure that there is very little delay between a user's input, the database receiving the input, and the user receiving the input. Emulate 1,000,000 requests at one time, with many of those going to one server, and ensure the database is still functioning and quick.

ID #7 - Speed & Optimization (Req 14)

Description: Ensure that the map takes no longer than 3 seconds to load.

ID #8 - Uptime & Integrity (Req 24,30,34,35,36,37,38)

Description: Have the application running normally for a week, and make sure maintenance is held within a 6 hour window on a single day, and big overhauls should not be needed for at least one year. With this, developers and park employees need to be able to update content in the parks(while users can't update this information), as well as consult 3rd party vendors about the application.

ID #9 - User Friendliness (Req 31,32, 51, 52,58,69,70,74)

Description: Ensure the application is available and functioning on iOS and Android, and includes a help section that has a user manual. Also ensure notification options in the settings are functional. Ensure any offensive words are blocked from being used in the application.

ID #10 - User Interface Optimization (Req 48,50,65)

Description: Ensure that the app is fully functional when in dark/light mode and when rotating between portrait and landscape.

ID #11 - Documentation & Updates (Req 59,60,71,72,73)

Description: Update notes should appear on the NPS website. The application should be shipped to NPS with a manual on how to use it. Updates should not reduce usability nor functionality, and should happen on Sundays.

ID #12 - Audio (Req 64)

Description: Check if there is any audio playing in the application. There should be no audio from the application.

ID #13 - Legal Requirements and Outsourcing (Req 76,77,78)

Description: Don't have the app development outsourced, as this makes legal issues more difficult. Consult with legal counsel that the application complies with local, state, and federal law, and is complicit with FCC standards.

III Design

22 Design Goals

The design goal of this system is to ensure tracking services operate accurately and with precision. Most of the functionality of this application is reliant on live location tracking and it is important for user safety and convenience that location data is accurately and frequently recorded on the live map. Therefore, it is absolutely necessary that a high-speed database is used, and transactions are optimized to be as fast as possible.

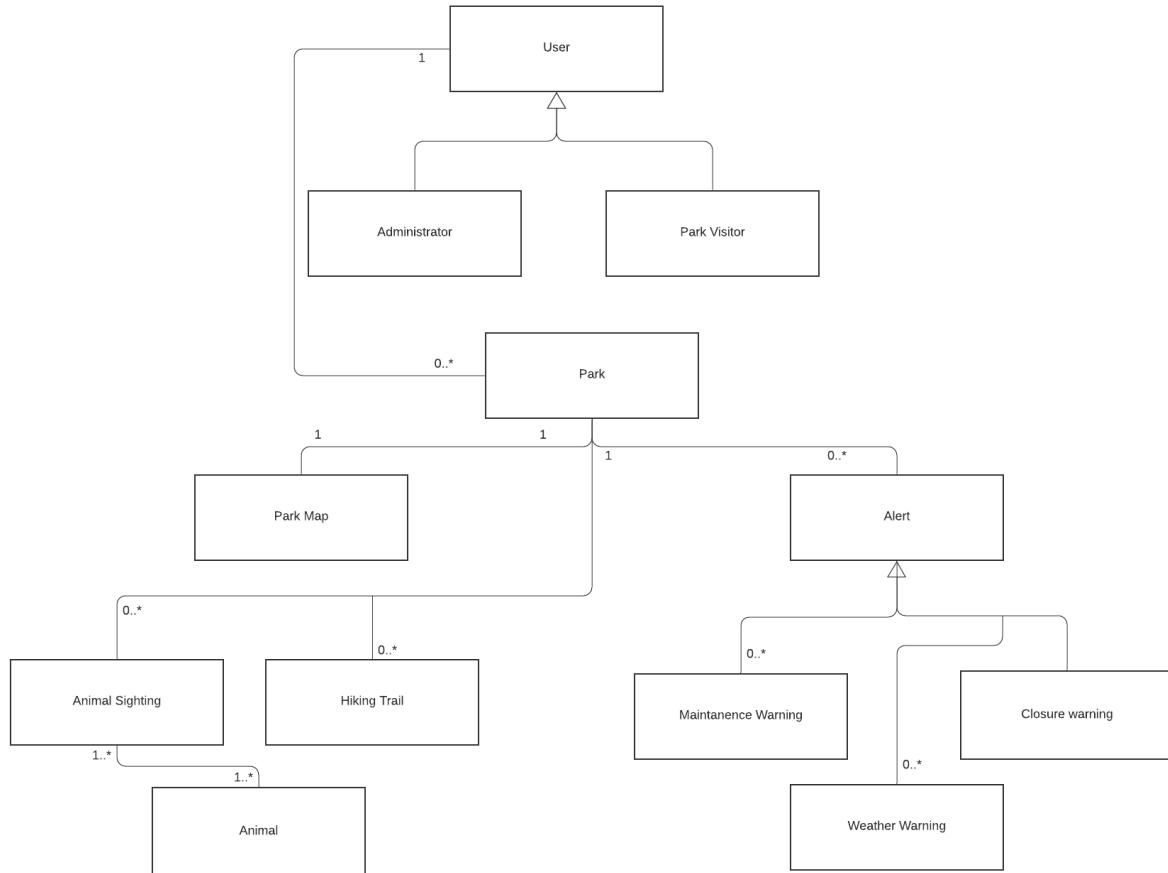
Moreover, because this is a mobile application and many national parks exhibit poor signal which may lead to fleeting battery life, it is also our goal to make use of battery saving techniques to prolong usage of the device as well as the application.

23 Current System Design

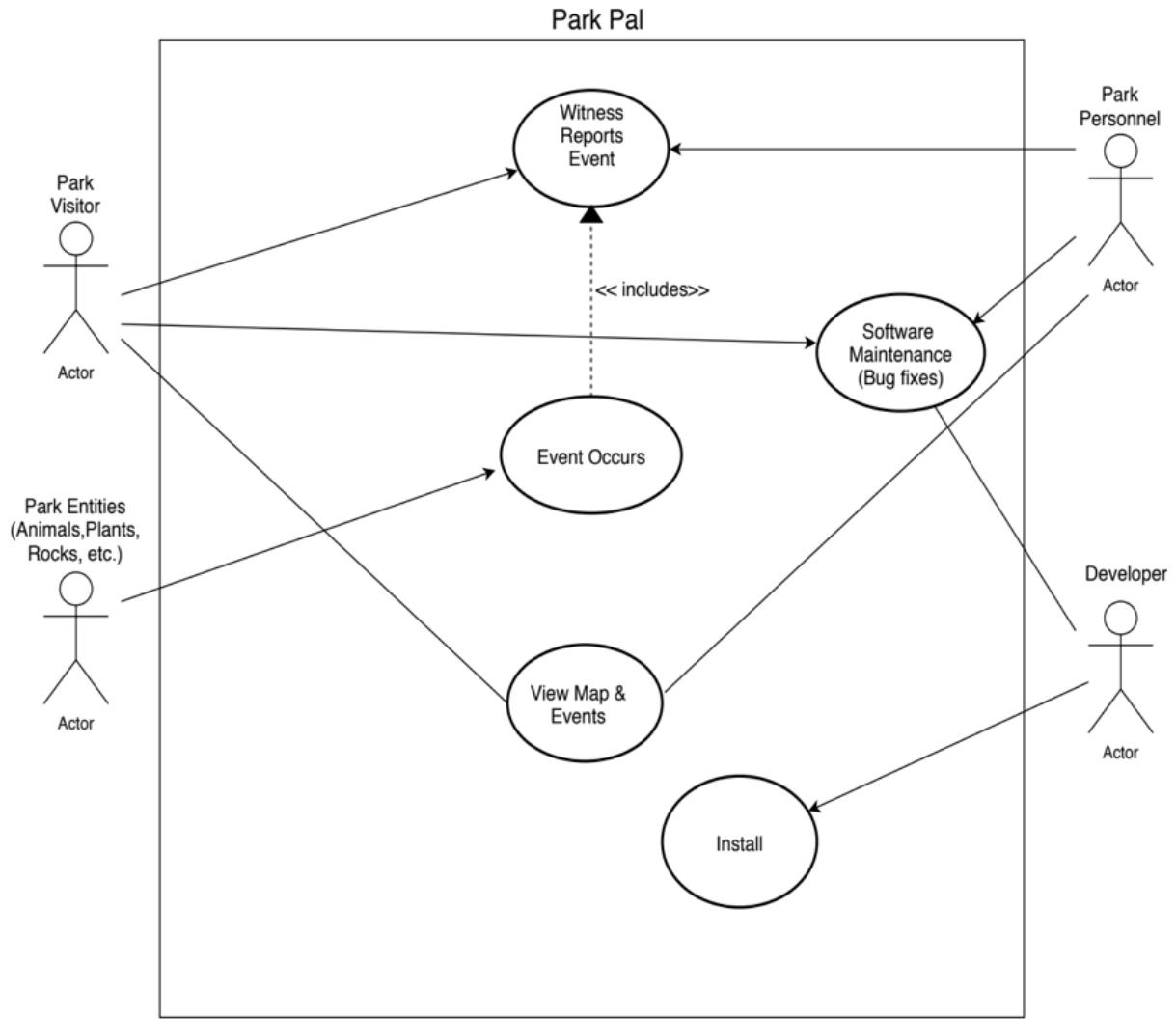
There is no pre-existing system, however this application will make use of pre-existing software such as a map API and database to enhance the functionality of the app and to add to the user's experience while using the application.

24 Proposed System Design

24a Initial System Analysis and Class Identification



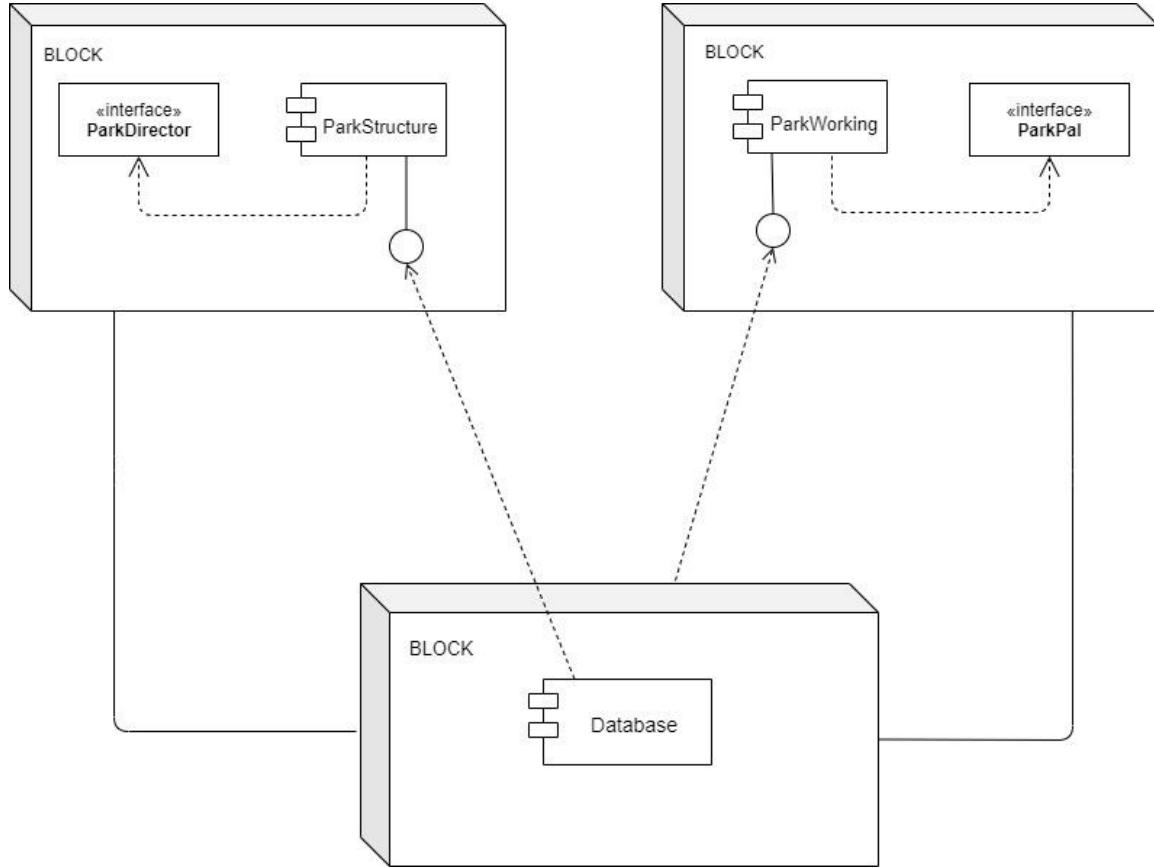
24b Dynamic Modelling of Use-Cases



24c Proposed System Architecture

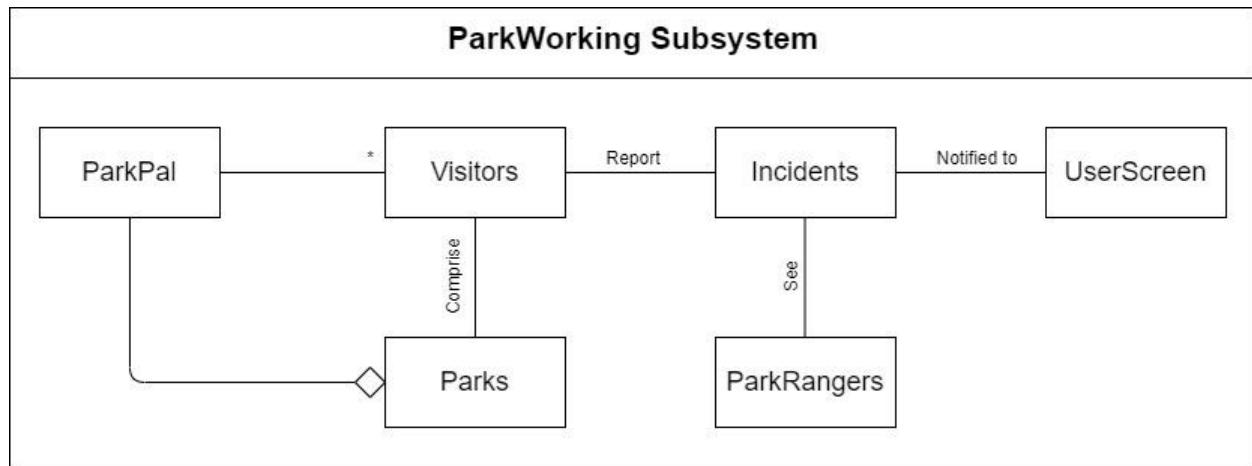
We propose the Client-Server architecture to be used as the underlying system architecture. All of the users are clients that will need to contact multiple servers depending on the action they are requesting to complete. Each national park will have a set of relational databases that will include separate databases for client actions, navigation services, as well as reports and events within the national park. The clients will know nothing about each other and will be running as unique processes with private address spaces.

24d Initial Subsystem Decomposition



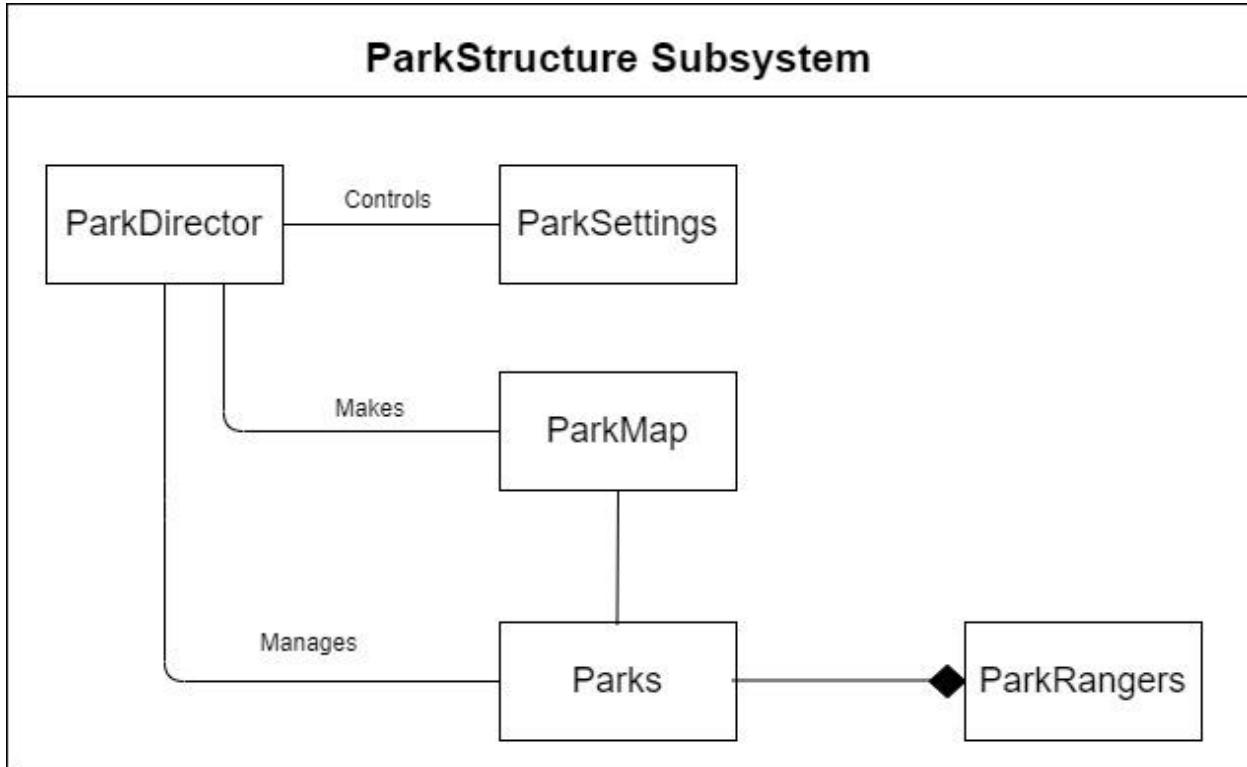
We see that the subsystem is decomposed into the park's structural basis and the park's working being connected by the database. These three blocks help us to evaluate and analyse the correct functioning of the Park Pal system.

Let's take a closer look at the ParkWorking subsystem:



We realize that the visitors report any fatalities or accidents happening in the park, which are notified to the user screen being seen by the park rangers to take further action. It is also important to notice that this allows the users to avoid such areas in advance for safety reasons.

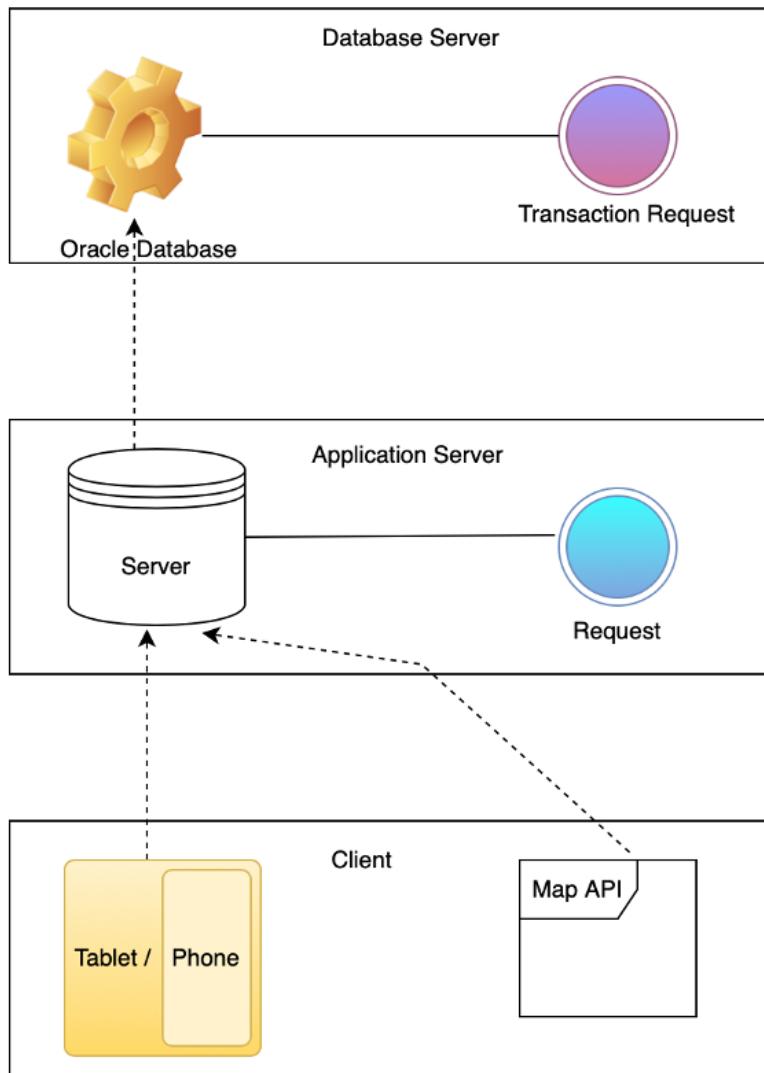
Now, let's observe the ParkStructure subsystem:



We realize that the ParkDirector controls the park settings such as some areas being banned for photography/videography, some areas having network jammers, etc. Also, the ParkMap made allows the users to conveniently and easily traverse the park, which comprises the park rangers.

25 Additional Design Considerations

25a Hardware / Software Mapping



25b Persistent Data Management

Data will be updated on a uniform system timer. User locations will be determined every five seconds and will be sent to the corresponding database server for the national park. Additionally, the system must remove the previous marker denoting the user's location on the map and place it at the current, updated coordinate. The system will shut down once the application has been killed from the user's back stack. At this point, location services will no longer be accessible.

Each national park will have its own individual database to save all data and metrics corresponding to that specific park. The databases will be stored on Oracle database servers. When relaunching the application, the application will automatically retrieve all the park's data and populate the map accordingly before the user will be allowed to interact with the application.

25c Access Control and Security

- Location: The primary security concern for this application is user locations. Users should not be able to access or view the locations of other users in order to protect their privacy and safety.
- Pictures: The application is not to have access to a user's camera roll. It will only ask them permission to use the camera in order to protect access to private images.

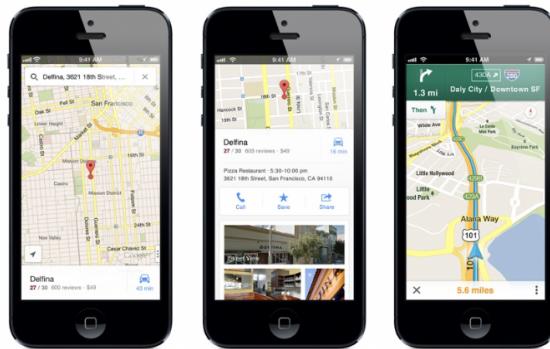
25d Global Software Control

We will need to add a login system to ensure that only authorized users can get access to the restricted functionality in order to avoid misuse.

25e Boundary Conditions

Every class in the class diagram must be checked for boundary conditions for each property based on their respective types.

25f User Interface



The user interface will provide travel routes, traffic times, and location and event icons.

Examples of event icons:



Appears on the map in the location of the GPS coordinates where a user has reported an event that should be approached with caution and is not immediate danger.



Appears on the map in the location of the GPS coordinates where a user has reported an event that can be classified as an emergency. Tourists should avoid the area.



Appears on the map in the location of the GPS coordinates where a user has reported a sighting. (e.g., animal sighting, rock, mineral, state of a natural resource).



Appears on the map in travel routes where there have been delays reported due to various events such as construction or animal presence.



Appears on the map to indicate official hiking trails inside of the park.

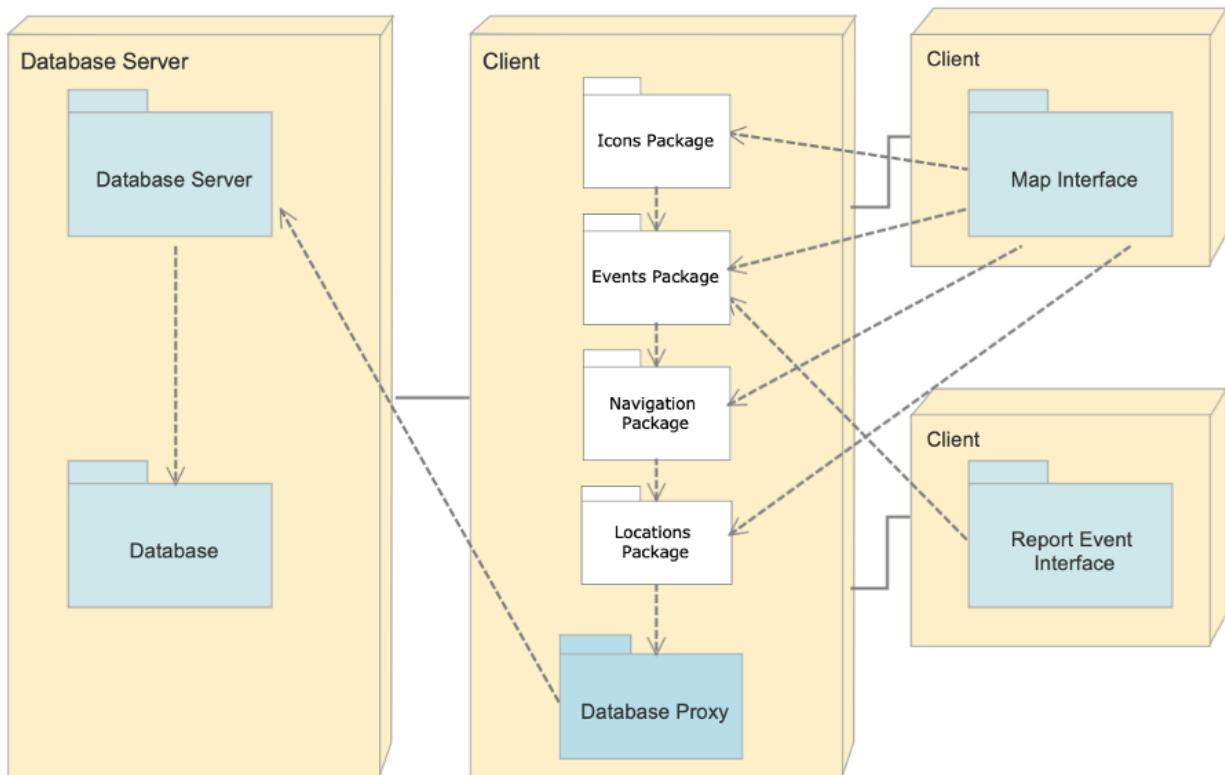


Appears on the map when there is an obstruction on a trail or main road.

25g Application of Design Patterns

- Composite: Map components will be interactive icons. Icons will either be composites which will contain other operations (e.g., comments, images), or they will be leaves which contain icons that can't be clicked.
- Bridge: The UI and the database implementation must operate independently of one another. When a user's location is obtained through GPS, it must both be sent to the database as well as updated on the user interface.
- Decorator: When adding icons to the map, they must know how to draw themselves.
- Observer: Those that are within the boundaries of the park will automatically be subscribed to notifications within that park. Notifications will be given to all users only when an emergency occurs to give notice to tourists.

26 Final System Design

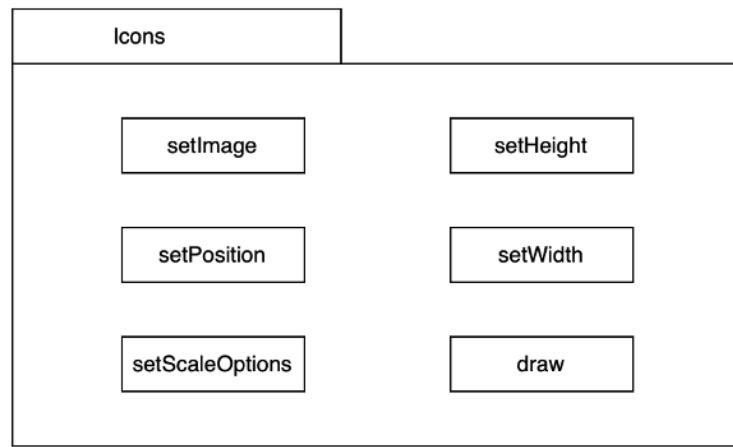


27 Object Design

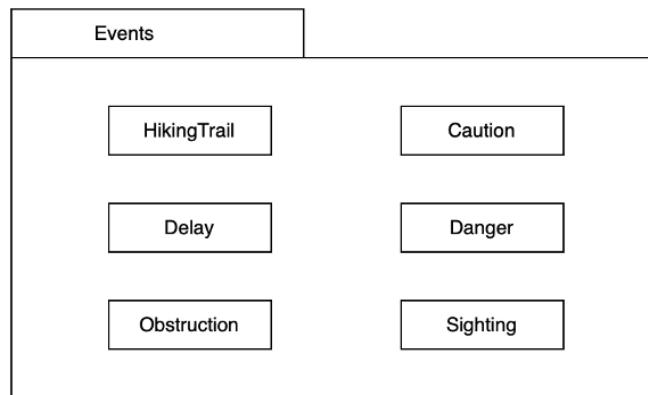
27a Packages

- Icons package: Contains the classes related to drawing icons on the map.
- Events Package: Contains various categorizations of events that appear as icons on the map.
- Navigation Package: Contains classes that connect with the map UI and retrieve information from the server.
- Locations Package: Contains classes that interact with the device's internal GPS system and send information to the server.

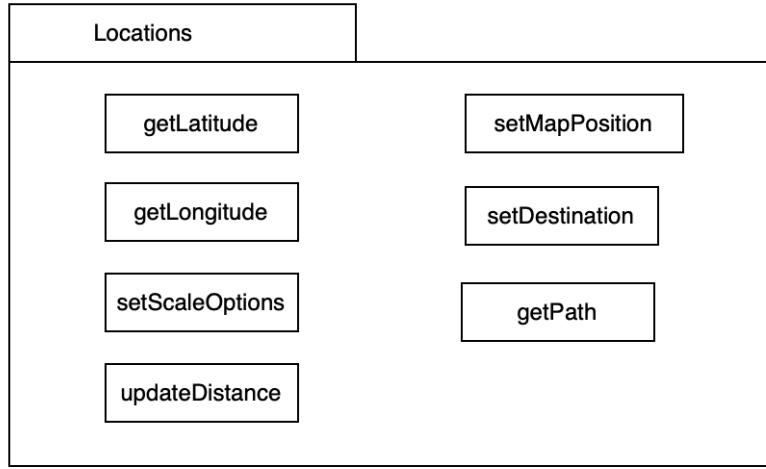
27b Subsystem I



27c Subsystem II



27d Subsystem III



IV Project Issues

28 Open Issues

I think some of the pertinent project issues are dealing with areas having phone network jammers as they restrict the feasibility of reporting a crime quickly and conveniently. Also, some users might want their location to be protected from other users while reporting a crime, and hence we would need to work with their privacy requirements and find a solution for it.

Other than these we would also need to curb fake incident reporters and set up a system to avoid indecent and vulgar photographs on the app. Finally, we also need to make sure that we only allow users within the range of the national parks to report their incidents since we don't have the appropriate manforce to accommodate emergency requests from every other location, and that does not fall under the scope of our purpose.

One logistical issue could be to reach the national parks, and ensure them about the sincerity of our application, since there are already many other applications available on PlayStore and AppStore, giving rise to competition and need for recognition in this consumer market.

Also, there could be some time lag in the information being updated due to high influx of users, which would need to be worked upon. We would also need to take care of users being comfortable with the map of the parks to avoid dangerous or unsafe areas when needed.

29 Off-the-Shelf Solutions

Some of the possible solutions for network jammers could be to store the information reported by the user and release it as soon as connected to the network to tackle emergencies. Also, we would set up a system supporting anonymity in reporting if and when requested.

Apart from these, we could place a tracker blocking obscene and indecent pictures and information from being reported. To restrict the area of usage to only the national parks, we would set up restrictions on the GPS.

A high speed relational database will be used to store all the information pertaining to the park as well as map and user data. The two highest speed databases are MySQL and Oracle.

A map API that is familiar to users with map experience will be used for the live map. The top two map APIs are Google Maps and Bing Maps.

Lastly, we could collaborate with our competitor applications to build a stronger system together which might allow scope for healthy competition promoting growth.

29a Ready-Made Products

MySQL Database

- Fast thread-based memory allocation system
- Transactional and non-transactional storage engines
- Implements SQL functions with highly optimized class libraries
- Provides a server as a separate program for use in client-server networked environments
- Object oriented and relational databases
- Tested with a broad range of compilers

Oracle Database

- High availability database
- Supports very large databases and big data
- Data integrity rules
- Controls and restricts the access of data through user-defined privileges

Google Maps API

- Map styling and customization
- Location markers
- Various APIs for places (e.g., latitude and longitude, geolocation using GPS)
- Various APIs for routes, roads and directions
- Interactive maps

Bing Maps API

- Interactive maps
- Geographical coordinates
- High resolution aerial imagery
- Route data
- Traffic information
- Spatial data sources used for storing and querying data

29b Reusable Components

See Section 29a.

29c Products That Can Be Copied

REI National Park Guide & Maps focuses on providing detailed hiking trail information at major National Parks. It allows users to rate the difficulty of trails and a list of camping, lodging and tours.

ParkFinder shows activities and that can be done within national parks, such as hiking, fishing, and boating. This application allows users to get directions, phone numbers and websites for various activity planning.

Both of these applications are not centered around a live map populated with user reported events, which Park Pal would be able to offer. Additionally, they are not used by park staff as part of their professional duties.

30 New Problems

30a Effects on the Current Environment

1. National park employees and facility maintenance workers will be allowed to and encouraged to monitor the map as a part of their professional duties to periodically check for tourists who may need help, or activities that need immediate attention and resolution. The park employees will hold the responsibility of using the application to minimize harm and dangerous situations by reporting to the location and calling the proper response teams. Adversely, this leaves room for park employees to use a mobile device for tasks other than work and may be tempting to use other applications not in relation to their job. Park employees also should not use this application to replace their professional duties. For example, park rangers should still roam areas of the park and inspect areas to see if there needs to be any maintenance or help allocated to a particular area.

2. When users report an animal sighting, this may incline other users to flood to the area to observe the animal. Large crowds of people may cause a disturbance to park wildlife or result in aggression in the animals if they feel their safety is threatened.
3. Some people are risk takers. If an event is marked as dangerous, people who seek thrills may challenge tackling the event. This can introduce unintended consequences for both tourists and also liabilities for the park.

30b Effects on the Installed Systems

- This application may deplete battery due to its usage in low signal areas and therefore users may have their usage of other applications become limited to preserve battery.
- To ensure a consistent performance, the application must coexist with both Android and iOS mobile operating systems, including updating the codebase when certain features become obsolete.

30c Potential User Problems

- Users may become immersed in using their phone during trips and it may unintentionally take away from their experience in the park.
- Users may become distracted by technology in sensitive areas with difficult terrain, possibly resulting in injury.
- Users may report false sightings of animals or events, causing other users to make trips to locations under false pretenses.
- There may be slight inconsistencies in features between one national park to another due to guidelines set in place by the National Park Service.
- Users that do not have much experience with maps may experience a learning curve in using the application.

30d Limitations in the Anticipated Implementation Environment That May Inhibit the New Product

- Certain elevations and areas far away from signal towers may result in rampant battery drainage.
- Tourists may become more distracted by their mobile device instead of embracing the nature around them.

- The use of cell phones in difficult terrain and weather conditions may result in injury and bodily harm.
- Because of the high volume of visitors in national parks each year, (250 million-300 million range) the application may experience performance issues such as delay or lag during peak seasons.
- Tourists flocking to reports of animal sightings on the map may interfere with the natural patterns of animals if they are not used to increased human presence. This can pose problems with the data of animals being tracked and studied by scientists in parks.
- People reporting fake events, or dramatizing events may lead to park personnel wasting their time to examine fraudulent reports.

30e Follow-Up Problems

High volume of users may lead to servers slowing down, or even crashing. This would be safeguarded by having an initial rollout phase in order to ensure scalability of the application.

In order to prevent fake events, if there are enough fake events reported against a user, they will be hardware banned from using the application.

There is an assumption that internet reception is not constant for all users, so there is a lot of functionality available when the user is offline.

Also, there might be use of indecent and vulgar content, which might be uploaded to the application, polluting the purpose of the app and causing concerns for some of the users. Also people might use the uploading feature to promote piracy, or other illegal cyber activities, which would need to be tackled and dealt with. The existing software does track and block indecent and vulgar content, but blocking piracy and other cyber crimes is something for which the application would need an updated system, to tackle with.

31 Migration to the New Product

Not applicable.

31a Requirements for Migration to the New Product

Not applicable.

31b Data That Has to Be Modified or Translated for the New System

Not applicable.

32 Risks

- This is rare, however weekly maintenance may interfere with the availability of the application if it is found that the time taken to update the software spans longer than overnight.
- Since there have been a reported 200 million to 300 million visitors of National Parks for the past five years, developers will need to be prepared to upgrade the server to manage a rapid number of requests to account for all the users.
- There are concerns for inadequate display in user location due to the fact that the GPS functions offline, however synchronizations to the server may experience delays.
- Using the navigation system while driving may pose a distraction to the driver.
- While this is not in the bounds of the development team, signal problems may become a nuisance for some users due to the remote location of parks.
- Users may mistakenly use this application as a point of contact for emergency personnel. It is noted that this application does not replace 911 or emergency contact numbers.

33 Costs

It is estimated that the core foundation of the application, such as a map and a reporting system, will take a team of five developers two months to develop. The next eight to ten months will be spent on the expansion of this application to encompass all fifty-eight national parks in the United States. During this time period, efforts will be focused on catering the application to fit the needs of that specific park, therefore employees of the park will participate in the initial development.

After the product has been released, it will be necessary for professionals from other domains to step in for the maintenance and longevity of the application. Data analysts will be required in gathering user data every four months and modeling their results to present to business consultants. The consultants will make suggestions to the developers to add or adjust features that may be most favorable to the users as well as the costs for the budget of the development team. The aforementioned business partners' salaries were documented in 6g.

Further, the team must be prepared to purchase and familiarize themselves with Mac computers and operating systems as iOS applications cannot be developed on any other operating system.

34 Waiting Room

1. Integration with other major applications.

- Uber & Lyft: When trying to access travel directions, an option for uber and ridesharing could be offered to users to help them plan their trip. This will only be included if the map API does not include options for rideshares.
- Uber Eats/GrubHub: If the park is within reasonable distance to food establishments, an option will be available to order food to the park.

2. Other ideas

- Trip Memory Book: Users will have a collective platform designated for sharing pictures and experiences during their park trip. This will likely be used by prospective park visitors planning activities and travel.
- Event Calendar: A calendar of events and community activities the park will be hosting. The calendar will provide dates, times, any registration requirements, and fees.
- Reward Points: Frequent national park visitors may acquire points whenever they check in to a park. The points will be able to be used towards food, reduced park fees, equipment rentals, and other activities.

35 Ideas for Solutions

- Android Studio should be used for developing the application for Android and Swiftic should be used to develop the application on the iOS platform. It must be noted that iOS applications may only be developed on Mac machines and operating systems, so therefore the developers must be equipped with those.
- It is highly recommended that an Oracle Database be used as it has the highest speed performance metrics compared to MySQL database, which is the runner up and underperforms only minimally.

- Testing should be done after each feature has been completed so that the efforts going towards the next features to be implemented need not be coupled with fault-filled prior features.
- Relational databases are highly recommended in the implementation because the primary key will be used in various tables housing parted data in regard to location, reports, and directions.

36 Project Retrospective

At the conclusion of the Park Pal App project, we realized how important it is to analyze, inspect and quantify the problems in our very surroundings, while finding solutions to them. The process of working with the National Parks, in order to make the entire process of visiting and traversing the park was very rewarding.

Of course, this did come with its own set of challenges. One of the biggest difficulties to overcome was being completely online for the end of the semester. This made meeting harder and it made presenting harder. But it also taught us remote engineering and gave us a good experience of working far yet together.

Also, we used the method of directly analyzing the experience of users in the national parks, along with looking at the workings of park rangers, and realized that there needs to be a means to have better communication between users and park rangers. We also tried to hold online user surveys to understand their opinions, but those weren't as useful as live interaction with visitors, helping us get their first hand users.

We would also recommend the use of a simple yet attractive interface for this application, since it is meant to be used by people of all ages and should thus be easy to use and access.

Apart from this, we used the Requirements Gathering Technique of 'Personas', wherein we created an imaginary personality, using it as our user requirements guide.

Finally, we would encourage to hold as many live interactions with users to understand their requirements, which we unfortunately weren't able to do due to the pandemic, but again such challenges helped us to flourish and creatively brainstorm ideas for the application, which in the end, rendered us fruitful results.

V Glossary

Warning: A notice of cautionary advice for possibly impending danger.

Obstruction: A blockage that prevents passage.

Trail: An established route planned for a particular purpose, in this case hiking.

National Park: An area protected by the federal government made for the enjoyment of the general public and the protection of wildlife.

NPS (National Park Service): A United States agency that manages national parks, monuments, and historical and conservation properties.

VI References / Bibliography

1. M. Fowler, UML Distilled, Third Edition, Boston: Pearson Education, 2004.
2. B. Bruegge and A. H. Dutoit, Object-Oriented Software Engineering - Using UML, Patterns, and Java, Third Edition, Prentice Hall.
3. G. Erich, et. al., Design Patterns – Elements of Reusable Object-Oriented Software, Addison-Wesley, 1994.
4. National Park Service (NPS), United States Department of the Interior.
5. Google Maps, Google LLC, Country of United States, Last Accessed April 30th, 2020.
6. M. Melnikova, et. al., Scavenger Hunt App, University of Illinois at Chicago, Spring 2018.
7. SQL Database, ISO/IEC, Stable Release: 2016.
8. Oracle Database, Oracle Corporation, Stable Release: 2019.
9. Bing Maps, Microsoft Corporation, Country of United States, Last Accessed April 30th, 2020.
10. <https://www.eteknix.com/google-maps-returns-on-the-iphone/>, Last Accessed April 20th, 2020.
11. <https://www.roadaffair.com/best-national-parks-in-the-usa/>, Last Accessed February 5th, 2020.

VII Index

| | |
|---------------------------|--------|
| Design | 60, 70 |
| Requirements | 28, 60 |
| Project issues | 70, 77 |
| Project Description | 09, 27 |

