



Enhancing Mobility

An Innovative Indoor Navigation
Solution for the Visually Impaired



Team 3



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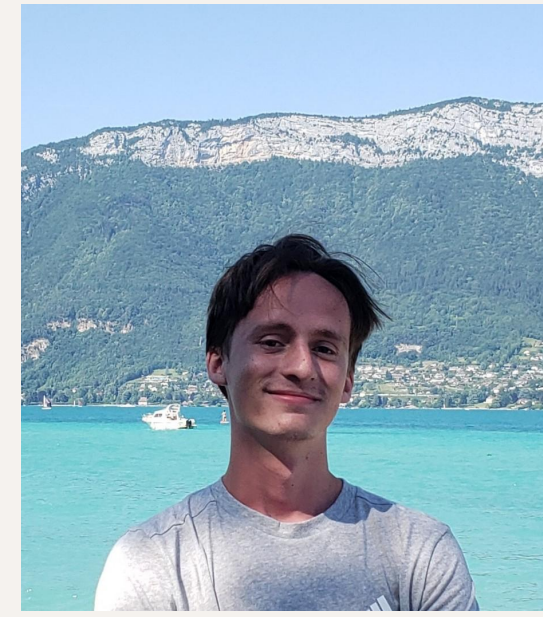
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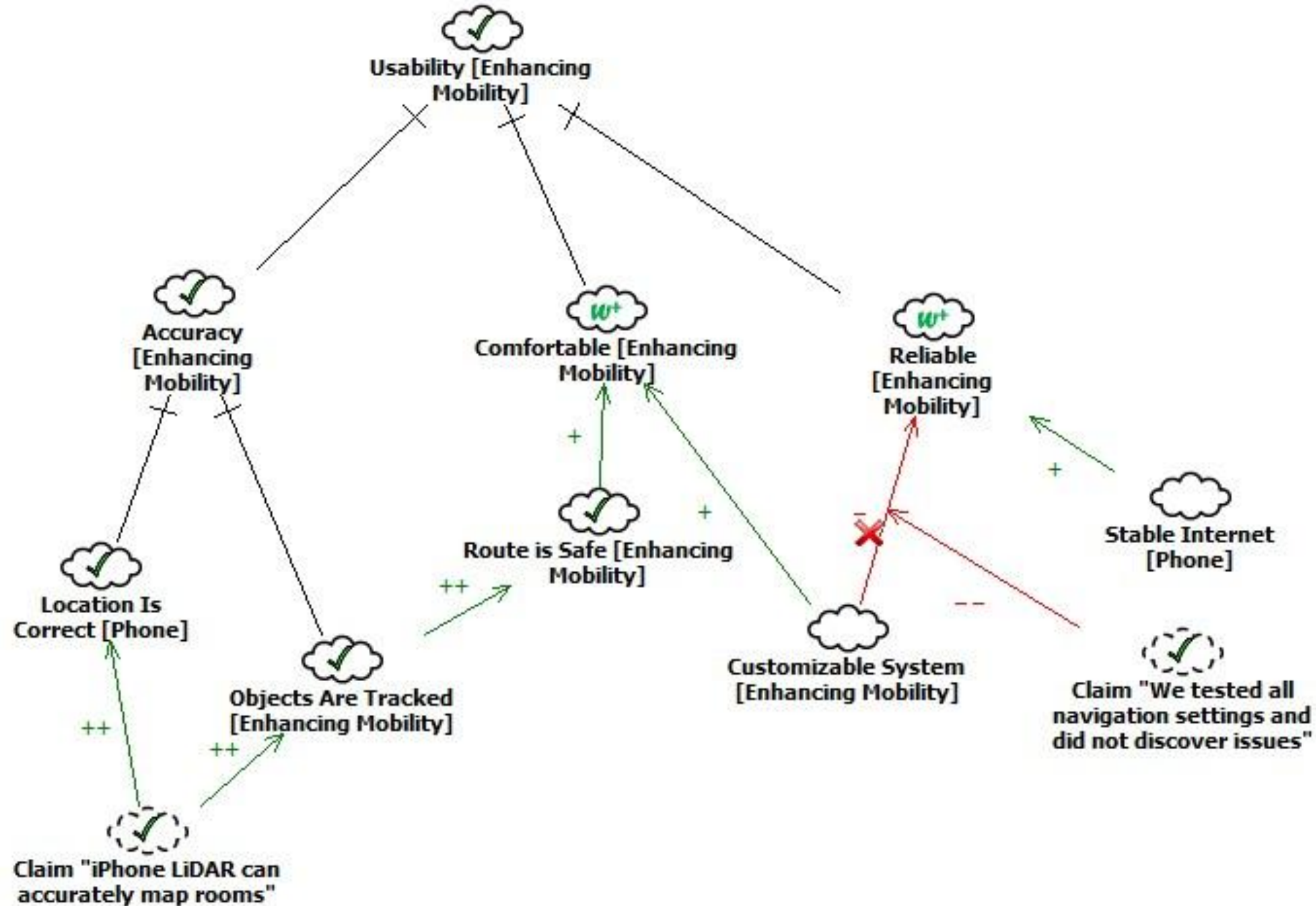


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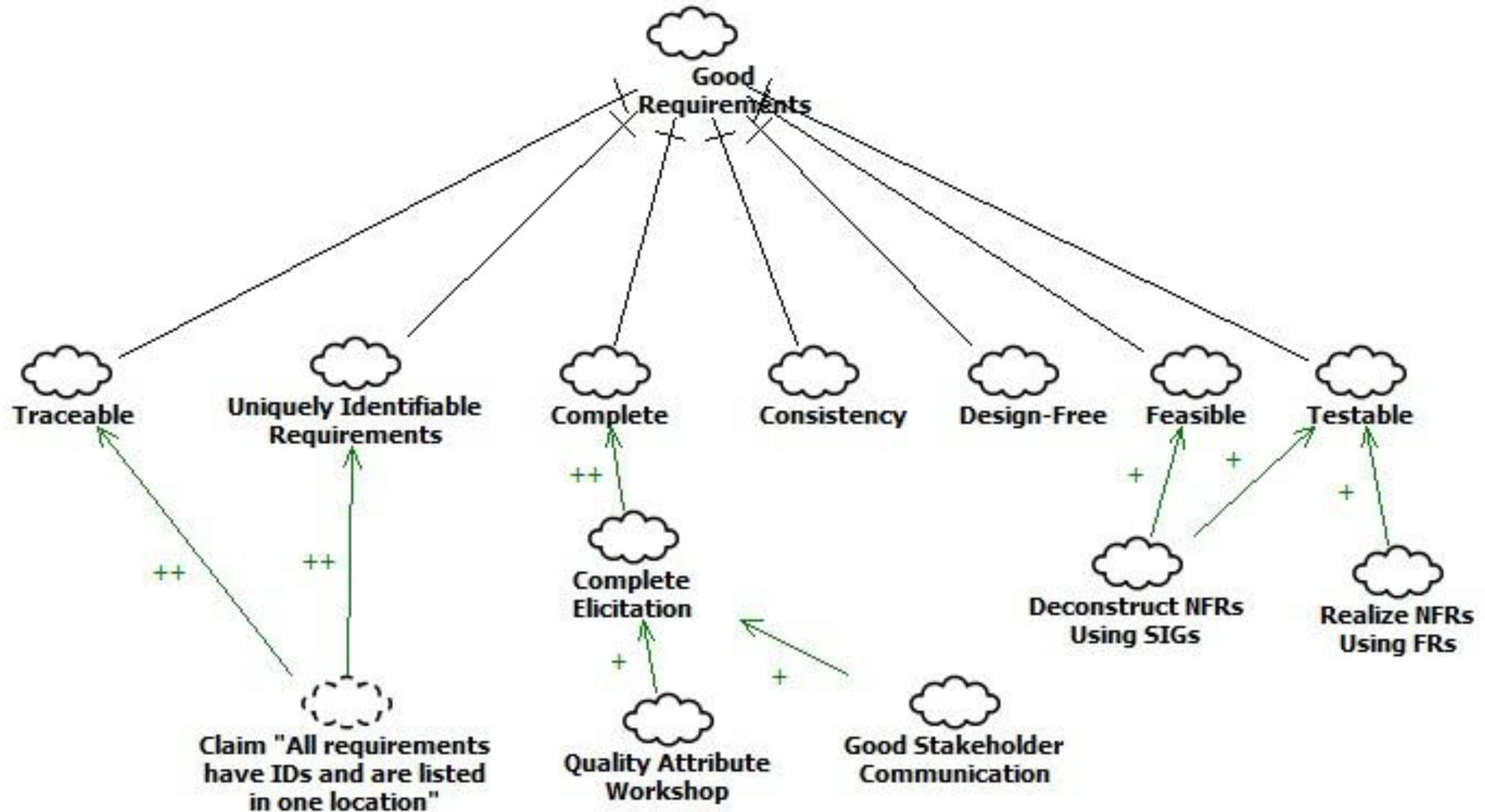
Vision: Problem

The problem of	Blind and visually impaired people being unable to see their surroundings indoors
affects	Blind and visually impaired people
The impact of which is	The blind and visually impaired people have a difficult time navigating indoors safely.
A successful solution would	Detect obstacles or other dangers in the user's path, warn the user, and reroute the user so the user can make it to their destination safely

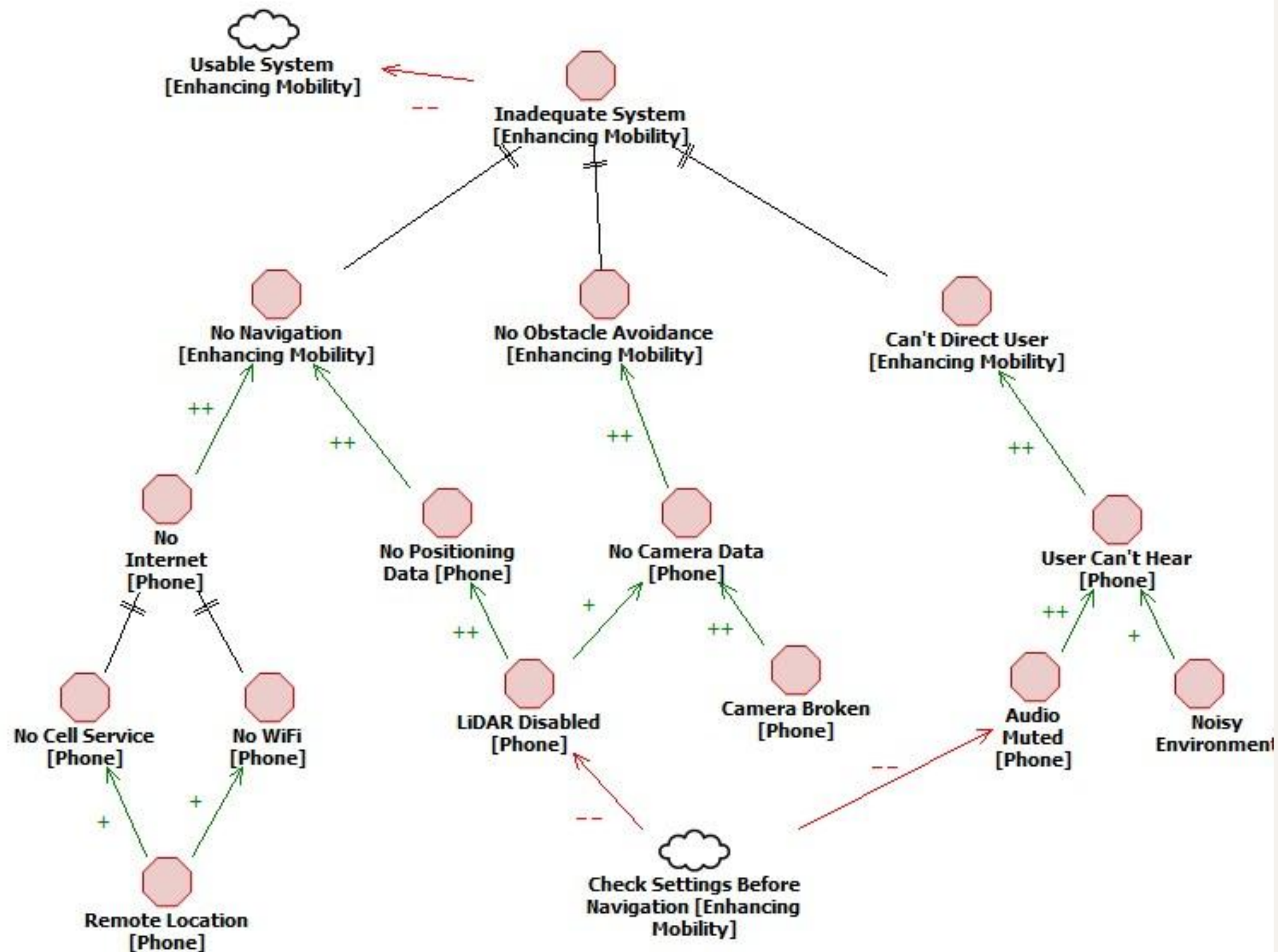
Vision: Product SIG



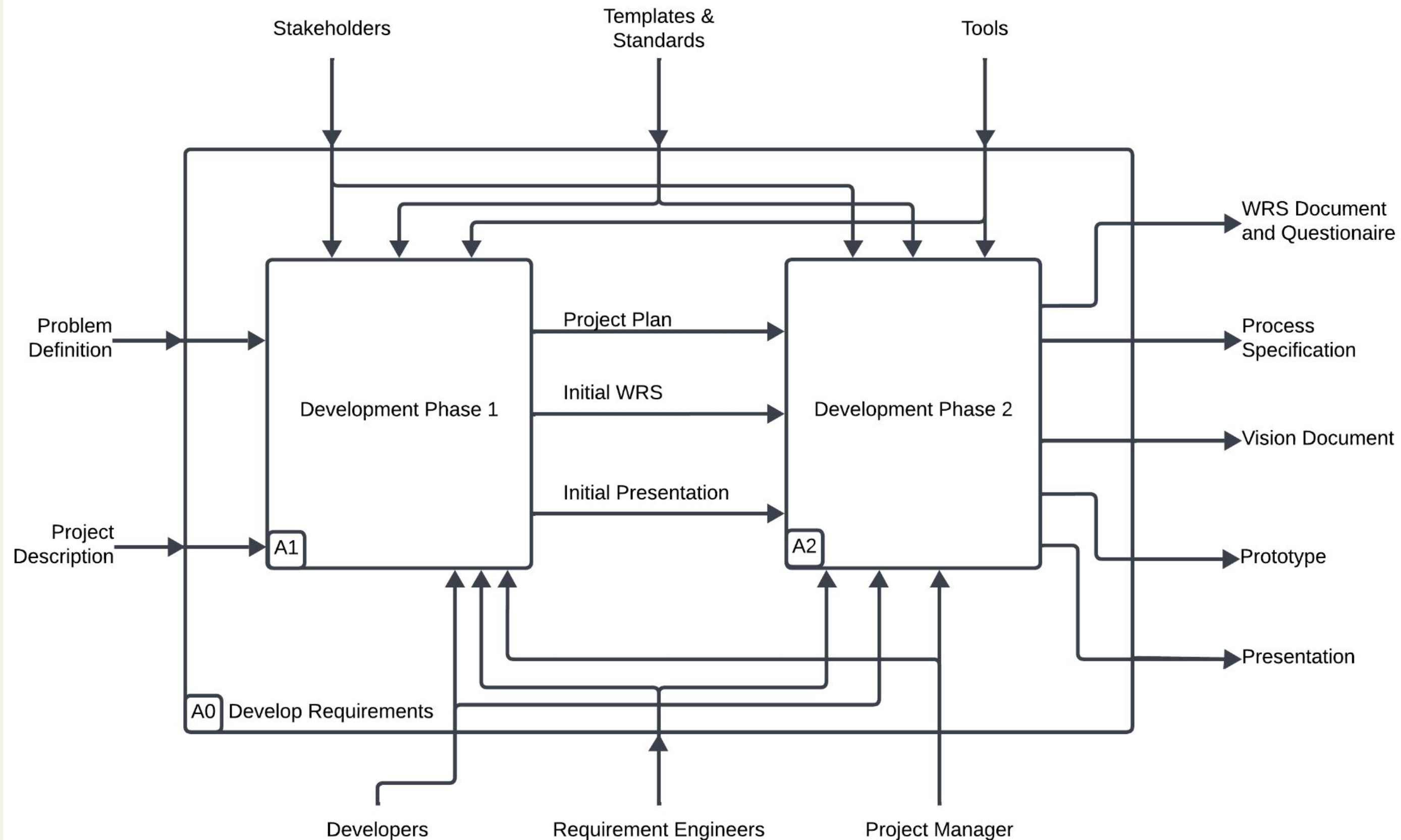
Vision: Process SIG



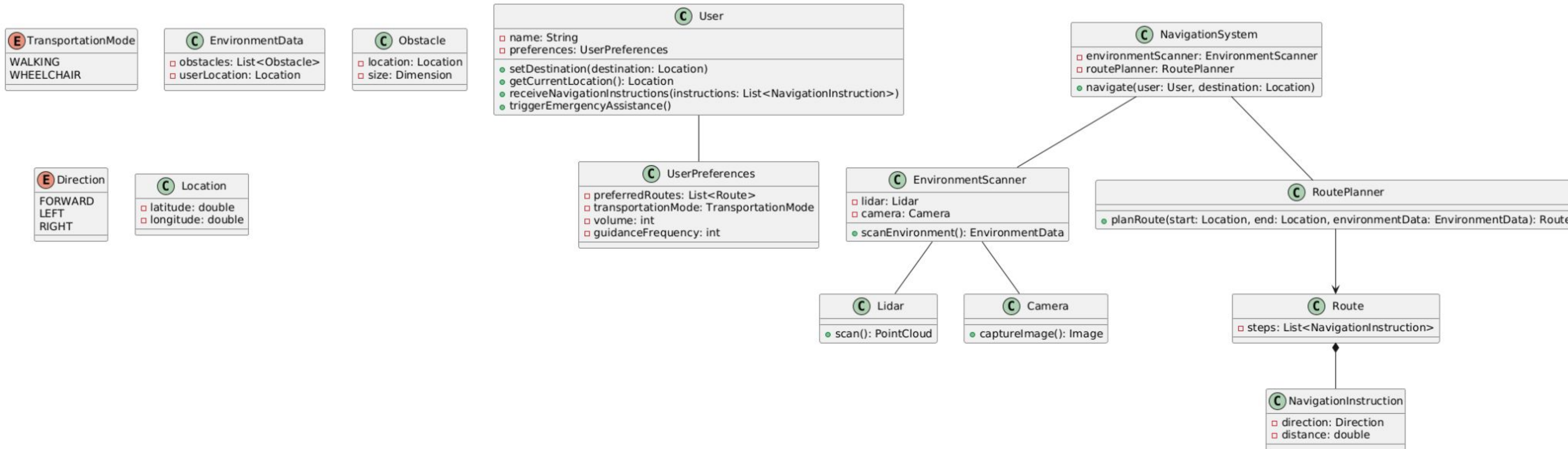
Vision: PLG



Process Specification: IDEF0

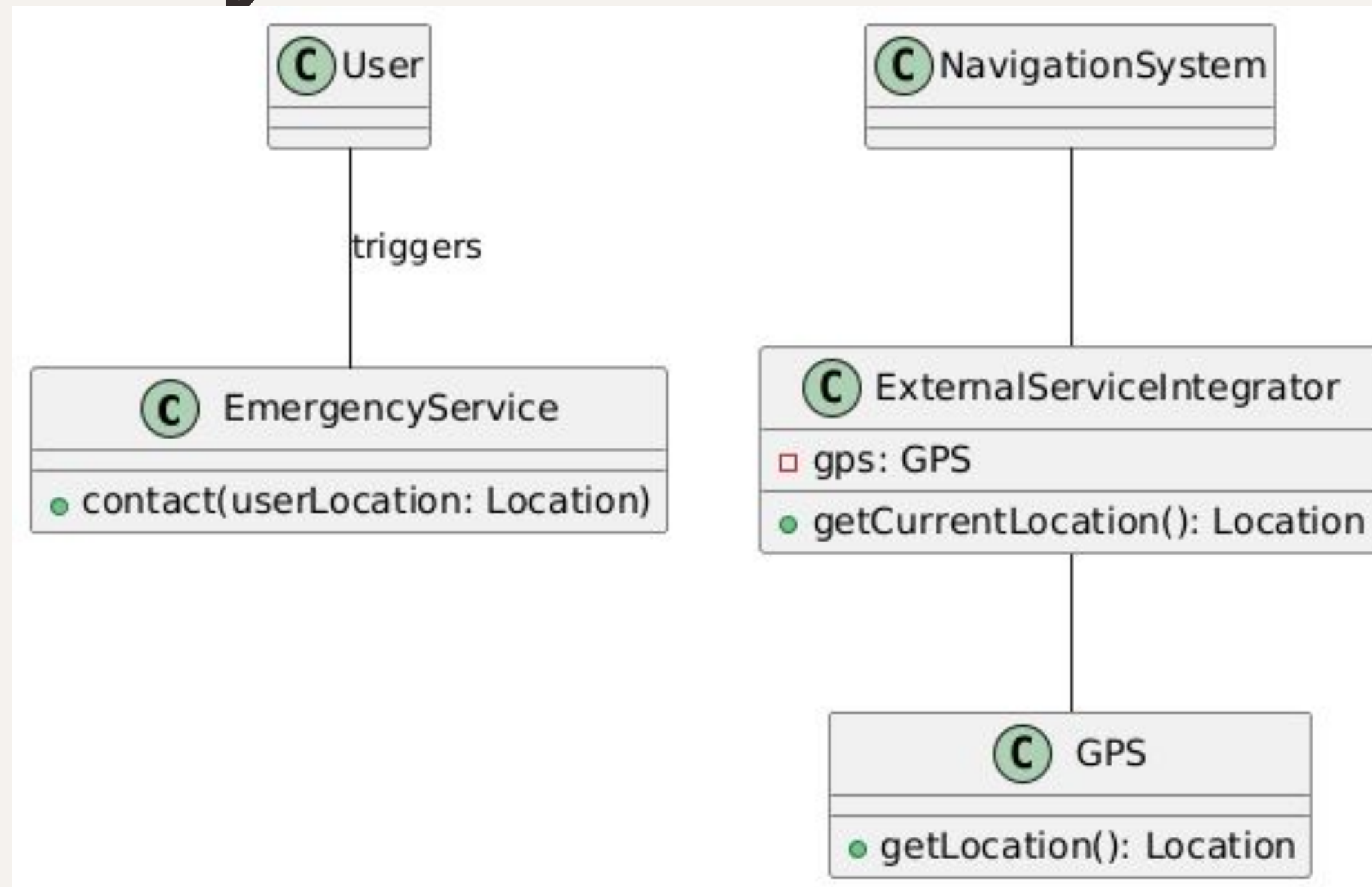


Core Navigation Functionality



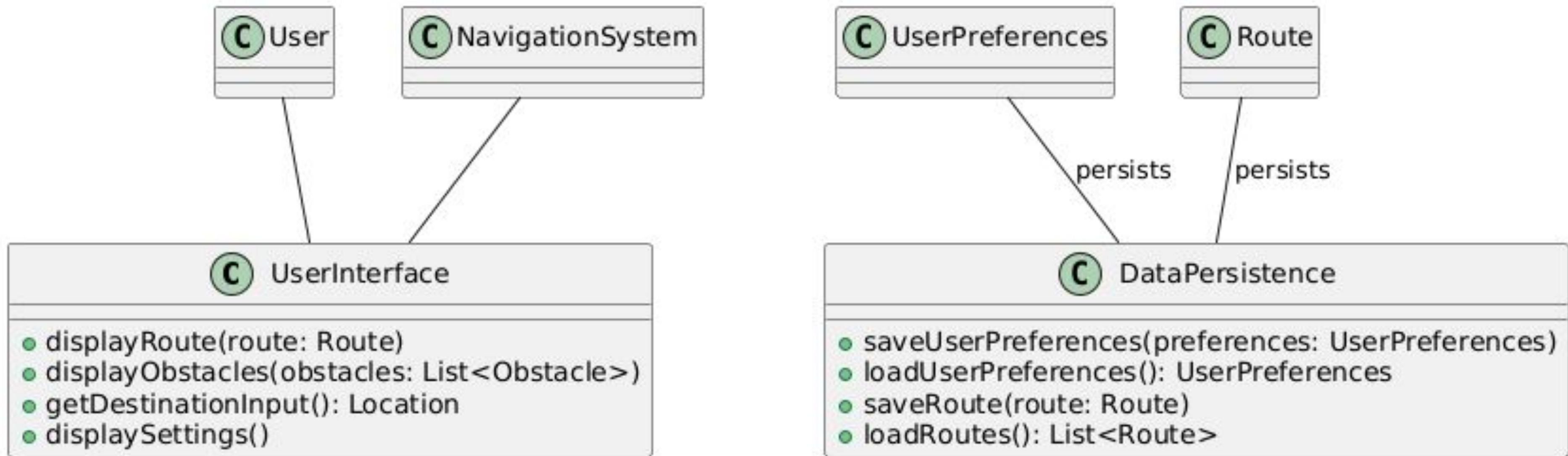
This diagram illustrates the core classes and their relationships involved in the navigation process. The **NavigationSystem** orchestrates the interaction between the **EnvironmentScanner** (which uses **Lidar** and **Camera** to perceive the surroundings) and the **RoutePlanner** to guide the **User** to their **Destination**. The **User** object also holds **UserPreferences** affecting navigation.

Emergency and External Services



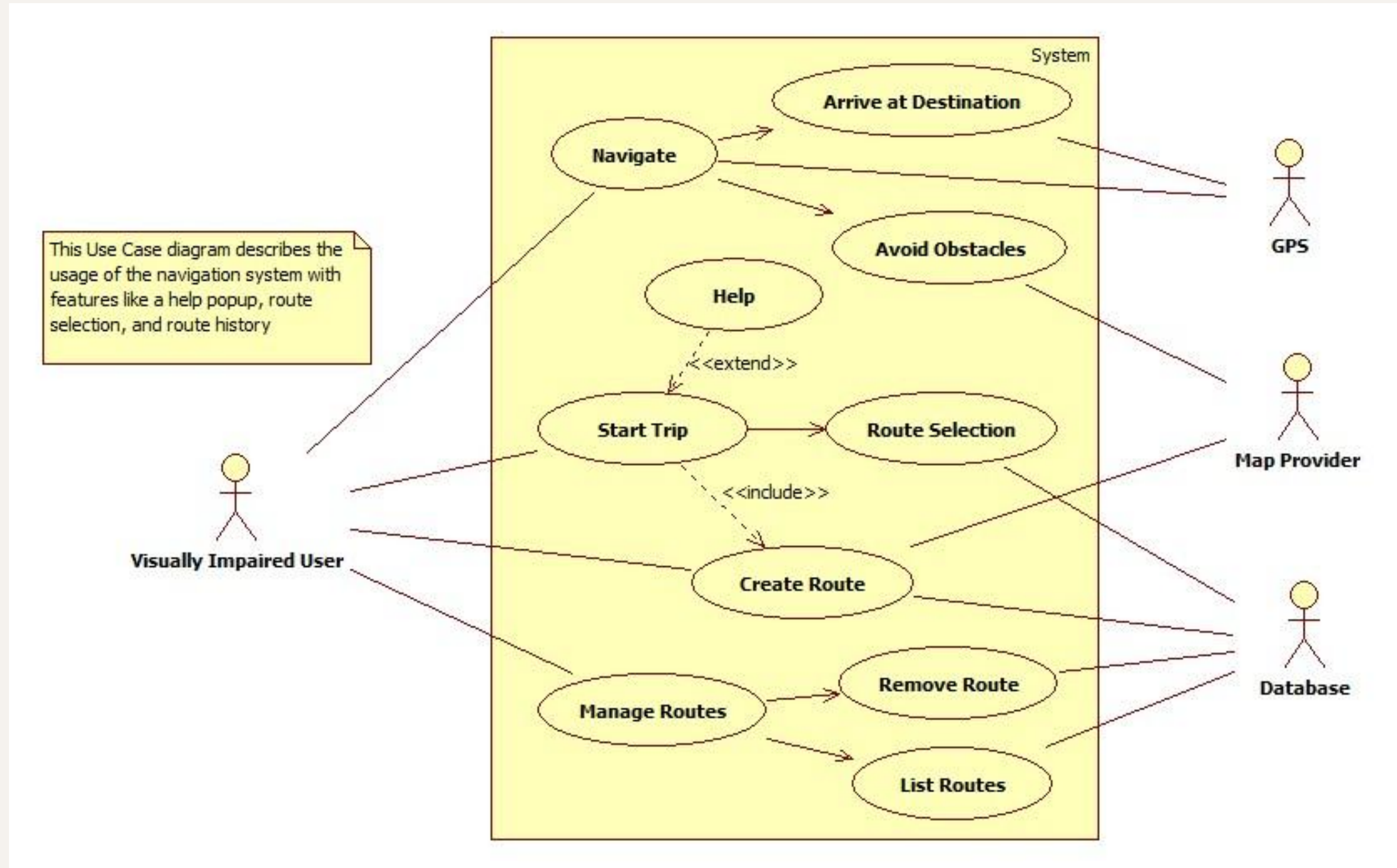
This diagram shows how the system integrates with external services. The **User** can trigger the **EmergencyService**. The **NavigationSystem** interacts with the **ExternalServiceIntegrator** which uses **GPS** for location data, enabling features like emergency assistance and location-based services.

Data Persistence and User Interface

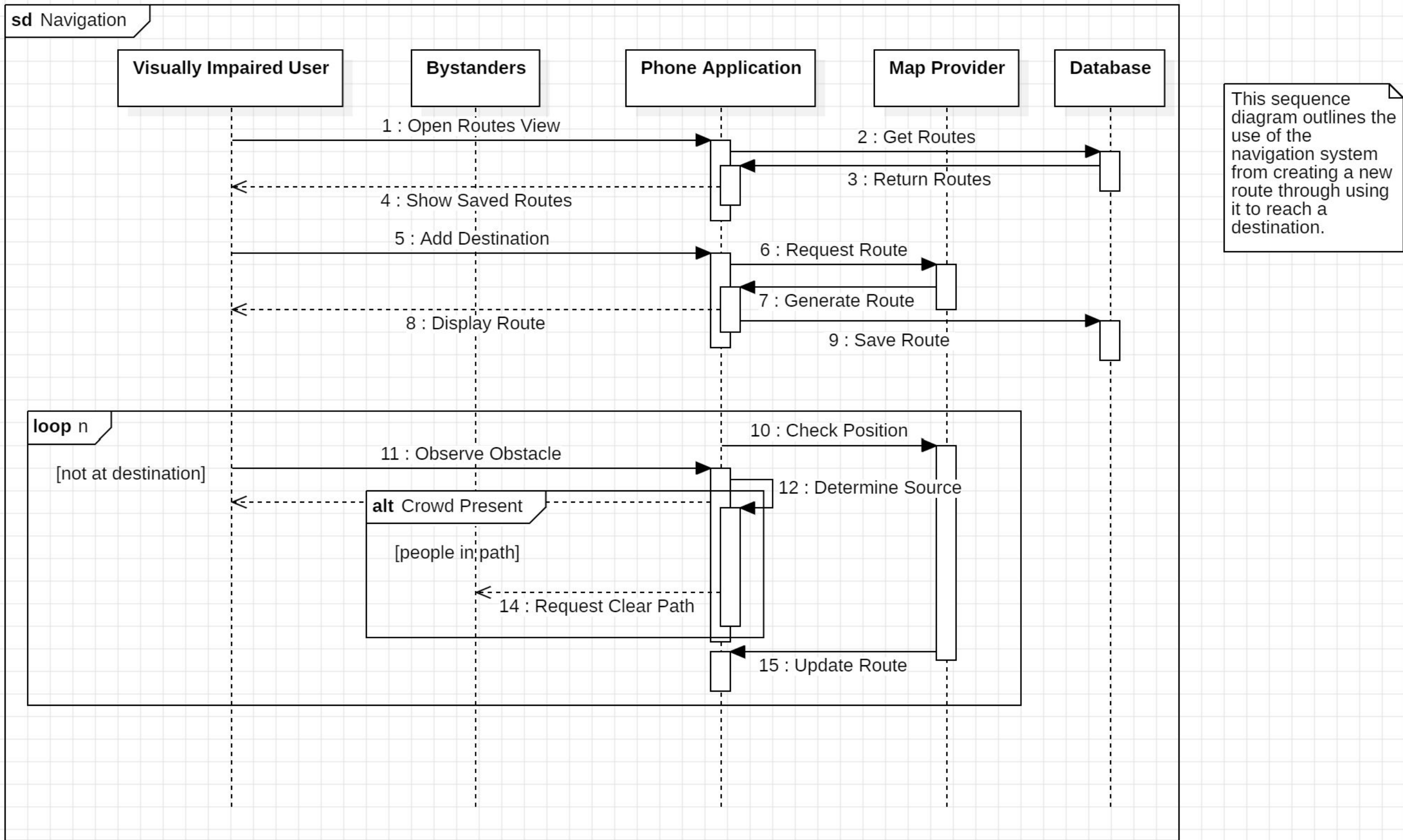


This diagram depicts the components responsible for user interaction and data management. The **UserInterface** handles displaying information (routes, obstacles, settings) and receiving input from the **User**. The **DataPersistence** class manages saving and loading of **UserPreferences** and **Routes**.

Navigation System Use Case



Navigation System Sequence



W R

D1: Objects in the user's surroundings can vary in size, shape, and distance, which may pose potential obstacles for individuals who are visually impaired.

D2: Visually impaired individuals often navigate crowded spaces with many people, which can create additional obstacles and require others to make way.

R1: The system shall notify nearby people to clear a path for the user by emitting an audible alert when it detects crowded conditions in close proximity

S

S1: If the LiDAR and camera data, processed through computer vision, detect a crowded space with people in close proximity, the app shall emit an audible alert to notify others to clear a path for the user.

P M

C – The phone has a camera sensor and a lidar sensor and a speaker as an actuator

P - Program

Functional Requirements

FR1 - Accepting from the user the destination location to go

FR2 - Suggest or confirm a possible destination location, utilizing the user's routine schedule or habit

FR3 - Figuring out and telling the user which routes can reach the destination location, and accepting the user's preference

FR4 - Telling the user to walk a distance (e.g., 2 minutes to reach a turning point, 30 steps to take)

FR5 - Telling the user to stop at the right place to turn

FR6 - Detecting obstacles and telling the user what to do in order to avoid collision

FR7 - Placing emergency calls and messages, possibly after detecting a fall or when the system cannot figure out the current location

FR8 - Figuring out what would be the next action(s), based on the user's schedule or habit, and suggesting and accepting the user's choice

Non-Functional Requirements

NFR1 - The system shall help the user safely navigate indoors

NFR2 - The system shall lead the user through the fastest route

NFR3 - The system shall lead the user through the route the user would feel the most comfortable with

NFR4 - The system shall be easily usable

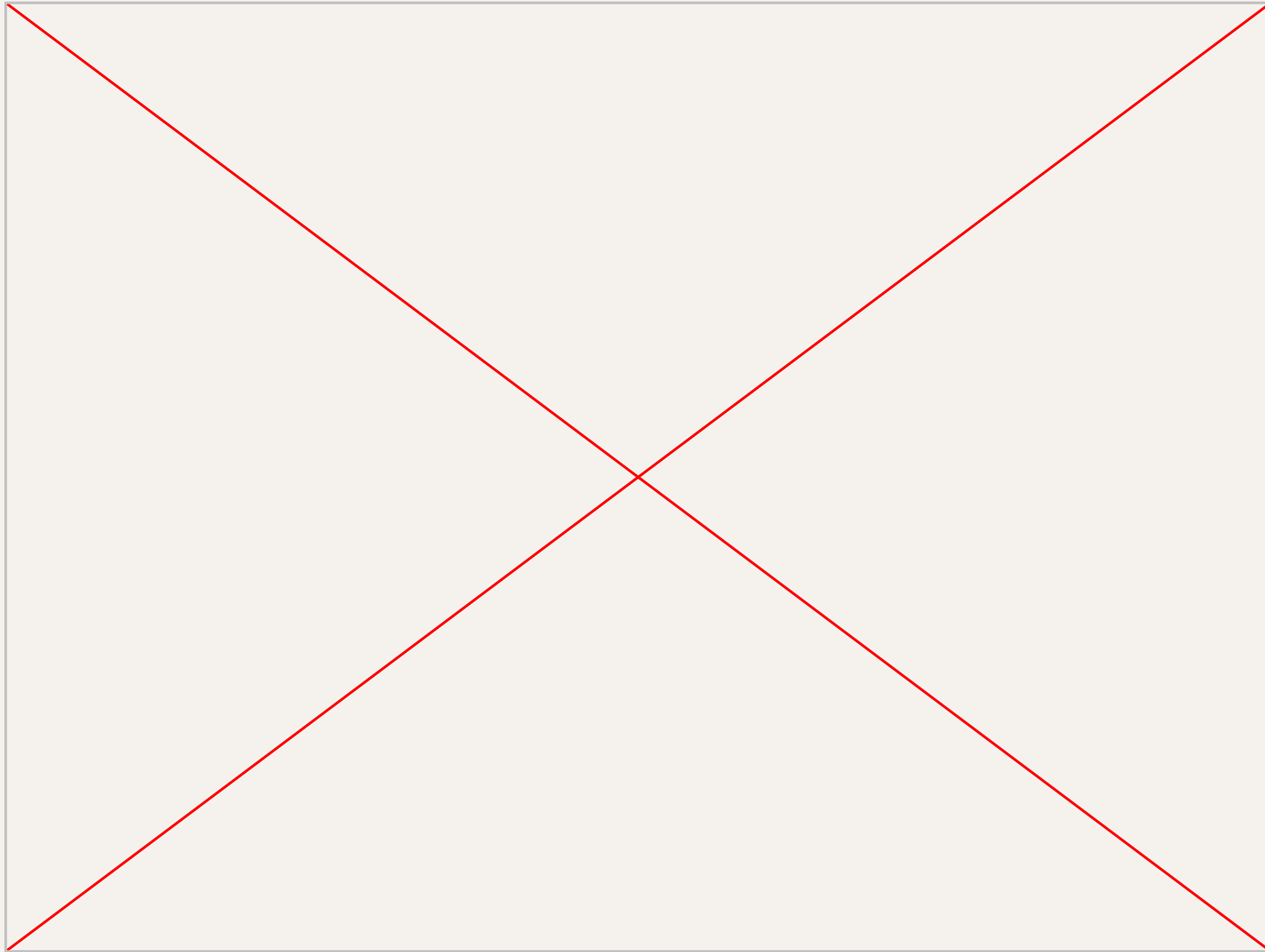
NFR5 - The system shall be ubiquitous

NFR6 - The system should be customizable to every user (e.g., the volume, the interval at which the system says something, the order of different things the system says, etc.)

NFR7 - The system should be easily extensible to accommodate the following typical variations: variations in interface, language, definitive needs of the user, new features, new sensors and hardware etc.

NFR8 - The system shall make safe, informed, and reasonable decisions regarding a user's preferences and physical capabilities

Prototype Demo



On Requirements Creep

Previously, we estimated a **10%** change in requirements per month.

After working with stakeholders, we determined that software for the blind needs to be reliable and predictable. Changes can introduce instability and may directly impact physical safety.

Thus, 10% was a reasonable upper bound and we kept changes to a minimum. It was a reasonable estimate.



Why Choose Our Solution?

- Highly Accessible and User-Centric Design
- Intuitive and easy-to-use UI
- **Cutting Edge LiDAR Technology**
- Real time, Reliable Guidance



Conclusion and Future Directions

We are committed to enhancing mobility through an innovative indoor navigation app.

Future developments will focus on **expanding functionalities**, integrating with smart city initiatives (**IOT**), and fostering **collaborations** to ensure widespread adoption and impact.



Appendix: Questionnaire

Questionnaire for Mobility Enhancement System

The purpose of the following questionnaire is to gauge the prospective direct and indirect users of an application that intends to assist those with visual impairments. Our study will try to find the major challenges blind people face in navigating in order to better tailor functionality that directly addresses these issues. If you know someone that has a visual impairment of any kind, please help them fill out this questionnaire to help make a difference.

Age:

- <20
- 20-35
- 40-55
- 55-70
- 70+

How often do you use your phone in a single day to assist you with everyday chores?

- 1-3 times a day
- 4-6 times a day
- 6-9 times a day
- 9+ times a day

How would you describe your level of vision impairment?

- Partially Blind
- Legally Blind
- Totally Blind

How do you typically navigate indoors?

- Cane
- Service Animal
- Assistance from others
- Other (please specify) _____

How do you typically navigate outdoors?

- Cane
- Service Animal
- Assistance from others
- Other (please specify) _____

How difficult is it to navigate indoors?

- Very Difficult
- Difficult
- A Little Difficult
- Not Difficult

How difficult is it to navigate outdoors?

- Very Difficult
- Difficult
- A Little Difficult
- Not Difficult

What challenges are you most cautious of when navigating new environments?

- Lack of clear paths
- Lack of planned accessible assistance
- Difficulty identifying obstacles
- Uneven surfaces

How do you like to interact with electronic devices?

- Voice commands and audio responses
- Screen Readers
- Tactile buttons with braille
- Other (please specify) _____

Appendix: User Manual

Introduction

The Enhancing Mobility App is designed to assist visually impaired users with indoor navigation. With features such as voice guidance, route saving, and AR-based calibration, the app provides an intuitive and efficient navigation experience.

App Features

- Voice Guidance: Audio prompts for navigation, including voice input for destinations.
- Saved Routes: Save and manage frequently used routes.
- Frequent Destinations: Quickly access commonly used locations.
- AR Calibration: Calibrate the app for better navigation accuracy.
- Customizable Settings: Adjust text size, contrast, feedback, and navigation preferences.
- Privacy Features: Backup, restore, and clear your saved data.

Getting Started

- Download and Install the App:
 - Available on the App Store.
- Grant Permissions:
 - Allow access to microphone, speech recognition, and camera for full functionality.
- Launch the App:
 - Start on the Home Screen, where you can access the app’s core features.

Main Screens and Their Functions

Home Screen

The first screen when launching the app.

- Features buttons to navigate to:
 - Start Navigation: Opens the navigation menu.
 - Calibration: Calibrates the app for improved accuracy.
 - Settings: Adjust preferences and configurations.
 - Help: Provides guidance on using the app.

Navigation Menu

From/To Fields:

- Enter starting and destination locations manually.
- Use the microphone button to input locations via voice. A sound will play to confirm activation.

Save Route Toggle:

- Enable this toggle to save the entered route to your saved routes list.

Saved Routes Button:

- View and manage previously saved routes.

Begin Navigation:

- Starts navigation for the entered route.

Saved Routes Management:

- View Saved Routes:
 - Access a list of all saved routes.
- Delete Routes:
 - Swipe left on a route to delete it.
- Clear All Routes:
 - Tap the "Clear All Routes" button to remove all saved routes.

Calibration

Displays an AR moving logo and instructions for calibration.

- Audio Assistance:
 - If enabled, the app audibly guides you to move your iPhone to scan the environment.
- Instructions:
 - Move your iPhone slowly around the environment for accurate calibration.

Settings

- Accessibility Settings:
 - Adjust text size (Small, Medium, Large).
 - Enable/disable high contrast mode for improved visibility.
 - Toggle haptic feedback for physical confirmation of actions.
- Audio Settings:
 - Mute voice guidance during navigation if needed.
- Navigation Preferences:
 - Select a preferred route type:
 - Shortest Path
 - Easiest Path
 - Wheelchair Accessible
 - Enable/disable automatic route saving.
 - Manage frequent destinations.
- Privacy Settings:
 - Clear all saved data.
 - Backup and restore settings and routes.

Saved Routes

- Displays a list of saved routes with options to:
 - Delete individual routes via swipe-to-delete.
 - Clear all routes using the "Clear All Routes" button.

Frequent Destinations

- Manage a list of commonly used locations:
 - Add new destinations by typing in a text box and tapping the "+" button.
 - Delete destinations using swipe-to-delete.

Help

- Provides a copy of the user manual



Thanks!

Do you have any
questions?

samuelpreston.me/se4351-project/

