

# GPS Based Campus Room Finder

Sprint 1  
2025-09-02

Name	Email Address
Aaron Downing	aaron.downing652@topper.wku.edu
Ryerson Brower	ryerson.brower178@topper.wku.edu
Kaden Hunt	kaden.hunt144@topper.wku.edu

Client: Michael Galloway  
CS 360  
Fall 2025  
Project Technical Documentation

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Project Overview . . . . .	1
1.2	Project Scope . . . . .	1
1.3	Technical Requirements . . . . .	2
1.3.1	Functional Requirements . . . . .	2
1.3.2	Non-Functional Requirements . . . . .	2
1.4	Target Hardware Details . . . . .	3
1.5	Software Product Development . . . . .	3
<b>2</b>	<b>Modeling and Design</b>	<b>3</b>
2.1	System Boundaries . . . . .	3
2.1.1	Physical . . . . .	3
2.1.2	Logical . . . . .	4
2.2	Wireframes and Storyboard . . . . .	4
2.3	UML . . . . .	4
2.3.1	Class Diagrams . . . . .	4
2.3.2	Use Case Diagrams . . . . .	6
2.3.3	Use Case Scenarios Developed from Use Case Diagrams (Primary, Secondary) . . . . .	8
2.3.4	Sequence Diagrams . . . . .	8
2.3.5	State Diagrams . . . . .	9
2.3.6	Component Diagrams . . . . .	10
2.3.7	Deployment Diagrams . . . . .	10
2.4	Version Control . . . . .	11
2.5	Requirements Traceability Table . . . . .	11
2.6	Data Dictionary . . . . .	12
2.7	User Experience . . . . .	12
2.7.1	Gameplay Diagram . . . . .	12
2.7.2	Gameplay Objectives . . . . .	12
2.7.3	User Skillset . . . . .	12
2.7.4	Gameplay mechanics . . . . .	12
2.7.5	Gameplay Items . . . . .	12
2.7.6	Gameplay Challenges . . . . .	12
2.7.7	Gameplay Menu Screens . . . . .	12
2.7.8	Gameplay Heads-Up Display . . . . .	13
2.7.9	Gameplay Art Style . . . . .	13
2.7.10	Gameplay Audio . . . . .	13
<b>3</b>	<b>Non-Functional Product Details</b>	<b>13</b>
3.1	Product Security . . . . .	13
3.1.1	Approach to Security in all Process Steps . . . . .	13
3.1.2	Security Threat Model . . . . .	13
3.1.3	Security Levels . . . . .	13
3.2	Product Performance . . . . .	13
3.2.1	Product Performance Requirements . . . . .	13
3.2.2	Measurable Performance Objectives . . . . .	13
3.2.3	Application Workload . . . . .	14
3.2.4	Hardware and Software Bottlenecks . . . . .	14
3.2.5	Synthetic Performance Benchmarks . . . . .	14
3.2.6	Performance Tests . . . . .	14

<b>4</b>	<b>Software Testing</b>	<b>14</b>
4.1	Software Testing Plan Template . . . . .	14
4.2	Unit Testing . . . . .	14
4.2.1	Source Code Coverage Tests . . . . .	14
4.2.2	Unit Tests and Results . . . . .	14
4.3	Integration Testing . . . . .	14
4.3.1	Integration Tests and Results . . . . .	14
4.4	System Testing . . . . .	15
4.4.1	System Tests and Results . . . . .	15
4.5	Acceptance Testing . . . . .	15
4.5.1	Acceptance Tests and Results . . . . .	15
<b>5</b>	<b>Conclusion</b>	<b>15</b>
<b>6</b>	<b>Appendix</b>	<b>15</b>
6.1	Software Product Build Instructions . . . . .	15
6.2	Software Product User Guide . . . . .	15
6.3	Source Code with Comments . . . . .	15

## List of Figures

1	The wireframe of the basic use of our GPS app. . . . .	4
2	Structural Design Pattern: <i>Facade</i> for routing & map services. . . . .	5
3	Creational Design Pattern: <i>Singleton</i> for AppConfig. . . . .	6
4	Behavioral Design Pattern: <i>State</i> . . . . .	6
5	Use Case Diagrams. . . . .	7
6	Use Case Scenario Table for the search room use case. . . . .	8
7	Sequence diagram for the user route request, generation, and update. . . . .	9
8	State UML diagram for the room search feature, showing user input, validation, query, error handling, and path display. . . . .	10
9	Component diagram. . . . .	10
10	Deployment diagram for mobile + external services. . . . .	11
11	Requirements Traceability Table. . . . .	12

# 1 Introduction

## 1.1 Project Overview

The GPS Based Campus Room Finder is a mobile application designed to simplify navigation for WKU students and faculty. The primary purpose of this project is to create a consistent and easy-to-use tool that addresses the common problem of navigating a large and unfamiliar campus environment. Using GPS technology, the application will help users quickly determine their current location and find the most efficient route to any building and room number on campus. This tool will eliminate the need for paper maps and provide an important resource for new and current members of WKU.

The final product will be a user-friendly mobile application that gives real-time guidance and an estimation of travel times. This software will be a valuable tool for the university with potential for expansion to include additional features that continue to enhance the campus experience.

## 1.2 Project Scope

The project scope defines the boundaries, commitments, and outputs required to deliver the GPS-Based Campus Room Finder. This scope covers all activities necessary to design, implement, test, and document a mobile application that meets the client's expectations while remaining usable and maintainable beyond the project timeline.

### **Deliverables & Outcomes:**

- **Written Reports:** Detailed organizational and technical documents submitted at the conclusion of each of the four sprints.
- **Presentations:** A presentation delivered at the end of each sprint to summarize progress and demonstrate results.
- **Evaluations:** Peer evaluation forms submitted individually by team members after each sprint.
- **Final Product:** A fully tested, documented, and maintainable Android mobile application that provides GPS-based navigation to campus buildings and rooms.

### **Work Required:**

- **Tasks:** All development tasks including source code creation, user interface design, system integration, testing, and documentation. Additional requirements will be integrated as identified throughout the project.
- **Team:**
  - Kaden Hunt — Project Manager
  - Aaron Downing — Documentation Draft
  - Ryerson Brower — Research Coordinator, Task Manager
- **Time Commitment:** Work will be divided across four sprints. Each team member will contribute 8–10 hours per week to development, meetings, and documentation.
- **Resources:** GitHub will serve as the version control system and task management platform. The documentation will be written collaboratively in Texmaker. The development will take place on personal laptops running Windows 10 or later which will meet the requirements of Android Studio. of Android Studio.
- **Schedule:** Deliverables align with the four milestone deadlines outlined on Blackboard. Weekly client meetings occur on Tuesdays at 12:35 p.m. in Snell Hall B104. Internal team meetings will take place on Thursdays at 2:00 p.m.

Altogether, this scope establishes what will be delivered, the benefits it provides, and the foundation for successful implementation

## 1.3 Technical Requirements

### 1.3.1 Functional Requirements

<b>Mandatory Functional Requirements</b>
The application will use GPS coordinates to determine the user's current location within the campus boundaries.
The application will allow the user to search for a specific building and room number using a text-based input.
The application will generate a step-by-step navigation route from the user's current location to the selected room.
The application will have an interactive display to navigate the user to the building and room.
The application will provide an estimated travel time based on the mobile location of the user.
<b>Extended Functional Requirements</b>
The application will provide voice-guided navigation for hands-free use.
The application will allow users to bookmark or "favorite" frequently visited rooms for quicker searches.
The application will provide a "recent searches" history so users can quickly reselect prior destinations

The functional requirements for the WKU GPS-based campus room finder are designed to help WKU students and faculty easily locate rooms across campus. By using GPS coordinates to determine the user's current location, the application provides accurate, real-time directions, allowing users to navigate campus quickly and effectively. The interactive display offers clear step-by-step guidance to the desired building and room number, featuring a user-friendly interface that makes input, ensuring easy accessibility for all users. To get rid of any other unnecessary confusion, the application will provide an estimated travel time based on the mobile location of the user. This feature also allows users to make better decisions about which route to take depending on their time constraints between classes. The applications goal is to address common problems such as getting lost or arriving late to class, enhancing convenience and creating a smoother, more reliable navigation experience across the WKU campus.

### 1.3.2 Non-Functional Requirements

<b>Mandatory Non-Functional Requirements</b>
The application will provide location updates with an accuracy of at least $\pm 5$ meters under clear sky conditions.
The application will deliver route generation results within 2 seconds of the user's search request.
The application will be compatible with either Android or iOS mobile operating systems.
The application will provide visual and text-based route guidance.
The application will support operation in both portrait and landscape orientations without loss of functionality.
All project source code must be developed by the CS 360 project team.
The project must use a database.
Performance metrics should be gathered and optimized.
Security metrics should be gathered and optimized
User interface metrics should be gathered and optimized.
<b>Extended Non-Functional Requirements</b>
The application should maintain functionality with limited or no internet connection
The application should consume minimal battery power while running in the background.
The application should be designed with a clean, intuitive user interface that prioritizes ease of use.
<b>Performance Non-Functional Requirements</b>
The application should load maps and calculate routes within 3 seconds under normal network conditions.
The application should maintain a user interface response delay of no more than 200 ms during normal operation.
The system should handle at least 100 concurrent users without significant degradation in performance.
The database should return query results within 1 second on average.
The application should ensure smooth real-time navigation updates with a refresh rate suitable for walking speed (1-2

The mandatory non functional requirements for the WKU GPS-based campus room finder ensure the application performs reliably, efficiently, and securely while providing users with a positive application experience. By requiring location updates with an accuracy of within 5 meters under clear sky conditions, the app guarantees

precise position for navigating campus. Delivering route generation results within 2 seconds ensures that users receive routes efficiently without unnecessary delays. Visual and text-based route guidance enhances accessibility and makes navigation possible for all users. Requiring all project source code must be developed by the CS 360 project team helps achieve the desired learning outcomes of the class and encourages accountability throughout the team in a real-world setting. Using a database enables efficient storage and retrieval of all building and rooms on campus. Additionally, gathered and optimized security metrics will ensure the application remains fast, safe, and easy to use, while also meeting quality standards set out by the client. Collectively, these requirements provide a reliable and high-quality tool for campus navigation.

## 1.4 Target Hardware Details

We will create a mobile app for students and faculty around campus. The target hardware for our mobile app will primarily be for smart phones on Android. The minimum requirements are: The minimum CPU required is a quad-core ARM-based processor (or the processor that's in most smart phones) to ensure real time GPS processing and navigation. Our test case for the CPU would be to run a continuous navigation to confirm smooth updating with no lag. You would need at least 2 GB of RAM so the product can also run things like GPS tracking at the same time and the rendering of the map. Our test case for the RAM would be to monitor memory usage under a heavy load. A minimum of 200 MB of persistent storage is needed for the application installation, location files, and maps. Our storage test case would be to install the app and see how much it takes up. Network connectivity will be necessary via Wi-Fi or 4G/5G mobile data, with at least 1 Mbps of sustained bandwidth for map updates and routing queries. The targeted output device will be a touchscreen of a smart phone.

We don't have a plan to place this app on PC or computers but it would be something to possibly implement in the future. A software we are using called Android studios also has some hardware requirement. These are: A OS of 64-bit Windows 10 or newer, RAM with 16 GB, a CPU with a processor with visualization support (Intel VT-x or AMD-V), micro architecture from after 2017. 16 GB of free disk space, preferably on a Solid State Drive (SSD). A GPU with at least 4 GB of VRAM.

## 1.5 Software Product Development

The software we are using already are Google doc, TexLive, github, Android Studio, SQL and VScode. Google doc we use to keep up with each others documents and any document we need to print out. For our documentations we are using TexLive to edit both or Organizational and Tech Docs. Github we used to get a repository that is easy to access and easy for us to place our updated docs and code. Git hub also helps use be able to access everything without having to send files back and forth. We already planed on using VScode and the coding language we will use to code our app is JAVA. VS code with the help of github makes it really easy to pull everyone's code when they edit it so once again we are not sending a ton of files and getting them mixed up. One of the more important software we will use is Android Studio. This will allow use to code and Android app easier. This will also let use visualize the app when we don't have a Android phone accessible. For our database to hold all the data for location of rooms and routes we will use SQL.

# 2 Modeling and Design

## 2.1 System Boundaries

### 2.1.1 Physical

The physical system boundaries for the GPS-Based Campus Room finder are limited to mobile devices, primarily Android smart phones used by WKU students and faculty. The application relies on the mobile phones built-in hardware components such as the GPS system, touchscreen interface, and mobile network for accurate navigation. It will not include any external hardware devices not included in the user's smart phone. The system interacts with Google Maps API (or similar) for real-time navigation and requires the campus buildings and room data stored in the project database. Any devices outside of android mobile devices, such as iphones, PCs, and kiosks, lie out of the scope of the project. The application requires minimum resources, 2GB of RAM and 100mb of storage will be enough which is available on most android phones. Security is ensured by relying on the built-in

authentication systems on the phone. The application is easily scalable by adding functionality for more android phones and adding a larger database.

### 2.1.2 Logical

The logical system boundaries for the GPS-Based Campus Room Finder defines the flow of the information and functions managed by the application. Internally, the system handles location detection, room and building searches, and route generation. It manages the retrieval of the campus building and room number data from the project database and uses the GPS coordinates for navigation. Externally, the system communicates with Google Maps API and user-interface to display directions and built-in mobile operating systems for device-level functions such as notifications. Any process beyond navigation, such as class scheduling and campus event times remain outside the logical scope of the project.

## 2.2 Wireframes and Storyboard

Our wire-frame shows the basic interactions one can do with our app. The user enters the app and either choose to search a location to go to or to use history to go to a previous location. Once one of these 2 options is chosen then a arrow pop ups on screen and starts pointing in the direction to go along side the arrow is some text instructions telling the user where to go. Once the user makes it near the location the app will tell them they are near and to look at room numbers. It will then give the option to put in a new location.

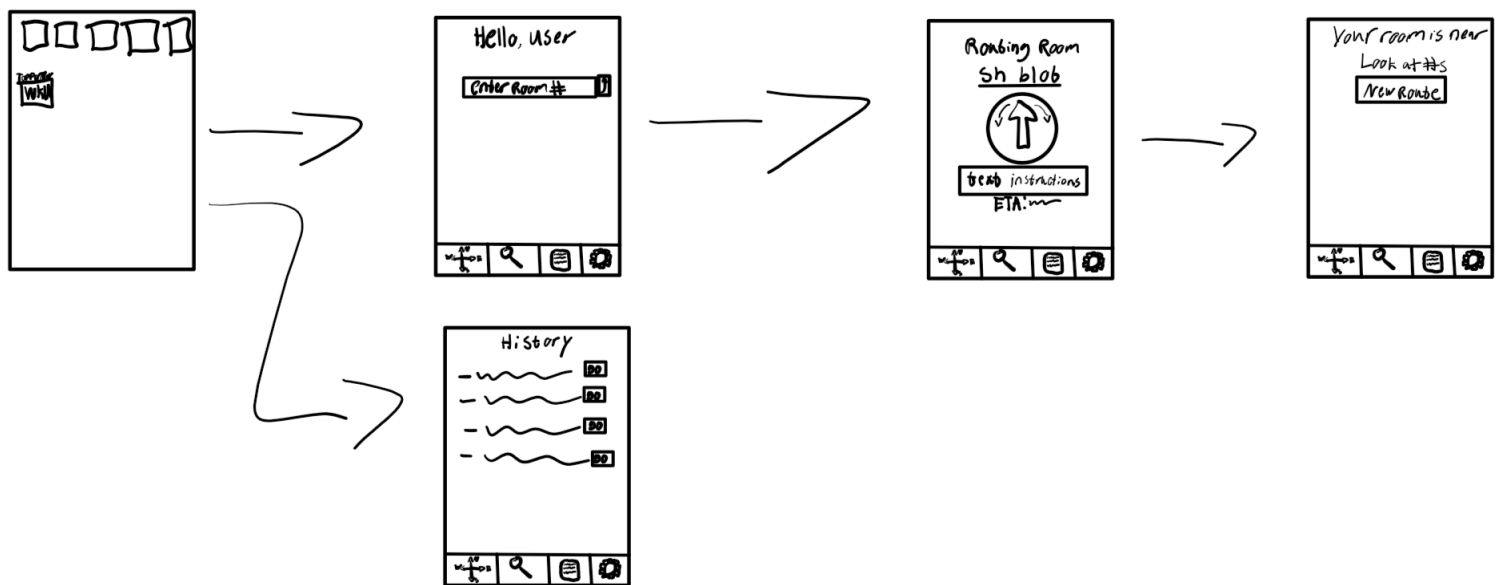


Figure 1: The wireframe of the basic use of our GPS app.

## 2.3 UML

### 2.3.1 Class Diagrams

Text goes here.



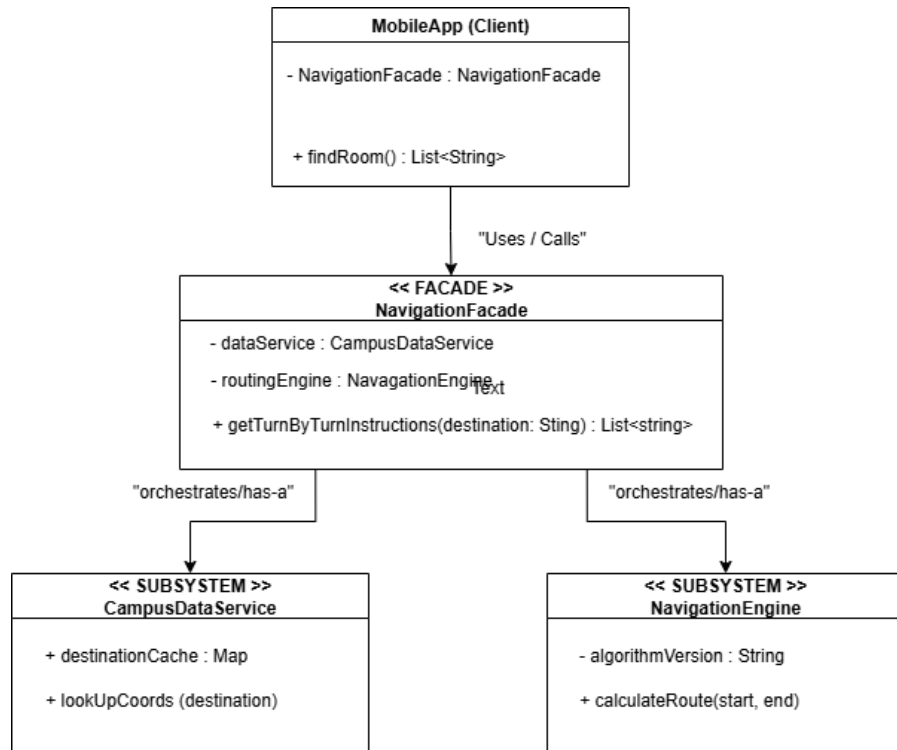


Figure 2: Structural Design Pattern: *Facade* for routing & map services.

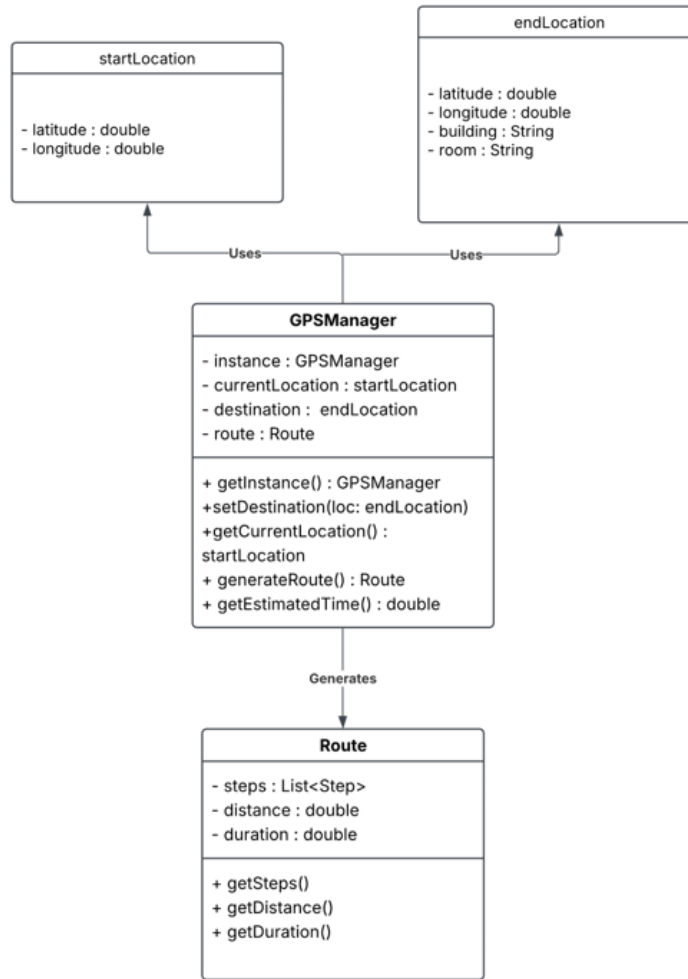


Figure 3: Creational Design Pattern: *Singleton* for AppConfig.

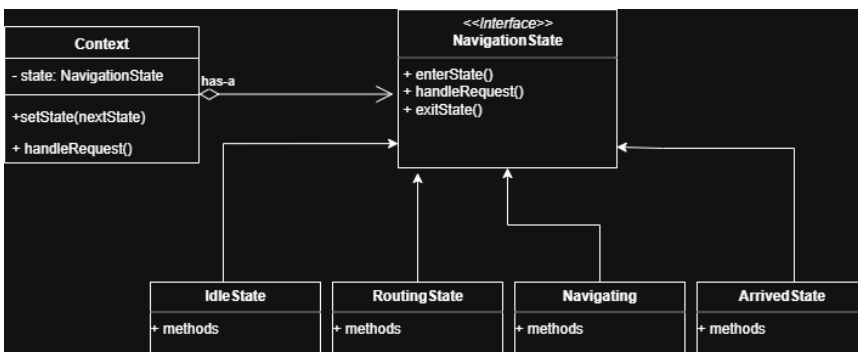


Figure 4: Behavioral Design Pattern: State.

### 2.3.2 Use Case Diagrams

Actors: Student/Faculty (User). Core use cases: Determine Location, Search Room, Generate Route, Display Estimated Travel Time

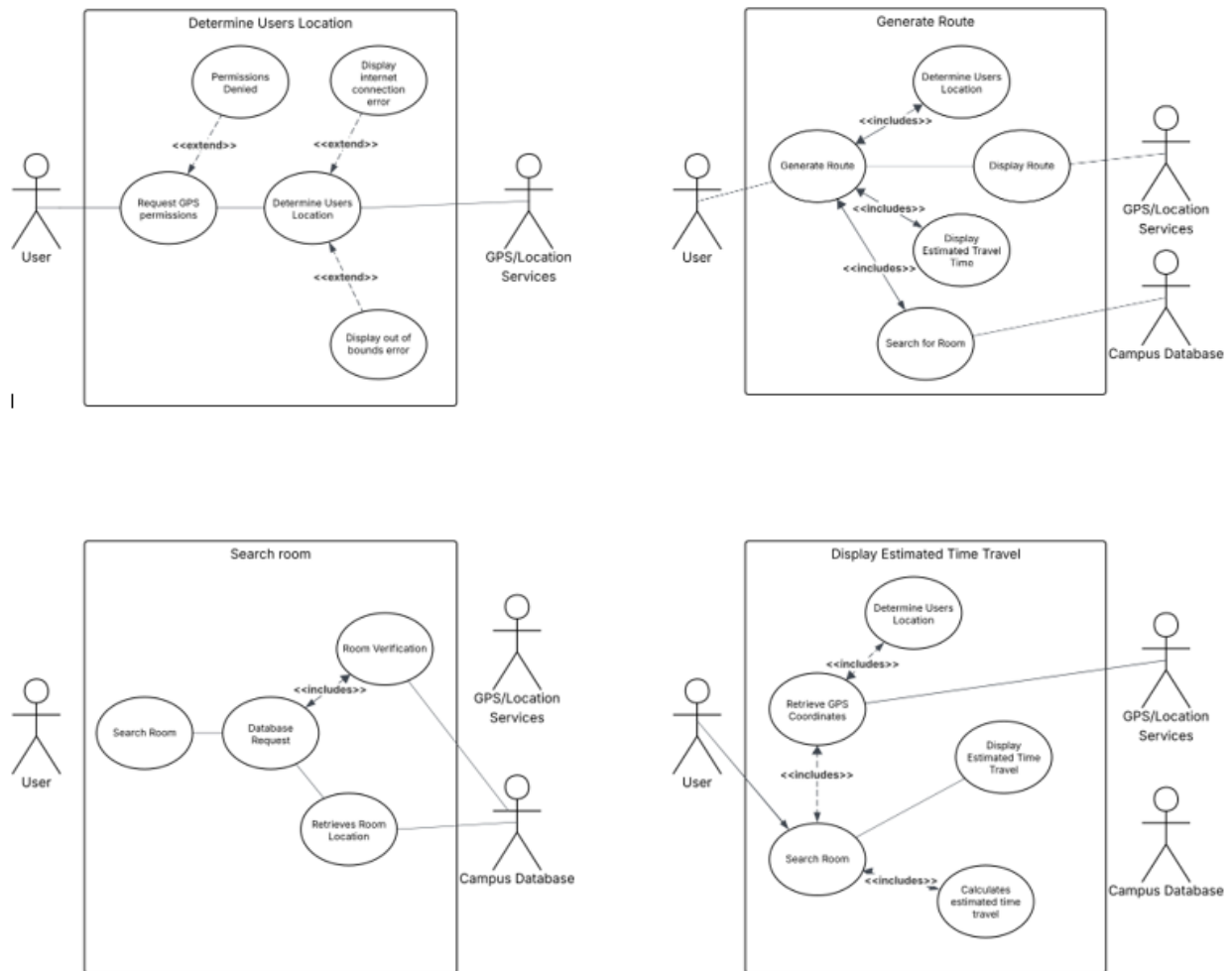


Figure 5: Use Case Diagrams.

### 2.3.3 Use Case Scenarios Developed from Use Case Diagrams (Primary, Secondary)

	Details
<b>Use Case Name</b>	Search Room
<b>Preconditions</b>	<ul style="list-style-type: none"><li>- User has access to the application</li><li>- Campus database <u>in</u> available and up to date</li><li>- GPS/Location services are enabled on the device</li></ul>
<b>Dependencies</b>	<ul style="list-style-type: none"><li>- GPS/Location Services for location context</li><li>- Campus Database for room details and verification</li></ul>
<b>Actors</b>	<ul style="list-style-type: none"><li>- User (Initiates search</li><li>- Campus Database (verifies and retrieves room info)</li><li>- GPS/Location Services (for navigation/location assistance)</li></ul>
<b>Primary Scenario</b>	<ol style="list-style-type: none"><li>1. User selects the option to search for a room</li><li>2. System sends a database request</li><li>3. The system verifies the room against the database</li><li>4. If valid, the system retrieves the room location.</li><li>5. The system provides the location <u>to</u> the user</li><li>6. The system provides the location to the user (optionally with GPS/Location based guidance)</li></ol>
<b>Secondary Scenarios</b>	<ul style="list-style-type: none"><li>- InvalidRoomIdentifier</li><li>- DatabaseUnavailable</li><li>- GPSUnavailable</li></ul>

Figure 6: Use Case Scenario Table for the search room use case.

### 2.3.4 Sequence Diagrams

The following sequence diagram shows the process of the actor (user) getting into the UI and requesting a location. This would then go through the database to get location data. It would then create a route from the users location and the desired room. As the user is moving the route would update in relation to the location of the user.

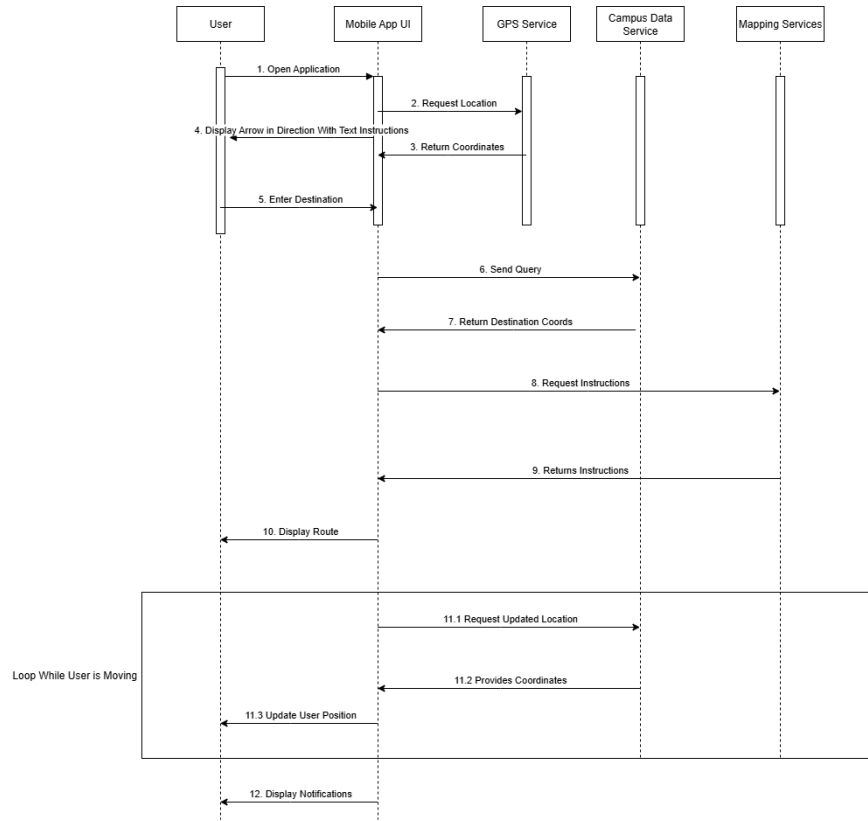


Figure 7: Sequence diagram for the user route request, generation, and update.

### 2.3.5 State Diagrams

The following state diagram models the process of a user searching for a campus room. The diagram begins when the user enters a room number and submits it. The system then validates the input: if it is invalid, the user is prompted to retry; if valid, the system queries the database. If the room is found, a path is generated and directions are displayed. If the room is not found, or a query fails, the user can correct their input and resubmit. This diagram focuses only on the search and route-display feature in Sprint 2, since implementation has not yet begun.

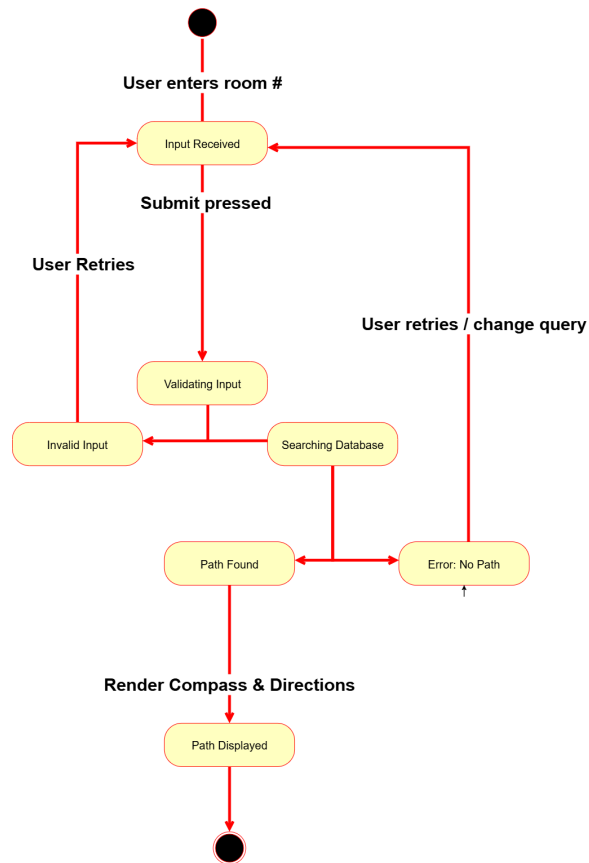


Figure 8: State UML diagram for the room search feature, showing user input, validation, query, error handling, and path display.

### 2.3.6 Component Diagrams

Text goes here.

Components: UI, Navigation Engine, Database, GPS Service, External API.

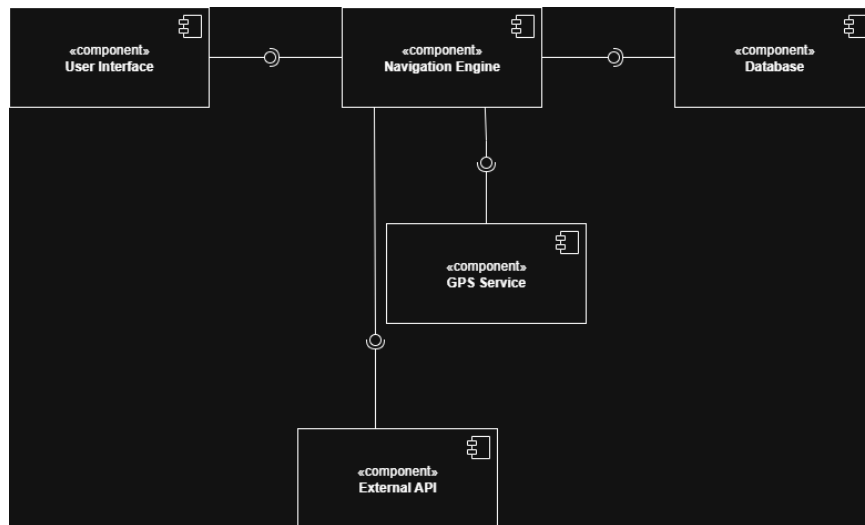


Figure 9: Component diagram.

### 2.3.7 Deployment Diagrams

The diagram shows the physical side of the system, which is the user device like a smart phone or tablet. Also related to the physical side there is the client UI. Then there is also the virtual that has database, and routing

engine that makes the route. The virtual also holds all the logic and back end APIs.

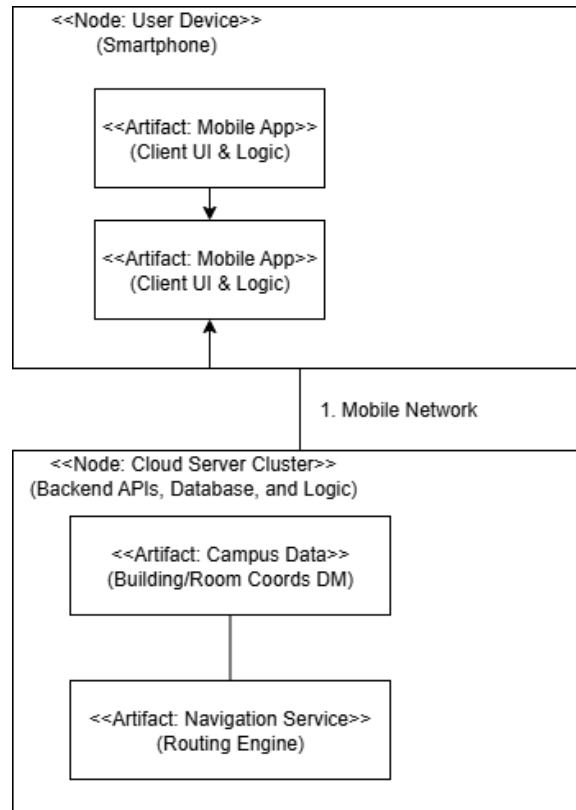


Figure 10: Deployment diagram for mobile + external services.

## 2.4 Version Control

Text goes here.

## 2.5 Requirements Traceability Table

The table ties requirements to use cases to verify coverage.

Requirement ID	Description	Use Case(s)	Design Component(s)	Test Case(s)
REQ-001	The system shall determine the user's current location using GPS.	UC-001 Determine User's Location	User Registration Module	TC-001 Verify GPS location retrieval under normal conditions; TC-002 Handle permission denied; TC-003 Handle no internet/out-of-bounds errors
REQ-002	The system shall generate a walking route from the user's current location to the selected room.	UC-002 Generate Route	Authentication Service	TC-004 Verify correct route displayed; TC-005 Handle missing room data; TC-006 Ensure alternate routes are calculated if primary route fails
REQ-003	The system shall allow users to search for a campus room by room number or name	UC-003 Search Room	Profile Management Component	TC-007 Verify room search results; TC-008 Handle invalid room input; TC-009 Handle unavailable database connection
REQ-004	The system shall display the estimated travel time to the selected room.	UC-004 Display Estimated Time Travel	Travel Time Calculator	TC-010 Verify travel time accuracy; TC-011 Handle GPS errors in time calculation; TC-012 Handle invalid room location data
REQ-005	The system shall display errors and feedback when location or room retrieval fails.	UC-001, UC-003, UC-004	Error Handling & Feedback Component	TC-013 Verify "permissions denied" message; TC-014 Verify "internet connection error"; TC-015 Verify "room not found" error

Figure 11: Requirements Traceability Table.

## 2.6 Data Dictionary

Text and table goes here.

## 2.7 User Experience

### 2.7.1 Gameplay Diagram

Text goes here.

### 2.7.2 Gameplay Objectives

Text goes here.

### 2.7.3 User Skillset

Text goes here.

### 2.7.4 Gameplay mechanics

Text goes here.

### 2.7.5 Gameplay Items

Text goes here.

### 2.7.6 Gameplay Challenges

Text goes here.

### 2.7.7 Gameplay Menu Screens

Text goes here.



### **2.7.8 Gameplay Heads-Up Display**

Text goes here.

### **2.7.9 Gameplay Art Style**

Text goes here.

### **2.7.10 Gameplay Audio**

Text goes here.

## **3 Non-Functional Product Details**

### **3.1 Product Security**

#### **3.1.1 Approach to Security in all Process Steps**

Text goes here.

#### **3.1.2 Security Threat Model**

Text goes here.

#### **3.1.3 Security Levels**

Text goes here

### **3.2 Product Performance**

#### **3.2.1 Product Performance Requirements**

The GPS Campus Room Finder must perform efficiently usual university network conditions. The application should load the navigation tool and calculate the navigation routes within 3 seconds, while also maintaining a smooth UI responsiveness with less than 200 ms delay for location updates. It must support at least 100 concurrent users without service degradation. The database should respond within 1 second on average. These requirements ensure reliable, real-time navigation to keep users satisfied. By defining performance metrics, the system guarantees an easily scalable, fast, and reliable experience.

- Navigation load time  $\leq 3$  seconds
- Route generation time  $\leq 3$  seconds
- UI response delay  $\leq 200$  ms
- Database query response  $\leq 1$  second
- Supports  $\geq 100$  concurrent users

#### **3.2.2 Measurable Performance Objectives**

The GPS-Based Campus Room Finder must meet specific performance objectives to ensure its smooth and reliable for users. System response times, accuracy, and scalability will be monitored during testing. The application should provide optimal routes and render navigation tools quickly to support real-time navigation. Location tracking must remain accurate when on campus, even with below optimal network latency. These measurable objectives ensure the system is consistent across devices even with sub-par conditions. The following metrics define the measurable performance goals to be achieved during testing and deployment. These metrics are response time, accuracy, interface responsiveness, query speed, and multi-user scalability.

- Route and map generation time  $\leq 3$  seconds
- Location accuracy within  $\pm 5$  meters
- User interface response delay  $\leq 200$  ms
- Database query response  $\leq 1$  second
- Support for  $\geq 100$  concurrent users without degradation
- Navigation refresh rate of 1–2 Hz during movement

### 3.2.3 Application Workload

Text goes here.

### 3.2.4 Hardware and Software Bottlenecks

Text goes here.

### 3.2.5 Synthetic Performance Benchmarks

Text goes here.

### 3.2.6 Performance Tests

Text goes here

## 4 Software Testing

### 4.1 Software Testing Plan Template

**Test Plan Identifier:**

**Introduction:**

**Test item:**

**Features to test/not to test:**

**Approach:**

**Test deliverables:**

**Item pass/fail criteria:**

**Environmental needs:**

**Responsibilities:**

**Staffing and training needs:**

**Schedule:**

**Risks and Mitigation:**

**Approvals:**

### 4.2 Unit Testing

Text goes here.

#### 4.2.1 Source Code Coverage Tests

Text goes here.

#### 4.2.2 Unit Tests and Results

Text goes here.

### **4.3 Integration Testing**

Text goes here.

#### **4.3.1 Integration Tests and Results**

Text goes here.

### **4.4 System Testing**

Text goes here.

#### **4.4.1 System Tests and Results**

Text goes here.

### **4.5 Acceptance Testing**

Text goes here.

#### **4.5.1 Acceptance Tests and Results**

Text goes here.

## **5 Conclusion**

Text goes here.

## **6 Appendix**

### **6.1 Software Product Build Instructions**

Text goes here.

### **6.2 Software Product User Guide**

Text goes here.

### **6.3 Source Code with Comments**

Text goes here.