Capstone Project

SRS Document of Real-Time Web-Based Bus Tracking System

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BSCS-AWM-153435 -2025

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Definition of Terms, Acronyms and Abbreviations

Term	Description
GPS	Global Positioning System
ETA	Estimated Time of Arrival
API	Application Programming Interface
HTTPS	Hypertext Transfer Protocol Secure
JSON	JavaScript Object Notation

Contents

1. Introduction

1.1 Purpose of Document

The purpose of this document is to describe what the Real-Time Web-Based Bus Tracking System will do and what is required to build it. It clearly explains the goals of the system, its main features, and how it should work so that everyone involved understands the same thing.

This document helps guide the design, development, and testing of the project. It will be used to make sure the final system meets all the needs and expectations of its users.

This document will serve as a guide for all project stakeholders including the project manager, supervisor, development team and prospective users.

1.2 Project Overview

The project under study is a Real-Time Web-Based Bus Tracking System that allows users to view the live location of buses operating in Sargodha. The system uses GPS technology to collect the location of each bus and displays it on an interactive Google Map within a web application.

The software will be used by passengers to check the current position, route, and estimated arrival time of buses. Transport administrators can also use it to monitor bus movement, manage routes, and ensure that services are running on schedule. The system will be accessible through any device with an internet connection, such as a smartphone or computer.

Goals:

1. To provide accurate, real-time information about bus locations and arrival times.
2. To reduce passenger waiting time and improve transport reliability.
3. To support efficient route and fleet management for transport authorities.

Benefits:

1. Saves time and increases convenience for passengers.
2. Improves coordination between drivers and administrators.
3. Enhances trust and satisfaction in public transportation.
4. Contributes to the digital transformation of local transport systems.

1.3 Scope

The proposed system focuses on the development of a web-based real-time bus tracking platform designed specifically for the local E-Bus transport network launched under the initiative of Chief Minister Maryam Nawaz in Sargodha, Pakistan.

The boundaries of the proposed system are defined below to ensure clear deliverables.

In-Scope:

1. Designing and developing a responsive web application that displays real-time bus locations on an interactive Google Maps interface.

2. Utilizing GPS modules integrated within buses or drivers' mobile devices to capture live coordinate data.
3. Implementing a centralized backend database for continuous data synchronization and route management.
4. Providing users with essential transport details such as bus number, route, estimated arrival time (ETA), and current position.
5. Incorporating notification features to alert passengers of bus arrivals or route delays.
6. Ensuring the system's functionality and usability across desktop and mobile browsers through PWA design principles.

Out-of-Scope

1. Integration with digital ticketing or payment systems.
2. Development of a dedicated native mobile application (Android/iOS).
3. Implementation of AI-based predictive analytics or route optimization algorithms.
4. Coverage of private, intercity, or non-governmental transport vehicles.
5. Operate offline; it will require an active internet connection for its services.

2. Overall System Description

The Real-Time Web-Based Bus Tracking System is being developed as a **Progressive Web Application (PWA)** to display real-time locations of public buses operating in Sargodha. The system's purpose is to improve travel convenience by allowing passengers to track buses, check estimated arrival times, and plan their routes efficiently through a responsive web interface.

The system will operate in an online environment, using GPS-enabled smartphones carried by bus drivers to transmit live location data. These coordinates will be stored and synchronized through a **Firebase backend**, while **Google Maps API** will provide real-time map visualization for passengers. The system will be accessible across devices mobile phones, tablets, and desktops without requiring installation, offering an app-like experience through PWA functionality.

Environment & Users:

1. The software will run on standard web browsers (Chrome, Edge, Safari, Firefox) and will be compatible with Windows, Android, and iOS devices.
2. **Passengers** will use the platform to view bus locations and arrival times.
3. **Drivers** will use their registered smartphones to send live GPS data to the database.

Constraints:

1. Requires stable internet connectivity for continuous data transmission and tracking updates.
2. Accuracy depends on GPS signal strength and network stability.
3. Limited offline support due to real-time nature of the application.

Assumptions:

1. All participating buses are equipped with GPS-enabled devices or drivers' smartphones.
2. Users have access to an internet-connected device and modern web browser.
3. Transport authority or university management provides bus route information and permissions for

testing.

Dependencies:

1. **Firebase** for real-time data synchronization, authentication, and hosting.
2. **Google Maps API** for live map rendering and route visualization.
3. **React.js** for frontend development and responsive user interface.

4.1 User characteristics

The system involves three main user groups, each playing a distinct role in its operation and functionality.

1. **Passengers:** Use the web application to view real-time bus locations, routes, and estimated arrival times. (Highest priority)
2. **Drivers:** Share live GPS data using registered smartphones to keep tracking accurate and up to date. (High priority)
3. **Developers (Project Team):** Design, develop, and maintain the system during its implementation and testing phases. (Lowest priority)

4.2 Operating environment

The system operates as a **web-based Progressive Web Application (PWA)** accessible through any modern browser without requiring installation.

It includes:

1. Any smartphone, tablet, laptop, or desktop with an active internet connection.
2. Compatible with Android, Windows, macOS, and iOS operating systems.
3. Accessible via common browsers such as Google Chrome, Microsoft Edge, and Safari.
4. Uses drivers' smartphones for live GPS tracking and Firebase Cloud for backend communication.
5. Requires a stable internet connection for real-time data synchronization and map updates.

4.3 System constraints

The system operates within several practical and technical limitations that define its effective scope.

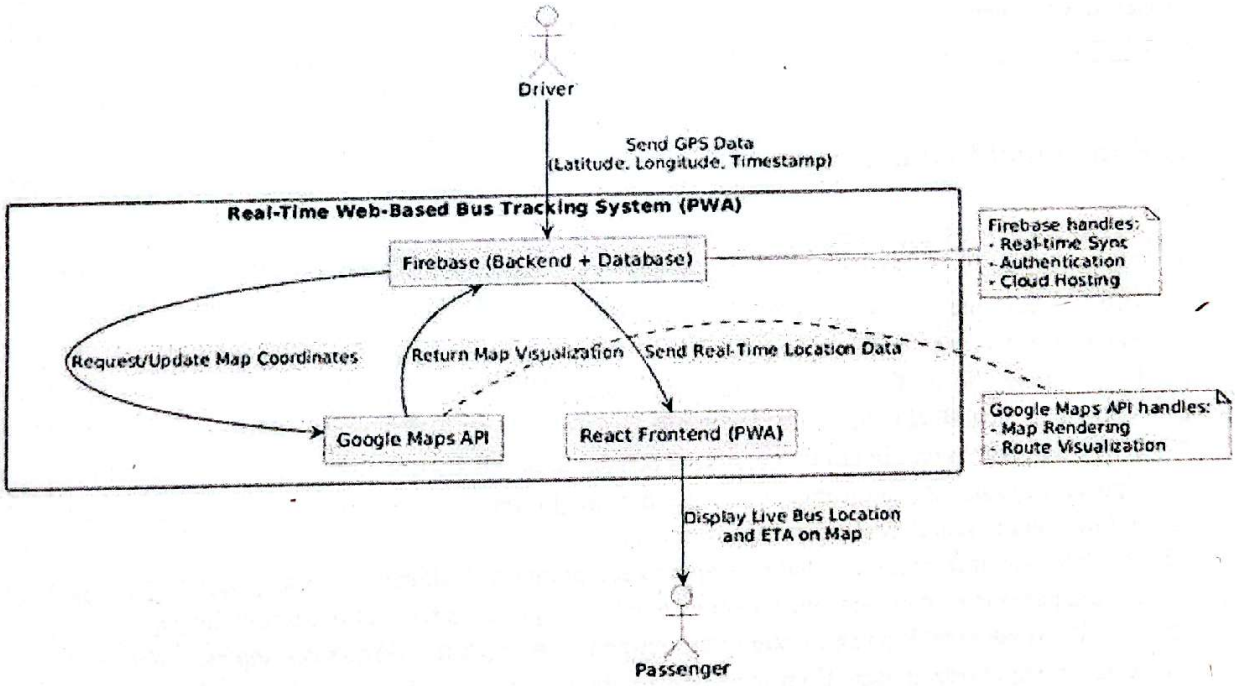
1. Depends on **Firebase** and **Google Maps API**, both restricted by free-tier usage limits.
2. Requires a **stable internet connection** for real-time tracking; the system does not function offline.

3. **GPS accuracy** may fluctuate due to weak signals or poor network connectivity.
4. Operates only on **internet-enabled devices** such as smartphones, laptops, or desktops.
5. Must ensure **data privacy and security compliance** with institutional and Google Cloud policies.
6. Requires users to have **basic smartphone and internet literacy** to navigate the interface.
7. Currently supports **English only**, limiting accessibility for non-English users.
8. Drivers must keep **GPS and mobile data active** throughout operation for accurate tracking.

5. External Interface Requirements

This section defines how the *Real-Time Web-Based Bus Tracking System* will interact with external hardware, software, and communication components

5.1 System Context Diagram



5.2 Hardware Interfaces

1. The system operates on standard internet-enabled devices such as smartphones, tablets, laptops, and desktops.
2. Drivers use GPS-enabled smartphones to send live location data.

3. Passengers access the system through web browsers on their devices.

5.3 Software Interfaces

The system interacts with several software components that enable its real-time functionality.

The table below outlines the key components and their respective roles in the system.

Software Name	Description
Operating System	The system will run on Windows, Android, and iOS through standard browsers such as Chrome, Edge, and Safari.
Programming Languages	The frontend is developed using React.js, while Firebase handles backend operations, database management, and authentication.
Database	Firebase Realtime Database is used to store and synchronize bus location data, user accounts, and route information.
Software Tools	Visual Studio Code is used for development; PlantUML for diagrams; and Microsoft Word for documentation and reporting.
External APIs/Libraries	Integrates with Google Maps API for live bus tracking and route visualization. Data is exchanged in JSON format via secure HTTPS connections.

6. Functional Requirements

1. Register a new user (passenger, driver, or admin) in the system.
2. Allow users to log in securely using email and password.
3. Display real-time bus locations on an interactive Google Map.
4. Show essential bus details such as bus number, route, and estimated arrival time (ETA).
5. Enable drivers to start or stop trip tracking and share live GPS coordinates.
6. Allow administrators to add, edit, or remove buses and routes.
7. Provide an admin dashboard to monitor all active buses and drivers.
8. Update location data automatically in real time using Firebase synchronization.
9. Allow users to search for a specific bus or route.
10. Display route information including start and end points with all major stops.
11. Ensure passengers can view bus movement and route progress without refreshing the page.
12. Provide responsive design ensuring full functionality on both mobile and desktop browsers.
13. Restrict unauthorized users from accessing admin or driver-only features.
14. Log basic system activities for performance monitoring and troubleshooting.

7. Non-functional Requirements

7.1 Performance Requirements

The application must be **interactive and responsive**, ensuring minimal delays during user interactions. Each

module should execute commands immediately after user input to provide a smooth and efficient experience.

All system components, including the **tracking module, map interface,** and **admin dashboard,** must be well-integrated and maintain a consistent workflow throughout the process. The system should update bus locations in real time, with minimal lag between GPS data transmission and display.

The application must handle multiple concurrent users without performance degradation and ensure that page load times remain within acceptable limits under normal network condition

7.2 Safety Requirements

1. The system should ensure reliable data transmission without loss or corruption.
2. In case of a network or GPS failure, the application must automatically resume data updates once the connection is restored.
3. Drivers' GPS tracking should stop automatically when the trip ends to protect privacy and save resources.
4. The system must not distract or interfere with the driver's operation of the vehicle.
5. Backup and recovery procedures must be in place to prevent data loss due to server or system failure.
6. The application should comply with standard safety and data handling policies defined by the institution or transport authority.

7.3 Security Requirements

1. All communication between client and server must be encrypted using HTTPS.
2. User authentication and authorization must be managed through Firebase Authentication.
3. Passwords and personal information must be securely stored in encrypted form.
4. Only authorized administrators can modify or delete bus and route information.
5. Sensitive data, such as driver details or route logs, must not be exposed through the user interface.
6. Automatic session timeouts should log out inactive users to maintain account security.
7. The system must comply with institutional and Google Cloud privacy guidelines.

7.4 User Documentation

1. An online help section will be included within the application to guide users on viewing live bus locations and route details.
2. On-screen tooltips and labels will assist first-time users in understanding navigation and features.
3. A short FAQ page will address common issues such as map loading, login errors, or missing bus data.
4. No external or printed user manuals will be provided, as the system is designed to be self-explanatory and simple to use.

8. Assumptions and Dependencies

It is assumed that all buses participating in the project will be equipped with GPS-enabled smartphones or tracking devices capable of transmitting accurate location data in real time. Drivers are expected to keep their GPS and mobile data services active throughout operation to ensure continuous updates. Passengers are assumed to have access to an internet-connected device and a modern browser to use the application effectively. Furthermore, it is assumed that the transport authority or university management will provide accurate route information and necessary permissions for implementation. The availability and stability of Google Maps API and Firebase services are also assumed, as these are critical for location tracking and data synchronization. Any deviation from these assumptions, such as inaccurate route data or unavailability of network services, may directly affect the system's functionality and reliability.

The project is dependent on several external factors and third-party services. The system relies on Firebase for real-time database synchronization, user authentication, and hosting, and on Google Maps API for live map rendering and route visualization. The accuracy of GPS signals and network strength also directly impact the performance of real-time tracking. Additionally, the project depends on institutional cooperation for providing access to operational bus data and permissions for pilot testing. Any interruption, delay, or modification in these dependencies could affect the development timeline, performance, or overall success of the system.

9. References

Ref. No.	Document Title	Date of Release/ Publication	Document Source
1	Project Proposal	Oct 20, 2003	https://github.com/Asma-Khanum1722/FYP-Project.git
2	Real-Time Bus Tracking System – Patel, D., Seth, R., Mishra, V., & Pathari, R.	March 2017	International Research Journal of Engineering and Technology (IRJET), 4(3), 743–746
3	*Real-Time Bus Monitoring System Using GPS* – Gharge, S., Chhaya, M., Chheda, G., & Deshpande, J.	May 2016	International Journal of Science and Research (IJSR), 5(5), 918–921
4	Progressive Web Apps (PWA) – Overview and Guide.	2024	Mozilla Developer Network (MDN). Retrieved from https://developer.mozilla.org/en-US/docs/Web/Progressive_web_apps