DIU Bus Live Location Finding Web Application

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This project report has been submitted in fulfilment of the requirements for the degree of
Bachelor of Science in Software Engineering

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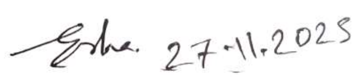

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DIU Bus Live Location Finding Web Application

MD IMRUL HASAN SAMI

Project submitted in fulfillment of the requirements
for the award of the degree of
Bachelor of Science/Master of Science

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ABSTRACT

In the present case, the university transport system lacks a digital tracking mechanism, which leaves it without a transport policy. students and faculty experiencing the state of uncertainty with the arrival of the bus. To address this challenge, the proposed project presents the DIU Bus Live Location Finding Web Application that is a real-time location tracking product created with the help of the MERN Stack (MongoDB, Express.js,).

The system is based on Socket.IO to create a two-way communication channel so that drivers can relay their live GPS positions in real time to a central server. Students can open an interactive map with moving bus icons that can be visualized in a responsive web interface. powered by Leaflet.js, and no login is required. Replacing the traditional manual. Project with this automated digital solution will schedule system and be able to make a big contribution. improve commuter safety, minimize the waiting time and modernize the transportation in general. experience on the DIU community.

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TABLE OF CONTENT

DECLARATION
TITLE PAGE
ACKNOWLEDGEMENTS ii
DEDICATION iii
ABSTRACT iv
TABLE OF CONTENT v
LIST OF TABLES vii
LIST OF FIGURES viii
LIST OF ABBREVIATIONS ix
CHAPTER 1 INTRODUCTION 11
1.1 Background 11
1.1.1 Context and Relevance 11
1.1.2 Problem Identification 11
1.1.3 Purpose and Justification 12
1.1.4 Scope 12
1.2 Project Planning and Initiation 12
1.2.1 Technical Feasibility 13
1.2.2 Operational Feasibility 13
1.2.3 Economic Feasibility 13
1.2.4 Legal and Ethical Feasibility 13
1.3 Target User Profile and Tentative Elicitation Process 14
1.3.1 Target User 14
1.3.2 User profile 14
1.3.3 Elicitation Process 16
1.4 Project Block Diagram 17
1.5 System Requirements 18
1.5.1 Hardware Requirements 18
1.5.2 Software Requirements 18
1.5.3 Constraints and Dependencies 18
1.6 Project Scheduling 19
1.7 Summary 21
CHAPTER 2 DESIGN AND IMPLEMENTATION 22

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2.1 Introduction	22
2.2 Functional Requirements	22
2.3 Non-Functional Requirements	24
2.4 Object-oriented System design using UML	26
2.4.1 Use Case Diagram	26
2.4.2 Case Description	27
2.4.3 Activity Diagram	32
2.4.4 Sequence Diagram	33
2.4.5 Class Diagram	34
2.4.6 ER Diagram	35
2.5 Coding: Appendix A	36
2.6 Summary	36
Chapter 3 Software Testing	37
3.1 Introduction	37
3.2 Testing Features	37
3.2.1 Feature to Be Tested	37
3.3 Testing Strategies	37
3.3.1 Test Approach	37
3.3.2 Pass/Fail Criteria	38
3.4 System Testing (Test Cases with Report)	38
3.5 Summary	43
Chapter 4 Deployment and Maintenance	44
4.1 Introduction	44
4.2 Follow the SRLC (software release life cycle)	44
Chapter 5 User Manual	44
5.1 Introduction	46
5.2 Project Functionalities	46
5.3 Summary	48
6.1 Introduction	49
6.2 Project Limitation	49
6.3 Scope	49
6.4 Future Work	49
6.5 Conclusion	50

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REFERENCES 51
APPENDICES 52
Appendix A: Sample Code 52
APPENDIX B: SURVEY QUESTIONNAIRE 56

LIST OF TABLES

Table No.	Table Name	Page No.
Table 1.1	User Profile for Students	14
Table 1.2	Project Gantt Chart	16
Table 2.1	Functional Requirements	17
Table 3.1	Test Case: Driver Login	25
Table 3.2	Test Case: Real-time Tracking	26

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LIST OF FIGURES

Figure No.	Figure Name	Page No.
Figure 1.1	System Block Diagram	16
Figure 2.1	Use Case Diagram	19
Figure 2.2	Activity Diagram	21
Figure 2.3	Sequence Diagram	22
Figure 2.4	Class Diagram	23
Figure 2.5	ER Diagram (Entity Relationship)	24
Figure 5.1	Registration Page Screenshot	28
Figure 5.2	Driver Dashboard Screenshot	29
Figure 5.3	Live Map View Screenshot	29

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LIST OF ABBREVIATIONS

Abbreviation	Full Meaning
DIU	Daffodil International University
GPS	Global Positioning System
API	Application Programming Interface
UI	User Interface
UX	User Experience
MERN	MongoDB, Express.js, React, Node.js
HTTP	Hypertext Transfer Protocol
JSON	JavaScript Object Notation
URL	Uniform Resource Locator
SRS	Software Requirements Specification

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LIST OF APPENDICES

Appendix A:	Sample Code and Logic	49
Appendix B:	SURVEY QUESTIONNAIRE	53

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CHAPTER 1 INTRODUCTION

1.1 Background

Daffodil International University (DIU) is a university with transportation issues that constitute the basic part of the daily campus life, as the Ashulia Smart City campus is located very far away in relation to the main city. Although the university offers a strong bus service, the management system is still more or less manual and analog. Students are also anxious and confused about the time of arrival of the bus and end up waiting long queues at the bus stops or the opposite, rush and miss the bus.

Overall, transportation technology has had a number of applications, both global and domestic in changing the way people travel. Applications such as Google Maps serve as the source of the static route, whereas ride-hailing applications such as Uber and Pathao allow tracking of personal vehicles in real-time. Intelligent Transport Systems (ITS) are also used to show live ETAs even in the developed countries by use of public transport. Though, these current solutions cannot be directly applied to the case of DIU and its private bus network due to the lack of route information, authorized access to the drivers, and a special interface with the university students.

The proposed project, which is the DIU Bus Live Location Finding Web Application, will address this gap in technology. Through the implementation of a special real-time tracking system like those employed by high-quality logistic companies, only adjusted to the university system, we will help to remove the phenomenon of the waiting game to thousands of students and university faculty members..

1.1.1 Context and Relevance

Digitization of transportation is necessary in the age of smart campuses. Daffodil International University offers extensive transport system to students. However, the absence of a real time tracking system complicates the situation where students are unable to know the exact time of arrival of the buses. In this project, an advanced web app is proposed to close this gap with the help of geolocation technology in real-time.

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Problem Identification

Nowadays, students use fixed schedules that are usually influenced by traffic jam or delays. One cannot even tell the position of a given bus at any given time. The key problems are:

- Time uncertainty with the arrival times of buses.
- Delays, long queues at bus stops.
- Communication failure between drivers and students in terms of location.

1.1.2 Purpose and Justification

This project is aimed at coming up with an easy to use web application that can give live tracking of the university buses. It adds value by:

- Saving students' time.
- Ensuring transparency of the transport system.
- Lessening the worry over being late to the bus.

1.1.3 Scope

This project scope includes:

- **Driver Module:** This will be a secure driver interface that allows the driver to start/stop broadcasting their position.
- **User Module:** A public map interface, in which students would be able to view buses in real-time.
- **Real-time Server:** An open-source node.js server used to process location updates in real-time.
- **Coverage:** It will concentrate on the routes that connect to the DIU Ashulia Smart City.

1.2 Project Planning and Initiation

Feasibility Study

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Feasibility study was done thoroughly to find out whether the project was viable. The analysis includes technical, operational, economical and legal.

1.2.1 Technical Feasibility

The project has high technical viability because it uses MERN (MongoDB,) Stack. It is based on a mature and well-supported technology stack Express.js, React, Node.js.

- **Real-time Capabilities:** We are implementing socket.io, a time-tested library of low-latency two-way communication, which guarantees real-time location information.
- **Geolocation:** The system uses the HTML5 Geolocation API, which is common to every smartphone available today, removing the cost of external.

- **1.2.2 Operational Feasibility**

The system is built in a manner that is user centric.

- **To the Drivers:** The interface is reduced to the simple press of a button, namely, Start/Stop. that those drivers with low technical literacy will be able to use it without being distracted.
- **To Students:** The web-based platform will not need any installation, which can be immediately accessed on any device with a URL. This simplicity guarantees the great adoption rates and easy implementation in the daily work of the university.

1.2.3 Economic Feasibility

This is a sustainable project that is economical.

- **Development Cost:** The cost of development is zero since it is a student project.
- **Infrastructure:** Our hosting is being done on free-tier cloud services (Render/Vercel). and OpenStreetMap (Leaflet.js) rather than the expensive Google Maps API. This renders the cost of maintenance as insignificant to the university versus the commercial tracking solutions.

1.2.4 Legal and Ethical Feasibility

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The system does not interfere with user privacy. The location information is not sent out until the driver. explicitly starts a trip. None of the personal data of students is monitored and stored or otherwise, and the general standards of data protection are observed. 1.3 Target User Profile and Tentative Elicitation Process.

1.3 Target User Profile and Tentative Elicitation Process

1.3.1 Target User

The "DIU Bus Live Location Finding Web Application" is meant to serve the logistical requirements of the Daffodil international university community. The primary The stakeholders and the people to be targeted by this system are:

- **Students:** The biggest group of users who have to travel to the university on a daily basis using university buses.
- **Faculty/ Staff:** The transportation is used by the Academic and administrative staff that use it service.
- **Bus Drivers:** The functional users that drive the buses and broadcasting location data.
- **Transport Admin:** The administrative staff that handles bus. driving schedules and driver accounts.

1.3.2 User profile

Table 0: User Profile for DIU Bus Tracking System

User Class	Note on Characteristics
Type of user	Student / Faculty
Age range	18 – 60 Years
Frequency of use	Daily (Twice or more per day during weekdays)
Mandatory	No
Computer experience	Moderate to High (Familiar with web browsers and smartphones)

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Education	Undergraduate / Postgraduate / PhD / Professionals
goal	To track real-time bus locations and minimize waiting time at bus stops.
Language skills	English and Bengali
Number of users	High (10,000+)
Training	None required (Intuitive User Interface)
Others system use	Google Maps, Uber, Pathao
Way of working	accessing the web link via smartphone while waiting for the bus.

Table 1: User Profile for DIU Bus Tracking System

User Class	**Note on Characteristics**
Type of user	Bus Driver
Age range	30 – 55 Years
Frequency of use	Daily (During active trip hours)
Mandatory	Yes (Required to broadcast location for the system to work)
Computer experience	Low to Moderate (Basic smartphone usage skills)
Education	Secondary / Higher Secondary
goal	To easily broadcast their live location without complex interactions.
Language skills	Bengali (Interface must be simple)
Number of users	Low (50 - 100 Drivers)
Training	Short hands-on training session (15-30 minutes)
Others system use	Basic Phone Calls, YouTube, WhatsApp
Way of working	Logging in and tapping "Start Tracking" at the beginning of a trip.

Table 2: User Profile for DIU Bus Tracking System

User Class	**Note on Characteristics**

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Type of user	System Administrator
Age range	25 – 45 Years
Frequency of use	Weekly or As needed (For maintenance and updates)
Mandatory	Yes (For system management)
Computer experience	High (Technical background)
Education	Graduate (IT or Engineering background)
goal	To manage driver accounts, monitor server health, and update routes.
Language skills	English
Number of users	Very Low (1 - 3 Admins)
Training	Self-trained (Documentation provided)
Others system use	Database Management Systems, Server Dashboards
Way of working	Accessing the admin panel via desktop/laptop.

1.3.3 Elicitation Process

The elicitation of requirements is the process that seeks to arrive at the needs and limitations of the different stakeholders to determine the scope of the system. In this project, we used a systematic elicitation procedure which entailed the following methodologies:

1. Definitions of Methods Used:

- **Interviews:** Face to face meetings with the heads of the transport section to. know administrative demands.
- **Surveys:** The data would be obtained through surveys in which the student body would be questioned about various characteristics pain points.
- **Observation:** Unit operation analysis of the existing bus queuing system at the Daffodil. Smart City campus.

2. Execution and Findings:

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- **Transport Section Interview:** We were informed that the university has more than 50 +. buses on varying routes. The administration needed a system that does not demand high cost. installation of hardware in each bus.
- **Student Survey:** A survey consisting of 100 or more students using a Google Forms showed that 85 percent of students are anxious about missing the bus, and 90 percent asked to have a visual map. interface.
- **Field Observation:** We noted that drivers have very little time to reply to phone calls made by students who wanted to know their locations because they are more engaged in traffic moves. This validated the requirement of an automated tracking system, which is passive.

1.4 Project Block Diagram

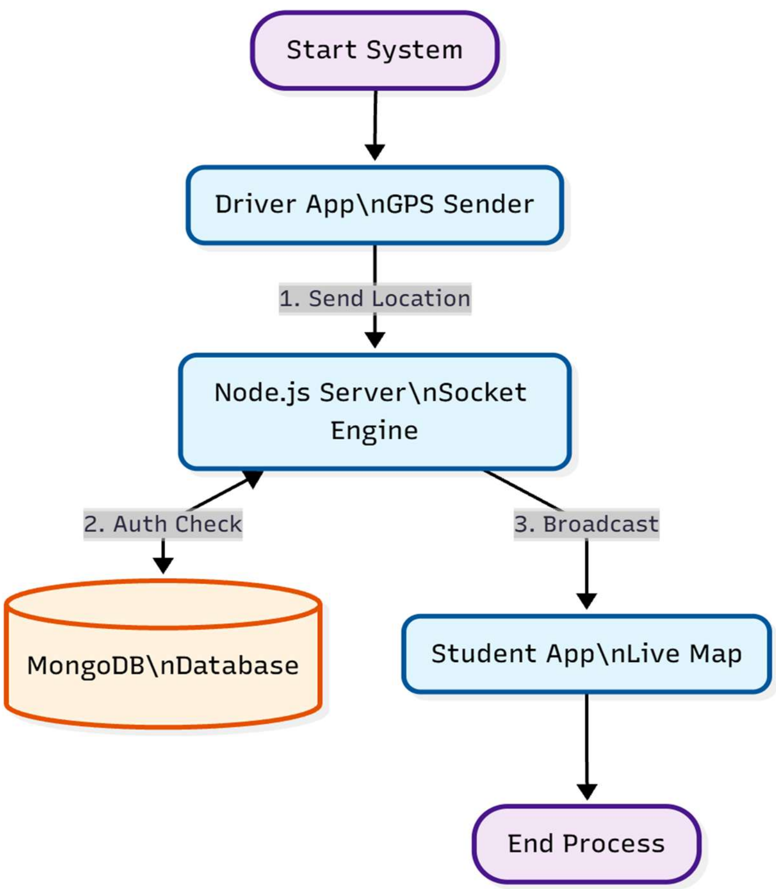

Figure 1: System Block Diagram

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1.5 System Requirements

1.5.1 Hardware Requirements

- Server: This can be any typical cloud server (e.g. AWS, Render, DigitalOcean).
- Client (Driver): Android smartphone and GPS enabled with Internet connection.
- Client (Student): Smartphone or Laptop and a Web browser.

1.5.2 Software Requirements

- Operating System: Cross-platform (Windows, Android, iOS, Linux).
- Backend: Node.js, Express.js.
- Frontend: HTML5, CSS3, JavaScript (Leaflet.js).
- Database: MongoDB.
- Real-time Engine: Socket.IO.

1.5.3 Constraints and Dependencies

Constraints:

- Internet Accessibility: The system must have a dedicated internet access (Wi-Fi or Mobile Data) to both the driver and the student. It does not support offline tracking.
- GPS Accuracy: The positioning accuracy is all based on the GPS device of the smart phone used by the driver. In rainy seasons or thick places, there can be minimal inaccuracies.
- Battery Life: Constant GPS and screen use on the device of the driver can consume the battery more than the normal ones.
- Browser Compatibility: The app is compatible with the current browsers (Chrome, Firefox, Safari) and might not work with the old fashioned legacy browsers (e.g., Internet Explorer).

Dependencies:

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- Leaflet API: The map interface is based on the open source Leaflet library and openstreetmap tiles. Slacknesses in their tile servers might be an issue to map drawing.

- Socket.IO Library: Socket.IO library is very stable and it is upon which real-time communication will rely.

- Hosting Service: The availability is determined by the uptime of the cloud hosting providers (Render and Vercel on the backend and frontend respectively).

1.6 Project Scheduling

The project was implemented based on the Agile Methodology that was divided into specific ones. surgeons in 12 weeks.

Gantt Chart:

Phase	Task Description	Duration	Start Week	End Week
Planning	Topic Selection, Proposal Defense, Feasibility Study	2 Weeks	1 Weeks	2 Weeks
Analysis	Requirement Gathering, Use Case Design, UI/UX Wireframing	2 Weeks	3 Weeks	4 Weeks
Design	Database Schema (ERD), System Architecture Design	1 Weeks	5 Weeks	5 Weeks
Development	Frontend (HTML/CSS), Backend (Node.js), API Integration	4 Weeks	6 Weeks	9 Weeks
Testing	Unit Testing, Driver Module Testing, Live Field Testing	2 Weeks	10 Weeks	12 Weeks
Documentation	Report Writing, Spiral Binding, Final Presentation	1 Weeks	12 Weeks	2 Weeks

Risk Management:

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There are various technical and operational risks involved in coming up with a real-time system. A risk assessment matrix was developed to address these possible problems.

Risk Assessment and Mitigation Plan

Risk ID	Risk Description	Probability	Impact	Mitigation Strategy
R01	**Network Instability:** Drivers may enter areas with poor 4G/internet coverage, causing the bus icon to freeze.	High	High	Implemented a "Reconnection Logic" in Socket.IO that automatically attempts to reconnect when the network is restored.
R02	**GPS Inaccuracy:** In cloudy weather or dense areas, GPS coordinates may fluctuate (drift).	Medium	Medium	We enabled enableHighAccuracy : true in the Geolocation API and added a logic to ignore sudden, unrealistic jumps in location.
R03	**API Service Downtime:** Dependency on third-party map tiles (OpenStreetMap) could fail.	Low	High	The system is designed to load cached map tiles or switch to a backup tile provider if the main server is down.
R04	**Battery Drain:** Continuous GPS usage may drain the driver's phone battery efficiently.	Medium	Low	The app is optimized to send location updates only every 5-10 seconds instead of every second to save power.
R05	**Server Overload:** Too many concurrent users (students) checking the map might slow down the free-tier server.	Low	High	Efficient code structure and lightweight JSON data packets are used to minimize server load.

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1.7 Summary

Chapter 1 has provided the basic background of the "DIU Bus Live Location Finding. Web Application". We started with real-time transport which was a critical deficit. data in Daffodil international university and contrasted it with what is available globally. examples of Uber and Google Maps just to confirm the necessity of a specific system. The feasibility study ensured that the project is feasible technically with the MERN stack and is economically viable with open-source tools. The requirement was also described. elicitation process, so that the system is actually needed by students and drivers. Lastly, a strong risk management strategy was developed to deal with possible risks such as failure of the network or inaccuracy of GPS. The chapter preconditions the system design and implementation is discussed in the following chapters.

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CHAPTER 2 DESIGN AND IMPLEMENTATION

2.1 Introduction

The chapter is a breakdown of the design and functional specifications of the system. The architecture of the "DIU Bus Live Location Finding Web Application" is based on the MERN stack, which guarantees a smooth information flow between the mobile interface of the driver and the map interface of the student. In this case, we specify the basic features (what the system does) and non-functional limitations (how the system can perform) so as to have a strong deployment.

2.2 Functional Requirements

The functional requirements have been to deal with the feedbacks about limited scope. extended to include Authentication, Tracking, Map Interaction and Administration.

FR01	**Driver Registration**
Description	The system must allow new drivers to register by providing their Full Name, University ID, valid Email, and a secure Password
Stakeholder	Driver

FR02	**Secure Login Authentication**
Description	The system must authenticate users (Drivers/Admins) using email and password before granting access to the dashboard. It should use JWT (JSON Web Token) for session security
Stakeholder	Driver,Admin

FR03	**Start Trip & Broadcast Location**
Description	Drivers must have a "Start Tracking" button that, when clicked, retrieves the device's GPS coordinates and broadcasts them to the server via Socket.IO
Stakeholder	Driver

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FR04	**Stop Trip**
Description	The system must provide a "Stop Tracking" button to end the session. This action stops the GPS usage and removes the bus icon from the student's map
Stakeholder	Driver

FR05	**View Live Map Interface**
Description	Students must be able to view a map centered on the DIU campus without needing to log in. The map should load using Leaflet.js tiles
Stakeholder	Student

FR06	**Real-time Bus Movement Animation**
Description	When the server receives a new location update, the bus marker on the student's map must move smoothly to the new position without refreshing the page
Stakeholder	Student

FR07	**View Bus Details (Pop-up)**
Description	Clicking on a bus icon should open a pop-up displaying specific details like "Bus Name" (e.g., DIU Bus 01) and "Last Active Time"
Stakeholder	Student

FR08	**GPS Permission Handling**
Description	The system must request location permission from the driver's browser. If denied, it should display an error message and prevent tracking
Stakeholder	Driver

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FR09	**Connection Status Indicator**
Description	The driver dashboard must show the current connection status (e.g., "Status: Active" or "Status: Disconnected") to inform the driver about network connectivity
Stakeholder	Driver

FR10	**Admin Dashboard Access**
Description	The system must have a dedicated admin panel where the administrator can view a list of all registered drivers and their current status
Stakeholder	Admin

FR11	**Manage Driver Accounts**
Description	The admin must be able to approve valid driver accounts or remove unauthorized users from the database
Stakeholder	Admin

FR12	**Logout Functionality**
Description	Users (Drivers/Admins) must be able to securely log out, which clears their session tokens from local storage and redirects them to the login page
Stakeholder	Driver,Admin

2.3 Non-Functional Requirements

Non-functional requirements indicate that although the system does something, certain requirements are not functional. guarantee the quality of the system.

2.3.1 Performance (Low Latency)

There must not be a latency between transmission of a location by the driver and the student. take a long time in less than 4G network environment.

2.3.2 Scalability

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The Node.js backend architecture should allow numerous simultaneous connections, simultaneously track a minimum of 50+ buses.

2.3.3 Reliability (Auto-Reconnect)

In the event that the internet connection of the driver becomes dead, the Socket.IO client will have to resume connection. shuts down automatically without stopping the app.

2.3.4 Usability (Mobile Responsiveness)

The interface should also be completely adaptive to the various screen sizes (Mobile, Tablet, desktop) since Smartphones will be the main tools used by drivers.

2.3.5 Security

The passwords should be hashed (by using bcrypt) then stored and the API endpoints should be. secured against illegal entry.

2.3.6 Availability

The software is hosted on cloud (Render / MongoDB Atlas) to achieve 99.9% uptime.

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2.4 Object-oriented System design using UML

2.4.1 Use Case Diagram

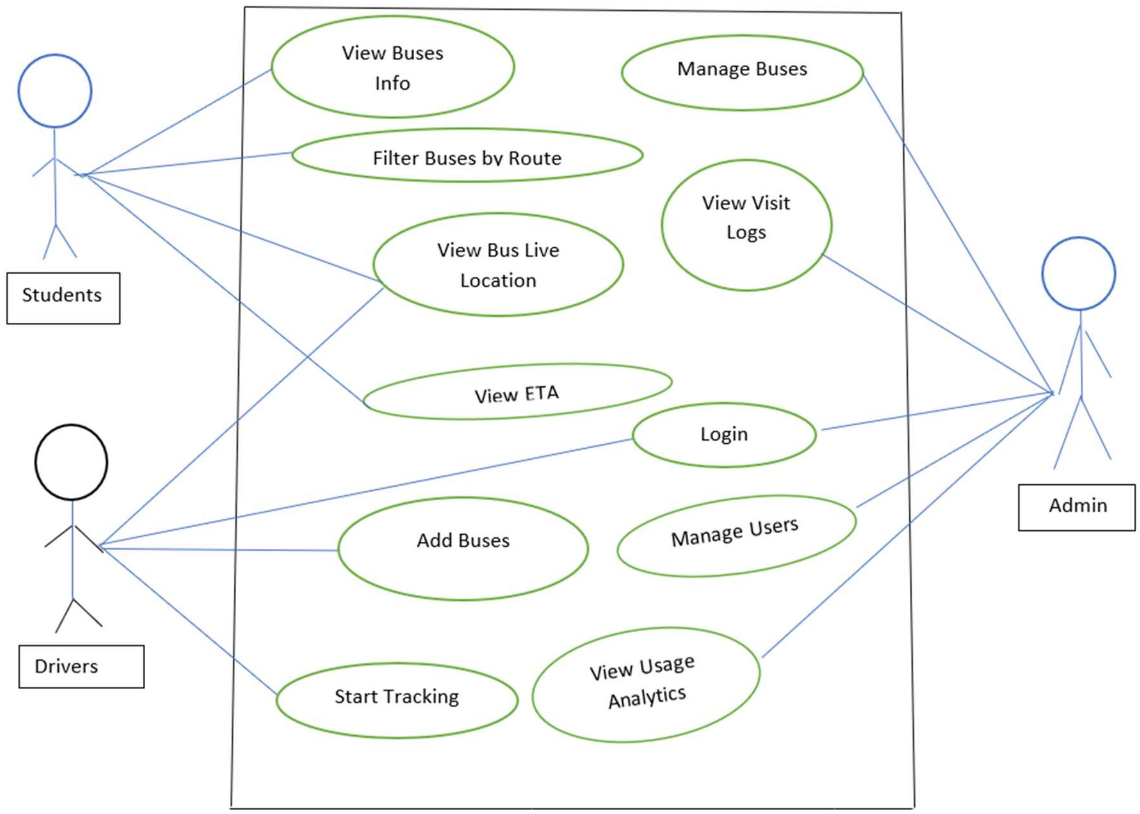

Figure 2: Use case Diagram

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2.4.2 Case Description

Case Case Description-01: Start Tracking (Driver)

Field	**Description**
Use Case Name	Start Tracking
Goal	To broadcast the bus's real-time geolocation to the server so students can see it.
Precondition	Driver must be logged in and have an active internet connection.
Success End Condition	Notification: "Status: Active. Sending Location..."
Failed End Condition	Notification: "GPS Permission Denied" or "Connection Failed".
Primary Actors	Driver
Secondary Actors	System (Server)
Trigger	Driver wants to start a trip and broadcast location
Main Success Scenario	1 Driver clicks the "Start Tracking" Button 2 System requests GPS/Location permission 3 Driver selects "Allow" 4 System captures Latitude and Longitude 5 System connects to the Server via Socket.io 6 System shows notification: "Status: Active" and updates the map
Alternative Flows	2.1 GPS Permission Denied 2.1.a. Driver clicks "Block" or "Deny" 2.1.b. System shows error: "Location permission is required"

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	<table><tr><td></td><td>2.1.c. Tracking does not start</td></tr></table> <table><tr><td>5.1</td><td>Internet Connection Lost</td></tr><tr><td></td><td>5.1.a. System fails to connect to server 5.1.b. System shows notification: "Reconnecting..."</td></tr></table>
Quality Requirements	The location must update within 2-5 seconds

Case Description-02: View Bus Live Location (Student)

Field	**Description**
Use Case Name	View Bus Live Location
Goal	To view the moving bus icons on the map in real-time
Precondition	Student must have a device with a web browser and internet connection
Success End Condition	Map loads successfully with bus markers moving
Failed End Condition	Map shows empty or "Server Error"
Primary Actors	Student
Secondary Actors	System (Google/OpenStreetMap API)
Trigger	Student opens the web application URL to check the bus position
Main Success Scenario	<table><tr><td>1</td><td>Student opens the web application URL</td></tr></table>

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<table>
<tr><td></td><td><table><tr><td>2</td><td>System loads the Map Interface</td></tr><tr><td>3</td><td>Client connects to the Backend Server</td></tr><tr><td>4</td><td>System fetches active bus data</td></tr><tr><td>5</td><td>System places Bus Marker on the map</td></tr><tr><td>6</td><td>The Marker moves automatically as the driver moves</td></tr></table></td></tr>
<tr><td>Alternative Flows</td><td><table><tr><td>4.1</td><td>No Active Buses</td></tr><tr><td></td><td><table><tr><td>4.1.a. System checks for online drivers</td></tr><tr><td>4.1.b. If no driver is active, the map remains empty</td></tr><tr><td>4.1.c. Notification: "No buses are currently active"</td></tr></table></td></tr></table>
<table><tr><td>2.1</td><td>Map API Error</td></tr><tr><td></td><td><table><tr><td>2.1.a. Map tiles fail to load</td></tr><tr><td>2.1.b. System displays a blank grid or fallback text</td></tr></table></td></tr></table></td></tr>
<tr><td>Quality Requirements</td><td>The map should load within 3 seconds on 4G network</td></tr>
</table>

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Case Description-03: Login (Admin & Driver)

Field	Description
Use Case Name	Login
Goal	To authenticate authorized users (Driver/Admin) to access secure dashboards
Precondition	User must be registered in the database with a valid email
Success End Condition	User is redirected to their specific Dashboard
Failed End Condition	Error Message: "Invalid Email or Password"
Primary Actors	Driver, Admin
Secondary Actors	Database (MongoDB)
Trigger	User navigates to the Login Page
Main Success Scenario	1 User enters Email and Password 2 User clicks the "Login" Button 3 System validates credentials with Database 4 System generates an Auth Token (JWT) 5 System identifies the Role (Driver or Admin) 6 System redirects user to the Dashboard
Alternative Flows	3.1 Invalid Credentials

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	<table><tr><td></td><td>3.1.a. Database finds no match for the email/password 3.1.b. System clears the password field 3.1.c. Error Message: "Invalid Credentials, Try Again"</td></tr></table> <table><tr><td>1.1</td><td>Empty Fields</td></tr><tr><td></td><td>1.1.a. User clicks Login without typing 1.1.b. System shows warning: "Please fill all fields"</td></tr></table>
Quality Requirements	Authentication process must complete under 1 second

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2.4.3 Activity Diagram

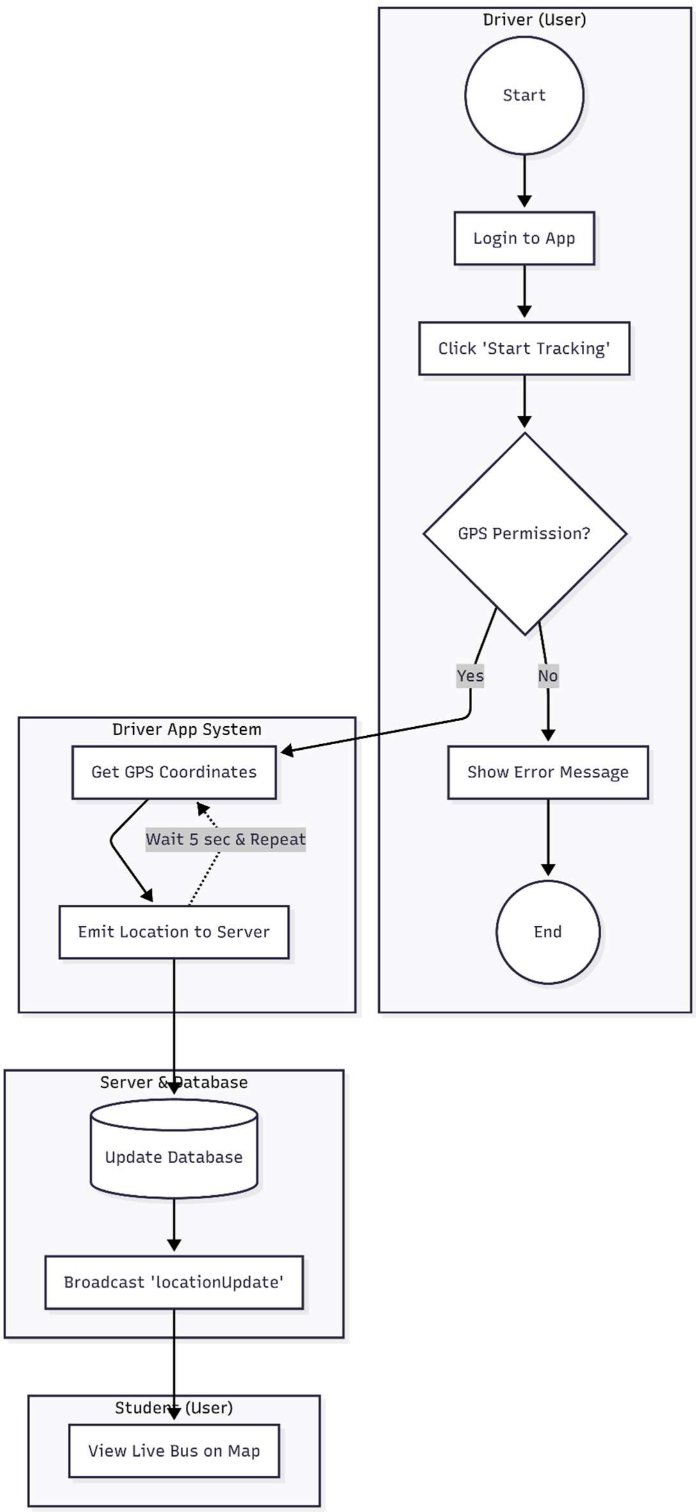

Figure 3: Activity Diagram

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2.4.4 Sequence Diagram

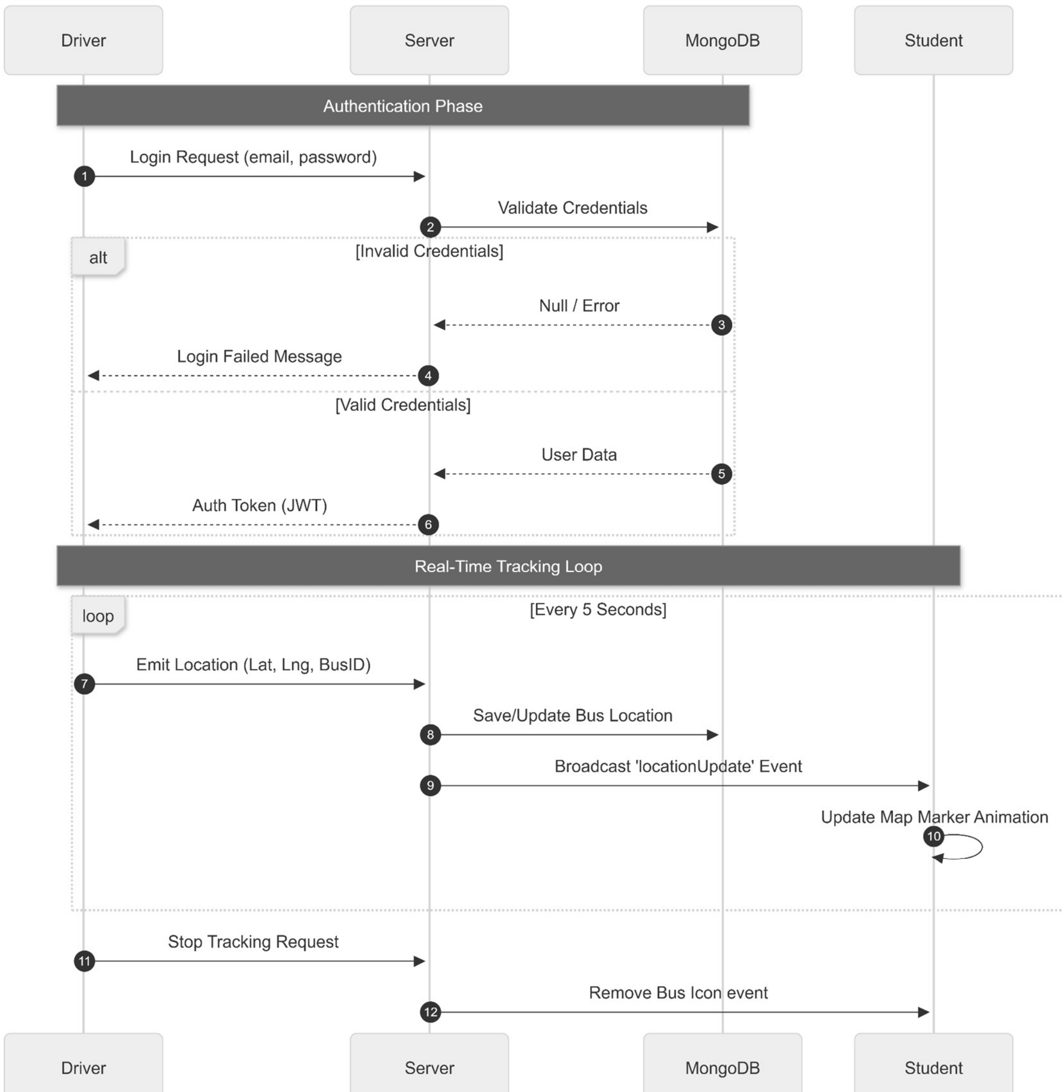

Figure 4: Sequence Diagram

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2.4.5 Class Diagram

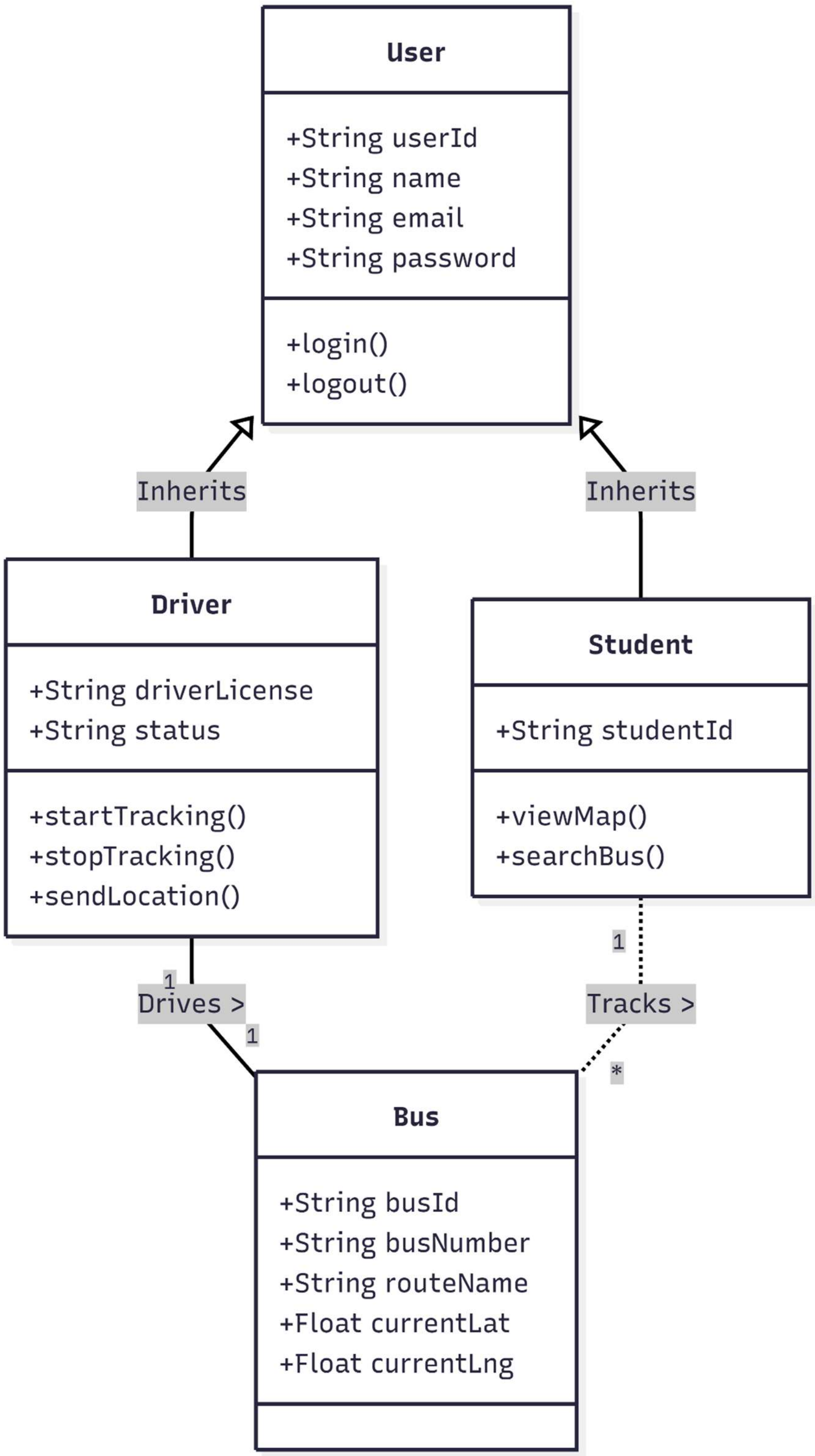

Figure 5: Class Diagram

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2.4.6 ER Diagram

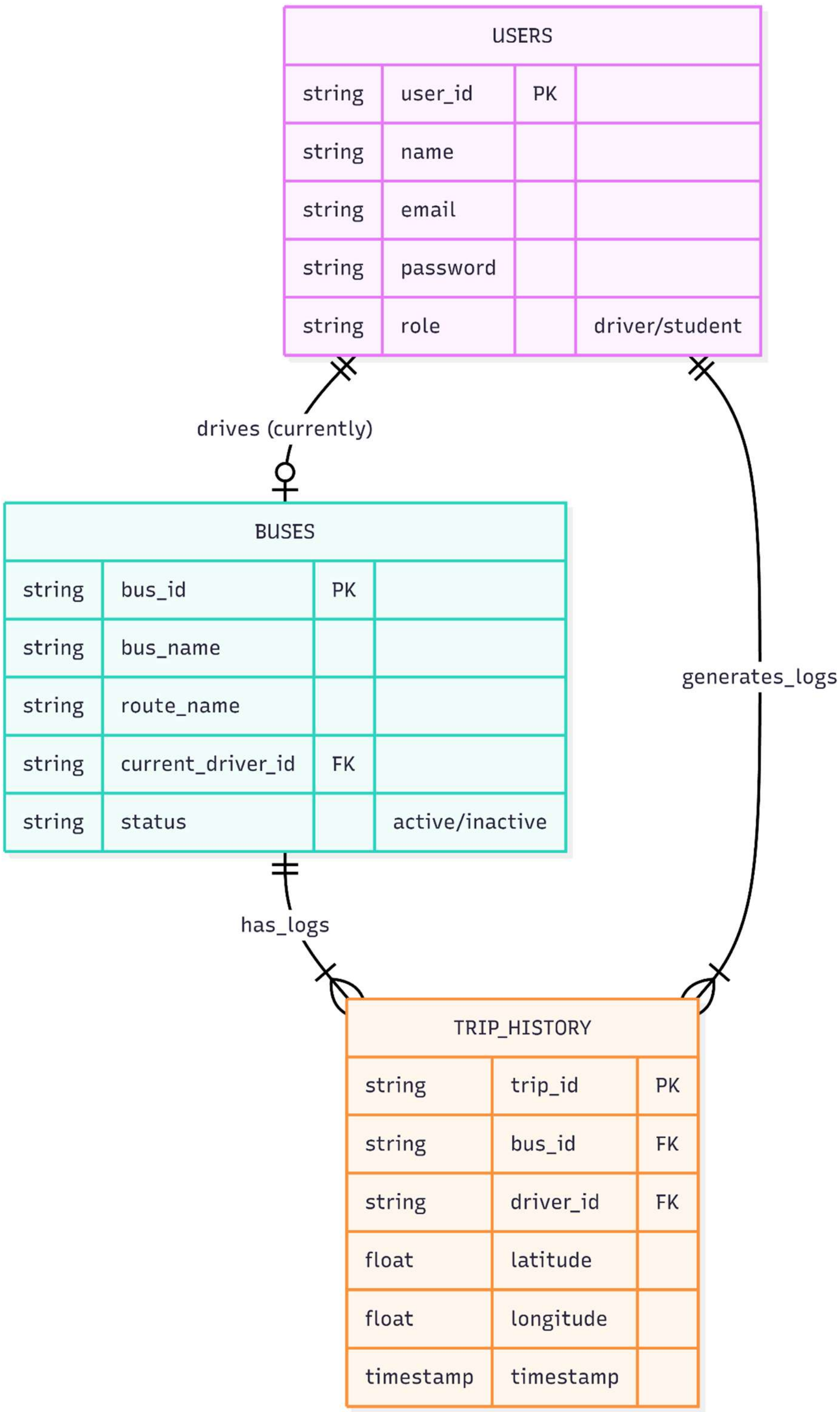

Figure 6: ER Diagram

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2.5 Coding: Appendix A

The MERN stack architecture strategy is applied to develop the application. The The backend is developed on the Node.js runtime environment using the Express framework to process API requests. Both real-time data transmission are critical with respect to. was coded in the Socket.IO library that provides a two-way connection. pathway through which the driver and the server communicate..

The user interface will be made using HTML5 and CSS3 on the frontend. responsiveness. The mapping interface is based on the Leaflet.js open-source library that displays maps and markers. The main rationale behind sending GPS position of the driver to the server and re-rendering the map on the student is the most notable in the construction. The attachment of the sample source codes of these main functionalities is in Appendix A.

2.6 Summary

In this chapter we have determined the broadened functional scope of the project, not only of the tracking module as well as the administrative and user interaction modules. These The requirements are the foundation of the system architecture and testing stages, which will be presented later in the chapters.

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Chapter 3 Software Testing

3.1 Introduction

The main objective of this testing phase was to test the stability and reliability of DIU Bus Live Location Finding Web Application. Given that it is a real-time tracking system with the use of GPS data transmission between drivers and students, intensive testing was done to confirm the accuracy of data, the performance of the system, and security. This chapter describes the testing characteristics, plans used and the specific test cases that were performed in order to test the system against the initial requirements.

3.2 Testing Features

3.2.1 Feature to Be Tested

The following core functionalities of the system were subjected to testing:

a. User & Driver Registration

b. Secure Login Authentication

c. GPS Permission Handling

d. Real-time Bus Tracking (Driver Side)

e. Live Map Rendering (Student Side)

f. Data Transmission via Socket.io

g. System Response to Invalid Inputs

h. Driver Logout Functionality

3.3 Testing Strategies

3.3.1 Test Approach

In this project, Black Box Testing strategy was used. This is a style that is based on testing the functionality of the software but does not take a peep into the inside code structure.

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- **Unit Testing:** Each of the individual components, including the validation of the registration form and the logic behind the Start Tracking button were tested separately.
- **Integration Testing:** This was a test that ensured that the Frontend (Client), Backend (Server), and Database to make sure that the data flowing involves the correct direction of the phone in the hand of the driver to the map of the student.

3.3.2 Pass/Fail Criteria

Pass: A test case is considered passed when the test result corresponds to the anticipated outcome (e.g., when the user manages to log in and is redirected to the dashboard).

Fail: When the system results in an error or crashes or acts in a manner it is not expected to (e.g. login has been successful with a incorrect password).

3.4 System Testing (Test Cases with Report)

Test Case 01: Driver Registration

<table>
<tr><td colspan="4">Test Case: 5.3.1</td><td colspan="4">Test Case Name: Driver Registration</td></tr>
<tr><td colspan="4">System: DIU Bus Tracker</td><td colspan="4">Subsystem: User Authentication</td></tr>
<tr><td colspan="4">Designed by: MD IMRUL HASAN SAMI</td><td colspan="4">Design Date: 10-10-2025</td></tr>
<tr><td colspan="4">Executed by: MD IMRUL HASAN SAMI</td><td colspan="4">Execution Date: 12-10-2025</td></tr>
<tr><td colspan="8">Description: The driver registers for the DIU Bus Tracker system by providing valid registration information.</td></tr>
<tr><td colspan="8">Pre-condition: The driver accesses the registration page.</td></tr>
<tr><td>Step</td><td>Name</td><td>Email</td><td>University ID</td><td>Password</td><td>Response</td><td>Pass /Fail</td><td>Comment</td></tr>
<tr><td>1</td><td>Sami</td><td>sami@diu.edu.bd</td><td>221-35-905</td><td>123456</td><td>Registration successful</td><td>Pass</td><td>The user registration is successful</td></tr>
</table>

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							with valid informatio n
2		sami@diu.edu.bd	221-35-905	123456	Name field empty	Pass	System correctly identifies missing name
3	**Sami**				Email field empty	Pass	System correctly identifies missing email
4	**Sami**	sami@diu.edu.bd		123456	ID field empty	Pass	System correctly identifies missing ID
5	**Sami**	sami@diu.edu.bd	221-35-905		Password field empty	Pass	System correctly identifies missing password
Post-condition: The user is successfully registered, and the registration process is considered successful with valid information.							

Test Results

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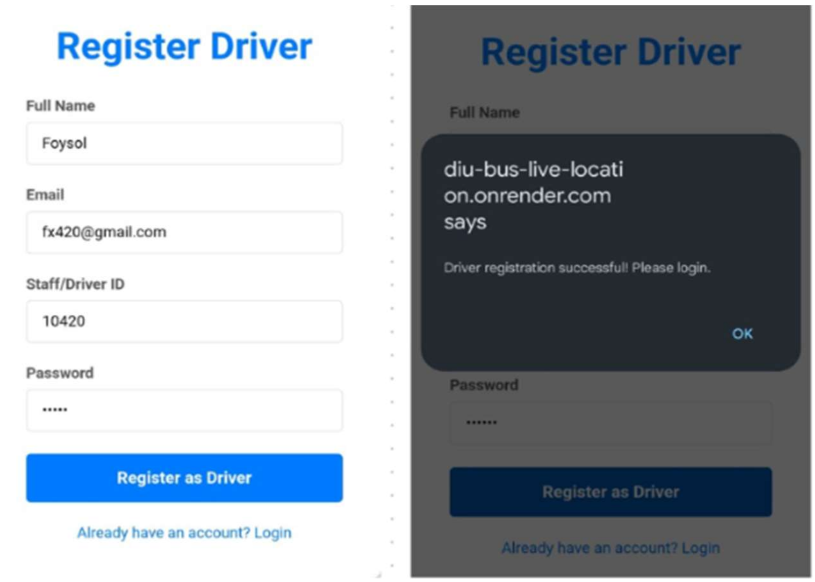

Test Case 02: Driver Login

Test Case: 5.3.2			**Test Case Name: Driver Login**			
System: DIU Bus Tracker			Subsystem: Authentication Module			
Designed by: MD IMRUL HASAN SAMI			Design Date: 10-10-2025			
Executed by: MD IMRUL HASAN SAMI			Execution Date: 13-10-2025			
Description: The registered driver logs in to the system to access the tracking dashboard						
Pre-condition: The driver must be registered and access the login page						
Step	**Name**	**Email**	**Password**	**Response**	**Pass /Fail**	**Comment**
1	Sami	sami@diu.edu.bd	123456	Redirect to Dashboard	Pass	Login is successful with valid credentials
2	Sami	sami@diu.edu.bd	0000000	Invalid Credentials	Pass	System prevents login with wrong password

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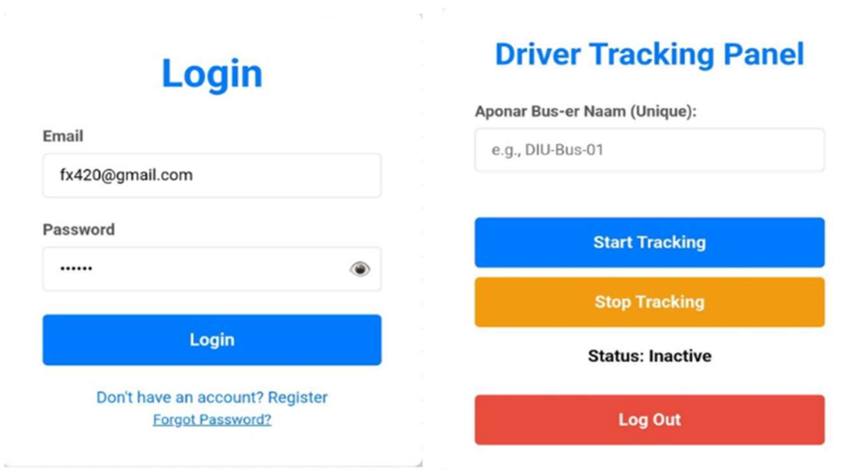
3	Sami	unknown@diu.edu.bd	123456	User not found	Pass	System prevents login for unregistered emails
4	Sami		123456	Fill all fields	Pass	Empty email field validation is working
Post-condition: The driver is authenticated and granted access to the secure tracking panel						

Test Results



Test Case 03: Start Live Tracking

Test Case: 5.3.3	**Test Case Name: Start Live Tracking**
System: DIU Bus Tracker	Subsystem: Authentication Module
Designed by: MD IMRUL HASAN SAMI	Design Date: 15-10-2025
Executed by: MD IMRUL HASAN SAMI	Execution Date: 18-10-2025
Description: The driver starts broadcasting their real-time location to the server for	

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students to see						
Pre-condition: Driver is logged in and GPS is enabled on the device						
Step	**Actor**	Action	GPS Permission	**Response**	**Pass /Fail**	**Comment**
1	Drive r	Click "Start"	Allow	Status: Active	Pass	Tracking started successfull y and location is sending
2	Drive r	Click "Start"	Block/Deny	Error: Location Denied	Pass	System correctly handled denied GPS permission
3	Drive r	Click "Start"	Allow	Map Updates	Pass	The bus icon moves on the map as the driver moves
Post-condition: The bus location is successfully broadcasted to the server and visible on the student map						

Test Results

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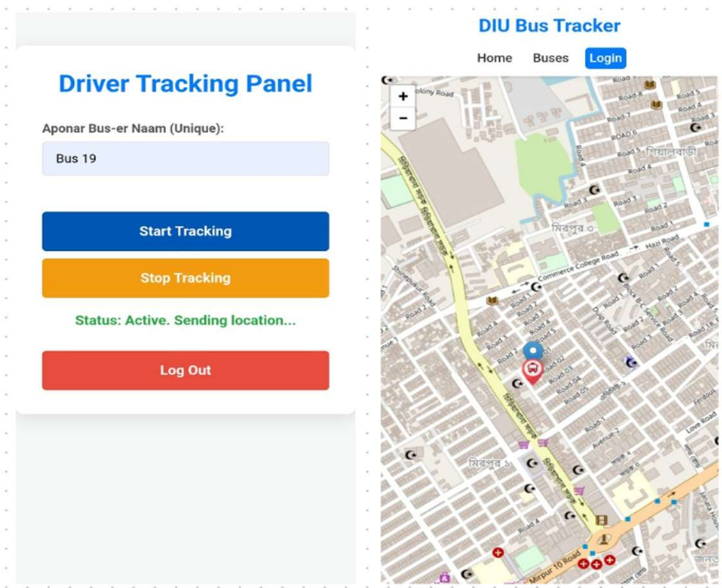

3.5 Summary

This chapter was a summary of the testing done on the DIU Bus Tracker system. We tested that by running certain test cases of registration, login and live tracking, we were able to verify that. the system addresses the functional requirements. The findings affirm that the application is steady, graceful in error management and is fit to be deployed in the real world.

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Chapter 4 Deployment and Maintenance

4.1 Introduction

The last stage of the software development life cycle is deployment in which the application is transferred out of a local environment to an active server to the end-users. For the "DIU Bus Live Location Finding Web Application," We used cloud-based solutions in Finding Web Application, location to make sure the location was high. availability and scalability. In this chapter, the deployment strategy, which is the software, is discussed. release life cycle (SRLC), and the maintenance plan taken in the project.

4.2 Follow the SRLC (software release life cycle)

To guarantee the seamless development to production, we took a guided SRLC. production. The steps were broken down into four steps:

1. **Development Phase:** The application has been developed locally at the beginning. Create a visual studio code environment. The frontend (HTML/CSS/JS) and the backend (Node.js) were localized and tested on localhost:3000.
2. **Testing Phase:** Unit and integration testing was done comprehensively. We used Socket.IO server to simulate multiple driver connections to ensure that the Socket.IO server was able to. support simultaneous location updates without failure.
3. **Staging Phase:** The application was staged to an environment on. Render.com (Free Tier). Here we were able to test the application on actual mobile. equipments across mobile data networks (4G/5G) to measure latency.
4. **Production Phase:** Once the staging phase is successful an actual production takes place. version was deployed. The database and backend API were on Render. was stored on MongoDB Atlas as a safe cloud storage.

Maintenance Plan:A maintenance plan has been to ensure that the system is sustainable in the long run. established:

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- Server Monitoring: Frequently reviewing the logs of the Render server to identify a downtime or a lack of it. latency spikes.
- Database Optimization: Clearing old trip history logs in MongoDB every now and then, in order to keep the query speed.
- API Updates: Revising the Leaflet.js and Socket.IO libraries to the most current. premakes to avoid security holes.
- User Feedback Loop: Gathering feedback on the usage of the system with the drivers about the Start. Monitoring" button responsiveness and updating the UI respectively.

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Chapter 5 User Manual

5.1 Introduction

This user manual will be a step by step guide on the operation of the "DIU Bus Tracker" system. It consists of two modules: Driver Panel (to broadcast the location of the bus) and Student View (to track the buses). The interface is also intuitive and it requires. low level of technical expertise.

5.2 Project Functionalities

Registration & Login

Figure: Registration

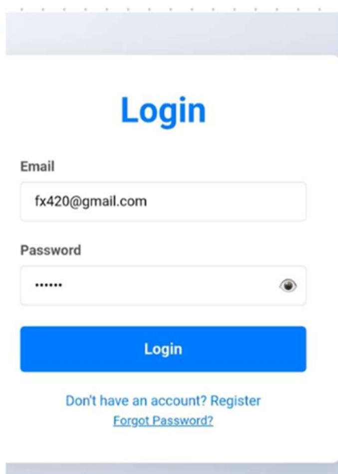

Figure: Login

Add Bus

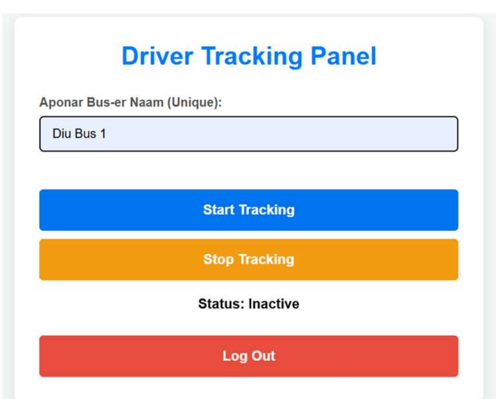

Figure : Add Bus

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Start Tracking

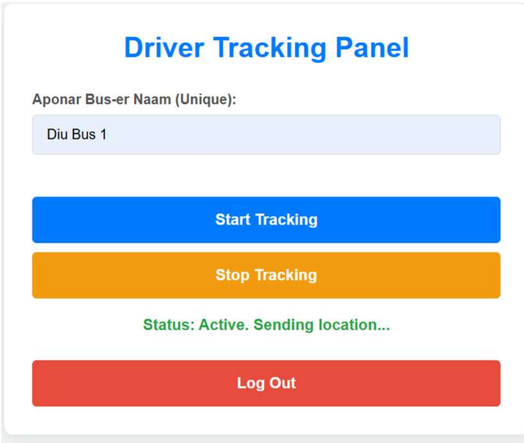

Figure: Start Tracking

5.2.1 Driver Registration & Login

- Step 1: Start the application and go to the page "Register".
- Step 2: Enter Full Name, Email and University ID and a secure Password.
- Step 3: Click "Register". On success, move to the "Login" page.
- Step 4: Add your credentials to access the Driver Dashboard.

5.2.2 Starting a Trip (Driver)

- Step 1: Make sure your GPS is on on the Dashboard.
- Step 2: Press the start tracking button.
- Step 3: There will be a browser popup that will request Location Permission. Click "Allow".
- Step 4: The status will be changed to Active: Sending Location... It means that now the students are able to see your bus on the map.
- Step 5: To terminate the trip, Gear Tracking.

5.2.3 Tracking a Bus (Student)

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- Step 1: launch the URL of the web application. Students do not need to log-in.
- Step 2: A home page will be opened with a map with the focus on DIU Campus.
- Step 3: The appearance of the active buses will be in the form of Bus Icons.
- Step 4: Click on the bus icon to view the information such as Bus Name and Last Updated.

5.3 Summary

The application is user friendly. One can begin broadcasting with just a button press by the drivers. Click and a live map is visible immediately without any elaborate installation by the students. This guarantees the college population a high adoption rate.

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Chapter 6 Project Summary

6.1 Introduction

The "DIU Bus Live Location Finding Web Application" was developed to address the critical issue of uncertainty in university transportation. By leveraging modern web technologies like the MERN stack and Socket.IO, we successfully created a real-time tracking solution that bridges the gap between drivers and students.

6.2 Project Limitation

Although it has been successful, the existing system has some weaknesses:

- **Internet Dependency:** The system depends on the constant internet connection. If a when driver goes into a "No Network Zone" the tracking will stop until connection is. restored.
- **GPS Accuracy:** The positioning is dependent on the smartphone of the driver. hardware. During bad weather or dense locations, the GPS positioning can vary by 10-15 meters.
- **Battery Consumption:** The GPS and screen will be active most of the time by the driver app. can empty the smartphone battery quicker than usual.

6.3 Scope

The scope of the project is currently as follows:

- Live positioning of all university buses in the Ashulia campus route.
- An Internet-based interface which can be used through any browser (Chrome, Firefox, Safari).
- Unless the drivers are authenticated, they have no access.

6.4 Future Work

In order to improve the system, it is planned to update the system in the future with the following features:

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- **Native Mobile App:** A specific Android/iOS application can be created on top of React Native with additional consideration to achieve background performance and battery optimization.
- **ETA Prediction:** AI-based algorithm to make the prediction of the "Estimated Time of Arrival" depending on the nature of the traffic.
- **Crowd Estimation:** Introducing a counter that is an IoT to demonstrate how. there are a good number of seats in the bus before it is coming.

6.5 Conclusion

This project has been able to show how real-time geolocation technology can be used in addressing everyday transportation issues. The DIU Bus Tracker, by giving real-time bus information to students, will lead to substantial shortening of waiting times and the commuting experience, in general. The system is easy to scale, economical and able to be implemented in a campus wide manner which is a step in the direction of a smarter university campus.

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[2] Socket.IO, "Introduction to Socket.IO," *Socket.io Documentation*, 2024. [Online]. Available: https://socket.io/docs/v4/. [Accessed: Nov. 6, 2025].

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APPENDICES

Appendix A: Sample Code

Backend (Server Logic):

```
// Receiving location from driver

socket.on('updateLocation', (data) => {

    // Store location in memory

    busLocations[data.busId] = data;

    // Broadcasting to all connected students

    io.emit('locationUpdate', data);

});
```

A.1 Backend Logic (Server-Side) This code snippet shows how the server receives location data from the driver via Socket.IO and immediately broadcasts it to all connected students.

```
// Initialize Socket.IO with CORS policy

const io = new Server(server, {

    cors: {

        origin: '*',

        methods: ['GET', 'POST']

    }
```


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```
});

// Handling Real-time Connections

io.on('connection', (socket) => {

    console.log('A user connected:', socket.id);



    // Event: Receive location update from Driver

    socket.on('updateLocation', (data) => {

        // Store the latest location in memory

        busLocations[data.busId] = data;

       // Broadcast the location to all connected Students

        io.emit('locationUpdate', data);

    });



    // Event: User Disconnect

    socket.on('disconnect', () => {

        console.log('User disconnected:', socket.id);

    });
```


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```
});
```

Frontend (Map Logic):

```
// Updating Marker on Map

socket.on('locationUpdate', (data) => {

    if (markers[data.busId]) {

        markers[data.busId].setLatLng([data.lat, data.lng]);

    } else {

        markers[data.busId] = L.marker([data.lat,
data.lng]).addTo(map);

    }

});
```

A.2 Driver-Side Logic (Geolocation) This function captures the driver's live GPS coordinates using the browser's Geolocation API and sends them to the server.

```
// Watch for location changes
navigator.geolocation.watchPosition(
    (position) => {
        const { latitude, longitude } = position.coords;
     // Update Status on Driver Panel
        statusDiv.innerText = `Status: Active. Sending location...`;

        // Send data to Server
        sendLocationToServer(busId, latitude, longitude);
```


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```
    },
    (error) => {
        console.error('Geolocation Error:', error);
        statusDiv.innerText = `Error: ${error.message}`;
    },
    {
        enableHighAccuracy: true, // Request precise GPS data
        timeout: 10000,
        maximumAge: 0
    }
);
```

A.3 Client-Side Logic (Map Rendering) This code runs on the student's browser. It listens for updates from the server and moves the bus icon on the map accordingly.

```
// Initialize Leaflet Map centered on DIU Ashulia Campus
const map = L.map('map').setView([23.8760, 90.3160], 15);

// Connect to Socket.IO Server
const socket = io();

// Listen for 'locationUpdate' event from Server
socket.on('locationUpdate', (data) => {
    const { busId, lat, lng, timestamp } = data;
    const newPosition = [lat, lng];

    // Check if the marker for this bus already exists
    if (busMarkers[busId]) {
        // Update existing marker position
        busMarkers[busId].setLatLng(newPosition);
        busMarkers[busId].setPopupContent(`<b>${busId}</b><br>Updated:
${new Date(timestamp).toLocaleTimeString()}`);
    } else {
        // Create a new marker if it doesn't exist
        busMarkers[busId] = L.marker(newPosition, { icon: busIcon })
            .addTo(map)
            .bindPopup(`<b>${busId}</b><br>Active Now`);
    }
});
```


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APPENDIX B: SURVEY QUESTIONNAIRE

B.1 Introduction The user requirements and technical constraints are very difficult to identify without the help of a. The survey was carried out as a structured one inside the campus of the Daffodil International University (DIU). The two major stakeholder groups that were targeted include the Students (the end-users) and the Bus Drivers (the). operators). In this process of data collection, 50 students and 5 drivers took part and this facilitated in justifying the appropriateness of the "DIU Bus Live Location Finding Web Application."

B.2 Student Survey Form

Participant Details:

- **Name (Optional): ___________________**
- **Department: ______________________**
- **Year/Semester: ___________________**

Questions:

1. **How do you currently travel to the university?**
    - University Bus
    - Public Transport
    - Personal Vehicle
    - Walk
2. **How often do you use the university bus service?**
    - Daily
    - Occasionally
    - Rarely
3. **What is the biggest challenge you face with the current bus system?**
    - Uncertain arrival times
    - Missing the bus
    - Overcrowding
    - Lack of schedule information
4. **Have you ever missed a bus because you didn't know its location?**
    - Yes
    - No
5. **Would a "Live Bus Tracking" mobile web app be helpful for you?**
    - Extremely Helpful
    - Somewhat Helpful
    - Not Needed

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6. **Do you have an active internet connection on your phone while commuting?**
    - Yes, always
    - Sometimes
    - No

B.3 Driver Feasibility Survey

Participant Details:

- **Bus Route: ________________________**
- **Years of Experience: ________________**

Questions:

1. **Do you use a smartphone (Android/iOS)?**
    - Yes
    - No
2. **Do you keep mobile data (Internet) enabled during trips?**
    - Yes
    - No
3. **Would you be willing to press a "Start Tracking" button on an app before starting your trip?**
    - Yes, if it is simple
    - No, it is distracting
4. **Does your phone battery last for the entire trip?**
    - Yes
    - No

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