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Bus Traversal System (Fare Calculation using GPS)

Prof. Arpita Agarwal
Department of Computer Engineering
Pillai College of Engineering, New Panvel
Navi Mumbai, India

Chirag Redij
Department of Computer Engineering
Pillai College of Engineering, New Panvel
Navi Mumbai, India

Khushi Sharma
Department of Computer Engineering
Pillai College of Engineering, New Panvel
Navi Mumbai, India

Anugraha Bijumon
Department of Computer Engineering
Pillai College of Engineering, New Panvel
Navi Mumbai, India

Tejas Patil
Department of Computer Engineering
Pillai College of Engineering, New Panvel
Navi Mumbai

***Abstract*— The Bus Traversal and Booking System is a cloud-based platform that is designed to cater to daily commuters who travel by local buses. The objective of this system is to provide users with a comprehensive set of features that are accessible through a single interface, aimed at making their commute hassle-free. The system utilizes Bluetooth Low Energy scanning to record the user's trip, with the fare dynamically calculated and deducted from their e-wallet. Additionally, the platform offers an interactive interface that allows users to access bus schedules, view route options for specific destinations, and get information about bus stops in their vicinity. A review feature is also available, enabling users to provide feedback, which can be used to make future modifications to the system. This system promotes e-ticket travel and helps reduce the misuse of the system by free riders. In future, the system can be used for any public transportation and eventually make the walk-in experience more efficient.**

Keywords*— *GeoLocation Tracking, Bluetooth Low Energy, Background Services, E-Wallet

I. INTRODUCTION

This project aims to revolutionize the way individuals navigate and pay for public transportation by introducing a mobile application powered by Bluetooth Low Energy (BLE) and GPS tracking technology. By seamlessly tracking users' journeys on buses, this app provides an effortless solution for calculating fares based on distance traveled. Leveraging advanced features such as real-time location tracking and fare calculation algorithms, our application offers users a convenient and transparent way to manage their transportation expenses. Not only does this streamline the payment process, but it also enhances the overall commuting experience by eliminating the hassle of traditional ticketing systems. Through this initiative, we envision a future where urban mobility is more accessible, efficient, and user-friendly, ultimately enhancing the quality of life for commuters worldwide.

A. Fundamentals

The fundamental idea behind the Bus Traversal and Booking System is to create a cloud-based platform that simplifies the daily commute for local bus users by providing a comprehensive set of features accessible through a single interface. By integrating BLE and e-wallets, the system aims to make the trip recording and payment process more efficient and convenient for users. The platform also offers an interactive interface that provides users with information about bus schedules, routes, and stops, as well as a review feature that allows them to provide feedback. The long-term vision for the system is to expand it to other forms of public transportation, with the goal of making the walk-in experience more efficient and promoting the use of public transportation.

B. Objectives

The current bus traversal and management system suffers from various challenges such as inefficient resource allocation, lack of real-time monitoring, and manual handling of operations, resulting in delays and inconvenience to passengers. These challenges can be addressed by implementing a cloud computing-based bus traversal and management system that leverages advanced technologies to provide a seamless and efficient travel experience.

The objectives of the Bus Traversal and Booking System are as follows:

1. Simplify the daily commute for local bus users by providing a comprehensive set of features accessible through a single interface.
2. Integrate BLE and e-wallets to make the trip recording and payment process more efficient and convenient for users.
3. Offer an interactive interface that provides users with information about bus schedules, routes, and stops.
4. Promote e-ticket travel and help reduce the misuse of the system by free riders.
5. Expand the system to other forms of public transportation, with the goal of making the walk-in experience more efficient and promoting the use of public transportation.
6. Improve transportation sustainability by encouraging more people to use public transportation, which can have a positive impact on traffic congestion and air pollution.

C. Scope

A report on Bus traversal and fare calculation using GPS may cover the following aspects:

- It will provide an overview of the current state of local bus transportation and the challenges faced by daily commuters and the context for the development of the Bus Traversal and Booking System.
- It will specify the objectives of the Bus Traversal and Booking System, outlining how it aims to simplify the daily commute for local bus users, promote e-ticket travel, and improve transportation sustainability.
- It contains the design of the Bus Traversal and Booking System, outlining the technical specifications, features, and functionalities of the platform.
- Analysis of Potential limitations and challenges associated with the bus traversal system
- Discussion of potential Impact and benefits of this system in society.
- Overall, the report on the Bus Traversal and Booking System would provide a comprehensive assessment of the development, implementation, and impact of this innovative platform, with a focus on its potential to improve the daily commute experience for local bus users and promote the use of public transportation.

D. Outline

The report is organized as follows: The introduction is given in Chapter 1. It describes the fundamentals of a Bus Booking System. A Bus Traversal System that calculates fares using GPS has transformed public transportation by providing real-time tracking of buses, accurate fare calculation, and valuable data for transit authorities. This system ensures convenience and efficiency for passengers while optimizing services and routes for transit operators. This chapter also presents the outline of the objective of the report. Chapter 2 describes the review of the relevant various techniques in the literature systems. It describes the pros and cons of each technique. Chapter 3 presents the Theory and proposed work. It describes the major approaches used in this work. The societal and technical applications are mentioned in Chapter 4. The summary of the report is presented in Chapter 5.

II. LITERATURE SURVEY

Using cloud computing in the Bus Traversal and Booking System can offer a number of advantages, including scalability, reliability, and cost-efficiency. By utilizing cloud computing, the system can easily handle large amounts of data and user traffic, making it scalable to accommodate the needs of a growing user base. Additionally, cloud computing provides greater reliability and uptime compared to on-premise hosting solutions, reducing the risk of system downtime or service disruptions. In this literature review, we aim to examine existing research on local bus transportation, e-ticketing systems, QR code scanning and e-wallet systems, interactive interfaces and information systems, and similar platforms to identify best practices and potential challenges. The review would help to inform the development and implementation of the Bus Traversal and Booking System, ensuring that it is built on best practices and is responsive to the needs of local bus commuters.

A. Literature Review

1. J. C. Gallage, K. B. U. Madushanka, K. K. T. L. Karunathilaka, M. I. Afkar, W. G. C. W. Kumara, “Implementation of an Android App for real-time bus tracking and information system” 2021, FAS, SEUSL [1] Live location as well ETA of the bus can be retrieved with the help of the GPS module on the bus & the GPS enabled mobile device of the user. There is no support for dynamic ticketing as users still have to book a ticket before boarding the bus.

2. Prof. Suchitra M, Apoorva K.B., Harshitha M, “RFID and GPS based Effective transport system”, IJERT-2018. [2] The system uses RFID cards as a means of authorization and payment and tracks the commercial vehicle using a separate GPS module. Provides a dynamic fare system based on Kilometers traveled. The UI for the system is cryptic and not very user-friendly. There is no way for potential commuters to know the bus's live location as it is not connected to the internet.

3. Swetha Sridharan, R. Venkatesh Prasad, Srinarayan.S, “Designing a smart transport system application for South Indian traffic scenarios - A modern approach towards digitalizing the transport systems”, ICCES 2017. [3] The proposed system works by installing a smart device on the commercial vehicle which will provide the functionalities of tracking and payment. The proposed system works by installing a smart device on the commercial vehicle which will provide the functionalities of tracking and payment.

4. Suresh Sankarananrayanan, Paul Hamilton “Mobile Enabled Bus Tracking and Ticketing System” 2014 ICoICT. [4] The live location of the bus is tracked using a GPS-enabled device which can be then looked up on the mobile device of the commuter. The user's e-ticket is verified before boarding. Does not deal with providing Expected Arrival Time, and shows little to no detail about other real-world situations happening on the map. The cost of adding this infrastructure will be massive to implement in urban areas.

III. PROPOSED SYSTEM

OVERVIEW

The system is a cloud-based platform that is designed to cater to daily commuters who travel by local buses. The system utilizes BLE to record the user's trip, with the fare dynamically calculated and deducted from their e-wallet. Additionally, the platform offers an interactive interface that allows users to access bus schedules, view route options for specific destinations, and get information about bus stops in their vicinity. A review feature is also available, enabling users to provide feedback, which can be used to make future modifications to the system.

1) Existing System Architecture: The existing system follows traditional techniques for traveling. Here the user specifies the route and destination which is followed by a list of buses in the vicinity that runs from the specified source to the destination. The cost is then generated using the two end nodes and then the user is advanced to the payment section. After completing all these procedures the user receives their ticket.

The current system may not be able to handle the growing demand for public transportation in many areas. This can result in overcrowded buses, longer wait times, and reduced service quality. This is especially true during peak hours or in densely populated areas where there is a high demand for public transportation. The capacity limitations can also result in lower revenue for transit agencies as they may not be able to charge passengers for each ride. The existing system of bus management may not be able to efficiently schedule bus routes, resulting in wasted resources and increased costs. Inefficient scheduling can also lead to delays, missed connections, and reduced service quality. Moreover, some routes may not be well connected, resulting in longer travel times for passengers. Some users can also misuse the facilities for free rides.

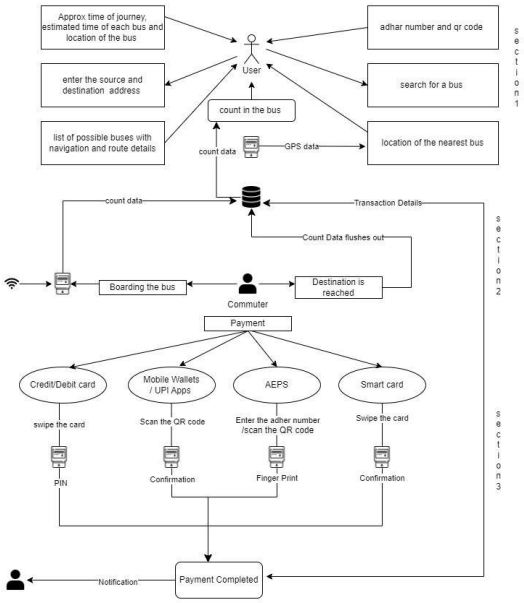


Fig 1. Flowchart of Existing System Architecture

2) Proposed System Architecture: The previous sections discussed the strengths and weaknesses of the existing system. To Overcome these issues the proposed system is designed in such a way that, the user when near the bus will get an alert, which indicates that the bus is nearby and swiping yes to onboarding starts the journey. The dynamic fare will be calculated by using GPS, we will keep track of the location of the user, and the fare will depend on the kilometres he has travelled instead of the two-node method in the existing system. While getting off at the destination, the user will again get an alert which when swiped yes will indicate that you have deboarded the bus and ended the journey and the fare will be automatically deducted from his e-wallet. Additionally, the platform offers an interactive interface that allows users to access bus schedules, view route options for specific destinations, and get information about bus stops in their vicinity. The proposed system architecture consists of three important modules: User interaction, User onboarding/deboarding and GPS live location.

- User Interaction: The user can register and log into the application. Users can view the nearer bus stops and have their own wallets for payment.
- User onboarding/deboarding: At the time of onboarding valid permissions will be checked and users will be allowed to onboard the bus. At the time of deboarding fare calculation and deducting money from the wallet, these actions will be carried out.
- GPS live location: GPS live location will be tracked during the time of onboarding and deboarding the bus.

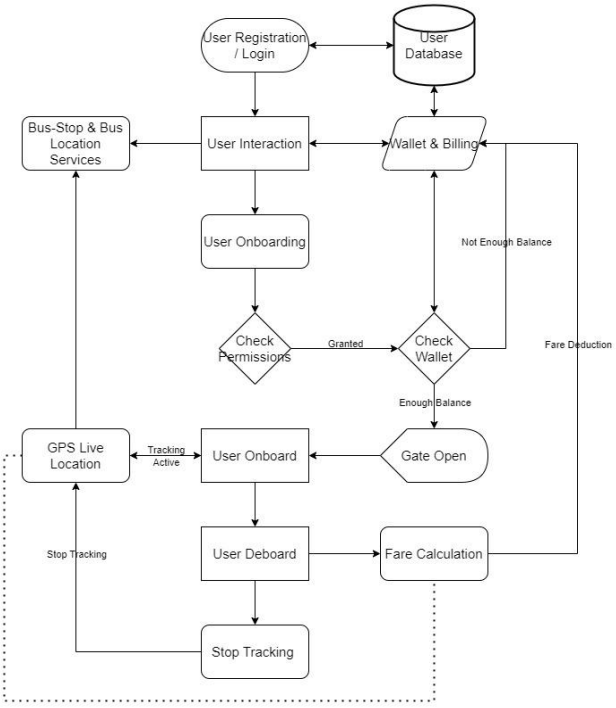


Fig 2. Flowchart of Proposed System Architecture

B. Implementation Details

The user has a mobile application installed on his mobile phone. The mobile application is an interface with the central server of the system. The user will log in (or register) to access the system's services. The application uses mobile service permissions such as the Internet, GPS_Fine_Location, and other necessary services for authorization. The user can search for nearby bus stops and he has a wallet in a mobile application through which he can make transactions.

At the time of onboarding the user will get a broadcasted message on their phone, this message will consist of a slider for onboarding and deboarding the bus, after this the conditions of being a valid user and the minimum wallet balance will be checked. Once the conditions are checked the user can board the bus. At the location at which the user onboards the bus the live GPS location tracking starts and the distance travelled is monitored till the user deboards the bus. When the BLE signals become stronger again a deboard slider pops up and the GPS location tracking can stop and the fare is calculated according to the distance traveled.

The Fare is deducted from the user's wallet and the user ends his journey.

1) Methodology and Algorithms:

Traditionally, the conventional approach to acquiring real-time bus location data involved the installation of specialized smart devices within each vehicle. However, over time, it became apparent that maintaining and managing these devices was both cumbersome and costly.

The chosen alternative method involves leveraging the information generated by users who are logged into the application. These users are actively sharing their live location data while using the app. By collecting and aggregating this user-generated data, we are able to create a comprehensive dataset that reflects the collective real-time positions of the buses. To obtain an accurate and reliable estimate of the bus's live location, a mean or average calculation is performed on this dataset.

This approach not only eliminates the need for additional hardware installations and the associated maintenance costs but also harnesses the power of community-generated data. It provides a practical, cost-effective, and hassle-free solution for tracking bus locations while ensuring that the system remains dynamic and responsive to the movements of the bus fleet.

Bluetooth Low Energy (BLE) technology is widely employed for broadcasting messages in various practical applications. BLE's broadcasting capability allows devices to efficiently transmit data to multiple recipients without requiring a direct connection, making it an excellent choice for scenarios where information dissemination is critical. One common application of BLE broadcasting is in the use of beacons, small devices that continually broadcast specific data, such as their identity or sensor readings. Mobile devices and other BLE-enabled hardware in proximity can receive these beacon broadcasts, enabling functionalities like proximity marketing, indoor navigation, and asset tracking. Additionally, BLE is instrumental in broadcasting sensor data, making it a valuable tool in scenarios involving environmental monitoring and tracking sensor-equipped assets. Furthermore, BLE's capability to broadcast device information for discovery purposes simplifies peer-to-peer device interactions, making it ideal for situations where devices need to identify and communicate with one another seamlessly. BLE's efficient use of power makes it an attractive choice for broadcasting applications, ensuring that messages can be delivered reliably while conserving energy resources.

Within our project, Bluetooth Low Energy (BLE) serves a multifaceted role, enhancing the user experience and operational efficiency. Firstly, BLE enables us to proactively communicate with passengers by broadcasting messages when a bus is in close proximity. These messages serve as timely notifications, alerting logged-in users about the impending arrival of the bus.

This feature enhances user convenience and ensures a smoother boarding process, reducing the likelihood of missed buses and improving the overall travel experience.
Additionally, BLE is integral to the user onboarding and deboarding process. When a user boards a bus, their mobile device interacts with the onboard BLE beacon, signaling their entry. Similarly, when a user disembarks, the BLE beacon at the bus stop records their exit. These interactions are crucial for monitoring the duration of the user's journey and calculating the fare accurately. By precisely tracking when and where users board and deboard, the system can determine the distance traveled, enabling a fair and transparent fare calculation.

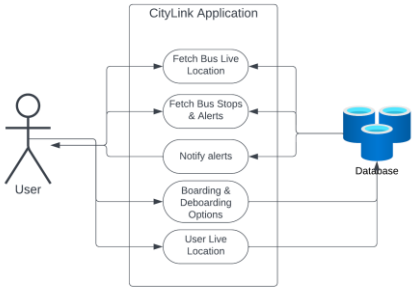


Fig 3. Use Case diagram

The use case diagram illustrates the comprehensive functionalities of a mobile application designed for bus services. Users engage in several key interactions facilitated by the application. Firstly, User Onboarding involves users logging in with their credentials or registering as new users. Prior to boarding a bus, a popup message will be sent to the user as it gets near the bus for validation, with the system also verifying their minimum wallet balance.

Users can conveniently Search Nearby Bus Stops through the application, assisting them in planning their routes and finding the nearest stops.GPS Tracking is initiated upon boarding, enabling live GPS location tracking throughout the journey to monitor the distance travelled. The application then Calculates Fare based on this distance and deducts the fare from the user's wallet, ensuring a seamless payment process. The Alerts issued by a specified user will be notified to other users and a listed view of all alerts will also be displayed in the application

Finally, to conclude their journey, users must engage in User Ends Journey through the message

2) Hardware and Software Specifications

The said project's application needs a Mobile Device which works on the Android Operating System.

Table I. Hardware details

Processor	2.2 GHz & above
HDD	4 GB & above
RAM	2 GB & above

Table II. Software Details

Operating System	Android 10 & above
Permissions	Bluetooth, Internet, GPS, System Services
App Size	12 Mb

IV. APPLICATIONS

1. Providing a platform for daily commuters.

The Bus Traversal and Booking System offers several advantages as a commuting platform for daily bus commuters. The system provides a single interface for accessing bus schedules, route options, and information about bus stops, saving time and reducing the hassle of finding information from different sources. The e-wallet feature allows for contactless payments, eliminating the need for cash transactions. The dynamically calculated fares and BLE technology simplify the fare calculation process, making it easier for users to pay for their trips. The GPS tracking technology allows for real-time tracking of bus locations, reducing wait times and allowing users to plan their trips more efficiently.

2. Preventing Free Rides

The Bus Traversal and Booking System provides several advantages in preventing free rides and ensuring fair fare collection. The e-wallet and BLE technologies eliminate the need for cash transactions and provide a secure payment method for passengers. Real-time tracking allows transportation authorities to detect and prevent fare evasion by monitoring the location of buses and identifying patterns of suspicious activity. These advantages can help transportation authorities reduce revenue losses and ensure that passengers pay their fair share for their transportation services

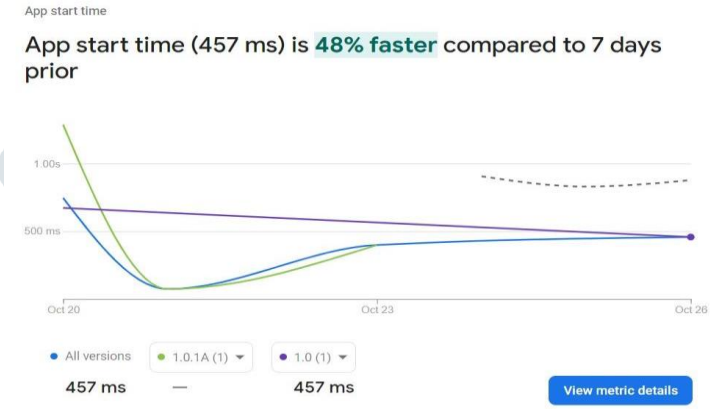
3. Use of Public Transportation

By Providing an Efficient Bus Traversal System maximizes the use of Public transportation. By promoting the use of public transportation, the Bus Traversal and Booking System can help reduce traffic congestion, improve air quality, and reduce carbon emissions, contributing to a more sustainable and efficient transportation system.

4. Future Scope

- This kind of technology can be used in different sectors to provide a "Walk-In Walk-Out" Experience.
- The data collected from users could be used to analyze locomotion patterns and improve bus services and efficiency.

A. Performance Evaluation



The Average StartUp time is 457 ms & lowest StartUp time is 78 ms

V. CONCLUSION

In this report, the study of different concepts is presented. The different concepts such as BLE, GPS technology, and E-wallet features. The objective of this system is to provide users with a comprehensive set of features that are accessible through a single interface, aimed at making their commute hassle-free. The report covers the objectives, scope, literature survey, and the existing system architecture of the Bus Traversal and Booking System. Additionally, the report outlines the benefits of using cloud computing in this system Overall, the report showcased how the Bus Traversal and Booking System provides a seamless and efficient experience for users, while also allowing transportation authorities to manage and optimize the system effectively.

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