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Review on UrbanSync – Real Time Public Transport Tracking System

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Abstract- Public transport is essential for mobility, especially in small and developing cities with limited private transport options. However, issues like unpredictable bus arrivals, long wait times, poor route information, and lack of real-time updates undermine its reliability and efficiency. This project proposes a Real-Time Public Transport Tracking System using GPS, mobile apps, and cloud-based data management. The system tracks the live location of public vehicles and provides updates via a passenger mobile app and display boards at bus stops. Commuters can view estimated arrival times (ETA), select optimal routes, and receive alerts on delays or route changes. Transport authorities benefit from backend monitoring, enabling real-time tracking, data-driven scheduling, and improved resource allocation. The system aims to reduce wait times, enhance commuter convenience, and increase public transport adoption. In the long term, it supports traffic decongestion and promotes sustainable urban mobility.

Keywords — Real-Time Tracking; GPS; Mobile Application; Cloud-Based System; Estimated Time of Arrival (ETA); Passenger Information System; Route Optimization; Smart Mobility; Transport Authority Monitoring; Data-Driven Scheduling; Resource Allocation; Urban Mobility; Traffic Decongestion; Sustainable Transportation.

I. INTRODUCTION

Public transport plays a vital role in connecting people, especially in growing cities where private vehicle ownership is limited. However, challenges such as uncertain bus timings, lack of proper route information, and long waiting periods often discourage people from using it. To address these issues, this project introduces a Real-Time Public Transport Tracking System. By using GPS, mobile applications, and cloud- based technology, the system provides live bus locations, estimated arrival times, and timely alerts. This not only improves convenience for passengers but also helps transport authorities manage fleets more effectively, leading to better service reliability and increased public trust in the system.

II. SYSTEM DESIGN

Application Architecture :
The UrbanSync mobile app is built on a layered architecture with four main components. The presentation layer provides an easy-to-use interface showing live bus locations, ETAs, routes, and alerts. The business logic layer manages route data, tracking, notifications, and user preferences. The data layer connects to backend servers through REST APIs for static information and WebSocket/MQTT for real-time updates, while also storing cached data locally for offline use.

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Finally, the integration layer links external services like Google Maps for route visualization, Firebase for push notifications, and analytics tools. This modular design ensures real-time performance, offline support, and scalability for future features such as digital ticketing.

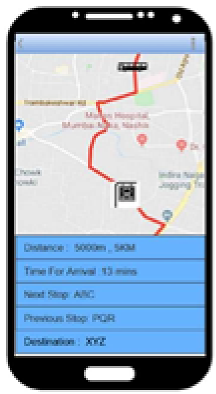

Fig 1. vehicle tracking Application Frame

Sensors

GPS Sensor/Module : Captures the real-time location (latitude, longitude, speed, direction) of the bus.
GSM/4G/5G Communication Module : Sends GPS data to the cloud backend through mobile internet.

III SOFTWARE ARCHITECTURE

The software architecture of UrbanSync – Real-Time Public Transport Tracking System follows a three-tier client–server model, ensuring scalability, security, and efficient data handling. The system consists of the Mobile Application, Backend Services, and Database & Cloud Infrastructure.
Mobile Application (Client Layer): Provides the user interface for passengers, enabling live bus tracking, ETA display, route search, and notifications. It communicates with the backend using REST APIs for static data and WebSocket/MQTT for real- time updates.
Backend Services (Application Layer): Acts as the core processing unit, receiving GPS data from vehicles, mapping positions to routes, calculating ETAs, and managing notifications. It also provides APIs for the mobile app, bus-stop displays, and the admin dashboard.
Database & Cloud Infrastructure (Data Layer): Stores route information, stop details, user profiles, and historical vehicle movement. A combination of relational databases (for routes, users) and time-series databases (for GPS logs) ensures efficient storage and retrieval. Cloud deployment supports scalability and reliability.

Vehicle Tracking Algorithm :

The vehicle tracking algorithm uses a GPS sensor on the bus to get its live location. This data is sent to the server through the internet, where the system processes it, removes errors, and finds the correct route. The server then calculates the bus's distance from the next stop and gives an Estimated Time of Arrival (ETA). Finally, this information is shown on the passenger app, bus-stop display boards, and the admin dashboard in real time.

Control Algorithms :

The control algorithm starts by collecting location data from the GPS and checking if it is valid. The information is then sent to the server, where it is processed to find the bus's position and calculate the Estimated Time of Arrival (ETA). The server updates the passenger app, bus-stop displays, and admin dashboard with this information. If delays or route changes occur, alerts are sent to users. This cycle continues in real time until the journey is completed.

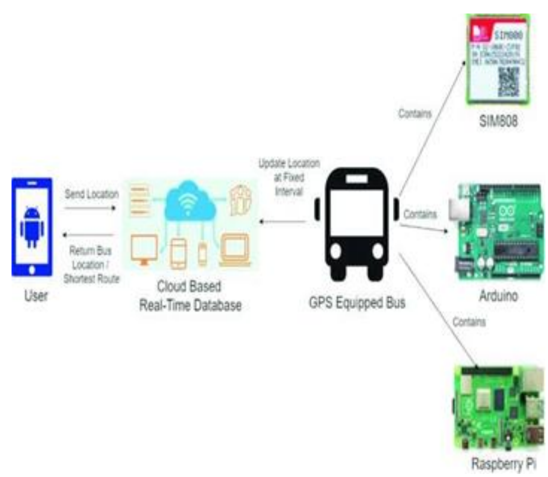

Fig 2. Project Architecture

IV. HARDWARE COMPONENTS

Arduino: Acts as the central controller, processing GPS data and managing communication with the server.

GPS Module (e.g., u-blox NEO-6M): Provides real-time vehicle location (latitude, longitude, speed).
GSM/4G LTE Module (e.g., SIM800L / SIM7600): Transmits GPS data to the cloud server through mobile networks.
Accelerometer & Gyroscope (IMU Sensor): Helps detect vehicle motion, sudden stops, and improves location accuracy when GPS signal is weak.
Battery Pack: Ensures stable power for GPS and communication modules with backup support.

V. PERFORMANCE EVALUATION

The performance of the UrbanSync – Real- Time Public Transport Tracking System is evaluated based on accuracy, speed, reliability, and user experience.

Location Accuracy:

- GPS modules provide an accuracy of 3–10 meters under open sky.
- System Latency: Passengers receive ETA and location updates within 3–8 seconds, ensuring near real-time tracking.

Scalability:

- The system can handle multiple vehicles and users simultaneously due to cloud- based deployment.

Reliability:

- Cached data ensures that passengers still see the last- known bus location during short outages.

User Experience:

- Passengers benefit from reduced waiting times and more predictable travel.

VI. LIMITATIONS

Although the UrbanSync system improves public transport efficiency, it has some limitations. GPS tracking may lose accuracy in tunnels, crowded city areas, or under poor weather conditions. The system is highly dependent on continuous internet connectivity, meaning weak network coverage can delay real-time updates. Hardware installation on every vehicle adds cost and requires regular power supply and maintenance. Additionally, handling and securing passenger as well as vehicle data raises privacy concerns. For large- scale deployment, higher infrastructure capacity and optimization would also be necessary.

VII. FUTURE WORK

The UrbanSync system can be further improved with advanced features. Integration of AI-based predictive models could provide more accurate ETAs by considering traffic, weather, and historical data. Smart ticketing through RFID, NFC, or mobile payments can be added to make commuting seamless. Use of IoT sensors and vehicle diagnostics will allow real-time monitoring of fuel usage, maintenance needs, and driving behavior. Incorporating solar- powered devices may reduce dependency on vehicle power. Future upgrades could also include multilingual support in the app, voice- enabled assistance for differently-abled passengers, and city-wide integration with metro or train services. These enhancements will make the system smarter, more reliable, and suitable for large-scale urban deployments.

VIII. PREVIOUS WORK

Early Systems (1990s): Search for terms like "bus tracking system," "public transport technology," and "fleet management." Look for articles discussing pilot programs in major cities.
GPS Era (2000s): Use keywords such as "GPS for buses," "real-time bus tracking," and "new transit technology." You might find articles about cities announcing their new tracking systems and the public's reaction.
Modern Systems (2010s - Present): Search for "public transit app," "real-time transit data," "smart city transportation," and "Moovit or Transit app launch." These articles often discuss the benefits of these

apps, their impact on ridership, and any challenges faced during implementation.


Real-time bus tracking kicks off at 5 stops in Trichy city

Implemented At ₹4 Lakh On Pilot Basis

KEEPING PASSENGERS INFORMED

Fig 3. Newspaper Copy

The Trichy district administration and TNSTC have launched a pilot project to track buses in real-time at five bus stops. The system cost ₹4 lakh and uses LED screens at bus stops to display bus arrival timings, helping passengers plan better and reduce waiting time. Currently, 42 buses have been fitted with GPS devices. The project is implemented at stops in Thiruvanaikoil, Killi Kallan checkpost, No 1 Tollgate, Kothari, and Sanapuram.

Trichy has around 360 bus stops (150 operated by TNSTC and 210 by private operators). Authorities will review the pilot's performance and expand it to more locations if successful. The system is expected to improve commuter convenience, reduce uncertainty, and encourage more people to use public transport.

IX. CONCLUSION

The UrbanSync – Real-Time Public Transport Tracking System provides an effective solution to common issues in public transport, such as uncertain bus arrivals, long waiting times, and lack of information. By integrating GPS, mobile applications, and cloud technology, the system delivers live bus tracking, accurate ETAs, and timely alerts to passengers, while also helping transport authorities manage fleets more efficiently. Although it has some limitations related to GPS accuracy, connectivity, and hardware costs, the system significantly improves commuter convenience and encourages greater use of public transport. In the long run, such solutions can contribute to reducing traffic congestion and promoting sustainable urban mobility.

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