Public Transport Tracking System

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Abstract: **This project presents a real-time public transport tracking system designed to enhance urban transportation efficiency and user experience. The system utilizes three NodeMCU microcontrollers, each integrated with a GPS module, to track the precise location of buses. These hardware components continuously collect geographical coordinates and transmit the data to a cloud-based platform via Wi-Fi connectivity. The cloud server processes and stores the location information, making it accessible to end-users through a web-based interface. Users can access the system via smartphones or computers to view the real-time positions of buses on an interactive map. The interface displays bus routes, current locations, estimated arrival times, and movement patterns. This implementation addresses common public transportation challenges such as unpredictable waiting times and lack of real-time information. The system provides reliable, up-to-date location data that helps passengers make informed decisions about their travel plans, potentially reducing waiting times and improving overall satisfaction with public transport services. The project demonstrates the practical application of IoT technology in solving real-world transportation problems. By leveraging cost-effective components like NodeMCU and standard GPS modules, the system offers a scalable and affordable solution for public transport tracking. The successful implementation validates the feasibility of using IoT devices for real-time location monitoring and sets the foundation for future enhancements including predictive analytics, crowd management, and integration with smart city infrastructure.**

Index Terms **–Node MCU. GPS Module, Thing Speak**

I. INTRODUCTION

Public transportation serves as the lifeline of urban mobility, connecting communities and facilitating economic activities. However, traditional transit systems often struggle with operational inefficiencies and passenger dissatisfaction due to inadequate real-time information. The emergence of Internet of Things (IoT) technology presents unprecedented opportunities to transform conventional public transport into smart, connected systems. This project addresses the critical need for real-time vehicle tracking by developing an innovative solution that leverages modern microcontroller technology and cloud computing. The core innovation of this system lies in its integration of cost-effective hardware components with robust cloud infrastructure. By deploying NodeMCU microcontrollers equipped with GPS modules on public transport vehicles, the system captures precise location data and transmits it seamlessly to cloud servers. This technological framework enables continuous monitoring of vehicle movements, providing both transportation authorities and passengers with unprecedented visibility into fleet operations. This implementation represents a significant advancement over conventional tracking methods, offering real-time updates, improved accuracy, and enhanced accessibility. The system's architecture demonstrates how simple IoT devices can be harnessed to solve complex urban mobility challenges. Furthermore, the project showcases the practical application of wireless communication protocols, data processing algorithms, and user interface design in creating comprehensive tracking solutions. The development of this real-time public transport tracking system not only addresses immediate operational needs but also contributes to the broader vision of smart city infrastructure. By providing reliable, up-to-the-minute information about vehicle locations, the system empowers commuters to make informed travel decisions while enabling transit authorities to optimize fleet management and service delivery.

II. LITERATURE REVIEW

Public transport tracking systems play a vital role in enhancing the efficiency and reliability of urban mobility networks. Recent studies have highlighted the integration of Global Positioning System (GPS) and Geographic Information System (GIS) technologies as the core framework for real-time vehicle monitoring and route optimization [1], [2]. These systems enable accurate location tracking, estimated time of arrival (ETA) prediction, and improved fleet management, leading to reduced waiting times and enhanced commuter satisfaction [3]. Mobile-based applications leveraging cloud computing and GPS data have further simplified access to real-time information for passengers and transport authorities [4].

Emerging research has also focused on the incorporation of Internet of Things (IoT) and machine learning techniques to improve system intelligence, enabling predictive analytics for delay detection, traffic congestion management, and route deviation alerts [5], [6]. Despite these advancements, challenges related to data accuracy, communication latency, and system scalability persist, particularly in developing regions [7]. Overall, the literature indicates that efficient transport tracking systems significantly contribute to sustainable urban development by promoting the use of public transit through reliability and transparency [8].

III. PROBLEM STATEMENT

In many urban and semi-urban areas, public transportation systems suffer from poor schedule adherence, lack of transparency, and inadequate real-time information for passengers. Commuters often face uncertainty regarding vehicle arrival times, unexpected delays, and inefficient route management. Existing manual or semi-automated tracking systems are limited by human error, outdated data, and poor coordination between drivers, operators, and users. This leads to reduced passenger satisfaction, decreased trust in public transport, and increased dependency on private vehicles—further worsening traffic congestion and air pollution. Hence, there is a strong need to develop a real-time public transport tracking system that provides accurate vehicle location data, enhances operational monitoring, and improves the overall commuter experience through accessible mobile or web-based platforms.

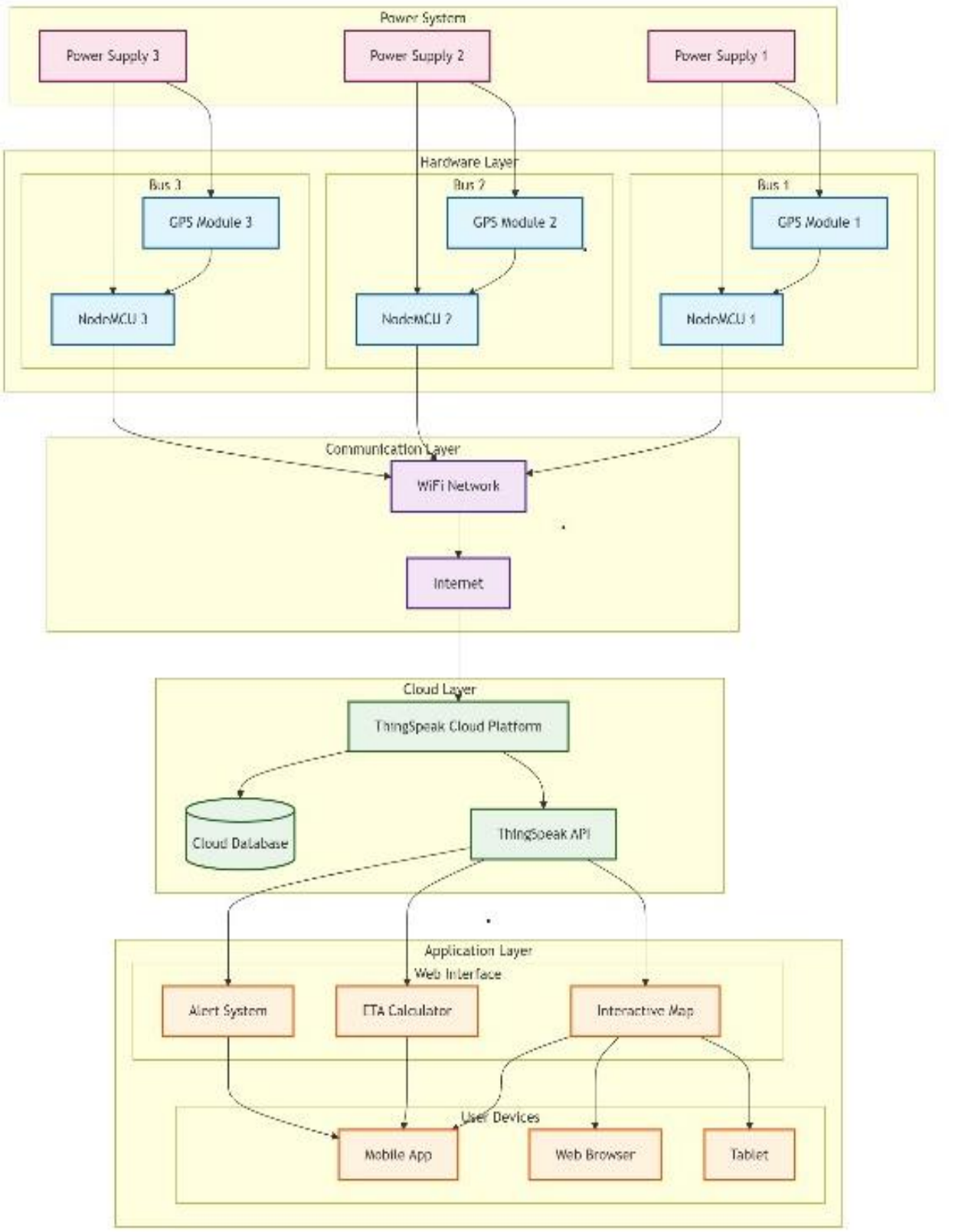
IV. OBJECTIVES OF THE PROJECT

1.To design and develop a real-time vehicle tracking system using GPS and IoT technologies.
2.To provide accurate and up-to-date information on vehicle location, estimated time of arrival (ETA), and route details to passengers
3.To create a user-friendly mobile or web interface for commuters to track public transport conveniently.

V.METHODOLOGY

The system follows an iterative development approach combining hardware integration, software development, and cloud implementation. The design methodology begins with requirement analysis, followed by system architecture design, component selection, and prototype development. The working mechanism involves a structured workflow where each NodeMCU microcontroller, equipped with a GPS module, is installed on individual buses. These devices continuously capture geographical coordinates (latitude and longitude) through GPS receivers. The NodeMCU processes this location data and transmits it to the cloud platform via Wi-Fi connectivity using HTTP/REST API protocols. The cloud server acts as the central repository, receiving, storing, and organizing location data from all three buses simultaneously. A web application interfaces with the cloud database to fetch real-time location updates at regular intervals. This front-end application processes the raw coordinate data and visualizes it on an interactive map interface using mapping libraries. Users can access this interface through web browsers on various devices to view current bus locations, track movement patterns, and receive estimated arrival times. The system implements error handling mechanisms for GPS signal loss or network disruptions, ensuring data integrity and system reliability throughout the operation.

VI.BLOCK DIAGRAM



The block diagram of the proposed Real-Time Public Transport Tracking System illustrates the end-to-end flow of data from vehicle-mounted sensing units to the end-user interface through cloud infrastructure. The system architecture is modular, scalable, and IoT-enabled, ensuring reliable real-time tracking of public transport vehicles.

Each public transport vehicle is equipped with a GPS-enabled IoT node, consisting of a NodeMCU ESP8266 microcontroller interfaced with a NEO-6M GPS module. The GPS module continuously receives satellite signals and computes real-time geographical coordinates, including latitude and longitude. These location parameters are transmitted to the NodeMCU through serial communication (UART interface).

The NodeMCU acts as the central processing and communication unit. It parses the raw GPS data using embedded libraries and formats the location information into structured data packets. Using its built-in Wi-Fi capability, the NodeMCU establishes an internet connection and uploads the processed data to the cloud server through HTTP-based API requests.

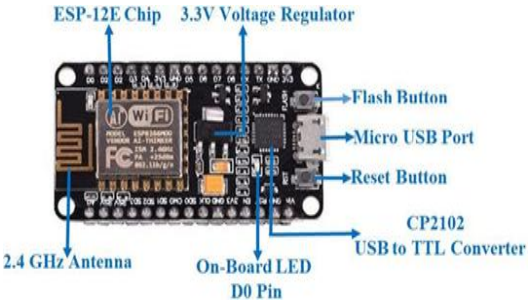
The cloud layer is implemented using the Thing Speak platform, which functions as a centralized data repository. It receives real-time location updates from multiple vehicles simultaneously, stores them securely, and enables time-stamped visualization of transport movement. The cloud platform also supports data analytics and historical tracking.

A web-based user interface retrieves live data from the cloud at regular intervals. The application maps the received coordinates onto a digital map, allowing users to monitor current bus positions, movement patterns, and estimated arrival times (ETA). This interface can be accessed using smartphones or computers, ensuring platform independence and ease of use.

Power to each IoT node is supplied through portable power banks, enabling uninterrupted operation during transit. Overall, the block diagram demonstrates a seamless integration of sensing, processing, communication, cloud storage, and visualization modules, forming a complete real-time public transport monitoring solution.

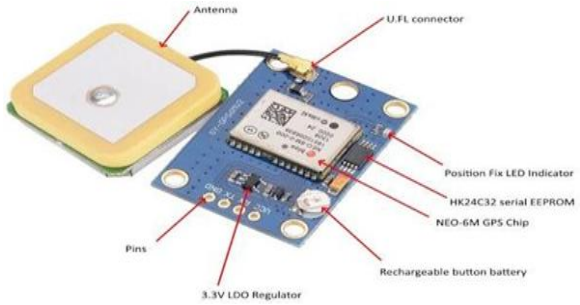
VII. COMPONENTS

1. NodeMCUESP8266(3units)-Microcontroller with Wi-Fi capability



Node MCU can be powered using a Micro USB jack and VIN pin (External Supply Pin). It supports UART, SPI, and I2C interface.

2. GPSModulesNEO-6M(3units)-For location tracking

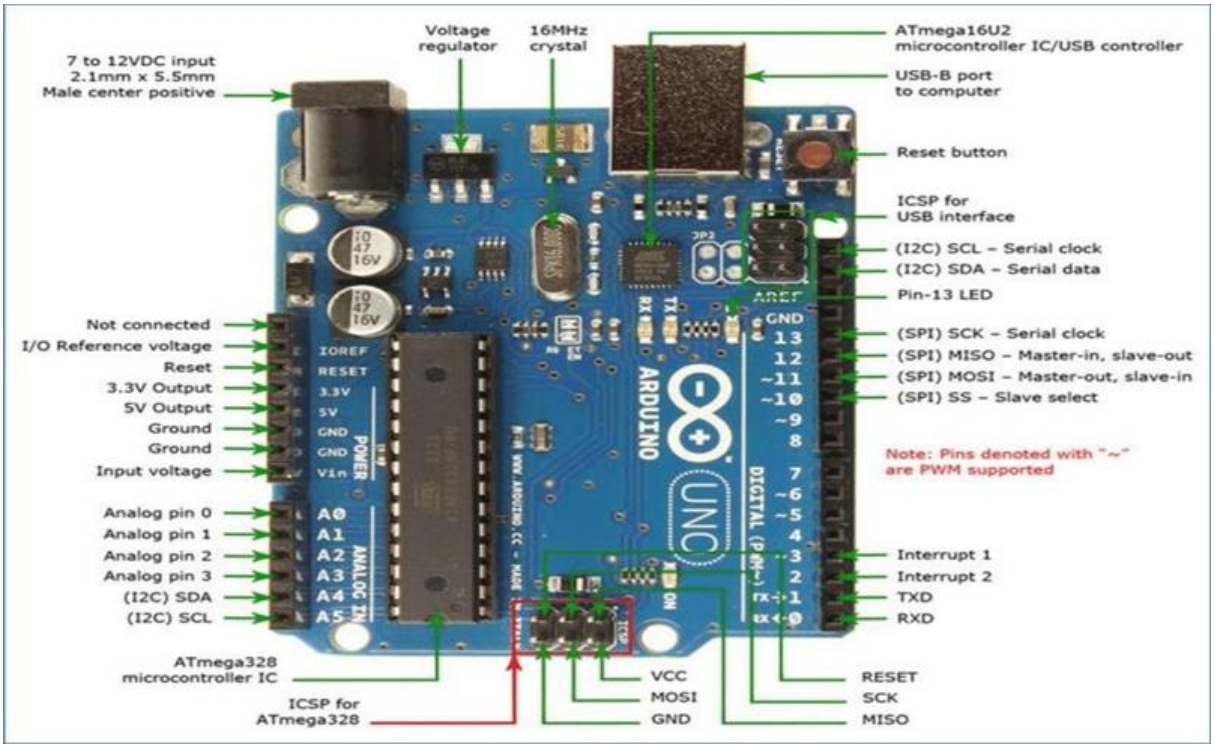


The Neo-6M GPS module operates by receiving signals from multiple satellites that are part of the Global Positioning System (GPS) network. These satellites continuously broadcast their positions and time data. The module captures these signals and calculates its distance from the satellites by analyzing the time it took for the signals to reach it. Using data from at least four satellites, theNeo-6M can determine its precise geographic coordinates (latitude and longitude), along with other information such as altitude, speed, and time.

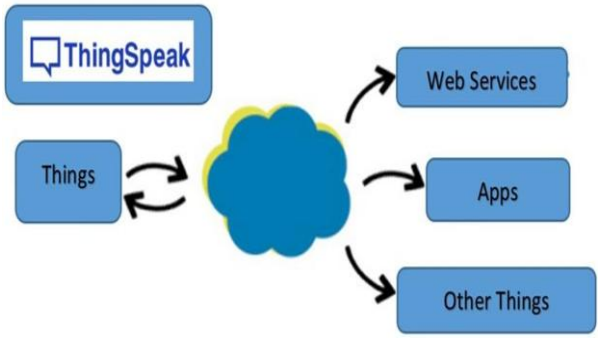
3. Power Banks (3units)-Mobile power supply

A power bank is a portable energy storage device used to charge electronic gadgets like mobile phones, tablets, smart watches, and other USB-powered devices when a regular power outlet is unavailable. It serves as a backup power source for users on the go.

4. Arduino IDE- For programming NodeMCU
Arduino devices are the new face of electronics engineering. The ability of Arduino to program electronic devices and integrate them into larger applications makes Arduino the most common choice of engineers in today's world. To work with Arduino, it is necessary to be aware of the construction of Arduino and the basic libraries that are used to work with Arduino.



5.ThingSpeakAPI-Cloudplatformfor datastorage

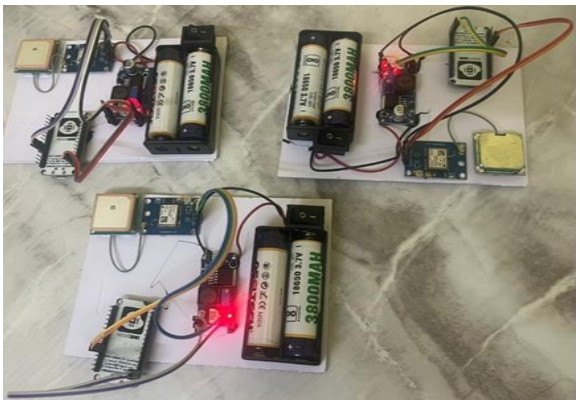


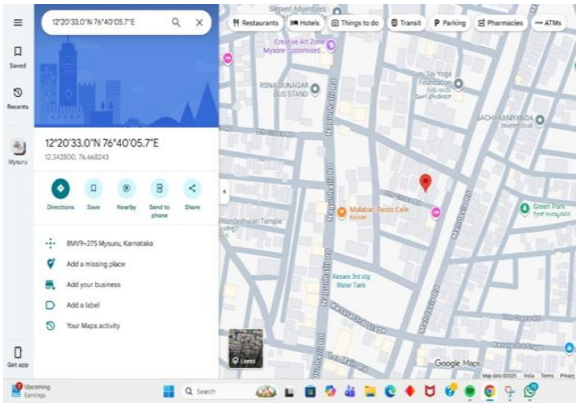
ThingSpeak is an IoT (Internet of Things) platform used to collect, store, analyze, and visualize sensor data from devices like Arduino, ESP8266, NodeMCU, Raspberry Pi, etc.

VIII. RESULT

The Real-Time Public Transport Tracking System represents a significant advancement in urban transportation management, leveraging IoT technology to bridge the information gap between public transport services and commuters. By implementing this system using NodeMCU microcontrollers and GPS modules, we have demonstrated a cost-effective, scalable solution that provides real-time bus location data to users through cloud-based platforms. This project successfully addresses the critical challenges of unpredictable waiting times and lack of real-time information that plague conventional public transportation systems. The integration of hardware components with cloud services and web interfaces creates a comprehensive

ecosystem that benefits both passengers and transit authorities. While the system has certain limitations related to network dependency and GPS accuracy, its advantages in improving passenger experience, optimizing fleet management, and promoting public transport usage far outweigh these challenges. The project establishes a strong foundation for future enhancements and integration with smart city infrastructure, potentially transforming how urban mobility is managed and experienced. As cities continue to grow and embrace digital transformation, such IoT-based solutions will play a crucial role in creating efficient, user-friendly, and sustainable public transportation networks.





IX. SCOPE OF THE PROJECT

The proposed system focuses on implementing a real-time public transport tracking and monitoring solution that integrates GPS modules with IoT-based data transmission. The system will collect vehicle location data and transmit it to a central server for processing and visualization on a mobile or web application. The scope includes both hardware components (such as GPS modules and microcontrollers) and software components (such as cloud databases and user interfaces). The system is designed primarily for bus transport networks, but the concept can be extended to other modes such as trains, taxis, or school transport services. Future enhancements may include predictive analytics using machine learning and integration with digital payment systems for a complete smart transport ecosystem.

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