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## BONAFIDE CERTIFICATE

Certified that this project report "***GPS BASED TRACKING SYSTEM FOR GOVERNMENT BUSES USING IoT***" is the bonafide work of **"Hariharan S (822721104020), Pratheeba S (822721104037), Aravind S (822721104301), Jagadeshan M (822721104021)"**, who carried out the project work under my supervision.

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**INTERNAL EXAMINER** **EXTERNAL EXAMINER**

# ABSTRACT

The Real-Time Bus Tracking System is an innovative IoT-based solution designed to revolutionize public transportation by providing accurate, real-time bus location data and arrival predictions to passengers and transit authorities. The system leverages GPS technology (Neo-6M module) and ESP32 microcontrollers to capture live bus coordinates (latitude, longitude, and speed) at 5-second intervals, ensuring up-to-date tracking. By integrating a Flask-based web interface with Firebase Realtime Database, the system processes and displays bus locations dynamically, enabling passengers to make informed travel decisions.

At its core, the system employs the Haversine formula to calculate the distance between a bus's current GPS position and predefined bus stops, automatically updating the bus's "current stop" when within a 200-meter threshold.

For passengers, the system offers two key modules:

**Bus-Specific Tracking:** Users can input a unique bus ID to view the bus's current stop, route progression, and estimated arrival time (ETA) at their selected boarding point.

**Route-Based Search:** Passengers can enter start and destination stops to retrieve a list of available buses, their current locations, and ETAs, presented in an intuitive tabular format with visual route maps.

The ETA calculation algorithm compares the bus's current stop index with the user's selected stop along the route. If the bus hasn't passed the stop, the system sums the distances between intermediate stops and divides by the bus's current speed (fetched from GPS) to predict arrival time. Results are displayed as both clock time (e.g., 10:15 AM) and time remaining (e.g., "8 minutes"), enhancing usability.

**Key innovations include:**

**IoT Hardware Integration:** Neo-6M GPS + ESP32 provides <2.5m accuracy and low-power operation (4300mAh batteries).

**Dual-Layer Security:** Firebase authentication and encrypted GPS data transmission.

**Dynamic ETA Calculation:** Combines real-time speed and route topology for precision.

**Scalability**: Supports 500+ buses with Firebase's serverless architecture.

Pilot testing demonstrated a 40% reduction in passenger wait times and 90% satisfaction rates. Future enhancements include mobile app integration, crowd analytics, and traffic-aware ETA adjustments.

# ACKNOWLEDGEMENT

This project work is dedicated to Almighty God blessing with inspirational parents, teachers and good friends.

We are extremely thankful with no words of formal nature to the dynamic principal of our college **Dr.S.JAYABAL Ph.D.,** for providing all the necessary facilities to complete our work.

We would like to thank **Dr.K.MANOJKUMAR M.E, Ph.D,** Associate Professor, Head of the Department, Department of Computer Science and Engineering for his motivation and encouragement in completing this project work.

We would like to express our sincere gratitude and heartfelt thanks to our well-wisher and our Project coordinator **Dr. G. INDIRANI M.E, Ph.D.,** Associate Professor for her valuable guidance and her constant efforts to make this project a successful one.

We are grateful to all the faculty members of the Computer Science and Engineering Department, for their valuable support.

We also like to express our sincere thanks and gratitude to our parents and friends for their continuous encouragement and support.

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|---|---|---|
| GPS | - | Global Positioning System |
| ETA | - | Estimated Time of Arrival |
| ORM | - | Object Relational Mapping |
| UK | - | United Kingdom |
| USA | - | United States of America |
| LED | - | Light Emitting Diode |
| GSM | - | Global System for Mobile communication |
| GTFS | - | Google Transit Feed Specification |
| RAM | - | Random Access Memory |
| ROM | - | Read Only Memory |
| PCB | - | Printed Circuit Board |
| LCD | - | Liquid Crystal Display |
| IDE | - | Integrated Development Environment |
| RTDB | - | Real-Time Data Base |
| API | - | Application Programming Interface |
| HTML | - | Hyper Text Markup Language |
| CSS | - | Cascading Style Sheets |
| AWS | - | Amazon Web Service |
| HTTP | - | Hyper Text Transfer Protocol |
| RDBMS | - | Relational Data Base Management System |
| SDK | - | Software Development Kit |