



# Developing a Cross-Platform Vehicle Tracking System using Node.js and WebSocket

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## Abstract

The scope of the project is to develop a real-time, cross-platform, scalable and reliable vehicle location tracking application. Location tracking of buses of an organization has been a persistent problem as the organization expands their operations. The transportation of employees using the bus fleet services of the organization serves to be a bottleneck due to ineffective tracking systems in place. We propose a cross platform application that tackles this problem. The application follows a client-server paradigm. The server is built using Node.js and GraphQL API. The client is built using React.js and Capacitor.js. The location updates are handled using WebSockets API. The passenger can track the location of bus in real time. The passenger receives SMS notifications of the location of bus. The admin can orchestrate the operations of the entire application. The driver client is used to track the location of buses. The project aims to minimize the tracking infrastructure and to adapt to modern technologies.

Key Terms: GPS – Global Positioning System, API – Application Programming Interface, SMS – Short Messaging Service

## 1. Introduction

The aim of our project is to develop a real-time, cross-platform vehicle tracking system using latest web technologies. The location of the vehicles of the organization can be tracked in real time

for admins and passengers. The passenger receives SMS before the bus arrives to the designated bus stop. The application provides sophisticated user interface with transparent functionalities.



## 2. Literature Survey

Obinna Ethelbert and others [1] proposed an authentication mechanism using JSON Web Token for managing Cloud SaaS applications. This paper is focused on the security and privacy challenges of cloud computing with specific reference to user authentication and access management for cloud SaaS applications. The suggested model uses a framework that harnesses the stateless and secure nature of JWT for client authentication and session management.

Salman Ahmed and Qamar Mahmood [2] proposed an alternate authentication-based scheme for applications using JSON Web Token. JWTs (JSON Web Token) is used for authentication of subsequent client requests without making frequent calls to the resource server or database. In this paper, they present an authentication technique for regeneration of JWT on each client request based on truly random timestamp values to enhance the authenticity of client on server.

Muhamad Haekal and Eliyani [3] proposed a system to handle

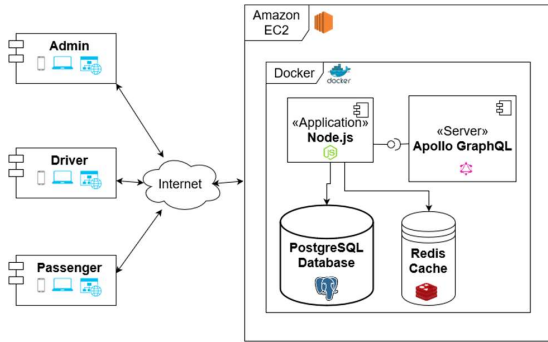
authentication using JSON Web Token. JSON Web Token is stateless, so it is suitable to be implemented on a RESTful Web Service application. In this research will be discussed how to implement authentication technique using token-based authentication method with a JSON Web Token.

Iman M. Almomani and others [4] proposed a ubiquitous GPS Vehicle Tracking and Management System. The main contribution of this paper is providing two types of end user applications, a web application and a mobile application. This way the proposed system provides a ubiquitous vehicle tracking system with maximum accessibility for the user anytime and anywhere.

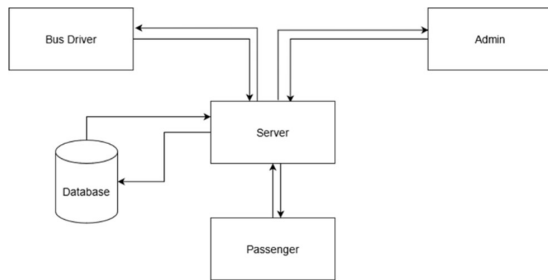
## 3. System Design

The proposed system solves the drawbacks faced by the existing system while using advanced technologies to ensure future sustainability of the software. The client-side application is built to be cross-platform. It is deployed in website, mobile app and desktop app

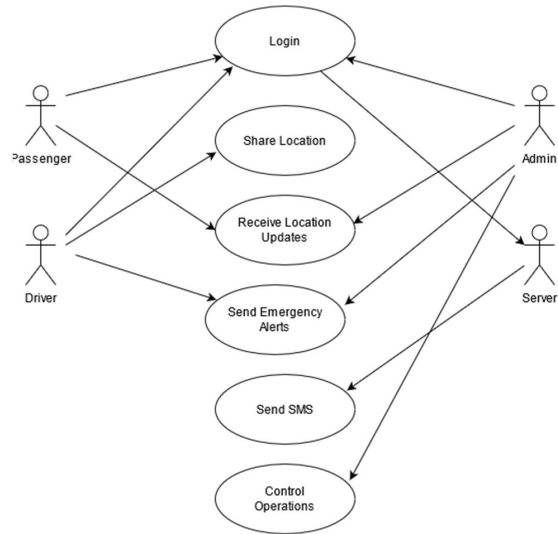
for seamless interoperability of the system.



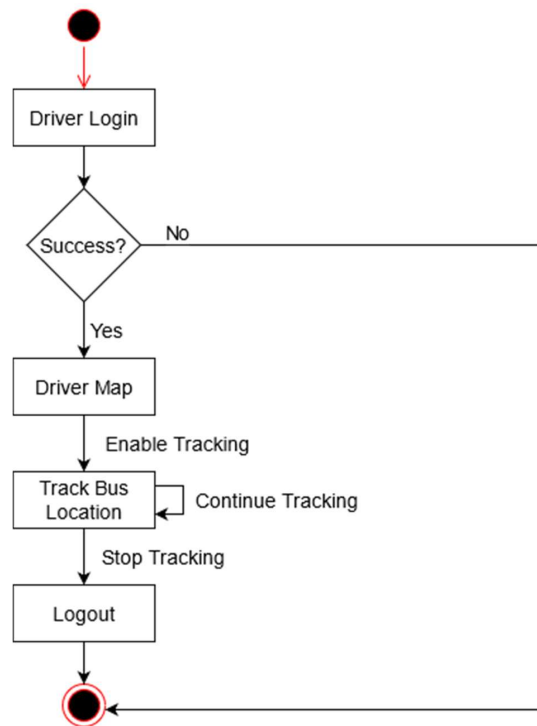
The server-side application is built using latest web framework which provides high performant and efficient memory usage of the resources in the server. The location tracking system is implemented using GraphQL and WebSockets, which provide low latency communication between client and server, while also implementing efficient caching policies.



The client-side application is developed for three entities, namely admin, driver and passenger. The admin has complete control of the data flow between server and client.



The driver software is used by the driver to publish the location of the bus to the server. The passenger and admin can subscribe to the server to get the location updates in real time.





The caching system implemented using Redis provides low latency and high frequency updates to the system. The overall infrastructure can be scaled both vertically and horizontally without affecting the existing infrastructure.

The passenger can track the location of other buses of the organization and can board the bus if the passenger fails to board the respective bus.

The entire application can be scaled vertically and horizontally without affecting the existing system.

The passenger can track the location of the buses in real time and get updates through SMS.

#### 4. Implementation

The system is composed of two major components, namely the server and client. The server is hosted in an Amazon EC2 instance and virtualized using Docker. The PostgreSQL database is installed in the EC2 instance as a Docker container. The server-side application is built using Node.js and the API system is built using GraphQL. The caching system is

implemented using Redis, which is also virtualized using Docker container.

The authentication system is built using JSON web token. The JWT is developed using the following notation:

$\$token = \$header + '.' + \$payload + '.' + \$signature;$

The header is created using the HMAC256 algorithm with following format:

```
{
  "alg": "HS256",
  "type": "jwt"
}
```

The payload comprises client ID, client name who gives the token, the expiry date of the token, and access right to the token.

Following is the JSON

format for payload:

```
{
  "iss": "api.busroutetracker.tech",
  "exp": 1426420800,
  "access": [ {
    "read-order"
```

```

    "read-outlet"
    ....
  }],
  "client_id": 1,
  "client_name": "John"
}

```

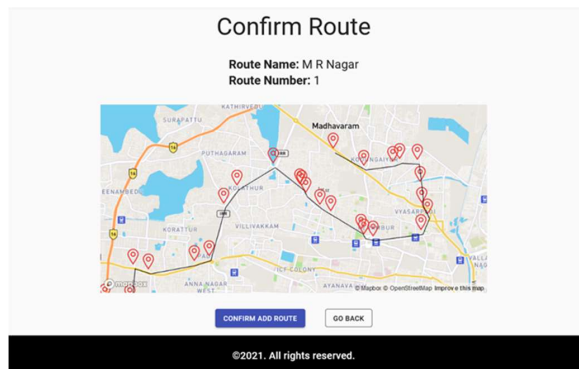
The JWT is signed using the signature which is generated as follows:

```

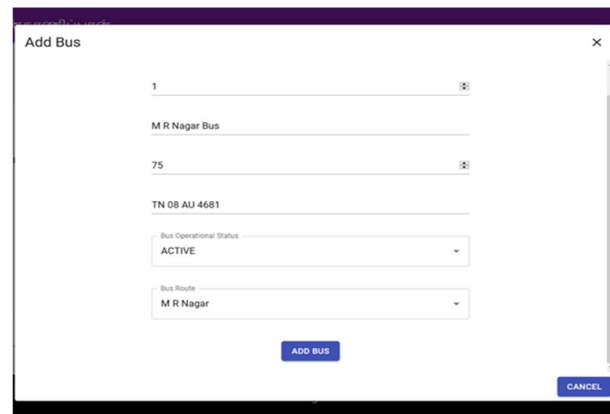
$signature= HMAC($header + $payload,
$key);

```

The client application is developed using React.js. The state management is handled by Redux.js. The client can be connected to the server using Apollo Client. The client application will be deployed to native platforms using Capacitor.js.

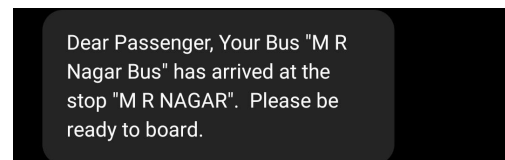


The admin application can perform CRUD operations for Driver, Passenger, Route, Route Point and Schedule. The admin can track the location of buses in the Admin Panel.



The driver will use the driver application and be able to login to the system. The driver will be able to share the location of the bus to the server.

The passenger will use the passenger application and be able to login to the system. The passenger will be able to receive SMS notifications of the location of the bus.





## Conclusion and Future Enhancement

In our paper, we focused to eliminate the need for dedicated tracking devices to lower the infrastructure requirements to support location tracking of vehicles. This led to being cost-effective and providing better services to the organization than the existing system. Since our project is cross-platform compatible, we can update the project to accommodate any future requirements.

The project was built for the majority of users who use Android smartphones as their primary device. However, in future, we expect to cater the needs of iOS users as well.

Moreover, there is scope for building a dedicated location tracking device using Arduino Uno and a GSM Module.

## References

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