# Smart Bus Management and Tracking System


**M. Hari Narasimhan, A. L. Reinhard Kenson, and S. Vigneshwari**

**Abstract** In this advancing world, boarding up buses has been one of the prominent problems faced by many remote users. So, we proposed a new smart system to allocate, schedule, and provide real-time information of the transport system. Therefore, to overcome these problems, we present a mobile application-based live tracking system to track buses through scheduling and live tracking using Google Maps application program interface (API) and then is managed with the help of an admin dashboard. The dashboard takes care of the management of the buses and drivers through allocation and scheduling. The required data is fed and supervised by the administrator through the admin dashboard. The driver app helps in providing the real-time location of the buses. The location data is then fed to the server hosted by Firebase. Then it is forwarded to the dashboard and is sent to the user application.

**Keywords** Google map · Firebase server · Dashboard · Administrator · Maps API

## 1 Introduction

Smartphones have become one of the most important devices used in this progressive world. Where for every need of the user, there is an app for it. It has become one of the most reliable devices in human history [1]. No one can survive in this digital world without a smartphone. From ordering merchandises to ordering food, smartphones have paved the way for digital marketing and online amenities [2]. Every necessity of the user is satisfied by the handheld device starting from transport to travel services

M. Hari Narasimhan (✉) · A. L. Reinhard Kenson · S. Vigneshwari
Department of Computer Science and Engineering, Sathyabama Institute of Science and Technology, Chennai, India
e-mail: narasimhan3737@gmail.com

A. L. Reinhard Kenson
e-mail: kenson.reinhard90@gmail.com

S. Vigneshwari
e-mail: vikiraju@gmail.com

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made available all around the world at any given point of time [3]. Many private companies create mobile applications for commercial use of the public through which many users are benefitted [4, 5]. Public transport is the means of transport for majority of people [6]. And also, other users include students and corporate professionals who share common transportation [7]. One of the major problems faced by these users is the ability to track their means of transport which makes it challenging to follow the bus schedules and manage their timings according to it [8]. Scheduled timing tends to get messed up due to real-life problems like traffic, accidents, and congestions [9]. Any user who wants to use the common transportation is unable to predict the arrival and departure timings due to various factors [10]. This system facilitates the user with the timing schedules and the live location of the transport system [11]. This system also accommodates the bus drivers by displaying the individually allocated buses for them [12]. This avoids confusions and paves a systematic and administrated method for allocation of buses [13]. It also includes facilities like emergency notification which notifies the administrator during emergencies. The Applications are native and rely on Firebase as the server [14, 15]. Firebase is the server through which the applications and dashboard are interconnected.

## 2 Related Work

Researchers have investigated the topic of bus tracking continuously. We can see that the use of IoT devices has become a relic of the past [16]. Over the modern age, smartphones have become an essential and convenient invention for both commercial and research purposes [17]. Most of the major companies and start-ups utilize mobile application for their business. Some even use them as their main product and is working on the further development of their application. Such companies and start-ups include Ola, Uber, Swiggy [18, 19].

From the previous researches, we can identify the approach to be dependent on Hardware for tracking. Kumbhar [20] has proposed the methodology of using three models consisting of the bus module, central control unit, and a client-side module. Each module present performs a separate task individually [21]. The bus app gives the live tracking of the bus data to the central control unit. When the user requests the location, the central control unit provides the live data of the user.

From this process, we understand that the central control unit provides the requested location to the user. But there is not a management system for managing buses and users at the same time. Kumbhar [20] has implemented this methodology using a GPS module and GPRS for receiving the real-time location.

Godge [22] has proposed a management system which maintains the users as well as the location of the buses [23]. Though they use IoT methodology for live tracking, the management system has proven to be user-friendly. This system helps the users for better usage and access to real-time location of the data.

Hoq [4] has proposed the usage of mobile phones as a means of real-time tracking from the inbuilt GPS module present in it. This system helps in avoiding the hardware

maintenance required when it comes to IoT devices. The system consists of a Web application as for the user interface in which the location gathered by the mobile app is displayed [24, 25].

## 3 Proposed Approach

Considering the previous approaches taken by different researchers, we can conclude that tracking buses through IoT devices might work though it might require maintenance, managing them in case of failure should not lead to mismanagement. It is one of the downfalls seen toward the diverse approaches taken so far. We propose a system to overcome this demerit as well as creating an efficient means of management and administration of the users, buses, routes, and drivers (Fig. 1).

Three different modules are developed for the usage of the drivers, users, and the administrator, respectively. We use Firebase as a backend server for interconnecting these modules. The bus app transmits the real-time location of the bus through the smartphone and pushes them to the server. The administrator controls the drivers and supervises over the routes and assigns it to the buses accordingly with the help of the admin dashboard. The location is accessed and observed with the help of Google Maps API.

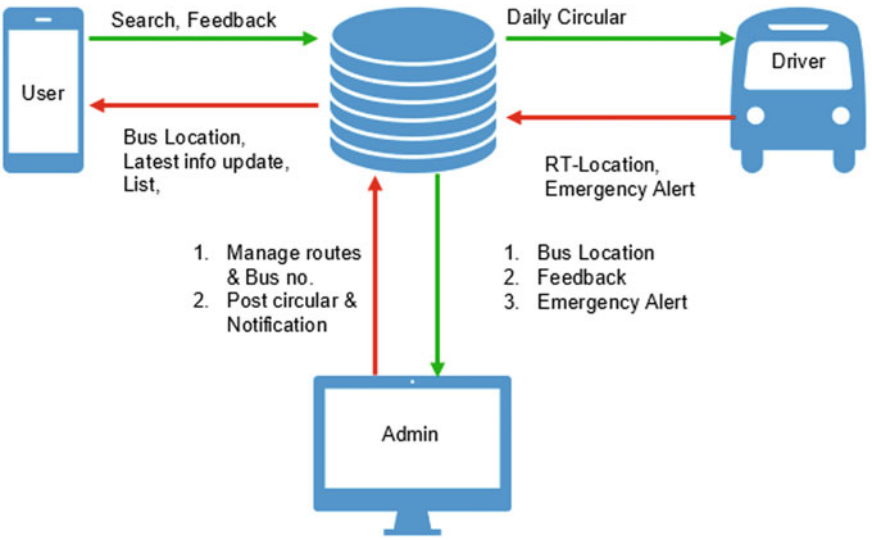


**Fig. 1** Architectural design of proposed model

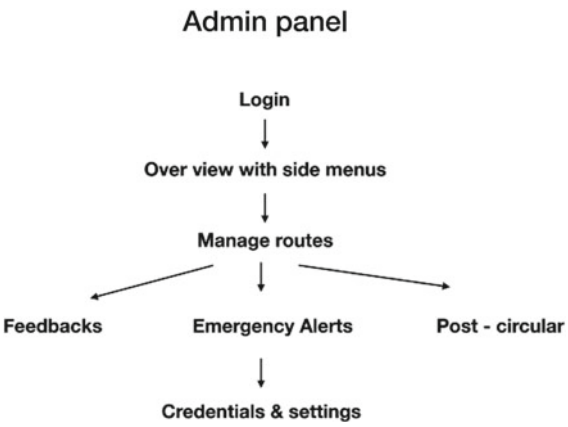


**Fig. 2** Architectural design of admin dashboard

## *3.1 Dashboard*

The dashboard is a significant part of this proposed system. It plays a crucial role in the allotment and management of the buses and routes. The admin is only given the privileges to modify data from the dashboard, whereas users other than the admin will not be permitted to access it. The location data present in the server is retrieved and showcased in it. The admin can access and modify the bus details available, their routes, and also the drivers assigned to that specific bus and route.

The server contains all the databases including the bus database, driver database, and route database necessary for the management by the administrator. At the time of development, these databases are already created and fed into the server. The databases are then supervised and modified by the administrator. The admin credentials are given only to the administrator for accessing the admin privileges. The admin acts as the superuser for this system.

Figure 2 depicts that an efficient user experience and functionality are the key aims while developing this dashboard. The administrator would understand the UI and ultimately avoid confusion and mismanagement whenever possible.

## *3.2 Driver App*

The driver app is the component used to get a real-time location from the driver's mobile device. The main objective of the application is to transmit real-time location seamlessly to the Firebase server. The drivers are distributed with individual credentials by the admin. The drivers can only access the application with their credentials.

The main page of the bus app consists of a toggle switch, which when toggled, will start to send the live location of the mobile device to the server. It consists of a


**Fig. 3** Architectural design of driver application

separate section for sending emergency alerts and receiving circulars from the admin (Fig. 3).

### *3.3 User App*

The user application is linked with the Firebase server and has the access to the buses and routes present in its database. The app is implemented with a search engine for better access of the user. When the user inserts the required bus, then the search engine displays the relevant search results. The searched query is checked in the server's database and displays the location of that bus. It uses Google Maps API for displaying the real-time location of the bus (Fig. 4).

## 4 Techniques and Methodologies Used

We use Firebase as the backend for this project. It acts as the backbone of the entire system. The dashboard is developed to react and connected with Firebase as its backend. The applications created are done on both on Android and iOS. We use Android Studio for nativity support for the Android application, whereas for the iOS application, we use Swift and XCode for its development.

Google Maps API is used for transmitting and receiving the location data from the driver app to the Firebase server. It is then received and displayed by the user app and dashboard, respectively. The dashboard uses the Maps API to react and access the live location of the buses. The API is obtained as a react component by the dashboard with JS as its framework.

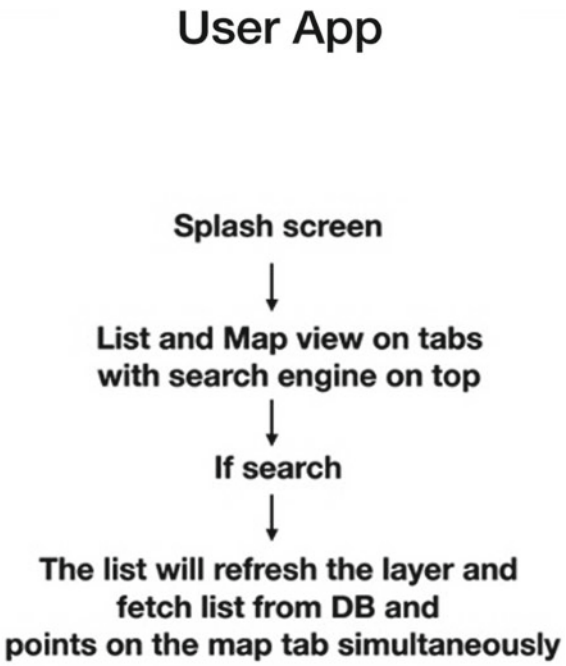


**Fig. 4** Architectural design of User Application

## 5 Results and Discussion

We have managed to create a user-friendly architecture with a full-fledged user interface. The dashboard elements consist of the necessary navigation pane, toolbars, content view, and maps (Fig. 5).

The home page consists of icons that redirects to the respective overview controller page according to the user necessity (Fig. 6).

The overview controller page consists of the details of the requisite transportation medium with necessary labels and characteristics that are indigenous to the respective medium. The details include the unique id of the real-time location, route maps, driver details, and the count of passengers (Fig. 7).

These above-mentioned figures are the prototypes of our proposed system. They are the stage of deployment on a real-time basis. These pages include the registration and login pages for both the driver app and the bus app. The buses registered send their GPS location to the Firebase server which is then retrieved by the admin dashboard and the user app.

Figure 8 represents the database in which each detail of the user and driver are saved at the process of registration. It is further then used for login and allocating the live location of the drivers. It is then read by the user through this database.

Figure 9 is the log file which saves the details of the users and drivers at the time of login. The usage of the real-time database is monitored in order to prevent confusion

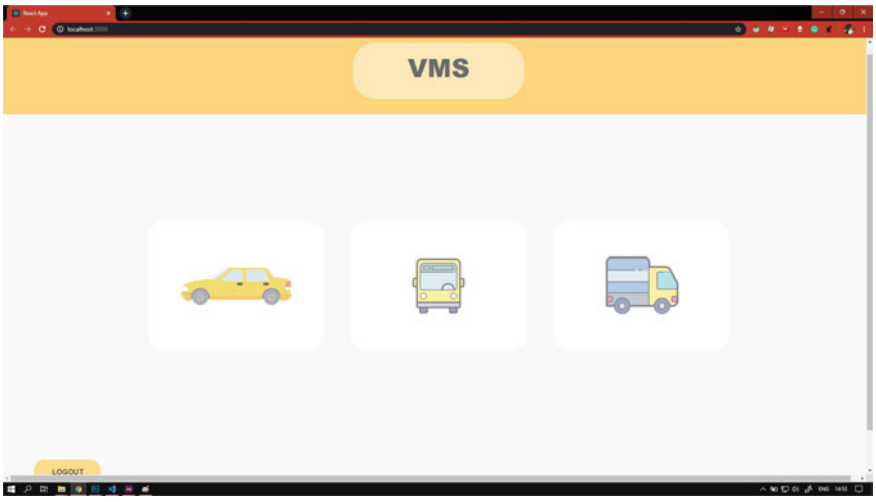


**Fig. 5** Home page

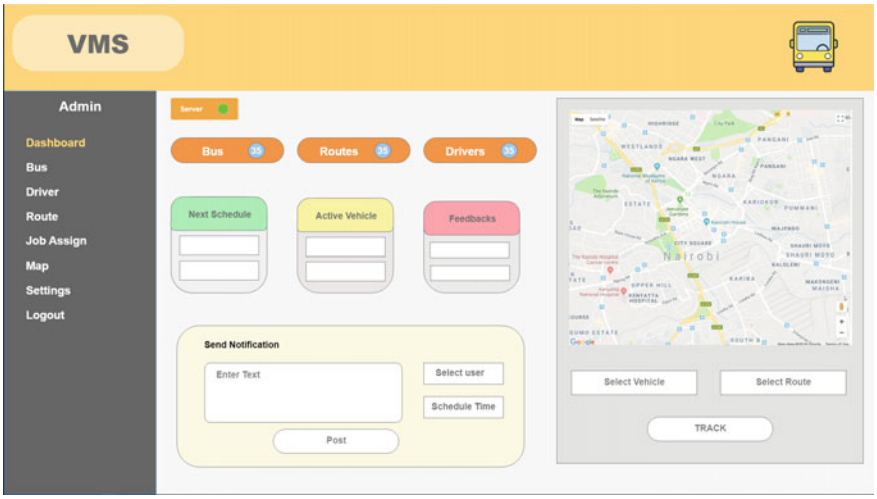


**Fig. 6** Overview controller page

and mismanagement. This mentions the user's login time corresponding with their usage through the user UID.

Once registered in the bus and user app, the credentials of the use are saved in the Firebase server, which in turn forms a new database in the server. The location transmitted from the bus app is also saved within the real-time database of the server. The credentials of the user are checked by the server and gives them access only after the authentication process.

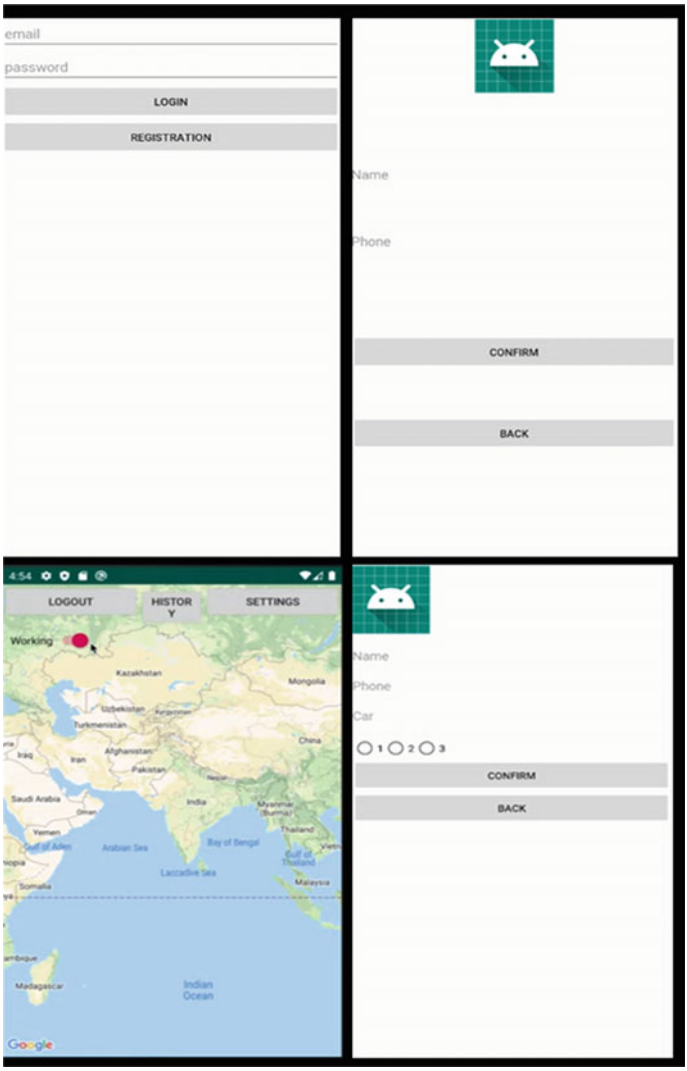


**Fig. 7** Application interface

## 6 Conclusion

Our proposed system tends to prove that developing a management system will increase the efficiency of administration. Also, it helps the user to get real-time location seamlessly. This architecture enables us to provide an efficient protocol and control over the transportation system. It gives clear-cut structure over the operation

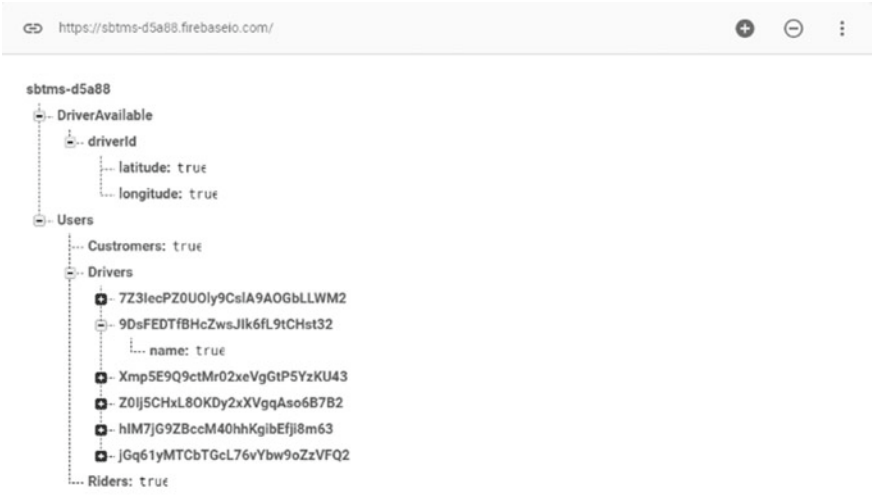


**Fig. 8** Real-time database hosted in Firebase

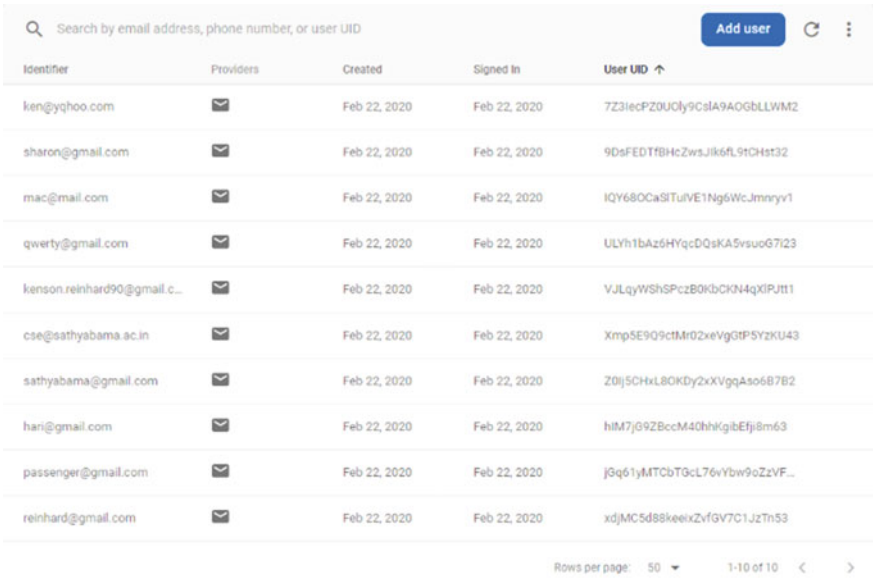


**Fig. 9** Real-time log database hosted in Firebase

and utilization over the graphical interface. The overview layout of the proposed modules gives easier navigation and management.

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