

# Rancang Bangun *Bus Tracker* Berbasis *Android*

Iman Fahrudi  
Departement of Electrical Engineering  
Batam State Polytechnic  
Batam, Indonesia  
imanfhz@gmail.com

Sabina Feriyani Septosa Sinaga  
Departement of Electrical Engineering  
Batam State Polytechnic  
Batam, Indonesia  
sabinaferiyani29@gmail.com

Eko Aryanto Panjaitan  
Departement of Electrical Engineering  
Batam State Polytechnic  
Batam, Indonesia  
aryantoeko333@gmail.com

**Abstract**—Bus tracker is a thing that can track the location of the bus in form of coordinate points that can be observe in real time on the android application that installed on the smartphone. This android application is build for the people bus user community to make it easier to knowing the location of the bus and the time when the bus is arrive. This research method uses a combination of GPS technology (Global Positioning System) to determine the position and GSM technology as a bridge for sending data from the microcontroller to the database. The results of this research will be useful and attract other people to participate in using the bus as the main transportation in order to reduce traffic jam.

**Keywords**— *Bus tracker, Android, GPS, GSM, Database*

## I. INTRODUCTION

Trans Batam Bus is one of the public transportation facilities provided by the Batam City Government that has existed since 2004 until now. This bus is very popular among the people of Batam because its fare is cheaper than other public transportation and its facilities are quite satisfactory. But behind its advantages, this bus also has shortcomings in its service. For example, the inaccuracy of bus arrival time to the intended bus stop, so that Trans Batam bus users are less comfortable because they have to wait for the arrival of the bus and the community is less aware of the existence of the bus so that the community cannot estimate the time of arrival of the bus. [1]

Therefore, to overcome these problems, the author designed a bus tracker to determine the location of the bus. Bus tracker is a vehicle location tracking system using GPS satellites accurately in the form of coordinates that can be observed in real time through digital maps. Bus tracker utilizes a combination of GSM and GPS technology in determining the coordinates of an object, then translates it into a map. [2]

This will make it easier for bus users to know the arrival time of the bus in real time which can be accessed through an android-based application. Android is a Linux-based operating system for mobile phones such as smartphones and tablet computers. Android provides an open platform for developers to create their own applications for use by various mobile devices. [3]

In this study, the authors conducted a literature study of previous relevant research to serve as a reference, namely research by Chintya Nermelita Mandalahi, Simon Siregar and Duddy Soegiarto in 2015 entitled "Designing a Bus Tracker for Smart City", the results of his research are in the form of a prototype of a vehicle tracking mechanism on a rental bus. [4]

Ataul Mujib, Ramiati, Yulindon and Rikki Vitria's research entitled Tracking Community Boats Experiencing Emergency Conditions in North Sipora Waters, Mentawai Islands Regency. Based on the Internet of Things, also uses a system that is almost the same except that the objects under review are different. [5]

Research by riyani rahardi, dedi triyanto, suhardi entitled "Designing A Motorcycle Security System With Fingerprint Sensor, Sms Gateway, And Gps Tracker Arduino-Based With Website Interface". The results of the research are in the form of tools to improve the vehicle security system by utilizing fingerprint sensors as a substitute for keys to turn on and off the vehicle. [6]

The research of Idriss Moumen, Najat Rafalia, Jaafar Abouchabaka, and Marouane Aoufi entitled "Real-time GPS Tracking System for IoT-enabled Connected Vehicles". The result of the research is a vehicle tracking device that utilizes IoT, VANET, and V2X communications for better decision making and sustainable transportation systems. [7]

Research by Ika Ainun Umami, Ade Rahmat Iskandar entitled "Designing a Fire Fighting Calling Application Equipped with Android-Based Global Positioning System (GPS) Navigation". The results of the research are in the form of a fire call application that has a function to make calls to firefighters if they need help. [8]

Jimmy Wong Wei Min, Nurfaulza Jali, Wang Yin Chai's research entitled "Vehicle Tracking System". This research presents a Vehicle Tracking System developed using a web-based system and an IoT platform (Arduino) that helps vehicle owners to track the location of their vehicles. Users can track the location of the vehicle either through a web-based system or via SMS. Using the web-based system, users can view the current location of the vehicle marked on Google Maps with the help of Google Maps API. [9]

## II. RESEARCH METHODOLOGY

Research methodology is a sequence of steps used in a study. As for having a goal, namely in compiling research has a systematic and more organized concept, each stage that is arranged can be seen in accordance with the research objectives desired by the researcher. [10]

In every research is required to use structured rules, as for the rules in question, namely: Each research explanation must have an article that describes the structure of the research, so that the implementation of research related to methods and tests to produce research that has relevance and is expected by researchers. Presentation of figures and tables is highly expected by including them in the form of sequential numbers. [11]

The implementation of the research design of the android application-based bus tracker is carried out in several stages starting from the study of literature related to related systems, system modeling and design, tool assembly, tool testing, data processing and analysis, and presentation in the form of a journal.

### A. Proposed system modeling and functions

This bus tracker system integrates GPS technology to determine the position of the bus and SIM800L as a cellular communication module to send bus and user location data to the database which is then converted into markers on the android application map menu display. The following below is a block diagram of the bus tracker system modeling:

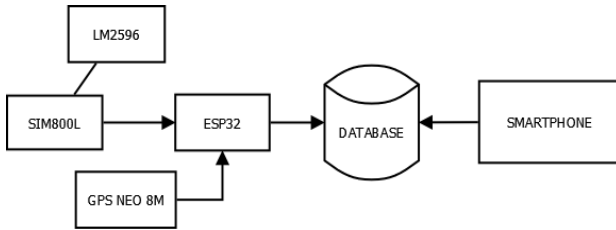


Figure 1. Block diagram system

This system serves to track the position of the bus in real time, so that users can find out the position of the bus and the estimated time of the bus to the departure stop through the android application that has been built.

### B. Hardware system modelling

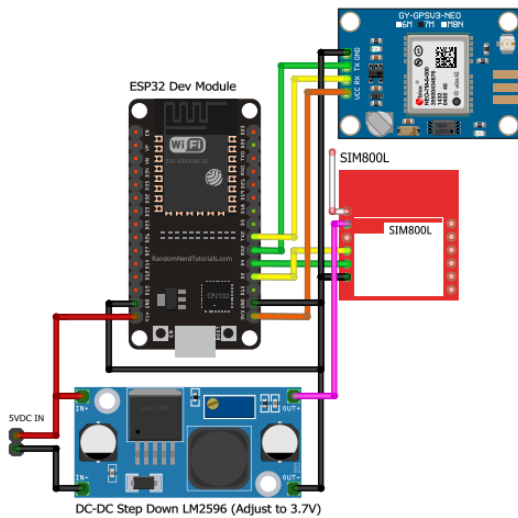


Figure 2. Hardware system

Figure 2. is the hardware design of the bus tracker. This hardware consists of several components, namely ESP 32, SIM800L, GPS Neo M8N, LM2596. ESP32

ESP 32 is a very powerful WI-FI and bluetooth enabled Soc with a very large number of GPIOs, and a development board that shows strength in the design of highly accessible IoT modules. The ESP32 Dev Kit board has 25 GPIOs (General Purpose Input Output) that have different characteristics. [12]

The reason for choosing this microcontroller is that ESP32 is equipped with two processor cores that allow parallel processing which can improve system performance in

processing data from GPS and SIM800L communication, besides that there are many research journals that use these microcontrollers so that they can be a reference, ESP 32 power consumption is relatively low so that the bus tracker device can operate for a longer period of time, and the price is relatively cheap and easy to find.

The Global Positioning System (GPS) is a satellite-based radio navigation system created and operated by the United States Department of Defense. GPS receivers use signals from satellites to determine their position. This determination is made by measuring the time it takes for the signal to travel from the satellite, and then multiplying that time by the speed of light ( $3 \times 10^8$  meters/second). By receiving signals from at least three different satellites, a GPS receiver can calculate the fixed position of a point on Earth, including latitude and longitude. When the signals of the fourth satellite are combined, the GPS receiver can also determine the point's altitude above mean sea level. This capability is very advantageous for navigation purposes on this bus tracker device. [13]

In this system, GPS functions to receive signals from satellites to accurately determine the geographical position of the bus which is then processed by the ESP 32 microcontroller. By utilizing the SIM800L module, the data is sent to the data base via a cellular network using the GSM or GPRS protocol.

The SIM800L GSM device serves as a means of communication with the user's cell phone and provides information about the vehicle's condition through a cellular network data connection. The module supports quad-band frequencies (850/900/1800/1900MHz) and has the ability to send and receive SMS messages and phone calls. In the event of an internet network interruption, the GSM SIM800L can send an SMS Gateway to a second device. [14]

Figure 3. shows the flowchart of the hardware design.

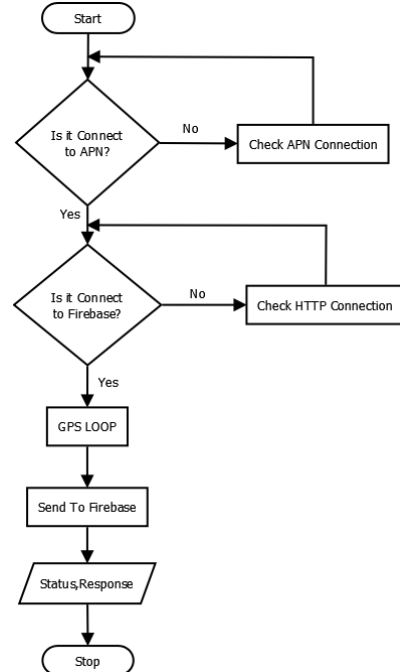


Figure 3. Flowchart hardware system

### C. Android application modeling

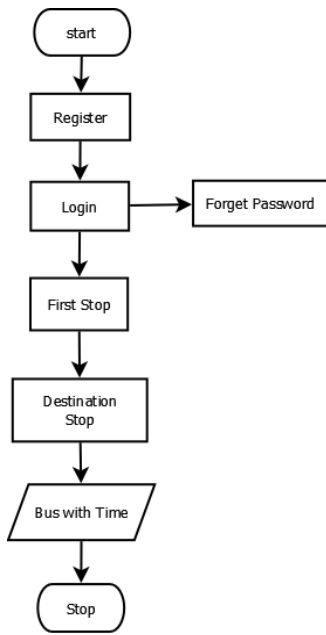


Figure 4. Flowchart application system

Figure 4. is an activity diagram that describes the activities carried out by users in using the application to find out the bus that will arrive at the selected bus stop.

This application is made using a nodular platform which is done by compiling a block puzzle of each component paired with each method and attribute, the block puzzle is automatically available when the developer puts the component on the application design page, the block puzzle arrangement is done on each screen by dragging and dropping on the block work area. The use of this block function replaces existing programming functions, making it easier for new developers to build applications.[15]



Figure 5. Design application

### III. RESULT AND DISCUSSION

In this section, it contains several discussions including device design outcomes, android application display, database display, and device testing.

#### A. Device design outcomes

This bus tracking device consists of several components, namely the ESP 32 dev module microcontroller, GPS Neo M8N, SIM800L, LM2596, USB port. The voltage source required for this device is 5 volts. However, the SIM800L component only requires a voltage of 3.7 - 4 volts to operate so that an LM2596 is needed as a voltage reducer. For

internet access this device uses a Telkomsel provider card. The following is an image of the bus tracker device:

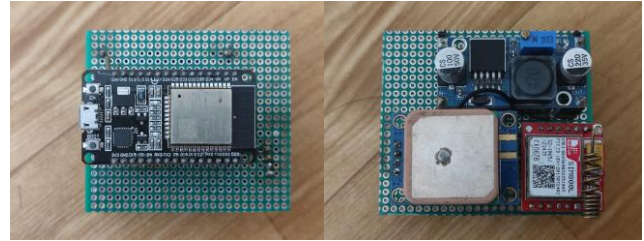


Figure 6. Device result

The specifications of this tool are using a 2G network, 5 volt input voltage, then for the data sent each time, in the program there are 3 elements, namely latitude, longitude and color. The three elements are represented by strings and then combined into one JSON string. In ESP32 each character requires 8 bits, in the program it sends about 200 bits of data in one transmission. With a rough calculation of the number of transmissions of one device in 12 hours / day, 1,728,000 bits of data can be obtained which is equivalent to approximately 210 Kb of data in 12 hours / day. The following calculation is a rough calculation and may vary depending on the actual length of the latitude, longitude and marker color values as well as the data type of the number using float or double and so on.

This device is installed on the Batam trans bus dashboard by taking a 5 volt voltage from the usb port on the bus dashboard. The way this device works is that the device will search for locations and update locations in real time which will be stored and processed in the firebase database. The location results will be displayed in the application that has been built.

#### B. Database view

Below is a view of the firebase database web page. Firebase Realtime Database is a realtime database that is stored in the cloud and supports multiple platforms such as Android, iOS, and Web. Data in Firebase is stored in JSON (JavaScript Object Notation) structure format. The Firebase database automatically synchronizes with client applications that connect to it. Multiplatform applications that use Android, iOS, and JavaScript SDKs will receive the latest data updates automatically when connected to the Firebase server. [16]

This database stores the realtime location of the bus in the form of latitude and longitude recorded by the bus tracker device and is used as a marker on the android application display.

The capabilities of this firebase database include:

1. This database is capable of running simultaneous connections of 100 connections. Simultaneous internet connection refers to the ability of a device or equipment to run multiple internet connections simultaneously. This means that the device is capable of connecting to multiple internet sources at the same time.
2. The document writing that can be done on this database is 20k writes/day and document reading is 50k reads/day. Hardware will write to the database every 5 seconds, therefore by following the batam

trans schedule which each route starts from 06.00 WIB to 18.00 WIB can be calculated in one day, one device will write data as many as 8,640 times to the database with a limit from a free account for writing data per day about 2 to 3 devices. As for reading data per day depends on the users who use the application.

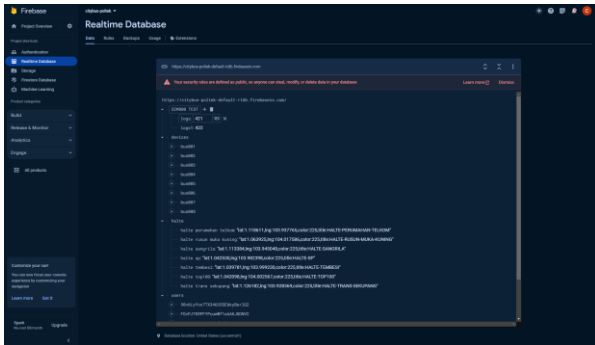


Figure 7. Database homepage

### C. Android application view

The image below is a view of this device application called GPS route navigation: city bus tracking. The app has four screens, namely:

#### 1. Initial view of the application

Initial menu display containing account registration and login. On this screen we can create a user account using a gmail account.



Figure 8. Start menu view

#### 2. Register account view

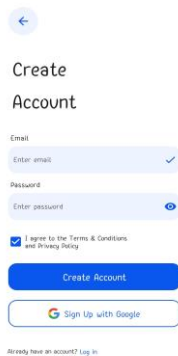


Figure 9. Register account view

In this menu, users can register their account using a gmail account.

#### 3. Login view

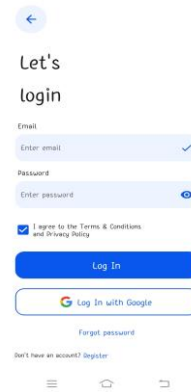


Figure 10. Login view

#### 4. Main menu view

The figure below shows the map page which is the main page in this application. This page will display a direct highlight of the user's position and the position of the Batam trans bus and will always update the position data in realtime.

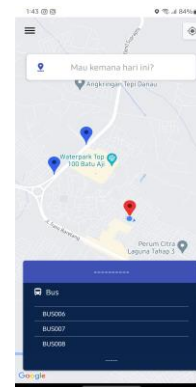


Figure 11. Main menu view

Figure 11. shows the display of the departure and destination route selection menu. The blue marker indicates the position of the bus stop and the red marker indicates the position of the bus. The application will continue to update the location of users and buses in realtime.

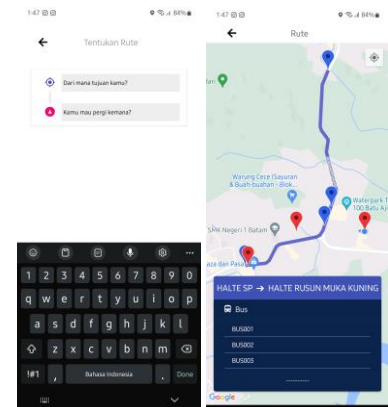


Figure 12. Map view

#### D. Testing SIM800L

Table 1. SIM800L sample data

No	Time	Status Code
1	12:53:51.522	200
2	12:53:58.426	200
3	12:54:05.283	200
4	12:54:12.414	200
5	12:54:19.272	200
6	12:54:26.121	200
...	...	...
262	13:35:49.482	200

Table 2. Blindspot sample data

No	Time	Status Code
...	...	...
245	13:33:49.169	-3
246	13:34:20.886	Reconnecting
247	13:34:20.886	Reconnecting
248	13:34:20.978	Reconnecting
249	13:34:21.052	Reconnecting
250	13:34:21.072	Reconnecting
251	13:34:21.072	Reconnecting
...	...	...

Data was collected on the Batam center - Sekupang route, but only via Tiban Lama bus stop - Sekupang Port bus stop. In the table there are several locations where the SIM module lost signal.

The 200 OK status value is a successful request to send data to Firebase. Status value -3 (TimeOut) this indicates that there is a set time for a response from the server, and that time has been exceeded before getting a response.

There are several reasons why you might get a -3 (TimeOut) response:

- Unstable GPRS Connection: If the GPRS connection is unstable or interrupted, it can cause a TimeOut because the data cannot be sent successfully.
- Unstable Network: Poor or unstable cellular network conditions can cause TimeOut connections such as the disappearance of 2G signals around tiban.
- Firebase or Server Down: If the Firebase server or destination server is not responding or experiencing issues, this could also cause a TimeOut.

#### E. Testing GPS

Table 3. GPS result data

No	Time	Latitude	Longitude
1	12:53:46.923	0.00000000	0.00000000
2	12:53:53.820	0.00000000	0.00000000
3	12:54:00.682	0.00000000	0.00000000

...	...	...	...
240	13:35:44.898	1.10798367	103.95244767

The experiment was carried out repeatedly and obtained results that were not much different, and summarized as a table, and it can be seen that the gps module did not get the location at the beginning of the power on only, if the gps has gotten the location but the device turns off but as soon as it turns on again, the gps can still take the location, but if it has lost power for approximately 30 seconds to 1 minute, the gps has the possibility of losing the location and will enter the signal search mode. for the blind spot of the route traveled, it seems that there are no obstacles either inside the vehicle or outside the vehicle.

#### IV. CONCLUSION

Based on the results and discussion that have been obtained, the following conclusions can be drawn:

1. The bus tracker device on the Trans Batam bus using GSM SIM800L and GPS Neo M8N has been successfully designed and can function properly. This device successfully obtains bus location data and also successfully sends the data to the firebase database which then the data is stored and processed into markers on the android application map page display.
2. The test results of this device also obtained quite good results by displaying accurate and realtime longitude and latitude points.
3. The use of bus tracker device technology also has limitations, which depend on the provider used. If the provider's network is not busy, data transmission will be faster and vice versa. In addition, the weather also affects the speed of sending location data.

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