A

Seminar Report

On

NOVEL AND SECURE BLOCKCHAIN FRAMEWORK FOR HEALTH APPLICATIONS IN IOT

Submitted in partial fulfillment for award of the degree of

Bachelor of Technology

In

Computer Science and Engineering

By

Himanshu Singh (2061825)

Under the Guidance of

Mr. Aviral Awasthi

ASSISTANT PROFESSOR

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING GRAPHIC ERA HILL UNIVERSITY, BHIMTAL CAMPUS

SATTAL ROAD, P.O. BHOWALI,

DISTRICT- NAINITAL-263132

2023-2024

STUDENT'S DECLARATION

I, **Himanshu Singh,** hereby declare the work, which is being presented in the report, entitled "**Design and Analysis of school bus information and tracking system"** in partial fulfillment of the requirement for the award of the degree **Bachelor of Technology (B.Tech.)** in the session **2023-2024**, is an authentic record of my work carried out under the supervision of **Mr. Aviral Awasthi.**

The matter embodied in this report has not been submitted by me for the award of any other degree.

Date:10 June 2024

Himanshu Singh

(2061825)

CERTIFICATE

The seminar report entitled **Design and Analysis of school bus information and tracking System** being submitted by **Himanshu Singh** of B.Tech.(CSE) to Graphic Era Hill University Bhimtal Campus for the award of bonafide work carried out by him. She has worked under my guidance and supervision and fulfilled the requirement for the submission of a report.

Mr. Aviral Awasthi	**Dr. Ankur Bist**
(Seminar Coordinator)	**(HOD, CSE)**

ACKNOWLEDGEMENT

I take immense pleasure in thanking the Honorable Director **'Prof. (Col.) Anil Nair (Retd.)',** GEHU Bhimtal Campus to permit me and carry out this report work with his excellent and optimistic supervision. This has all been possible due to his novel inspiration, able guidance, and useful suggestions that helped me to develop as a creative researcher and complete the research work, in time.

Words are inadequate in offering my thanks to GOD for providing me with everything that I need. I again want to extend thanks to our president **'Prof. (Dr.) Kamal Ghanshala'** for providing me with all infrastructure and facilities to work in need without which this work could not be possible.

Many thanks to **'Dr. Ankur Singh Bisht'**(Head, Department of Computer Science and Engineering, GEHU Bhimtal Campus), & **'Mr. Aviral Awasthi'** (Assistant Professor, Department of Computer Science and Engineering, GEHU Bhimtal Campus), our seminar coordinator and other faculties for their insightful comments, constructive suggestions, valuable advice, and time in reviewing this thesis.

Finally, yet importantly, I would like to express my heartiest thanks to my beloved parents,for their moral support, affection, and blessings. I would also like to pay my sincere thanks to all my friends and well-wishers for their help and wishes for the successful completion of this research.

Himanshu Singh, 2061825

ABSTRACT

The school bus is a means of transportation that is very attractive to students because it is free. This study aims to develope an application that can track school bus trips and provide information about bus passengers. Bus location information sent to the user application can help students estimate the arrival time of the school bus at the pick-up point. In addition, information on the identity of school bus passengers can be used by parents to monitor the whereabouts of their children going to or from school on the bus. This application uses the global positioning system (GPS) of the smartphone on the school bus to find out the location of the bus and send it along with passenger identification information to the user application. To read passenger identities,near field communication (NFC) cards are used as passenger identity cards by tapping them on a smartphone on a school bus. Tests have been carried out on all functions of the application features and testing the accuracy of location reading and tracking of school bus trips, obtained latitude and longitude tolerance values of about 3.2 meters

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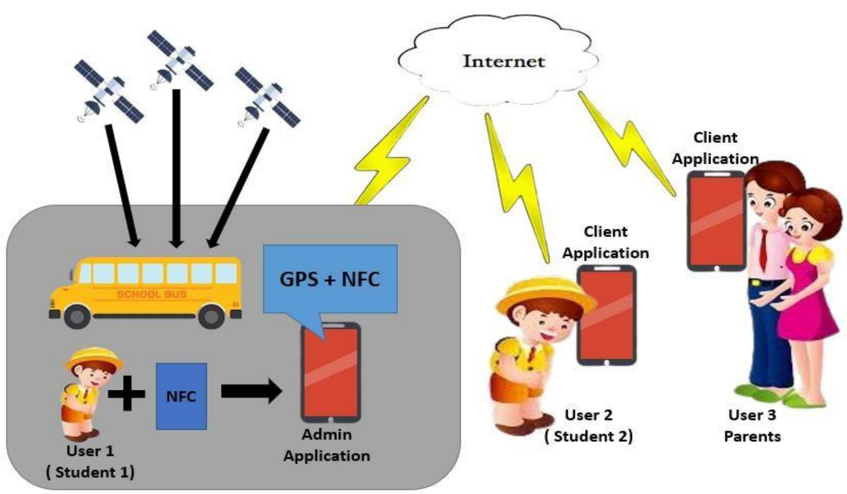
CHAPTER 1: INTRODUCTION

Transportation is a tool to make it easier for humans to carry out transportation and movement activities. Bus is a means of transportation that is widely used in various countries, including Indonesia. One of the advantages of buses as a means of transportation is that they can carry many people so that the cost is cheap. In some regency where this research was conducted, buses are not only used as a means of inter-city transportation but also used by the local government as school buses to facilitate students going to and from school for free.

The length of the track that the bus has to pass and the bus departure schedule are not yet orderly, making it difficult to predict the arrival of the bus at each stop. As a result, it is not uncommon for students to have to wait for a long time or miss the bus when they arrive at the pick-up point. Lack of information about the position of the buses due to the absence of a departure schedule makes the school buses provided by the local government perform badly.

The length of the bus travel route and the lack of orderly bus travel schedules make the obstacles faced because the arrival schedule is often late. This raises concerns for parents who are waiting for their children at home. This research tries to find a solution to the problem of delays in bus arrivals and the limited information about passengers on the bus, namely developing an application using global positioning system (GPS) and near field communication (NFC) cards.

By using GPS , the whereabouts of the bus during the trip can be identified and the NFC card is used as an identity card for students riding the bus . Bus location information and passenger identities are sent to all application users using the internet network . So that application users can anticipate the arrival time of the bus at each pick-up location.



CHAPTER 2: TELEMATICS TECHNOLOGY FOR VEHICLE MONITORING

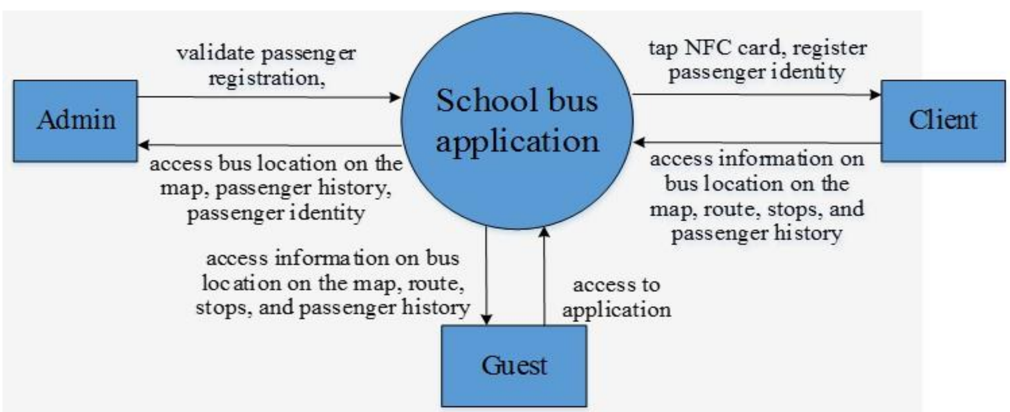
This report describes telematics technology for various vehicle monitoring applications such as vehicle location tracking and vehicle theft location. The report proposes a school bus monitoring system using localization and speed sensors with GPS data communication signal comparison .This allows parents and school authorities to track school bus trips in real-time.

Real-Time Vehicle Tracking:

A study that develops and tests a vehicle tracking system using GPS and communication devices with the global system for mobile (GSM) was conducted so that the position of the vehicle can be tracked in real time using a smartphone application . The Google Maps application programming interface (API) is used to display the vehicle on the map in the smartphone application. Thus, users will be able to continuously monitor a moving vehicle on demand using the smartphone application and determine the estimated distance and time for the vehicle to arrive at a given destination. To demonstrate the feasibility and effectiveness of the system, this paper presents experimental results of the vehicle tracking system and some experiences on practical implementations.

Passenger Identity Verification

Passenger identity is needed to record who is riding public transportation so that the public can find out about it. The personal identification in mobile scenarios has attracted a lot of attention in the last few years due to the emergence of new communications paradigms that enable the establishment of ad hoc communications. These communications must be carried out in a secure way since they can be involved in applications such as payments and access systems. Consequently, new secure systems should be proposed for managing security in such complex, mobile, and variable conditions. This paper proposes a new authentication system based on the Spanish identification (ID) card and wireless NFC technology [13]. It uses cryptography techniques and authentication certificates to establish secure communications between two interlocutors. The proposed network-oriented architecture enables the proposed authentication system to operate in both local and remote modes.



CHAPTER 3: METHODOLOGIES

The methodology of this study involves the design and implementation of a school bus monitoring system that integrates GPS and NFC technologies for real-time tracking and passenger identification. The system is structured to allow three types of users—students on the bus, students waiting for the bus, and parents—to access real-time information about the bus location and passenger data.

A. System Design

The system's architecture, as depicted in the block diagram (Figure 1), consists of the following key components:

- **GPS Module**: Installed on the school bus, the GPS module communicates with satellites to obtain real-time longitude and latitude coordinates of the bus. This data is then transmitted to the user's smartphone application.
- **NFC Reader**: Integrated into the admin smartphone on the bus, the NFC reader is used to read student identity cards. This reader captures passenger data each time a student boards or alights the bus.
- **Smartphone Applications**: There are two primary applications—one for the admin (bus driver) and one for users (students and parents). The admin application manages GPS and NFC functions, while the user application allows for tracking the bus location and viewing passenger information.

B. Data Flow and Processes

The data flow within the system can be summarized as follows:

1. **Activation of GPS and NFC**: The bus driver activates the GPS and NFC functionalities on the admin smartphone using the dedicated application.
2. **Student Registration**: Students must first register by filling out their personal identification details. Once registered, their information is stored and linked to their NFC card.
3. **Boarding the Bus**: When a student boards the bus, they tap their NFC card on the admin smartphone. The system registers the student as a passenger, updating the passenger count and recording the time of boarding.
4. **Real-Time Tracking**: The GPS module continuously sends location data to the admin application, which then forwards this information to the user application. Users can access this data to track the bus in real-time.
5. **Alighting the Bus**: Upon reaching their destination, students tap their NFC card again to signal that they are alighting. The system updates the passenger count and logs the time and location of alighting.

C. User Interaction

- **User 1 (Student on the Bus):** This user type carries an NFC card and interacts with the admin smartphone for boarding and alighting the bus.
- **User 2 (Student Waiting for the Bus):** This user can access the application to track the bus's current location and estimated arrival time.
- **User 3 (Parents):** Parents use the application to monitor the bus route and ensure their child's safety by checking the bus's real-time location and passenger status.

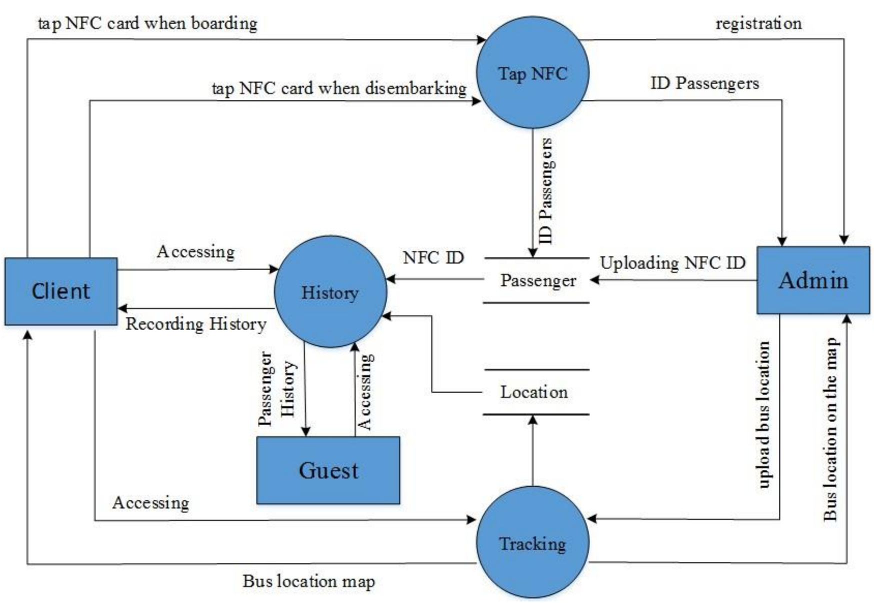
D. Data Flow Diagrams (DFD)

- **DFD Level 0:** Illustrates the overall flow of data between the system and users, highlighting how information is processed and disseminated.
- **DFD Level 1:** Provides a detailed view of specific processes such as tapping the NFC card, tracking the bus, and managing passenger history. These processes are performed by the admin, client, and guest users.

E. Experimental Implementation

The proposed system was implemented and tested in X regency, involving three bus routes (A, B, and C), each with 13 stops. The testing phase involved monitoring the system's performance in real-time tracking and passenger identification, ensuring the reliability and accuracy of data transmission and user interactions.

By integrating GPS and NFC technologies, the system effectively enhances the safety and convenience of school bus transportation, providing real-time visibility and secure passenger identification. The methodology ensures a seamless experience for all users, from boarding to tracking and monitoring the bus journey.



CHAPTER 4: SYSTEM IMPLEMENTATION

The implementation of the school bus information and tracking system is based on experimental data collection and literature study. This provides the data used as input for the application, which consists of two main parts: a general system description and the detailed working of the system.

The developed system aims to facilitate students and parents in finding information about bus locations and passenger details. The system consists of two primary components:

a. Admin Application This application is embedded in a smartphone placed in the school bus and serves multiple functions:

- **Route Selection**: Allows the admin to select the school bus route.
- **Coordinate Reader**: Tracks the school bus location using the smartphone's GPS.
- **NFC Card Reader**: Identifies passengers using NFC cards.
- **NFC Card Registration**: Registers new NFC cards that have not been previously registered.
- **Map Display**: Shows the school bus route on a map.
- **Passenger History Management**: Records and displays information about passenger boarding and alighting times and locations.

b. Client Application This application can be accessed by anyone who installs the school bus information and tracking system application. Its functions include:

- **Tracking Menu**: Provides options to track the school bus or view passenger information.
- **Route Display**: Shows different bus routes in distinct colors (route A in red, route B in green, route C in blue).
- **Bus Stop Display**: Shows all bus stops along each route.
- **Passenger Information**: Displays the number of passengers on board and their history, including boarding and alighting times and locations.

System Functionality

The working of the school bus information and tracking system is illustrated in the following steps:

Admin Application

1. **Route Selection**: The bus driver selects the route for the school bus.
2. **Location Tracking**: The application reads the school bus location using Google Maps.
3. **NFC Card Reading**: When an NFC card is tapped on the admin smartphone, the application reads the card data from the database server.
    - **New Passenger Registration**: If the NFC card data is not found, the passenger must register by providing their name and ID.
4. **Passenger Information Display**: Once registered, the application displays information about the number of passengers and their history.

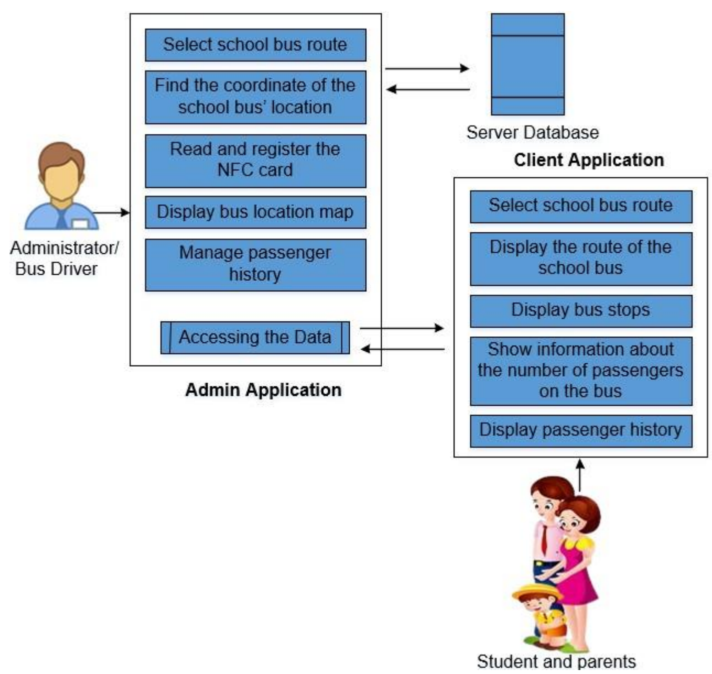
Client Application

1. **Route and Stop Selection**: Users can select the desired bus route, shown in different colors, and view the bus stops marked in sequence.
2. **Monitoring**: Displays information on the number of passengers and their boarding/alighting history.

Detailed Workflow

Based on the flow diagram (Figure 6), the process is explained as follows:

1. **NFC Card Tapping**: The passenger taps their NFC card on the admin smartphone.
2. **NFC Card Reading**: The admin smartphone reads the NFC card. If successful, proceed; if not, repeat the step.
3. **Passenger Registration**: If the card is read successfully, and if required, the passenger registers by entering their name and ID.
4. **Data Storage**: The passenger's details (name, ID number, boarding time, and alighting time/location) are stored in the database.
5. **History Display**: The passenger's information appears in the passenger history section of the application.



CHAPTER 5: RESULT AND DISCUSSIONS

This section presents the results of testing and discusses the application that has been built, focusing on the functions of each feature and the overall performance of the application. Performance tests were conducted on the GPS capabilities and the smartphone's ability to read NFC tags.

A. GPS Test Results

The GPS test included performance and accuracy evaluations of the GPS in reading the school bus location. The test compared the results obtained from the school bus tracking application with those from the My GPS Coordinates application. Figure 8 illustrates the readings from both applications at Bus Stop 1.

School Bus Tracking Application Testing Results:

- Location: Bus Stop 1 (8° 5’ 23.2”, 111°50’16.3”)

Other Device (My GPS Coordinates) Testing Results:

- Location: Bus Stop 1 (8° 5’ 23.0”, 111°50’16.3”)

The test used the decimal degree (DD) format, converting latitude and longitude distances to degree minute second (DMS) format to determine the distances in meters. The conversion formula used is shown in Table 2. A difference of 0.1 seconds in latitude and longitude equates to approximately 3.09 meters, calculated by multiplying 0.1 seconds by 30.92 meters.

From the comparison test results, the distance difference between latitude and longitude readings from the two applications was approximately 3.09 meters.

Table 2. DMS to DD and Meter Conversion

DD Difference	DMS Conversion	Meter Conversion
0.1 seconds	1 degree	30.92 meters

5.2 School Bus Route Testing

To further evaluate the accuracy of the school bus tracking application, tests were conducted along the actual school bus routes. The goal was to determine the application's performance by comparing its coordinates obtained from Google Maps with those from the My GPS Coordinates application.

Data was collected at each bus stop for all three routes (A, B, and C). The coordinates were initially recorded in DD format and then converted to DMS to measure the distance differences in meters.

Tables 3-5. Comparison of GPS Coordinates

The results showed that the readings at several bus stops had significant distance differences. This was attributed to the variable quality of the communication network along the bus routes. The average difference in latitude values was approximately 3.09 meters, while the average difference in longitude values was approximately 3.32 meters.

Summary of GPS Test Results:

Route	Average Latitude Difference (meters)	Average Longitude Difference (meters)
A	3.09	3.32
B	3.09	3.32
C	3.09	3.32

The comparison testing indicated that while the school bus tracking application provided accurate GPS coordinates, there were minor discrepancies due to network quality variations. These discrepancies were within acceptable limits for the application's intended use.

5.3 NFC Reading Test

The smartphone's ability to read NFC tags was also tested. The test involved multiple attempts to read NFC cards to ensure consistent and accurate passenger identification. The results confirmed that the NFC reader successfully identified passengers, recorded boarding and alighting times, and updated passenger history without significant issues.

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CHAPTER 6: CONCLUSION

The implementation of the school bus information and tracking system on actual school buses has yielded promising results. The accuracy of the GPS functionality was validated through comparison with the My GPS Coordinates application, showing a minor latitude distance difference of 3.09 meters and a longitude distance difference of 3.32 meters. These results confirm that the school bus tracking application performs well in providing real-time location data.

However, it was observed that GPS reading accuracy varied at different bus stop locations. These discrepancies were mainly due to the varying quality of communication networks along the bus routes. Poor network quality in certain areas can affect the timely uploading of location data, but overall, the application still provided useful and accurate tracking information.

The NFC reading tests indicated that the maximum effective reading distance for the NFC card is 6 cm, and the card can be read from multiple positions around the smartphone. This functionality ensures accurate and efficient passenger identification and tracking.

In summary, the school bus information and tracking system has proven to be a reliable and effective solution for monitoring school bus locations and managing passenger information. While network quality can impact performance in some areas, the system provides valuable real-time information for students, parents, and school authorities, significantly enhancing the safety and efficiency of school transportation.

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Design and Analysis of school bus information and tracking system

Himanshu Singh
Departement of Computer Science Engineering, Graphic Era Hill University Bhimtal, Uttrakhand,India

Abstract: The school bus is a means of transportation that is very attractive to students because it is free. This study aims to develope an application that can track school bus trips and provide information about bus passengers. Bus location information sent to the user application can help students estimate the arrivaltime of the school bus at the pick-up point. In addition, information on the identity of school bus passengers can be used by parents to monitor the whereabouts of their children going to or from school on the bus. This application uses the global positioning system (GPS) of the smartphone on theschool bus to find out the location of the bus and send it along with passengeridentification information to the user application. To read passenger identities,near field communication (NFC) cards are used as passenger identity cards bytapping them on a smartphone on a school bus. Tests have been carried out onall functions of the application features and testing the accuracy of location reading and tracking of school bus trips, obtained latitude and longitude tolerance values of about 3.2 meters.

1. INTRODUCTION

Transportation is a tool to make it easier for humans to carry out transportation and movement activities. Bus is a means of transportation that is widely used in various countries, including Indonesia. One of the advantages of buses as a means of transportation is that they can carry many people so that the cost is cheap. In some regency where this research was conducted, buses are not only used as a means of inter-city transportation but also used by the local government as school buses to facilitate students going to and from school for free [2]. The length of the track that the bus has to pass and the bus departure schedule are not yet orderly, making it difficult to predict the arrival of the bus at each stop. As a result, it is not uncommon for students to have to wait for a long time or miss the bus when they arrive at the pick-up point. Lack of information about the position of the buses due to the absence of a departure schedule makes the school buses provided by the local government perform badly. The length of the bus travel route and the lack of orderly bus travel schedules make the obstacles faced because the arrival schedule is often late. This raises concerns for parents who are waiting for their children at home.

This research tries to find a solution to the problem of delays in bus arrivals and the limited information about passengers on the bus, namely developing an application using global positioning system (GPS) and near field communication (NFC) cards. By using GPS [3]-[5], the whereabouts of the bus during the trip can be identified and the NFC card is used as an identity card for students riding the bus [6], [7]. Bus location information and passenger identities are sent to all application users using the internet network [8], [9] so that application users can anticipate the arrival time of the bus at each pick-up location.

2. RELATED WORK

This paper describes telematics technology for various vehicle monitoring applications such as vehicle location tracking and vehicle theft location [10]. The researcher proposes a school bus monitoring system using localization and speed sensors using GPS data communication signal comparison [11]. This allows parents and school authorities to track school bus trips in real-time [12]. A study that develops and tests a vehicle tracking system using GPS and communication devices using global system for mobile (GSM) was conducted so that the position of the vehicle can be tracked in real time using a Smartphone application [2], [3], [6]. The Google maps application programming interface (API) is used to display the vehicle on the map in the smartphone application. Thus, users will be able to continuously monitor a moving vehicle on demand using the Smartphone application and determine the estimated distance and time for the vehicle to arrive at a given destination. In order to show the feasibility and effectiveness of the system, this paper presents experimental results of the vehicle tracking system and some experiences on practical implementations [12].

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3. RESEARCH METHOD

3.1. System design

Figure 1 shows a block diagram of the system for tracking or knowing the location of an object, in this case a school bus. The GPS on the smartphone gets a signal from a satellite [14] which contains information about the longitude and latitude of the object being tracked through an application embedded in a smartphone on a school bus. This information will be forwarded to users via an application embedded in the user's smartphone to indicate the location of the school bus. In addition, information about school bus passenger data is also sent. Passenger identities are read using an NFC card as a student identity card [15]. Data on NFC is read via an NFC reader installed on a smartphone on the bus. This reading can also be used as a sign that the passengers on the bus have increased by one. This information is expected to be known by user 2, namely students who will take the bus, or by user 3, namely parents, through an application that is embedded in the user's smartphone.

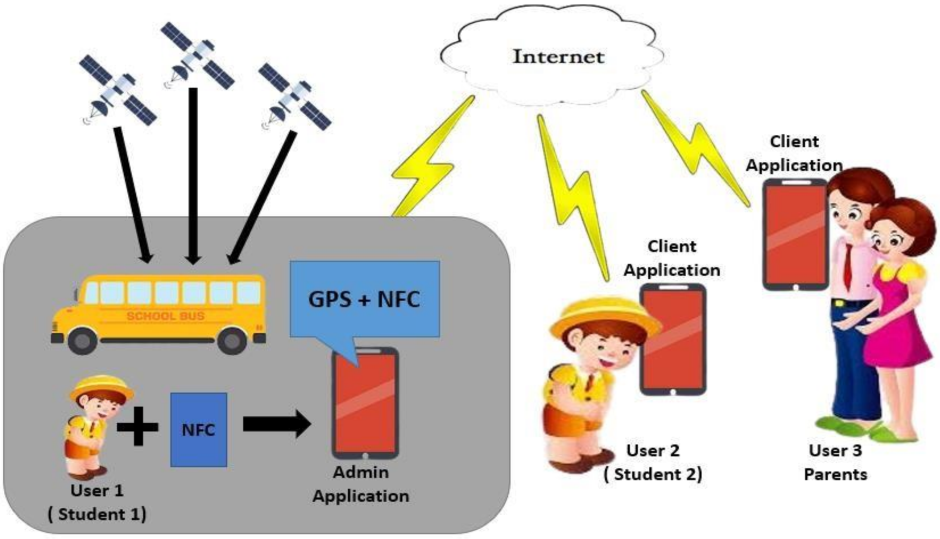
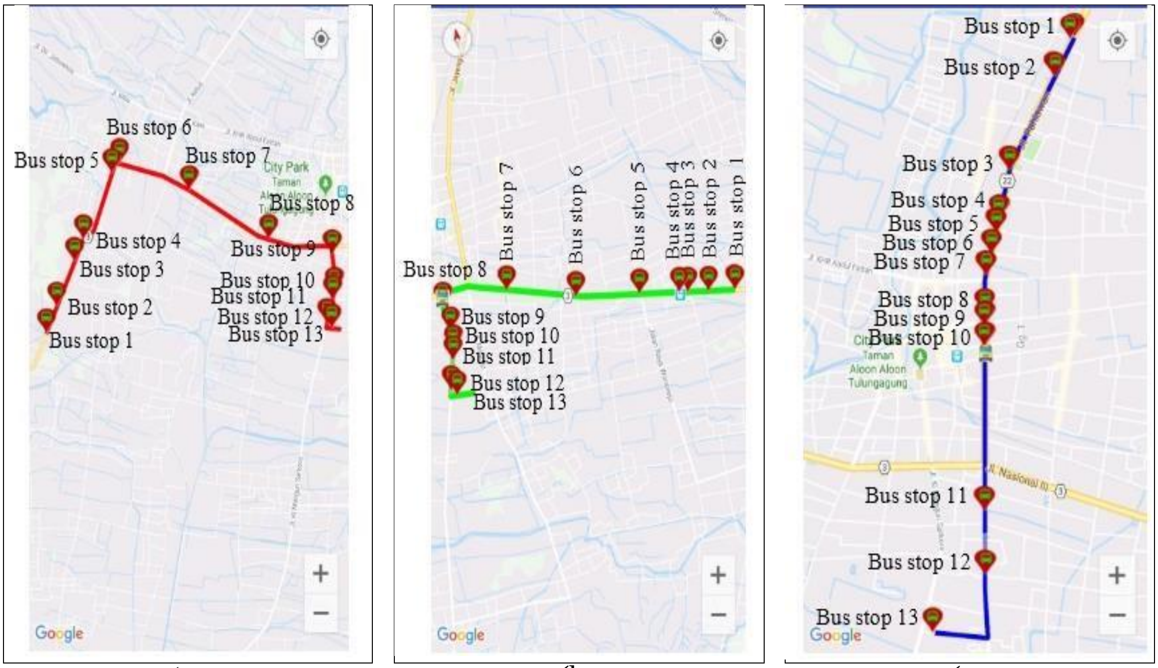


Figure 1. System block diagram

In the block diagram, there are 3 users consisting of user 1 as the student on the bus, user 2 as the student who will ride the school bus, and user 3, namely the parents. User 1 is a student who rides a school bus and already has an NFC card which is then tapped on the admin smartphone. The process of tapping the NFC card when the student rides the school bus will be recorded in the passenger history, when the passenger is boarded [16], what will be recorded is the name of the student's identity, ID number and time of the school bus ride [17]. Then the admin application tracks or finds out the location of the bus using GPS on the admin smartphone. The GPS will receive a tracking signal from the satellite which contains the longitude and latitude data of the current bus location [18]. Furthermore, the location and passenger identity will be sent to other users so that user 2, namely students who will ride the school bus, can see information about the whereabouts of the bus and the number of passengers. Similarly, user 3, namely parents, can monitor their sons and daughters who use school buses for school transportation. The school bus to be tracked is a school bus in X regency which has 3 routes, namely route A, B, and C, each of which has 13 bus stops which will be explained in Figure 2. The A, B, and C routes and the stops are shown in Figures 2(a)-2(c).



(a) (b) (c)

Figure 2. The bus stops map from route, (a) route A, (b) route B, and (c) route C

3.2. The working of the system

The way the system works is explained as shown in:

- The school bus driver activates GPS and NFC on the admin smartphone on the bus by activating the adminapplication, so that users 2 and 3 can track the location of the school bus.
- Students and parents can access the user application by using a smartphone connected to the internet to findout the whereabouts and passenger information according to the route chosen by the student.
- Students who ride the school bus can tap the NFC card they already have. If NFC is read, it means that thestudent has been registered as a passenger. If the NFC card is not recognized, the student must register.
- Students register by filling in their personal identification. The application then reads the NFC card as thename of the student who has registered so there is no need to re-register.
- When the NFC card is tapped on the admin smartphone one time, it indicates the number of passengers hasincreased and the history will display the name of the student and the time when getting on the school bus.
- Students who get off the school bus re-tap the NFC card to provide information that passengers havedecreased and the history will add to the student's time off and the location where the student gets off.

In a flow chart, the working of the system can be described as shown in Figure 3.

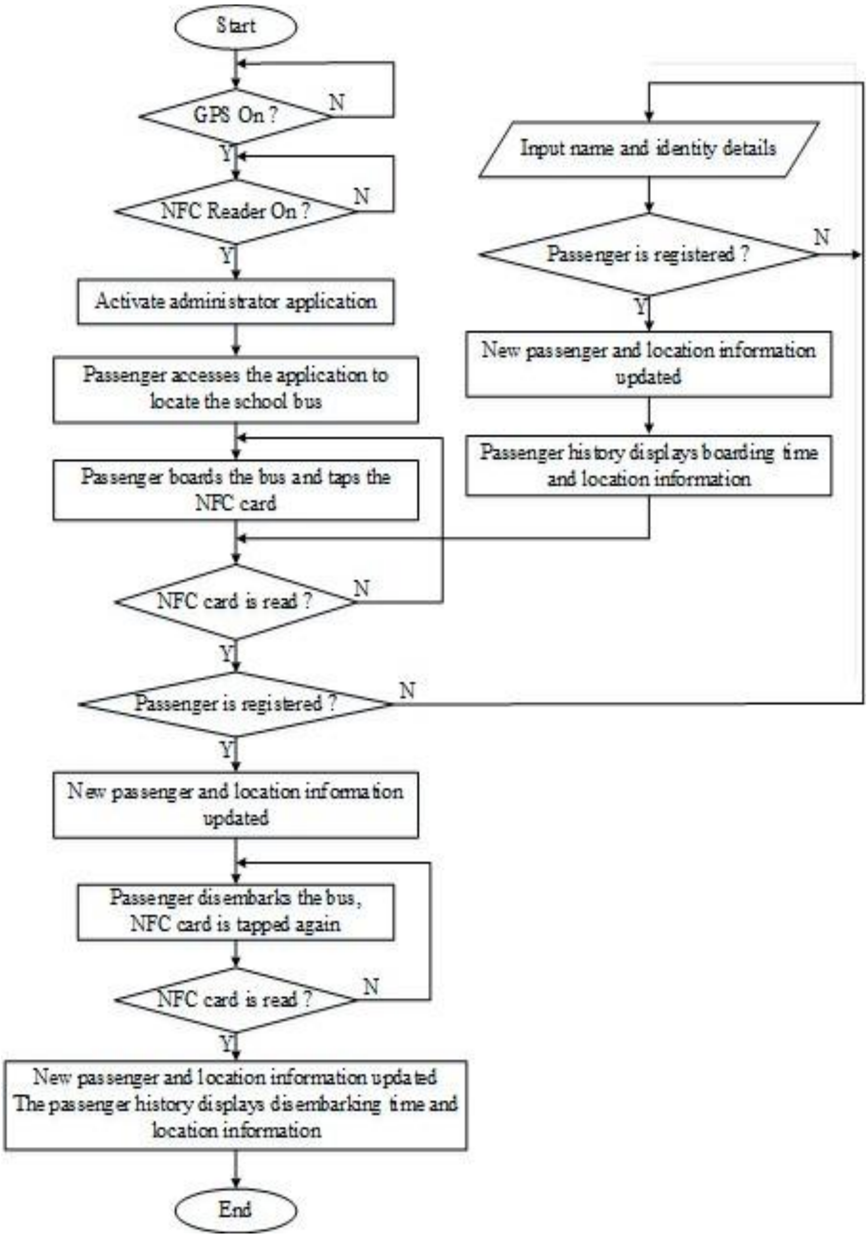


Figure 3. Flow diagram of the working of the system

3.3. Data flow diagram (DFD)

DFD level 0 in Figure 4 describes the flow of data to and from user and system. Table 1 illustrates the access right at DFD level 0. DFD level 1 shown in Figure 5 describes in more detail the data flow and processes carried out by the system.

DFD level 1 in Figure 5 shows three processes, which are tapping the NFC card, tracking, and showing history, all of which are performed by 3 users, namely the admin, the client, and the guest. The admin is responsible for validating the guest who has performed registration and reading the bus location coordinates with the help of the GPS as the input for tracking. The process of tapping the NFC card allows the device to read the information about the identity of the passenger which is stored in the card. The information is then sent to the admin in order to be recorded in the passenger history as a passenger on-board of the bus. The tracking process manages the bus location coordinate in order to be informed to the client as well as the guest. Meanwhile, the history process manages all activities happening in the bus, including recording the identity of the passenger who gets in and gets out of the bus.

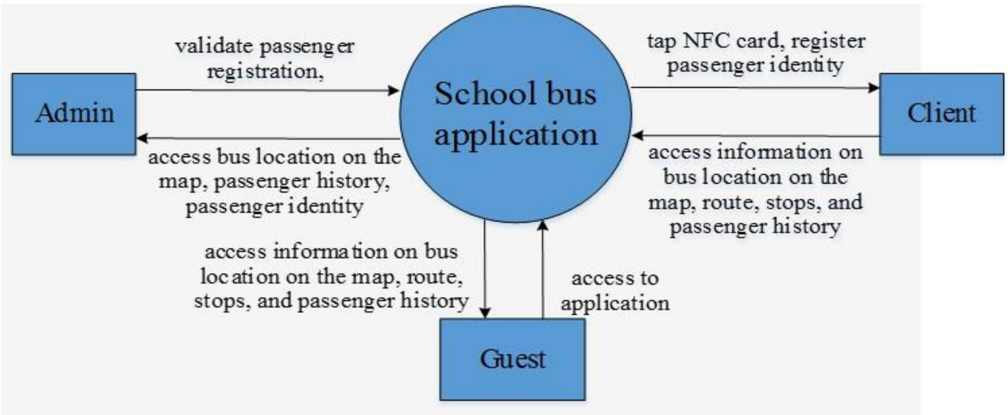


Figure 4. DFD level 0 of the application for school bus information and

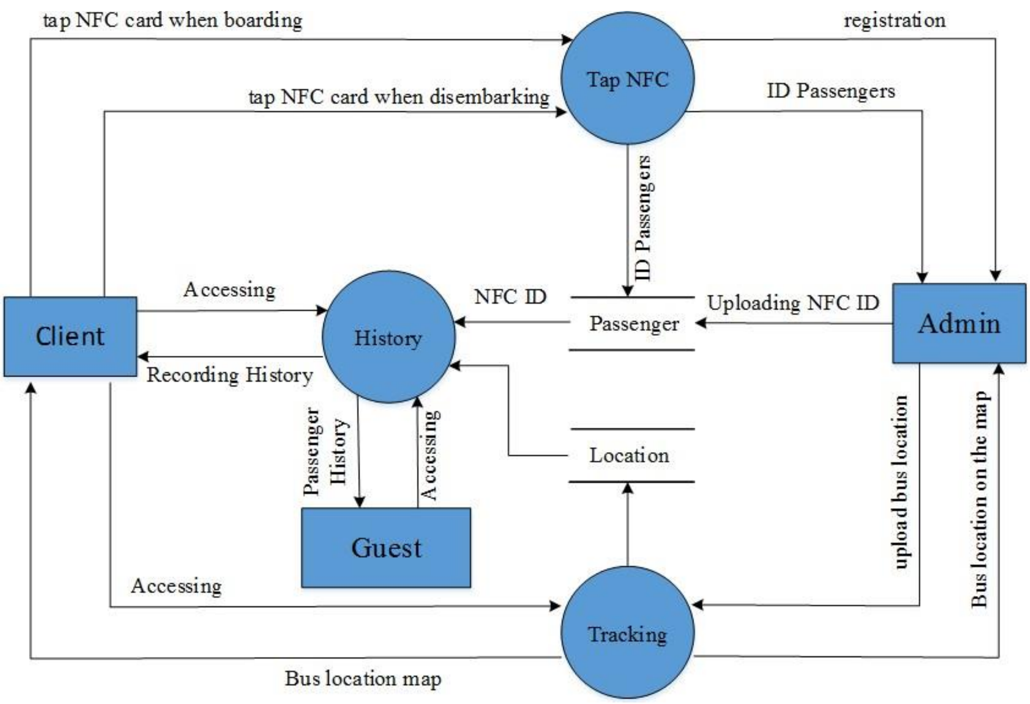


Figure 5. DFD level 1 for the application for school bus information and tracking systems

4. SYSTEM IMPLEMENTATION

The implementation of the system is based on experimental data collection and literature study whichprovides data used as input for the application for school bus information and tracking system. An overview of the implementation of the school bus information and tracking system application consists of two parts, namely the description of the system in general and how the system works. How to get the desired result is also explained how the designed application works. The test results will be described in the results section belowof this session.

4.1. General system description

The system developed is intended to make it easier for students and parents to find information about the location of buses and information on passengers on the school bus. This system consists of two parts, namely:

a. Admin application, which is an application embedded in a smart phone placed in a school bus and is used as a reader for the location of the school bus and as a reader for student's NFC cards. The application consists the following:
   - Feature to select the route for the school bus to be followed.
   - Feature for coordinate reader which tracks the location of a school bus using the smart phone's GPS.
   - Feature to read NFC card which identify the passengers on the school bus.
   - Feature to register NFC cards that have not been registered.
   - Display of a map that matches the route of the school bus.
   - Feature to manage passenger history in which the information about student's boarding time as well asget off time and location can be accessed.

b. The Client application, which is an application that can be accessed by everyone who install the school bus information and tracking system application. This application tracks the location of the school bus and provides information about the number of passengers on a bus and the passenger history. The functions ofthis application include:
   - Tracking menu options or passenger information.
   - Feature to display the selections of school bus routes.
   - Feature to display the bus routes, which are colored differently for each route; route A is in red, route Bin green, and route C in blue.
   - Feature to display the school bus stops.
   - Feature to display information on the number of passengers on board the school bus.
   - Feature to display passenger history where the information about passenger's boarding time as well asdisembark time and location can be found.

4.2. The working of the application

The working of the application for school bus information and tracking system in general is shown in Figure 6. The figure illustrates the working scheme of the school bus information and tracking system application as shown in:

a. Admin application: the administrator (bus driver) selects a route that the school bus will pass. After that, the application reads the location of the school bus using Google Maps. When an NFC card is tapped on the administrator’s smart phone, the administrator application reads the NFC card to display data as registered to and stored on the database server. If the data is not on the database server, the passenger is required to register as a new passenger by filling in the passenger's data which include name and ID. Once registered, the passenger’s information is read to provide information about the number of passengers and passenger history.

b. Client application: this client application can be used by students, parents, and the department of transportation to monitor the performance of school buses. In the client application, the user can select the desired route out of the three routes, which are shown in different colors, as well as the bus stops that are marked with numbers indicating the order of the stops. The client application also displays information on the number of passengers on the bus and passenger history to help users find out and monitor.

Based on the flow diagram in Figure 6, the process is explained as follow:

- NFC card is tapped to the administrator’s smart phone that is used as a reader to identify the passenger’s ID number on the NFC card.
- The administrator’s smart phone reads the NFC card. If the NFC card is read successfully then passenger proceeds to the next step. If the reader fails to read the passenger’s ID, the passenger repeats the first step.
- After the administrator’s smart phone successfully reads the ID on the NFC card, registration is required. This registration is done by entering the student's name which is necessary as an ID identifier in the application.
- The data in the form of name and passenger’s details that have been registered are then stored in the database.
- After that, the passenger’s name, ID number on NFC card, and the boarding time as well as the disembark time and location appear in the passenger history in the application

The process of school bus information and tracking system shown on Figure 7. Start from tap the NFC card then read the data by administrator. After that the track will saved on database system.

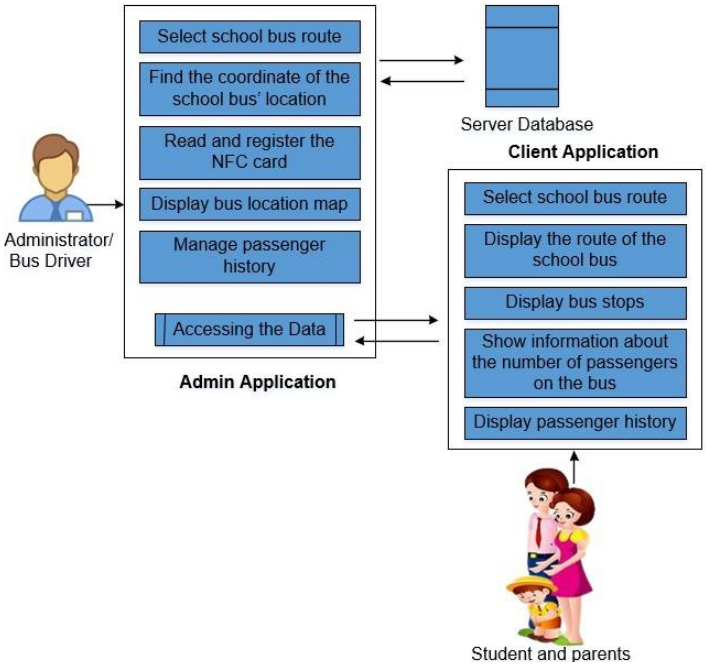


Figure 6. The working of the application

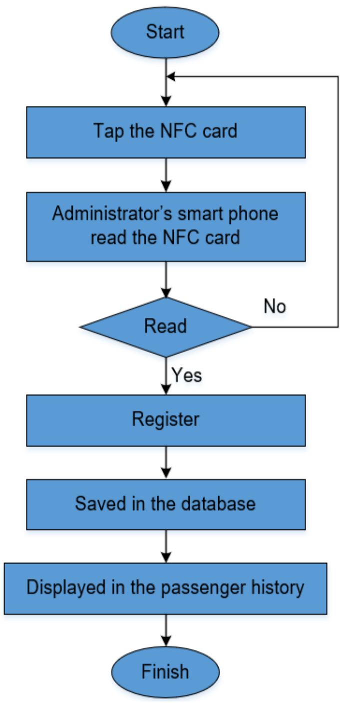


Figure 7. The work flow diagram of school bus information and tracking system application

5. RESULTS AND DISCUSSION

This section presents the results of testing and discusses the application that has been built, specifically the functions of each feature and the overall performance of the application. For peformane has been tested about GPS test results with make comparison between school bus tracking application and GPS coordinates application. Smartphone's ability to read NFC was also tested in this research.

5.1. GPS test results

This test includes the performance and accuracy tests of GPS in reading the location of the school bus. The test was carried out by comparing the results of the location reading using the school bus tracking application and the reading results from another device using My GPS Coordinates application. Figure 8 gives information on the readings between the two devices using school bus tracking system application and My GPS Coordinate application.

School Bus Tracking Application Testing Results

Location: Bus Stop 1 (8° 5’ 23.2”, 111°50’16.3”)

Other Device (My GPS Coordinates) Testing Results

Location: Bus Stop 1 (8° 5’ 23.0”, 111°50’16.3”)

Figure 8. Results displayed on the smart phone using GPS location reading

The testing used decimal degree (DD) format, where the latitude and longitude distances are necessary to be converted to degree minute second (DMS) to determine the latitude and longitude distances in meters [19]. The conversion of distance in degrees minute second unit into meter or kilometer uses formula as follows in Table 2. In the comparison testing of school bus tracking application and My GPS coordinates application, the value of latitude and longitude in distance units with a difference of 0.1 seconds is 3.09 meters, which is obtained from the calculation of 0.1 seconds multiplies by 30.92 meters. From the results of this comparison test, the distance difference between latitude and longitude is more or less 3.09 meters. The difference between latitude and longitude that has been obtained proves that the school bus tracking application is working well and stable.

Table 2. DMS to DD and meter conversion

Conversion DMS into DD and Meter
1 degree (1º)=40.075 Km: 360º=111,320 Km
1 minute (1')=111,320 Km: 60=1,855 Km
1 second (1")=1,855 Km: 60=30,92 Meter

1.1. Testing school bus tracking application school bus routes

From comparison testing on the accuracy of the school bus tracking application and My GPS Coordinates application, it is necessary to test the application on the routes that are passed by the school bus. The goal is to determine the performance of the school bus tracking application. The test was carried out by riding a school bus and the data were collected from each bus stop. In this test, the performance of the application was measured by comparing the application's coordinates obtained from Google Maps [20] with the coordinates obtained from My GPS Coordinates application [21].

In Tables 3-5, the comparison of testing results between the school bus tracking application and My GPS Coordinates application for all three routes had used the decimal degree (DD) format, and so it is necessary to convert it to degree minute second (DMS) in order to find out the difference in distance in meter unit [22]. From the comparison of the two applications, it is known that the readings at several bus stops have significant differences in distance. This is because the quality of the communication network is not evenly distributed along the bus route. The results of the tests that have been carried out obtained a comparison between the school bus tracking application and the My GPS coordinates application, with the latitude value difference at approximately 3.09 meters and longitude value at 3.32 meters.

Table 3. The distance difference from testing results of school bus tracking application and My GPS coordinates application for route A

Location bus stop	Latitude		Longitude		Distance differences			
	School bus tracking application	My GPS coordinates application	School bus tracking application	My GPS coordinates application	Latitude		Longitude	
					"	m	"	m
1	8° 5′ 23.2″	8° 5′ 23.0″	111°50′16.3″	111°50′16.3″	0.2	6.18	0	0.00
2	8° 5′ 4.8″	8° 5′ 4.9″	111°50′24.6″	111°50′24.7″	0.1	3.09	0.1	3.09
3	8°4′34.5″	8°4′34.2″	111°50′38.9″	111°50′38.8″	0.3	9.27	0.1	3.09
4	8°4′19.1″	8°4′19.1″	111°50′46.2″	111°50′46.2″	0.0	0.00	0.0	0.00
5	8°3′33.7″	8°3′33.9″	111°51′9.5″	111°51′9.4″	0.2	6.18	0.2	3.09
6	8°3′27.4″	8°3′27.4″	111°51′15.4″	111°51′15.5″	0.0	0.00	0.1	3.09
7	8°3′45.2″	8°3′45.4″	111°52′12.1″	111°52′11.9″	0.2	6.18	0.2	6.18
8	8°4′18.7″	8°4′18.8″	111°53′16.3″	111°53′16.2″	0.1	3.09	0.1	3.09
9	8°4′28.9″	8°4′29.1″	111°54′7.9″	111°54′7.8″	0.2	6.18	0.1	3.09
10	8°4′54.4″	8°4′54.4″	111°54′10.2″	111°54′10.0″	0.0	0.00	0.2	6.18
11	8°4′59.7″	8°4′59.7″	111°54′8.5″	111°54′8.5″	0.0	0.00	0.0	0.00
12	8°5′15.9″	8°5′15.9″	111°54′3.6″	111°54′3.7″	0.0	0.00	0.3	9.27
13	8°5′19.4″	8°5′19.4″	111°54′6.9″	111°54′7.0″	0.0	0.00	0.1	3.09
	Average distance difference				0.1	3.09	0.1	3.32

Table 4. The distance difference from testing results of school bus tracking application and My GPS coordinates application for route B

Location bus stop	Latitude		Longitude		Distance differences			
	School bus tracking application	My GPS coordinates application	School bus tracking application	My GPS coordinates application	Latitude		Longitude	
					"	m	"	m
1.	8°5′1.1″	8°5′1.2″	111°57′16.3″	111°57′16,4″	0.2	6.18	0.1	3.09
2.	8°2′58.2″	8°4′58.2″	111°56′59.6″	111°56′59,4″	0.0	0.00	0.2	6.18
3.	8°4′55.9″	8°4′56.0″	111°56′46.3″	111°56′46,4″	0.1	3.09	0.1	3.09
4.	8°4′54.9″	8°4′54.8″	111°56′40.7″	111°56′40,8″	0.1	3.09	0.1	3.09
5.	8°4′50.3″	8°4′50.4″	111°56′15.2″	111°56′15,0″	0.1	3.09	0.2	6.18
6.	8°4′43.1″	8°4′43.3″	111°55′34.2″	111°55′34,5″	0.2	6.18	0.3	9.27

7.	8°4’30.3”	8°4’29.9”	111°54’50.6”	111°54’50.5”	0.4	12.36	0.1	3.09
8.	8°4’30.5”	8°4’30.6”	111°54’7.7”	111°54’7.6”	0.1	3.09	0.1	3.09
9.	8°4’44.6”	8°4’44.5”	111°54’9.7”	111°54’9.8”	0.1	3.09	0.1	3.09
10.	8°4’54.5”	8°4’54.6”	111°54’9.4”	111°54’9.5”	0.1	3.09	0.1	3.09
11.	8°4’59.9”	8°4’59.8”	111°54’7.9”	111°54’8.2”	0.1	3.09	0.3	9.27
12.	8°5’15.8”	8°5’15.6”	111°54’3.3”	111°54’3.3”	0.2	6.18	0.3	9.27
13.	8°5’19.6”	8°5’19.6”	111°54’6.9”	111°54’7.1”	0.0	0.00	0.2	6.18
Average distance difference					0.1	3.09	0.1	3.32

Table 5. The distance difference from testing results of school bus tracking application and My GPS coordinates application for route C

Location bus stop	Latitude		Longitude		Distance differences			
	School bus tracking application	My GPS coordinates application	School bus tracking application	My GPS coordinates application	Latitude		Longitude	
					“	m	“	m
1.	8°1’59.7”	8°1’59.6”	111°54’58.3”	111°54’58.8”	0.1	3.09	0.5	15.45
2.	8°2’12.4”	8°2’12.3”	111°54’51.9”	111°54’52.6”	0.1	3.09	0.3	9.27
3.	8°2’44.0”	8°2’43.9”	111°54’35.2”	111°54’35.1”	0.1	3.09	0.1	3.09
4.	8°3’0.6”	8°3’0.4”	111°54’31.4”	111°54’31.3”	0.2	6.18	0.1	3.09
5.	8°3’4.9”	8°3’4.6”	111°54’30.2”	111°54’30.1”	0.3	9.27	0.1	3.09
6.	8°3’12.0”	8°3’11.9”	111°54’28.7”	111°54’28.6”	0.1	3.09	0.1	3.09
7.	8°3’19.3”	8°3’19.1”	111°54’26.6”	111°54’26.8”	0.2	6.18	0.2	6.18
8.	8°3’32.2”	8°3’32.3”	111°54’26.1”	111°54’26.3”	0.1	3.09	0.2	6.18
9.	8°3’36.6”	8°3’36.7”	111°54’26.2”	111°54’26.1”	0.1	3.09	0.1	3.09
10.	8°3’43.3”	8°3’43.2”	111°54’26.1”	111°54’26.1”	0.1	3.09	0.0	0.00
11.	8°4’38.6”	8°4’38.8”	111°54’26.0”	111°54’26.6”	0.2	6.18	0.6	18.54
12.	8°4’59.9”	8°4’59.9”	111°54’26.2”	111°54’26.5”	0.2	6.18	0.3	9.27
13.	8°5’19.3”	8°5’19.2”	111°54’7.0”	111°54’7.1”	0.1	3.09	0.1	3.09
Average distance difference					0.1	3.09	0.2	6.41

1. CONCLUSION

The application for school bus information and tracking system has been implemented into the actual school bus and resulted in several concluding points are made and described as shown in: i) based on the test results obtained from comparing the results of the reading of My GPS coordinates application, the latitude distance difference is 3.09 meters and the longitude distance difference is 3.32 meters. This indicates that the school bus tracking application has worked well; and ii) there are differences in the results of GPS readings at several bus stop locations because there are some areas that have poor quality communication networks, causing the uploading of locations not optimum. From the reading distance test, the maximum distance for reading data in the NFC card is 6 cm and the positions of the NFC Card which can be read are on the right, left and back of the smartphone.

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