ASHESI UNIVERSITY COLLEGE

MyRide: THE FUTURE OF INTELLIGENCE TRANSPORT SYSTEM

IN GHANA

APPLIED PROJECT

B.Sc. Computer Science

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APPLIED PROJECT

Applied Project submitted to the Department of Computer Science, Ashesi

University College in partial fulfilment of the requirements for the award of

Bachelor of Science degree in Computer Science

Beatrice Migaliza Lung'ahu

April 2016

DECLARATION

I hereby declare that this [capstone type] is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature:

…………………………………………………………………………………………………

Candidate's Name

…………………………………………………………………………………………………

Date: …………………………………………………………………………………………

I hereby declare that preparation and presentation of this applied project were supervised in accordance with the guidelines on supervision of applied project laid down by Ashesi University College.

Supervisor's Signature:

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Supervisor's Name:

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Date: …………………………………………………………………………………………

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Abstract

Public transit is a very important tool in Ghana for those looking to ease their commutes and also reduce car dependence. Due to the high reliance from the public, the need for information about the public system is very significant to those patronizing the service. This report presents MyRide system -an intelligent transit information system that uses the internet, mobile technology, GPS satellites and crowd sourcing. Its objective is to facilitate intra-city transportation in Ghana by providing real time information about buses. The information is provided via channels such as mobile devices, the web and SMS.

Users of MyRide are not only limited to bus riders, but can also be employed by bus drivers and the bus management. It is aimed to be used by transit agencies that have a structured system of relaying their services to the commuters. The report discusses user requirements specification, system design and architecture, implementation of the system, and finally, testing and results.

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Chapter 1 : INTRODUCTION

Public road transport is the most popular means of transportation in Ghana. According to Metro mass Transit, a public bus agency in Ghana, three out of four Ghanaians use public transport to reach their destination in the Greater Accra Region (Public Transport in Ghana, n.d.). Since Greater Accra is heavily congested when compared to any other regions in Ghana, it has the highest priority to set up efficient intra-city (transportation within the city) public transport. Greater Accra has not set up efficient intra-city public transport because there are predicaments that consumers go through. These include: knowing exactly when a bus arrives and the total time it takes to get to destination, getting traffic update and the updates on the state of the bus, being able to tell the amount of money they will spend on transportation, finding the real time location of a bus, and being able to plan their trip. The bus management does not have a real time information on the buses, hence they cannot have full control of the buses when they are out on the road.

The report discusses the design and implementation of an intelligent transit system, called MyRide, to be used by travel agencies in Accra, Ghana and mainly at the intra-city level of transportation. MyRide makes use of mobile phones, web technology and Global Positioning System (GPS) to provide the real information to commuters, drivers and the bus management.

1.1 Background, Purpose and significance

Intra-city public transport in Accra Ghana has three options for commuters. They are the commuter bus, taxi and the minivan popularly referred to as 'Tro-tro'. Taxis are generally expensive and not commonly used by the average Ghanaians. Tro-tros are the most common way to travel for Ghanaians. They are managed by the Ghana Private Road Transport Union (GPTU),

which is comprised of the owners of the minibuses. Commuter buses are used to perform intra-city, intercity - travel between different cities - and long distance travel (Public Transport in Ghana, n.d.). An example of commuter bus agency that has been successful is the Metro Mass Transit Limited, which has flexible schedules and cheap fare rates. It operates in the main corridors of Accra city as well as its outskirts.

For the Tro-tro, commuters can board at any point along the road besides the bus stops. The bus conductor, referred to as the 'mate' helps the driver to know when to stop the bus or when to depart and collect fare from passengers. He shouts the destination of the bus for the pedestrians to hear in order to decide if they want to board the 'tro-tro' or not. Since most of the Tro-tros normally wait at the bus station to fill up before they depart, it is difficult to find an empty seat outside the station unless someone has alighted. The duration of travel is not standard thereby making it difficult for the average traveler to plan out a trip.

Commuters experience the same problems with the commuter buses just as the "Tro-Tros". Commuter buses, such as the Metro Mass Transit (MMT) buses, have direct trips to certain locations, which benefit the customers since they do not need a transit bus. An example is an MMT bus travelling all the way from Berekuso in the Eastern Region to Accra Central in the Greater-Accra Region of Ghana. During this trip, passengers do not have to make any stop overs to get a different bus as it would be the case with the "Tro-tros". The only problem with the MMT buses is that a passenger cannot tell whether the bus is full or not, when the bus arrives and the total time to travel. MMT drivers have to deal with distractions regarding when to stop as the 'mate' has to keep alerting him. For ticketing, the MMT agency recently introduced the Group 200 buses, which support the use of an electronic card to pay for travel. Passengers are required to move closer to the exit door when the bus is approaching their destination in order to press a button to alert the

driver when to stop. This is very dangerous since the passengers might end up getting injured in the course of moving towards the exit door while the bus is in motion. Traffic information is never readily available to both the drivers, passengers and the management of the public transport. An example is when an accident happens on a particular route. If an approaching bus does not have any information about the accident, they will end up spending a lot of time in traffic that could have been avoided if a different route had been taken.

With full implementation of MyRide system, the users will have full control of public transport. The commuters will be able to comfortably access real time information of a bus and plan for their trip. The driver will be able to tell when to stop the bus. The bus management will be able to monitor the bus routines and be able to tell how they can improve their services. Finally, traffic status will be available to all the users hence they will be able to prepare ahead.

1.2 Objective

Public riders practice at least 23 skills to travel independently. These include arriving at a correct bus stop on time to catch a particular bus, boarding the correct bus and determining when to signal the driver when they want to get off the bus at the correct stop (Sean Barbeau, 2010). The objective of MyRide system is to help riders find transiting using the public transport easier so their travel experience can be enhanced. The information that is available to the users in the MyRide system include: the arrival time of the bus, availability of a bus in a particular route, whether the bus is full or not, the mode of payment, the bus status and the traffic information of a particular route, the nearest bus to them, which bus to board while transiting and where to board the next bus. These can be summarized into three main features which are:

- **Tracking real-time information of a bus**

The real time information includes the current location of a particular bus on the specified routes, the departure and arrival time of the bus, the mode of payment of that particular bus and the current status of the bus.

- **Provide information to the bus management**

  The management should be able to monitor all that happens on the bus, the current location of the bus and the route the bus travelled in a day and all the daily transactions carried on a particular bus.

- **Crowd sourcing**

  Give the users the chance to update traffic information of a particular location and the status of a bus. Traffic status will the drivers and the commuters to make informed decisions so that they do not end up wasting time.

1.3 Implications

The successful implementation of this project would be a step towards improving the transit experience of the commuters, drivers and the bus management. It will greatly impact the commuters who patronize public transport each day. Being able to access real time information of a bus is very important to a commuter as they will be able to plan ahead of their trip. It will also impact the management such that they will be able to track the bus daily activities and since the services will be open to the commuters, they will strive to give the best service.

1.4 Approach

A transit system that provides necessary information to the driver, commuter and the bus management will be built. This system uses mobile and web application interfaces and is compatible with any smartphone or web browser and mobile browser. The first step taken was to learn more about public transport system in Accra Ghana and the challenges faced by all users.

This was achieved by approaching Metro Mass transit in Accra Ghana. Besides interviewing, public transport routines were observed, as well as the interaction of users as they patronize the service. The findings were used to define requirement analysis that was used to develop the system.

1.5 Motivation

Ghana's transport system is very unpredictable and one cannot easily tell the real time location of a bus. Two things played a major motivation on this project. The first was having to find a bus heading to a particular direction proved difficult for new patrons of the public transport system. This is associated with unnecessary struggle of hoping from one bus to another to find the right bus heading to a particular destination. Secondly, since most of the buses in Ghana do not have a formal schedule, it becomes really difficult for the user to tell the location and time for the next bus.

1.6 Literature Review

Availability of transit information is very crucial in the modern world. Big cities in the developed countries have real time information of transit system displayed at the bus stops and rail station. For the developing countries they only have the airplanes real time information at the airports. Developing countries have limited displays at bus stops due to the high cost associated with it. With the availability of mobile devices, computers and the internet, there are transit systems have been developed to provide real time information of transit. These transit systems are built according to the level of technology and accessibility of relevant information in a country. One motivation for developing the transit systems is the availability of mobile devices that can support additional personalized functionality such as customized alerts and the flexibility of accessing the information. Another motivation is the unlikely that real time information of a bus will be available at every bus stop or any accessible place.

One of the earliest transit tracking systems is BusView, an online transit system developed by Daniel Dailey and others of Washington University (Brian Ferris; Ferris, 2009). This transit system was mainly dependent on the internet, hence no internet connection meant no service. The features present in the system were the ability to provide real time information of the bus. This was achieved by displaying a map and icons representing the current location of the buses. The system could also predict departure time of a bus. This was made possible by integrating BusView with MyBus - an independent transit system developed at Washington University that served the same purpose as Busview. Upon clicking on a bus icon on BusView map display, the user was directed to MyBus page which showed the departure time predication of that particular bus. The last feature was an alarm notification on arrival to the rider's location. This feature allowed the user to set an alarm at a certain location and have BusView provide notification of a bus arrival at that point (Daniel J. Dailey, 2001). The application is no longer used as new transit systems that have advanced features and technology were developed afterwards.

Google Transit followed BusView. It was first launched as a lab product in December 2005 (Ferris, 2009). Its main feature is public transportation trip planning that combines the latest travel agency data with the power of Google maps. It integrates transit stop, route, schedule and fare information to make trip planning quick and easy for the users (Google Transit Partner Program, 2016) . Google transit has been integrated to Google Maps, and now offers transit information to more than 405 cities all over the world. Aside the fact that it provides trip planning on a web based interface, Google transit exists on a number of mobile devices making the use of mobile sensors such as WiFi and GPS to improve usability of the Google Maps app (Ferris, 2009). The trip planning feature in Google transit is not customized for the developing countries, hence the names of some places are not found.

Other examples of transit systems that are widely used on mobile devices are OneBusAway and Tiramisu (Italian word meaning "pick me up"). OneBusAway was developed by Brian Ferris, Kari Watkins and others of University of Washington. It provides real time information for the Seattle bus riders through a variety of interfaces including web, SMS and Mobile devices (Ferris, 2009). It is an improvement of BusView since BusView was mainly used on a web browser and provided limited information. The dominant features of OneBusAway include a real time tracker, service alerts and the trip planner. With the real time tracker, one option is available for the users is, telephone numbers are provide whereby a commuter can call and have real time information read to them. The commuter can also access the real time information form the SMS interface or a standard web browser and a website optimized internet enabled phones. With service alerts commuters are continually updated on emergencies as they emerge. These could be weather or traffic emergencies. The trip planner feature uses an origin and destination address to search for one or more scheduled trips that travel between the two locations.

Tiramisu, unlike the others, focuses on crowd sourcing acquisition of information about the bus location and fullness, where it provides a platform for reporting problems and positive experiences with a transit system (Aaron SteinFeld, 2011). One unique feature from the mentioned transit system is its ability to support specific information and reporting needs for riders with disabilities. Its other features such as real-time tracker and alerts are similar as the other transit systems, the only difference being that Tiramisu uses crowd sourcing to make these functionality available to the other users. The riders feel involved with the system since they have control over the system in terms of determining the current location of the bus and its capacity.

The mentioned transit systems were developed in the United States, a country that has enough technological resources available. Catch The Bus is a transit system that was developed

by Ivan Digber, a student from Ashesi University College in Ghana to improve the transit experience of the school's community. The system provides relevant information to the bus riders such as real time information and the traffic updates. The main objectives of the system were to log on the current location of the bus, present the information to the users in a presentable manner and provide bus information to the low end phone users (Digber, 2012). Catch The Bus system had a GPS device which had to be put in the bus to log on the current location of the bus and send it to the database.

Table 1-1 showing comparing features in the transit systems

Feature	Tiramisu	OneBusAway	BusView	Google Transit	Catch The Bus
Real Time GPS Tracking	YES	YES	YES	YES	YES
Trip planning					NO
Alert System	YES	YES	NO	NO	NO
Crowd Sourcing	YES	NO	NO	NO	NO
SMS Interface	YES	YES	NO	NO	YES
Web Interface	YES	YES	YES	YES	YES
Mobile Application (Used in Smartphone)	YES	YES	NO	YES	YES
Predict arrival of the bus	YES	YES	YES	NO	IN PROGRESS
GPS equipment equipped in the bus	NO	YES	YES	NO	YES

The rest of the report is organized as follows: Chapter 2, Requirement analysis-which gives details of the requirement specifications, Chapter 3 Design and Architecture-shows the system design of various components and the architecture pattern used, Chapter 4 Implementation-describes the

implementation including tools, libraries frameworks APIs and components used to develop MyRide, Chapter 5 Testing and Results-discusses the testing techniques used and the results in each test, chapter 6 conclusions and recommendations-summary of the degree to which the project meets functional requirement and the Appendices-provides use case system testing.

Chapter 2 : SOFTWARE REQUIREMENT SPECIFICATION

This chapter gives detailed description of the requirement specification for MyRide transit system. It explains the system users, interface and interaction with other applications and the system constraint. The chapter served as reference during the implementation of the system.

2.1 Overall Description

This section gives an overview of the entire system.

2.1.1 Product Perspective

MyRide system consist of two parts; MyRide GPS log application and MyRide user interaction application. MyRide GPS log application is an android application used to provide the current location of a bus by pushing the longitude and latitude of a place to the database. MyRide user interaction application is used to provide real time information to the driver, bus rider and the bus management. This is either in form of a web application-one that runs on a web browser, or a mobile application installed in a smartphone device.

A database is required to store data input. MyRide log application and MyRide user interaction communicates to the server while sending and retrieving the data to the database.
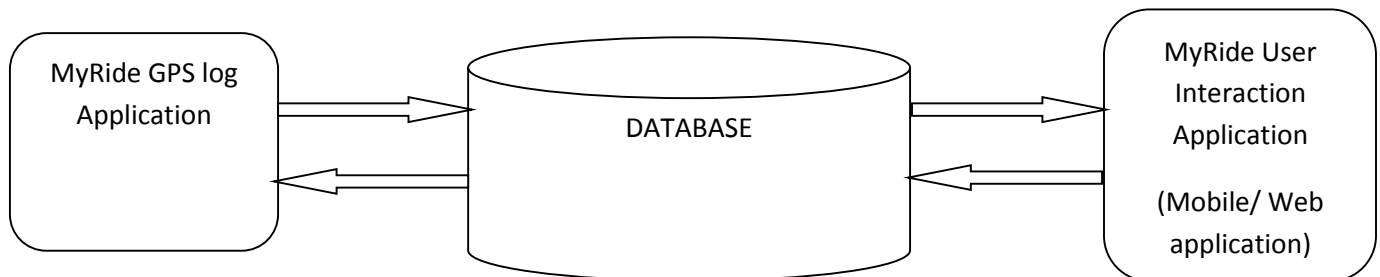
Figure 2-1 Interactivity between the MyRide Log and MyRide Interactive application

2.1.2 Product Functions

The major goals of MyRide system are to:

- Allow bus riders to have access to bus information and view real time information of the bus

- Serve as a monitoring tool to the bus management

The major functions the product performs are to:

- Log on the current location of the bus using GPS device in this case an android phone

- Guide the users while travelling by providing real time information of a bus

- Allow the management to update details about the bus

- Allow other users to update details about the traffic status which includes an accident occurrence or a traffic congestion.

2.1.3 User Classes and Characteristics

MyRide has three groups of users; the bus rider, the bus driver and the management.

This is anyone who patronizes the bus service and has a mobile device. The user does not have to have any prior knowledge of using the application. This user is expected to have a smart mobile device such as a smart phone, tablet or iPad. With this can view the real time information of a bus in a more interactive way. They must ensure that the devices they are using have good internet connection
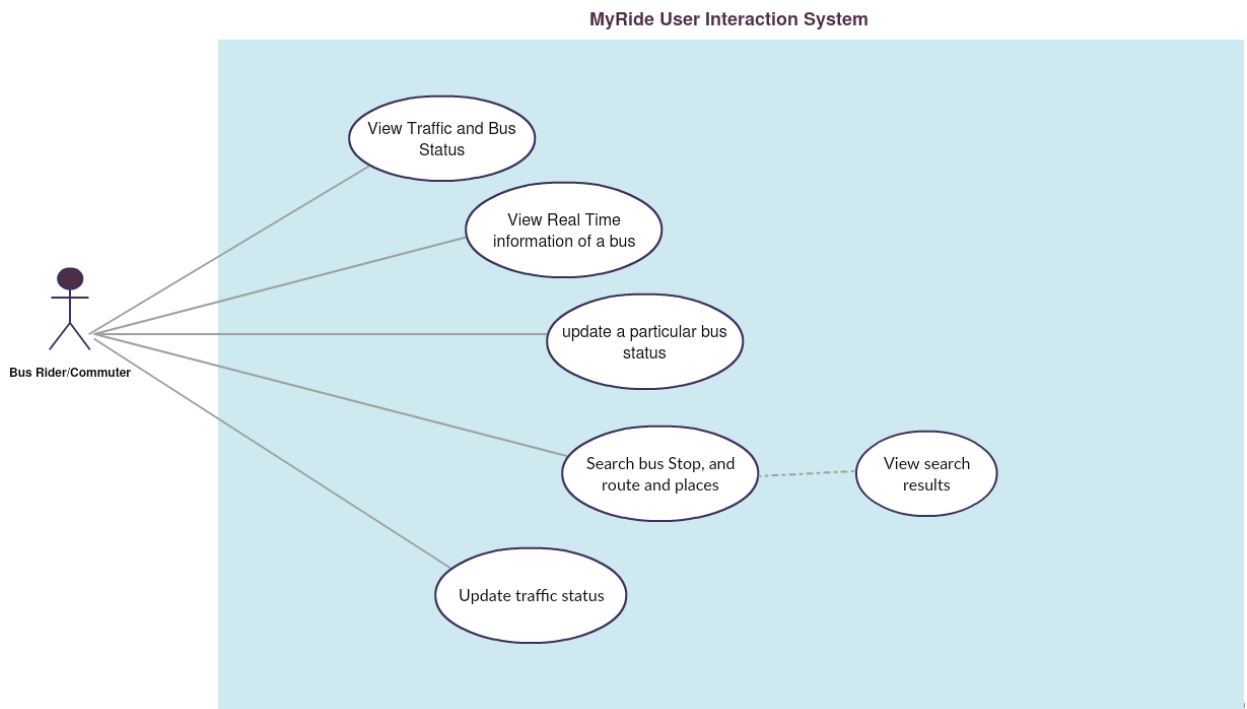
Figure 2-2 Showing Use Case UML diagram of the Bus Rider

2.1.3.2 The bus driver

This is the person driving the bus. He/she can update the current location of a bus i.e. if a bus breaks down. The driver can also update the traffic information of a bus especially when caught in a heavy traffic congestion.

MyRide User Interaction System

update a particular bus status

Bus Driver

Update traffic status
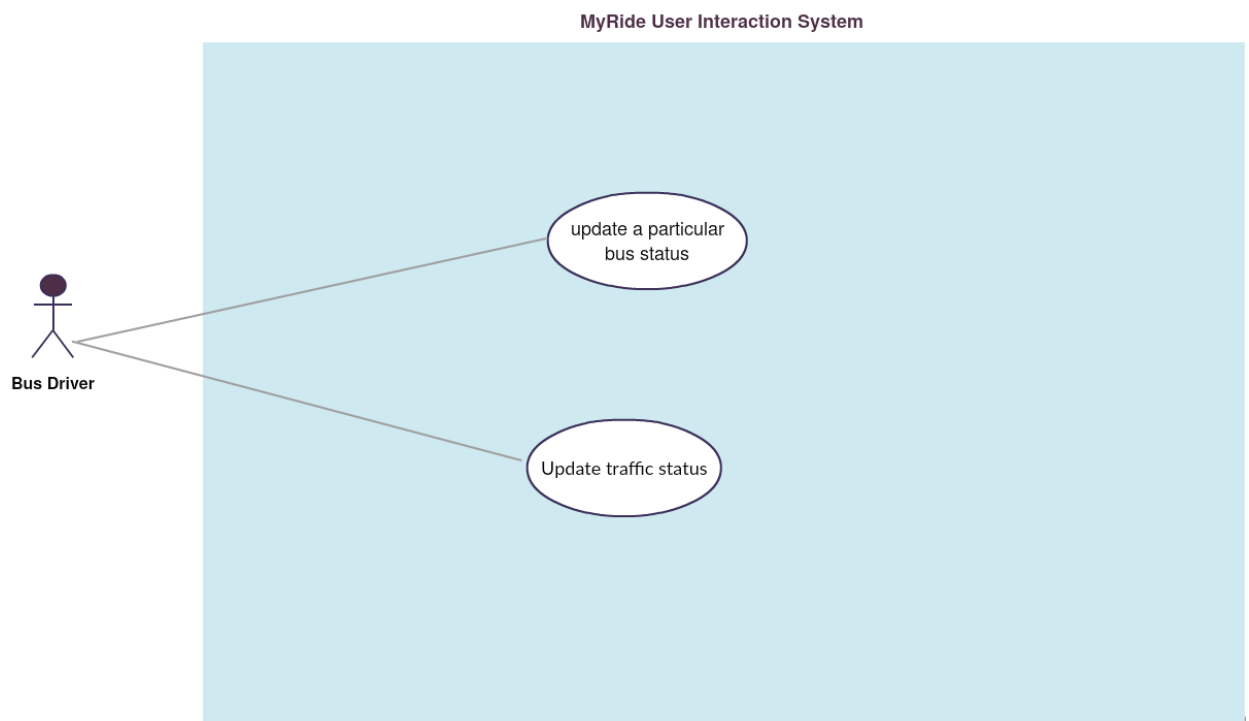
Figure 2-3 Showing Driver Use Case UML Diagram

2.1.3.2   The bus Management

The management are the administration department of the bus agency. All they have to do is update the current status of the buses i.e. add a bus to a particular route and stop a particular bus

from offering its service. They also monitor the daily usage of the bus i.e. tracing where the places the bus has been to. This is visually presented to them.
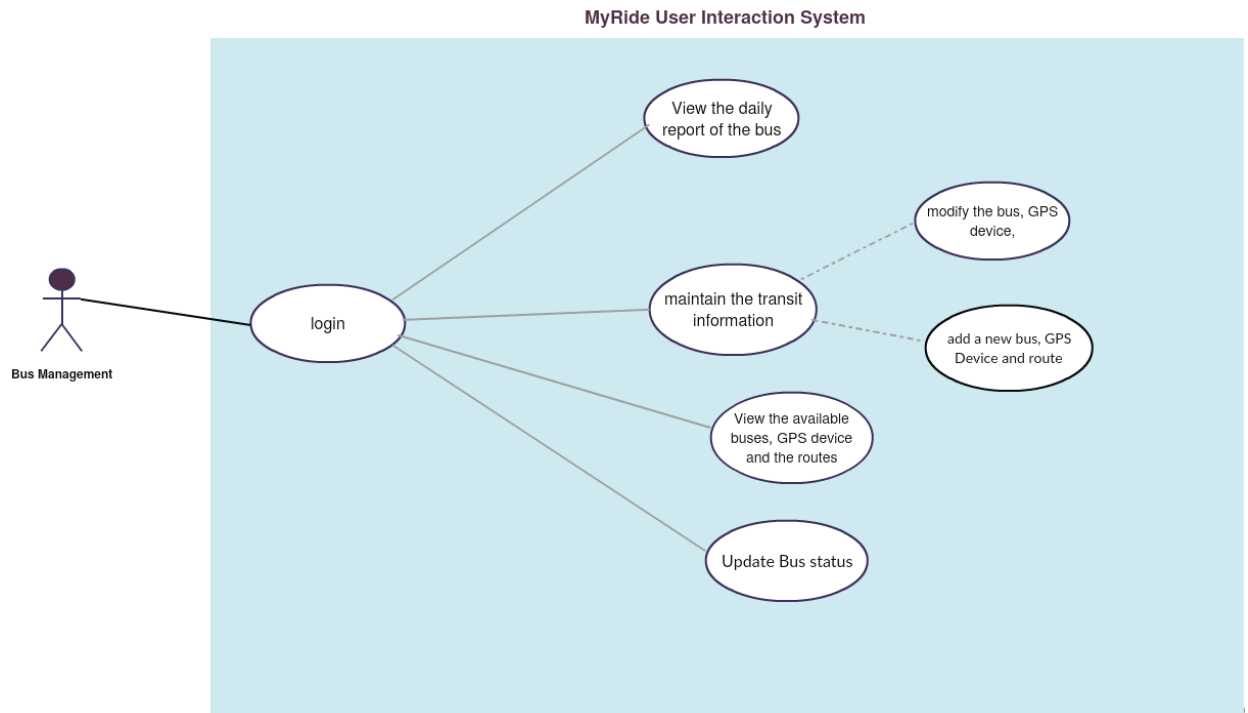
Figure 2-4 Showing Bus Management Use Case UML Diagram

2.1.4 Constraints

Internet connectivity is the major constraint of MyRide system. This is because of the GPS, which requires constant internet access to function. Internet will also be used to push and pull data from the database as the users interact with the system.

Crowdsourcing is another constraint of MyRide system. This is because the commuters might not fill in the appropriate information or just not fill in at all. This will negatively affect some functionality of the system which is to tell whether the bus is full, traffic and bus status.

2.2 Specific requirements

This section describes the external interface, functional and non-functional requirement of MyRide.

2.2.1 External interface Requirements

The external interfaces are the interfaces that the users will directly interact with while using the system.

2.2.1.1 User Interfaces

Different user classes of MyRide have a different interface apart from the home page which is a map displaying the user's current position and the current location of a bus. These interface is accessible to any user group without any restrictions. Most of the application functionality are found at this particular interface hence it is very crucial. At the rider's page, the bus rider can view the status of the traffic and bus, view the bus stops available and the bus information at each bus stop.

The bus management interface shows the management team the daily transactions of the bus and gives them the option of adding new things such as a new bus and a new GPS device.

2.2.1.2 Hardware Interfaces

The product is supported on a desktop computer which will mainly be used by the management while monitoring the daily transaction and the bus movement. Using a web application in this case is more convenient to them for user friendliness as they need a bigger interface to add functionalities and monitor the buses. The mobile application that logs the current location of a bus is used on android smartphones. The mobile phone will then be kept in a particular bus.

2.2.2 Functional requirements

This section describes the major functions of the system. They are divided according to each user requirement starting with the bus rider, followed by the driver of the bus and lastly the management of the bus. Each functional requirement provides the title, description, rational and the dependency if need be.

2.2.2.1 User 1 – Bus Rider

These functional requirements are specific to the bus rider user.

2.2.2.1.1 Functional Requirement 1.1

TITLE: Display the map of the given area centering the current location of the user

DESCRIPTION: Given that the user has launched MyRide application on the mobile or the web portal, the first page displayed is a map showing the users current location. The user's current location is displayed by a yellow marker.

RATIONAL: In order for the bus rider to see visual representation of where he/ she hence find it easy to navigate and relate to the features on the map.

2.2.2.1.2 Functional Requirement 1.2

TITLE: Search (Bus Stop, Route, Destination)

DESCRIPTION: The user should be able to search for his/ her destination, bus stop or route. The search text option should be available for the user to search in case they are not able to locate the place on the map.

RATIONAL: In order to help the users to quickly point out where they are going on the map and also get specific information.

2.2.2.1.3   Functional Requirement 1.3

TITLE: Map search results

DESCRIPTION: The results of the search should be displayed on the map so that it is more visual to the user. If the user searched for a destination, there should be a polyline from the user's current position to the destination. Bus markers of the buses and bus stops available on the route from the user's current positon to the destination should also be displayed.

RATIONAL: results are displayed on the map for the user to visually view the information.

DEPENDENT: Functional Requirement 1.2

2.2.2.1.4   Functional Requirement 1.4

TITLE: Check for the Bus Details/ real time information

DESCRIPTION: After the search results have been displayed the user should:

- View the current location of a particular bus they want to use

- Check whether the bus is full or not from the result when the bus is clicked

- Know if the bus has any issues raised like broken glass or a puncture

RATIONAL: In order for the user to make informed decision whether they want to board a particular bus or not

DEPENDENT: Functional Requirement 1.2 and 1.3

2.2.2.1.5   Functional Requirement 1.5

TITLE: View Traffic and Bus Status

DESCRIPTION: The user be able to view the traffic and bus status. This should be displayed in the order of the latest update.

RATIONAL: In order for the bus riders to make informed decision on whether they are going patronize a particular bus or not, or whether they are going to use a different route.

2.2.2.1.6   Functional Requirement 1.6

TITLE: Display the bus stops, the current location of the bus and the traffic status on the map

DESCRIPTION: The map shows the current location of the bus as it changes, the locations with traffic update and the bus stops at every route.

RATIONAL: This enables user to visually relate what is on the map and is able to make sound decisions.

2.2.2.1.7   Functional Requirement 1.7

TITLE: Update bus status

DESCRIPTION: The user should be able to update the status of a particular bus. This may be a broken window glass, dirty seats, flat tire etc.

RATIONAL: In order to alert other users and the management on what is happening on a particular bus.

2.2.2.1.8   Functional Requirement 1.8

TITLE: Update traffic status

DESCRIPTION: The user should be able to update the traffic status i.e. if there is an accident along a way, traffic jam or very dangerous potholes.

RATIONAL: In order for the other users and the management to be able to make informed decisions i.e. whether to use a particular route or not.

2.2.2.2 User 2 – Bus Driver

2.2.2.2.1 Functional requirement 2.1
TITLE: Update bus and traffic status

DESCRIPTION: The driver should be able to update the bus status that is when he /she is not driving. These maybe; the bus has broken down or has a flat tire. The bus requires servicing. This update will be viewed by the bus management and the users. They can also update traffic status

RATIONAL: In order for the bus management and the commuters to tell what is happening and take the necessary action as possible.

2.2.2.3 User 3 – Bus Management
This section provides the functional requirements of the bus management.

2.2.2.3.1 Functional Requirement 3.1
TITLE: Register an Agency/ Sign up

DESCRIPTION: The Bus manager should be able to register their agency by feeling in mandatory information which is: agency name, company email, Phone Number and location. After submission, the user will have to wait for verification before proceeding.

2.2.2.3.2 Functional Requirement 3.2

TITLE: Login as agency

DESCRIPTION: The bus manager should be able to login to their agency page by filling in mandatory information which is: agency name, company email, Phone Number and location. After submission, the user waits for verification before proceeding to the management dashboard.

Rational: This is secure MyRide System so that not just anyone can modify and have access to the critical information.

2.2.2.3.3 Functional Requirement 3.3

TITLE: Management Information

The Bus management should be able to manage information concerning their agencies these are:

Scenario 1: Add information

The management should be able to add information when necessary. These includes adding a new bus, adding a new driver, adding a new route and GPS device.

Scenario 2: Edit information

The management should be able to edit already existing information. These includes; editing the GPS device information, bus information, route information and agency information.

Scenario 3: Generate Reports:

The bus management should be able to generate quarterly, weekly, monthly or yearly report.

Scenario 4: Update Bus Status

This activity may be to remove a particular bus from the list or state a problem the bus has. The information should be visible to the commuters.

2.2.2.3.4 Functional Requirement 3.4

TITLE: View Daily transaction and information on all buses in the agency

DESCRIPTION: The management should be able to view the daily information of the bus where they have been at what time and for how long.

2.2.3   Non- Functional Requirements (NFR)

This section describes the system attributes which are; maintainability, security, portability and reliability.

2.2.3.1 Maintainability

TITLE: Ability to extend the application

DESCRIPTION: The system is written in such a way that new functionalities can be added in future.

RATIONAL: In order to improve the system and add new functions to it

2.2.3.2 Security

NFR 1

TITLE: Bus Management Login

DESCRIPTION: The bus management should login for authentication purpose so that not anyone will view details of a particular agency, and make changes

RATIONAL: In order to prevent unauthorized access of the agency information

NFR 2

TITLE: Communication security between server and the system.

DESCRIPTION: The login and signup information is encrypted before it is sent to the database.

RATIONAL: This is to prevent eavesdroppers from accessing the information and using it to gain unauthorized access.

2.2.3.3 Portability

TITLE: Application portability

DESCRIPTION: Since MyRide user interaction is a PhoneGap application, it should run in android, IOS windows, Amazon and blackberry platform. It should also load in any web and a mobile browser.

RATIONAL: Bus users use different types of smartphones hence restricting the system to a particular smartphone will make it inefficient.

2.2.3.3 Availability

NFR 1

TITLE: GPS Device

DESCRIPTION: There should a GPS device installed in the buses so as to send location data to the database.

RATIONAL: In order to log in the current location of the bus.

NFR 2

TITLE: Internet Connection

DESCRIPTION: Internet connection should be constantly available since functionalities like the google map and GPS device would require internet connection to function properly

RATIONAL: In order to ensure smooth running of the application and communication between the server and the application.

2.2.3.4 Reliability

TITLE: The ability of the system to yield same results every time.

DESCRIPTION: the system should be able to produce consistent results during each search instance. The results should 100% consistent. The plan is to do as many tests as possible to test system reliability.

Chapter 3 : ARCHITECTURE AND DESIGN

This section discusses the design and the architecture of MyRide System. It presents the architecture pattern and discusses each module in detail, and shows activity diagrams and the interfaces designed to represent interactivity with the system

3.1 System Overview and Architecture

MyRide System architecture makes use of an n-tier architectural design, which is server-client based architecture. In this design, the presentation, data processing and the data management functions are separated from one another so it is possible to make changes to each tier even after deployment. The number of tiers used for MyRide system were four which include the data presentation tier, data rendering and visualization tier, data processing tier, and the data storage and retrieval which is the database tier.

The illustration of the design architecture is shown below:

Table 3-1 Showing the 4-Tier Architecture of MyRide System

Data Presentation /User Interface Tier **Web Application || Mobile Application**
Data Rendering and Visualization (DR V)
Data Processing Layer (DPL)
Data Storage and retrieval- MyRide Database (DSR)

3.1.1 Data Presentation

This layer is responsible for displaying an interface in order for the user to interact with MyRide system. The Web application interface and the mobile application interface are similar.

The only difference is the navigation menu which is hidden in a mobile interface but present on desktop web browser interface. The interface displayed includes Google Map centering the current location of the user and the current location of the buses and the bus stops available. The bus management is be prompted to a login page. After logging in, they can view the interface to add the bus details, GPS, bus Stops, bus schedules and the driver's details. All user groups have access to viewing the real time information of a bus and the buses available.

3.1.2 Data Rendering and Visualization

This layer is responsible for communicating with the data processing layer and the data presentation layer. The results from the data processing layer are made available to the interface. The user input from the data presentation is picked and passed to the data processing layer where it is sent for processing. This layer acts as a connection management layer because of the tasks it performs.

3.1.3 Data Processing Layer

This layer is responsible for processing the data that is obtained from user input before sending it to the database. It will also process data from the database before it is passed to the data rendering and visualization layer. The processes include real time location of the bus, finding the nearest bus from a location, trip planning from the bus daily schedule, GPS device logging current location, granting permission to the management to add the details.

3.1.4 Data retrieval and storage

This layer is responsible for loading data from the data processing layer to the database and retrieving data from the database to the data processing layer. The information stored and retrieved

includes the current location details of the bus, the updates, the traffic updates, the bus schedules

and the bus stops and routes available in a given place.

3.2 Activity Diagrams

These diagrams show the flow in activities of some requirement specification. The activity

flow is sequential to yield result as expected.

3.2.1 Search Activity Diagram
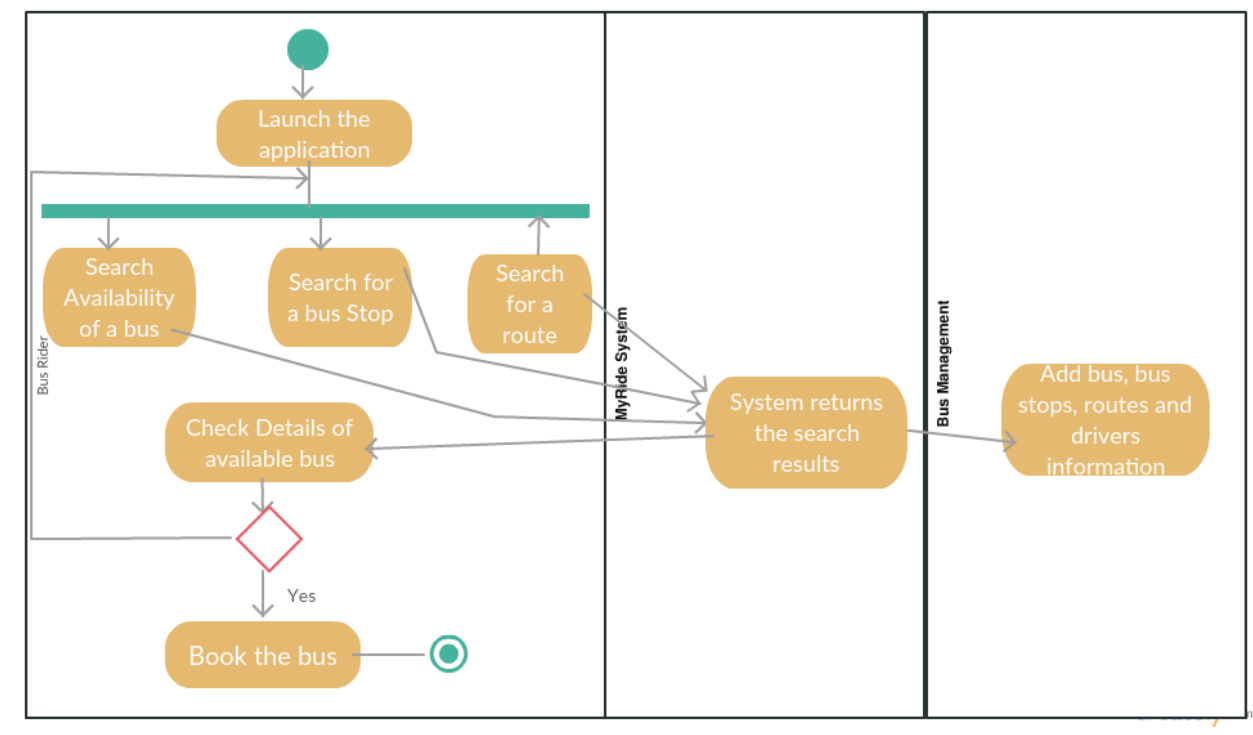
Figure 3-1 Search Activity Diagram

For the user to search for either a particular bus, route or a bus stop, they have to first

launch MyRide application. To search for a bus, the bus rider navigates to their page and enters

the name of the bus on the search box. To search for routes, the bus rider will enter the route name

or type the place of departure and destination. All the search is sent to the data processing layer

which gets the command and retrieves results from the database. The result is then presented to the user via the presentation layer.

3.2.2 Log Current Location of the Bus
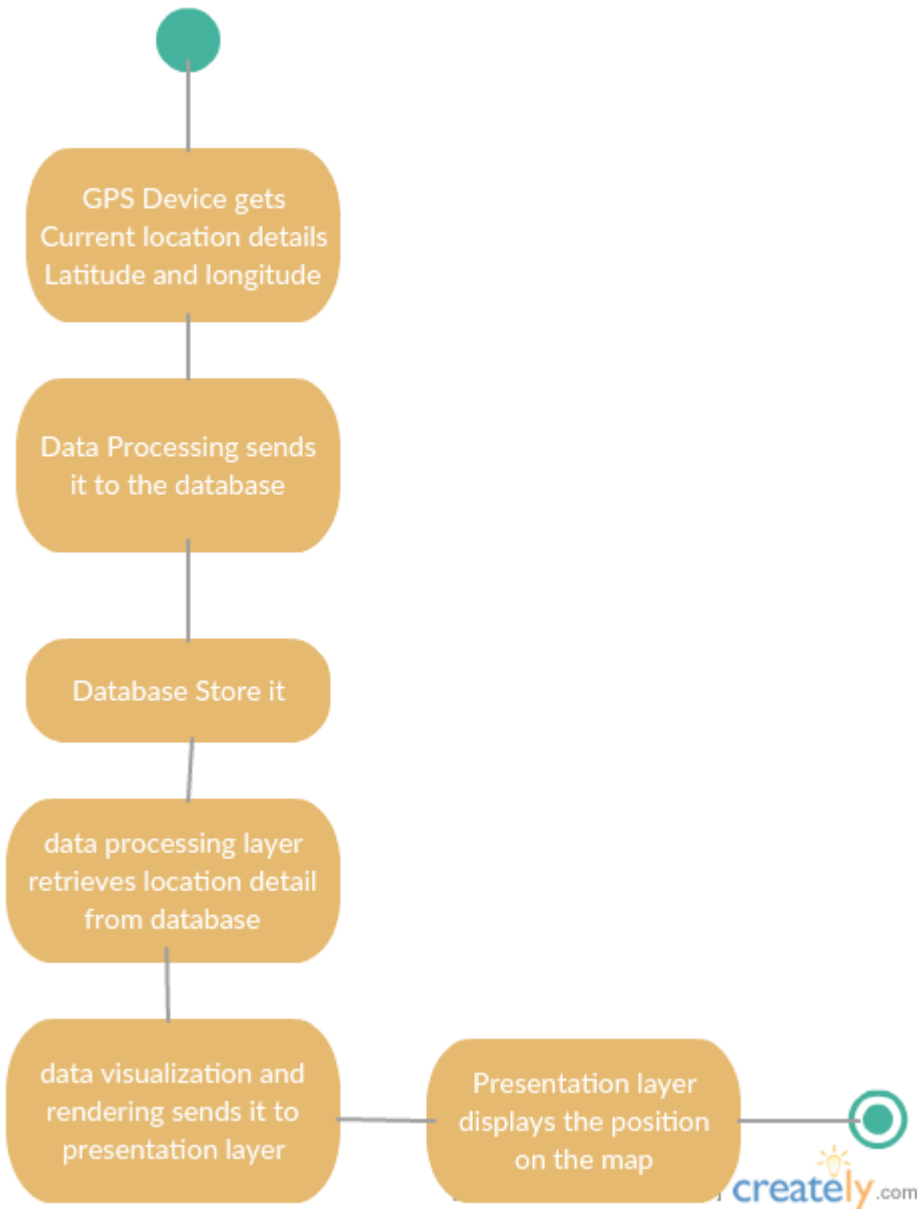
Figure 3-2 Figure showing Log Current Location of Bus activity diagram

The GPS device gets the current position of the bus and sends it to the data processing layer which processes the information. It sends it for storage in the Data storage and retrieval – MyRide database. The latitude and longitude of the current location sent to the database is then retrieved and passed to the data processing layer where it is processed and then sent to the data rendering and visualization where it is made available to the interface. The current position is then displayed on Google map in the form of clickable bus markers.

3.2.3 Update Bus and Traffic Status
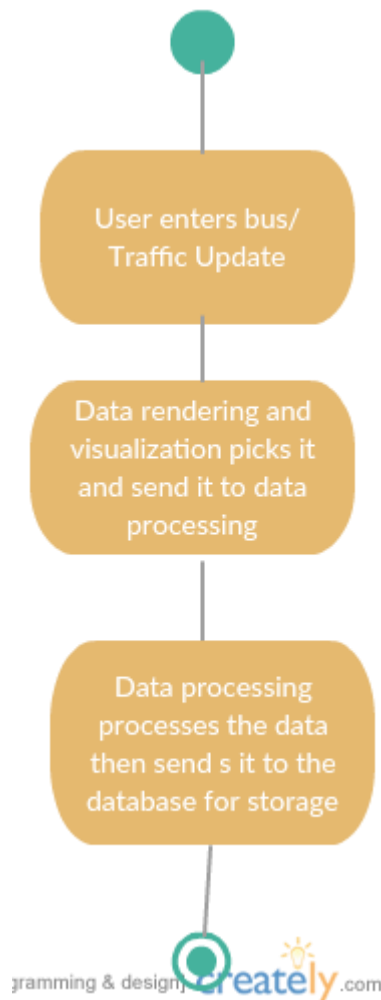
Figure 3-3 Update Traffic/Bus Status

The user selects either the bus or traffic to update. They will then be prompted with a form to fill the update. The update information will then be send to MyRide Database for storage.

3.2.4 Viewing the Bus/ Traffic status
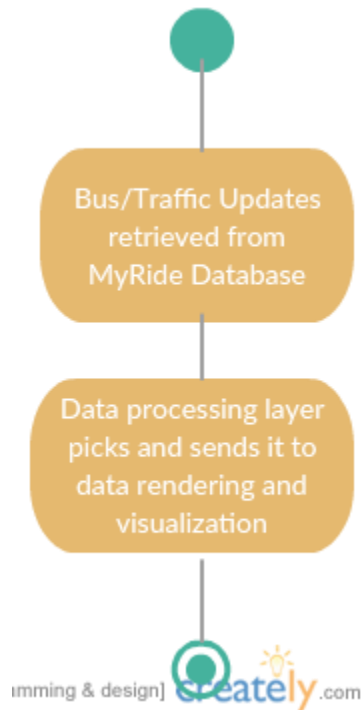
Figure 3-4 View Traffic/Bus Status activity diagram

For the bus and traffic updates to be displayed on the users interface, the data has to be retrieved from MyRide database. The data processing layer will then pick the data process it before making it available in the data visualization and rendering layer where it is displayed to the user interface.

3.3 Database Design

The database contains all the information the user needs to access while on transit. This includes the routes, the buses available, available seats on the bus, the bus schedules and the current location of the bus. In order to accomplish successful communication between the user and MyRide application, the data in the database must be successfully stored and retrieved from the database. The tables used in the database represent a component in MyRide system. The table below shows the database tables used to model MyRide system.

Table 3-2 Showing the tables used in MyRide database

Table Name	Field Name	Data Types	Field Description
Bus	Bus_Id Bus_Name Bus_DriverId Bus_RouteCode Bus_Agency	Int Primary Key Varchar Varchar Varchar Varchar	This table will contain information on Bus is, bus name, bus Driver, Bus Route of a particular bus
Routes	Route_Code Bus_Id	Varchar Varchar	The tables holds the names of a particular route
Bus Stops	Bus_Stop_Id Bus_StopName Route_Id Longitude Latitude	Int Primary Key Varchar Varchar Float Float	This table encompasses the names of the various bus stops in the greater Accra region
GPS_Device	Device_id longitude latitude Timelogged	Int Primary Key Float Float timestamp	This table has the GPS device details. These are the details that will be used to locate a particular bus
Traffic_jam	JamId Update_time Jam_statement Longitude Latitude Level_of_traffic	Int Primary key timestamp Varchar Float Float Varchar	This table has information on all the traffic jam updates from the users
Driver	Driver_Id Driver_Name Driver_Bus	Int primary Key Varchar Varchar	Contains details about a driver of a particular agency

	Driver_Route Bus_Agency	Varchar	
Bus management	Admin_Id Admin_Name AdminPassword	Int primary key Varchar Char	encloses information about the bus management of a particular agency
Accident Table	UpdateId Update_time Update Longitude Latitude Accident_level Payment_Mode	Int Timestamp Text Float Float Varchar	The table holds information on the accidents updated by the user
bus_info	info_id BusIdInfo fromNode toNode nextStop capacity_status	Int primary key varchar int int int varchar	This table has bus information
Bus_ Status	Status_Id Status Importance Date_updated BusName	Int Primary key Varchar Varchar Timestamp varchar	Comprises the status of a particular bus as updated by the user.
track_the_bus	Track_id Device_id Longitude Latitude TimeLogged	int Varchar Float Float timestamp	contains the track record of the bus as it moves throughout the day

Chapter 4 : IMPLEMENTATION

As mentioned in Chapter 2, MyRide has two main applications:

1. MyRide Log application. This will be used on a GPS device, the device will be an android mobile phone. It will obtain location information from the GPS then send it to the server which will store it in MyRide database.

2. The second application is the one that users will interact with "MyRide" application. This one obtains information from the server and makes it available to the users. The users to enter information which is send to the server and retrieved latter.

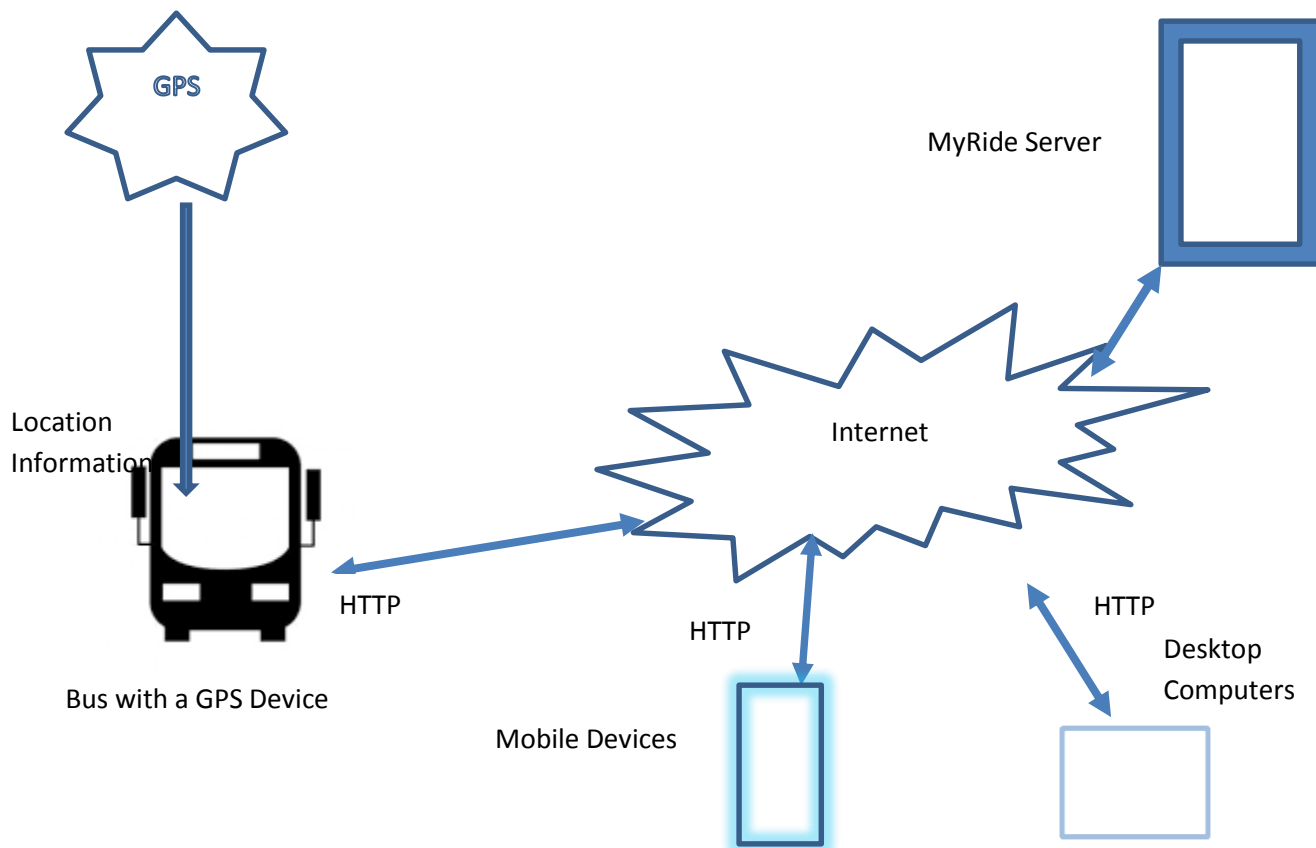The figure below shows the representation of the interactivity of the different modules.

Figure 4-1 Representation of the interactivity of MyRide Modules

4.1 Implementation Tools, API, Framework and Libraries

Since MyRide application consists of two applications that communicate to the server, two different implementations were done. These are: implementing MyRide log application and implementing MyRide user interactive application.

4.1.1 MyRide Log Application

This was developed using the Android development platform-the Android Studio. The programming language used here was Java. Android platform provided the API that was used as reference during development. The following are the android libraries used in the implementation:

- LocationManager - this library provides access to system location and updates the current location of the device after a specified distance or time.

- Location - this represents the geographical location. It consist of latitude, longitude and the timestamp

  Note: for locationmanager and location to work, the methods require the ACCESS_COURSE_LOCATION and ACCESS_FINE _LOCATION permissions which is enabled in the applications, manifest file.

- Service- This keeps the application running in the background.

4.1.2 MyRide User Interactive application

Since this application was to be converted to a phone application using PhoneGap, the tools used to develop the webpages were Hypertext Markup Language (HTML), Cascading CSS and JavaScript. The framework used to enhance the interface feel and interactivity was Materializecss. Materializecss has JavaScript that and CSS files that are mainly included in the instances where

needed. Components that used Materializecss include forms, modal pop ups, buttons and general layout of each webpage.

Hypertext preprocessor (PHP) which is a server scripting language was used to represent all the major components and communication to the server. The major components included the bus, GPS software and the current location of a bus. Asynchronous JavaScript XML (AJAX) was used to load pages and communicate with the server side script PHP.

The API used in this application is the Google Map API. Which made use of the google Direction and places libraries. The places library identified places on google maps by place id whenever a search was performed. The direction API made it easy to tell directions from one location to another on the map as it made drew a polyline from start to destination.

4.2 Database Technology

Database management system used for implementation was MySQL. To establish connection to the database, query the database or fetch results from the database, PHP language was used to program these functionalities. AJAX was used to communicate with the database whereby it either retrieved information from or stored information to MyRide database.

4.3 Display current location of the a bus on the Map

The position of the bus that shows up on the map should change at an interval of 30 seconds if the bus is in motion. To achieve this, each GPS device was uniquely identified by the bus ID it was put on and it served as a primary key on the GPS table. Once the location detail is sent to the database, the subsequent latitude, longitude and time override the previous ones except the device ID which remains the same. This was achieved by writing an SQL query which overrides the

previous inputs of longitude and attitude. Clickable Google markers were used to represent the buses.

4.4 Display of the route to a location

To display the route to a location on the, the Direction API was used. The inputs were entered in the HTML format input tag. The functionality of obtaining the place and finding its place id and drawing a polyline from start to destination was performed by a single function in JavaScript.

4.5 Client Server Technology

To enable a client server network in MyRide system, scripting languages like PHP and JavaScript was used. Hypertext Transfer Protocol (HTTP) communicates with the server by sending requests. In this case the client requests for the html files HTTP sends a request to the server which then provides the html files to the client. AJAX which communicates with the server side scripts is very useful in the server client communication in this case since PhoneGap does not process PHP files.

4.6 Challenges Faced

The major challenge faced during implementation was that Google map did not display on PhoneGap. At first it displayed an error message that stated that the API key used in the map was not valid. After the error was rectified, the map did not show at all on the PhoneGap. It was later discovered that the function to obtain the current location is deprecated on unsafe server hence the map could not show on PhoneGap application. Using a coordinates was the other option of displaying the map.

The other challenge faced was logging the current location of the bus to the database. The challenge was using the service library that was supposed to run the application as long as the track

toggle button was not off. This challenge was solved by implementing MyRide_Service class that extended service.

Chapter 5 : TESTING AND RESULTS

Testing is intended to show that the program does what it is intended to do and also discover the defects before putting the system into use (Sommerville, 2014). The three types of testing are development testing, release testing and user testing. Development testing, where the system is tested during development to discover any bugs and defects, was used to test MyRide application. The reason for selecting development testing is because the system was not complete enough to carry out the release testing-where a separate testing team tests the program before it is released, and user testing-where potential users of the system test it in their own environment. Development testing involves three different categories of testing which were all employed to test MyRide these are: Unit testing, Component testing and System testing.

5.1 Unit Testing

This kind of testing focuses on the functionality of objects or methods in the program. Individual program units are tested to satisfy that they are working as expected and yield the correct result. PhpUnit testing was used to carry out unit testing on the PHP function developed. Below is a table showing the classes that were tested and each method in the class:

Table 5-1 Unit testing on Classes and methods

Class	Method	Pass/fail
GPSDevice	addGPSDevice()	Pass
	retriveLocationDetails()	Pass
Bus	addNewBus()	Pass
busStops	addNewBusStops()	Pass
Routes	addNewRoute()	Pass
Administrator	signUp()	Pass
	Login()	Pass

5.2 Component Testing

This kind of testing involves testing of different system components. Software components are composite components made up of several interacting objects. Unlike unit testing, test cases are applied to the interface of the composite component created by combining the components. The components tested were updating the status of a bus, displaying the bus status, Management login and the adding to the database.

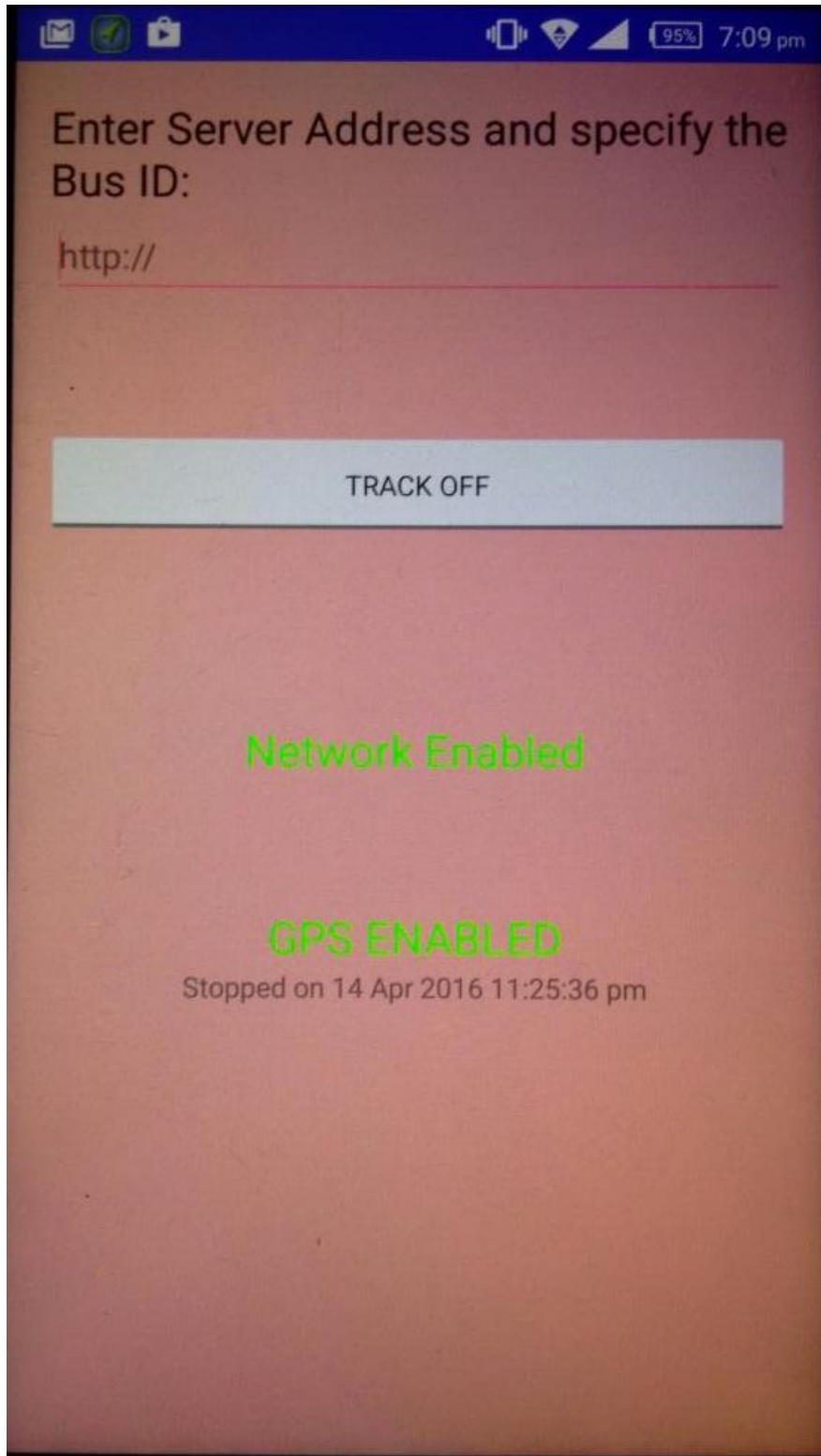The following figures show different component testing carried out on MyRide system

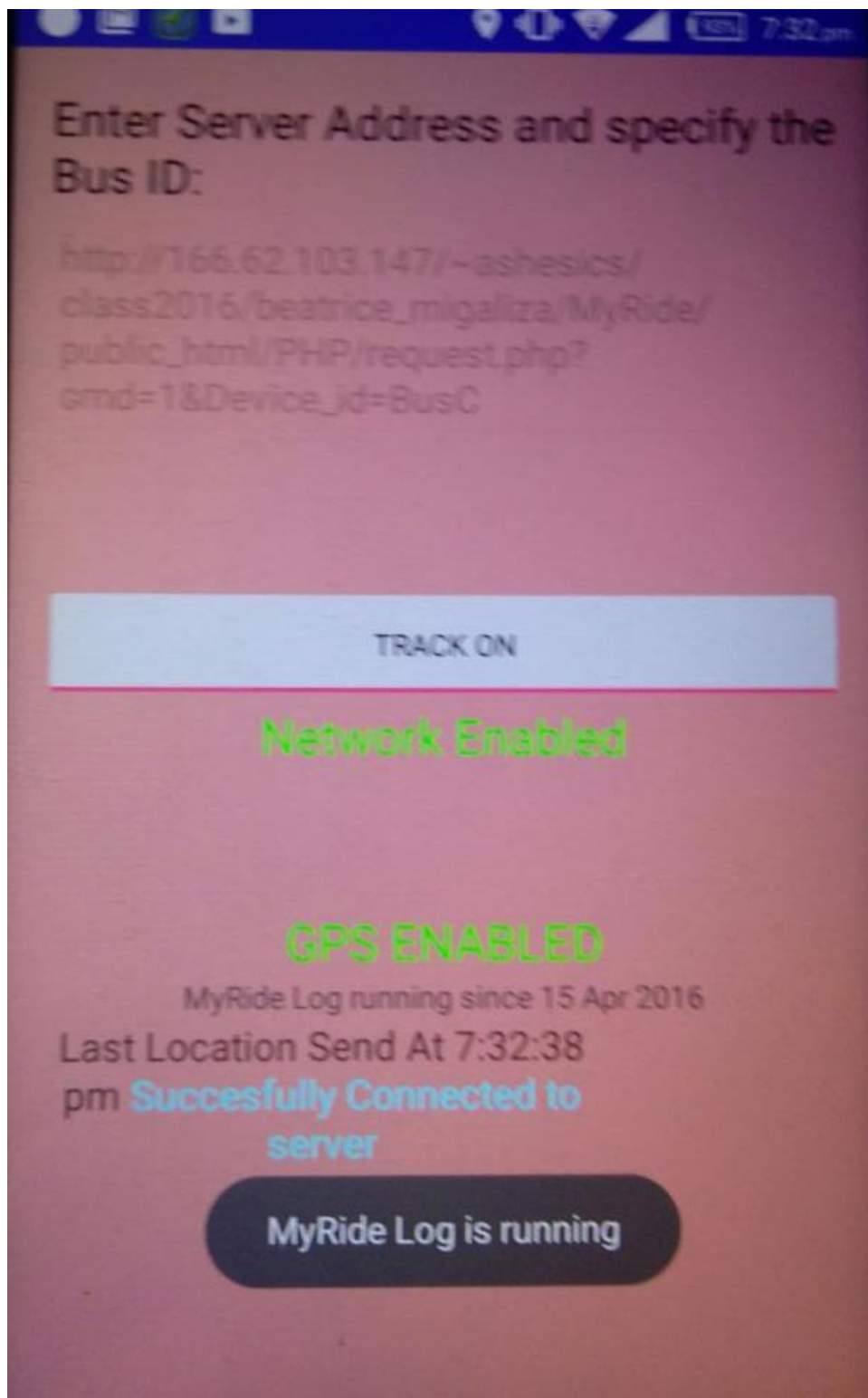Figure 5-1 Testing the Functioning of MyRide Log application to check network and GPS recognition

Figure 5-2 Testing the logging of current location details to the server

Figure 5-3 Testing the display of the map centering the current location of the user

Figure 5-4Testing the display of a Ashesi Berekuso route

Figure 5-5 Testing the display of bus stops and buses that stop at Taifa Round About bus stop

5.3 System testing

This involves integrating components to create a version of the system and then test the integrated system (Sommerville, 2014). System testing consists of two types of testing which are functional and non-functional testing. Non-functional testing is the testing done to validate system non-functional requirements while functional testing is the testing done to validate system functional requirements.

5.3.1 Functional testing

The functional testing carried out on MyRide system tested the major functional requirements mentioned in the requirement specification in Chapter2. The functional testing carried out have been explained in the appendix.

5.3.2 Non-functional Testing

The non-functional testing carried out on MyRide system was to test the system maintainability and security. In terms of security, the system restricts update of information by an authorized person. It makes use of attribute based access control, an access control that restricts access based on the attribute property, to restrict update of information like bus, GPS and driver. Only the users who have an attribute property of management can update the transit details. In terms of maintainability the system allows addition of functionalities

Chapter 6 : CONCLUSION AND FUTURE WORK

The report above discusses the implementation of MyRide transit system designed for intra-city public transportation in Accra Ghana. The implementation ideas were borrowed from the already existing systems such as OneBusAway, Tiramisu and Google Transit. The solution presented made use of the GPS satellite, GPS device, Google maps and internet to provide transit information to its users.

MyRide system allows for more features and functionalities to be added. In order to implement a working. The following are yet to be implemented:

- Planning the trip. This should show the route, total time to arrive to arrive to a destination, the best route possible and the number of transfers to make and where the transfers should be made.
- predicting arrival time of a bus
- Show the approaching buses to a particular bus stop
- Integrate mobile money payment
- Add bus updates which show on when the bus link on the map is clicked.
  Implement USSD application for use by feature phones that do not have the same functionalities as the smart phones.

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Appendix

Appendix A: Use Cases

This section describes the particular tests that were carried out on the system.

Table A-1 Functional Test to test logging current location of the bus on the map

Step	Test Step	Expected Results	Actual Results	Requirement Validated	Pass/ fail
Log Current location of the bus on the map					
1	The GPS device was given to a student who was driving to Accra town	The current location is supposed to update after every 30 seconds as the bus moves	• Current location of the bus on the map updated after every 30 seconds • At times there was delay due to inconsistent internet connectivity • The coordinates of the places the bus went to were logged into the track_the_bus table.	1.2	Pass

Table A-2 Functional Test to test search of a particular route and update of traffic and bus status

Step	Test Step	Expected Results	Actual Results	Requirement Validated	Pass /fail
Search (Route)					
1	Two Users located at different locations in Accra were asked to launch the map then query a route they wanted to search for	The map was supposed to return a highlighted polyline that had the buses available and the bus stops on that particular rout. They could click on the bus icons and view information about the bus	The users were able to see the route they were searching for. However since the buses were limited those who searched for buses that were not in the range of the location of the bus or bus stops entered did not see the buses. But those who searched for route that had a bus or bus stops were able to view them		pass
3	Two users were asked to update a traffic status and update the status of the bus	The user was supposed to be prompted to update traffic or bus status depending on what they had selected. The latest Bus status updated was supposed to display at the bottom of the map. The traffic status update displayed at the users location on the map.	• The latest bus status updated displayed at the bottom of the map • The traffic status displayed at the position as markers		Pass

Table A-3 Functional Test to test management Login

| Step	Test Step	Expected Results	Actual Results	Requirement Validated	Pass/ fail
Management to manage information Functional Requirement 3.3					
1	Enter User name and password in the text box present in the sign up page	User should be able to enter text	The user was able to enter text in the input text space		pass
2	Click the login button	The page should redirect the user to the bus management page if the login is successful if not alert him/ her that the login is not successful			
3	If forgotten password, the user should click the "forget password link"	Redirect the user to forget password page, where they have to enter their phone number to			
4	If the user does not have an account they have to click the "Register Now" link	Redirect the user to sign up page where they are supposed to sign up-(enter the details presented to them)			Pass
5	If the login is successful, the user can select the component they want to update be it bus, GPS device, bus stops or bus schedule	A pop up form appear after selecting a component to edit or update	Pop up form appeared when the add component – name was clicked		Pass
6	Click add button	Should let the user know they have successfully added by displaying a modal then close the modal form			Pass
7	Click cancel	Should close the pop up form without making any changes			Pass
8	Click on the component info	View the clicked component info			

Appendix B: Database Model
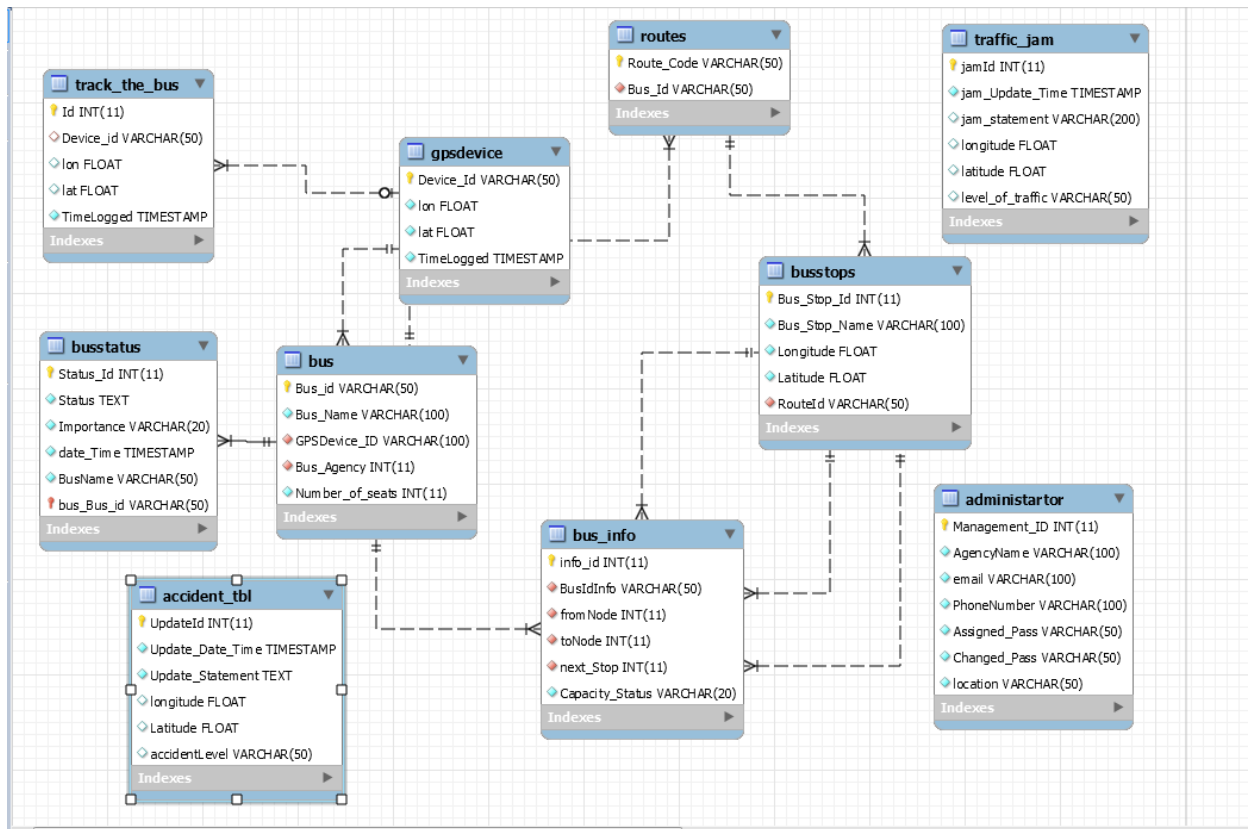
Figure B-1 Entity Relational Model of MyRide database