BUS TRACKING SYSTEM

BY

CHAI CHING LOONG

A REPORT

SUBMITTED TO

University Tunku Abdul Rahman

in partial fulfillment of the requirements

for the degree of

BACHELOR OF INFORMATION SYSTEM ENGINEERING (HONS)

Faculty of Information and Communication Technology

(Perak Campus)

MAY 2013

UNIVERSITI TUNKU ABDUL RAHMAN

REPORT STATUS DECLARATION FORM

Title: _____

_____

Academic Session: _____

I _____

(CAPITAL LETTER)

declare that I allow this Final Year Project Report to be kept in

Universiti Tunku Abdul Rahman Library subject to the regulations as follows:

1. The dissertation is a property of the Library.
2. The Library is allowed to make copies of this dissertation for academic purposes.

Verified by,

_____ _____

(Author's signature) (Supervisor's signature)

Address:

_____

_____ _____

_____ Supervisor's name

Date: _____ **Date**: _____

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF _____

Date: _____

SUBMISSION OF FINAL YEAR PROJECT /DISSERTATION/THESIS

It is hereby certified that _____(ID No: _____) has completed this final year project/ dissertation/ thesis* entitled "_____" under the supervision of _____ (Supervisor) from the Department of _____, Faculty of _____ , and _____ (Co-Supervisor)* from the Department of _____, Faculty of _____.

I understand that University will upload softcopy of my final year project / dissertation/ thesis* in pdf format into UTAR Institutional Repository, which may be made accessible to UTAR community and public.

Yours truly,

_____

( )

DECLARATION OF ORIGINALITY

I declare that this report entitled "_____" is my own work except as cited in the references. The report has not been accepted for any degree and is not being submitted concurrently in candidature for any degree or other award.

Signature : _____

Name : _____

Date : _____

ACKNOWLEDGEMENT

My deepest gratitude goes to my supervisor, Mr. Liew Shiuh Deh for his guidance, advice and constructive comments on project development process, requirement specification and so forth. Besides, he also guides me in the software development life cycles and taught me how to build a good system. He also provides a lot of feedback to me during the system development which increases the overall quality of this project.

In addition, I would like to express my utmost appreciation to my moderator, Dr. Lau Phooi Yee for her invaluable guidance and advice as well as encouragements when finding the titles for the proposed system.

My thanks also go to my academic advisor, Mr. Soong Hoong Cheng for his support and advice.

I would also like to take this opportunity to say thank you to all my friends who had given suggestion and idea for this project and helping me in system testing. Their helps are truly appreciated.

ABSTRACT

The main purpose of this project is to develop a real time bus tracking system to enhance current bus service system and reduce the workload of bus management team. The poor services provided by bus service providers are because majority of them are still implementing manual work. Moreover, passengers are impatient while they are waiting in bus stop because they are not able to know exactly how long to wait and where the next coming bus is.

Global Positioning System (GPS) is the main technology implemented behind the system. A GPS receiver is used to track on real time bus coordination by continuously receiving the position data which are latitude and longitude values from GPS satellite, then send the position data back to main server and server process the raw position data into real time information for users. This system is implemented on Internet so that passengers are able to view the information through Internet access devices. Methodology applied in this project is prototype development model. The system developed in this project is not modules independently, all modules have to integrate become a working system. Therefore, prototype is developed and use for system evaluations, testing and enhancements.

After all modules integration, the system is able to provide a more accurate bus arrival time and to reduce workload performed by bus management team.

TABLE OF CONTENTS

LIST OF FIGURE

LIST OF ABBREVIATION

AJAX	Asynchronous Java Script and XML
APU	Asia Pacific University
DEF	Department of Estate and Facilities
ERD	Entities Relationship Diagram
FYP	Final Year Project
GPS	Global Position System
iOS	iPhone Operating System
IRIS	Intelligence Route Information System
JSP	Java Server Pages
NIU	Northern Illinios University
PHP	PHP: Hypertext Processor
SBS	Singapore Bus Service
USA	United State American
UTAR	University Tunku Abdul Rahman
XML	Extensible Markup Language

LIST OF TABLES

CHAPTER 1: INTRODUCTION

1.1 Overview

Among all public transportation services, bus service is the major transportation used by public. Especially in a busy town or city, bus is the most easy, convenient and cheaper transportation. Various reasons that people take bus instead of driving own vehicle such as traffic jam, heavy parking fee and lack of parking slot in destination.

However, bus transportation service has very poor transportation information system nowadays. Bus user do not know the exactly arrival time for a bus, but only know the scheduled arrival time. Compare to train or flight transportation system, bus transportation service does not have a proper system to track all buses position and the actual arrival time in every bus stops. These problems occur because current bus service system did not apply real time tracking technology to track on each buses on the road and also lack of a platform to update latest bus traffic information to bus users.

In order to solve these problems and enhance current bus service system, real time bus tracking system has to develop and implement. With real time bus tracking system, bus position data is connected real time and transmitted to a central server for processing and extracting transit information. The main technology used to develop this system is Global Positioning System (GPS). GPS technology able to receives the position of an object from space-based satellite navigation system through a GPS receiver. Some programming languages such as PHP, JavaScript, AJAX, JavaServlet and Java Server Pages (JSP) will be used to develop the proposed system. The developed bus tracking system will able to provide bus users a real time platform to check on updated bus traffic information, for examples bus arrival or departure time. Besides, this system also able to reduce workload for bus management team and provide an immediate platform to update latest and accurate bus traffic information to bus users.

In order to understand more about current bus transportation system nowadays, I will take University Tunku Abdul Rahman (UTAR) bus transportation systems as my final year project (FYP) environment. Study on current bus transportation system and find out the problems. Solve and enhance current bus transportation system with proposed system - Bus Tracking System.

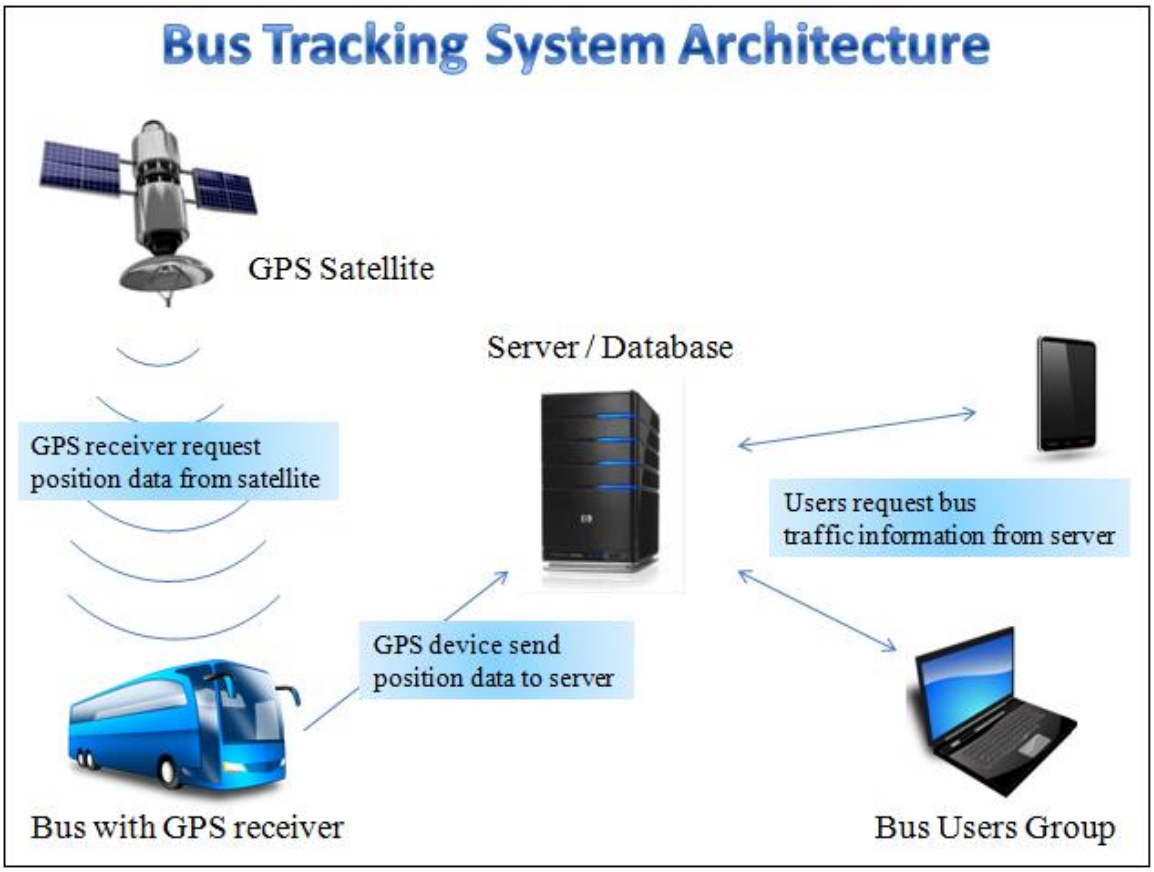


Figure 1.1 Bus tracking System Architecture

1.2 Problem Statement

One of the problems occurring in current UTAR bus service is student did not know exactly what time a bus will arrive, but only know the scheduled arrival time. Student needs to wait for a bus without knowing what time the bus will arrive actually. Sometime, student might feel anxious and impatient when they waiting for a bus if they do not know what time the bus will arrive especially when student rushing of time for certain reason. Additionally, this situation wasted a lot of time when waiting in bus stop because the time wasted can actually spend on other matter. Examples to describe this issue, a student have to take the 7.40am bus to attend an 8am morning class and the class is important and cannot be late. The scheduled time for the bus is 7.40am, but the exactly arrival time for the bus will be different due to traffic status. If the bus arrives at exactly 7.40am, the student will not late for the class. But if the bus delay 5 to 10 minutes, the student will late for the class. Thus, the student unable to make decision whether to wait for the 7.40am bus or walks in to campus before 7.40am because the student do not know the exactly arrival of the bus and it would be risky to wait for the 7.40am bus.

There is dangerous situation when student waiting in bus stop. Due to delay or missed bus, student needs to wait long time in bus stop. In the same time, student might become robbery target. For example, a student plan to take the 7am bus but the bus was delay 15 minutes due to traffic jam. If the bus is not delay, the student is already inside the bus on the way into campus. But due to delay 15 minutes, robber has 15 minutes more chance to target on the student. This unpredictable problem was very dangerous for student and it will reduce the confident of student to take bus service.

Besides, current UTAR bus management unable to schedule an accurate bus timetable for student. This is because current bus system is implementing manual tracking on bus arrival time and travel duration between two bus stops. The estimated arrival time is calculated based on the average travel duration between two bus stops. It was not accurate because of various uncertainties will happened on each bus stop. Given an example to illustrate this problem, bus management team was manually recorded the travel time between bus stop A and bus stop B. And estimated arrival time in bus stop B

was calculated by average of travel time between these two bus stops. However, the bus will delay on bus stop B because there are many students queuing up to take the bus in bus top A. In other way, the bus will reach bus stop B early if there are no student take this bus in bus stop A. Moreover, the whole bus route timetable will be delay if delay happen continuously. This issue occurs because current bus system unable to strain for uncertainties and unpredictable situations happened in every bus stop.

Lack of real time platform is the serious communication problem between bus user and bus management team. Without a real time platform, bus management side unable to update latest bus traffic information for students. Students also cannot check on the updated bus schedule if there is a bus delay happens. For example, student can choose walk to the building he or she want to go instead of waiting for a delay bus if there is a real time platform for student to know about the bus is delay.

1.3 Objectives

The main objective of the proposed system is to apply GPS tracking technology into bus transportation system currently operating in UTAR. The proposed system will install GPS receiver on buses to perform real time position tracking bus during operating hours. The bus position data will send to central server and process become bus traffic information which needed to provide for bus users. By this real time position tracking system, it will increase the accuracy of bus timetable scheduling.

In proposed system, a real time platform is developed between student and bus management team. With this platform, students able to check on real time bus arrival time for particular bus stop and latest or updated bus traffic information. Moreover, bus management team able to update latest bus traffic information on time to bus users through real time platform. Compare to current bus system in UTAR which still posting bus timetable on notice board in paper form, the proposed system is more effectiveness.

Besides, bus tracking system able to reduce major workload done by bus management team. First of all, real time bus position tracking system will automatically calculate the arrival time for next bus stop of particular bus. Second, this system provides a platform allow bus management team to update bus schedule through Internet instead of posting paper form bus timetable on notice broad. By reducing workload of bus management team, they can utilize the time in other matters in order to enhance quality of bus service.

1.4 Project Scope

The proposed system is aim to enable real time bus position tracking and build a real time platform to enhance communication between bus user and bus management team. There are several modules in this proposed system and the details are as follow.

1. Bus Positioning Module (Global Positioning System - GPS)
   This module is build for bus positioning purpose. An Android Smartphone will put in a bus which already installed with this module. This module will continuously send the bus position to central server with interval 3 sec.

2. Central Server Processing Module
   Central server will receive position data from bus position module with interval 1 second. When central server received bus position data, this module will automatically store the data into related table in server database. Based on the latest position data received, this module will process the data and update latest bus arrival time in the main bus timetable. With this automatically updating module, bus user able to retrieve updated bus traffic information from server when request to view bus timetable.

3. Real Time Bus Arrival Time Display - Web Pages
   This module will build in web page for bus user to check on bus arrival time through Internet. By applying AJAX technology, this module will continuously retrieve the latest data from central server and display the latest bus arrival time for every bus stop in the web page. Typically with interval time 3 sec

4. Bus Position Mapping Module - Web Page
   Bus mapping module is develop to show user about the bus position in a map. First, this module will load the map file from server. After that, this module will based on the latest bus position data in the server database received from the "Bus Positioning Module" to coordinate the current bus position into the map loaded in

user display. Additionally, this module continuously updates the buses position in the map with interval 3 seconds.

5. Bus Status Update Module

   This module is used by bus driver to update bus status into database when bus is operating. It is a situation where the bus is fully occupied with passengers and this module allow bus driver to send a "Full" message to server with only one click. Therefore, others bus user who is waiting in bus stop able to know that the bus is fully occupied in real time.

1.5 Chapter Summary

The following chapter would be Chapter 2 Literature Reviews which will describe the studies on existing systems, technologies needed and methodologies. Next would be Chapter 3 Methodology which discuss more about the Methodology chosen after studies on Chapter 2, requirements analysis and project timeline. Following by Chapter 4, System design which discuss about interface design, database design. Chapter 5 would be System Features which describe about few important feature of proposed system. Continue with Chapter 6, it is System Implementation. Describe about system development and implementation. Chapter 7 will be the System Testing and the last chapter would be Chapter 8 Conclusion and future enhancements.

CHAPTER 2: LITERATURE REVIEWS

Bus transportation service is every way, but without a good bus management system, bus service may not fully utilize. In our country, majority bus service providers are not performing real time bus tracking. They only provide scheduled timetable which is not accurate in real time.

However, there is a University in Malaysia successfully implemented real time bus tracking system. In oversea countries, there are many university implemented real time tracking system for shuttle bus service. Thus, studies are performed on the bus tracking system implemented by Asia Pacific University (APU) in Malaysia, Northern Illinois University (NIU) located in USA and Rice University in Texas, USA.

Moreover, in order to understand more about current bus tracking system technology. Study also performed on Singapore Bus Service (SBS) Transit. It provided an application called Intelligence Route Information System (iris NextBus) for Singapore bus users to find out estimated bus arrival time. Iris NextBus also available in mobile application and study is emphasized on it mobile application.

Besides, studies are also performed on technologies involved and methodology applies in the proposed system.

2.1 ANALYSIS ON EXISTING SYSTEMS

There are existing bus tracking systems implemented by Asia Pacific University (APU), Northern Illinois University (NIU), Rice University and Singapore Bus Service (SBS). Studies in detailed are performed and stated as following.

2.1.1 ANALYSIS ON ASIA PACIFIC UNIVERSITY (APU) BUS TRACKING SYSTEM

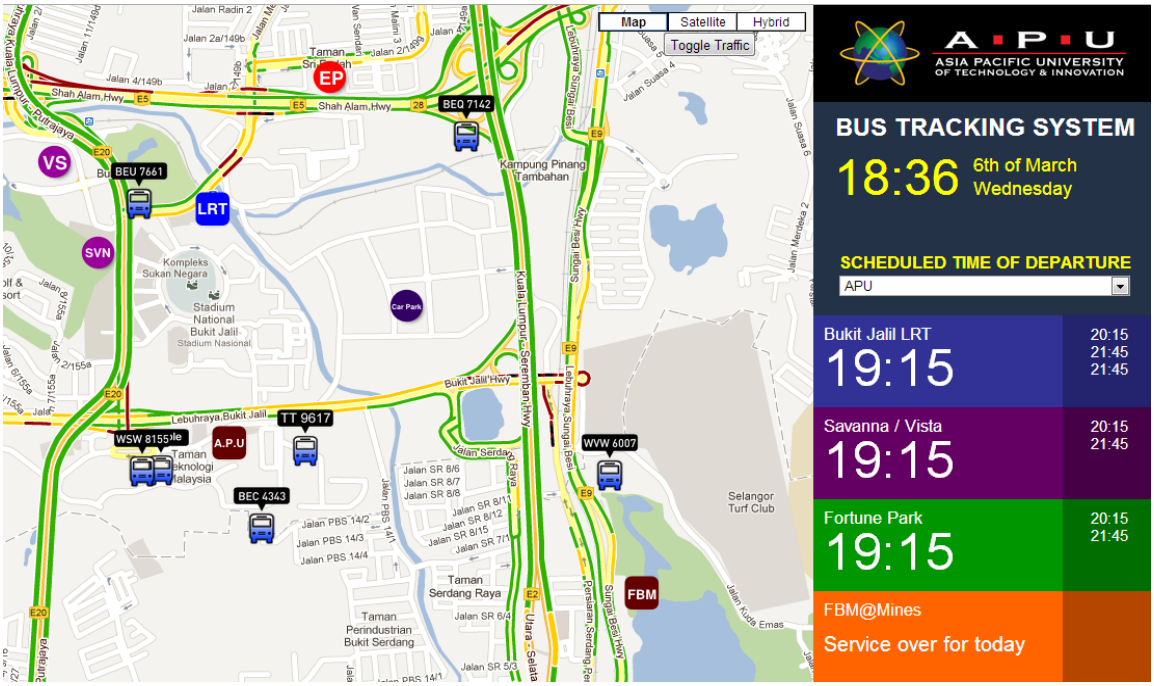


Figure 2.1: Screenshot for APU bus tracking system. (Asia Pacific University, n.d.)

The bus tracking system show in Figure 2.1 is developed by Asia Pacific University (APU). It is built in a web page with Google Map embedded. The web page allows APU students to check on bus traffic status anytime in anywhere as long as use a device with browser and Internet accessibility.

There are bus icons allocated inside the map and those icons indicated that a particular bus real time position. The bus plate number is linked with every bus icon in the map. It is to ensure that student take the right bus with bus plate number verification

when the bus is reach a bus stop because different bus will move to different route. Next, there is a bus timetable in right hand side of the web page. Show student about the bus arrival time in each bus stop. The most important feature is the web page will automatically refresh every 5 second.

However, this system still got limitations. The timetable provided in this system is still the scheduled time of departure for each bus stop. This system still unable to provide the exactly arrival time for each buses based on the exactly position of bus. But at least students can confirm that a bus is approaching to a bus stop based on the movement of a bus icon in the map.

Second, this web page only shows the most important destination bus stop of a bus route but do not show the whole bus route to student. Student might not know others bus stop is on which bus route. Moreover, beside those main destination bus stop. Many others small bus stop does not show in the map. If the student does not know how to refer on map, the student will not know where is the bus stop allocated in map and which bus should take. If there is bus stop icon in the map, this problem will solved.

The APU bus tracking system will be the design fundamental for proposed system. Since APU bus tracking system operating in same environment (University bus service), the design of system will be suitable to build for proposed system in this project.

2.1.2 ANALYSIS ON NORTHERN ILLINOIS UNIVERSITY (NIU) BUS TRACKING SYSTEM

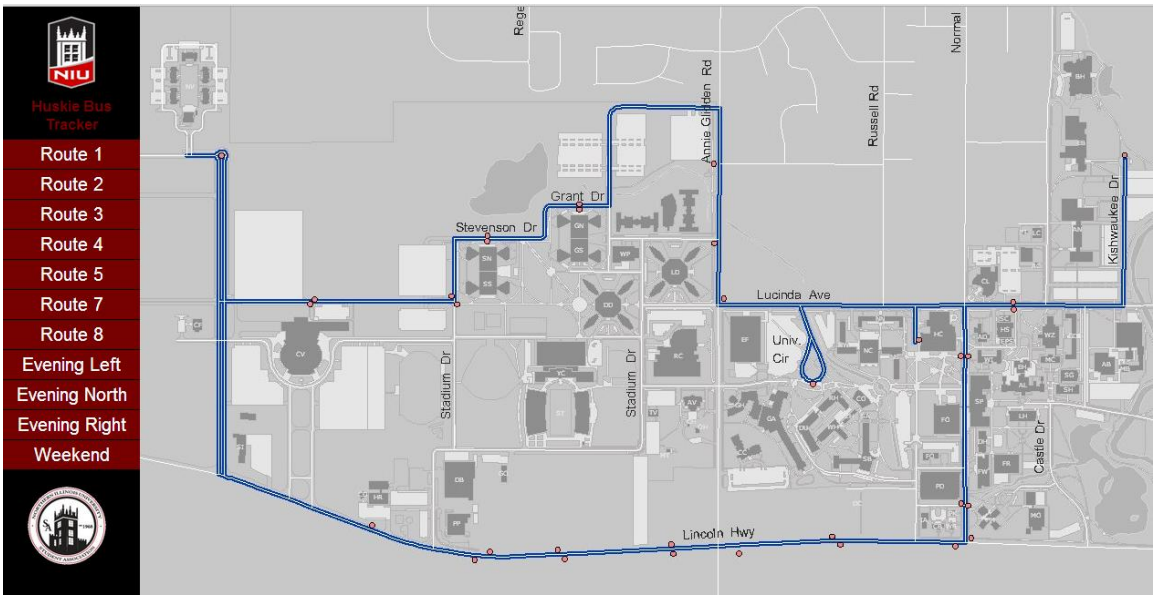


Figure 2.2: Screenshot for NIU bus tracking system - Route 4 (Huskie Bus Tracker, n.d.)

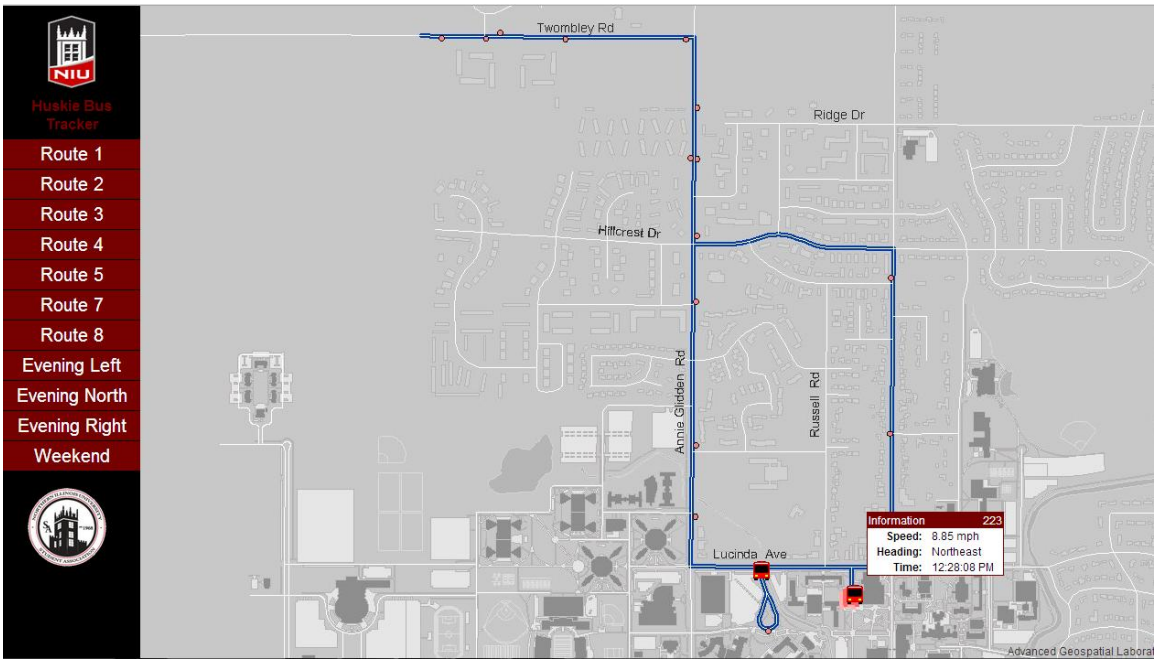


Figure 2.3: Screenshot for NIU bus tracking system - Route 1 (Huskie Bus Tracker, n.d.)

The bus tracking system show in Figure 2.2 and Figure 2.3 is developed by Northern Illinois University. The uniqueness of NIU bus tracking system is the map is not using Google Map, but use jpg format map converted from Google Map. The purpose of using jpg map is to use different map to show different bus route. In Figure 2.2 is showing the "Route 4" bus route and the map in Figure 2.3 are showing "Route 1" bus route.

In Figure 2.3, there are two type of bus icon. One of the bus icons with shadow is indicate that the bus is moving and the bus icon without shadow is not moving. The bus information will show on a pop-up box when user place mouse cursor on a bus icon. Moreover, there are orange color dot beside the bus route and those dot is represent bus stops in the map.

One of the strengths for NIU bus tracking system is the web page does not refresh when updating bus position. It is using a real time programming skill to update the bus icon position in the map without reload the whole map image. Second advantage is this bus tracking system divided different bus route into different map image. This can clearly show the bus route to users which the bus will go to. Moreover, there are bus stop icons allocated among the bus route. User can easily know where the bus stops are located and able to know which bus stop is belonging to which bus route. Lastly, the bus icons differentiate with shadow. The bus icon with shadow mean it is moving and another one without shadow is not moving. User may know about the bus is moving or not. If the bus is not moving, user might try rush to the bus stop to take the bus.

However, one of the drawbacks of this system is it does not show the bus arrival time or bus timetable on the web page. It is a big problem if a bus user does not know how to estimate the bus arrival time based on the movement of a bus icon in the map. Furthermore, it does not show whether the bus is on service or not. If the bus is out of service, the icon in the map will just not moving. But users do not know it is out of service and user might wait for the bus. It shells put information to show user about bus traffic status.

Different bus will have different route, if all buses is moving in a single map. Users might felt confusing to look for the bus the user wants to take. Thus, the advantage of NIU bus tracking system will be needed for proposed system. Differentiate different bus route with different map will show better information to users. Users can filter the bus route the user want to go and look of the correct bus which need to take.

2.1.3 ANALYSIS ON RICE UNIVERSITY SHUTTLE BUS TRACKNING SYSTEM

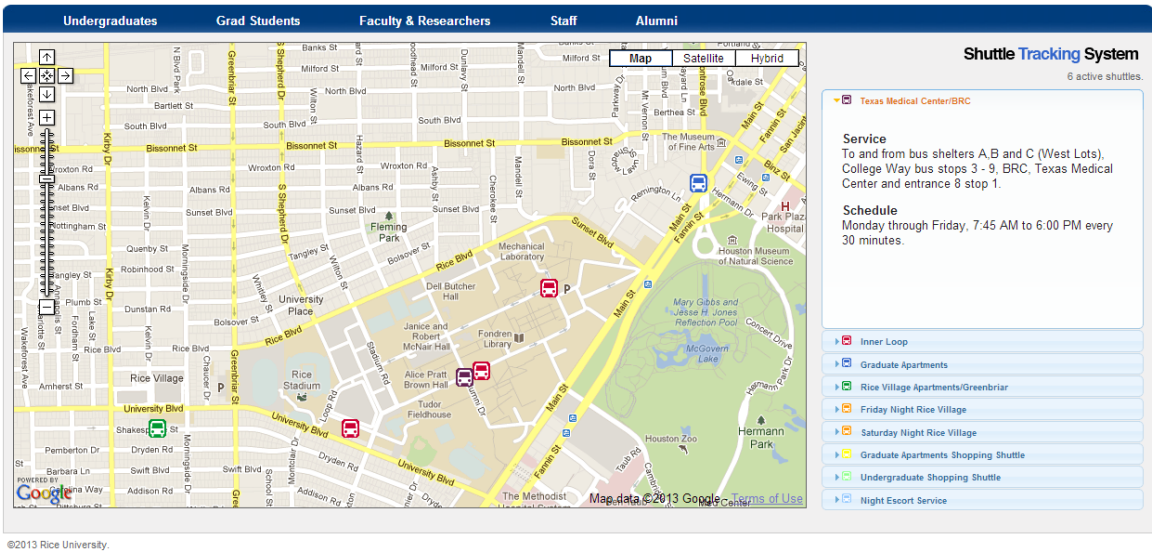


Figure 2.4: Screenshot on Rice University shuttle tracking system (Rice University, Shuttle Tacking System, 2013)

The shuttle bus tracking system show in Figure 2.8 is developed by Rice University located in Texas, USA. The system is built in web page embedded with Google Map and simple interface to show bus services information.

The map is showing the campus area of Rice University and the position of buses. The strength of Rice University tracking system is the bus position update speed. Every bus icon is the map will update location with interval 2 seconds. It is very fast update speed compare with other bus tracking system available. With high update speed, the bus icons seem like moving in the map from user point of view. Moreover, the map allow user to zoom in and zoom out without affect bus icons update speed. When user zooms in to look at particular area, the bus icon update speed is still the same.

There are few different bus icons with different color in the map. Each color indicates different bus service and different route in the campus. In the right hand side of the web page, there are few tab boxes to show user about different shuttle bus service information. The information included bus route and bus scheduled arrival time.

The weaknesses of Rice University Shuttle tracking system is it do not show bus routes in the map. User will not know where the buses moving to if user do not know about the bus route. Those bus stops also not available in the map, this will be difficult for some users that do not know where the bus stop allocated in the map. Another drawback of this system is it does not show the real time bus arrival time to user. User has to estimate the bus arrival time by the movement of a bus icon in the map.

In the proposed system, bus position and arrival time update speed is very important to determine accurately of the system. Faster update speed will increase the level of real time information system. Thus, the update speed of Rice university shuttle tracking system will be as an example for proposed system. However, update speed more depends on Internet access speed. Therefore, the initial update speed for proposed system will be set to 3 seconds interval instead of the faster update speed with 2 seconds interval.

2.1.4 ANALYSIS ON SINGAPORE BUS SERVICE (SBS - iris NextBus) SYSTEM

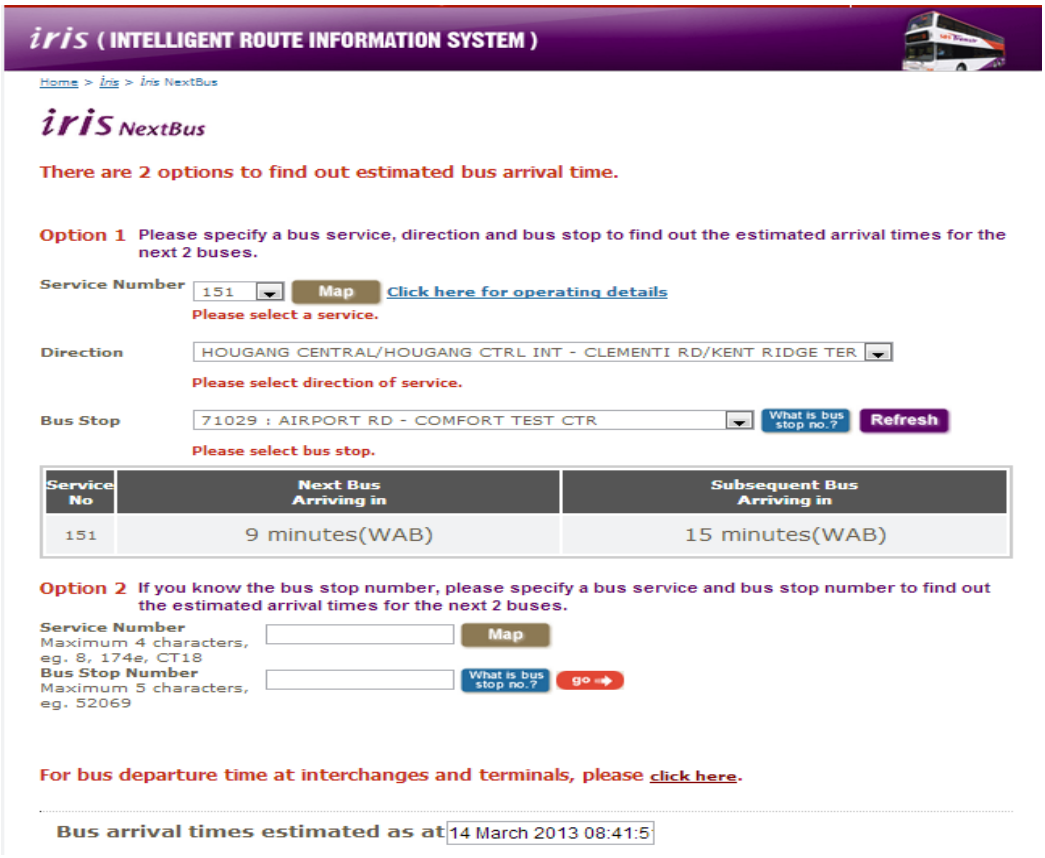


Figure 2 .5: Screenshot of SBS iris NextBus application - Web page version option 1(SBS Transit, n.d.)

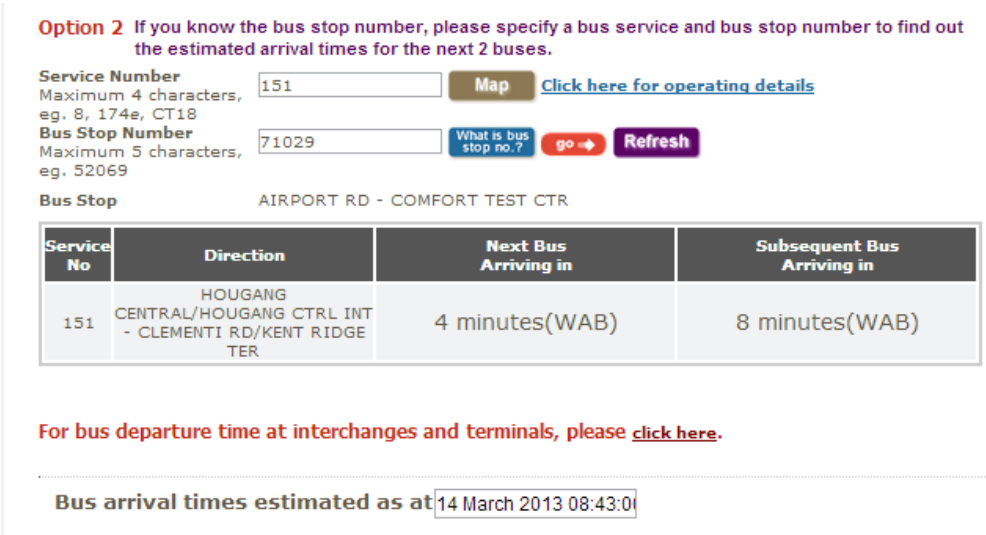


Figure 2.6: Screenshot of SBS iris NextBus application - Web page version option 2 (SBS Transit, n.d.)

Singapore Bus Service (SBS) iris NextBus application is a public bus tracking system developed by Singapore bus service operator. iris is the acronym for Intelligence Route Information System (SBS Transit, n.d.). This system provided bus traffic information to Singaporeans and travelers. Provided a real time platform to check on bus traffic status and enhance travel experience to users.

SBS iris NextBus application is available in two different platforms, which are web page and mobile application. For web page version, there are two options to let user find out the estimated arrival time. First option is let user choose from a list when user do not know about the service number and the bus stop number which show in Figure 2.4. First step, choose service number to query database. Next, choose the direction if there are different direction for the bus service chosen in first step and last step is select the bus stop number which user wish to find out. Finally the web page will refresh and the estimated arrival time is shown. It also showed the subsequent bus arrival time for users.

In Figure 2.5 show the second option to find out the bus arrival time. This option allows users to enter service number and bus stop number directly if the user knows about the bus service and bus top number. Press on "GO" button, the web page will refresh and show the details for the bus service enter by user. Both option results will also show the time for next bus arrival at the bottom side.

Figure 2.7: Screenshot of SBS iris NextBus application search interface- Mobile Application (SBS Transit, n.d.)

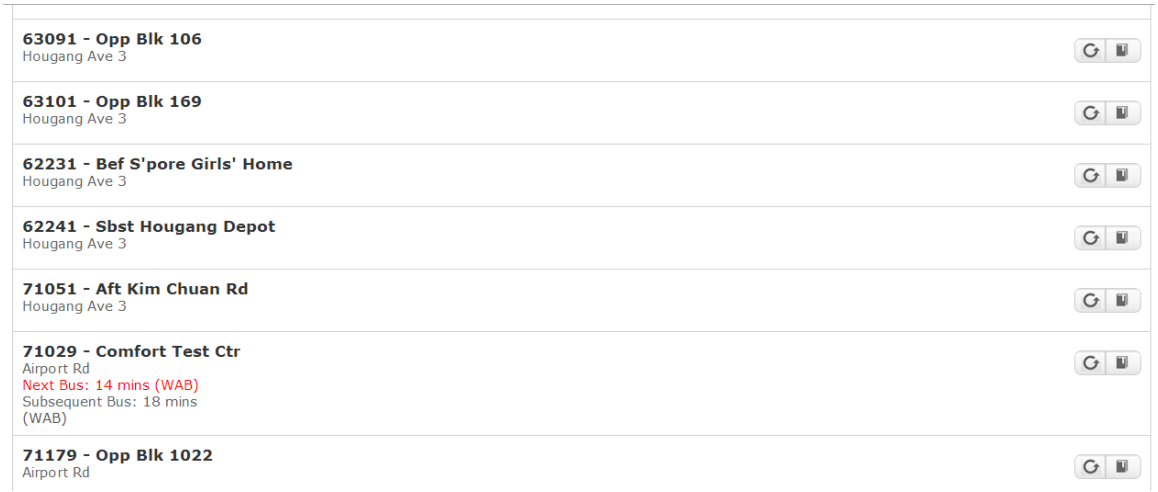


Figure 2.8: Screenshot of SBS iris NextBus application bus arrival time display interface - Mobile Application (SBS Transit, n.d.)

The iris NextBus mobile version provided is shown in Figure 2.6 and Figure 2.7. First, user search for the particular bus service with service number and those bus stop under the service number with be query and show to user. Next, user click on the refresh button in right hand side and the estimated arrival time will be show to user.

The advantage of SBS iris NextBus application is it allows user to manually search for a particular bus route or bus stop arrival time. Users can search for the bus which the user wants only, so it won't confuse users with whole list of bus arrival time that user do not needs to know. This advantage can help user to reduce data loading when requesting for bus traffic data, because it only show the information which the user want to know. Moreover, the system clearly shows every bus stop with bus stop number and location to users so that user able to know which bus stop it is. Furthermore, this system

provided mobile application version. User can use mobile device to check on bus arrival time in every way instead of using computer.

There are limitation on this system, it is the user has to know the exactly location name, bus stop number and bus route in order to use this system. Because this system is not view in map, so that user has to familiar with the bus route or bus stop number to request for correct bus traffic information from this application.

The mobile application version of SBS iris NextBus system will be needed to the proposed system. Nowadays, every people at least will hold one smart phone on hand. Thus, it is better to have mobile application version for an efficiency system.

2.2 STUDIES ON TECHNOLOGY INVOLVED

In order to build a system, studies on major technologies are needed. There are Global Positioning System (GPS) and Android mobile application platform. Studies in detailed are stated as following.

2.2.1 GLOBAL POSITIONING SYSTEM (GPS)

GPS is a satellite based navigator system developed by the Department of Defense of USA. Initially is designed to assist coordination of location for military plane and ship worldwide. Today, GPS feature was extended into commercial and scientific field. Commercially, GPS was used for navigation and as a position tool for vehicle, plane and ship (Maggi Glasscoe, 1998). In order to receive GPS data from satellite, a device called GPS receiver is needed. Nowadays, almost every Smartphone in market is embedded with GPS receiver.

The GPS Satellites System

GPS uses 27 satellites (24 active, 3 are meant for backup) to allocate position request by GPS receiver. The 24 satellites are orbiting the earth about 20,000 km above the Earth. They are constantly moving, making two complete orbits in less than 24 hours. These satellites are traveling at speed of about 7,000 miles per hour. GPS satellites are powered by solar energy. The GPS system also called NAVSTAR, the official name of GPS by U.S. Department of Defense. (GARMIN, n.d.)

The accuracy of position tracking by satellites will affected by certain atmospheric factor, typically a normal GPS receiver receive position accurate are within 15 meters. Nowadays, newer GPS receiver is developed and enhanced to receive position data with accurate level within 3 meters on average.

Assisted GPS (A-GPS)

Assisted GPS is a technology to enhance the performance of standard GPS. Typically A-GPS is implemented in devices connected to the cellular network, which is the mobile device or smart phone nowadays. Originally, GPS receiver build-in in smart phone will receive the position data from satellites when the smart phone request for position information. If there is a case inside a city with many building around, the signal transmit from satellites will be reflected by the building before reach the smart phone. Thus, Assisted GPS is developed to overcome this problem.

To allow smart phone users to obtain faster position information in their phone, A-GPS acquires information about the location from satellites and stores within the cellular network so that the information does not need to download from satellites when users request it. Beside of directly receive position from satellites, A-GPS uses proximity distance between cellular towers and the requesting smart phone to calculate the position for the smart phone requesting of position information. (Fred Zahradnik, n.d.)

GPS Position Measurement

Latitude and longitude are primary denoted in degrees. However, the increment is expressed as minutes and seconds when less than one degree. It also can convert to decimal for calculation. Latitude lines is measure north and south between the pole, while longitude lines is measure the west and east position (Live View GPS, n.d.). For example, the latitude and longitude position of Kampar McDonald would be 4 º19' 34.5972" N, 101 º8 ' 40.7544" W. It can be read as latitude 4 degree 19 minutes 34.5972 seconds, longitude 101 degree 8 minutes 40.7544 seconds. It can also convert to decimal, latitude 4.326277407216858 and longitude 101.14465355873108 (data taken from: http://locates.com.au/gps.html)

In bus tracking system, bus positioning module will install in a smart phone with GPS feature. This module will active GPS receiver in the smart phone and continuously receive the position data from satellite system by the GPS receiver and send to central server with interval 2 seconds.

2.2.2 MOBILE APPLICATION PLATFORM - ANDROID OPERATING SYSTEM

Android is a Linux based operating system developed by Google. Typically, Android was designed primarily for touch screen mobile devices such as smart phone and tablet. Nowadays, Android was developed until version 4.2. It also called Jelly Bean.

According to a smart phone usage statistics done by an author named Anson Alexander, Android has to highest market share in year 2012 (Anson Alexander, 2012). There are some reason why Android is better then iOS is stated into a list in as follow (Simon Hill, 2013).

1. **Multiple devices** - Android operating system is applicable for variety of smart phone such as Samsung, HTC and Sony.
2. **Multiple price points** - Because of multiple devices are supporting Android operating system, variety of model is available in market from low price to higher price. So that, user can buys an Android phone according budget.
3. **Customization** - Android is always allowed user to have customization on Android platform smart phone while iOS phone want to keep control from customization by user.
4. **Integrated with Google services** - Android phone is integrated with some Google services such as Google Map, Google mail, Google Drive and so on.

There is another statistics shown that how smart phone user used their smart phone in daily life (Anson Alexander, 2013). The statistics showed that 72% of smart phone users are using their smart phone for map and it is the second higher. This number showing that most smart phone users are using their smart phone to allocated their position or showing the direction to a destination. People tend to use smart phone instead of pure GPS devices for position allocation, this is because today smart phone is embedded with GPS feature (James Kendrick, 2011).

In term of development for GPS application in Android operating system platform, Google was provided very convenient tools for developers to develop application with GPS feature (Android Developers, n.d.). Developer can easily customize the GPS feature according to their needs. Besides, Google is also provided Google Map for developers. Once Google Map is plugged into application, user can easily retrieve map in anywhere over the world.

In bus tracking system, Android has been chosen for mobile application version of the system. This is because of the advantages provided by Android stated above. Firstly, Android is applicable for multiple devices and also with wide range of prices for different model and specification of phone. With this point, it can say that every person is able to own an Android phone. Additionally, most Android smart phone model available in market is embedded with GPS feature. Furthermore, GPS feature can easily created by developer because of useful tools provided by Google. Therefore, Android platform is chosen for the mobile application version of the proposed system.

2.3 STUDIES ON SYSTEM METHODOLOGY

Methodology is a set of practices. In system development processes, methodology is a framework to structure, plan and control the processes within the system development processes in order to develop a high quality system. There are many type of different methodologies exist and methodologies basically build with the foundation pillar of the System Development Life Cycle (SDLC). SDLC consists of five processes in order to develop a system; there are planning, analysis, design, implementation, testing and maintenance (TUTOR, 2012). Thus, in order to find the most suitable system development methodology, studies are preformed on the waterfall development, agile development and prototype development.

2.3.1 WATERFALL DEVELOPMENT

Waterfall development model is a popular version of system development life cycle model for system engineering. It often considered as classis approach to the system development life cycle and it is a linear and sequential development method (Margaret Rouse, 2007). Waterfall model basically aid developers to develop a high quality system step by step. The uniqueness of this model is developers have to be complete a stage before process to next stage and it cannot return to previous stage after process to next stage. The stages of waterfall model are shown in Figure 2.9 below.

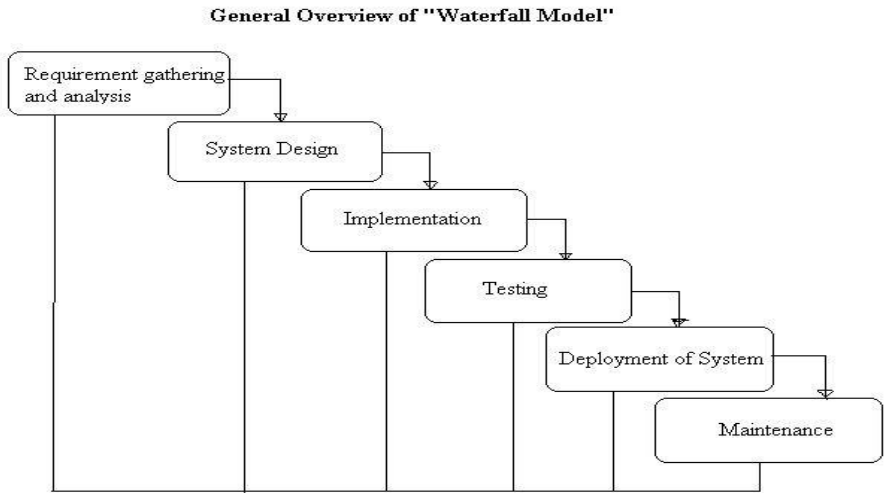


Figure 2.9 General Overview of Waterfall Model (Nilesh Parekh, 2011)

2.3.1.1 ADVANTAGES AND DISADVANTAGES OF WATERFALL DEVELOPMENT

There are advantages and disadvantages by using waterfall development model in system development. (Margaret Rouse, 2007) (Nilesh Parekh, 2011)

Advantages	Disadvantages
Clear compartmentalization and managerial control of work in waterfall model, so it is easier to schedule for tasks to be completed within a specific time period.	A stage must be completed before process to next stage, so backward or revision on stage is not allowed.
Detailed documentations and descriptions in every stage to allow every member in development team have clear understanding on the project and carry on the tasks with correct direction.	This model is time consuming because every stage must be clearly verified and completed before process to next stage. If a stage is delay, whole development life cycle will be delay.
This model is easy to implement in system development project due to its linear model.	Very low user involvement as users will not provide feedback immediately.
Project cost can be accurately estimated with linear development model.	Backtracking on pervious stage might be difficult and required a lot of cost.

Table 2.1 Advantages and Disadvantages of Waterfall Development

The waterfall model has few advantages; it consists of detailed requirement which can be identified earlier before proceeding to the next stage to prevent the change of requirement. The waterfall model is common models which are used by the developers due to its simplicity and it is easy to understand. The detailed description in every stage helps the new members in the development team to understand the software better so that they could carry on with their task as soon as possible. However, there are some disadvantages in using waterfall model. Changing the requirement in the later stage is not possible as it might incur a very high cost. The time taken to go from a stage to another stage is very long which might cause delay in the project. Other than that, the user involvement is very low where feedback from the user is not available.

2.3.2 INCREMENTAL AND ITERATIVE DEVELOPMENT

Incremental and iterative development model is a method of system development that develops system based on different deliverables or version. It is a cyclic system development model developed in response to the weakness of the waterfall development model. In this model, different part of the system is developed at various times then integrated with the final system. It begins with planning stage and continues through iterative development cycles which consist of analysis and design, implementation, testing and evaluation stage. The basic idea of the incremental and iterative development is to build a system through repetitive cycles known as iteration and in a shorter time. (Cory Janssen, n.d.)

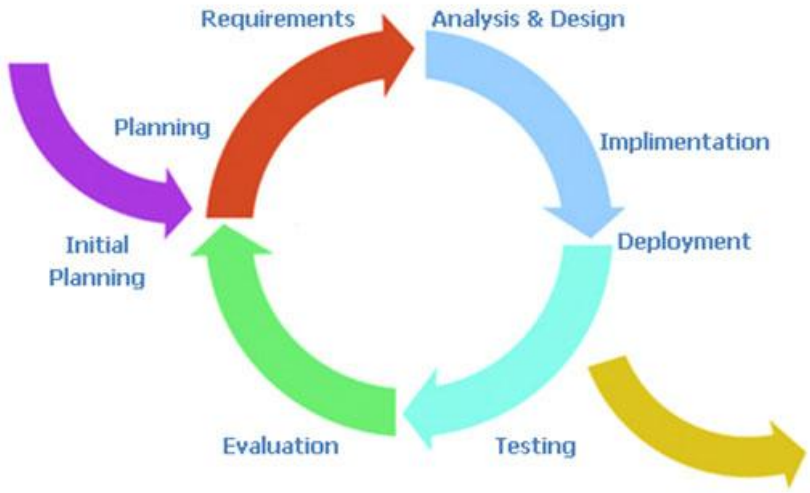


Figure 2.10 Incremental and Iterative Development Model (Arctern, 2011)

2.3.2.1 ADVANTAGES AND DISADVANTAGES OF INCREMENTAL AND ITERATIVE DEVELOPMENT

There are advantages and disadvantages in using iterative and incremental development model in system development. (ISTQB GUIDE, n.d.) (Fred Swartz, n.d.)

Advantages	Disadvantages
User can use the first version of the system to gain experience and make changes to the requirements in next iteration	System coding need to start at early stage, thus system programmers must have strong programming skill.
User can use the first increment of system immediately if the requirements are satisfied without the need to wait for the full system	Need a good and clear planning and design on the final system before it broken down and build incrementally.
The highest-priority services receive the most testing which reduce the chance of software failures in the system	

Table 2.2 Advantages and Disadvantages of Iterative and Incremental Development

The advantages of using the incremental and iterative development are that the user does not need to wait for the full system to be release before using it. As soon as the first version of the system is complete, the user can straightaway use it to perform the desired task. The user is able to use the system first and perform modification in the requirement in the next iteration. The highest priority function received the most testing and this would reduce the chance of software failure in the system. However the disadvantages of using this development would be the coding part must complete in early stage, strong programming skill are required. Besides, planning and design for this development model must be very clear. Before the final system broken down into different version to build incrementally, team member must have clear vision to the final system and the main objectives of the system.

2.3.3 PROTOTYPE DEVELOPMENT

The evolutionary development is also known as prototyping. The prototype is a model of system which is not based on strict planning, but is an approximation of final system. The prototype is developed based on current known requirements. With the prototype, user can have "actual feel" of the system and have better understanding about the final system. With this, users may give better and further requirements to the final system, thus final system will developed based on the acceptances to the prototype from users and the final system should be perfectly meet user expectations. (ISTQB GUIDE, n.d.) (Penna Sparrow, n.d.)

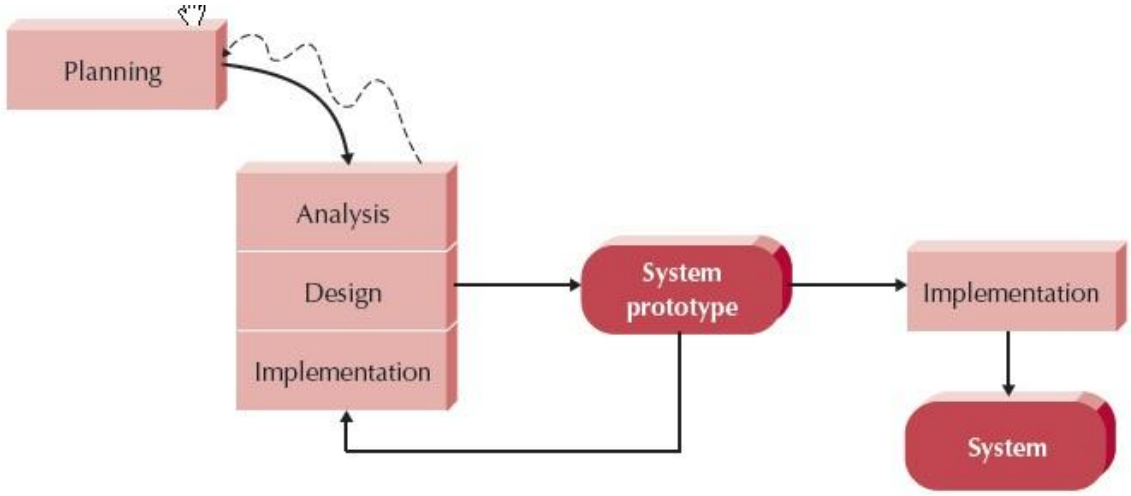


Figure 2.11 Prototype Development Model (Elfira Nureza Ardina, 2010)

2.3.3.1 ADVANTAGES AND DISADVANTAGES OF PROTOTYPE DEVELOPMENT

There are some advantages and disadvantages in using prototype development model in system development. (ISTQB GUIDE, n.d.) (Penna Sparrow, n.d.)

Advantages	Disadvantages
Reducing development time as an initial version of system (prototype) is developed in early stage.	Prototype will rebuild as the previous prototype is not accepted by users. Thus, it is time consuming and expensive.
User get better understanding about the final system due to functioning model of the final system provided.	Complexity of the final system increase as the scope of system may expand beyond original plans.
Error able to detect during early stage, hence reduce risk of failure of the system.	Resource wasted as the prototype is not able to reuse due to bad quality of code developed.
High user involvement in development.	

Table 2.3 Advantages and Disadvantages of Prototype Development

The prototyping has an advantage reducing development time effectively as the prototype is developed in early stage. This model able to let users get better understanding about the system early due to working model (prototype) is developed and hand on by user. Hence, prototype development model has high user involvement. Besides, error can be detected during prototype evaluation. Thus, reduce risk of failure of the system.

There are some disadvantages in using prototyping. Prototype involved high cost and time consuming due to prototype rebuild as the user acceptances to the prototype is low. Complexity of the system would be increase as the scope and requirements of the system may expand beyond the original plan. This is because of user might come out with new requirements after evaluation on the prototype. The resources used to develop prototype will be wasted because it is unable to reuse in final system development due to bad quality of code developed.

2.3.4 OUTCOME OF STUDIES ON SYSTEM METHODOLOGY

After studies are performed on the three methodologies, prototype development model has been chosen for the bus tracking system. Prototyping model allow developer to develop a prototype based on the main requirements and let users to test on the prototype in order to figure out the errors or new requirements. As the new requirements exist, a new prototype will develop. This process will loop until the latest prototype accepts by user, by meeting major requirements. Then process to final system development stages. With this model, high quality of final system will developed based on feedbacks from users in prototype testing stage and enhancement in the prototyping loop. The chosen methodology will be discussed more detailed in Chapter 3.

CHAPTER 3: METHODOLOGY

The methodology chosen must be suitable for the development of the system as the methodology will step-by-step guide developer and developer must follow in order to develop and deliver the system successfully. In this chapter, chosen methodology will be discussed in the development of Bus Tracking System.

3.1 CHOSEN METHODOLOGY

After studies on suitable methodologies performed in chapter 2, prototype development methodology is chosen. The reason in choosing this methodology is because of the advantages provided by this methodology will assist the development of proposed system to success path. The main reason to choose prototyping is because the proposed system will involve more user interaction in order to acquire more user feedbacks and able to produce a successful system under user expectations.

In development processes of bus tracking system, there are many uncertainly existed. In the bus tracking process, there would be many errors or unexpected results occur and this will affect the accuracy of estimated bus arrival time for users. In Users perspective, the accuracy of estimated arrival time will determine the success of the system. Therefore, prototyping approach is suitable to test on acceptation of final system from users. According to this methodology, if user rejected a prototype, a new prototype is developed based on new requirements from user feedback and test on user again. Once the prototype is accepted by user, it would be the model for final system. With high user involvement in prototyping process, the quality of final system will be increased.

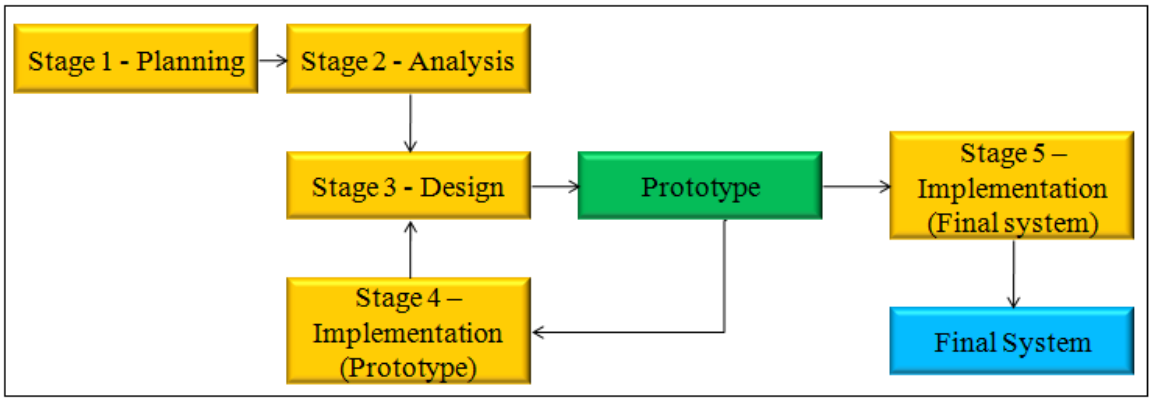


Figure 3.1 Prototype Development Stages

3.2 APPLICATION OF CHOSEN METHODOLOGY

There are 5 stages in prototyping development methodology which are planning, analysis, design, prototype implementation and final system implementation. Every stages are discussed in detailed in this section.

3.2.1 STAGE 1 - PLANNING

Planning has been done in first stage. After discussion with project supervisor, the name for proposed project "Bus Tracking System" is produced. After confirmation of project title, studies on existing bus tracking system are performed. Unfortunately, there is only one University in Malaysia provided bus tracking system on shuttle bus service. So, studies on existing system are performed on few foreign countries and Universities. The fundamental of proposed system was clearly verified after studies performed on existing system.

Based on studies performed on existing system, some common problems were found and problem statements were generated. The estimated bus arrival time is very important to determine the performance of bus service. Bus user have to know what is the exactly time the bus will arrive on bus stop. Furthermore, the existing systems are

provided real time bus tracking in map view instead of just showing timetable to user. Based on the studies, we can say that graphically view on bus tracking systems is one of the main expectations from user. By showing bus position is a map, user can know where exactly the bus now and how far or how long the bus will arrive.

Scope of the project was done in planning stage too. However, there is a problem within the project scope. Because of the proposed project is focused on UTAR bus system. So, the map of UTAR area is needed. Unfortunately, UTAR area is not available in Google map. Thus, we can't use Google map as mapping tools. This is because UTAR is not built when the latest version of Google map is published. Therefore, the map of UTAR area has to draw out instead of plug-in Google map into the proposed system.

Based on problem statements, objective of proposed system had been clarified. It is to enhance current UTAR bus system and increase the performance of bus service provided to student. Finally, the final project scope was identified to meet the project objectives and overcome the problems on problem statements.

Deliverables: Project Title, Problem statements, objectives and project scopes

3.2.2 STAGE 2 - ANALYSIS

In this stage, analyses on existing systems have been made. Few bus tracking systems available had been studied and the main system requirements had been founded. User want to know where is the position of the bus before arrive and showing bus position in a map is more meaningful instead of just showing estimated arrival time.

Besides, observation on current UTAR bus system has been made. Student only know about the scheduled arrival time but somehow the bus is not arrived on time. Students felt impatient while waiting at bus stop. Furthermore, interview has been done with the student waiting in bus stop. The result of interview is student want to know when the bus will arrive while student is waiting in bus stops and student is not really

trusted on the timetable scheduled by bus management team. Thus, functional and non-functional requirements are gathered from observation and interview.

Next, literature reviews in term of technologies, suitable programming language, platforms and methodologies are made. This is done to ensure that the proposed system delivered matches the user's requirements and expectations. A study on technology needed is to know how the technology work and make use of it in proposed system. Study on suitable programming language and different platforms are important to ensure that the programming language is sufficient to build the proposed system and how to integrate different modules with different platforms into a meaningful system to provide useful information to user. Finally, study on suitable methodology is to understand more about the chosen methodology in aiding the proposed system development processes.

Deliverables: Requirements analysis, functional and non-functional requirements, literature reviews (in term of technology needed, suitable programming language, platforms and methodology)

3.2.3 STAGE 3 - DESIGN

The development of proposed system is begun and functional system has to be developed in this stage. In prototyping methodology, this design stage will be the prototyping loop point and the first prototype is developed in the first loop. After the first prototype has been evaluated by user and came out with new requirements, development process will loop back to this stage. Redesign and rebuild the second prototype.

In the first prototype design process, prototype is developed based on the main requirements acquired at stage 2. Prototyping is only focus on functionality of system instead of focus on user interface. Thus, prototype is build with simple interface and more effort will put on functions and features modules of the system.

The next step would be the design of database; the Entity Relationship Diagram (ERD) must be design so that the entities can be extracted. All the data needed for the

system must be included and properly assigned. Primary key and foreign key of each table should be assigned in order to draft out the relationship for every table in database. So that we can know that which data is needed to be process and which data should be show to the user. Besides, normalization must be performed in order to create a smooth and efficiency database.

A test plan for first prototype must be designed so that testing can be done once the first prototype is developed. In prototyping model, test plan is create based on different prototype. This is because new version prototype will have new requirements and the first test plan will be specifically tested on first prototype requirements.

Deliverables: Entities relationship diagram (ERD), first version prototype and first version test plan.

3.2.4 STAGE 4 - IMPLEMENTATION (PROTOTYPE)

In this stage, prototype will be deployed and implemented in real environment. Selected users will test on the prototype and evaluate the system. First, users will test on the first prototype based on the test plan created in stage 3 and test result will be recorded for further evaluation. Evaluation for the first prototype will be performed based on the test result gathered from users.

Interview and observation will be performed while testing on prototype. These activities are performed to verify the acceptance of the prototype by users. Observation is performed while the prototype is implemented in real environment to observe whether the functions and features provided in the prototype is satisfied the system requirements and users requirements discussed in early stage. If users are not satisfied with current prototype functionalities, interview will be done with users to acquire new requirements. Thus, system development process will loop back to design stage and the new prototype is developed based on the new requirements provided by user.

Deliverables: Test results, new requirements (If the prototype is not satisfy user)

3.2.5 STAGE 5 - IMPLEMENTATTION (FINAL SYSTEM)

This stage is executed when the prototype is accepted by users. When the latest version of prototype is satisfied user requirements, development process will jump out from prototyping loop. The final system will then developed based on the accepted prototype. The accepted prototype will became the fundamental of final system and the user interface of final system will be enhanced. Functionalities in the accepted prototype will fully apply into final system.

After final system is developed, final testing will be performed. Go through the final testing, the final system is ready to deploy and implement into real operating environment. Finally, the whole processes of development must be documented so that the system can be easily maintained in future.

Deliverables: Final system

3.3 PROJECT TIMELINE

ID	Task Name	Start	Finish	Duration
1	Project Planning	1/31/2013	2/12/2013	9d
2	Identify Problem Statements	2/13/2013	2/18/2013	4d
3	Identify Objectives and Project Scopes	2/19/2013	2/20/2013	2d
4	Literature Reviews	2/21/2013	3/6/2013	10d
5	Preliminary Report	3/7/2013	3/13/2013	5d
6	Define Methodology	3/14/2013	3/25/2013	8d
7	Define Requirements	3/26/2013	3/27/2013	2d
8	Design Prototype	3/28/2013	4/3/2013	5d
9	Design ERD	4/4/2013	4/10/2013	5d
10	FYP Report Submission	4/11/2013	4/11/2013	1d

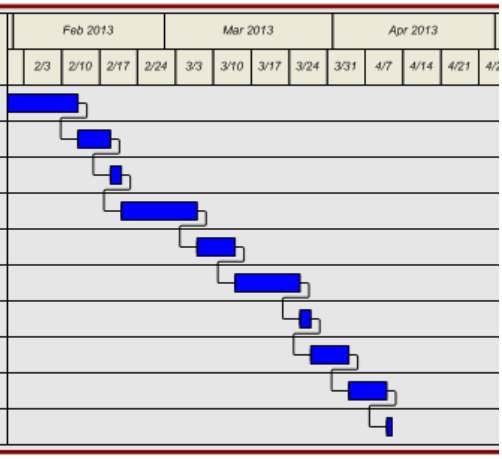


Figure 3.2 Gantt chart for FYP 1

3.4 REQUIREMENT SPECIFICATIONS

In this section, the user requirements, functional and non-functional requirements will be stated in detailed.

3.4.1 USER REQUIREMENTS

There are two main target users for the proposed system, bus user (student) and bus management team. The requirement from different user is stated below.

Bus user (Student/Passenger)

Student is the main user of the proposed system because the main objective of bus tracking system is to provide estimated bus arrival time for student. The student must able to retrieve real time estimated bus arrival time for every bus stop. While waiting in bus stop, student able to access bus tracking system with mobile device instead of using computer to access. This is the main purpose of bus tracking system in mobile application is developed. Beside of just showing timetable to student, student is able to know where a particular bus located is. The system is provided real time bus tracking system with mapping feature, which mean student able to view the bus position with a map. With this mapping technique, student able to know where is a bus position based on the map in real time.

Bus Driver

Bus driver is the second important user of this system. Bus driver is the one who update the information while bus driver is on bus operating hours. Bus driver is able to update bus status accordingly in order to inform bus users about immediate situation.

3.4.2 FUNCTIONAL REQUIREMENTS

Functional requirement is refer to the functionalities must be apply to a system. The functional requirements of bus tracking system are stated below.

1. The system must be able to show information to user in real time.
2. The system must be able to process the position data received from bus positioning module and calculate the estimated time to user.
3. The system must be able to show estimated arrival time for every bus in every bus stop.
4. The system must be able to allow user retrieve information from mobile device and computer.
5. The system must be able to do mapping with the position data retrieved from bus positioning module and show the bus position in a map view to user.

3.4.3 NON-FUNCTIONAL REQUIREMENTS

1. The system should provide the accurate estimated bus arrival time to user.
2. The system should reduce the paper work done by bus management team.
3. The system should be able to increase the efficiency and performance of bus service.
4. The system should reduce work done by bus management team by automated calculation of estimated bus arrival time and showing real time bus position to user.
5. The system should allow user to access information in anywhere with anytime.

CHAPTER 4: SYSTEM DESIGN

System design is one of the most important things that developer has to do before develop a system. A good system design may give a good startup and able to cope with system requirements. In this chapter, system design would be introduced. Interface design of the system will be explained.

4.1 INTERFACE DESIGN

The interface design of bus information web pages must be as simple as possible so that bus users able to get information easily. The interface design must be consistency so that bus users able to remember where are the position of important information is and no need to relearn how to use the system every time they login.

After studies on few existing bus tracking system, the design of APU University bus tracking system had been chosen for proposed system interface design. The web page is divided into two main parts, which is map with bus position and bus timetable.

The first part on left hand side would be the map. The map image is fixed as background image on the map container when user loads this web page on he/she browser. This is because the width and height of the map must be fixed for bus position plotting module. Secondly, the map will not refresh until the user refresh the browser.

The second part would be the bus timetable. First of all at top of the right hand side container will be the UTAR logo image, following by title and current time. Next would be the choices of different bus indicated by radio button. The last part would be the bus detail information and timetable container and this container will change according to the radio button selection.

Figure 4.1 show the layout design of system interface.

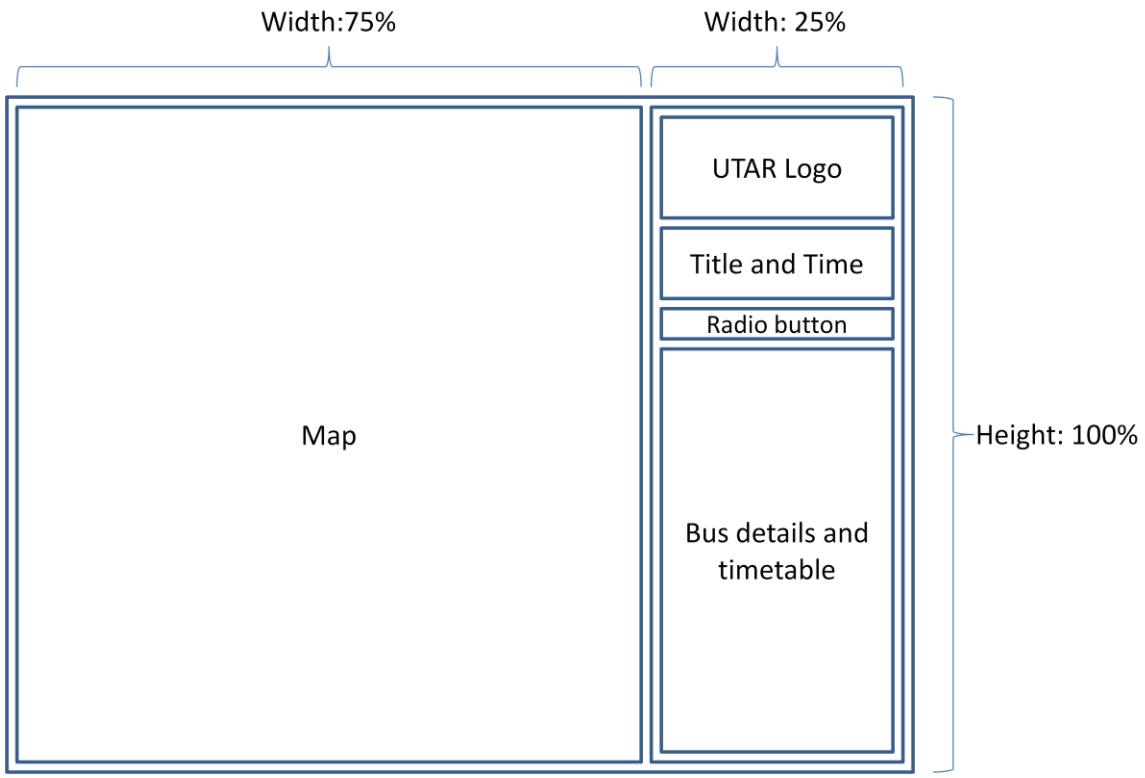


Figure 4.1 Layout of the system.

4.2 CUSTOM MAP

The suggested system environment would be the UTAR shuttle bus service. The UTAR shuttle bus is routing within UTAR campus area and student accommodation area which is called “Westlake”. Unfortunately, these areas are not updated inside Google Map as shown as below. This is because the UTAR campus area is not updated by Google Inc. when UTAR campus was build.

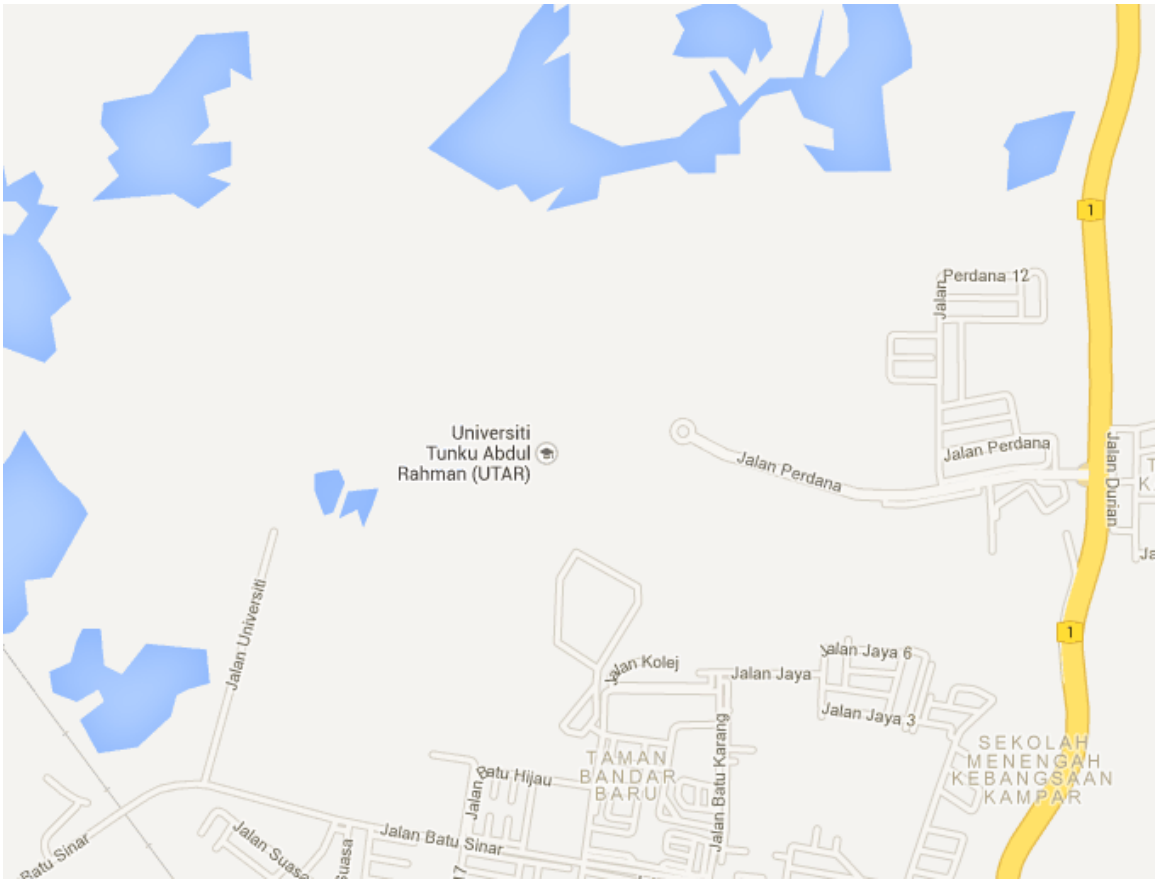


Figure 4.2 UTAR area in Google Map

Department of Estate and Facilities (DEF) of UTAR have created a custom map for UTAR campus area and also the Westlake student accommodation area. Therefore, the maps created by DEF of UTAR will be use in the proposed system as show in figure 4.3 and figure 4.4.

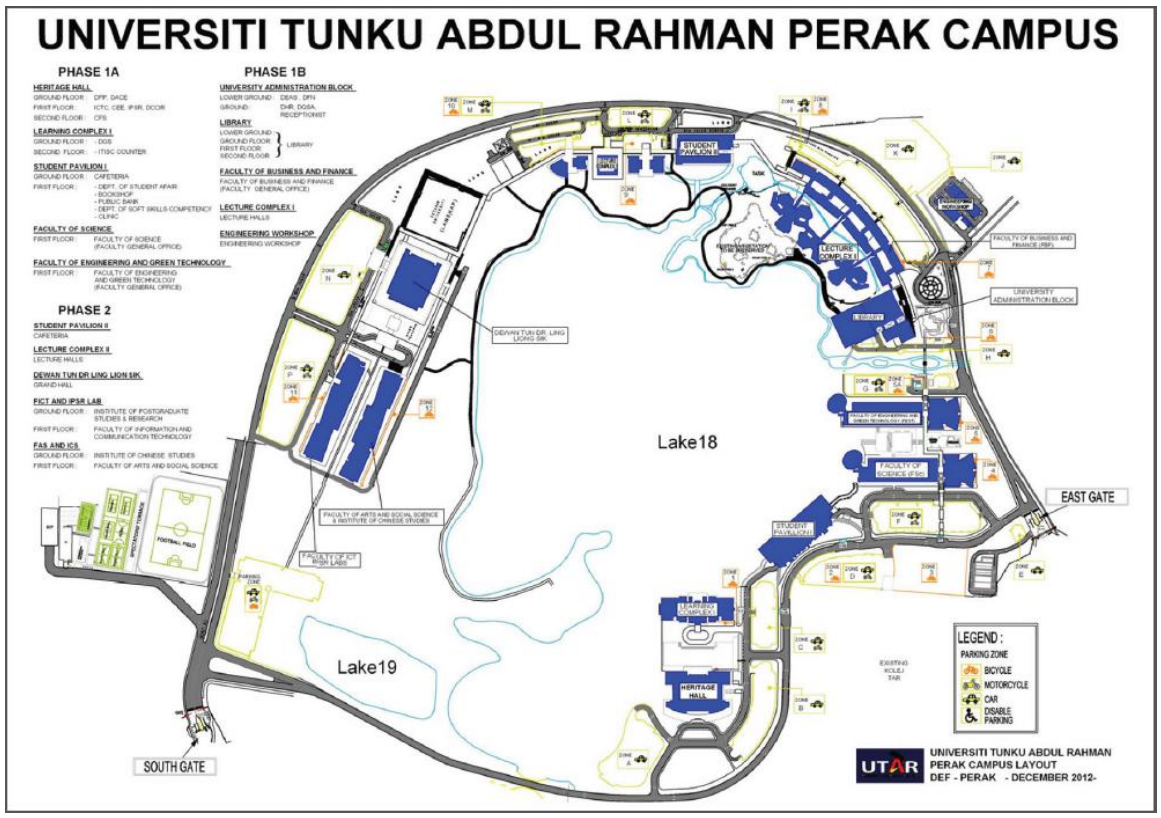


Figure 4.3 UTAR Perak Campus area map created by DEF of UTAR

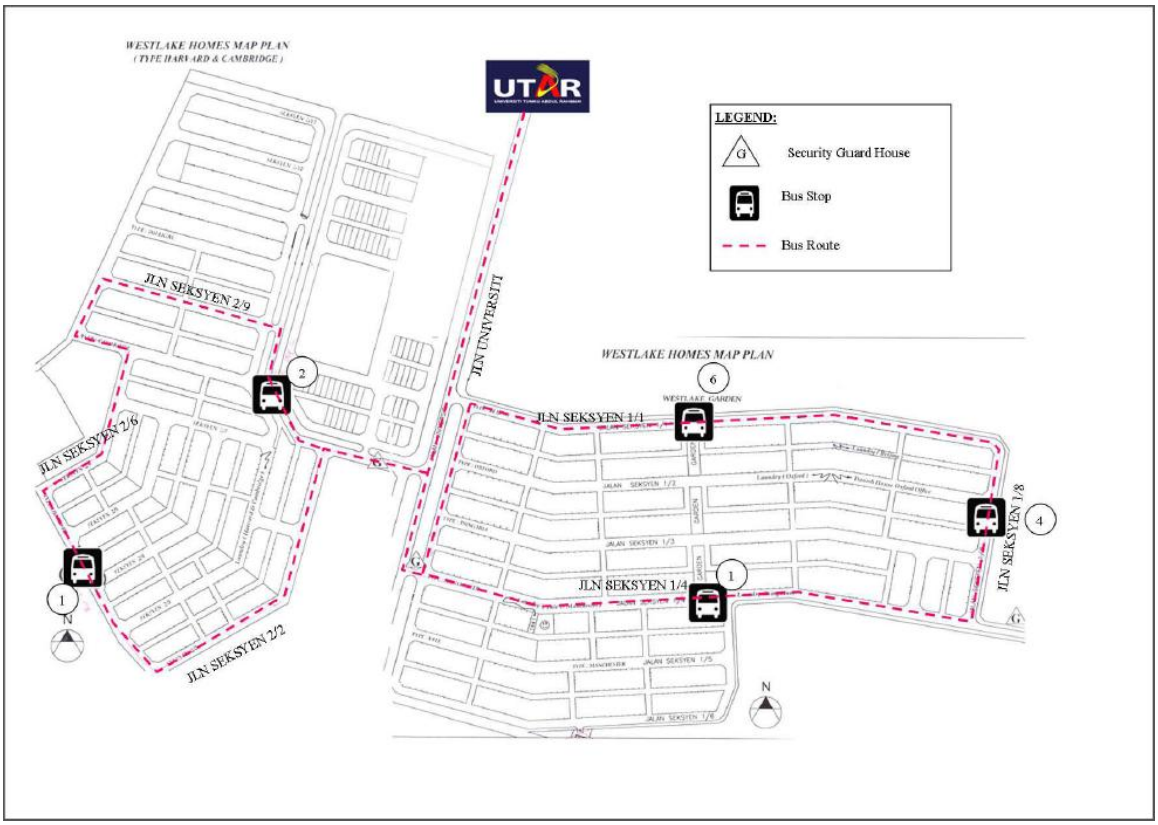


Figure 4.4 Westlake Home Map Plan with bus route created by DEF of UTAR (Student accommodation area)

According to the UTAR Perak campus area custom map created by DEF, there are too many information inside. The map needed to modify in order to stick with proposed system design requirement. For example, delete some useless information, adding a color line to indicated bus route, add bus stop icon accordingly and add a legend box. With those modifications on the map, bus user able to know the bus route direction and the location of bus stop. The modified version as show as figure 4.5.

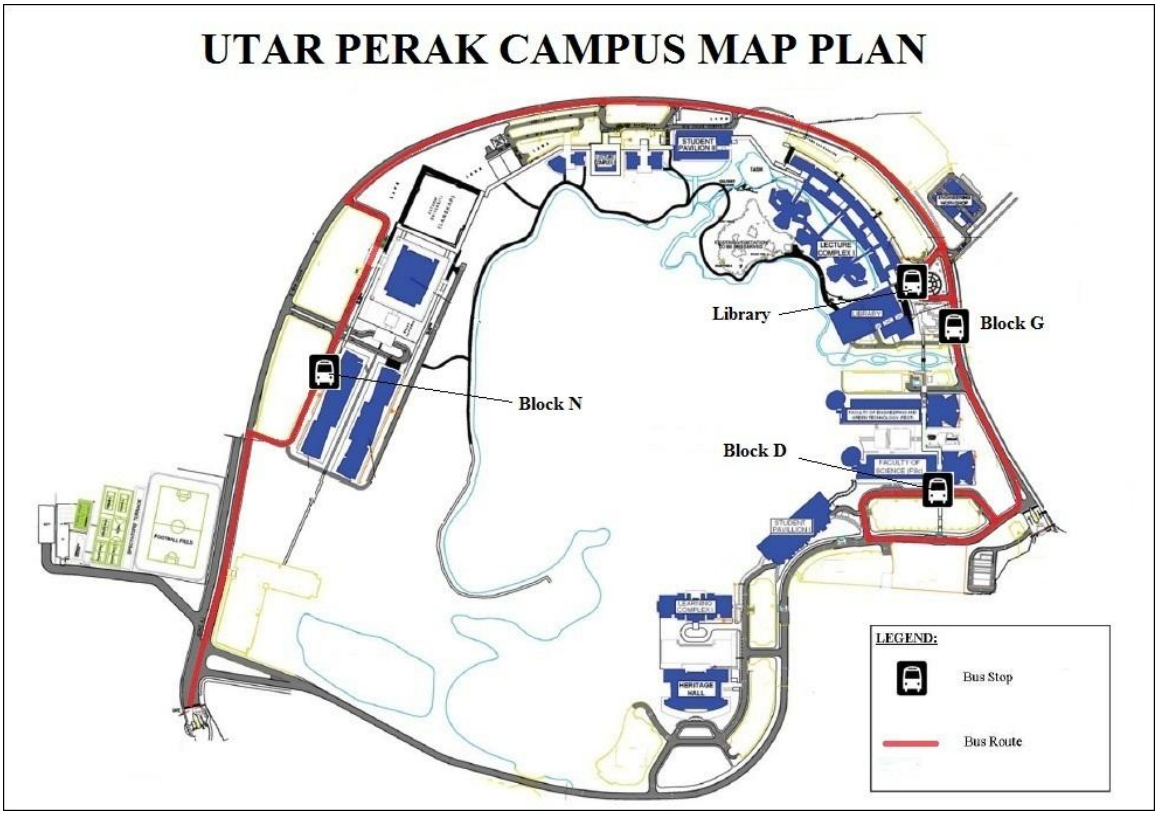


Figure 4.5 Modified UTAR Perak campus area custom map.

4.3 DATABASE DESIGN (ERD)

Database is the core part for a system. It stores all the important data input from external environment and provided a tidy place for data storage. Good database design would enhance the system data flow process and provide easy way to retrieve and data storing.

The entities relationship diagram (ERD) was created for preparation of system development. A good design of ERD would able to provide accurate information for system users. The ERD diagram is show as figure 4.6.

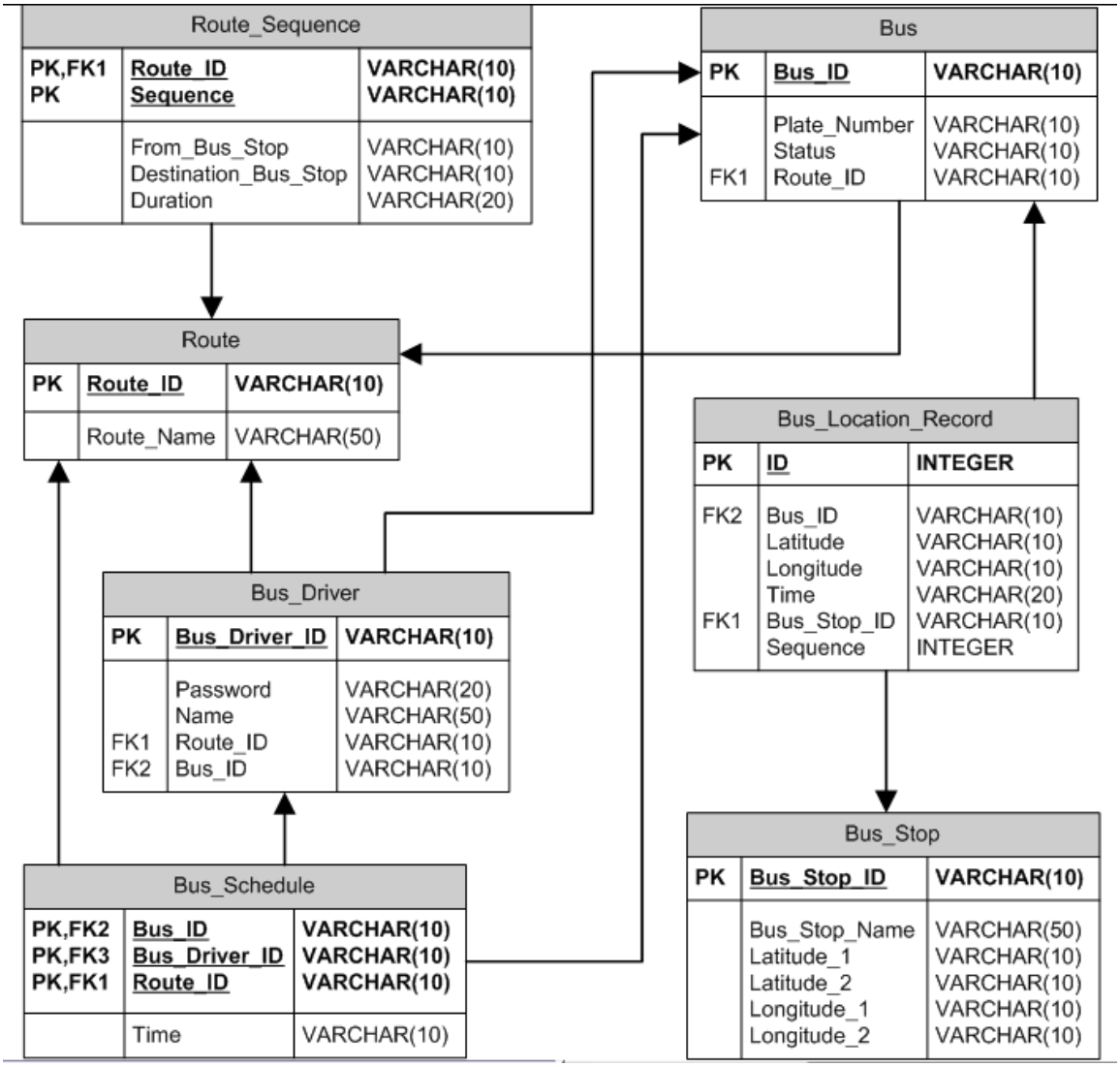


Figure 4.6 Entities Relationship Diagram (ERD)

4.4 DATA DICTIONARY

Bus Entity

Entity Name	Attributes	Description	Data Type	Null
Bus	Bus_ID	Identify bus uniquely	Varchar (10)	No
	Plate_Number	Bus plate number	Varchar (10)	No
	Status	Status of bus	Varchar (10)	No
	Route_ID	Identify the route of a bus	Varchar (10)	No

Bus Driver

Entity Name	Attributes	Description	Data Type	Null
Bus_Driver	Bus_Driver_ID	Identify bus driver uniquely	Varchar (10)	No
	Password	Password for a driver ID	Varchar (30)	Yes
	Name	Name of driver	Varchar (50)	Yes
	Bus_ID	Identify the bus assigned to driver	Varchar (10)	No
	Route_ID	Identify the route assigned to driver	Varchar (10)	No

Bus Stop Entity

Entity Name	Attributes	Description	Data Type	Null
Bus_Stop	Bus_Stop_ID	Identify bus stop uniquely	Varchar (10)	No
	Bus_Stop_Name	Name of bus stop	Varchar (50)	No
	Latitude_1	Initial latitude value at bus stop	Varchar (10)	Yes
	Latitude_2	Last latitude value at bus stop	Varchar (10)	Yes
	Longitude_1	Initial longitude value at bus stop	Varchar (10)	Yes
	Longitude_2	Last longitude value at bus stop	Varchar (10)	Yes

Bus Location Record Entity

Entity Name	Attributes	Description	Data Type	Null
Bus_Location_Record	ID	Identify the number of bus location record uniquely	Int (10)	No
	Bus_ID	Identify bus uniquely	Varchar (10)	No
	Latitude	Latitude value of bus position	Varchar (10)	Yes

	Longitude	Longitude value of bus position	Varchar (10)	Yes
	Time	Time of the record input	Varchar (20)	No
	Bus_Stop_ID	Identify bus stop uniquely	Varchar (10)	Yes
	Sequence	Identify bus stop sequence	Int (10)	No

Route Entity

Entity Name	Attributes	Description	Data Type	Null
Route	Route_ID	Identify route uniquely	Varchar (10)	No
	Route_Name	Name of route	Varchar (50)	No

Route Sequence Entity

Entity Name	Attributes	Description	Data Type	Null
Route_Sequence	Route_ID	Identify route uniquely	Varchar (10)	No
	Sequence	Sequence of route	Varchar (10)	No
	From_Bus_Stop	Bus stop ID of starting bus stop	Varchar (10)	Yes
	Destination_Bus_Stop	Bus stop ID of next bus stop	Varchar (10)	Yes

	Duration	Time taken between two bus stops	Varchar (20)	No

Schedule Entity

Entity Name	Attributes	Description	Data Type	Null
Schedule	Bus_ID	Identify bus uniquely	Varchar (10)	No
	Bus_Driver_ID	Identify bus driver uniquely	Varchar (10)	No
	Route_ID	Identify route uniquely	Varchar (10)	No
	Time	Scheduled starting time for a bus route	Varchar(20)	No

4.5 SYSTEM FLOW CHART

System flow chart is a graphically representation of the flow of data in a system and it represents the work processes of the system (Bimlendu Roy, n.d). System flow chart is using specific symbol to represent specific action and process. With system flow chart, the system process can be easily defined. The system flow chart of proposed system had been defined in following figures.

4.5.1 REAL TIME BUS POSITION AND TIMETABLE DISPLAY

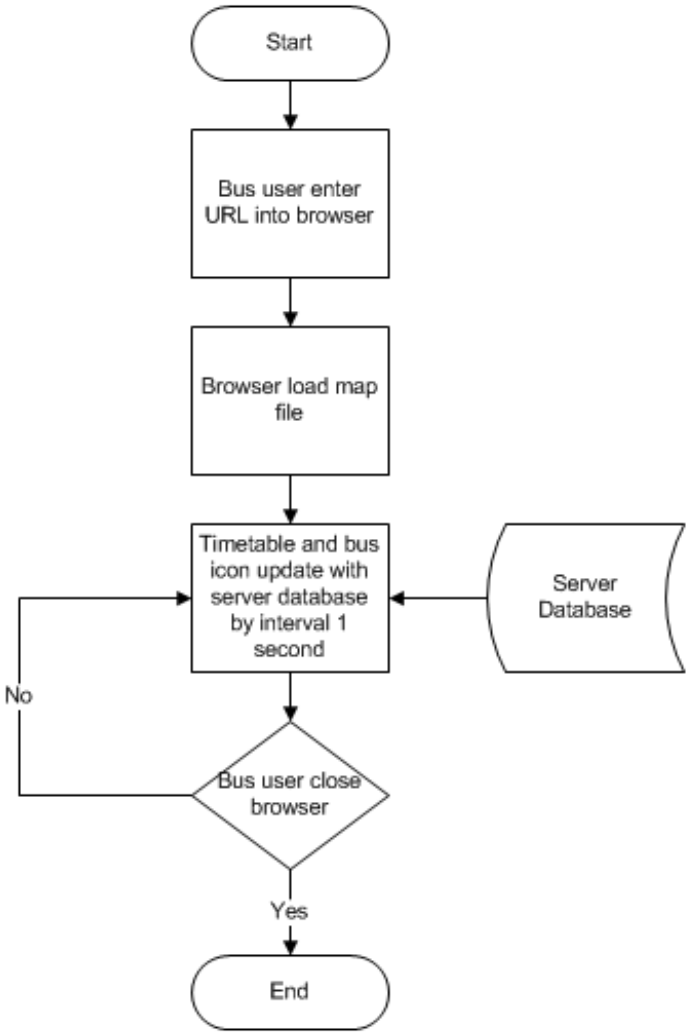


Figure 4.7 Data flowchart for real time bus position and timetable display

4.5.2 BUS DRIVER LOGIN TO BUS POSITIONING MODULE

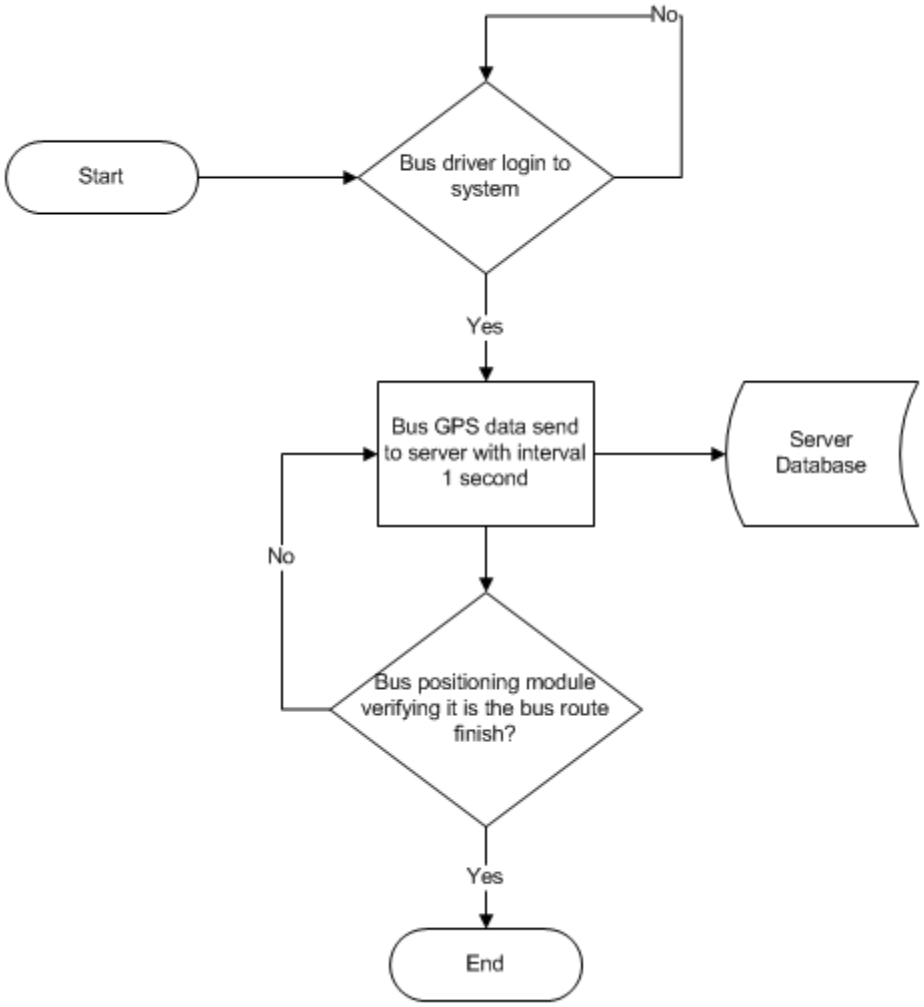


Figure 4.8 Data flowchart for bus driver login to bus positioning module

CHAPTER 5: SYSTEM FEATURES

The system consists of few features to show bus traffic information to bus user. By using those features, bus users able to know about the updated bus traffic information. The feature of system will explain in detail as following.

5.1 REAL BUS POSITION MAPPING DESIGN

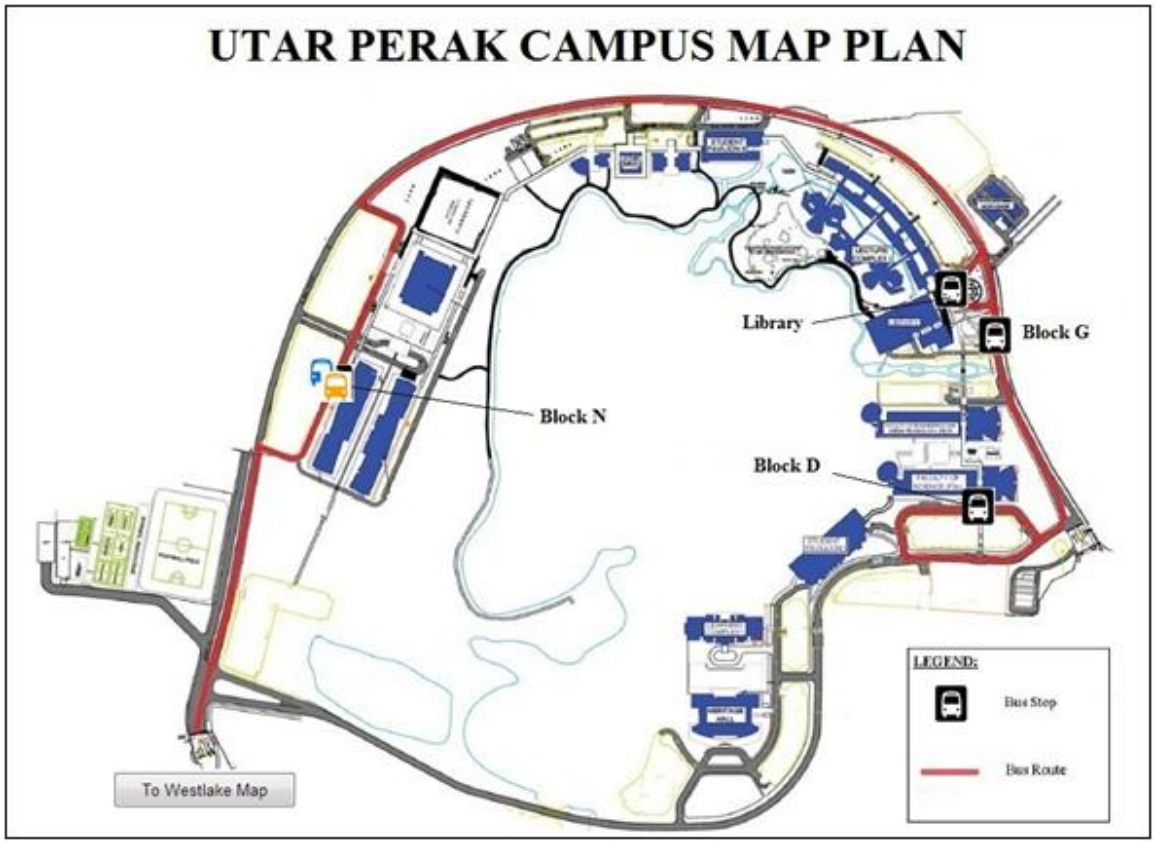


Figure 5.1 Real time bus positions mapping in UTAR campus map

Refer to figure 5.1, the map was showing the UTAR campus area. There are label to show that the location of each bus stop. Besides, the route of bus is highlighted with red color. With the label display, bus users able to know where are the bus stop located and where the bus will going to.

The most important thing is the bus icon which is indicated the real time bus position. According to figure 5.1, the two bus icons is plotted at “Block N” bus stop area, which mean the two buses is located at Block N bus stop in real time. And the bus icon will automatically update its position according to the latest GPS data in server.

5.2 REAL TIME BUS ARRIVAL TIME DISPLAY

Bus Stop	Estimated Arrival Time
Block G	-:-
Block N	-:-
Bus Stop 1 (Harvard & Cambridge)	14:50 pm
Bus Stop 2 (Harvard & Cambridge)	14:52 pm
Bus Stop 1 (Westlake Home)	14:55 pm
Bus Stop 4 (Westlake Home)	14:58 pm
Bus Stop 6 (Westlake Home)	15:00 pm
Block N	15:05 pm
Library	15:09 pm
Block D	15:12 pm

Figure 5.2 Table of real time bus arrival time

There is a table to display the bus arrival time in every bus stop. The table will update according to the latest data in server. With this timetable, bus users able to know when a bus will arrive in particular bus stop.

5.3 BUS STATUS UPDATE

Figure 5.3 Bus status update in driver module

This feature is purposely developed for bus driver to able update bus status to server. Refer to figure 5.3, there are three buttons in the module, there are “Full” button, “Not Full” button and “Send break down request” button.

The “Full” and “Not Full” buttons are used to update bus status when the bus is fully filled. The bus status will change to “Full” when bus driver click on “Full” button and bus status change to “Not Full” is “Not Full” button is clicked. The “Send break down request” button is a button to inform management side when the bus break down on the road.

This feature is very useful to update latest bus status to bus users who are waiting in bus stop.

CHAPTER 6: SYSTEM IMPLEMENTATION

System implementation is performed once system design was done. During system implementation, step-by-step development and installation would be performed. Due to this project is applied prototype methodology, system implementation would be divided into two stage as defined in chapter 3, methodology studies. First stage would be prototype implementation and second stage is the final system implementation.

However, there is a very important things had to be done before system implementation. There is the ratio between custom map pixel value and GPS value have to calculated before implement the bus position mapping module.

6.1 BUS POSITION PLOTTING IN CUSTOM MAP

While a bus is operating or moving, the bus position mapping modules is able to plot a bus position onto custom map based on the GPS data received from the bus position module. The main objective to plotting the bus position on the custom map purposed to shows the real time bus position to bus users, so that bus users able to know where are the bus located and make the decision which bus stop to catch up the bus.

Besides, as mention in system design stage, custom map is needed for proposed system because the UTAR campus area map is not provided by Google Map. And the custom map created by DEF of UTAR was a picture file, which is jpeg file format.

Before the module work, the ratio between custom map pixel unit and the GPS position (Latitude and Longitude) unit must be calculated in order to match the GPS position data on the custom map. Furthermore, a formula had been generated in order to let system able to automatically calculate the pixel value position in custom map based on GPS data received and able to plot the bus position with bus icon on the custom map.

6.1.1 METHOD OF CALCULATION THE RATIO BETWEEN CUSTOM MAP PIXEL VALUE AND GPS VALUE

There are few steps to calculate the ratio, step-by-step calculation would be describe as following.

Step 1 - Obtain 4 points in GPS value within the custom map area which 2 points in horizontal line and 2 points with vertical line. For horizontal line, the y-axis (Latitude) value must be same and for vertical line, x-axis (Longitude) value must be same. This is needed in order to obtain a linear line for both horizontal and vertical line. The recorded 4 GPS value point as show in figure 6.1.

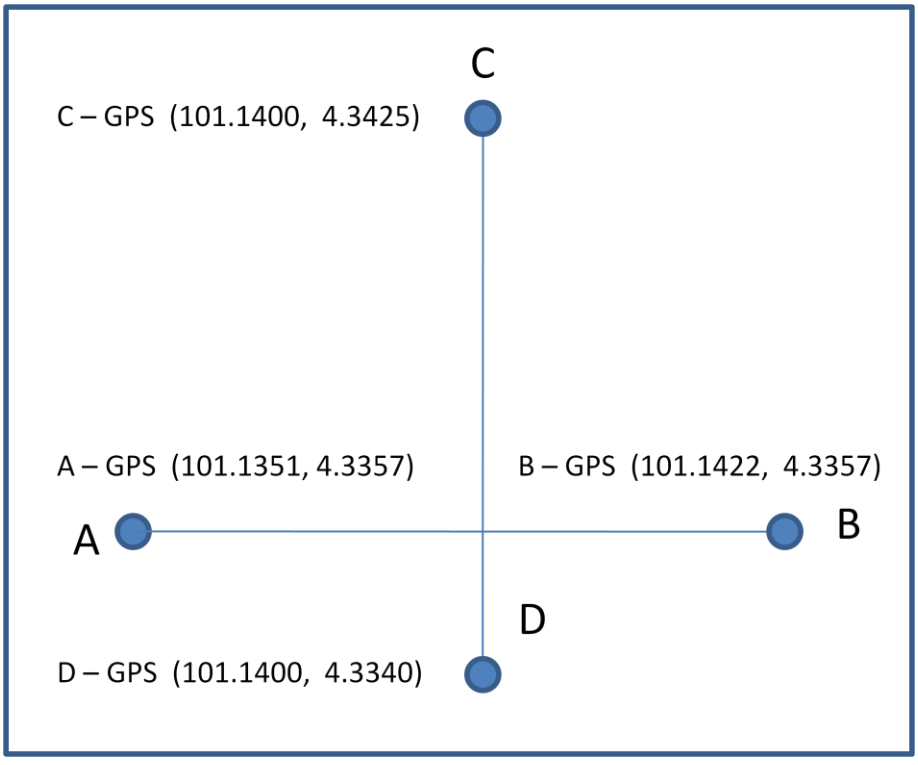


Figure 6.1 Step 1 Custom map with 4 GPS value points (Horizontal and vertical)

Step 2 - Take the pixel value for the 4 point same as the 4 point in GPS value within the custom map taken on step 1.

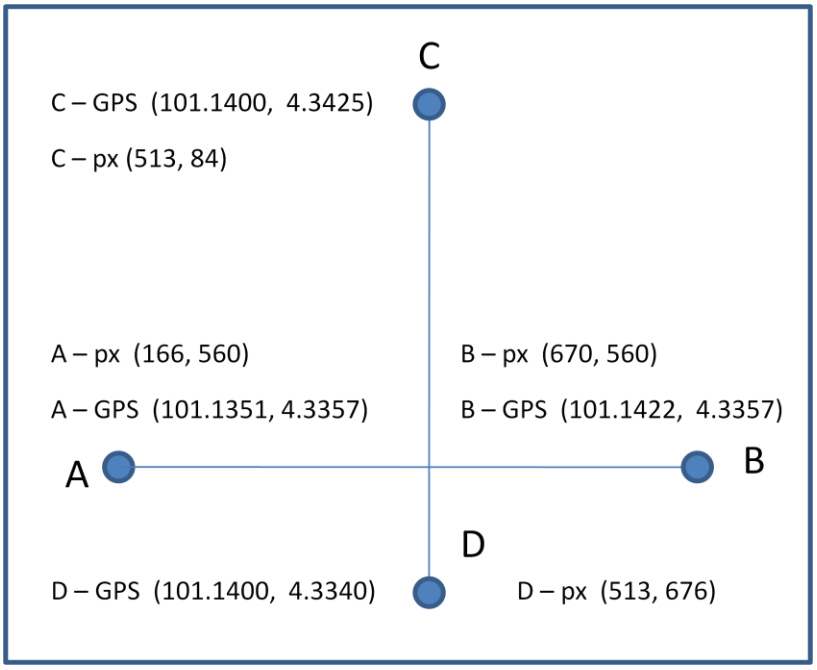


Figure 6.2 Step 2 - Custom map with 4 point GPS value and pixel values.

Step 3 - Calculate the distance in GPS value and pixel value between 2 points in horizontal line and 2 points in vertical line. Compare the GPS unit value distance with pixel value distance and get the ratio between GPS unit and pixel unit. The following table shows the calculation of ratio.

For **X-axis** (point A - point B)	For **Y - axis** (point C - point D)
(A - px) - (B - px) = (A - GPS) - (B - GPS)	(C - px) - (D - px) = (C - GPS) - (D -GPS)
670 - 166 = 101.1422 - 101.1351	84 - 676 = 4.3425 - 4.3340
504 px = 0.0071 GPS unit	592 px = 0.0085 GPS unit
1px = 0.0071 / 504	1 px = 0.0085 / 592
1px = 0.00001408730159 GPS unit	**1 px = 0.00001435810811 GPS unit**

Table 6.1 Calculation of ratio between pixel value and GPS unit.

Step 4 - With the ratio between two unit, calculate the initial point from point A in GPS unit which is located in (0, 0) pixel value in the custom map. Table 6.2 show the calculation of initial point in GPS unit.

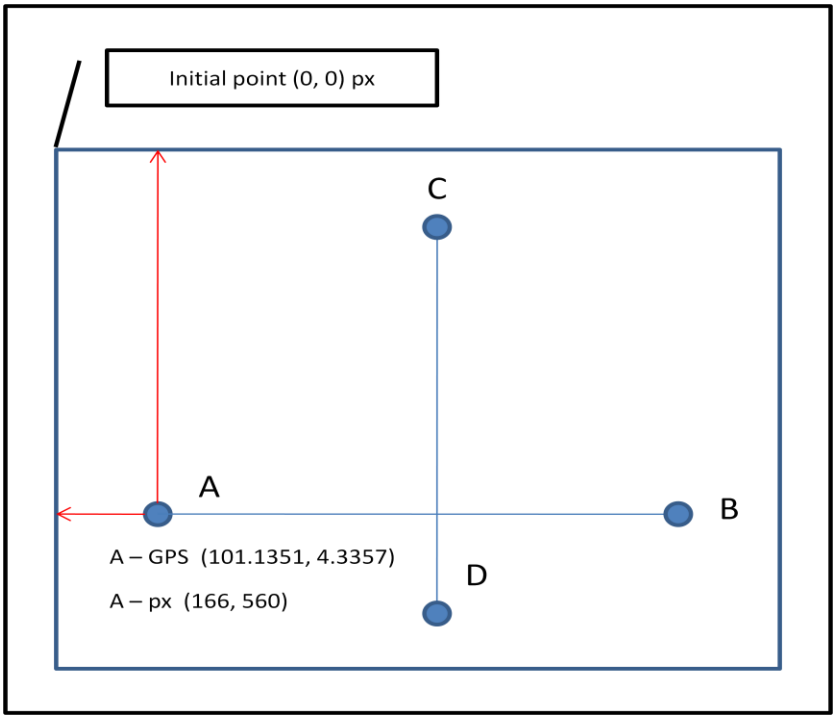


Figure 6.3 Step 4 - Calculate initial point from point A.

From point A (166, 560) px, (101.1351, 4.3357) GPS unit	
Point A (X-axis) X = 166 px 166 px * 0.00001408730159 = 0.0023 GPS unit From point A (166 px) to initial point (0 px) is heading to west, so the GPS coordinate at initial point have to minus from point A. 101.1351 - 0.0023 = **101.1328**	Point A (Y - axis) Y = 560 px 560 px * 0.00001435810811 = 0.0080 GPS unit From point A (560 px) to initial point (0 px) is heading to North, so the GPS coordinate at initial point have to plus from point A. 4.3357 + 0.0080 = **4.3437**

Therefore, the GPS coordinate value at initial point (0, 0) px in custom map would be (101.1328, 4.3437) based on calculation above.	

Table 6.2 Calculation of initial point in GPS unit

Step 5 - Based on the initial point calculated in step 4, the ratio calculated in step 3 and the data received from bus positing module, the bus position able to plot on the custom map dynamically by applying a formula.

Before applying the formula, the reverse ratio is needed which is from GPS unit to pixel unit. This is because input data received from bus positing module is GPS unit, to plot it on the map, it have to convert to pixel value. Table 6.3 show the conversion from GPS unit to pixel unit.

From GPS unit -> pixel value	
For **X-axis** (point A - point B)	For **Y - axis** (point C - point D)
0.0071 GPS unit = 504 px 0.0001 = 504 / 71 **0.0001 GPS unit = 7.0986 px**	0.0085 GPS unit = 592 px 0.0001 = 592 / 85 **0.0001 GPS unit = 6.9647 px**

Table 6.3 GPS unit to pixel unit conversion.

6.1.2 BUS POSITION PLOTTING FORMULA

The figure 6.4 shows the formula of calculation for bus position in pixel value.

x-axis pixel value = ((Input Longitude – Initial Longitude) * (x-axis ratio)

y-axis pixel value = ((Initial Latitude – Input Latitude) * (y-axis ratio)

Figure 6.4 Formula of calculate pixel value with input GPS data.

To prove that this formula is work, the GPS value and pixel value for point A will be used for formula proving. The result calculated from the formula must be equal to the point A pixel value.

Point A GPS value = (101.1351, 4.3357)

Point A pixel value = (166, 560)

Initial (longitude, latitude) = (101.1328, 4.3437)

X-axis ratio = 0.0001 GPS unit = 7.0986 px

1 GPS unit = 70986 px

Y-axis ratio = 0.0001 GPS unit = 6.9647 px

1 GPS unit = 69647 px

X-axis px = ((101.1351 - 101.1328) * 70986)

= 0.0023 * 70986

= 163.26 px

~ 163 px

Y-axis px = ((4.3437 - 4.3357) *69647

= 0.0080 * 69647

= 557.18 px

~ 557 px

The result calculated from formula is (163, 557) px. Compare to the point A value which is (166, 560) px, the result getting is very close. Therefore, the formula is proved that able to use for calculation of bus position in custom map.

6.2 IMPLEMENTATION (PROTOTYPE)

The first thing that has to do during implementation is download all the software needed for system development. The first software needed is Appserv, Appserv is a server installation package setup which consists of Apache server (PHP server) and MYSQL server (Database server) with phpMyAdmin, phpMyAdmin is the management page for MYSQL database server which created by PHP programming language.

Next would be download the phpDesigner8 software. Because this project is implement on web page, so that web page programming is needed and PHP programming language would be chosen programming language. phpDesigner8 is a web programming

coding software. It provided the easy way to do PHP coding. Therefore, this software used to develop web pages for proposed system. The last software needed to download is Eclipse Juno. Eclipse Juno is Android platform programming language coding software. It was used to develop bus positioning module which this module will be install in Android platform device.

After all modules had been developed, a server is needed in order to integrate all the modules to let the whole system work. However, for prototype implementation, the server would be installed within local network. This is because prototype is mainly focused on modules functionality, so that local network is enough for prototype implementation. Within local network server, it able to testing on web pages development which able to display the developed web pages on browser and database server connectivity.

Continue with creation of bus position module which able to receive GPS data via Android platform smart phone. The module is installed inside a selected smart phone after the module developed using Eclipse Juno Android coding software. Then, this module is used to receive GPS data and send data into the local network database server. Besides, this module also used to obtain the GPS value of every bus stop. The reason of record down every bus stop GPS value is to enable system to identify some specific GPS value is bus stop coordination.

With the function of bus positioning module, few sample of bus route data had been recorded. The average duration between every bus stop can be taken through analysis on sample data. And the average duration time able to let system calculate the real time estimated bus arrival time at every bus stop.

6.3 IMPLEMENTATION (FINAL SYSTEM)

In final system implementation, system has to put on Internet in order to let bus users check on bus information and also enable the system running on real time environment through Internet.

To setup server to public, the server computer have to open its connection port to public network. Port forwarding had to done on router so that router can forward public network request to the local network server and the local network server also able to send out reply to public network. Next, the public IP address has to put it on DNS server. This is because most of the IP address connected by ADSL line will be set as dynamic IP which the public IP will change time to time by Internet service provider. The DNS server will automatically resolve the public IP with a fixed domain name after the public IP had been registered on DNS server. Therefore, a free dynamic DNS service had been choose and register (http://www.dnsdynamic.org/**)** and the domain name registered is "bustracking.imap01.com". The server able to access through the domain name instead of IP address after the public IP had been registered with fixed domain name. The following figure shows the network architecture of proposed system.

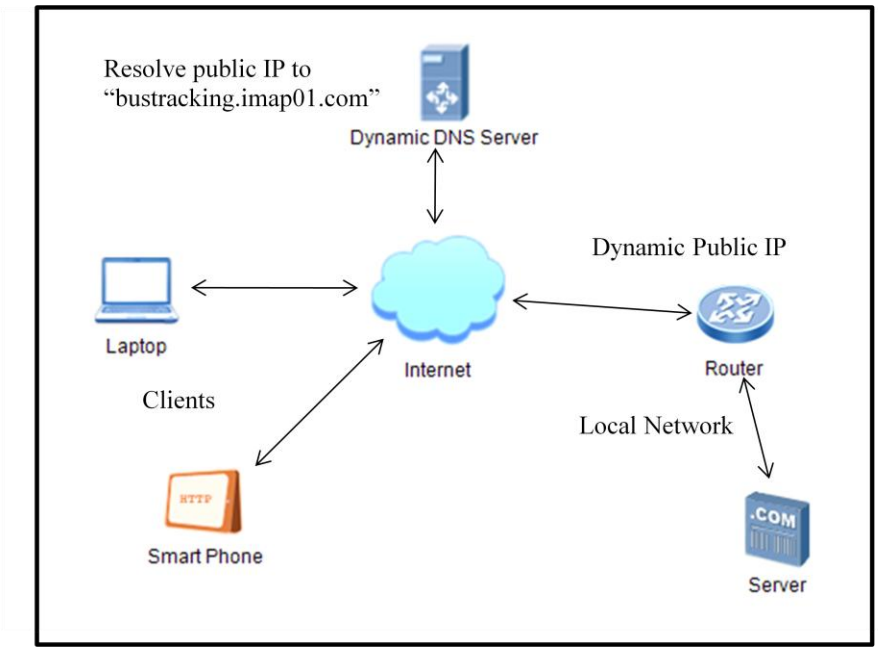


Figure 6.5 Network architecture of system

After the system is open to public users, the interface of web pages has to be enhanced. The real time bus position could be clearly display on the map with bus icon movement where it is simultaneous with real time moving or operating bus. Bus arrival time at every bus stop will also been showed on web page in tidy table.

The interface of bus position module installed in smart phone also has to enhance in order to stick with the role of bus driver, where bus driver able to send bus status to server with one button. However, bus driver is not able to stop the bus position data convey to server, this can be act as the control of management team to observe bus driver working performance. However, bus driver able to decide whether the bus is fully filled or not. The status of bus able to update by bus driver with single button in real time so that bus user able to know about the status of bus before the bus is arrive next bus stop. Besides, there is a button for bus driver to inform management team and bus users immediately when the bus is break down.

Lastly, the final system implementation was successfully implemented and final system testing will be performed.

CHAPTER 7: SYSTEM TESTING

Once system implementation is done, system testing will be performed to testing on system performance .System testing is an important process in system development project. It will perform after development process which the actual system or prototype is created. Testing phase is very useful and important because this process able to trickle out the errors inside the software. Normally testing criteria is based on user and system requirements, to verify whether the system meet the requirements or not. System reliability is very important for a system to the end users and testing process able to verify the reliability of the system.

System testing may divide two parts which is unit testing and module integration testing. Unit testing is a kind of testing on each of the individual component in a large system. Before modules integration, unit testing performed on each module able to ensure that every module is working perfectly. The module integration testing would be a testing on the process of combination of all modules. Once all modules able to communicate with each others, the final system is done and the integration testing would test on the complete system.

7.1 UNIT TESTING

Test Case 1: Bus Positioning Module - Unit Testing

No	Test Objective	Test Step	Expected result	Result
1.	To ensure that the module able to receive GPS data by GPS receiver.	1) Turn on GPS feature. 2) Run the bus positioning module installed. 3) Observe the GPS data receive from satellite.	The GPS location data should display on the screen.	Pass

2.	To ensure that the module able to send GPS data received to server.	1) Run the module installed in smart phone. 2) Observe the data table in database located in server computer.	The database should receive GPS data from bus position module.	Pass
3.	To ensure that the module will continuously send updated GPS location data to server when location is changed.	1) Run the module installed in smart phone. 2) Move the smart phone to other location. 3) Observe the data table in database. 4) Repeat step 2 and 3 few times.	The database should continuously receive updated GPS location data.	Pass

Table 7.1 Bus Positioning Module - Unit Testing

Test case 2: Real Time Bus Position Mapping Module - Unit Testing

No	Test Objective	Test Step	Expected result	Result
1.	To ensure that the bus icon able to plot on the custom map correctly.	1) Manually insert a bus stop GPS value into database. 2) Change the module code to retrieve the insert GPS data in step 1.	The bus icon should plot on the particular bus stop.	Pass

		3) Run module (web page) on browser. 4) Observe the bus icon.		
2.	To ensure that the bus icon will automatically update with interval 1 second.	1) Take a bus trip and bring along the smart phone which installed with bus positioning module. 2) Run the bus positioning module which installed in smart phone when the bus starts moving. 3) Run the module (web page) on browser. 4) Observe the bus icon movement (Updating).	The bus icon should update position with interval 1 second.	Pass

Table 7.2 Real Time Bus Position Mapping Module - Unit Testing

Test Case 3: Real Time Bus Arrival Time Display Module - Unit Testing

No	Test Objective	Test Step	Expected result	Result
1.	To ensure the timetable able to display all the bus stop name and bus arrival time according to bus selected.	1) Run the module on browser. 2) Select different bus (radio button). 3) Observe the timetable.	The timetable should update accordingly when either radio button is selected.	Pass
2.	To ensure that the timetable will update when the bus is pass through a bus stop.	1) Take a bus trip and bring along the smart phone installed with bus positioning module. 2) Run the bus positing module which installed in smart phone when the bus is moving. 3) Run the module (web page) on browser.	The timetable will update accordingly when the bus is passing through a bus stop.	Pass

		4) Observe the timetable when the bus is passing through a bus stop.		

Table 7.3 Real Time Bus Arrival Time Display Module - Unit Testing

Test Case 4: Bus Status Update Module - Unit Testing

No	Test Objective	Test Step	Expected result	Result
1.	To ensure that the module able to update bus status.	1) Run the module which installed in smart phone. 2) Click on “Full” and “Not Full” button. 3) Observe the bus status changing on web page.	The bus status should update accordingly.	Pass

Table 7.4 Status Update Module - Unit Testing

7.2 MODULES INTEGRATION TESTING

Test Case 5: Modules Integration Testing

No	Test Objective	Test Step	Expected result	Result
1.	To ensure that all modules is able to communicate with server.	1) Run all modules 2) Observe bus icon position on map. 3) Observe the changing of timetable.	All modules should able to communicate with server and the bus information should display smoothly and correctly.	Pass

Table 7.5 Modules Integration Testing

CHAPTER 8: CONCLUSION

While waiting for a bus, people may felt impatient and anxious if he or she does not know when the bus will arrive. For the bus management side, it is very difficult to provide an accurate schedule for bus user due to some uncertainties may happen on the road such as traffic jam or bus break down. When a bus is delayed, bus management side should inform bus user immediately. However, they do not have a platform to inform bus user in real time about the latest bus traffic status.

In order to enhance bus system and increase the performance of bus service provider, the bus tracking system is needed. Bus tracking system provided a real time platform for bus user to check on bus traffic status in anytime and anywhere. It also provided a platform for bus service provider to monitor bus status and update latest information to user.

8.1 FUTURE ENHANCEMENT

The estimated bus arrival time is based on the average of arrival time in every bus stop in current version of system and it is not the most accurate estimated time. Because the current system does not consider about unexpected situation happened on the road such as traffic status and bus users boarding status. In future, the system will enhance to provide more accurate estimated arrival time to user.

There are many other enhancements for the proposed system, one of the important enhancement would be create an artificial intelligence program to automatically study and analysis bus route data to provide most optimum estimate arrival time. By applying artificial intelligence program, the system will become more valuable because of the accuracy of estimation on arrival time.

REFERENCES

Android Developers, n.d.. Location and Sensors. Available from: <http://developer.android.com/guide/topics/sensors/index.html> [2 Apr 2013]

Anson Alexander, 2012. *Smartphone Usage Statistics 2012*. 24 Jan 2012. Available from: <http://ansonalex.com/infographics/smartphone-usage-statistics-2012-infographic/> [2 Apr 2013]

Anson Alexander, 2013. *Smartphone Usage Statistics and Trends 2013*. 19 Feb 2013. Available from: <http://ansonalex.com/infographics/smartphone-usage-statistics-and-trends-2013-infographic/> [2 Apr 2013]

AppBrain, 2013. *Number of Available Android Applications*. Available from :< http://www.appbrain.com/stats/number-of-android-apps> [18 March 2013]

Arctern, 2011. *Iterative & Incremental Development Model*. Available from: <http://www.arctern.com/Development_Methodologies.aspx> [28 March 2013]

Asia Pacific University, *Bus Tracking System*. Available from: <http://webspace.apiit.edu.my/links/tracking/> [6 March 2013]

Bimlendu Roy, n.d, Definition of System Flowchart, Available from: < http://www.ehow.com/facts_6283102_definition-system-flowchart.html> [26 August 2013]

Cory Janssen, n.d., *Iterative and Incremental Development*. Available from: <http://www.techopedia.com/definition/25895/iterative-and-incremental-development> [28 March 2013]

Fred Swartz, n.d., *Iterative and Incremental Development*. Available from: <http://www.javafaq.nu/java-article797.html> [28 March 2013]

Fred Zahradnik, n.d.. About.com Guide, *Assisted GPS*. Available from: <http://gps.about.com/od/glossary/g/A-GPS.htm> [20 March 2013]

GARMIN, n.d. *What is GPS?*. Available from: <http://www8.garmin.com/aboutGPS/> [20 March 2013]

Huskie Bus Tracker, n.d.. Northern Illinios University. Available from: http://huskietracks.niu.edu/DynamicDefault.asp [13 March 2013]

ISTQB GUIDE, n.d., *What is Incremental model- advantages, disadvantages and when to use it?*. Available from: <http://istqbexamcertification.com/what-is-incremental-model-advantages-disadvantages-and-when-to-use-it/> [28 March 2013]

ISTQB GUIDE, n.d., *What is Prototype model- advantages, disadvantages and when to use it?*. Available from: <http://istqbexamcertification.com/what-is-prototype-model-advantages-disadvantages-and-when-to-use-it/> [28 March 2013]

James Kendrick,2011. *Smartphone for GPS Navigation is better than a dedicated device*. 28 June 2011. Available from: http://www.zdnet.com/blog/mobile-news/smartphone-for-gps-navigation-is-better-than-a-dedicated-device/3055 [2 Apr 2013]

Live View GPS, n.d.. *GPS Tracking - What Is Latitude And Longitude*. Available from: <http://www.liveviewgps.com/blog/gps-tracking-latitude-longitude/ >[18 March 2013]

Maggi Glasscoe, 1998. *What is GPS?* 13 August 1998.Available from: <http://scign.jpl.nasa.gov/learn/gps1.htm> [14 March 2013]

Margaret Rouse, 2007.*Waterfall Model*. February 2007.Available from: <http://searchsoftwarequality.techtarget.com/definition/waterfall-model> [28 March 2013]

Nilesh Parakh, 2011. *The Waterfall Model Explained*. 12 Sep 2011.Available from: http://www.buzzle.com/editorials/1-5-2005-63768.asp [28 March 2013]

Oracle, n.d.. *Java Servlet Technology*. Available from: <http://www.oracle.com/technetwork/java/index-jsp-135475.html> [18 March 2013]

Penna Sparrow, n.d., *Prototype Model: Advantages and Disadvantages*. Available from: <http://www.ianswer4u.com/2011/11/prototype-model-advantages-and.html#axzz2PGr494gD> [28 March 2103]

Rice University, n.d.. *Shuttle Tracking System*, 2013. Available from: <http://bus.rice.edu/full/>. [19 March 2013]

SBS Transit, n.d.. *iris (Intelligence Route Information System).* Available from: http://www.sbstransit.com.sg/iris/overview.aspx [15 March 2013]

SBS Transit, n.d.. *iris NextBus*. Available from: http://www.sbstransit.com.sg/iris3/validation_page.aspx [15 March 2013]

SBS Transit, n.d.. *Mobile Version*. Available from: <http://mobileiris.sbstransit.com.sg/> [15 March 2013]

Simon Hill, 2013. 10 reasons why Android is still better then iOS. 17 Jan 2013. Available from: http://www.androidauthority.com/10-reasons-why-android-is-still-better-than-ios-145370/ [2 Apr 2013]

Elfira Nureza Ardina, 2010. *Chapter 1 Introduction To System Analysis And Design*. Available from: <http://ekohandoyo.blog.undip.ac.id/2010/01/17/chapter-1-introduction-to-system-analysis-and-design/> [28 March 2013]

TUTOR, 2012, n.d.. *What is sdlc?*.Available from: <http://www.sdlc.ws/what-is-sdlc/> [28 March 2013]

w3School.com, n.d.. *AJAX Introduction*. Available from: <http://www.w3schools.com/ajax/ajax_intro.asp> [18 March 2013]

w3School.com, n.d.. *PHP Introduction*. Available from: <http://www.w3schools.com/php/php_intro.asp> [18 March 2013]

APPENDIX

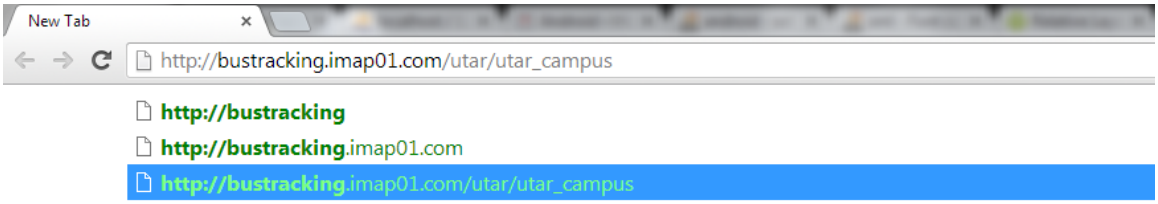
APPENDIX A: USER MANUAL

1.0 Real Time Bus Position and Bus Arrival Time Display

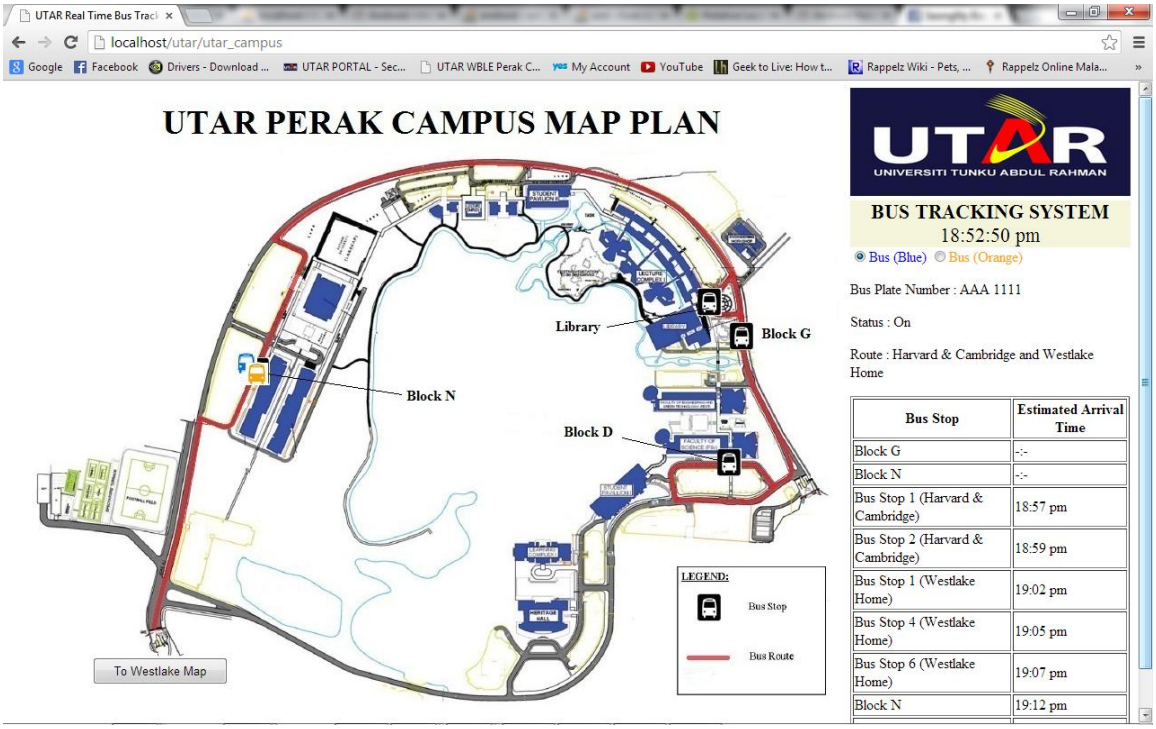
1. Open any browser (Google Chrome, Firefox, IE, etc) on computer.

2. Enter the http address of the system.

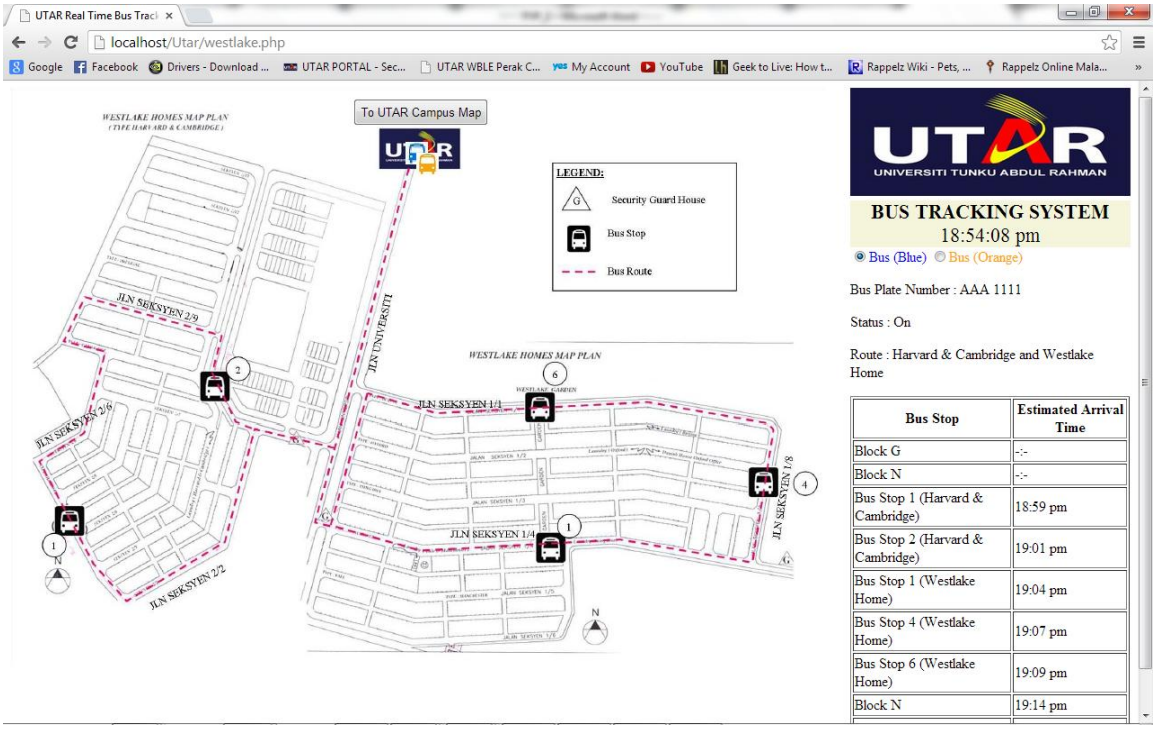
(http://bustracking.imap01.com/utar/utar_campus.php)



3. The bus information web page should display on browser.



4. Click on the “To Westlake Map” button will load the Westlake map page.



5. Click on the radio button can switch the timetable accordingly.

Bus (Blue) Bus (Orange)

Bus Plate Number : AAA 1111

Status : On

Route : Harvard & Cambridge and Westlake Home

Bus Stop	Estimated Arrival Time
Block G	-:-
Block N	-:-
Bus Stop 1 (Harvard & Cambridge)	19:00 pm
Bus Stop 2 (Harvard & Cambridge)	19:02 pm
Bus Stop 1 (Westlake Home)	19:05 pm
Bus Stop 4 (Westlake Home)	19:08 pm
Bus Stop 6 (Westlake Home)	19:10 pm
Block N	19:15 pm
Library	19:19 pm
Block D	19:22 pm

Bus (Blue) Bus (Orange)

Bus Plate Number : BBB 2222

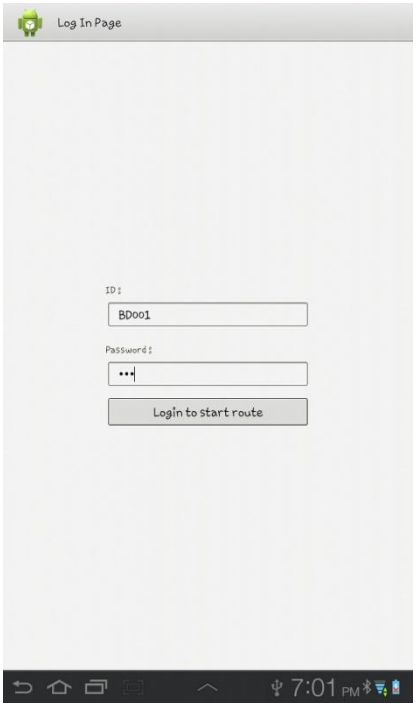
Status : Westlake Home

Route : undefined

Bus Stop	Estimated Arrival Time
Block G	-:-
Block N	-:-
Bus Stop 1 (Westlake Home)	-:-
Bus Stop 4 (Westlake Home)	-:-
Bus Stop 6 (Westlake Home)	-:-
Block N	-:-
Library	18:59 pm
Block D	19:02 pm

2.0 Bus Driver Module Manual

1. The first page is log in page. Enter ID and password correctly and click on “Login to start route” button when bus driver is begin his route.



2. If ID and password is correct, it will jump to “Bus Positioning Module” page.

3. In driver module page, bus driver is not able to log out because bus driver cannot logout the system during working hours. Besides, there are three buttons on the screen. The “Full” button is to update bus status when the bus a fully occupied. Bus driver able to change back the bus status become “Not full” once the “Not Full” button is clicked. At the most bottom side, a button labeled “Send break down request”. This button will send an emergency break down massage to server when it is clicked.