Vehicle Tracking System (VTS)

SysCall

Index Number	Name
114003 E	M. F. H. M. Adheeb
114150 B	T. M. K. B. Thennakoon
114058 B	M. H. U. K. Jayasinghe
114066 X	A. K. D. M. Karunarathne
114169 P	A. L. H. H. Liyanage

Faculty of Information Technology

University of Moratuwa

October 2013

Vehicle Tracking System (VTS)

SysCall

Index Number	Name
114003 E	M. F. H. M. Adheeb
114150 B	T. M. K. B. Thennakoon
114058 B	M. H. U. K. Jayasinghe
114066 X	A. K. D. M. Karunarathne
114169 P	A. L. H. H. Liyanage

Dissertation submitted to the Faculty of Information Technology, University of Moratuwa, Sri Lanka for the partial fulfillment of the requirements of the Honors Degree of Bachelor of Science in Information Technology.

Faculty of Information Technology

University of Moratuwa

October 2013

Declaration

We declare that this thesis is our own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

Name of Students	Signature of Students
M. F. H. M. Adheeb	……
T. M. K. B. Thennakoon	……
M. H. U. K. Jayasinghe	……
A. K. D. M. Karunarathne	……
A. L. H. H. Liyanage	……

Date: ……..

Supervised by,

Name of Supervisor	Signature of Supervisor
Dr. Lochandaka Ranathunga	……

Date: ……..

Dedication

We wish to dedicate this work Mr. D.K. Withanage, dean of the Faculty of Information technology, who guided us in this course module & Dr. Lochandaka Ranathunga, our supervisor, senior lecturer and Head of Department of Information Technology, who provided us an opportunity to do our project work on “Vehicle Tracking System” for Sri Lanka Ports Authority. There is no doubt in us that without his continued support and guidance we could not have completed this project.

Acknowledgements

Apart from the efforts of us, the success of this project depends largely on the encouragement and guidelines of many others.

First of all we would like we would like to acknowledge for the guidance of Mr. D.K. Withanage when doing this course module.

Then we would like acknowledge the inspirational instruction and guidance of Dr. Lochandaka Ranathunga. You have given us a tremendous support and help to carry on our woks and without your supervision this project would not have materialized.

We also take this opportunity to express a deep sense of gratitude to Mr. Ranjith Sepala, Chief Human Resource Manager, Sri Lanka Ports Authority, for his cordial support, valuable information and guidance, which helped us in completing this task through various stages. We should say that we were able to gain invaluable experience by doing this project with Sri Lanka Ports Authority.

Besides, we would like to thank staff of our faculty, Faculty of Information Technology for providing us with a good environment and facilities to complete this project.

We are grateful to all our batch mates and senior batches of FIT, University of Moratuwa, for there constant support and help. They shared their knowledge, their ideas, and numerous tips all of which help us to success in our project.

Last but not least we wish to thank our parents and friends for their understandings and supports on us in completing this project.

Without helps of the particular that mentioned above, we would face many difficulties while doing this project.

Abstract

Sri Lanka Ports Authority (SLPA) is one of the largest and highly responsible government agencies in Sri Lanka. Efficiency and accuracy of operations at the port, directly affects the development of the country. Because of that SLPA looks forward for some new projects where they can lead the authority to more efficient level. This prime mover tracking system is one of those projects. The vehicle tracking system will enable the owner or a third party to track the vehicle's location. This paper proposed to design a vehicle tracking system that works using GPS and GSM technology, which would be the accurate way of tracking vehicle. The GPS device will continuously give the data i.e. the latitude and longitude indicating the position of the vehicle and with some more details. The same data is sent to the server at the other end from where the position of the vehicle is demanded. There those data will map on a web application and will give the path of the vehicle in real time. Not only that this application is capable of keeping records of history, showing driver details and handles number of prime movers at once. And one of the most concerned facts in this project is security of this site. We strongly believe that the outcome of this project will help to prevent problem of their transport system and time wastage of their employees.

Table of Contents

List of Figures and Tables

Chapter 1

Introduction to VTS

1.1 Introduction

This document mainly conveys the information about the functionality and the performance of this project, Vehicle Tracking System (VTS). This project had been designed to help our client, Sri Lanka Ports Authority (SLPA). The main purpose of this project is to develop a Tracking System for the vehicles using the GPS technology and show the tracked vehicles on a digital map. VTS is mainly focused on the prime movers which are inside the port and nearby Colombo. This document implies considerations that we had been kept in our minds throughout the design of the project and achievements we earned while completing this project. Furthermore, the document provides a list of references, and gives an overview of functional, non-functional and other requirements for the creation of the product using appropriate diagrams. By referring this document any one can have a detailed knowledge about our project work and how we done that.

SLPA plays a major role in Sri Lanka economy. Therefore efficient and reliable service from SLPA is directly linked to the growth of the economy of our country. This system will greatly enhanced the capacity of the planning staff in allocating and assigning prime movers to sectors according to the work load and the availability, proximity of vehicles to the relevant location.

1.2 Background & Motivation

The core operation at the SLPA is loading and unloading containers to and from ships. This operation directly affects the revenue generation and income of the SLPA and directly relies on the performance and availability of prime movers. Thus the efficient and affective vehicle allocation, management and planning holds a great importance. The difference between profit and loss depends on the speed and

efficiency of this operation and a vehicle tracking system such as VTS will eliminate the obstacles affecting this operation.

1.3 Problem in Brief

As mentioned above, one of the most important functions at the SLPA depends on the prime movers. It is very important for the operational staff of SLPA to be able to know the location and availability of prime movers to use them in the most efficient manner to support this critical function. Sometimes vehicles may break down or get stuck due to some reason. Sometimes delays are caused due to the lethargy and neglect of drivers. At times work skiving is a major problem. Due to lack of knowledge about the vehicles location, state and other information, it is a tedious task to assign prime movers and this causes delays, under using and over using of vehicles and wastage of resources. Apart from the above situations, depending on the type of cargo it is essential to track the movement of vehicles to prevent smuggling operations and other illegal activities.

Currently there is no system to track the movement of vehicles and as result the planning and operations staff of SLPA has to face a lot of difficulties and a considerable amount of resources are wasted.

1.4 Aim & Objectives

Aim: The aim of this project is to develop a system to track prime movers and their locations show on a digital map to subscribe users using GPS & GPRS technology.

Objectives:

- Take an idea about the domain; be familiar with the port environment.
- Study of GSM[1]/GPRS[2] and GPS[3] technology
- Design and develop a system for solving the problem
- Preparation of the User Manual for the system
- Evaluation of the proposed solution
- Preparation of final documentation

1.5 Proposed Solution

As a solution for above problem we proposed a Vehicle Tracking System for the prime movers which is based on GPS and GSM / GPRS technologies. A GPS module with GSM/GPRS module is attached to the prime mover. The GPS module is capable of getting the current location coordinates of the prime movers and the GSM / GPRS module will upload those coordinates to a server. The system will retrieve those coordinates and map the movements of the prime movers on to a digital map.

Details of the vehicles can also be viewed through this system. The operational staff of SLPA can view these details real time and can use this information to effectively allocate and assign prime movers to transport containers, thus minimizing cost and wastage and discrepancies.

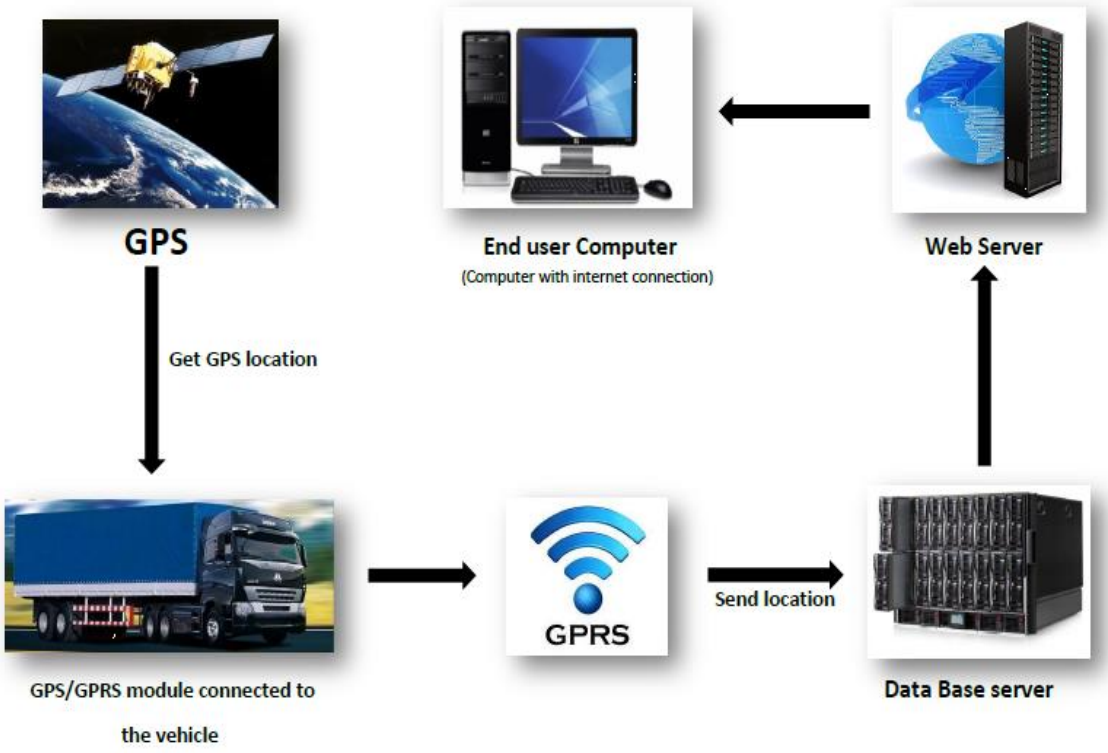


Figure 1.1: Top Level Design of VTS

1.6 Structure of the Dissertation

Chapter 1 of the dissertation describes about the introduction of the project, "Vehicle Tracking System". Chapter 2 discusses about the reviews of others' work. Chapter 3

focuses on the technologies we used to develop this system & our approach in developing this project and a detailed idea of the analysis and design is on chapter 4 & chapter 5. Chapter 6 describes about the implementation of Vehicle Tracking System & Evaluation and Test Cases are described on chapter 7. Conclusion and Further work is on chapter 8 of this dissertation. Before finalizing the project report we are talking about the individual performances of team members. Finally, this document includes the references and will review the appendices.

Chapter 2

Review of Others' Work

2.1 Introduction

This chapter describes the background of the project & gives a clear idea about the difference between existing systems and other approaches similar to our system. When considering the vehicle tracking systems available in Sri Lanka, there are some companies who provide GPS tracking service for their customers.

There are some of GPS vehicle tracking systems used in other developed countries too. The techniques used by these systems are highly advanced and very complicated when comparing with our knowledge. For an example these systems use advanced satellite systems for vehicle tracking purposes. Therefore we used our own knowledge gathered by many references when we were developing this system.

2.2 Similar Approaches

This is some kind of a comparison in existing vehicle tracking systems in Sri Lanka. When we compared our system with other systems we found some advantages and privileges in our system.

i. Tekno Track[4] vehicle tracking systems
ii. Sala ProSat[5] vehicle tracking systems
iii. Accuar-Tech[6] vehicle tracking systems
iv. Smart Track[7] vehicle tracking systems

2.2.1 Tekno Track vehicle tracking systems

Tekno Track (Pvt) Ltd is a GPS tracking company providing internet-based access to live vehicle tracking. Knowing where your vehicles are at all times gives you the power to make time and money-saving decisions with a quick glance.

2.2.2 Sala ProSat vehicle tracking systems

Sala ProSat is providing navigation systems for private vehicles and also deploys vehicle tracking systems upon user request. Sala has been a pioneer in introducing new technology to Sri Lanka and now along with Sala Geo Information Systems (Pvt) Ltd it shall introduce an advanced telematics (GPS Navigation) product to the consumer market.

2.2.3 Accuar-Tech vehicle tracking systems

Accura-tech is proudly partnered with number of companies which offer GPS tracking in order to facilitate hardware, technology know-how and integration of technologies. Its own expert development team is engaged with its partners on customizing applications using state-of-the-art technologies to meet customer needs.

2.2.4 Smart Track vehicle tracking systems

Smart Track systems provide wide range of vehicle and fleet tracking systems, and also in cooperating with international logistic management systems they are providing containers tracking service.

2.3 Summary

The technologies used in overseas countries are highly advanced and expensive. So we tried our best to develop a system which avoids the drawbacks of existing systems.

	Generic features	Turn off the engine	History playback	SMS alerts	Geo-fencing[8]	SOS alerts
Tekno Track	Included	Available	Available	Available	Available	Available
Sala ProSat	Included	Available	N/A	Available	Available	Available
Accuar-Tech	Included	N/A	Available	N/A	Available	N/A
Smart Track	Included	N/A	N/A	Available	N/A	Available

Table 2.1: Comparison of existing vehicle tracking systems

In the next chapter, we are going to talk about Usage of Technologies in developing Vehicle Tracking System.

Chapter 3

Usage of Technologies in VTS

3.1 Introduction

To develop this project, Vehicle Tracking System we used a lot of new technologies as well as old technologies too. Therefore we had to learn most of those technologies as well as shine up knowledge about optimization of queries. In the previous chapter we gave some background information about our project. This chapter describes about the technologies and techniques that we used to solve the problem. This is a brief description of those technologies that we used for the implementation of VTS.

3.2 Technology Adapted

When developing this project we mainly considered on following technologies.

i. Global Positioning System (GPS)
ii. General Packet-Radio Service (GPRS)
iii. Transmission Control Protocol[9] (TCP)
iv. Protocol used by GPS/GPRS Module[10]
v. Socket[11] Programming
vi. Web Technologies (PHP[12], JavaScript[13], Apache[14])
vii. Database Management Technologies (MySQL[15])

3.2.1 Global Positioning System (GPS)

The Global Positioning System (GPS) is a Global Navigation Satellite System [16] (GNSS) which provides location and time information, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites. GPS is maintained by the United States government and is freely accessible by anyone with a GPS receiver.

The Global Positioning System (GPS) is made possible by a group of satellites in orbit around the earth orbit that transmit precise signals, allowing GPS receivers to calculate and display accurate location, speed, and time information to the user.

By capturing the signals from three or more satellites (among a constellation of 31 satellites available), GPS receivers are able to use the principle of trilateration to pinpoint a location.

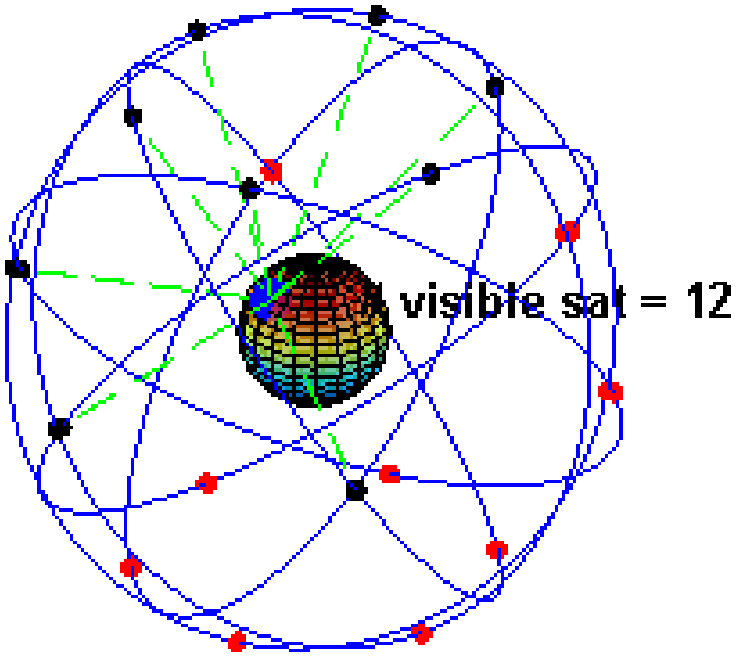


Figure 3.1: GPS Constellation visual example

3.2.2 General Packet-Radio Service (GPRS)

General Packet Radio Service (GPRS) is a packet oriented mobile data service on the cellular communication system's Global System for Mobile communications (GSM).

GPRS is a best-effort service, which provides minimum of 56-114 kbit/second data transfer speed (in a 2G network) and it guarantees a certain Quality of Service [17] (QoS) during the connection.

3.2.3 Transmission Control Protocol (TCP)

TCP protocol is one of the main original core protocols of the Internet Protocol (IP) suite, and commonly known as TCP/IP. This protocol provides reliable, ordered and

error checked delivery of stream of data packets between devices (PCs, Mobile phones etc.) connected to an intranet or the public internet. We chose TCP as our data transfer protocol because it can create a reliable connection between the GPS/GPRS module and the GPS Coordinate Listener application which runs on the main server.

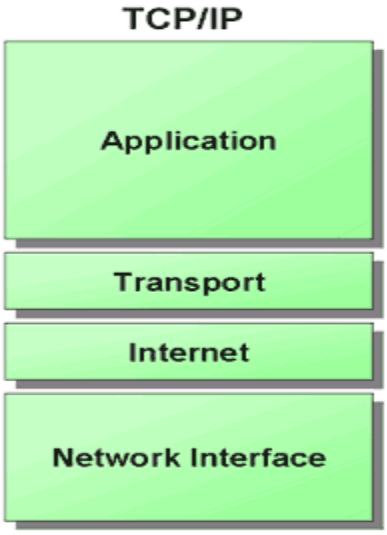


Figure 3.2: TCP/IP suite layers

3.2.4 Protocol used by GPS/GPRS Module

This is the main device which is attached to each prime mover for tracking its route. This module is capable of getting the current location coordinates of the prime mover by using the GPS service and send those coordinates to a remote server wither using SMS alerts over GSM or TCP connection via GPRS. For this project as it works as a real time tracking system we used TCP connection via GPRS between the module and the remote server because SMS delivery over GSM is at maximum of 10 per minute.

Figure 3.3: AVL VT300 GPS Tracker Module

We used AVL VT300 GPS/GPRS Module for implementation of the VTS. This module has its own propriety protocol of sending the GPS coordinates which it gets from the Global Satellite Navigation System. We have programmed our main server using Socket Programming technologies to understand that protocol and store the received data in a central database.

3.2.5 Socket Programming

Socket programming is also known as Computer Network programming and our location coordinates receiving server is programmed using Python language to get the location coordinates form each of GPS / GRPS modules. Socket address refers to an IP address of a computer which is connected to a network and a port number of and specific application which is in IP:Port format. The GPS / GPRS module is capable of sending its data to a specific socket using TCP connection via GPRS.

3.2.6 Web Technologies

In developing this project we used PHP language for Server Side Web Scripting and JavaScript for the Client Side Web Scripting. We also used Apache server for web hosting services. Therefore we had to be familiar with those technologies.

3.2.7 Database Management Technologies

When the remote server gets data from the GPS module for the later use of that data, it needs to be stored in some database. For that we used a database which was created using MySQL language to store data when received and retrieve those stored data when requested by the user.

3.3. Summary

When developing this project, Vehicle Tracking System (VTS) we had to learn and get knowledge on new technologies like GPS, GNSS and as well as the old technologies like GPRS, TCP, Web Technologies and Socket Programming etc.

Next chapter will describe Our Approach in developing Vehicle Tracking System.

Chapter 4

Our Approach to VTS

4.1 Introduction

This chapter of the dissertation will explain how we adopt the technologies to solve the problem faced by SLPA. This will also include the users, inputs, outputs and the process of VTS.

4.2 Technologies used in VTS

As we mentioned in Chapter 3, we have used technologies such as GPS, GPRS, GSM, TCP Protocol, Socket Programming, Web Technologies (PHP, JavaScript, and Apache Server) and Database Management Technologies (MySQL) in implementing VTS.

4.3 Inputs for VTS

A GPS Tracker Module (AVL VT300) will be attached to each and every vehicle which are needed to be tracked by the system and that modules are configured to send their location coordinates to the main server via GPRS continuously with an interval of 15 seconds. These location coordinates will be the main input for VTS to track the vehicles on a digital map.

4.4 Outputs of VTS

As GPS Tracker Modules sends the location coordinates to the main server using GPRS and their proprietary protocol, the main server has a daemon running which can understand that protocol and store that location coordinates in a database.

Figure 4.1: GPS Listener daemon running on the server

If a manager or any authorized staff member of Administration Department of SLPA wants to check the current locations of the vehicle he can log in to the system via web application and vehicles which are currently moving will be shown on the digital map.

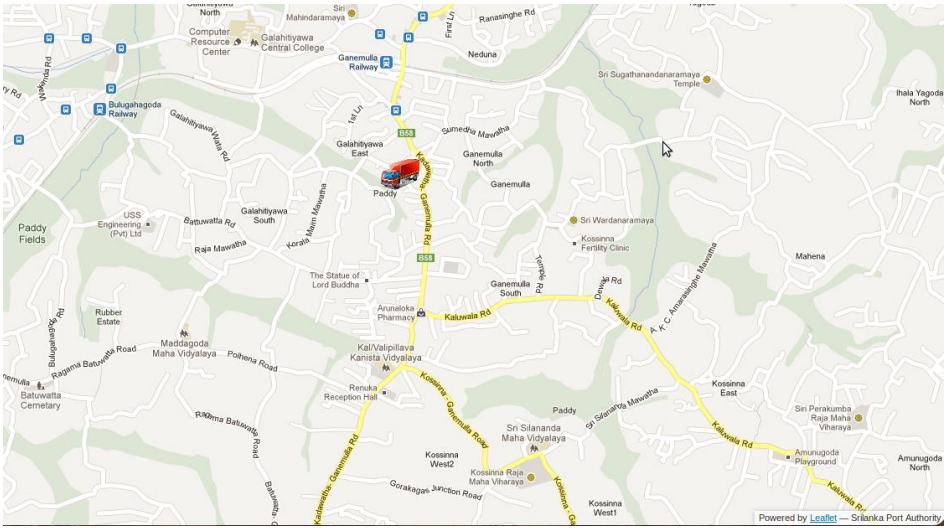


Figure 4.2: Real time tracking on the digital map

Other than real time tracking function if the user needs information of the vehicle, the system can give that information also.

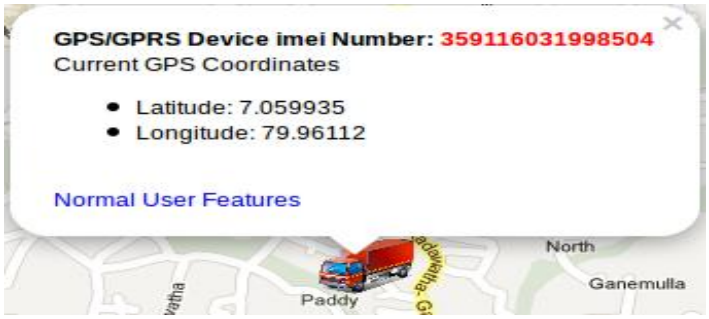


Figure 4.3: System showing information of the vehicle

4.5 Summary

VTS uses the location coordinates from the GPS Tracker modules as the main input. When the server received that information the GPS listener daemon will store that information to a database.

If any user of this system needs to check the current locations of the vehicles it can be easily done by logging into the web application using the credentials given to the user.

Next we are going to talk about the Analysis we done & the Design of the VTS.

Chapter 5

Analysis & Design

5.1 Introduction

This chapter mainly describes about the analysis we done in designing the system. Basically this chapter will discuss more about the analytical background of the project. It also includes the main structure of the system.

5.2 Analysis

According to the requirements of our client, SLPA we have to create a system which can perform its functionalities in an efficient manner. So that we have to our analysis in correct manner and figure out the procedure and the floor of the system.

Initially we figured out how the GPS Navigation Service works and which information that we can get from using GPS service. And the next challenge is to track each vehicle from a remote location using GPS coordinates. For this there should be a device which can locate its coordinates and send those details to the main server. We found GPS/GPRS/GSM module which is capable of locate its current location and send those details to some other user by SMS or GPRS. According to the client's requirements, the vehicles need to be tracked in real time manner so we used GPRS method instead of SMS via GSM because SMS deliveries are limited up to maximum of 10 SMS per minute.

Next challenge we faced is selecting a Digital Maps service for the system as we need to show the tracked vehicles on a digital map. We have found some digital map service providers like Google Maps[18], Open Street Maps[19] & Bing Maps[20] etc. As the system should be capable of tracking the prime movers inside the port, the digital map must include the roads inside the Colombo Port premises also. But those roads are not available in most of digital maps and we found only two digital maps providers, Google maps and Open Street Maps are suitable for this system.

Among them Google Maps has some Terms of Services and query limit in the free version, so we decided to use Open Street Maps instead of Google Maps in developing the system.

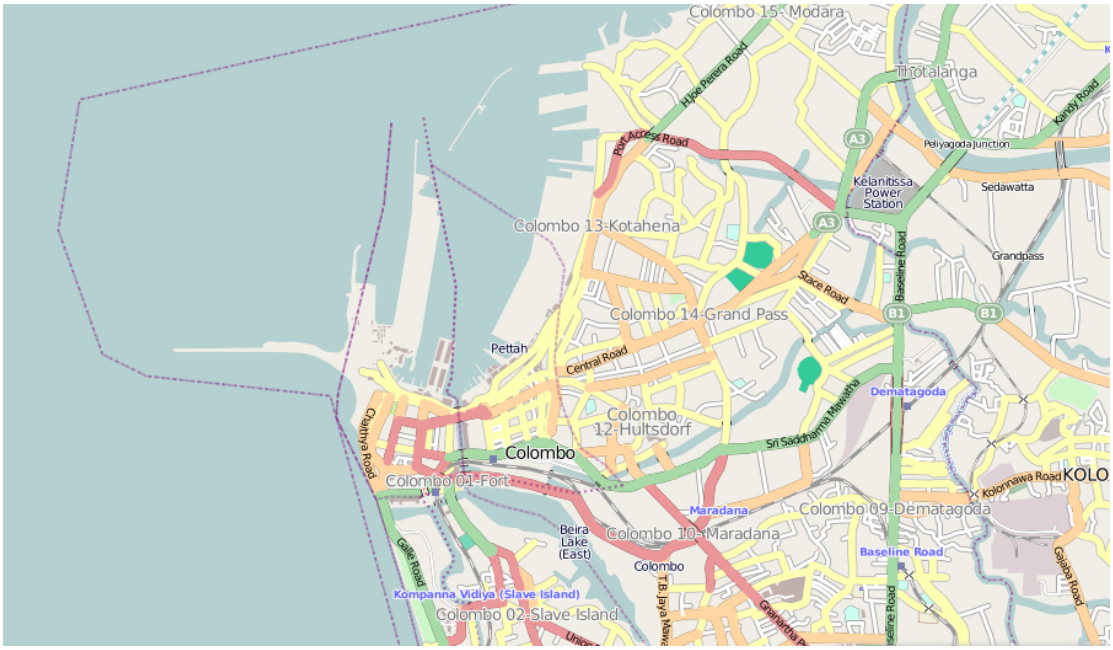


Figure 5.1: Open Street Maps (Colombo Area)

5.3 Design

Designing of the Vehicle Tracking system can be mainly divided in to four parts.

i. Network Application (TCP GPS Coordinates Listener)
ii. Database for storing GPS data of vehicles
iii. Web site and Admin Panel
iv. Web Application to log vehicles leaving the Port

5.3.1 Network Application

This is the application of the project which is able to receive location coordinates from the vehicles and store them in the database. This application listens to a specific port (9090) of the running machine and if there is any data receives form a new module, this application creates a new thread for that module and handles that module. And the listening for the new modules still continues while handling the modules. When data received, the data string is spitted and stored in a database table for later use.

5.3.2 Database for storing data

When data is received from the GPS trackers attached to the vehicles, the GPS Listener application is able to split the data strings and send them to a database for tracking purposes and further analysis purposes of the users of this system.

```
mysql> show columns in coordinates;
+------------------------+-------------+------+-----+---------+-------+
| Field                  | Type        | Null | Key | Default | Extra |
+------------------------+-------------+------+-----+---------+-------+
| serial                 | varchar(15) | YES  |     | NULL    |       |
| phone_number           | varchar(12) | YES  |     | NULL    |       |
| sat_time               | datetime    | NO   | PRI | NULL    |       |
| sat_status             | char(1)     | YES  |     | NULL    |       |
| latitude               | float(10,6) | YES  |     | NULL    |       |
| latitude_h             | char(1)     | YES  |     | NULL    |       |
| longitude              | float(10,5) | YES  |     | NULL    |       |
| longitude_h            | char(1)     | YES  |     | NULL    |       |
| speed                  | float(6,3)  | YES  |     | NULL    |       |
| bearing                | float(6,2)  | YES  |     | NULL    |       |
| magnetic_var           | float(6,3)  | YES  |     | NULL    |       |
| magnetic_var_direction | char(1)     | YES  |     | NULL    |       |
| imei                   | varchar(20) | YES  |     | NULL    |       |
| location_area_code     | varchar(7)  | YES  |     | NULL    |       |
| cell_id                | varchar(7)  | YES  |     | NULL    |       |
| number_of_satalites    | int(2)      | YES  |     | NULL    |       |
+------------------------+-------------+------+-----+---------+-------+
```

Figure 5.2: Schema of tables in the database

5.3.3 Web site and Admin panel

This is one of the application that user has the control on this system. User needs to login to the system using the given credentials and according to user level privileges to the system are provided.

Figure 5.3: Web site Login

5.3.4 Web Application to log vehicles leaving the Port

This application uses to keep records of the drivers and vehicles that are leaving the port. User needs to login to this application and after a successful login user can add, update records of the drivers and vehicles that are leaving the Port.

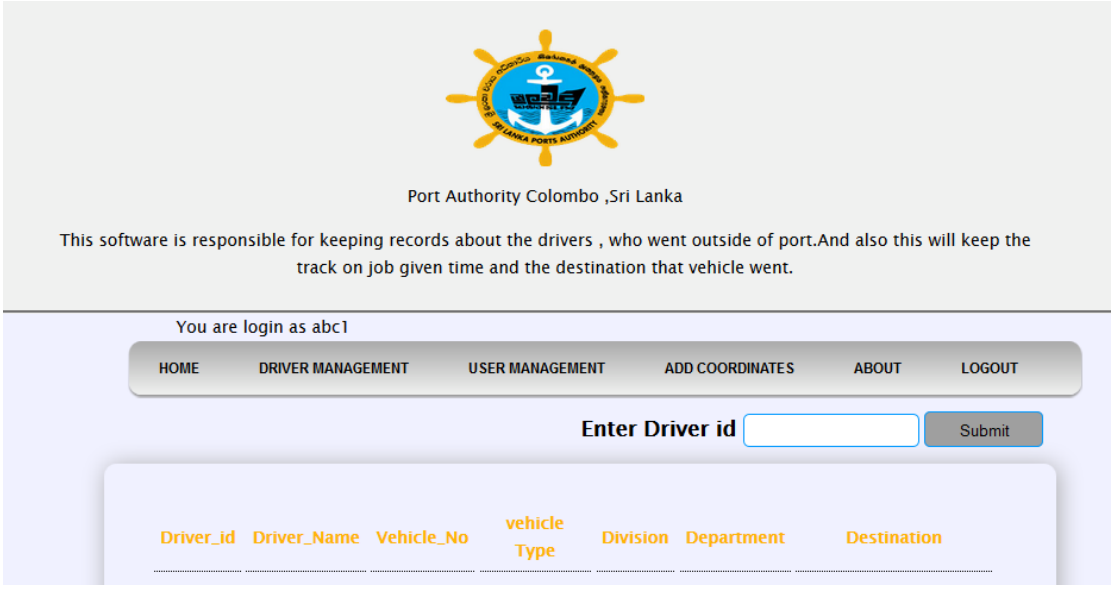


Figure 5.4: Web application search page

5.4 Summary

After we got the idea of the client's requirements, we started analyzing what we are going to do in order to solve the problem. In the analyzing we identified the major parts of the proposed system. They are TCP GPS Listener, Database, Web Site and admin panel & the web application to log details of vehicles leaving the Port. Then we searched what are new technologies we need to develop the above three parts. After that we were able to develop the system according to client's needs.

Next we will look into the Implementation section of the Vehicle Tracking System.

Chapter 6

Implementation of VTS

6.1 Introduction

The previous chapter described the analysis and the design of this project, Vehicle Tracking System. We are going to discuss implantation of the system in this chapter.

6.2 Implementation of major components

i. Configuration of GPS Tracker module
ii. Implementation of TCP GPS Coordinates Listener
iii. Implementation of Tile Server for storing maps
iv. Implementation of Web site and admin panel
v. Implementation of application to log details of vehicles leaving the Port

6.2.1 Configuration of GPS Tracker module

We have chosen AVL VT300 GPS Tracker module for implementation of this system. After Connecting GPS & GSM Antennas and inserting the SIM card into the unit, it needs to be configured for first time use.

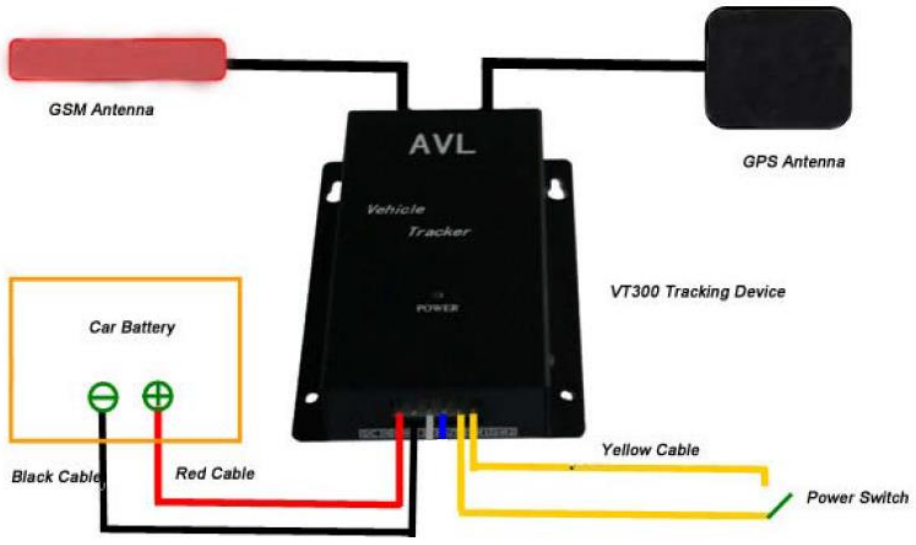


Figure 6.1: Connections of AVL VT300

The unit needs to be configured using SMS messages to enable GPS tracking function. For that we need to set APN (given by mobile service provider), IP and Port of the main server and GPRS data sending interval for the unit. Optionally we can give an identification number for each module and use a password protection to stop unauthorized re-configurations. Following commands needs to be sent via SMS for configuration of the device. (Default password is set to "000000")

Set ID for VT300

Command: W<password>,010,ID
Note: Tracker ID must not over 14 digits.
Example: W000000,010,123456789
VT300 will then reply with an SMS ('Set SIM Ok/123456789') to confirm this setting.

Set APN by SMS

Command: W<password>,011,APN,APN Name,APN Password
Note: If no APN name and password required, input APN only.
Example: W000000,011,CMNET
VT300 will reply with an SMS (like 'Set APN Ok/CMNET') to confirm this setting.

Set IP Address and Port

Command: W<password>,012,IP,PORT
Example: W000000,012,202.116.11.12,8000
VT300 will then reply an SMS ('Set IP Ok /202.116.11.12,8000') to confirm this setting.

Set Time Interval for Sending GPRS Packet

Command: W<password>,014,time interval(in unit of 10 seconds)
Example: W000000,014,00003
VT300 will send a GPRS packet every 30 seconds

Enable GPRS Tracking Function

Command: W<password>,013,X
X=0, to turn off GPRS function(default);
X=1, to set TCP
X=2, to set UDP
Example: W000000,013,1
VT300 will reply with an SMS to confirm this setting.

After finishing above shown configurations the unit will send its location coordinates to the server via GPRS.

6.2.2 Implementation of TCP GPS Coordinates Listener

This was a socket programming application which binds an IP address and port of the running machine and listens to any requests for that socket. We programmed this TCP listener using Python scripting language. The program listens to the specific port (9090) of the running machine and processes the requests that are coming to that socket. Figure 6.2 shows the flow chart of the TCP Listener running on port 9090.

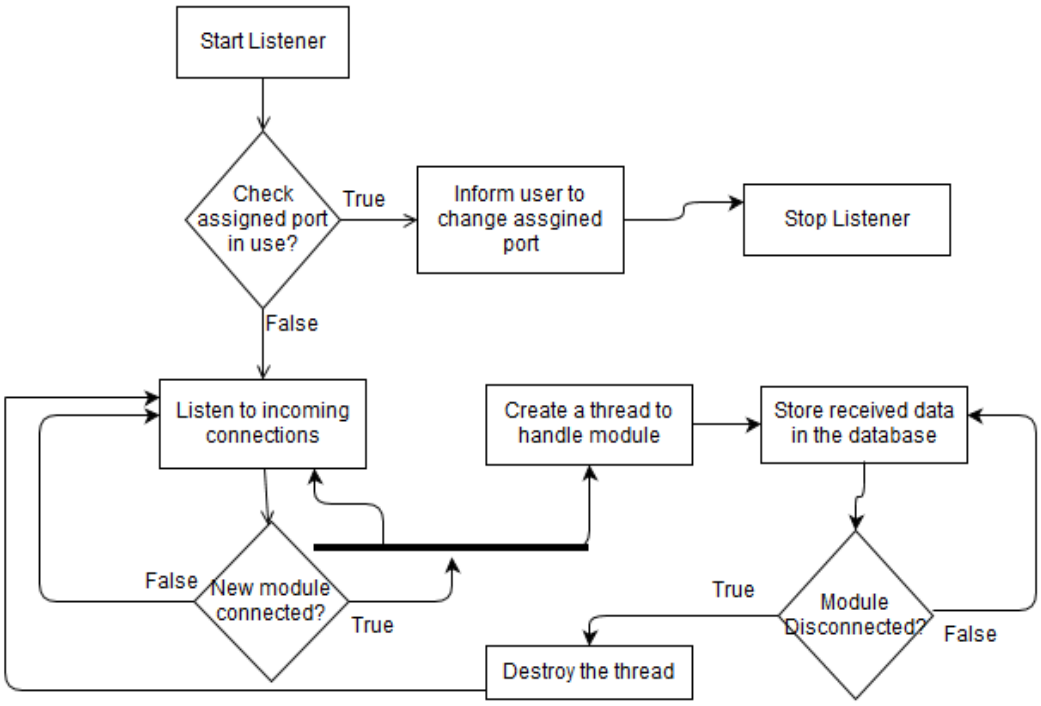


Figure 6.2: Flow Chart for TCP Listener

As new GPS tracker unit starts sending its location to the main server via GPRS this application can read the data string and store those data in the central database which we use for whole system. Because of real tracking is needed, the database may flooded. So we used Haversine Algorithm [21] to calculate distance between locations coordinates and for optimize them.

And also to prevent DoS [22] attacks we used Luhn Algorithm [23] to validate IMEI [24] of each and every tracker before its coordinates are stored in the database for further use. Figure 6.3 shows the ER diagram of the central database which we use for the whole system.

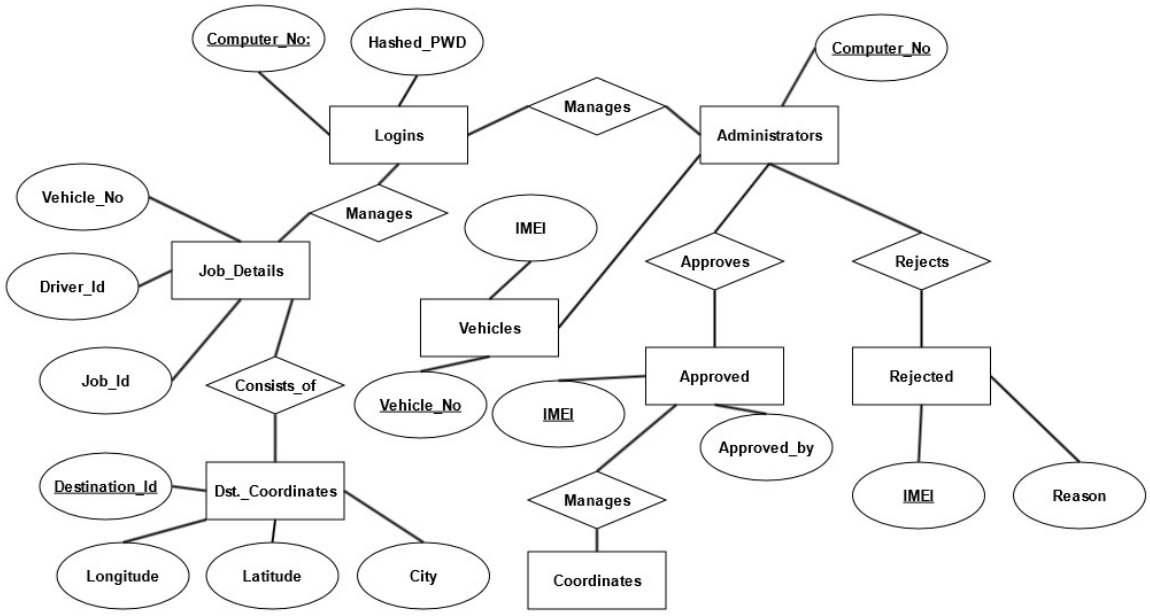


Figure 6.3: ER Diagram of central database

6.2.3 Implementation of Tile Server for storing maps

Most of the existing tracking systems use online maps for their tracking purposes so the end users who are using those systems needs access to the public internet to load maps in to their pcs. In our system used a tile server to store maps in a central pc which is already connected to the intranet. As this system uses for tracking purposes in Sri Lanka we have downloaded a digital map of Sri Lanka and stored it in the tile server. So the all the users who have access to the intranet can use our system.

6.2.4 Implementation of Web site and admin panel

This is the main module of this system which allows users to login to the system (Figure 5.3) and after a successful login; the users are allowed to monitor the vehicles on digital map which shows the real time location of the vehicle.

There are two user levels in this system which can be identified as an Administrator user and a normal user. Normal users are only allowed see the real time location of the vehicles and the journey history of the vehicles.

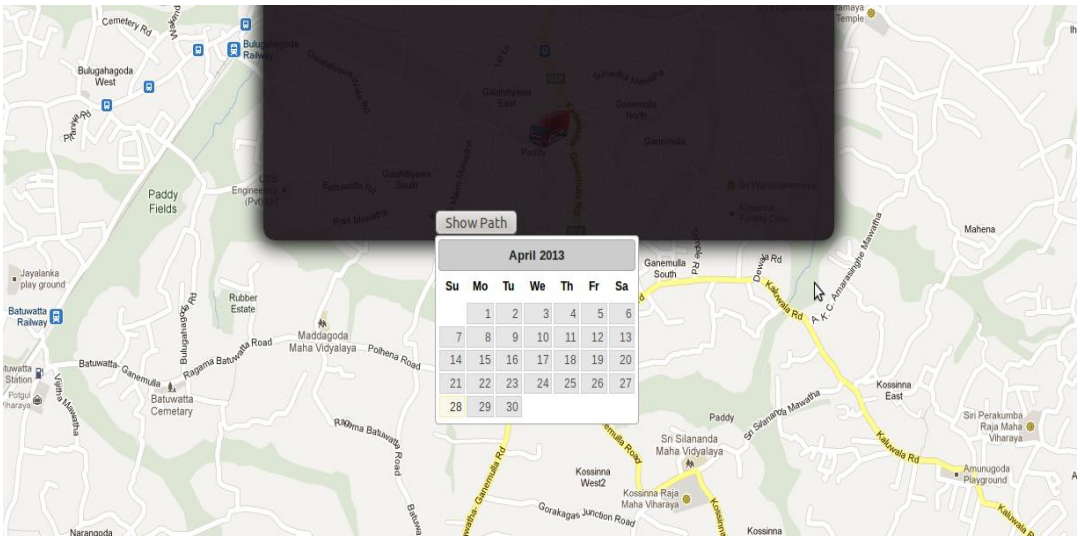
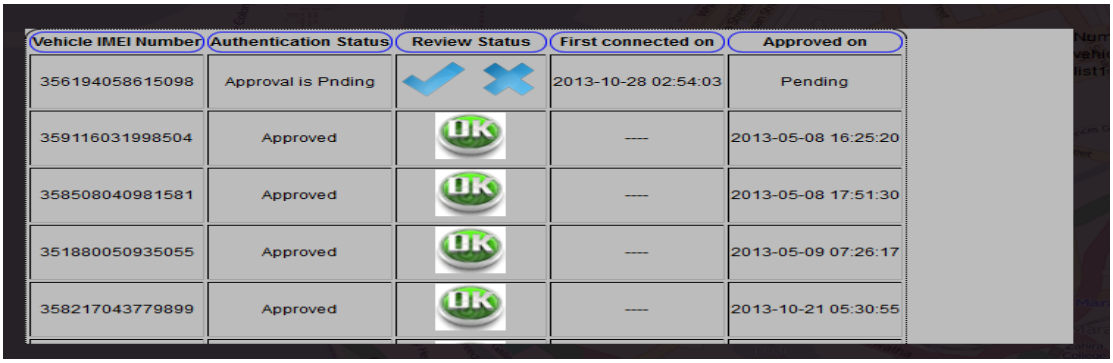


Figure 6.4: Show history by date

Administrators also have all the privileges and some administrative rights on this system. They can add or remove vehicles and manage the normal users who are using the system. When a module initiates a connection to the server, administrator's approval is required before its tracking to be started. This precaution is taken to avoid Denial of Service (DoS) attacks to the TCP Listener which reduces performance of the whole system.



Vehicle IMEI Number	Authentication Status	Review Status	First connected on	Approved on
356194058615098	Approval is Pnding		2013-10-28 02:54:03	Pending
359116031998504	Approved	OK	----	2013-05-08 16:25:20
358508040981581	Approved	OK	----	2013-05-08 17:51:30
351880050935055	Approved	OK	----	2013-05-09 07:26:17
358217043779899	Approved	OK	----	2013-10-21 05:30:55

Figure 6.5: New modules requesting administrator's approval to be tracked

6.2.5 Implementation of application to log details of vehicles leaving the Port

The major purpose of developing this system is to keep records of the drivers and vehicles, which are leaving the port. The system will maintain two user levels called Administrator and the Normal user. Both Administrator and Normal user can add drivers, edit the details of drivers, delete drivers from the system, edit user details and add new locations.

In addition to that Administrator can add new users and remove any users. When the user log in to the system the current information of the all drivers will display and by entering the driver's computer number, the user can view complete details of the driver. Then the user can edit driver details or remove drivers. Following figure will show this system with test data.

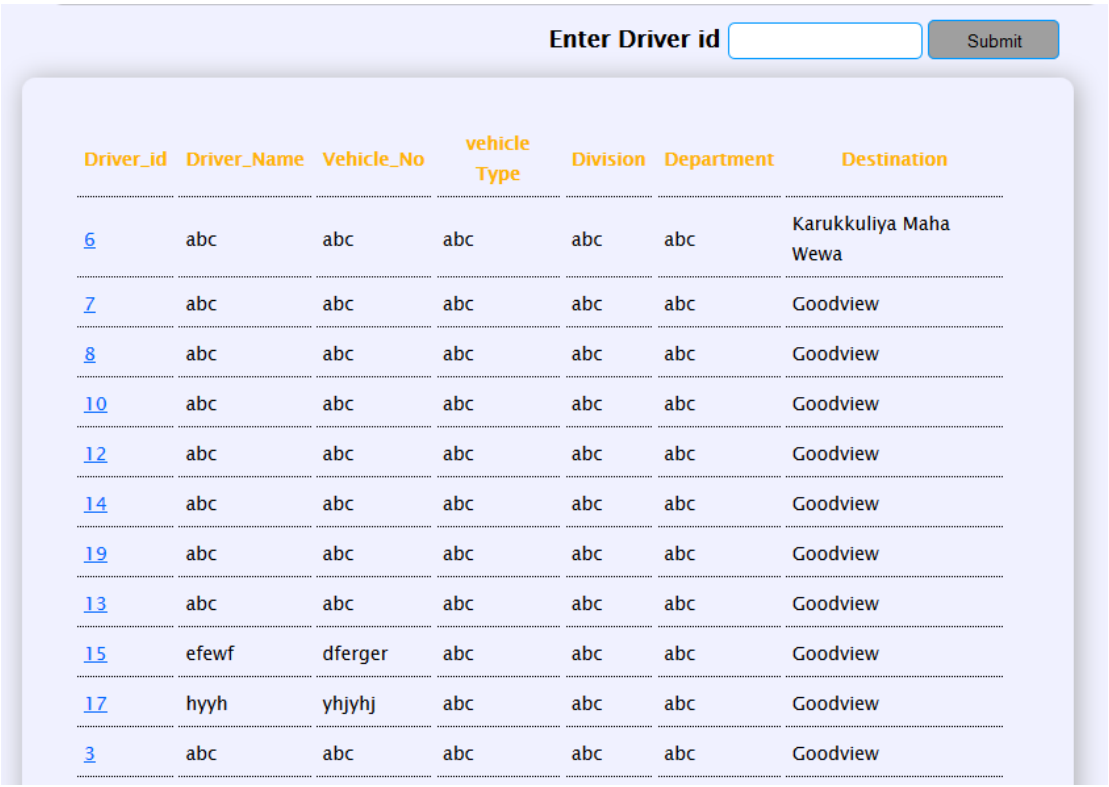


Figure 6.6: System to log vehicles leaving the Port

6.3 Summary

Implementation of Vehicle Tracking System is mainly divided into 5 major steps. As mentioned on this chapter those are Configuration of Configuration of GPS Tracker module, Implementation of TCP GPS Coordinates Listener, Implementation of Tile

Server for storing maps, Implementation of Web site and admin panel & Implementation of application to log details of vehicles leaving the Port.

On the next chapter we are going to talk about Evaluation & Testing we done for this system.

Chapter 7

Evaluation

7.1 Introduction

In this project our main goal was to develop a Vehicle Tracking System for Sri Lanka Ports Authority. In this chapter we are going to discuss about how we achieve our project objectives by evaluating the solutions. We did many designs and experiments and we always discussed with SLPA about them to find the best way to reach our goal. We have done number of test cases to ensure that this project works properly without any failure.

7.2 Project Design

Before make the final design for the project, we had number of discussions with Mr. Sepala on behalf of SLPA. He gave all the information we need. We had showed our design to Mr. Sepala time to time and asked for changes. As they are the users of this Vehicle Tracking System, we always try our best to fulfill their requirements.

7.3 Control Experiments

7.3.1 Login Test Cases

Sri Lanka Ports Authority is a highly secured Authority in Sri Lanka Government. Security of this Authority should be highly ensured as it is one of the largest and highly responsible government agencies in the country. Therefore we have to make sure that our website is a secured one. There are two logins for this website as admin and normal user. For this both parties we provide user name and password. We tested this logins for incorrect passwords and user names.

Test Case 1

In the first test case though incorrect password didn't allow accessing the website, there was no any notification about that attempt and any number of attempts to login was allowed.

Test Case 2

After we made changes in the website, we did the second test case for login. Providing incorrect password or user name didn't allow accessing the website. And those attempts were notified to administrator of the website.

7.3.2 Tracking Vehicles Test Cases

As we didn't have the tracking device in the moment we used GPS/GPRS enabled mobile phone as vehicles for control experiments. We have to turn on GPS/GPRS function of the device then admin of the website should add that device to vehicle list. Then tracked vehicle is displayed and the movements of the vehicle are showed on the map. If the vehicle didn't move there was no any optimization method but all the coordinates were showed.

Test Case 1

In this test case we used real time tracking without any optimization methods and we found that database will be flooded in few seconds due to large number of records per table.

Test Case 2

In this test case we used a mechanism to optimize location coordinates. We calculated the distance from previous location to new location and if distance is less than 10m and time difference between records are less than 10 seconds we ignored the newly arrived record. By using this mechanism we were able to reduce the number of records per table. To calculate the distance between location coordinates we used Haversine Formulae and it is explained in Appendix B.

7.3.3 Adding new vehicles to the system

First we had an idea of manually adding new vehicles to the system, but to make the system we changed to an automatic mechanism. After the GPS tracker unit is configured and turned on system will asks permission from the administrator to check whether this vehicle needs to be tracked. If permission granted, then the new vehicle will be tracked on the map.

But we faced the problem of DoS attacks because any device can act as GPS tracker unit and make connections to the server. So there is risk of flooding the server. Therefore we used Luhn Algorithm to validate the IMEI of GPS device and administrator has the right to choose whether the vehicle needs to be tracked or not. Luhn Algorithm will be explained in Appendix C.

7.4 Summary

To evaluate the system and ensure the system works properly without failures, we have done number of test cases. We also showed our system tour client and did the changes as they wanted.

Next we are going to focus on Conclusion and Further work sections.

Chapter 8

Conclusion & Further work

8.1 Introduction

In previous chapters of this dissertation we have discussed about the problem faced by the SLPA, proposed solution, implementation and technologies used in implementing the solution. This chapter includes conclusion of the dissertation and further implantations planned to this system.

8.2 Conclusion & Discussion of the project

Our main objective is to develop a real time vehicle tracking system to track, prime movers of SLPA. We have used GPRS enabled GPS device which is attached prime mover is used to get the location of the prime mover. Those location details are showed in a digital map where the administrative staff of SLPA can monitor their prime movers.

When we consider about our achievements of this project, we are glad to say that we could achieve almost all objectives successfully. Currently we are planning to make our system more efficient and user friendly.

8.3 Further Improvements

Current system of capable of tracking prime movers in a real time digital map using GPRS enabled GPS units. The following improvements are planned to add to the system later.

i. Add facility to monitor fuel level/ oil level of the prime mover
ii. Add facility to generate reports per prime mover and per month according to users' requests
iii. Add facility to communicate with the prime mover using system

8.4 Summary

Sri Lanka Ports Authority needed a system to track their prime movers in a real time map. So we developed a system which uses location coordinates from GPRS enabled GPS device which is attached to the prime mover as the input and show the prime movers on a digital map. We have almost achieved our objectives in a successful manner and currently planning further improvements for this system.

References

1 – http://en.wikipedia.org/wiki/GSM

2 – http://en.wikipedia.org/wiki/GPRS

3 – http://en.wikipedia.org/wiki/GPS

4 – http://www.teknotrack.lk/

5 – http://www.salagis.com/

6 – http://www.accura-tech.com/gps_tracking.php

7 – http://www.spartamatrix.com/index.php

8 – http://en.wikipedia.org/wiki/Geo-fence

9 – http://en.wikipedia.org/wiki/Transmission_Control_Protocol

10 – http://lanagps.com/Media/Default/Doc/VT300_User_Manual.pdf

11 – http://en.wikipedia.org/wiki/Network_socket

12 – http://www.php.net/manual/en/index.php

13 – http://www.w3schools.com/js/

14 – http://www.apache.org/

15 – http://dev.mysql.com/

16 – http://en.wikipedia.org/wiki/Satellite_navigation

17 – http://en.wikipedia.org/wiki/Quality_of_service

18 – https://maps.google.com/

19 – http://www.openstreetmap.org/

20 – http://www.bing.com/maps/

21 – http://en.wikipedia.org/wiki/Haversine_formula

22 – https://en.wikipedia.org/wiki/Denial-of-service_attack

23 – http://en.wikipedia.org/wiki/Luhn_algorithm

24 – http://www.webopedia.com/TERM/I/IMEI.html

Appendix A

Individual Contribution

Name of the Student: M.F.H.M. Adheeb (Reg. No: 114003 E)

As the team leader, I set goals and objectives to my team and divided tasks among my team members, making sure that they were accomplished on schedule. I also developed various algorithms for the server and other various functions and features of the web based tracking system and to process data received from the GPS devices and stored in the data base, to make the system more informative and to analyze and present data in a user friendly and meaningful manner, along with my team mate Uvindhu.

Therefore I had to learn Python and basics of network programming technologies when developing Vehicle tracking System.

Name of the Student: T.M.K.B. Thennakoon (Reg. No: 114150 B)

The overall goal of the project is to develop a prime movers tracking system which particularly meets the needs of the administrators of Sri Lanka Port Authority. In this project, I took one of a major role of our project to interpret the data to end users, which were collected by the main server. In the initial period of the development process, I made a prototype that could achieve basic but the most important functionality of the system, based on the initial design idea. The prototype is a single web page with a map which can display a polyline on the map as a route and a route information table when given the start place and total distance. The web interface is also capable of visualizing the live positions of prime movers, .Though the graphical user interface was really simple, and it at least provided the possibility that the design of the system was feasible. After considering about the user friendliness and simplicity of the system, I made it possible for user to click on the marker (prime mover icon) and get basic information about current position of the vehicle and speed

of it and also display user specific information according to the session details. When I consider about the map services which can adopt to our system, the most easiest API was Google maps API, but because of the Google's fairly usage policy I was unable to integrate Google maps API, in their usage policy statement they have clearly mentioned that "If consumers can easily sign up for a password without charge or if the purpose of the password protected map is to enhance the publicly available map (i.e. administration), then your site is likely within the Terms of Service. If this is not the case, you will need to use Google Maps API for Business."

Without violating those policies my next best alternative was open street maps , from the name itself it gives the meaning that the information is free to use (under some GPL) Then we consider about using OSM as our primary map layer. Apart from improving of the functionalities of the web interface, I also took part in configuring a open street tile server which is another functionality of the project. By deploying our own tile server within the system's local network, it allows the systems to work without depending on internet (standalone). Local tile server generate tile on the fly, and cache the tiles for better future performance. Because of, the tiles (building block of the map) are coming from local server; system can work without an internet connection.

When achieving our objectives I learnt new things on web designing technologies and advanced web programming using languages such as PHP, JavaScript & Ajax etc.

Name of the Student: M.H.U.K. Jayasinghe (Reg. No: 114058 B)

My contribution to the project was finding a way to receive GPS data to the server pc which are sent from the GPS/GPRS modules continuously. First of all I surf the internet to find out how those modules send GPS information to the other users. Then I found out that most of the modules support SMS via GSM method and TCP or UDP connection via GPRS. As we used TCP connection via GPRS, then I was eager to find how the remote server can retrieve that information. After reading some documents on that topic I found that if we can develop a TCP Listener on the remote server to listen a specific port (9090) then the module can send information to that port of the

remote server, so we can receive GPS information from the module and store them in a database.

Then I developed some TCP listeners with the help of Adheeb by using various programming languages like PHP, C# and Python etc. As we are planning to system to run on an UNIX server Adheeb and I decided to use Python for coding the program. Then we faced a problem of getting information from more than one module at a time and we found that we can use multi-threading to solve it.

Then we had the challenge of optimizing the location coordinates, because if not there is a risk of server malfunctioning due to huge data records. We found that we can calculate the distance between locations coordinates using Haversine Function and we applied it to calculate distance between two coordinates. New record will be entered to the table only if distance and time between two records is greater than some value. By using that algorithm we were able reduce the number of records in the table.

When doing my part of this project I learnt many things on network protocols such as UDP & TCP. I also had to learn advance programming techniques such as network programming (handle data via sockets) using Python language.

Name of the Student: A.K.D.M. Karunarathne (Reg. No: 114066 X)

My part of the project was to develop an application to log details of vehicles leaving the Port premises and a part of the Web site. I'm responsible for setting the database connectivity and perform the data insertion, deletion and update in the Web site. With the use of this web Application users should be able to add new vehicles add new users, edit the details of users and the vehicles and delete users and the vehicle information from our system. To perform the above functionalities I decide to maintain two user levels and suggest PHP is the most suitable scripting language for this purpose. It becomes much easier because we have learnt this language as a subject in our course module.

In addition to the web site, I have to develop another application to keep record of the drivers, job given time, job destination and the details of vehicles, which went outside

of port. To accomplish that requirement I decide to develop it as sub web site of the main web application.

This web site contains basically two windows together with several dialog windows. I decide to maintain two user levels called Administrator and the Normal user. Both Administrator and Normal user can add drivers, edit the details of drivers, delete drivers from the system, edit user details and add new locations. In addition to that Administrator can add new users and remove any users. When the user log in to the system the current information of the all drivers will display and by entering the driver's computer number, the user can view complete details of the driver. Then the user can edit driver details or remove drivers.

When doing this project I learnt technologies on web programming with PHP, JavaScript, and Ajax etc. And I also learnt Visual C# programming also because the application to log vehicle details leaving Port premises was decided to develop as a windows application earlier.

Name of the Student: A.L.H.H. Liyanage (Reg. No: 114169 P)

My part of this project is to design an interface to the web application. The interface should be a user friendly and easy to handle one, because the users of this application mainly focus to the outcome of the project. All the information they need to find should be located on proper places. The outlook of this project should be a simple one, though the cording part is much complex.

We have designed our interface as follows. First page is welcome and login page. Because of security reasons we have made to different logins for the administrator and normal user. Therefore I have to design two different interfaces for the admin and the user. Admin has more features like add vehicles, add users and so on witch normal user doesn't have. After login, the second page shows the map. On this page the map is highlighted because we have to focus the attention of the user to the map. Other than that on that page the user can see a button to view history. What user has to do is click on that and select the date. Then the paths of prime movers travel on that day will display on the map. There is a facility where user can change the map type. Here

we let the user to select the view of map as he or she prefer. At the moment I have designed for that point, and as we develop further there may be slight differences on the design.

And if the user needs to know about the vehicle location and driver details, the application is design to show then when you put the mouse point on the relevant vehicle. Like that I design it in a user friendly manner.

Other than this I have helped to design and implement the data base for the system as well. And I helped to Dinuka to develop the vehicle log system for prime movers which leave the Port.

Appendix B

Haversine Formulae

Source: Wikipedia (The Free Encyclopedia)…..

The Haversine formula is an equation important in navigation, giving great-circle distances between two points on a sphere from their longitudes and latitudes. It is a special case of a more general formula in spherical trigonometry, the law of Haversines, relating the sides and angles of spherical triangles.

These names follow from the fact that they are customarily written in terms of the Haversine function, given by $\text{haversin}(\theta) = \sin^2(\theta/2)$. The formulas could equally be written in terms of any multiple of the haversine, such as the older versine function (twice the haversine). The haversine had, perhaps, a slight advantage in that its maximum is one, so that logarithmic tables of its values could end at zero. These days, the haversine form is also convenient in that it has no coefficient in front of the $\sin^2$ function.

Distance between two location coordinates is calculated as follows.

```
dlon = lon2 - lon1
// Longitude difference of two locations

dlat = lat2 - lat1
// Latitude difference between two locations

a = (sin(dlat/2))^2 + cos(lat1) * cos(lat2) * (sin(dlon/2))^2
c = 2 * atan2( sqrt(a), sqrt(1-a) )
// Haversine calculation

d = R * c (where R is the radius of the Earth)
// Radius of the Earth is about 6371km
```

In the above implemented system as the vehicles sends their location coordinates to the database with an interval of 10seconds, there is a risk of database is getting filled and unavailable. There before enter a new record to the database we calculate the distance between previous location and current location using the Havaersine Function. If the distance is less than 10 meters and time stamp is also less than 20 seconds the system will ignore the current record as the vehicle is not traveled much distance in the time.

By using the above algorithm we were able to reduce the size of the tables at a considerable amount.

Appendix C

Luhn Algorithm

Source: Wikipedia (The Free Encyclopedia)…..

The Luhn algorithm or Luhn formula, also known as the "modulus 10" or "mod 10" algorithm, is a simple checksum formula used to validate a variety of identification numbers, such as credit card numbers, IMEI numbers, National Provider Identifier numbers in US and Canadian Social Insurance Numbers. It was created by IBM scientist Hans Peter Luhn and described in U.S. Patent No. 2,950,048, filed on January 6, 1954, and granted on August 23, 1960.

The algorithm is in the public domain and is in wide use today. It is specified in ISO/IEC 7812-1. It is not intended to be a cryptographically secure hash function; it was designed to protect against accidental errors, not malicious attacks. Most credit cards and many government identification numbers use the algorithm as a simple method of distinguishing valid numbers from collections of random digits.

We have used this algorithm to validate IMEI numbers of the GPS tracker units for we can prevent DoS attacks to the system.