HOTEL ASSETS, PERSONNEL AND VEHICLE MANAGEMENT SYSTEM

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ABSTRACT

HOTEL ASSETS PERSONNEL AND VEHICLE MANAGEMENT SYSTEM

In this project we present the design and implementation of a tracking and management system which makes use of the RFID technology for indoor assets and personnel tracking and will be integrated with a GPS and GSM/GPRS module for outdoor tracking of personnel and vehicles, thereby allowing the organization to keep track of all its assets, personnel and vehicles with a single system server. For outdoor tracking we have designed a SIM548c (GSM/GPRS/GPS module) based unit that takes location information from a GPS receiver and polls it directly to a website by making use of the nationwide GSM/GPRS network coverage. The indoor tracking unit has been developed which makes use of UHF Passive RFID reader and passive RFID tags. The authorized personnel will be allowed to monitor their movement and usage statistics. The information from all the tracking modules is constantly sent to a centralized web server and a database keeps records for future use. The information of vehicles is displayed on Google Map and a floor plan has been developed for presenting location of assets and personnel inside the premises.

An operational prototype of the full system has been developed to demonstrate the comprehensiveness and effectiveness of a system that can be very useful for large scale organizations. By automating management functions for an organization, the effectiveness and productivity of the organization will increase and will create a competitive market where companies increasingly rely on technology for tasks that were originally done manually.

DECLARATION

No portion of the work presented in this dissertation has been submitted in support of another award or qualification either at this institution or elsewhere.

DEDICATION

To Almighty Allah, for Whose greatness we do not have enough words,

To our parents and friends, without whose unflinching support and unstinting cooperation, a work of this magnitude would not have been possible

ACKNOWLEDGEMENTS

There is no success without the will of Allah. We are grateful to Allah, Who has given us guidance, strength and enabled us to accomplish this task. Whatever we have achieved, we owe it to Him, in totality.

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Contents

List of Abbreviations ..... **xii**

1. Introduction **1**

1.1. Overview 1

1.2. Statement of Problem 2

1.3. Approach 4

1.4. Objectives 5

2. Literature Review **6**

2.1. Biometric Attendance Control Management System 6

2.2. Barcode Access Management 7

2.3. CCTV Surveillance systems 7

2.4. Vehicle Tracking System 8

2.5. GPS (Global Positioning System) 8

2.6. GPRS (General Packet Radio Service) 12

2.7. Introduction to RFID 15

2.7.1 RFID systems 16

2.7.2 Active and passive tags 18

2.8. Proposed solution 18

3. Design and Development **20**

3.1. Outdoor tracking unit 22

3.1.1. The SIM548c 22

3.1.2. Power supply: Interfacing the tracker with a 12 V car battery 23

3.1.3. Powering on the SIM548c module 24

3.1.4. Status Indication 25

3.1.5. Extracting coordinates from GPS 25

3.1.6. Interfacing with Computer through Serial Port for testing 25

3.1.7. Coding the microcontroller to extract the coordinates 26

3.1.8. Serial communication with the microcontroller 27

3.1.9. Posting location information to the website 29

3.2. Indoor Tracking System 36

3.3. Receiving System 37

3.3.1. Web server Setup 37

3.3.2. Database 42

3.3.3. Website “HMS” 44

3.3.4. Google map API 48

3.3.5. JAVA Script Control Function 51
3.3.6. JAVA Script GUI 53
4. Equipment used 56
4.1. Hardware 56
4.1.1. SIM548c module 56
4.1.2. Microcontroller 59
4.1.3 Power Supply ICs 61
4.1.4 Voltage Inverter 62
4.1.5 RFID reader 62
4.1.6. Wi-tribe device 65
4.1.7. Wi-Fi router 65
4.2. Software 65
4.2.1. Proteus 65
4.2.2. Keil uVision 4 66
4.2.3. Hyper terminal 66
4.2.4. Wampserver 68
4.2.5. MySQL 68
4.2.6. Adobe Dreamweaver 69
4.2.7. RFID reader software 69
4.2.8. Net Beans IDE 69
5. Analysis 70
5.1. Simple and Cost Effective Solution 71
5.2. Real time locating system 72
5.3. Compact Design and Ease of Install 72
5.4. Automated Tracking system 74
5.5. Access control and Theft prevention 74
5.6. Efficient Monitoring 76
5.7. Ubiquitous web interface 77
5.8. Authorized access to web site 78
5.9. Fast and Efficient Polling 80
6. Future Work 81
6.1. Constraints 81
6.1.1. GPRS Coverage: 81
6.1.2. Active Vs Passive 81
6.1.3. RFID an expensive tracking solution 82

6.2. Improvements 82
6.2.1. Introducing Geo-Fencing 82
6.2.2. Introducing Dual SIM 82
6.2.3. Introducing Memory Card 83
6.2.4. Compacting the tracker circuit 83
6.2.5. Using Active RFID System 83
6.3. Commercial Implementation 84
6.3.1. Multiple Outdoor units installed in different Vehicles 84
6.3.2. Database Expansion 84
6.3.3. Ethernet infrastructure for connecting multiple RFIDs with the server 84
7. Conclusion 85
8. Bibliography 86
9. Glossary 87

List of Figures

Figure 1: Overview of tracking units 1

Figure 2: System Flow Chart 4

Figure 3: Constellation of 24 Satellites 9

Figure 4: Location of Satellite at distance R 11

Figure 5: With 2 Satellites, the user can be at A or B 11

Figure 6: Triangulation with 3 satellites 12

Figure 7: GPRS Class Specifications 14

Figure 8: RFID System 16

Figure 9: Outdoor Tracking Functional Flow Chart 21

Figure 10: Indoor Tracking Functional Flow Chart 22

Figure 11: Power Supply Circuit 23

Figure 12: Power on Timing Diagram 24

Figure 13: GPS Data in HyperTerminal 26

Figure 14: Wireshark Packet analysis of POST Method 33

Figure 15: RFID Software 37

Figure 16: DUC Software to check IP 38

Figure 17: Automatic Updating at No-IP Servers 39

Figure 18: WAMP Server 40

Figure 19: Apache Configuration File (Server Name) 40

Figure 20: Apache Configuration File (Document Root) 40

Figure 21: Apache Configuration File (Set Login Page) 41

Figure 22: Port Forwarding in WiTribe Device 41

Figure 23: Setting up MySQL Server Instance 43

Figure 24: MySQL Database “gps_management” 43
Figure 25: Setting up Database connection in MySQL 44
Figure 26: Setting up website parameters in Dreamweaver 45
Figure 27: HTML Form 45
Figure 28: MySQL Connection Inside Dreamweaver 46
Figure 29: SIM1 Table in MySQL to save Coordinates 47
Figure 30: INSERT Record Server Behavior in Dreamweaver 48
Figure 31: Storing Coordinates from MySQL table in XML Markers format 49
Figure 32: Plotting XML Markers on Google Map 50
Figure 33: Google Map Integrated in Website 51
Figure 34: GUI Displaying Multiple Tag Locations 54
Figure 35: RFID GUI – Unauthorized Entry 55
Figure 36: Sim 548C Module 56
Figure 37: Sim 548C Schematic 57
Figure 38: 89c52 Pin Outs 60
Figure 39: Invengo RFID reader XCRF-804 62
Figure 40: RFID UHF Antenna XCAF-11L 64
Figure 41: Testing of GSM communication in HyperTerminal 67
Figure 42: Testing of GPS Module in HyperTerminal 67
Figure 43: Sim 548C Compact Design and Dimensions 73
Figure 44: Alarms in RFID GUI 75
Figure 45: Systematic coordinate storage in MySQL tables 76
Figure 46: Home Page of HMS 77
Figure 47: Outdoor Tracking Section 78

Figure 48: Login Page of HMS 79

Figure 49: User access privilege control 79

List of Tables

Table 1: GPRMC Command Format 27

Table 2: Pin outs of SIM548c and their description 57

List of Abbreviations

SIM	Subscriber Identity Module
RFID	Radio Frequency Identification
GSM	Global System for Mobiles
GPRS	General Packet Radio Service
UHF	Ultra High Frequency
API	Application Programming Interface
GUI	Graphical User Interface
HMS	Hotel Management System
Wi-Fi	Wireless Fidelity
PHP	Hypertext Preprocessor
TCP	Transmission Control Protocol
IP	Internet Protocol
GPS	Global Positioning System
RF	Radio Frequency
EPC	Electronic Product Code
IC	Integrated Circuits

1. Introduction

1.1. Overview

The project aims to design and implement a tracking and management system which will make use of the RFID technology for indoor assets and personnel tracking and will be integrated with a GPS and GSM/GPRS module for outdoor tracking of personnel and vehicles, thereby allowing the organization to keep track of all its assets, personnel and vehicles with a single system server. The authorized personnel will be allowed to monitor their movement and usage statistics. The information from all the tracking modules will be constantly sent to a centralized server and a database will keep records for future use. This complete system shown in Figure 1 will provide a comprehensive and effective management solution to large scale organizations.

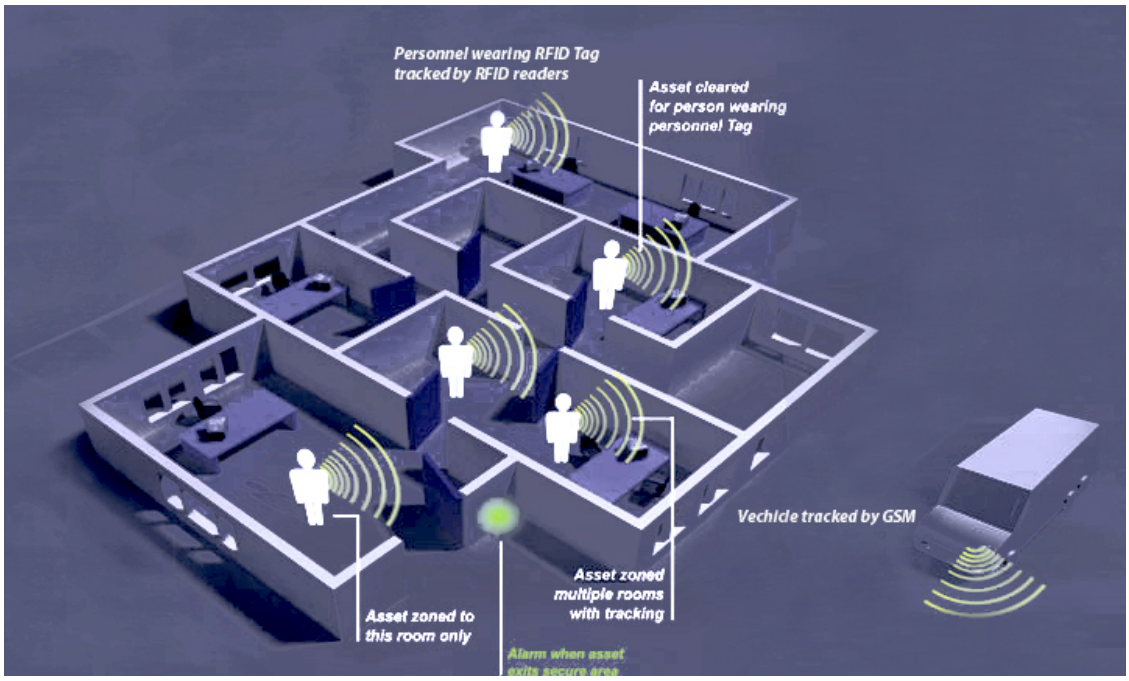


Figure 1: Overview of tracking units

1.2. Statement of Problem

For organizations with large number of assets, manual searching for inventory, keeping track of personnel and vehicles consumes large amounts of manpower and time and decreases overall productivity and efficiency. Handling and management of more manpower requires more expenses and greater wages by the company, leading to loss of revenue and profits and incurring management issues. In case of misplaced or stolen assets manual identification process may consume a long time and result in wasteful expenditure of resources. It might be very difficult to keep track of the movement and position of all the employees of the organization during work hours especially in a critical situation where the services of a particular person are required. Implementation of automated tracking will greatly reduce the amount of man power required for searching and locating of assets, personnel and vehicles. It requires capital investment but running cost is minimal compared to the manual solution, since only in case of damaged or failure of tracking equipment will require some expenditure. The overall efficiency of the system increase greatly with lesser effort and the process of tracing becomes much less time consuming. Real time monitoring will allow detection of misplaced or stolen assets within no time. Real time monitoring of personnel within and outside the premises prevents unauthorized, illegal or unethical activities, thereby increasing productivity and simplifying personnel management.

The project is specifically designed for Hotel management; however it is applicable for any large organization. For the case of asset tracking, a large scale Hotel has a large number of fixed assets which are expensive. RFID tracking through readers and tags will serve this purpose. For the case of vehicle tracking, every hotel has chauffer services for

pick and drop of visitors. This includes catering to the arrival of intended visitors from the airports, railway stations, bus terminals. Also it provides transport to people staying in the hotel. The hotel has its own car fleet for this purpose. To keep in check the movement of this fleet and to effectively manage it, the outdoor tracking through GSM/GPRS and GPS provides the proper solution. For the case of personnel tracking, a hotel boasts large number of employees from the management level to the janitors. People of different status e.g. businessmen, industrialists, bankers, politicians, foreigners, also the common man visits and stays in hotels for business meetings, dining outs, recreational and relaxation visit etc. There should be an effective personnel authorization system which will ensure that no mismanagement happens when catering to the needs of VIPs and by restricting the employees allowed to interact with them reduces the risk of any misconduct (security of VIPs, theft of their possessions etc). This will greatly aid the hotel owners by improving their reputation and overall generating an image of an effectively run hotel in a competitive environment. Personnel's tracking is made possible through the use of wearable RFID tags.

There are many multinationals and large scale industries established in Pakistan. The scale of the industry or organization raises many issues regarding management, tracking and tracing of the assets, personnel and vehicles and running the organization in an efficient way. This affects the productivity of the organization. Loss of assets or misplacing or misusing of assets is also a critical issue which has to be dealt with. The tracking system provides the effective and efficient framework within which the organization's productivity will increase greatly and benefit the society and industry of Pakistan.

1.3. Approach

The project comprises of three parts (shown in Figure 2); vehicle tracking prototype, indoor tracking prototype and the server end.

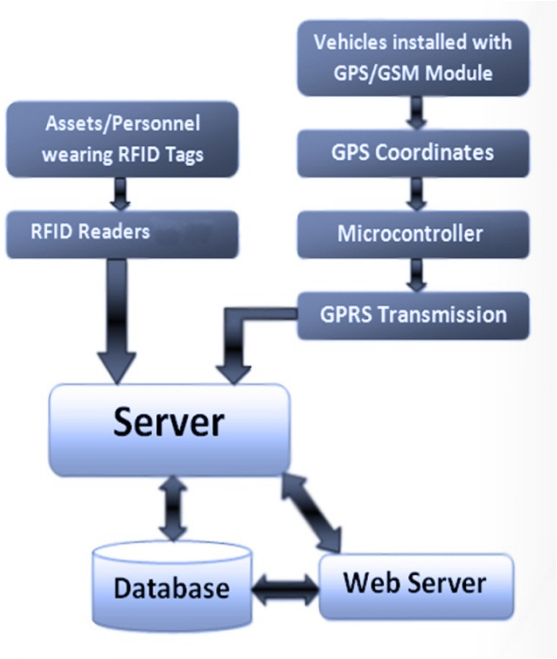


Figure 2: System Flow Chart

For vehicle tracking prototype, we needed a module that could wirelessly send the location coordinates of the vehicle to the server at all times. This led to the selection of SIM548c (a GPS and GSM/GPRS based module) as the core of the outdoor tracking unit (compact circuit board). This module was selected for the reason that it has the capability of sending information over the nationwide GSM/GPRS network via internet. Also, this means of transmission of information is economic and secure. A microcontroller receives coordinates from GPS module and this location information is polled directly onto a website via GPRS. This approach was used so as to enable real time tracking of vehicles as information is polled to the website every forty seconds. The information is saved to a MySQL database to keep record of every vehicle. The location is displayed on Google

Maps in real time. To develop the indoor tracking prototype and to simulate single room environment, one RFID reader and multiple RFID tags are used. The RFID reader is passive and works in 900MHz UHF range. Test subjects are given passive RFID tags, assets are attached with another RFID passive tag. The reader picks up the tag ID whenever the tag comes into its read range. The reader is interfaced with the server via IP network, and it sends the received tag's ID in a TCP/IP packet. At the server end, a web server was created to host the website. A control function extracts relevant data and stores it in a database.

1.4. Objectives

Several objectives were set and later, were successfully accomplished. A brief outline of the project goals is as follows

a) Implementation of a tracking system, both indoors and outdoors, for an organization with multiple assets personnel and vehicles.
b) To use GSM technology for real time outdoor tracking and to use GPS for finding coordinates.
c) Usage of RFID devices (reader and tags) for real time tracking of indoor personnel and assets.
d) Implementation of a centralized database for ease of access and greater control.
e) To create a web server that hosts a website
f) Tracing of assets, personnel and vehicles via database queries.
g) Designing a user interface for providing the authorized employees with access to the tracking system.

2. Literature Review

What is an electronic management system? It is an organized approach to the study of the informationneeds of an organization'smanagement at every level in making operational, tactical, and strategic decisions. Its objective is to design and implement procedures, processes, and routines that provide suitably detailedreports in an accurate, consistent, and timely manner.

In an electronic management system, modern, computerized systems continuously gather relevantdata, both from inside and outside an organization. This data is then processed, integrated, and stored in a centralized database (or data warehouse) where it is constantly updated and made available to all who have the authority to access it, in a form that suits their purpose. Some of the management systems currently employed in the industries and companies are as follows

2.1. Biometric Attendance Control Management System

Biometric attendance system is highly secured management system. Biometric technology is an unquestionable verification or identification of a person by various physiological characteristics, which cannot be transferred or copied. This type of system logs all the attendance and entry/exit events and generates user friendly web reports for management purposes. Biometric Attendance Control System provides automated time and attendance control, which is designed to facilitate the employees as well as the organization. Multiple web based reports and email alerts are generated which display all the occurred events, processes and desired data.

2.2. Barcode Access Management

Barcode Access Management refers to managing and monitoring entrances and exits in a facility or area within a facility. These systems rely on computer controlled locks and readers to provide access. Electronically controlled locks and door sensors give the ability to lock and unlock the door on the basis of electronic commands from the management software. The lock communicates the time and duration of opening and closing to the barcode access management software. Access can be restricted to specific time periods and denied for others. Access can easily be denied for barcode access or control numbers that are lost or are believed to be compromised. Barcode Access Management systems offer increased security and improved reporting over manual systems. Barcode Access Management systems includes

a) An employee ID tag with the control or access number encoded in a barcode.
b) Barcode Reader allows reading of the employee access number and communicates with the access management software
c) Barcode Access Management Software stores the access control lists and communicates with barcode readers and locks. It locks and unlocks access points in accordance with the rules set up for each area and access or control number.

2.3. CCTV Surveillance systems

Closed circuit TV surveillance systems employ different strategically installed cameras in the premises. They constantly capture in video and send it to a centralized system where

an observer is sitting to monitor the video feed from each room where the camera is installed.

2.4. Vehicle Tracking System

In this type of System, a vehicle tracking unit is installed in the vehicle. Then the vehicle will show up on a digital map and can be tracked online. A user friendly, web based application, is provided to the customer company with secured access, to monitor their vehicles and to generate various kinds of reports to analyze data.Alarms or Alerts are generated according to the pre-customized setup for Geo-fences and Speed.

These vehicle tracking Systems able the customer to locate their vehicles and ensure that the vehicle follows the designated route by Geo-fencing the route and defining the allowed and not allowed zones. System can generate notification when the vehicle leaves the allowed zone and when the vehicle enters a restricted zone.

These vehicle tracking systems help organization by reducing operational cost, improving performance, Increasing work efficiency, fuel wastage, Security and visibility of fleet.

2.5. GPS (Global Positioning System)

The GPS system belongs to the Department of Defense (DOD) and is officially known as the NAVSTAR System (Navigation Satellite Timing and Ranging). Its primary purpose was to enable the U.S. Government and the Department of Defense to accurately determine one's position at any point on the surface of earth. A minimum group of 24

satellites would be required to meet the objectives of the GPS program. Figure 3 shows a constellation of 24 satellites around the earth.

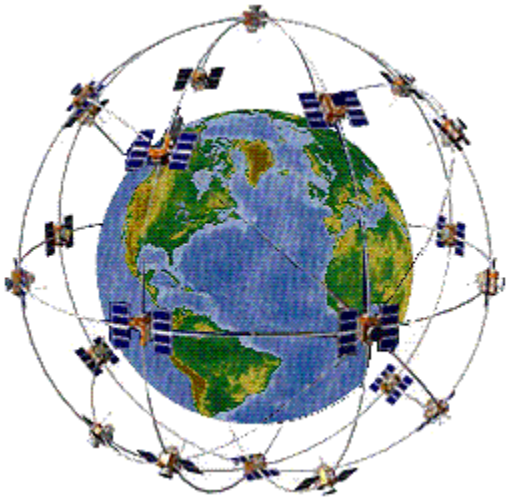


Figure 3: Constellation of 24 Satellites

GPS was originally developed for military use but soon became it was realized that there would be myriad of civilian applications as well like marine navigation and surveying. Since then, a numerous applications have emerged, like fleet management , personal positioning for scientific and commercial, landing aids for aircraft, navigation aids for automobiles and hand held devices As receivers have shrunk in size and weight and costs continue to drop, applications and the number of users has rapidly grown.

Components of the GPS System:

There are three main components of the GPS system: the space segment, more commonly known as the satellite, the control segment – ground stations run by the DOD and the user segment which comprises of all the users and their GPS receivers.

GPS Signal Characteristics:

Each GPS satellite transmits information at two carrier frequencies, called L1 and L2. The carriers L1 and L2 are pure radio waves. Data from the GPS satellites is represented as long strings of 1's and 0's, which means it is all digital. This information is much simpler to superimpose on the carrier frequency, providing a more reliable and error-free signal. This type of data transmission is also less susceptible to jamming.

Determining Position using GPS:

The GPS system determines location using a technique known as "tri-lateration". This technique refers to using distances from several known locations to compute the coordinates of an unknown location. The "known locations" in this case are the positions of GPS satellites. Therefore, in order to calculate your position for your GPS receiver, the location of each visible GPS satellite is needed. The distance to the GPS satellites can be determined by estimating the amount of time it takes for their signals to reach the receiver.

Calculating Your Location:

Once the positions of all the visible GPS satellites and distances to those satellites from the receiver, then the position of the GPS receiver is calculated. It can be best explained one step at a time. For example, the distance "R" from one satellite to our receiver is known. In two dimensions, thereceiver could be anywhere on a circle of radius R, as shown on the following figure (Figure 4).

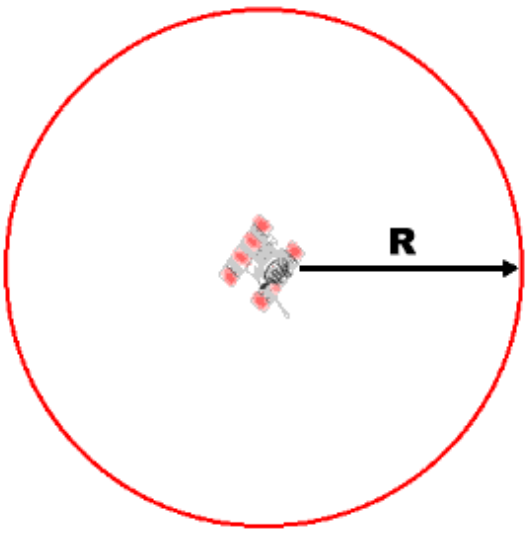


Figure 4: Location of Satellite at distance R

If we have ranges from two satellites, then two circles can be drawn and their point of intersection noted. In the example below(Figure 5), the receiver could be at point A or point B.

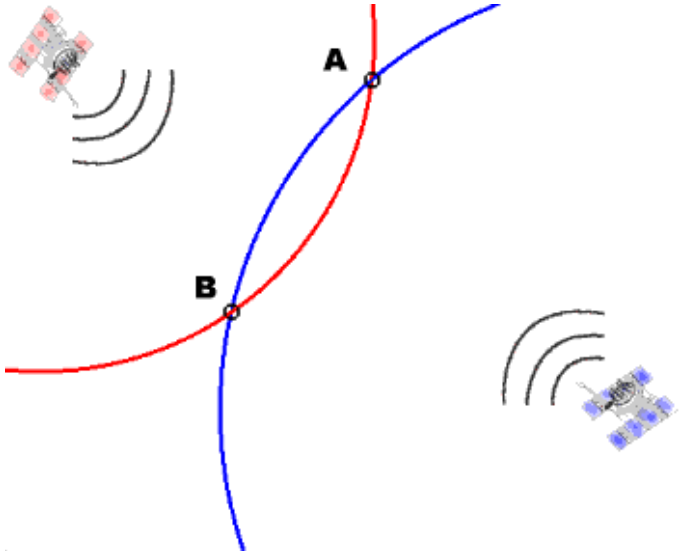


Figure 5: With 2 Satellites, the user can be at A or B

This is still not good enough. If we add one more satellite and one more range, then we can determine a unique solution, as shown on the following figure (Figure 6).

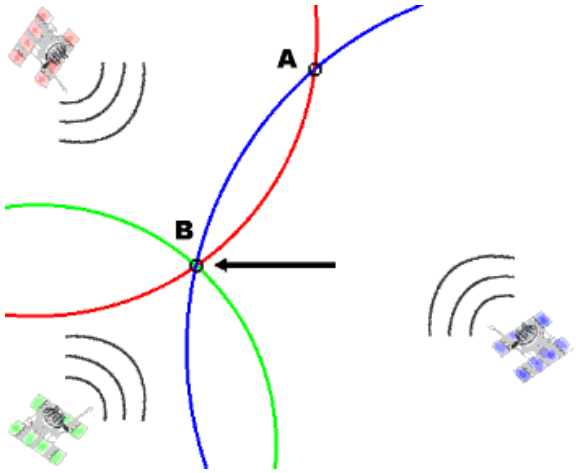


Figure 6: Triangulation with 3 satellites

2.6. GPRS (General Packet Radio Service)

GPRS is a non-voice packet based communication service for mobile devices that allows data to be sent and received across the existing TDMA networks. It is a step towards 3G and is an upgrade to 2.5G. It provides both standards with a way to handle higher-data speeds and the transition to 3G. It has made mobile data faster, cheaper and user friendlier than ever before. By introducing Internet Protocol (IP) and packet switching to existing mobile networks, it gives mobile users faster data speeds, and particularly suits bursty Internet traffic. It enables voice and data calls to be handled simultaneously. Connection setup is almost instantaneous, and users can have always-on connectivity to the mobile Internet, enjoying high-speed delivery of e-mails with large file attachment, Web surfing, and access to corporate LANs.

GPRS Device Classes:

GPRS devices are not as straightforward as you may think. There are in fact three different classes of device.

a) Class A

Class A terminals have two transceivers which allow them to send /receive data and voice at the same time. This class of device takes full advantage of GPRS and GSM. You can be taking a call and receiving data all at the same time.

b) Class B

Class B devices can be attached to both GPRS and GSM services but they can be used on only one service at a time. A Class B mobile can make or receive a voice call, or send and or receive a SMS message during a GPRS connection. During voice calls or texting the GPRS service is suspended but it is re-established when the voice call or SMS session is complete.

c) Class C

Class C devices can be attached to either GPRS or GSM services but user needs to switch manually between the two different types.

GPRS Multi Slot Classes:

GPRS mobiles are also categorized by the data rates they can support. Within GSM there are eight time slots that can be used to provide TDMA, allowing multiple mobiles onto a single RF signal carrier. Within GPRS it is possible to use more than one slot to enable much higher data rates to be achieved when these are available. The different speed classes of the mobiles are dependent upon the number of slots that can be used in either direction.

GPRS CLASS	SLOTS USED	MAX UPLOAD SPEED KBPS	MAX DOWNLOAD SPEED KBPS
2	3	8 - 12	16 - 24
4	4	8 - 12	24 - 36
6	4	24 - 36	24 - 36
8	5	8 - 12	/ 32 - 40
10	5	16 - 24	32 - 48
12	5	32 - 48	32 - 48

Figure7: GPRS Class Specifications

Here are some key benefits of GPRS:

a) Speed

GPRS is packet switched. Higher connection speeds are attainable at around 56–118 kilobits per second (kbps), a vast improvement on circuit switched networks of 9.6 kbps. Theoretical maximum speeds of up to 171.2 kilobits per second (kbps) are achievable with GPRS using all eight timeslots at the same time. This is about three times as fast as the data transmission speeds possible over today's fixed telecommunications networks and ten times as fast as current Circuit Switched Data services. However in the very short term, speeds of 20-50 kbps are more realistic. By allowing information to be transmitted more quickly, immediately and efficiently across the mobile network, GPRS may well be a relatively less costly mobile data service compared to SMS and Circuit Switched Data.

b) Always on connectivity

GPRS is an always-on service. GPRS facilitates instant connections whereby information can be sent or received immediately as the need arises, subject to radio coverage. No dial-up modem connection is necessary. This is why GPRS users are sometimes referred to be

as being "always connected". Immediacy is one of the advantages of GPRS (and SMS) when compared to Circuit Switched Data. High immediacy is a very important feature for time critical applications such as remote credit card authorization where it would be unacceptable to keep the customer waiting for even thirty extra seconds.

c) New and Better applications

GPRS facilitates several new applications that have not previously been available over GSM networks due to the limitations in speed of Circuit Switched Data (9.6 kbps) and message length of the Short Message Service (160 characters).Due to its high-speed connection and always-on connectivity GPRS enables full Internet applications and services such as video conferencing straight to your desktop or mobile device. Users are able to explore the Internet or their own corporate networks more efficiently than they could when using GSM. There is often no need to redevelop existing applications.

2.7. Introduction to RFID

In general terms, RFID (Radio Frequency Identification) is a means of identifying a person or object using a radio frequency transmission. The technology can be used to identify, track, sort or detect a wide variety of objects. Communication takes place between a reader (interrogator) and a transponder (Silicon Chip connected to an antenna) often called a tag. Tags can either be active (powered by battery) or passive (powered by the reader field), and come in various forms including Smart cards, Tags, Labels, watches and even embedded in mobile phones. The communication frequencies used depends to a

large extent on the application, and range from 125 KHz to 2.45 GHz. Figure 8 shows how an RFID system works.

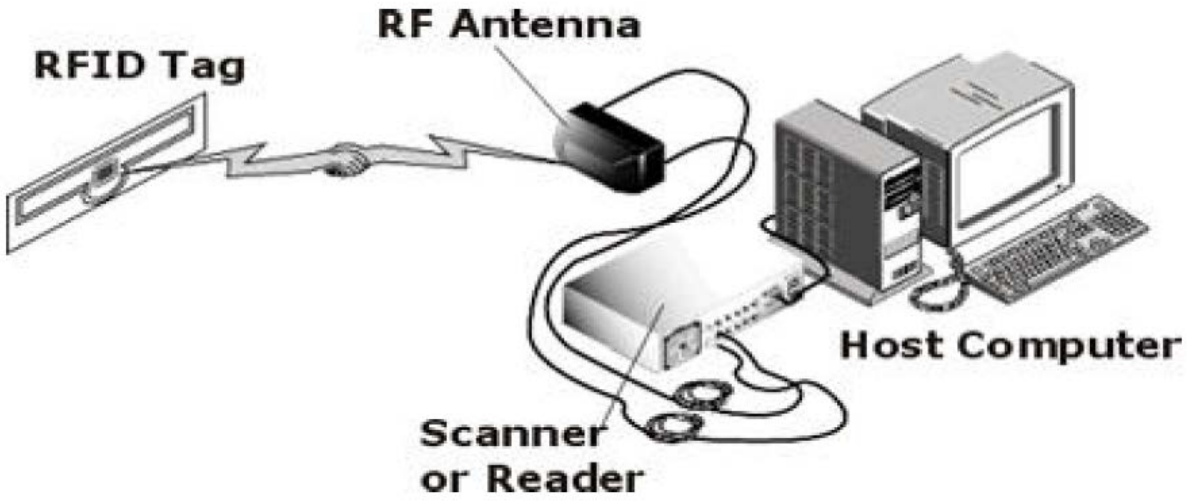


Figure 8: RFID System

2.7.1 RFID systems

RFID stands for Radio Frequency Identification and can be explained as a kind of wireless data transfer. RFID Tags are very small devices consisting of a microchip and an antenna and tag has a certain amount of internal memory (EEPROM) in which it stores information about the object, such as its unique identification (serial) number. These tags can be read by RFID readers through radio waves

In a typical system tags are attached to objects. When these tags pass through a field generated by a reader, they transmit tag's information back to the reader, thereby identifying the object. Until recently the focus of RFID technology was mainly on tags

and readers which were being used in systems where relatively low volumes of data are involved.

The communication process between the reader and tag is managed and controlled by oneof several protocols, such as the ISO 15693 and ISO 18000-3 for HF or the ISO 18000-6,and EPC for UHF. Basically what happens is that when the reader is switched on, it startsemitting a signal at the selected frequency band (typically 860 - 915MHz for UHF or 13.56MHz for HF).

Any corresponding tag in the vicinity of the reader will detect the signal and use the energyfrom it to wake up and supply operating power to its internal circuits. Once the Tag has decoded the signal as valid,it replies to the reader, and indicates its presence by modulating (affecting) the reader field.

One very important feature of these systems in anti-collision. If many tags are present then they will all reply at the same time, which at the reader end is seen as a signal collision and an indication of multiple tags. The reader manages thisproblem by using an anti-collision algorithm designed to allow tags to be sorted andindividually selected. There are many different types of algorithms which are defined as part of the protocol standards. The number of tags that can be identified depends on the frequency and protocol used, and can typically range from 50 tags/s for HF and up to 200 tags/s for UHF. Once a tag is selected, the reader is able to perform a number of operations such as read the tags identifier number, or in the case of a read/write tag write information to it. After finishing dialoging with the tag, the reader can then either remove it from the list, or put it on standby until a later time. This process continues under control of the anti-collision algorithm until all tags have been selected.

2.7.2 Active and passive tags

Passive tags can be read at a distance of up to 4 - 5m using the UHF frequency band, whilst the other types of tags (semi-passive and active) can achieve much greater distances of up to 100m or semi-passive, and several kilometers for Active. This large difference in communication performance can be explained by the following

a) Passive tags use the reader field as a source of energy for the chip and forCommunication from and to the reader. The available power from the reader field, not only reduces very rapidly with distance ,but is also controlled by strict regulations, resulting in a limited communication distance of 4 - 5m when using the UHF frequency band (860 MHz – 930 MHz).

b) Semi-Passive (battery assisted backscatter) tags have built in batteries andtherefore do not require energy from the reader field to power the chip. This allows them to function with much lower signal power levels, resulting in greater distances of up to 100 meters. Distance is limited mainly due to the fact that tag does not have an integrated transmitter, and is still obliged to use the reader field to communicate back to the reader.

c) Active tags are battery powered devices that have an active transmitter onboard.Unlike passive tags, active tags generate RF energy and apply it to the antenna. This autonomy from the reader means that they can communicate at distances of over several kilometers.

2.8. Proposed solution

The proposed solution aims to design and implement a tracking and management system which will make use of the RFID technology for indoor assets and personnel tracking and

will be integrated with a GPS and GSM/GPRS module for outdoor tracking of personnel and vehicles, thereby allowing the organization to keep track of all its assets, personnel and vehicles with a single system server. The authorized personnel will be allowed to monitor their movement and usage statistics. The information from all the tracking modules will be constantly sent to a centralized server and a database will keep records for future use. This complete system will provide a comprehensive and effective management solution to large scale organizations. This solution will keep buildings, staff and assets secure by giving flexible control over who is allowed to enter a building and keep the track of the company's transport to manage its fleet.

3. Design and Development

Concept of the project

The project can be subdivided into two main parts, outdoor tracking unit and indoor tracking unit.

To develop the outdoor tracking prototype (Figure 9), a GPS unit is interfaced with a microcontroller which can receive the coordinates and poll it directly to a website.The microcontrollersupports a serial port for communication with GPS and the GSM modules. The microcontroller code searches for the relevant information from all the data received from GPS module, and extracts latitude and longitude information. This information is temporarily stored in its memory, until it can transmit it over GPRS service. The microcontroller activates the GSM module using a string of commands known as AT commands. It posts the location information previously obtained from the GPS module to the website over GSM network via GPRS.

On the server side, the latitude and longitude information is saved to a MySQL database and also displayed on Google Maps. A web server has been developed to host the website.

To develop the indoor tracking prototype (Figure 10), a few mobile and fixed assets are given RFID active tags. The RFID are installed in the rooms to be monitored. Fixed tags broadcast unchanged location information, while the mobile assets/personnel broadcast their current location within the rooms.

The RFID readers are interfaced with the server through Ethernet connection. A control function has been developed which can extract relevant information from incoming data and upload it to the website at the same time, saving it to the database.

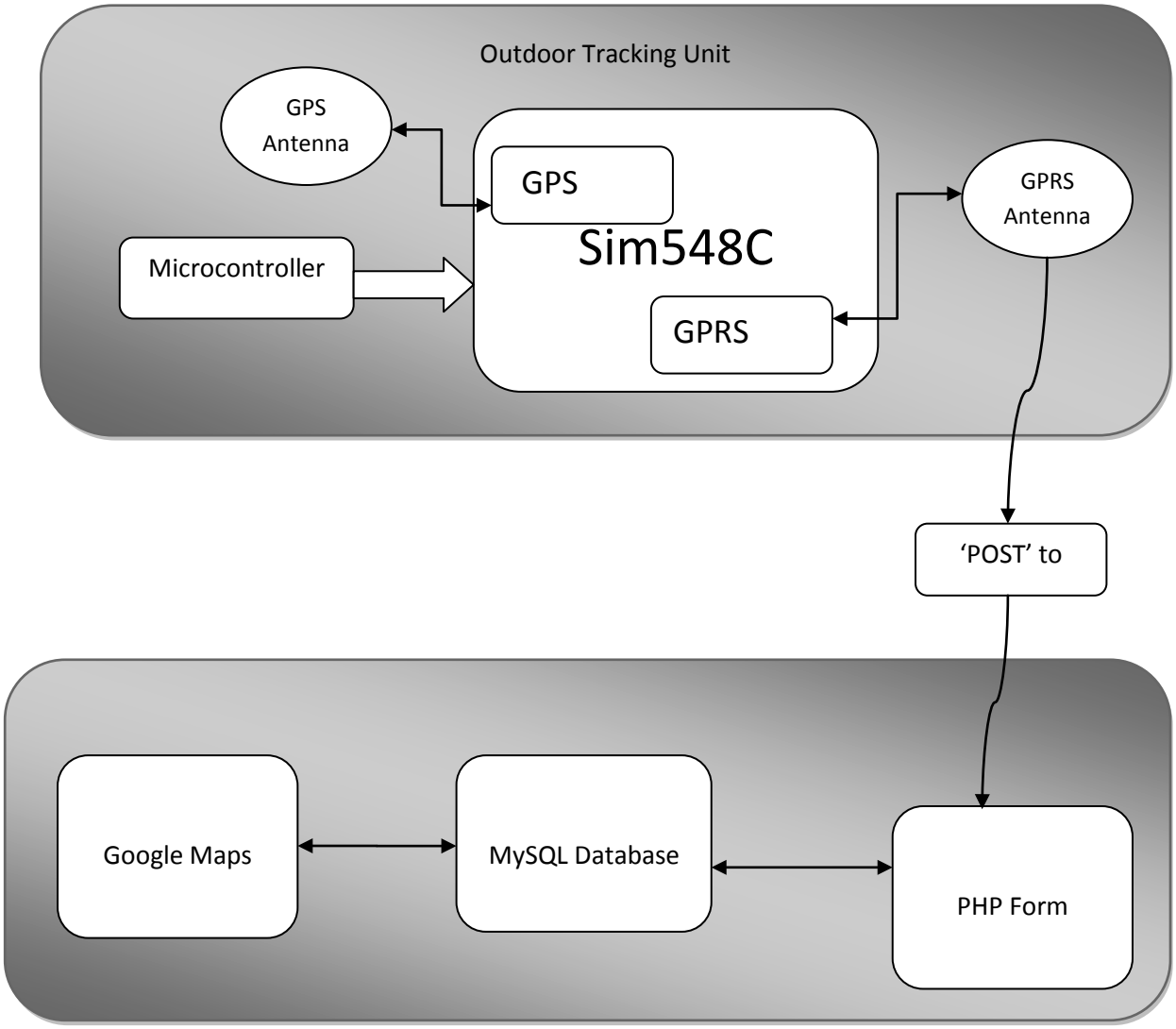


Figure 9: Outdoor Tracking Functional Flow Chart

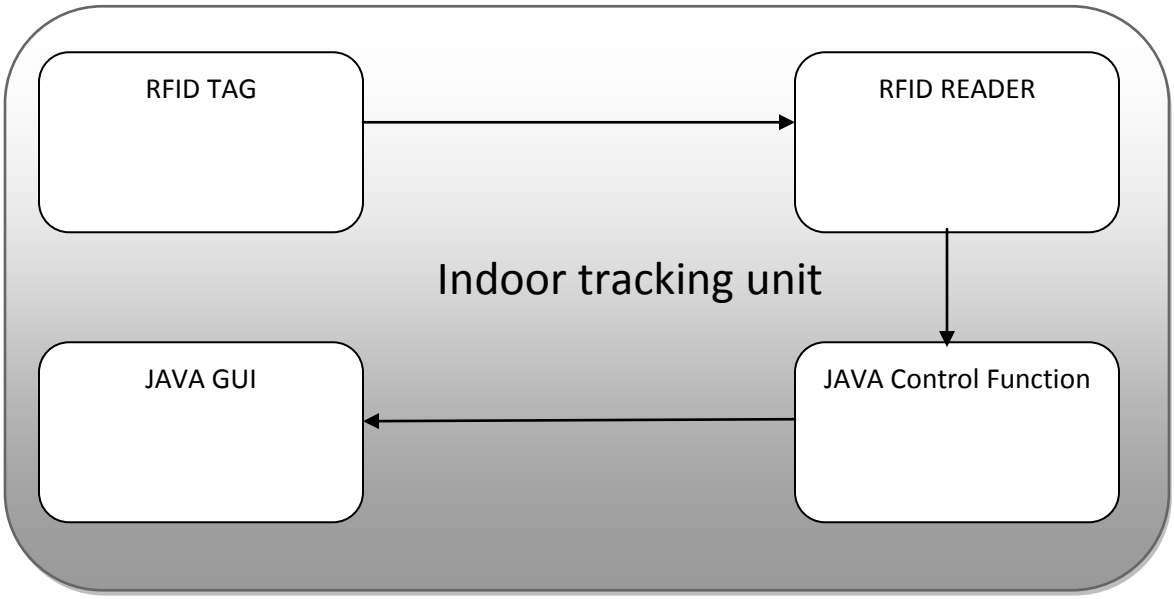


Figure 10: Indoor Tracking Functional Flow Chart

3.1. Outdoor tracking unit

The outdoor tracking unit is the vehicle tracker. Components of this unit are discussed in detail as follows

3.1.1. The SIM548c

To put together the vehicle tracker we have developed a compact circuit board that houses the Sim548c. This is a quad-band GSM/GPRS module that is also equipped with GPS. The GSM/GPRS part of this module can be controlled using AT commands via serial interface. The GPS part has two serial interfaces. The module can be interfaced with two SIM cards at a time. It is very small in size and so our vehicle tracker is a compact unit that can be easily installed in a vehicle.

3.1.2. Power supply

The SIM548c requires a supply voltage of 3.4V to 4.5V and a current upto a maximum of 2A during RF activity for the GSM/GPRS part and a supply voltage of 3.3V (+/- 5%) for the GPS segment. To fulfill this requirement and also to be able to interface it with a vehicle battery we designed a power supply circuit (Figure 11) that steps down 12V (from the vehicle battery) into 4V for the GSM/GPRS part, 5V for the microcontroller and 3.3V for the GPS part of the module. The circuit employs three voltage regulators in parallel. Because the current is too high, heat sinks have been used with the regulators so as to keep them from getting damaged.

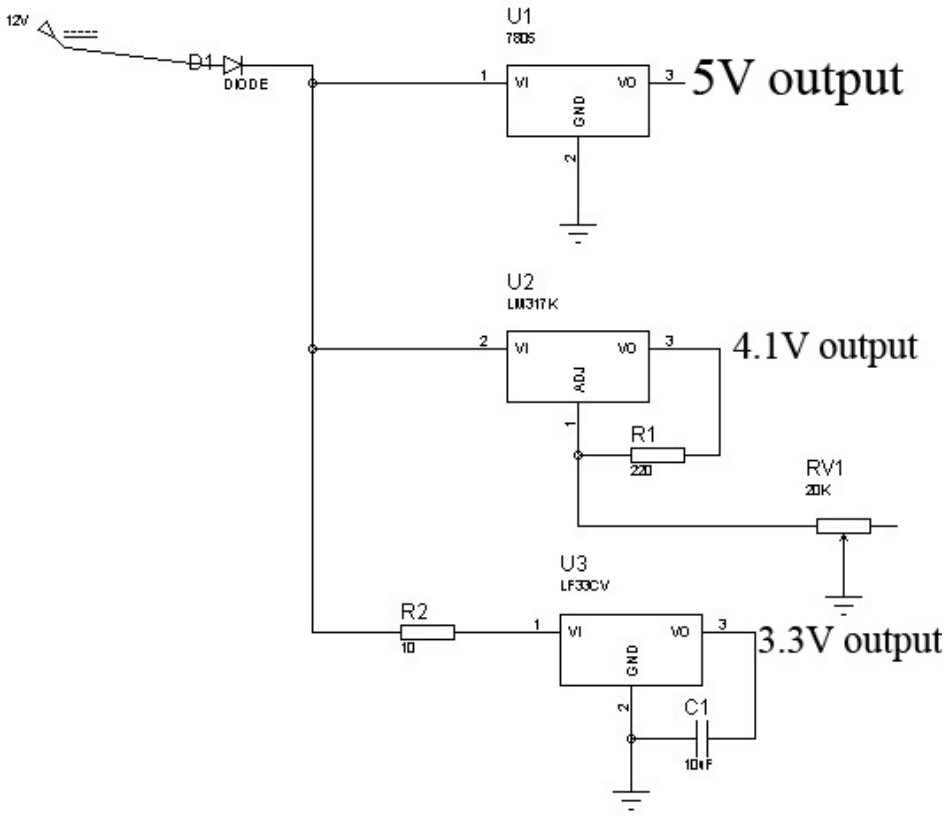


Figure 11: Power Supply Circuit

3.1.3. Powering on the SIM548c module

To power on the module, pin 13, the PWRKEY has to be pulled low for at least 2s and then released (Figure 12). To achieve this, we used a relay and one pin (pin 25) of the microcontroller. The powering on circuit's Pin 1 of the relay is connected to the PWRKEY, pin 2 left open, pin three is connected to pin25 of the microcontroller, pin four is grounded and pin 5 is connected to +5V. Whenever there is a potential difference between pin 3 and 4, pin 5 connects to either pin 1 or pin 2. To switch on the SIM548c module, PWRKEY has to be pulled low. The microcontroller is programmed to first make pin 3 equal to zero. This connects Pin 5 to pin 2 and pin 1 is open. Now, pin three is made high for a very short duration. During this time, pin1 is connected to pin 5 – PWRKEY is being grounded. The pin 3 is then made low again. As a result the module powers on.

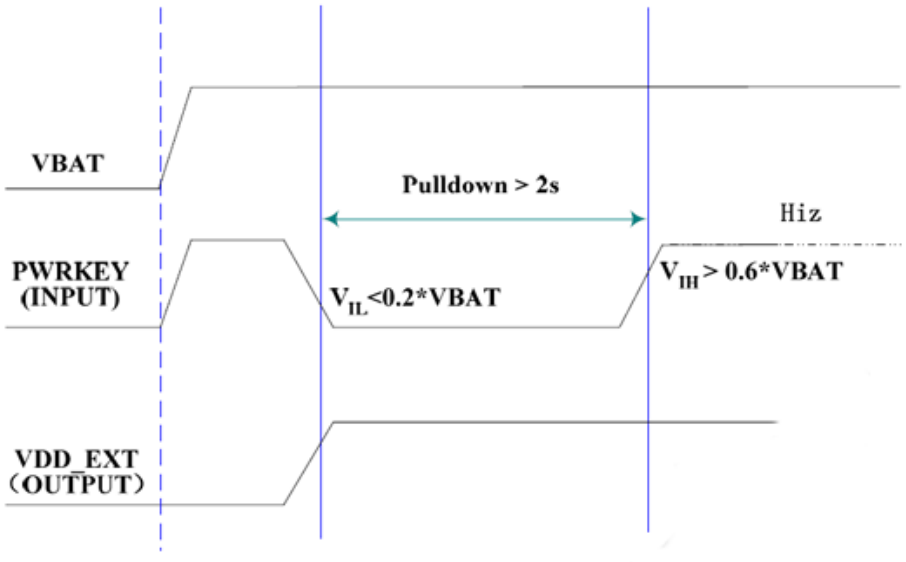


Figure 12: Power on Timing Diagram

3.1.4. Status Indication

The module sends out status messages whenever the PWRKEY is pulled low. If the module is to be powered on, once the PWRKEY is pulled low for the specified amount of time and released, "**CALL READY**" message will appear once the network registration process has been completed. The STATUS light will switch on. When the PWRKEY is pulled low to switch off the circuit, "**NORMAL POWER DOWN**" message is shown and the STATUS light switches off.

3.1.5. Extracting coordinates from GPS

The first thing after powering on is getting location information from the GPS module of the SIM548c. The GPS module is interfaced with an antenna. The antenna receives information from visible satellites and the receiver performs triangulation calculations. In the initial stages, we tested Sim548C GPS module over serial port using HyperTerminal.

3.1.6. Interfacing with Computer through Serial Port for testing

Initially, the GPS module was tested with HyperTerminal by serially connecting it to the PC.HyperTerminal was configured to use COM1 port at a baud rate of 4800 bps with 8 physical bits including 1 stop bit and no flow control. A GPS receiver is an always on receiver that is, once powered on, it continuously receives GPS data. The GPS module sends data in the NMEA protocol. All NMEA 0183 sentences are ASCII and each sentence begins with a dollar sign ($) and ends with a carriage return linefeed (<CR><LF>). Fig 13 shows the format of the data received by the GPS receiver. Among

all the received strings, one that begins with '$GPRMC' contains latitude and longitude in a specified format.

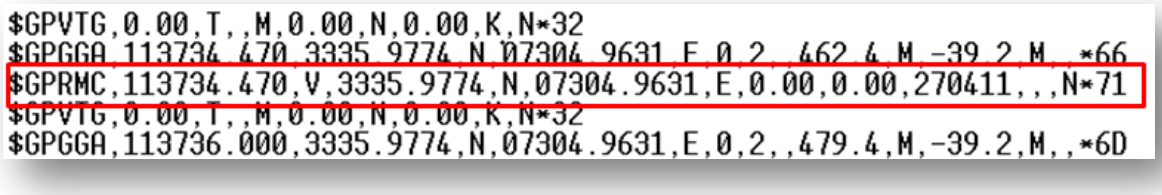


Figure 13: GPS Data in HyperTerminal

3.1.7. Coding the microcontroller to extract the coordinates

The module was then serially connected with a microcontroller (AT8952) which has been coded to implement a search function to check for the $GPRMC string and when found, extract the latitude and longitude information. The program transmits the latitude and longitude value over the GSM/GPRS network to the server end. The interval, after which vehicle location needs to be transmitted, can be set as per requirement.

The format of the GPRMC command line is given in Table 1.

$GPRMC,hhmmss.ss,A,llll.ll,a,yyyyy.yy,a,x.x,x.x,xxxxxx,x.x,a,i*hh<CR><LF>

Table 1: GPRMC Command Format

	Field	Example	Comments
1	Sentence ID	$GPRMC	Recommended Minimum Specific GNSS Data
2	UTC Time	113734	Hhmmss.sss
3	Status	V	A=Valid, V=Invalid
4	Latitude	3335.977	dddmm.mmmm
5	N/S Indicator	N	N=North, S=South
6	Longitude	7304.963	dddmm.mmmm
7	E/W Indicator	E	E=East, W=West
8	Speed over ground	0	Knots
9	Course over ground	0	Degrees
10	UTC Date	270411	DDMMYY

3.1.8. Serial communication with the microcontroller

The microcontroller serial port is configured through serial() function. In this mode, the timer registers of 8051 are used. We have used Timer1 register in mode 2, which is 8-bit auto reload.

Baud Rate = (KxOscFreq)/(32x12x[256 - (TH1)])

If SMOD = 0, then K = 1.

If SMOD = 1, then K = 2 (SMOD is in the PCON register).

TH1 must be an integer value. Rounding off TH1 to the nearest integer may not produce the desired baud rate. In this case, the user may have to choose another crystal frequency. In our case, since we are using 11.0592MHz crystal, we have set the TH1 register to 0xFA value. This produces a baud rate of 4800bps, same as the sim548c module which was configured to operate in 4800bps mode using the command AT+IPR=4800**.**

The SCON register handles the serial communication. It is used to control the data sent on the serial port. It has been configured to the value 0x40, which enables the serial ports of the microcontroller to be used in Mode 1 which is 8-bit UART. Then the timer control bit is set 1 so that the timer function starts.

Microcontroller has an internal register known as SBUF which is an 8-bit register used to serially transmit or receive a complete byte. To transmit data to an external device, we must place the whole byte in the SBUF register. Once it is successfully transmitted, TI flag is set 1 by the microcontroller hardware which must be manually cleared through the software. This process is done through the use of transmit data function. This function is only used to send single characters to Sim548c.

A similar function called send_serial is used which transmits whole string of bytes serially to Sim548c. It basically makes use of a pointer variable and a loop which loops through all characters stored sequentially in the memory location beginning at the pointer variable value and sends them one by one to SBUF register.

Serial communication has a single interrupt, termed as Interrupt 4, which belongs to both receive and transfer. The interrupts must be enabled by software in order for the

microcontroller to respond to them. There is a register called IE (interrupt enable) that is responsible for enabling (unmasking) and disabling (masking) the interrupts.

The data to be transmitted or received is placed in the internal buffer of the microcontroller, SBUF. TI (transfer interrupt) is raised when the last bit of the framed data, the stop bit, is transferred; indicating that the SBUF register is ready to transfer the next byte. RI (received interrupt) is raised indicating that the received bytes need to be picked up before they are lost by new incoming serial data. If the interrupt bit in the IE register is enabled, when RI or TI is raised the 8051 gets interrupted and jumps to memory location 0023H to execute the ISR. In that ISR, TI and RI flags need to be examined to see which one caused the interrupt, and respond accordingly.

3.1.9. Posting location information to the website

Initiating a GPRS session through SIM548c

Sim548c has integrated GPRS support. GPRS sessions can be initiated once the SIM card registers itself with the network. This can be checked by sending the **AT+CREG?**command over the HyperTerminal. The response code indicates the network attached state:

AT+CREG: <n><stat>

<n> 0 – disable network registration code

1 – Enable network registration code

2 – Enable network registration code with location information

<stat> 0 – not registered, searching

1 – Registered, home network

2 -- Not registered, not searching

3 -- Registration denied

4 -- unknown

If the output of AT+CREG?is**0,1**, it indicates successful attach.

Next, network GPRS attach is performed by the command **AT+CGATT=1,** if the module is not already attached to GPRS service**.** The module is forced manually to attach to GPRS service by sending this command. If the response is **OK,** it indicates successful attach, if it gives **CME ERROR: +107,** it means GPRS service is not available.

To communicate with the network service, a PDP context has to be defined. This is only required once (upon first module power up) or after the module has been flashed. The command used is **AT+CGDCONT=1,"IP", "ufone.ppt.wap2".** This programs the module and ensures that all packets exchanged between the network and the module is IP packets. The id number of this context is 1.

The user can specify QOS parameters to reach a trade-off between contradictory features (peak throughput, precedence, delay, reliability, mean throughput). This is generally ignored by the network, which provides a best effort service. However the user can still specify the QOS parameters by sending the command **AT+CGQREG=1,0,0,3,0,0.**

PDP contexts

Packet Data Protocol (PDP) context is the connection or link between a mobile device and a network server that allows them to communicate with each other. A PDP context lasts only for the duration of a specific connection. The PDP context request includes the

Access Point Name, which specifies the external network with which to make the connection, and in what fashion.

To establish a GPRS connection with the web page, first a PDP context has to be opened. This is done by sending the following commands:

a. AT+CGACT=1,1

The former parameter is set 1 to activate the GPRS session and the latter parameter is set 1 to invoke the previously defined PDP context.

b. AT+CSTT=”access point**”**

Generally, the network provides the user with access point information; this can manually be achieved by using this command. The SIM currently in use belongs to PK-UFONE network, so the access point to be used is **“ufone.ppt.wap2”.** It is almost every time assigned by the network.

c. AT+CIICR

To force the module into manually starting a wireless connection with the GPRS node, thiscommand is used. This is also not required generally, because once the target IP address is specified, a wireless connection is automatically established between the module and network.

d. AT+CIFSR

To get a local IP address, this command is sent. In response, an IP address is given to the GSM/GPRS module.

e. AT+CIPHEAD =1

To add an IP header when receiving data, this command is used.

Once a PDP context has been opened, a connection has to be made with the server before sending data to it. This is done by the commands mentioned below:

AT+CDNSORIP=1

The module cannot automatically recognize the destination address as being a domain name or an IP address. To connect with a domain name server instead of an IP address, this commandis used.

In between all these commands, appropriate delays are given because once the command has been sent from the microcontroller; the serial port receives the command character by character and transmits it to the serial port of SIM 548c module. Once the command has been received by the module, it sends it over the air interface to GSM network. Till the response is received, microcontroller cannot send another command. To avoid this overlapping, we used hit and trial method and found that 200 milli seconds delay is most appropriate to avoid conflicting commands.

Posting Latitude and Longitude to web page

At this point, a GPRS connection has been established with the network. To connect to the web server, a TCP connection has to be started. The command used is

AT+CIPSTART="TCP","hotm.no-ip.biz","80”

This command opens a TCP connection with hotm.no-ip.biz on port 80. The response to this command is ‘CONNECT OK’ indicating that a connection has successfully been established with the web server.

To send data on the previously established TCP connection the command **AT+CIPSEND** is used. The latitude and longitude have to be uploaded directly to a web page. We have made use of HTTP post method. To serve this purpose, a PHP page was created that has one HTML form containing four text fields – one each for longitude, latitude and inc.To post the latitude, longitude and inc to the web page, microcontroller has to send an HTTP POST method string containing the various commands necessary to perform POST action. The commands specified in the POST method, when formatted for our use, were found from observing packet syntax from Wireshark. Dummy coordinates were manually submitted from the save.php webpage opened in a browser, and observed the syntax of POST method using Wireshark (Figure 14).

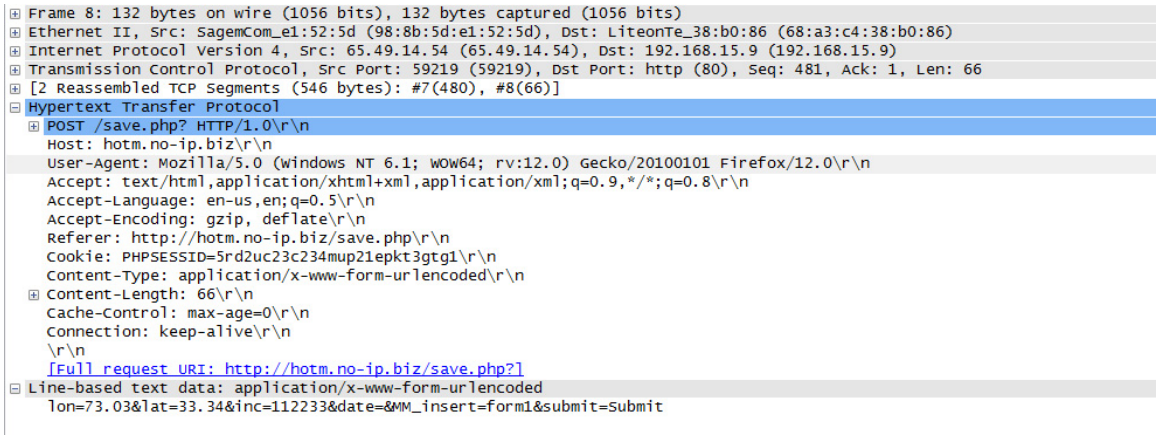


Figure 14: Wireshark Packet analysis of POST Method

If the following commands are sent to the web server, they invoke the POST method by uploading coordinates to save.php webpage, and therefore to the MySQL table.

```
POST /save.php HTTP/1.1
HOST: hotm.no-ip.biz
Content-Type: application/x-www-form-urlencoded
Content-Length: 66
lat=33.34&lon=73.03&inc=1112233&MM_insert=form1&submit=Submit
```

Next, the microcontroller checks if the GPS receiver has synchronized and it is capable of transmitting the obtained coordinates.If the info string contains “A” in 18^{th} index, indicating synchronization, microcontroller sends received coordinates, if “V” is present indicating invalid synchronization state, it sends dummy coordinates.

If the above mentioned condition is met, the microcontroller performs the extraction of latitude, longitude and time and puts each in a string array. The latitude is stored in the array lat1, longitude in lon1 and time in the array named ‘time’. Now, the microcontroller uses the send_serial() function to first, send **AT+CIPSEND** and then carriage return command is given serially by sending the character “\r”. Now each line in the POST Method string is sent serially one by one by the microcontroller. Each command is followed by carriage return and line feed to indicate start of new line to the module. When the last command is to be sent, each variable in the POST command like “lat” and “lon” is followed by the microcontroller variables “lat1” and “lon1” respectively.This performs “Submit” action on the save.php webpage, by equating the form fields like “lat”

and “lon” to the values in the microcontroller variables “lat1” and “lon1” which contain the received coordinates.

In short, the whole command that is being serially sent to the GSM/GPRS module is:

lat=lat1&lon=lon1&inc=time&MM_insert=form1&submit=Submit

If the abovementioned condition is not met, that is, the GPS receiver has not synchronized, the following command is sent:

lat=33.346927&lon=073.037513&inc=100998&MM_insert=form1&submit=Submit

This means that unless the receiver is synchronized, the microcontroller sends dummy data and once the GPS receiver has synch-ed, the real coordinates of the location of the vehicle are transmitted.

All AT commands except **AT+CIPSEND** are transmitted through the use of “\n” which is equivalent to carriage return. **AT+CIPSEND** is also transmitted through the use of carriage return command but the subsequent command like “**POST /save.php HTTP/1.1”** or “HOST: hotm.no-ip.biz”is sent by entering the following sequence of commands:

transmit_data(0x0D); (This is carriage return, or CTRL+M)

transmit_data(0x0A); (This is line feed, or CTRL+J)

transmit_data(0x1A); (This is substitute character, or CTRL+Z)

3.2. Indoor Tracking System

The tracking of assets and personnel required the use of an RFID reader and RFID tags. The RFID reader model used is Invengo InfoTech XCRF-804. The RFID reader can be connected to the computer via Ethernet interface or serial. The reader has 4 RF ports which can each be connected to RFID antennas. The available antenna was XCAF-11L. It is connected to port 1 of the reader via its RF connecting cable.

RFID reader comes with its own software as shown in the screen shot (Figure 15). The software is simple to use. It is first initialized by assigning the IP address of the RFID reader (by default 192.168.0.209), and then open port command is given. This establishes connection with the reader after selecting the Ethernet interface. Then the reader is powered on and initiated in the Read ID mode. This powers on the antenna and it starts broadcasting the unmodulated carrier wave. When a RFID tag comes within range, it backscatters its tag ID which is received by the antenna and decoded by the reader. The reader assembles an IP packet and sends it down the pipeline on Ethernet interface to computer.

In an actual model, the whole organizations premises would be installed with multiple rfid readers and antennae in each room. All the readers will be connected with the centralized server computer via an Ethernet router. So packets will arrive from each reader on the server computer and then can be individually treated according to the sending Reader to detect the presence of each tag in separate room.

For prototyping purpose and due to limitation of hardware, our indoor tracking unit's design consists of only one RFID reader.

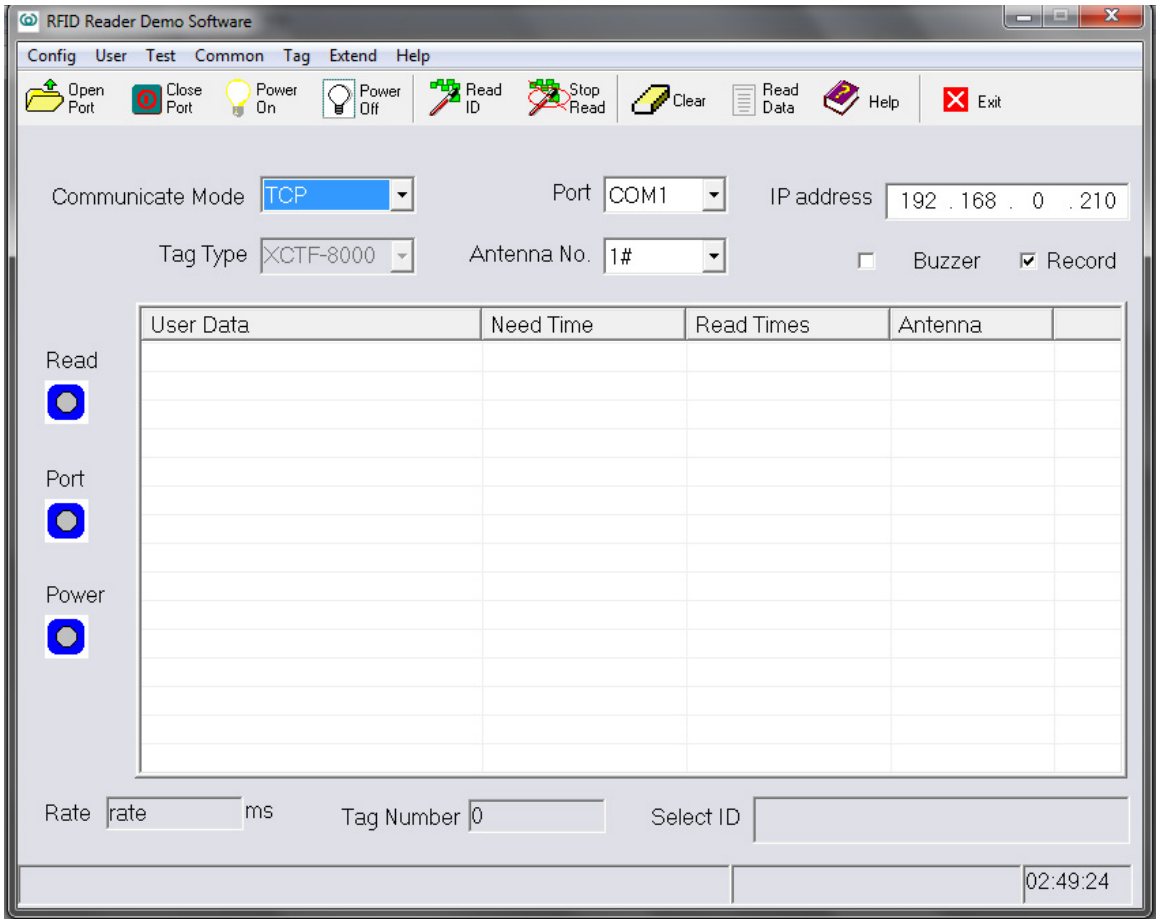


Figure 15: RFID Software

3.3. Receiving System

The receiving system comprises of the website, database and Java GUI for indoor tracking system. Each of these is discussed in detail in the following passages.

3.3.1. Web server Setup

In order to have GPRS communication from outdoor tracking unit to our centralized computer system, a web server has to be running on the computer. Instead of purchasing web space and a domain name, we decided to develop our own personal web server. For this purpose, a free domain name was registered, “hotm.no-ip.biz”. For registering in a

DNS routing system, we made use of a dynamic routing server, No-ip. Dynamic routing DNS systems use their own servers to allow routing to free registered domain names. By registering “hotm.no-ip.biz” in their servers, a domain name and routing to our web space was set up.

Now to accomplish routing to web space, Wi-Tribe local internet connection device was used. Wi-tribe’s internet device, whenever it is switched on, is assigned an IP address by their servers. Next, No-ip’s software, DUC was installed which automatically updates the internet gateway device’s IP address which is connected to the computer on which we are developing the web server, against our registered domain name in the No-ip’s servers.

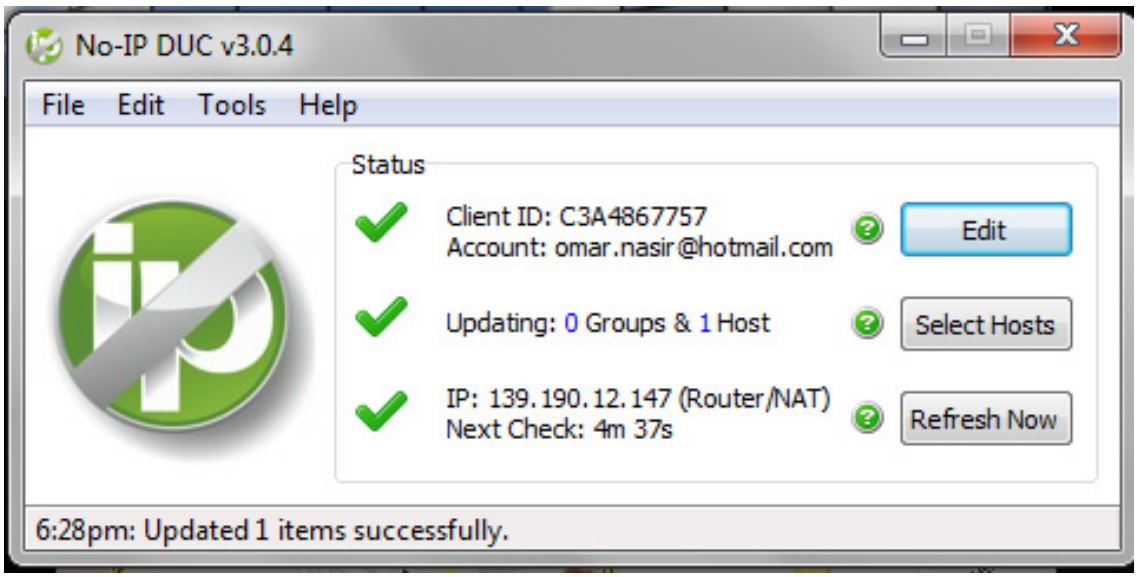


Figure 16: DUC Software to check IP

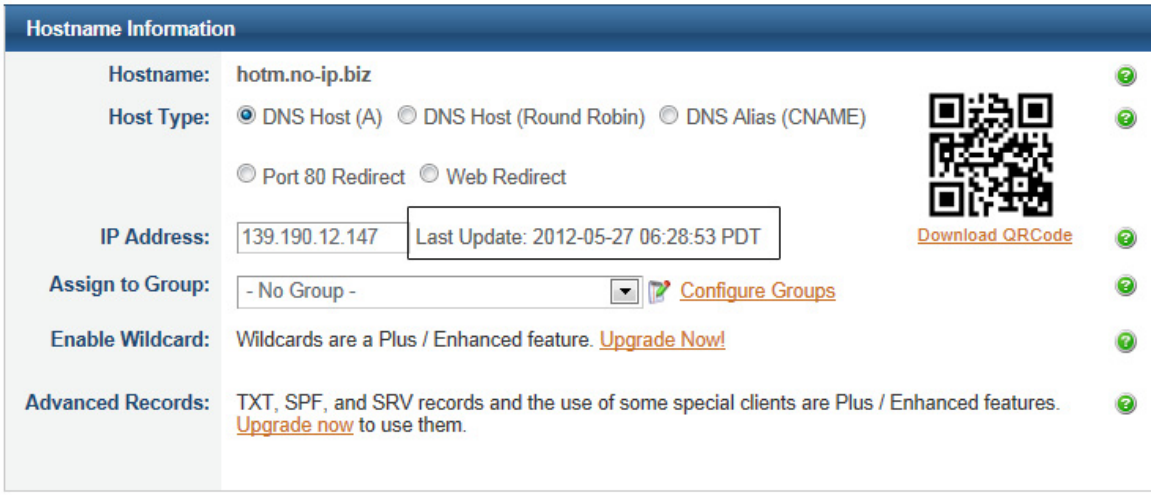


Figure 17: Automatic Updating at No-IP Servers

Whenever someone requests our domain name, the dynamic DNS service enables the requesting computer to be routed towards our web space by giving them IP address of our Wi-tribe internet device as destination address.

When the request arrives at the Wi-tribe internet device, it has to be directed toward the web space being maintained in the computer. A local web server was installed known as “WAMP Server”. This includes Apache server, MySQL and PHP in one package to be operated as a web server (Figure 18).

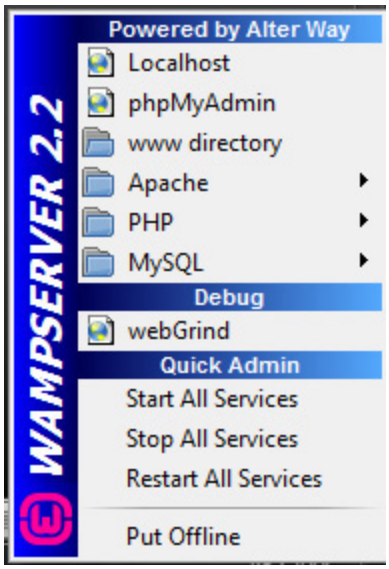


Figure 18: WAMP Server

Apache configuration file was modified so as to make it listen to incoming connections on port 80 for domain name requests “hotm.no-ip.biz”. The command in the apache configuration file, httpd.conf is shown in Figure 19.

```
# ServerName gives the name and port that the server uses to identify itself.
# This can often be determined automatically, but we recommend you specify
# it explicitly to prevent problems during startup.
#
# If your host doesn't have a registered DNS name, enter its IP address here.
#
ServerName hotm.no-ip.biz:80
```

Figure 19: Apache Configuration File (Server Name)

The website php files were placed in the www folder of wamp server after configuring the server with this command shown in Figure 20.

```
# DocumentRoot: The directory out of which you will serve your
# documents. By default, all requests are taken from this directory, but
# symbolic links and aliases may be used to point to other locations.
#
DocumentRoot "c:/wamp/www/"
```

Figure 20: Apache Configuration File (Document Root)

The start page of the website was set to be “login.php” and is shown in Figure 21.

```
# DirectoryIndex: sets the file that Apache will serve if a directory
# is requested.
#
    DirectoryIndex login.php
```

Figure 21: Apache Configuration File (Set Login Page)

The final step in initializing the web server was to configure the internet device to forward all incoming requests to the personal computer on which WAMP was running. The Wi-tribe was then configured to enable port forwarding (Figure 22).

Figure 22: Port Forwarding in WiTribe Device

All incoming requests on port 80 were forwarded to a specific local IP (the IP address of the personal computer which is 192.168.15.9) on port 80 (on which WAMP server was listening for incoming connections). In this way, requests for hotm.no-ip.biz are

forwarded to web pages placed in our personal computer. This enabled us to perform IP based communication through GPRS between our remote outdoor tracking module and our local web server.

3.3.2. Database

To save incoming data from our outdoor tracking unit, we had to develop some mechanism via records were to be kept. This led us to develop a database system on MySQL programming language. MySQL was chosen because of its simplicity, effectiveness, robust performance and an easy to use interface.

The first step in creating a MySQL database is to develop an SQL server. We created a new Server instance, “SQLserver” and assigned it the default SQL local port 3306. The address of the server process therefore is localhost:3306. This allows for other applications to connect to MySQL service through this address, running on the same machine.

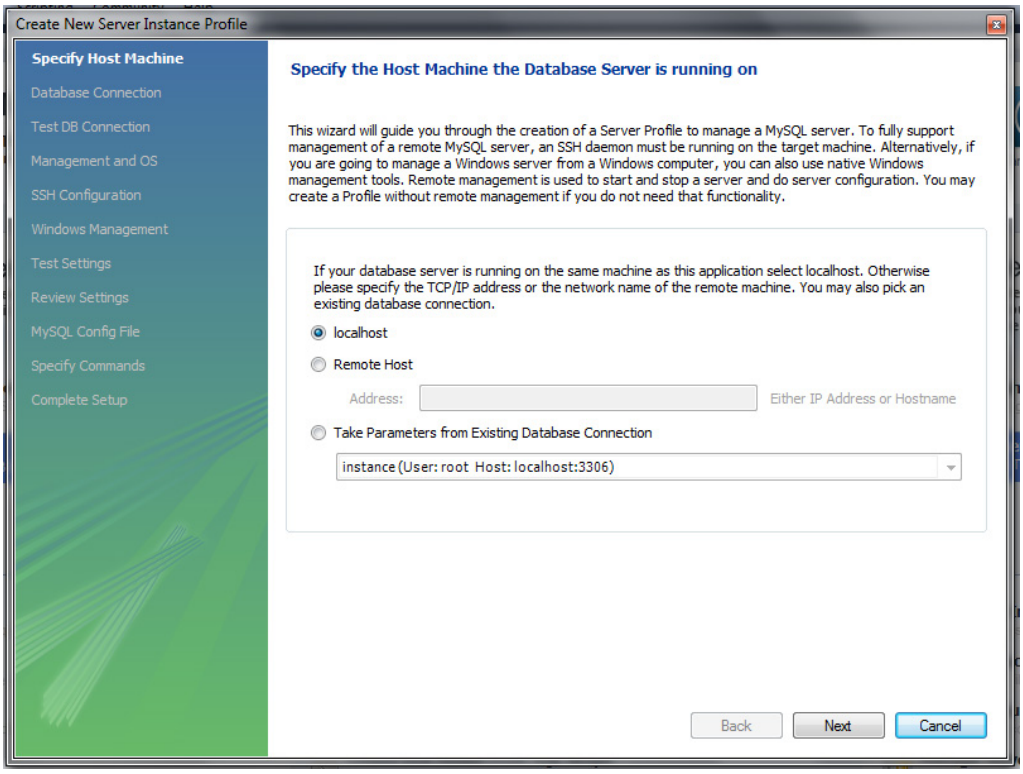


Figure 23: Setting up MySQL Server Instance

Next we created a new database connection and assigned it the name “instance”. It was given the same localhost:3306 address along with a username and password for security. The connection parameter was set to TCP/IP for local connections to this database. MySQL generated a schema which was named “gps_management”.

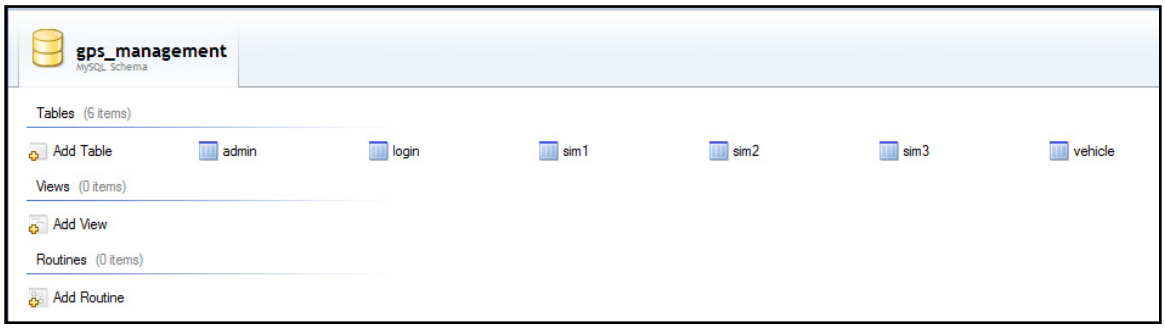


Figure 24: MySQL Database “gps_management”

This is the actual database which will be used by other applications to connect to. The database “gps_management” was therefore established at the local host port 3306.

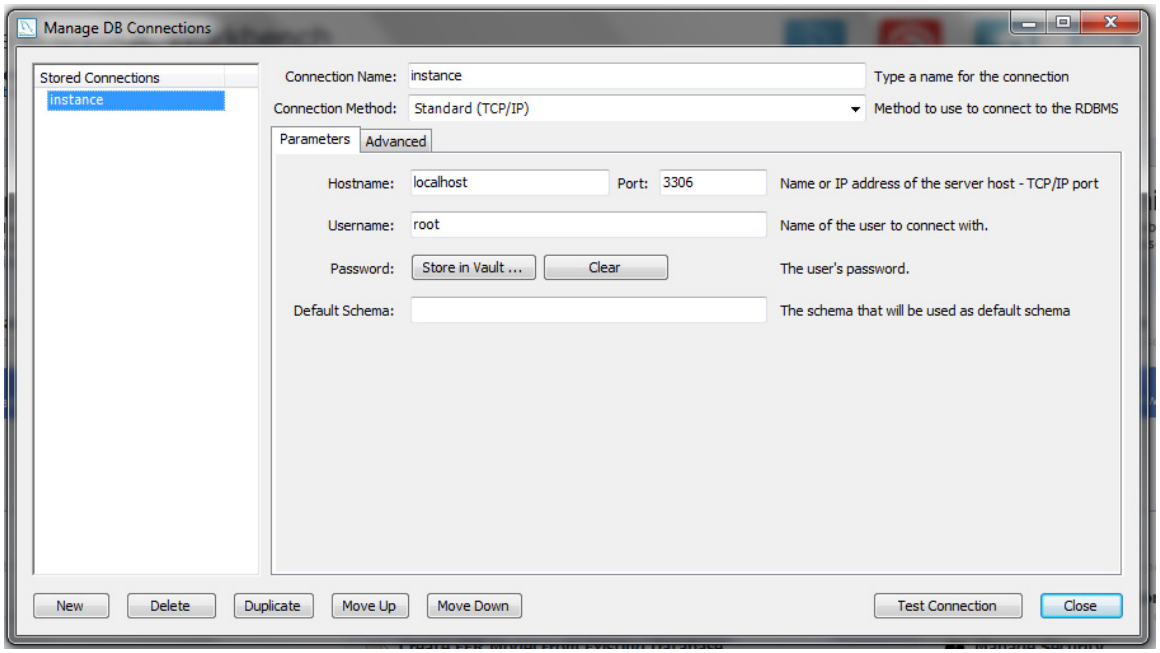


Figure 25: Setting up Database connection in MySQL

3.3.3. Website “HMS”

Once the web server had been established, the next step was to create a web page that was going to “capture” incoming coordinate information via GPRS communication from microcontroller from our outdoor tracking unit, and then save this data in our MySQL table. This is achieved through implementing server-side programming languages. We chose to develop our web pages on PHP, since it is an efficient web server language and it offers the best integration with MySQL database.

Developing a web page requires a complete web site set up. The software Adobe Dreamweaver offers a very efficient interface to quickly set up websites. It also offers

various functions regarding PHP functions. We started by creating a new Dreamweaver site and chose PHP as our server side programming language. The default folder for uploading our web pages was chosen as “www” folder located in our WAMP server directory. After setting up the parameters for testing and uploading, the Dreamweaver web site had been set up.

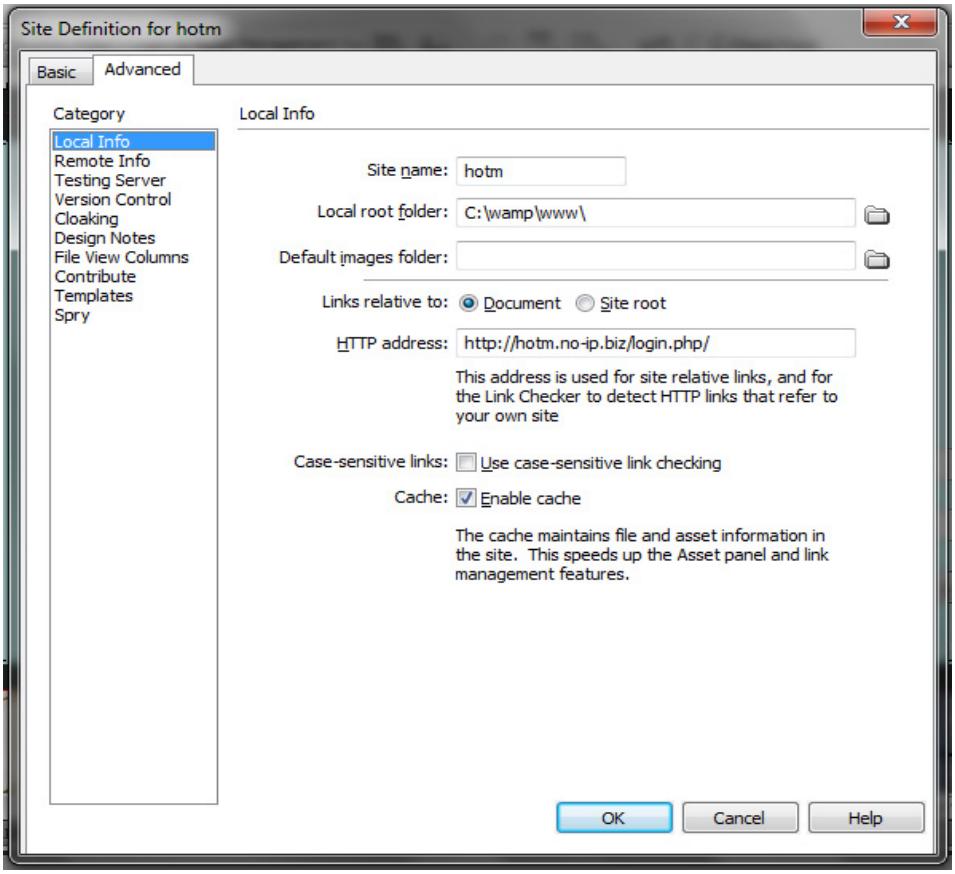


Figure 26: Setting up website parameters in Dreamweaver

We developed a simple web page, “save.php” which contains an HTML form.

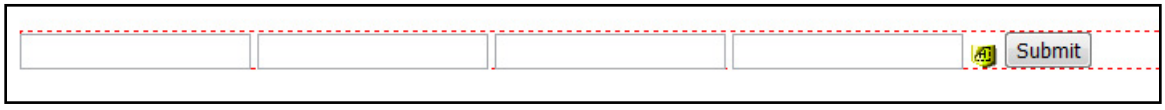


Figure 27: HTML Form

Three dynamic text fields were created, to store latitude, longitude and date from the microcontroller. A fourth text field is used to insert the current time and date from the web page into MySQL once the SUBMIT button was pressed or the form action of "POST" method had been called. This was done so that when the microcontroller sends a POST command via GPRS connection, the fourth text field will automatically insert the time and date of receiving of coordinates at server side in MySQL table. This allows for checking of transmitted time from microcontroller and reception time at server.

The connection to MySQL database was initiated via Dreamweaver's PHP functions (Figure 28). A MySQL connection element was created and it was given localhost:3306 address.

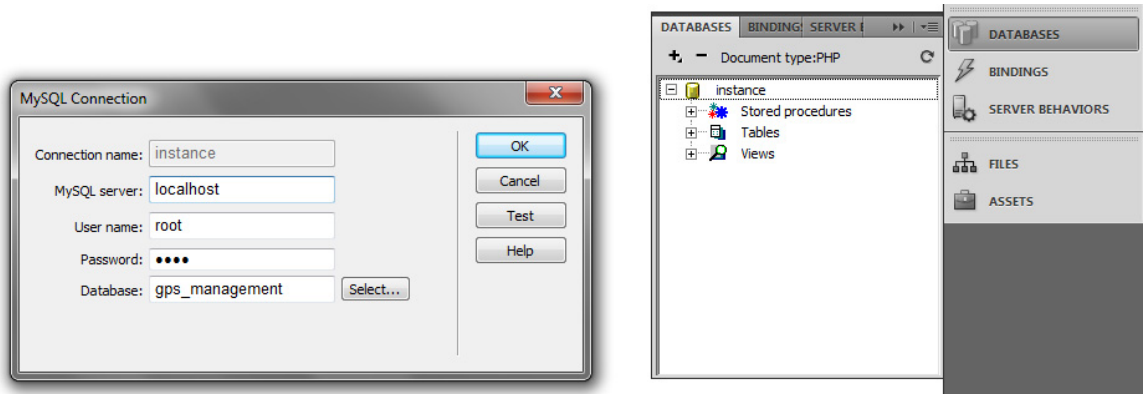
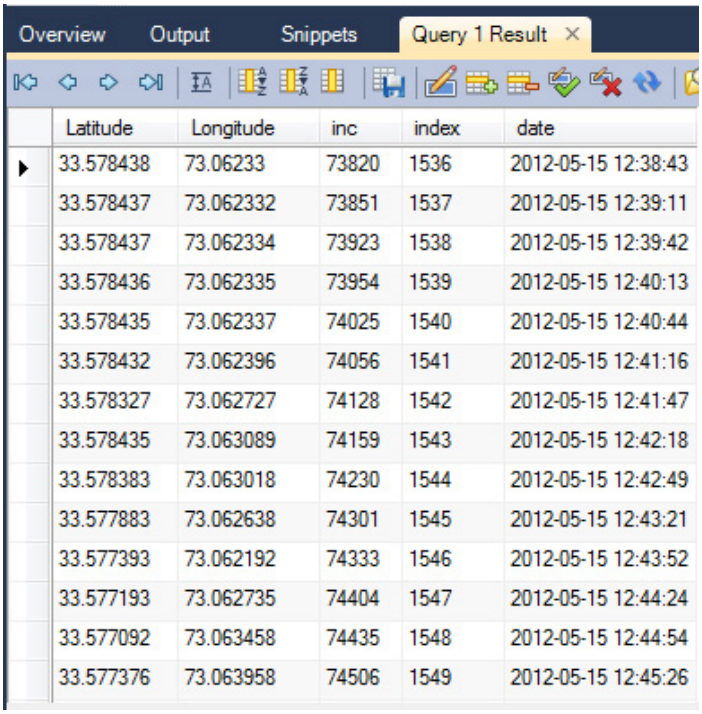


Figure 28: MySQL Connection Inside Dreamweaver

Dreamweaver automatically opens a connection to the MySQL database we had created. Now MySQL database connection "instance" became callable in Dreamweaver. This allowed us to create a server behavior element which executes a MySQL query "INSERT" record whenever POST method is executed on the HTML Form.

A table was created in MySQL named “sim1”, to store coordinates from tracker number 1. It contains five columns, index, latitude, longitude, inc and date/time. The server behavior element in Dreamweaver was given “sim1” table as target table in the “gps_management” database through database connection “instance”. Each text field had been linked with its corresponding column in MySQL table. When the POST method was called, values in the text field were automatically inserted into the table via the INSERT record query. The SIM 1 table is shown in Figure 29.



Latitude	Longitude	inc	index	date
33.578438	73.06233	73820	1536	2012-05-15 12:38:43
33.578437	73.062332	73851	1537	2012-05-15 12:39:11
33.578437	73.062334	73923	1538	2012-05-15 12:39:42
33.578436	73.062335	73954	1539	2012-05-15 12:40:13
33.578435	73.062337	74025	1540	2012-05-15 12:40:44
33.578432	73.062396	74056	1541	2012-05-15 12:41:16
33.578327	73.062727	74128	1542	2012-05-15 12:41:47
33.578435	73.063089	74159	1543	2012-05-15 12:42:18
33.578383	73.063018	74230	1544	2012-05-15 12:42:49
33.577883	73.062638	74301	1545	2012-05-15 12:43:21
33.577393	73.062192	74333	1546	2012-05-15 12:43:52
33.577193	73.062735	74404	1547	2012-05-15 12:44:24
33.577092	73.063458	74435	1548	2012-05-15 12:44:54
33.577376	73.063958	74506	1549	2012-05-15 12:45:26

Figure 29: SIM1 Table in MySQL to save Coordinates

The INSERT record server behavior is shown in Figure 30.

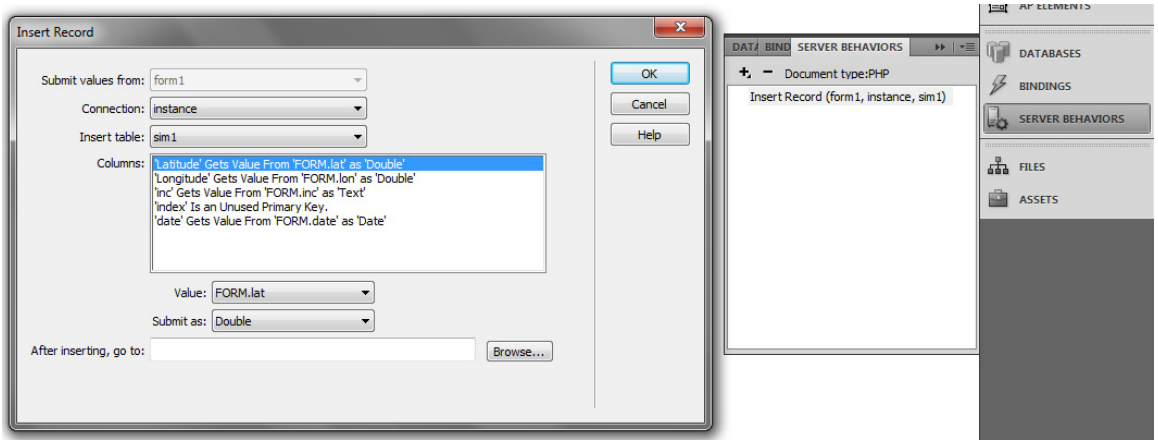


Figure 30: INSERT Record Server Behavior in Dreamweaver

Numerous other functions are inserted in the website to develop an entry level management system. A login page restricts users from accessing the website. Admin level user has numerous functions such as creating, modifying and removing another user privileges to access the website. Normal users can only view the web pages but don't have the authority to alter permissions. After giving restrictions from WAMP server's APACHE configuration file to allow access only to login page, when the domain name is requested, the user is redirected to login page.

3.3.4. Google map API

The core server side functionality in any vehicle tracking system is the ability to display the location of the vehicle on a map. We chose Google's Google Map API service for this purpose. GMap API is easy to interface with MySQL tables and the API itself is written in JavaScript which is a simple and an easy language.

The methodology of integrating Google Map API in a website is simple. A script tag indicates the beginning and ending of JavaScript. The API offers integrating with MySQL tables through various methods; the one we used involves the use of XML

markers. Basically, each row from MySQL table is retrieved once the connection to the database is opened from the webpage using the same address parameters of locahost:3306. This row contains latitude and longitude. Each value from this row is passed onto XML markers in an array form.

```
// Iterate through the rows, printing XML nodes for each
while ($row = @mysql_fetch_assoc($result)){
  // ADD TO XML DOCUMENT NODE
  echo '<marker ';
  echo 'lat="' . $row['Latitude'] . '" ';
  echo 'lng="' . $row['Longitude'] . '" ';
  echo '/>';
}
```

Figure 31: Storing Coordinates from MySQL table inXML Markers format

There are two web pages to implement this logic. The primary web page contains the JavaScript container code for Google Map API. This requires latitude and longitude in XML markers form. The secondary webpage, which is loaded through the on Load function in the primary page, is responsible for opening the connection to database, retrieving the coordinates and storing them in XML markers form. These markers are passed to the primary page which then iterates through the array and one by one, plots marker icons on the Google map, according to the value of latitude and longitude.

```
// Change this depending on the name of your PHP file
downloadUrl("phpsqlajax_genxml.php", function(data) {
  var xml = data.responseXML;
  var markers = xml.documentElement.getElementsByTagName("marker");
  for (var i = 0; i < markers.length; i++) {
    var point = new google.maps.LatLng(
        parseFloat(markers[i].getAttribute("lat")),
        parseFloat(markers[i].getAttribute("lng")));
    var marker = new google.maps.Marker({
      //marker.image = "http://google-maps-icons.googlecode.com/files/car.png";
      map: map,
      position: point,
       });
    bindInfoWindow(marker, map, infoWindow);
  }
});
}
```

Figure 32: Plotting XML Markers on Google Map

The user only has to request the primary webpage. This performs the function of accessing the MySQL table, retrieving of coordinates and plotting of coordinates on the map. The webpage is given a META refresh tag of 40 seconds. This makes the web page refresh its coordinates every 40 seconds and so real time plotting and locating of the vehicle was achieved. This Web page is shown in Figure 33.

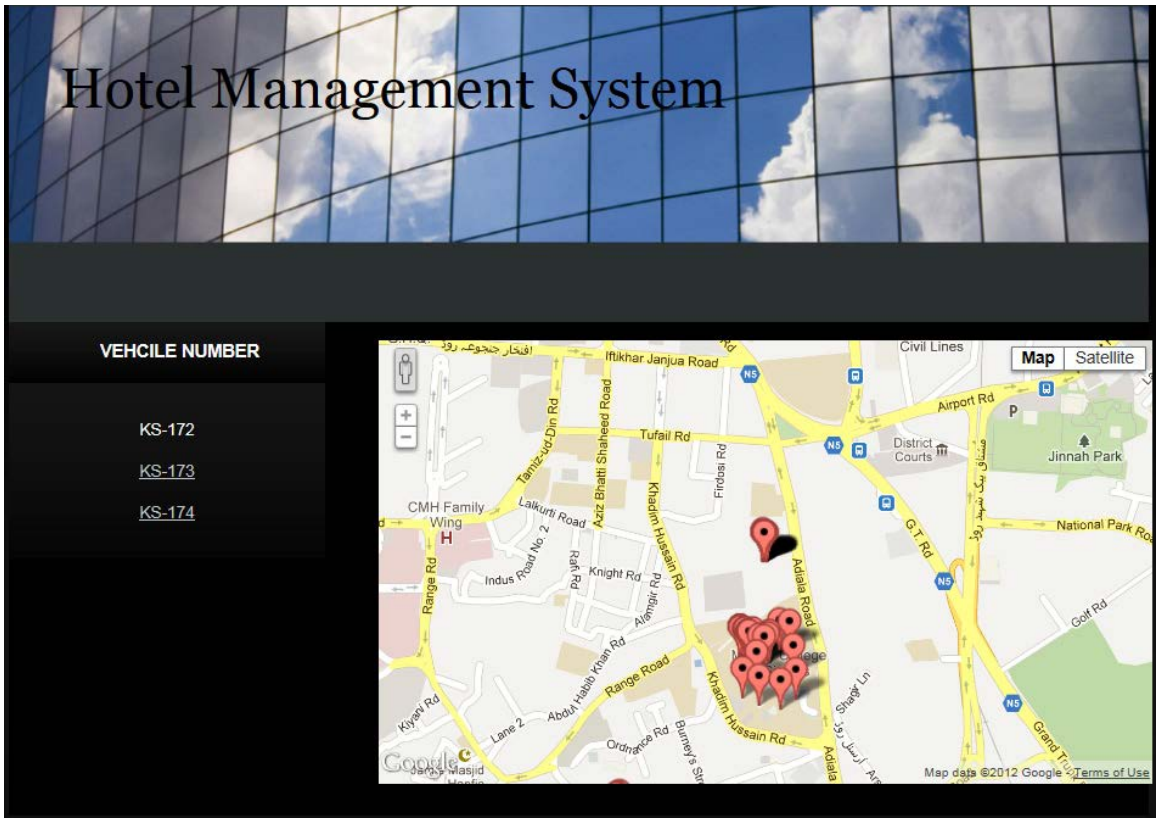


Figure 33: Google Map Integrated in Website

3.3.5. JAVA Script Control Function

The RFIDreader once powered on and given the read command continuously transmits tag IDs of tags within range. The requirement was to develop a GUI with some control function to extract incoming data from the reader in real time. JAVA language on Net beans IDE was used. It comes with a library “swing” which offers drag and drop functionality to create quick and effective GUIs.

In Net beans, first a package was defined. Two classes were created, one containing the GUI code and was assigned the parent main function, and the other containing the control function to extract incoming packets and observe which tag had been detected. JAVA has

libraries which offer support for packet handling through either Ethernet or Wi-Fi. JnetPcap is a similarlibrary which makes use of WinPcap driver. WinPcap is a driver which offers packet capturing functions.

In the control function, initially, the JnetPcaplibray is used to find all available TCP/IP interfaces. There are a few parameters in the library on whose values depends what mode we are running for packet capturing. To capture all packets without truncation, the JAVA driver is run in promiscuous mode. One the parameters for this mode are declared, an open device command is used to establish packet capturing on the specified interface.

Wireshark software was used to understand the structure of IP packet sent by the RFID reader. Apart from the standard TCP, IP and Ethernet headers, payload header size was 19 bytes. The complete tag ID was included in these 19 bytes. So in order to extract the tag ID from the captured packet in JAVA, a packet handler routine was initiated, which is called every time a packet is captured. In this routine, the packet's payload is separated from other headers and then converted into string format. Subsequently, substring commands are used to separate the tag ID from the payload by giving the starting and ending point of the ID within the payload string as offsets in the substring commands.

In the prototype model, we have made use of 4 RFID Tags that were available to us. By reading tag IDs from the RFID reader's own software, we initialized string constructors in JAVA equal to these IDs. So when the string is extracted from the payload, it is matched to each of these four string variables. Whichever comparison results in True, JAVA declares that particular tag to be found (located in the vicinity of the reader).

3.3.6. JAVA Script GUI

The next step was to develop a GUI which will display the tag on screen, if it is found by the control function. The drag and drop features allowed for us to put up a background image of a 3D room. 4 labels, including 3 for personnel (Person A, Person B and Person C) and one for a single Asset were put inside the room. These labels belong to JLabel class of swing library and have an inherent property that their visibility can be toggled on and off.

The labels were declared as public objects in the GUI and so were callable in the main function. In the IF ELSE statements when the control function was matching the received string with the predefined tag ID strings, upon matching, the corresponding tag's label in the GUI was called through its public object and its visibility property was set to True (initially being False). Therefore, when a tag ID has been found after capturing a packet send from the RFID reader, the equivalent label identifying the tag on-screen becomes visible, thereby allowing for the user to indentify which tag is in the vicinity of the antenna. Due to the limitation of avaibility of one RFID reader only, the GUI developed could only work for single room prototype simulation. The developed GUI is shown in Figure 34.

Figure 34: GUI Displaying Multiple Tag Locations

A bottleneck in passive RFID systems is that they don't offer anti collision algorithms with the effectiveness found in Active RFID systems. Also, active systems have the capability to read multiple tags at the same time. This is generally not the case with passive systems. So, at any given moment, the packet in the pipeline would enable the GUI to display only one tag's label on-screen. This would cause flickering for other tags in the read range. To overcome, this problem, JAVA's timer library was used. Whenever a tag was found, its timer was initiated with 3 seconds countdown. If the same tag is detected within 3 seconds, the timer is reset. If the timer expires, then its timer routine method is called. In this method, the public object of the tag's label is called and its

visibility is set to false. This indicates that the tag has moved out of the range of the reader.

A few managerial functions were implemented in the GUI, such as restricting unauthorized personnel access to the prototype room, or indication of asset missing. This is implemented easily, such as when tag number X is detected; an alarm is shown on-screen for the observer to be notified immediately of unauthorized access to the room. Also, when the asset is removed from the reader's vicinity, if its countdown timer expires, an alarm will be generated to show on-screen possible dislocation of the asset. This allows for the observer to identify missing equipment at the same time, preventing loss or theft of expensive assets.

Figure 35: RFID GUI – Unauthorized Entry

4. Equipment used

4.1. Hardware

4.1.1. SIM548c module

The SIM548c (Figure 36) GSM/GPRS and GPS module was used in our outdoor tracking unit because it is integrated with GPRS and GPS services, both of which we required for our project.

SIM548C module is a Quad-Band GSM/GPRS enabled, compact plug-in module. It is also equipped with GPS functionality for real-time satellite navigation.

Figure 36: Sim 548C Module

With dimensions of 55mm*33mm*8.2mm, shown in Figure 1, SIM548C offers a practically compact solution to our outdoor tracking unit. The interface between the module and our tracking unit is a 60-pin connector, on top of which the module is mounted.

The Schematic of the SIM548c module to operate it is shown in Figure 2.

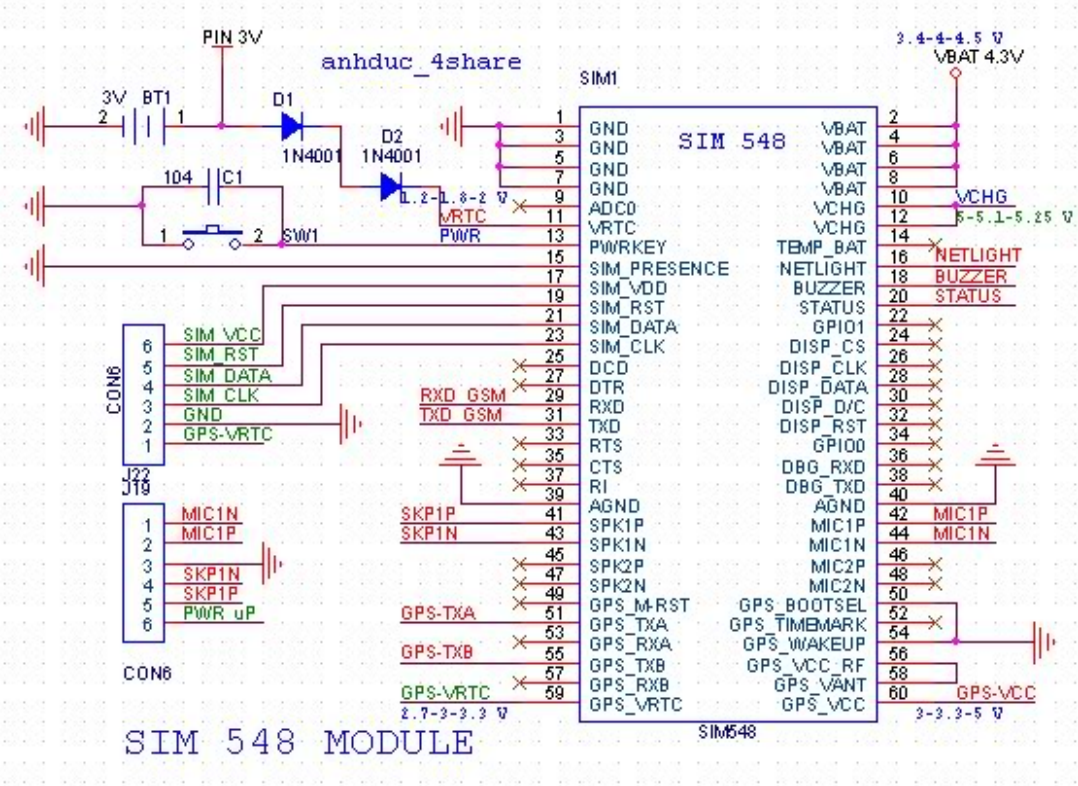


Figure 37: Sim 548C Schematic

The pin outs of the module along with their description, is given in Table 1.

Table 2:Pin outs of SIM548c and their description

Pin Number	Pin Name	Description
2,4,6,8	VBAT	Dedicated to connect the supply voltage, 3.4V…4.5V
11	VRTC	RTC current input from the backup battery when the VBAT is not supplied for the system, 1.2V….2.0V
10,12	VCHG	Voltage input for the charge circuit, 1.1*VBAT….5.25V
60	GPS-VCC	Power supply for GPS whole part, 3V….5.0V
29	GSM RXD	Receive GSM data
31	GSM TXD	Transmit GSM data
51	GPS-TXA	Serial data output for port A

The module has three interfaces:

a) GPS Application Interface

A high performance GPS receiver has been integrated to offer GPS functionality; it continuously tracks all satellites in view and provides accurate satellite position data.

The GPS signal detected by the antenna is amplified, filtered and converted to an intermediate frequency (IF). It is then converted to a digital IF signal by the A/D converter. The digital signal is then passed to the baseband section. The on-board processor runs an algorithm that calculates the position, velocity and time. The calculations, termed as navigation solution, can be transformed into the desired coordinate system. The data of the navigation solution is available at the GPS UART. The GPS module has the following specifications,

i. Autonomous position accuracy: <10m
ii. Update rate: Default 1Hz.
iii. Max. Altitude: <60.000 ft
iv. Max. Velocity: <1.000 knots
v. Protocol: Default NMEA, 4800bps

b) GSM/GPRS application interface

We have utilized the GPRS functionality of the module in our project. AT commands are used for setting up, transmitting and receiving data and teardown of the GPRS connection. We have utilized the GPRS services of UfoneTelecommunication Company.

c) Antenna Interface

A dual antenna, supporting both GSM and GPS, has been used with the SIM548c. The antenna is the most critical item for successful GPS reception in a weak signal environment. Proper placement of the antenna ensures that satellites at all elevations can be seen, and therefore, accurate fix measurements are obtained.

4.1.2. Microcontroller

Microcontroller is the CPU of our outdoor tracking unit. It is responsible for getting the raw data from the GPS part of the SIM548c, looking out for the part where the coordinates are placed, then extracting the coordinates and sending them through the GPRS part of the module, to a web server. To achieve all of this, we have used AT89c52 microcontroller.

The AT89C52 is a low-power, high-performance CMOS 8-bit microcomputer with 8KB of Flash Erasable and Programmable Read Only Memory (EPROM). The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C52 is a powerful microcontroller which provides a very flexible and cost-effective solution to many embedded control applications. There are various high-level programming language compilers for the 8051. The compiler used by us for programming the microcontroller is KeiluVision 4.

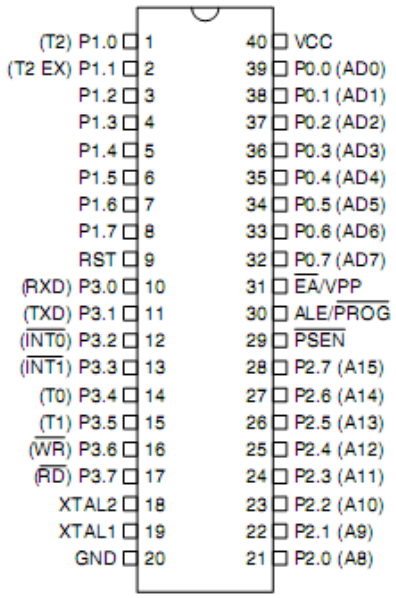


Figure 38: 89c52 Pin outs

The basic pins, depicted in Figure 3 are listed below along with their specific purpose,

a) Pin 31 & 40 are connected to 5V supply whereas pin 20 is grounded

b) Crystal oscillator of 11.0592MHz is connected between pin 18 & 19, along with two stabilizing capacitors of 33pF. The 8051 uses the crystal to synchronize it's operation as it needs an external oscillator that decides it's operating frequency

c) Pin 10 (RXD) & 11(TXD) are connected to GPS TXA and the GSM RXD of the SIM548c module respectively.

d) Pin 25 is used to control the switching of the relay, which is used to switch on or off the GSM part of the SIM548c module.

e) A reset circuit is connected to pin 9. Initial charging of the capacitor makes RST high, and blocks DC when it is fully charged.

4.1.3. Power Supply ICs

Since the outdoor tracking unit is needed to be installed in a vehicle, so we needed to design the power circuit of our unit so that it could be powered up with a vehicle's battery. For that, we used regulator ICs.

a) 7805 regulator

This IC regulates the supply voltage to a steady +5 volts. We require this regulator to provide a 5 volt supply to the microcontroller.

b) LF33CV

This regulator IC regulates the supply voltage to a steady 3.3 volts (as indicated in the name). We have used this IC to power the GPS part of the SIM548c module, since it requires approximately 3.3 volts.

c) LM317T

LM317T is an adjustable 3-terminal positive voltage regulator, designed to supply more than 1.5 amperes of load current with an output voltage adjustable from 1.2 volts to 37 volts. A variable resistor is used along with the IC to adjust the output voltage.

We used a 3k pot to achieve an output voltage of around 4.1 volts. This voltage is supplied to power the GSM/GPRS part of the SIM548c module. Since a very high current requirement is there (3Amps), so a heat sink is also placed along with the LM317 IC to avoid the IC's temperature rise to dangerous levels.

4.1.4. Voltage Inverter

In the testing stage of our outdoor unit, we connected a 500W inverter to a car's battery, which converted the 12VDC to 220VAC. From there, we powered the unit by connecting its adapter to the inverter.

4.1.5. RFID reader

In order to develop our indoor tracking system, we used passive RFID technology. We have used RFID reader manufactured by a Chinese company Invengo. Figure 4 shows the RFID reader used in our project.

Figure 39: Invengo RFID reader XCRF-804

This is a passive RFID reader; model number XCRF-804, working in 900MHz range. Salient features of the reader include:

a) RF air protocol: EPCglobal Class 1 Gen 2; ISO18000-6C

b) Operating frequency: 902-928 MHz

c) Modulation: PR-ASK

d) Up to 4 SMA type Antenna ports

e) Communication interface: RS-232 and 10/100 Ethernet\

f) Read distance: up to 10 feet

g) Read rate: up to 120 passive tags per second

h) Output power: adjustable between 20-30 dBm

The RFID reader comes with proprietary software which is used to control various device parameters and displays the IDs of the received RFID tags.

RFID tags

RFID tags, which were also provided along with the reader, were used to track assets and personnel. These are stick-on tags containing an RFID micro-chip and a micro-strip antenna. Since there is no battery onboard the tags, so the tag ID would only be detected once it comes within the read range of the RFID UHF antenna. For tracking personnel, the tags were attached to their Hotel ID cards. On assets, the tags were attached in such a way that they could easily be detected by the antenna once in its vicinity, as well as be hidden from sight.

RFID antenna

For detecting the RFID tags, we have used the antenna; model number XCAF-11L, which also works in the UHF range. This antenna is an essential operational component in reader-tag communications, meeting the needs of a near-field RFID system requirement. Figure 5 shows the RFID antenna used in our project.

Figure 40: RFID UHF Antenna XCAF-11L

Certain features of the antenna include:

a) 902-928 MHz operating frequency

b) Center frequency: 915 MHz

c) Circular polarization, for providing exceptional performance in situations where tag orientation to the reader cannot be controlled.

d) 5.8 dBi gain

e) Manageable dimensions: 150*150*5 mm

f) SMA type connector

g) Beamwidth: 50°(E) / 50°(H)

h) Impedance: 50 ohms

4.1.6. Wi-tribe device

Wi-tribe device was used to provide internet connection so that the web server could go online and the extracted GPS co-ordinates could be quickly and easily polled to the website. We got a 1Mbps internet connection to fulfill our requirement.

4.1.7. Wi-Fi router

A wifi router was required to provide wireless internet connection to the server machine. The RFID reader was connected to the server through the Ethernet cable, so the only feasible option to provide internet connection to the server was to use a wifi router, connected to the wi-tribe device.

4.2. Software

4.2.1. Proteus

For simulation and testing of our circuits, we used Lab Center's Proteus. This was done before actually implementing the hardware. In our test circuit, we added serial ports for interfacing with the computer. The COM port in Proteus simulates the working of the computer's Communication port. The data being serially transmitted and received was displayed through the virtual terminal provided in Proteus. The microcontroller codes were tested using Proteus before actually burning them in the microcontroller.

4.2.2. KeiluVision 4

The programming of the microcontroller 89c52 has totally been carried out in C compiler KeiluVision 4. The code of each module was individually constructed. The code for extracting the GPS co-ordinates from the sim548c was constructed.Next, the code for establishing a GPRS connection and polling the extracted co-ordinates through GPRS, directly to the web application was contructed.

4.2.3. Hyper terminal

HyperTerminal performs the functions of communication and terminal emulation. It makes use of serial ports and the controls associated with external devices. The connections provided by HyperTerminal make it easy to retrieve data from these devices, as well as be able to execute commands to the devices from the main computer system.

HyperTerminal was used for two experimental purposes. The first one being that we wanted to test and explore various AT commands, and then finding the right ones in order to establish a GPRS connection and transmitting the data. Figure 34 shows the various AT commands used in HyperTerminal. The hex-equivalents for various AT commands were also reviewed and then incorporated into the microcontroller code.

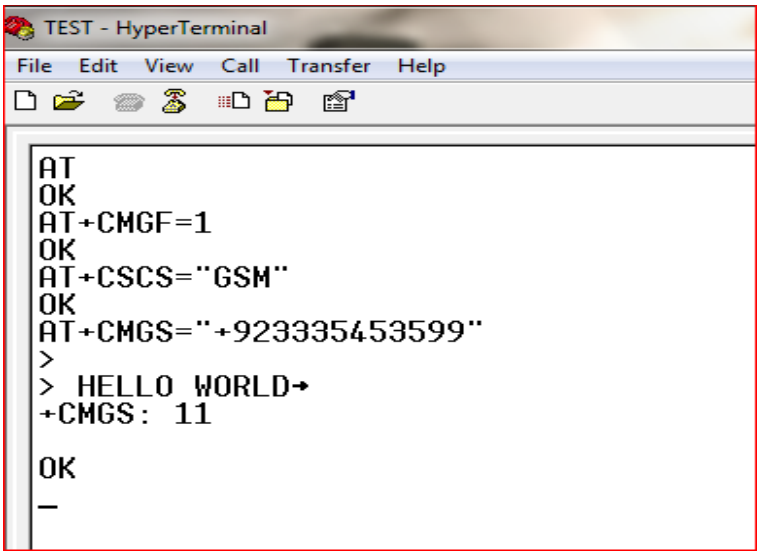


Figure 41: Testing of GSM communication in HyperTerminal

The second purpose of using hyper terminal was to examine the GPS data being received by the sim548c from the GPS antenna. Using hyper terminal, we were able to find out that the GPS co-ordinates along with the date and time are received by the module in the $GPRMC line. This helped us in writing the microcontroller code for extracting the co-ordinates. Using hyper terminal, we could also tell whether the module is synchronized with the satellite or not. Figure 42 shows reception of GPS data in Hyper Terminal.

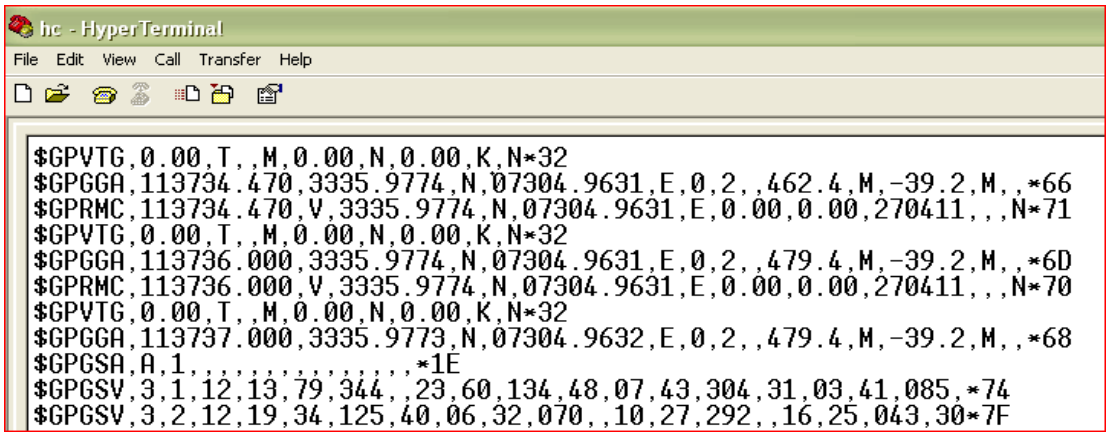


Figure 42: Testing of GPS Module in HyperTerminal

4.2.4. Wampserver

Wampserver was used to develop our web server. Wamp server is easier to operate as compared to other server softwares and it is not expensive too. Wamp server is the combination of different components such as Windows, Apache, MYSQL, PHP server which is available in single package. Due to wamp server, any dynamic website can serve over computer networking system such as internet as well as private network. One of the major benefit of wampserver is that it allowed us to develop, upgrade components, perform any web development task and carefully test everything offline first, which reduced the risks of creating problems on the live server.

4.2.5. MySQL

MySQL is an open-source, database development software. We used MySQL due to many reasons. Firstly, it is open-source, so we could use it for free. It is also highly customizable. It is also possible to easily integrate the MySQL database system to various platforms, such as C++, Java, PHP, python, etc. Due to all the above mentioned reasons and many others, we decided to use MySQL database management system to maintain and manage the location records of all the vehicles in the hotel's vehicle fleet. Various tables in the database are accessed by the PHP service in order to display the position of the vehicle based on the values from the tables.

4.2.6. Adobe Dreamweaver

Adobe Dreamweaver is a web development application, which we used in our project to develop our website. Dreamweaverwas chosen due to many reasons, some of which include easier website management, a wide range of rollover buttons - to avoid manually coding the rollover buttons and the inclusion of many template files which made designing the website simpler for us. Dreamweaver also supports many server side scripting languages, such as ASP, PHP, Scriplet, ColdFusion, etc. PHP scripting was used to develop the website.

4.2.7. RFID reader software

The RFID system that was used in our project came with proprietary software. Using this software, we could control the RFID antenna power from 20dBm to 30dBm; select the tag types that are to be read by the reader and antenna types. It also displays the Ids of all the tags that are detected by the antenna. The tag Ids from this software were imported into netbeans IDE.

4.2.8. Net Beans IDE

Net Beans IDE is an open-source Integrated Development Environment. Net Beans IDE supports the development of all Java application types. The detected RFID tag IDs from the proprietary software were imported to Net Beans IDE where they were shown graphically.

The main reason to use Net Beans IDE instead of any other Java IDE was that it has the swing library pre-installed. Swing is the main Java GUI library. Swing components are completely written in Java language, so they are not dependent on any platform.

5. Analysis

In this project, a working prototype of an integrated electronic management system with two tracking modules was built, which utilizes existing GSM infrastructure and makes use of a compact GPS/GSM enabled device, and which makes use of RFID technology for real time tracking inside buildings.

As explained previously in section 2 Literature review, there are numerous existing management systems which make use of different technologies such as barcode readers, fingerprint recognition systems, authorization control systems etc. There are many vehicle fleet tracking systems in place in today's world. The different technologies each have their pros and cons, and they offer different functions in their own capacity. However, there doesn't exist one single management system which offers equivalent functionality to all of these systems. For example, fingerprint system offers authorization control. Only those personnel can enter the room who are allowed access. But this system doesn't offer capabilities which are provided by CCTV surveillance systems. Also, no real system exists which offers theft prevention since any missing asset from the premises isn't detected until a manual search is carried out. The indoor tracking unit prototype has capabilities which include all of these mentioned and many more. It can provide authorization control, it can provide real time surveillance, it can track and locate the personnel and assets inside the buildingand it can immediately detect the theft or loss of assets within seconds it is removed from its place.

The existing vehicle fleet management systems make use of GPS trackers installed inside the car. Most operate on the basis that when the server end requests the location of the

car, the module responds by transmitting the most recent coordinates back to the user over GSM network, preferably through SMS. The outdoor prototype constantly polls data to the server, which allows for real time plotting and tracking of the vehicle based on its current position. The user can visually track the vehicle through the use of online map services. The tracking is done through GPRS, which allows for fast and efficient polling of coordinates directly to the website.

5.1. Simple and Cost Effective Solution

The outdoor tracking unit has been developed using the simple and easy to use 8052 microcontroller. It provides basic functionality which is enough considering the amount of information we require to be processed on the on board vehicle tracking unit. This microcontroller can communicate effectively with the Sim 548C module via serial interface, and contains enough on board memory to carry out GPRS communication based commands.

The total information exchanged between the module and the server end in one transmission comes out to be roughly 3.2 Kilo bytes of data. The fastest polling time achieved is around 20 seconds. For our prototype, we have inserted some delays and the coordinates are sent every 30 seconds. So, in one minute, a total of 6.4 Kilo bytes are exchanged between the server and module. The GPRS packet data consumption per day, in Mega bytes, by the SIM card in the module comes out to be roughly 9.2 MB. So for continuous polling throughout the month, the total information in MBs handled by the module is 270MB. This is very nominal considering monthly packages offered by different telecom operators which allow for monthly usage of packet data up to even 2

GB in some cases. The running cost for the SIM per month will not be more than 150-200 Rs/- if some package is availed.

5.2. Real time locating system

The system developed is a real time locating system. It means that it provides the server end with the coordinates of the target in real time. The GPS feature in Sim548C module is used for this purpose. The constant reception of coordinates by this part and subsequent relaying of this information to the server end makes the system completely real time. The administrator has the option to modify the transmission time according to his needs. He can allow delays between transmissions up to any number of minutes he likes, or he can reduce it to the bare minimum level of roughly 20 seconds.

The RFID indoor tracking system has excellent data rates which allows for extremely fast processing of tag IDs and updating of tag's location in the server end. This also makes it real time in nature.

5.3. Compact Design and Ease of Install

The tracking module is very small, and can be installed in the vehicle very easily. The dimensions are not bigger than a human hand (Figure 43). This small and compact module offers real time tracking solution for vehicle fleet tracking.

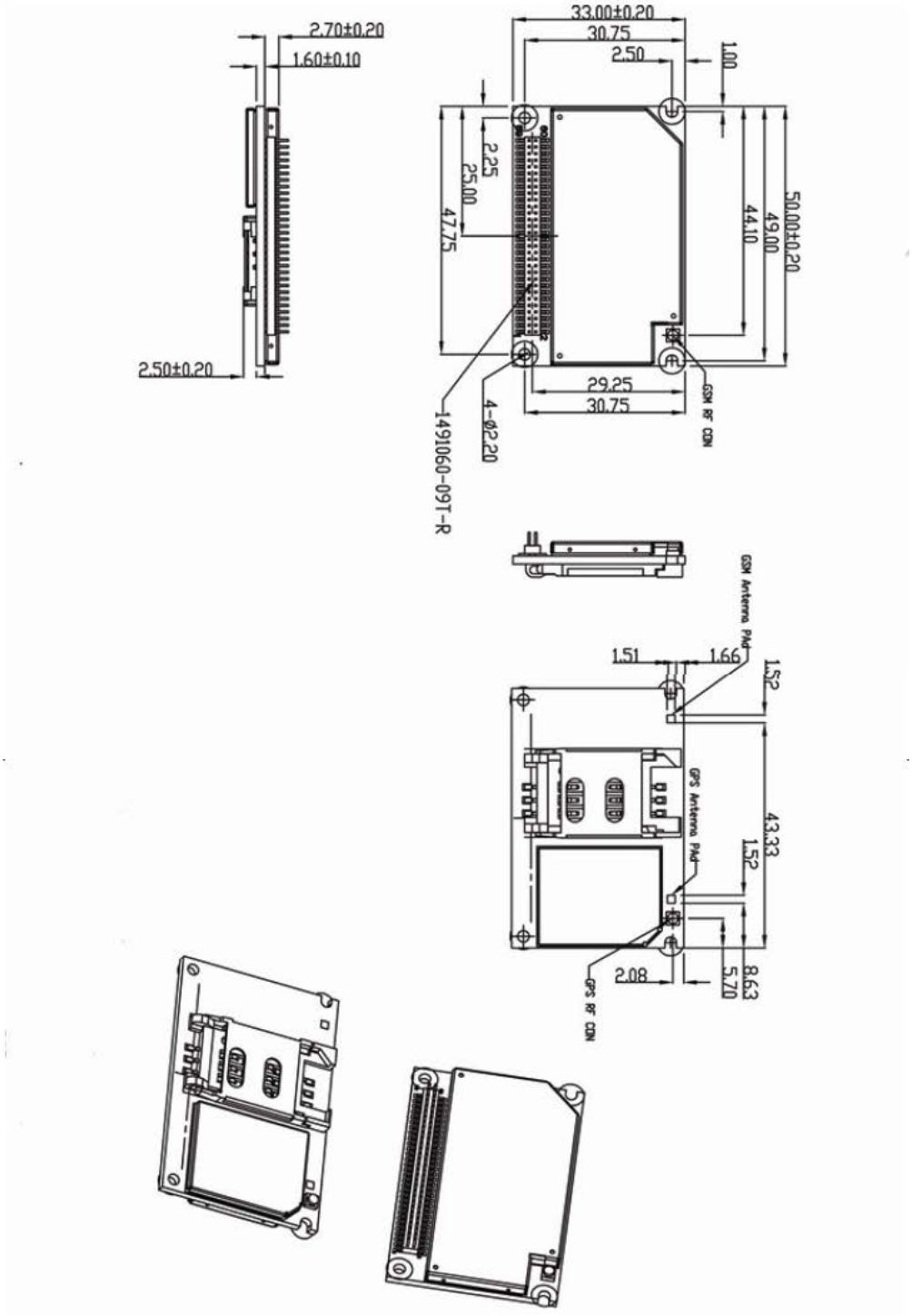


Figure 43: Sim 548C Compact design and dimensions

The RFID readers come with wall mountable attachments which the organization can install easily in appropriate locations within their premises.

5.4. Automated Tracking system

Once both tracking units have been installed, there is no need for intervention by the manager or administrator. The vehicle tracking unit only requires connection with the car's battery and once it is supplied power, it constantly submits the coordinates information to the server end.

The indoor tracking unit, similarly, requires to be switched on only once. Then it monitors any RFID tag within range and sends its ID over Ethernet interface constantly to the server end. No human interaction is required, as the data is automatically retrieved from the incoming packets and sent to the user interface.

5.5. Access control and Theft Prevention

The JAVA GUI can be configured to implement numerous managerial functions. We have implement authorization control and theft prevention. Whenever an unauthorized person comes in the room, its tag ID is picked up by the RFID reader. The JAVA control function has already been configured to identify which tags are not allowed inside the room. An alarm is generated when the tag has been detected, thereby indicating to the observer that an unauthorized person has entered the room.

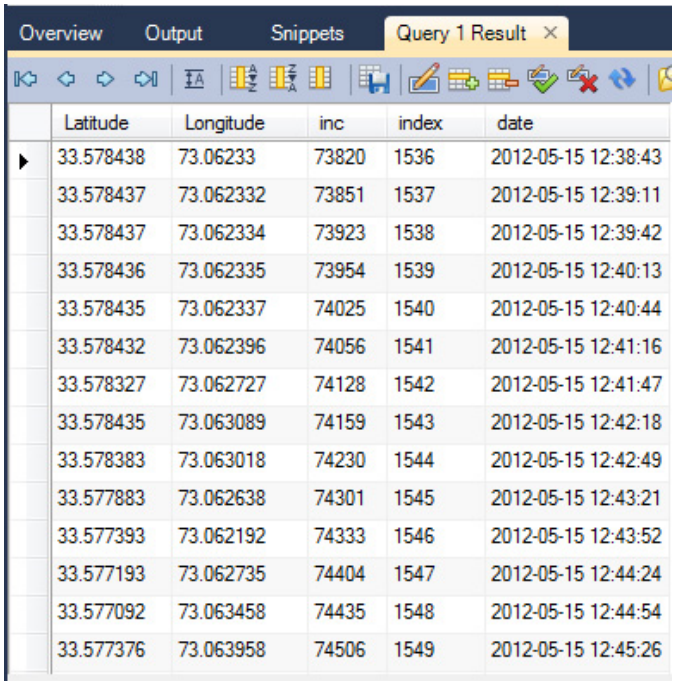
Similarly alarm is generated when the asset to which the RFID tag was attached is removed from the room (goes out of the range of the RFID reader). This is indicative of

two scenarios: either the asset is being stolen or the asset got misplaced. In either case, the observer is informed of the dislocation of the asset and the alarm is a visual alert displayed on screen (Figure 44).

Figure 44: Alarms in RFID GUI

5.6. Efficient Monitoring

The MySQL database is categorically defined for each of the vehicle tracking unit. Each unit's coordinates are sent to the server and stored in separate tables (shown in Figure 45), for ease of access and classification of information.



Latitude	Longitude	inc	index	date
33.578438	73.06233	73820	1536	2012-05-15 12:38:43
33.578437	73.062332	73851	1537	2012-05-15 12:39:11
33.578437	73.062334	73923	1538	2012-05-15 12:39:42
33.578436	73.062335	73954	1539	2012-05-15 12:40:13
33.578435	73.062337	74025	1540	2012-05-15 12:40:44
33.578432	73.062396	74056	1541	2012-05-15 12:41:16
33.578327	73.062727	74128	1542	2012-05-15 12:41:47
33.578435	73.063089	74159	1543	2012-05-15 12:42:18
33.578383	73.063018	74230	1544	2012-05-15 12:42:49
33.577883	73.062638	74301	1545	2012-05-15 12:43:21
33.577393	73.062192	74333	1546	2012-05-15 12:43:52
33.577193	73.062735	74404	1547	2012-05-15 12:44:24
33.577092	73.063458	74435	1548	2012-05-15 12:44:54
33.577376	73.063958	74506	1549	2012-05-15 12:45:26

Figure 45: Systematic coordinate storage in MySQL tables

As is evident, the latitude and longitude are stored in different columns with the time of insertion and time of transmission. The time of insertion is indicated by the date column and the time of transmission is indicated by the inc field in UTC format.

5.7. Ubiquitous Web Interface

An illustrative and interactive web interface not only makes accessing vehicle tracking information more easier, it also makes it ubiquitous in the sense that both the administrator as well as the managers may access the tracking information from anywhere and at any time. The data maintained is both elaborate and current, such that it is updated in real time with every received GPRS packet, containing the coordinates, at the server. Figure 46 shows the main page of the website.

Figure 46: Home Page of HMS

Figure 47 shows the main page of the Outdoor Tracking section.

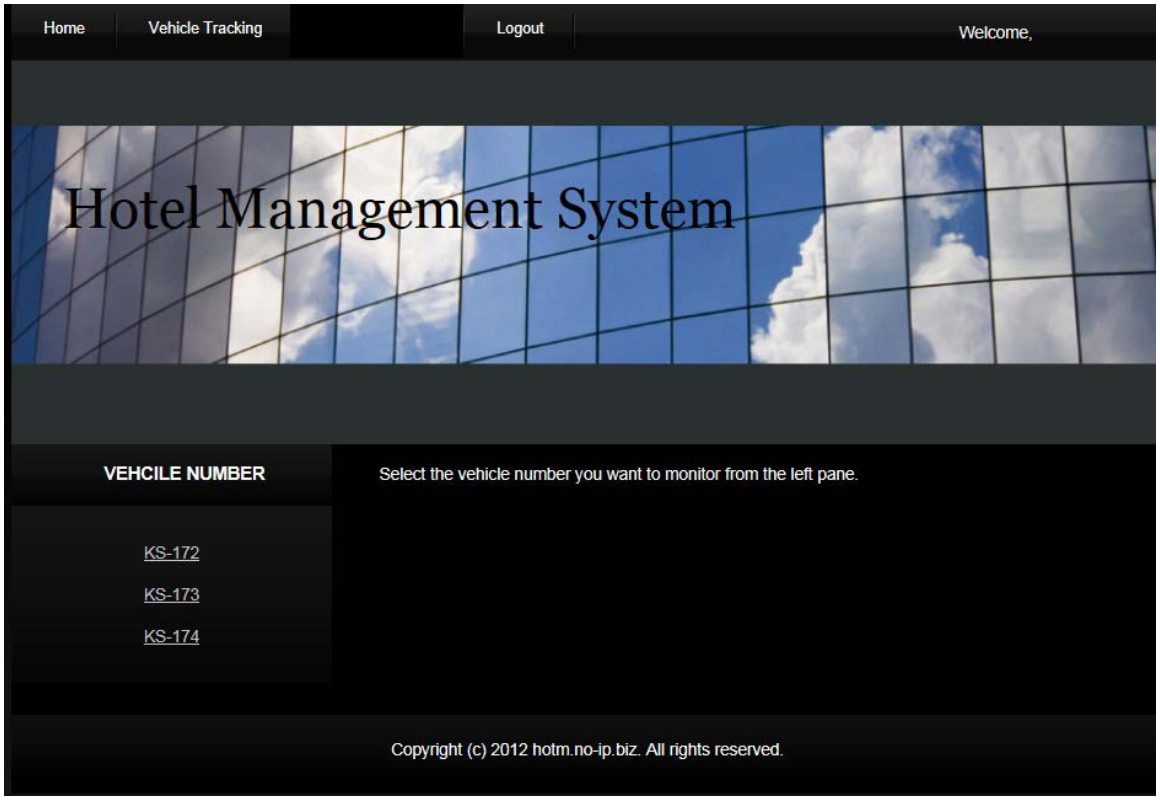


Figure 47: Outdoor tracking section

5.8. Authorized Access to Web Site

The login page is designed to restrict access to the web site. The website can only be accessed by those allowed by the administrator. The non-administrator users can only view vehicle tracking information but cannot create new user privileges or deny user privileges. This allows for secure, multi-tier access to the website inside the organization.

Figure 48: Login Page of HMS

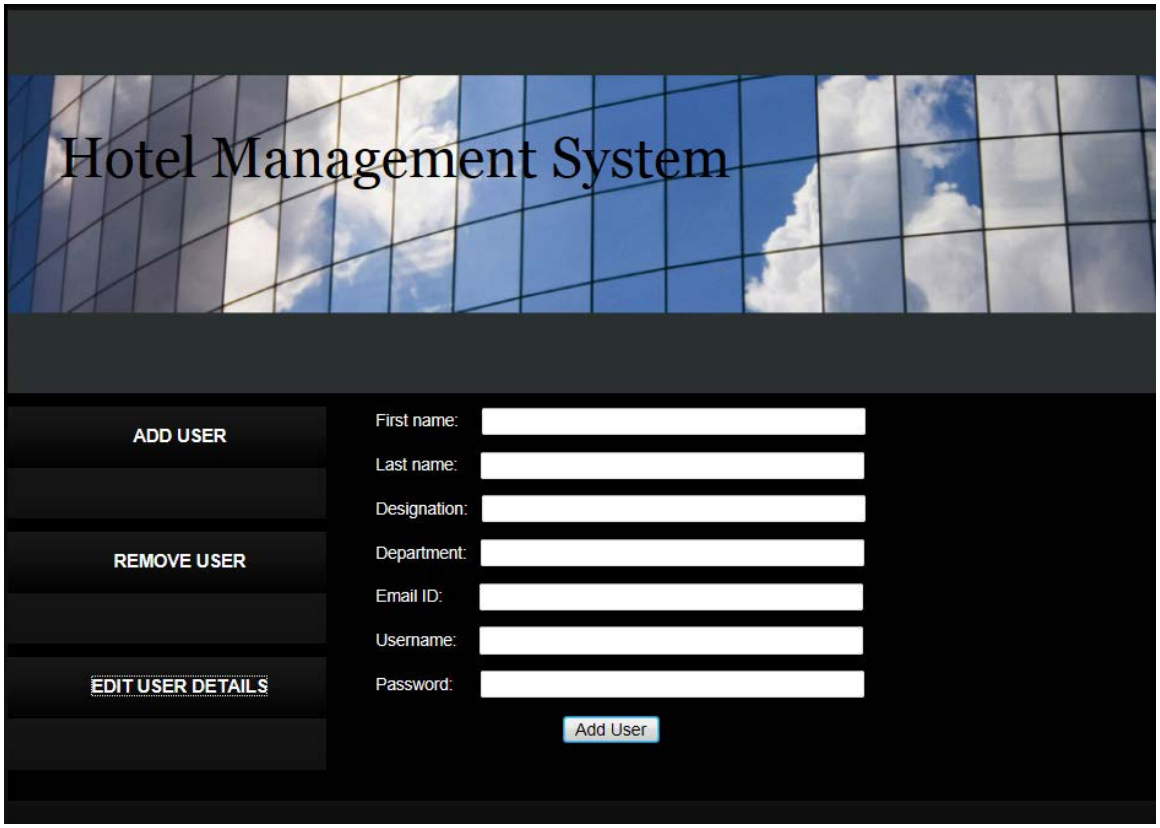


Figure 49: User access privilege control

5.9. Fast and Efficient Polling

The coordinates are sent to the web site very quickly, with very little delay time in between them. The minimum achieved delay is 20 seconds, it can however be set to any amount as per the administrator's directive. The incoming data can be polled directly to the website, only the requirement is to set up a web server. This leads to reduced complexity at server end, as no hardware is required. For example, for SMS communication with the module and server, we would have required installing a GSM modem, usage of GPRS eliminates this need.

6. Future Work

6.1. Constraints

The objective of developing a prototype for Hotel Management System (GPS/GSM/GPRS Tracking module for vehicles, RFID based tracking of personnel and assets, profiling and reporting system has been successfully achieved, along with a number of additional features that add to the efficiency of the system). Nevertheless, the devised prototype has some constraints, which if overcome would lead to even better and improved performance by the system.

6.1.1. GPRS Coverage

The communication between vehicle tracking module and backend server is done on GPRS. As long as vehicle remains in the coverage area of cellular service provider tracker keeps on polling, but the moment it is out of coverage area its communication between the tracker and server breaks down. Beside the coverage area problem, there are some coverage sites where GPRS service is not available this is also a potential constraint.

6.1.2. Active Vs Passive

For real time locating system Active RFID tags and readers are used, because they have higher range, higher data rate and large tag reading rate as compared to Passive RFID tags and Reader. Due to lack of funding we could not able to get the Active RFID tags and readers, we borrowed the Passive RFID Tags and a reader to provide the proof of concept of indoor tracking through RFID technology.

6.1.3. RFID an expensive tracking solution

We have used RFID technology for indoor tracking which is an expensive choice for any type of organization. It is expensive because it is a newer technology then other used for these purposes. As this RFID technology will get common with time, it will get cheaper. Still our solution is for large scale organization.

6.2. Improvements

Owing to the constraints present in the prototype, the future work would require improvements in the prototype that would overcome the constraints discussed above, that might be faced when the system is considered for mass implementation. These improvements will include enhancing the hardware and adding more features that would add to the efficiency of the system.

6.2.1. Introducing Geo-Fencing

The geo-fencing feature can be introduced in our vehicle tracking unit which will ensure that each vehicle follows the route designated by the management. Management can define allowed and not allowed zones by putting virtual fences. System can generate notification or alarm/alert when the vehicle leaves the allowed zone and when the vehicle enters the not allowed zone.

6.2.2. Introducing Dual SIM

The dual SIM feature can be introduced in our tracking module which would ensure that communication link between the tracker and the server is maintained at all times. This

can be achieved by switching from the primary service provider to the secondary service provider when vehicle goes out of the coverage area of the primary service provider.

6.2.3. Introducing Memory Card

Memory card can be introduced in our tracking module which will keep storing the location information of the vehicle when it is out of the coverage area of service provider. When the vehicle tracker gets back into the coverage area of the service provider, the stored location information is transmitted to the server.

6.2.4. Compacting the tracker circuit

The vehicle tracker module can be made more compact by using a multi-layer PCB and QFN (Quad Flat No-leads) package micro-controller. This will enable us to install our tracker module at places inside the vehicle concealed from its passengers.

6.2.5. Using Active RFID System

For developing a practical solution for real time locating system inside the premises, active RFID technology can be used instead of passive technology. One of the main reasons for using active RFID technology is that its range is much higher than the passive counter-part (80m-100m as compare to 4-5m). Other reasons include higher data rates, tag reading rate and the antenna's reading capability is independent of tag orientation towards it.

6.3. Commercial Implementation

The project developed is a prototype, which can be implemented commercially, after making some required modifications to make the system fit for mass implementation. These considerations have been listed below.

6.3.1. Multiple Outdoor units installed in different Vehicles

For the demonstration, one tracker was developed with a home web server for communication. When developing the system on a large scale, for example, for more than 50 vehicles, the web server would have to be developed on an independent dedicated system with multiple instances of the server running to handle the inflow of data.

6.3.2. Database Expansion

The database currently contains a few tables to handle login credentials and inflow of coordinate data from a single tracker. When designing on a large scale, the database will have to be designed categorically and made more efficient to handle large amounts of data.

6.3.3. Ethernet infrastructure for connecting multiple RFIDs with the server

When installing multiple RFID readers throughout the premises, an Ethernet infrastructure would have to be placed in order to provide connectivity with all the readers. For this purpose, multiple routers, switches can be used. To save space inside the building, the system can be switched to readers with Wi-Fi capability, thereby eliminating the need to lay down Ethernet wires and use of switches.

7. Conclusion

The project is a step towards developing comprehensive electronic management systems for large scale organizations. A complete working prototype has been developed which demonstrates the effectiveness of an integrated management system employing the use of real time tracking and locating. It relies on the existing GSM infrastructure which has been implemented on a very large scale thereby making the devices work effectively almost everywhere. The tracking unit is easy to install and produce with minimal costs to the developer. Very basic training is required for proper usage of the system.

The system developed is efficient and provides robust communication between all the developed modules. It is effective in all environments and is reliable. It has the capability to be expanded into a management system with many functions, which can be tailored to suit the organization's needs, thereby making the system very flexible. Also, the system can have a lot more devices connected to it, making it scalable in size. It is aimed at large scale organizations, equipping them with technology dependant managerial functions which will lead to a competitive market and eventually, innovation towards more efficient and technology driven automated management systems.

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9. Glossary

Radio Frequency Identification (RFID)

This technology is a means of identifying a person or object using a radio frequency transmission. It can be used to identify, track, sort or detect a wide variety of objects. Communication takes place between a reader (interrogator) and a transponder (Silicon Chip connected to an antenna) often called a tag.

Hotel Management System (HMS)

A system that keeps track of hotel assets, vehicles and personnel, records and analyses their movements.

Global Positioning System (GPS)

Aspace-based global navigation satellite system (GNSS) that provides location and time information in all weather, anywhere on or near the Earth

Global System for Mobiles (GSM)

A standard set developed by the European Telecommunications Standards Institute (ETSI) to describe technologies for second generation (or "2G") digital cellular networks.

MySQL

It is a relational database management system (RDBMS) that runs as a server providing multi-user access to a number of databases. The SQL phrase stands for Structured Query Language.

Hypertext Preprocessor(PHP)

A general-purpose scripting language originally designed for web development to produce dynamic web pages.

Real time system

A real-time system is one that processes information and produce a response within a specified time

Polling

To trigger a response from a client or a terminal

Remote control

A feature that enables server to wirelessly operate or manipulate the working of a device

Electrical grid

An electrical grid is an interconnected network for delivering electricity from suppliers to consumers.

Signal-to-noise ratio

Ratio that compares the level of a desired signal to the level of background noise

Attenuation

A general term that refers to any reduction in the strength of a signal

routing protocols

Ultra High Frequency (UHF)

The mode of communication for wireless technology

Wi-Fi

A wireless standard for connecting electronic devices

Interrupt service routine *(*ISR*)*

A software routine that hardware invokes in response to an interrupt

Serial Data Buffer (SBUF)

A buffer that stores the data that is to be transmitted, or data that has been received serially.

Web Server

It can refer to either the hardware (the computer) or the software (the computer application) that helps to deliver Web content that can be accessed through the Internet.

Centralized Data

A Centralized database is a database located and maintained in one location, unlike a distributed database. All data is located in one place.

Circuit Switched Data (CSD)

It is the original form of data transmission developed for the time division multiple access (TDMA)-based cellular network systems like GSM. CSD uses a single radio time slot and deliver 9.6 k bit/s data rate to the GSM Network user.

Google Map API

The developer of Google Map allowed developers to integrate Google Maps into their websites. By using the Google Maps API, it is possible to embed Google Maps site into an external website, on to which site specific data can be overlaid.

General Packet Radio Service(GPRS)

GPRS is a non-voice packet based communication service for mobile devices that allows data to be sent and received across the existing TDMA networks. It is a step towards 3G and is an upgrade to 2.5G.

Control Function

It is an operation that does the recording, processing, transmission, or interpretation of data.

Transmission Control Protocol and Internet Protocol(TCP/IP)

It is the set of communications protocols used for the Internet and similar networks, and generally the most popular protocol stack for wide area networks.