

# GPS/GSM based Vehicle Tracking System

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## ABSTRACT

Quality of life of people in India is demeaning with the growing traffic congestion. Congestion leads to air pollution, decrease in accessibility and increased travel time. System and technology is growing even in microseconds. GPS is mounting its reputation in day to day life applications. With increasing use of smart phones and growing popularity of the GPS based applications, it has become feasible for the commuter to track the real time position of the vehicle and make better travelling decision. This paper aims to build the client server android based application for the efficient vehicle tracking.

## Keywords

GPS, GSM, Android SDK, Tracking system, Google Maps, Passenger information system

## 1. INTRODUCTION

Various uncertain conditions in the daily operation of public transportation systems, affects the movement of vehicles as the day progresses. Traffic congestion, uncertainty in passenger demand, uneven vehicle-dispatching times, unexpected delays and incidents are the major reasons for the passengers to reach office late. Many commuters are late to their respective errands because they are unable to decide whether to wait for the bus or take an alternative. LED screens at bus stops showing the bus arrival time help reduce the apprehension of passengers waiting for the bus. Interfaces such as smart phone could make public conveyance system more user-friendly by disseminating arrival time information of the bus and thus increases its effectiveness among various transportation modes [7].

The current location and estimated arrival time of the vehicle is provided to the passenger by the vehicle tracking system. In relation to the estimated arrival time the passengers can decide whether to wait for the vehicle or not. This helps in making better travelling decisions by the passengers. From this system it can also be determined whether the vehicle is yet to come or has been missed. To make life more efficient the system provides necessary basic information.

For enhancing public transport, it has to be made more reliable for which various concepts have been suggested. Intelligent transport systems are developed to make transportation easier and comfortable. Intelligent Transport system is route that is tested to mitigate traffic congestion models. There are various concepts that are included in it. Some of them are providing the travelers with the reliable information like real time passenger information system, pre-trip information systems, automatic vehicle location system, vehicle arrival notifications, timed transfers and determining priority of road to vehicle at intersections. Other concepts are about providing comfort, improving stops and number of passenger information systems.

By providing the information of the arrival time of the transit vehicle, Global Positioning System (GPS), Wireless communication systems and other systems have made public

transport in developing countries way more reliable. Travel time information system is another most important information system. However, directly this information cannot be extracted. The satisfaction of transit users and the ridership increases with the reliable travel time information system. As the number of vehicle reduces this decreases the congestion. Successful real time vehicle arrival system on highways have been developed by many metropolitan areas of developed countries but due to stochastic nature of urban traffic still there are difficulties in the provision of real time vehicle arrival time information on urban streets. Considering undisciplined traffic and the lack of collected data, application of such a system in developing countries is even worse. Hence, to come with better vehicle arrival systems a good algorithm that can predict the arrival time of the vehicle with reasonable accuracy is required.

This paper is systematized as follow: Segment 2 includes need for the system. Segment 3 shows the techniques for the system. Segment 4 includes technologies involved (GPS and Android). Segment 5 gives the analysis of the existing system. Segment 6 defines the key components of the Vehicle tracking system. Segment 7 and 8 shows results and conclusion respectively.

## 2. NEED FOR GPS BASED VEHICLE TRACKING SYSTEM

Congestion leads to air pollution, decrease in accessibility and increased travel time. In developed countries still many people use their private vehicles. In developing countries also, the degree of vehicle ownership is increasing at a faster rate. Many concepts have been applied for the mitigation of congestion. One of them is to expand and improve the public transport system. A good public transport system is very important for the economic growth of the country. With good and reliable public transport satisfaction among the travelers increases which decreases the number of private vehicles. A good public transport system improves the quality of life providing better mobility, accessibility, social cohesion and secures the environment. To make a transportation system reliable android application is made as it is very easily available and user friendly.

Public transport can be impractical for people who need to adhere to strict schedules. The variations from the official vehicle schedule are understandable and unavoidable. But along with this if there is lack of communication regarding delay of the vehicle then traveler might be wasting time. If the vehicle is late, will make the traveler late and if the vehicle is early than its time will even make travelers late because they might miss the vehicle. Even if the vehicle is on time, travelers have no way to know the information about the vehicle and ends up adopting alternative modes of transportation.

With the increasing use of smart phones, it has become very easy for people to stay in contact. Initially business was conducted only during business hours and pre-planned locations. With the advances in recent year meetings have

become impromptu. Because of these advances more precision is required in scheduling activities with more accuracy.

These technologies have improved making business run more efficiently by making commuters who use public transport reach on time. The lack of certainty that vehicle travelers face applies not only to business world but also to everyone. Students need to reach on time for their classes, commuters traveling to go social get together. This technology helps the transit users know the potential delay in the vehicle schedules so that they can plan accordingly and increase the efficiency. Employees can notify the managers or the clients about the delay and reschedule the meetings. Students can also inform about their delay to the respective group members.

### 3. TECHNIQUES FOR VEHICLE TRACKING SYSTEM

Figure 1 Shows various techniques for tracking a vehicle.

Real time location based systems that uses LCD screens that are placed on every stop displays the arrival time of the vehicle uses RF (Radio Frequency) transceivers. The location is displayed on the LCD screen along with vehicle number as the vehicle enters the range of reception.

SMS (Short message service) is used over the GSM networks to transfer the vehicle location coordinates. The location information is sent to the central server over the GSM networks using SMS and stored in the database. User sends the request and receives the information through SMS.

Through the web based application users can track the vehicle graphically. Also the web based systems enables users with different operating systems platforms to easily reach the details with the help of internet access.

Vehicle tracking system using Android application has inbuilt GPS service provided by the Smartphone to get its GPS coordinates. These coordinates are transferred to the central server. The users can retrieve information through android application.

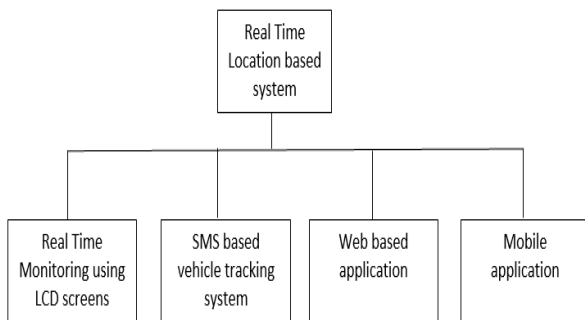


Fig 1: Various Real time location based systems

### 4. TECHNOLOGIES

GPS based tracking system is required which tracks the real time location of the vehicle and this information is used effectively by the commuters to make better travelling decision. System and technology is growing even in nanoseconds. GPS is growing its popularity in day to day life applications. In this era of IV Generation Smartphone and palmtops have become a valuable part of the human beings. We often listen to the words Android and Maps. Android has made life easier and comfortable.

### 4.1 Global Positioning System (GPS)

The technology GPS is used in vast number of applications now-a-days. One such application is tracing the vehicle and keeping systematic observe on them. The route travelled by the vehicle and its location can be informed by this tracking system, and that information can be witnessed from any other remote position [5].

Now-a-days various agencies employ Global Positioning Systems (GPS) to track the position of the transit's vehicle. The major concern is reliability of the results obtained from the GPS. GPS is considered to be one of the most widely used and reliable techniques for tracking the location. It is operated by United States of Department of Defense. The idea behind the working of GPS is that time is calculated by the receiver that a pseudo code takes to get from the GPS Satellite to that receiver on the surface of earth. This time is approximately 0.1 seconds in practice. From this distance, we can calculate the distance(X) between the receiver on earth's surface and the GPS Satellite, as speed of sending code is known and the time can be measured. The Satellite imaginarily places the receiver somewhere on the surface of a sphere with radius (X). The setup of the arrangement is shown in Figure 2a. Then the second satellite carries the same process. This narrows the possibilities of existence of the receiver as it can be present only at intersection of the two virtual spheres. The elliptical region is the intersection of the two spheres where there is a possibility of the receiver to be present. Figure 2b shows the arrangement. By further carrying out the same process for the third satellite, the possible locations can be further reduced to just two points as shown in Figure 2c.

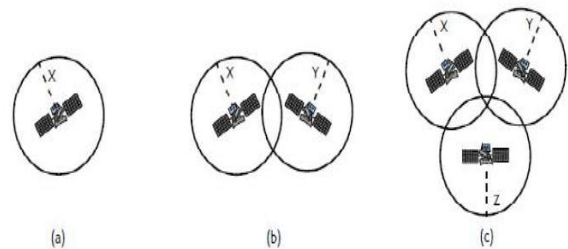


Fig 2: GPS position computation using (a) one satellite (b) two satellites (c) three satellites

One of the two possible points in Figure 2c is ignored because it is either moving with unrealistic speed or it is much far away from the surface of the earth. If three dimensional positions are required, measurements from the fourth satellite are counted i.e. latitude, longitude and altitude. Figure 2 explains the two-dimensional system. The standard GPS facility is satisfactorily accurate, but there are certain applications where much higher accuracy is required. To obtain such higher accuracy, differential GPS was developed. In differential GPS, for higher accuracy the errors caused due to delays when signal passes through the troposphere and the ionosphere are corrected.

GPS gives longitude and latitude in following 3 conventions:

- Degrees minutes' seconds: 40° 27' 46" N 79° 48' 56" W
- Degrees decimal minutes: 40° 16.767' N 79° 158.933' W
- Decimal degrees: 40.436° N 79.782° W

The system implementation uses Decimal degrees'

representation.

Following are the sources of errors that might arise:

- The speed of the radio waves traveling is slow down by the disturbances caused in the atmosphere
- Correct results might not be collected in the absence of clear Line of sight (LOS) like in underground subways, in presence of clouds.
- The radio waves get bounce off by the skyscrapers which gives the wrong results.
- Sending corrupt location data and misreporting the position are the common satellite errors.

Following are the methods of correction:

- The receiver's inaccuracy can easily be calculated by using Differential GPS (DGPS) hardware. The station for that area broadcasts the signal correction information.
- The area where GPS enabled device is present, advanced systems which have higher accuracy are deployed that estimates the distance to the base station.
- Signals between the adjacent antenna service providers are interpolated with which device is always connected.

## **4.2 Android**

Android application is proposed for the system as Android Smartphone consists of GPS system, with the use of which the current location of the transit vehicle and the passenger can be easily tracked. GPS system in the Smart phones can be easily used with appropriate security permissions. Android is developed by Google and is an open source operating system for mobile devices. One of the major features provided by Android is the set of Android applications (apps) provided through Android market that enables the users to extend the functionality. Android applications have made life much easier and faster. Applications are made very user friendly which makes it very popular. These apps are developed by professionals and a group of hobbyist programmers using enhances form of java. Android provides a lot of documented help for new developers.

The Android Software Development Kit (SDK) is a set of tools and APIs (Application Program Interface) that facilitates the development of Android application. The Android SDK Manager provides an excellent feature to install API components according to the different versions of the Android OS with ease. Another key feature of SDK is that it provides the developers with Android emulator which ensures the developers to deploy their code and test its working on different virtual phones with different specifications.

## **5. EXISTING SYSTEMS**

Vehicle tracking system has been a part of Intelligent Transport system since 1970s but were hardware based which used sensors. The data mining techniques were used by software based solution which came in late 1990s. The reliability is increased with addition of traffic pattern. In 2000s GPS was started being used to trace the real time location of the vehicle.

Real time bus tracking systems are standalone systems that displays the arrival time of the buses on LCD screens on

every bus stop. The system consists of microprocessor, LED's, RF transceiver, power source, battery. RF transceiver gets the signal that contains its GPS coordinates and it is installed over every bus. Then microprocessor will process the data. At every bus stop RF transceiver are installed to receive information regarding bus coordinates. When the transmitter enters the range of reception they will get active otherwise these will be passive circuits. The bus number along with location is displayed on the LCD screen [1].

SMS (Short message service) is used to transfer the vehicle location coordinates over the GSM networks. The GPS receiver in the vehicle calculates the latitude and longitude of the vehicle coordinates. Using SMS this information is sent to the central server over the GSM networks and this information is stored in the database. Users can retrieve the information by sending the vehicle number and the route number. SMS is sent to user that contains the arrival time of the vehicle [2].

Web based vehicle tracking system comprises of the central server system, vehicle- mounted tracking devices and the web based application. Through the web based application users can track the vehicle graphically using the web based systems. These systems also enable the users with different operating system platforms to easily reach the details with the help of internet access [3].

Bus tracking system using Android application uses the inbuilt GPS service provided by the Smartphone. Smartphone is mounted on each bus and to get its GPS coordinates. These coordinates are transferred to the central server. Users can retrieve information through android application where users select the bus number, route number and, receive the arrival time of the bus with respect to the user's current location instead of the bus stop. Maps are also used to graphically plot the bus and the user on the Google- maps [4].

The route travelled by the vehicle and its location can be informed by this tracking system, and that information can be witnessed from any other remote position. The system comprises of 16x2 LCD, GPS, Atmega microcontroller MAX 232, GSM and at the client side a web application is developed and all the required modules are interfaced using software. A Web Application and a GSM mobile is there in monitoring unit. The location co-ordinates of the vehicle are traced with GSM mobile and then the owner can get the exact position of the vehicle by typing those co-ordinates in web application [5].

## **6. SYSTEM ARCHITECTURE**

The system architecture for vehicle tracking system is proposed in Figure 3. It is based on the client-server application in which the commuter acts as the client and the vehicle in which GPS is mounted acts as the server. Two applications are developed in which one acts as client side application and other acts as server side application. The commuter uses the client side application on his smart phone whereas the server side application is used by the vehicle in which GPS system is installed. We have developed an android application for both client and server side as it is easily available and user friendly.

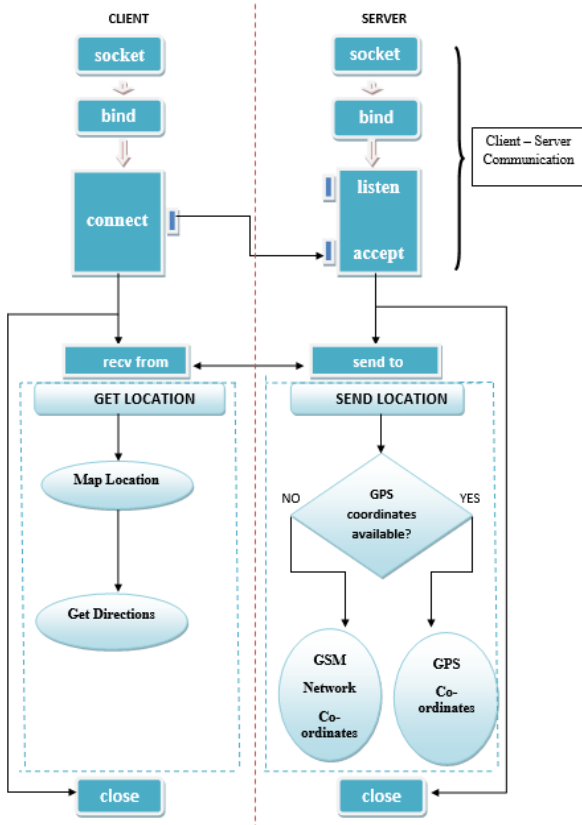


Fig 3: The workflow of client server application

The GPS based vehicle tracking system is categorized into two major modules as follows:

**Module 1(Commuter module):** This module is the client side of our android application which is installed on android based smart phone used by the commuter. It is used by the commuter to track the location of the vehicle it wants to travel in and also to get an idea of its estimated arrival time. The basic requirement of this application is presence of GPS and GPRS.

**Module 2(Vehicle module):** This module is the server side of our android application. This is where most of the processing is done. On establishing successful connection with the client, it sends its current real time location coordinates of the vehicle to the commuter from which the commuter can map the location on the Google maps.

The working of the client server application developed is explained below:

In order to establish the connection with the server, the client initiates the communication by creating the socket (IP + Port number) and then it sends the connect() request to the server and waits for server’s response. The server responds with the message “Client Connected...” as shown in Figure 5c. This is how the connection is established between the client and the server. After successful connection establishment, the server and client are now ready to exchange the data.

On click event of Send Location button as shown in Figure 3, the server (vehicle) sends its location coordinates to the client (commuter). If the GPS coordinates are available, then GPS coordinates are sent by the server to the client otherwise the nearest GSM network location coordinates are sent as shown in Figure 4. For the location coordinates to be available, the GPS of the smart phone must be turned on.

```

btnSendLoc.setOnClickListener((arg0) -> {
    Location gpsLocation = appLocationService
        .getLocation(LocationManager.GPS_PROVIDER);
    Location nwLocation = appLocationService
        .getLocation(LocationManager.NETWORK_PROVIDER);

    if (gpsLocation != null) {
        latitude = gpsLocation.getLatitude();
        longitude = gpsLocation.getLongitude();
        Toast.makeText(getApplicationContext(),
            "Your GPS Location Sent : \nLatitude: " + latitude
                + "\nLongitude: " + longitude,
            Toast.LENGTH_LONG).show();
        getMyLocationAddress();
    } else {
        if (nwLocation != null) {
            latitude = nwLocation.getLatitude();
            longitude = nwLocation.getLongitude();
            Toast.makeText(getApplicationContext(),
                "Your NW Location Sent : \nLatitude: " + latitude
                    + "\nLongitude: " + longitude,
                Toast.LENGTH_LONG).show();
            getMyLocationAddress();
        } else {
            Toast.makeText(getApplicationContext(),
                "No Network available, Please check your GPS",
                Toast.LENGTH_LONG).show();
        }
    }
}

```

Fig 4: Code Snnipet to check availability of location coordinates

On click event of Get Location button the client receives location coordinates from server and then the client can map it on the Google maps to get the estimated distance and time for the vehicle to reach the commuter. Client can also get the directions i.e. the shortest path between the vehicle and the commuter. This is how the commuter can track the vehicle it wishes to board on.

## 7. RESULTS

The system is the client server android application. The commuter acts as the client and the vehicle whose location is to be located acts as the server in this application. The following section shows the screenshots of this client server application, the processing is done at the server side. Location co-ordinates are sent from the server to the client.

Figure 5a is the server side application which has IP (172.31.164.77) and port number (8080) for communication. Server is waiting for the client to communicate. Figure 5b is the client side application which tries to make connection to the server side by using the IP address and port number of the server.

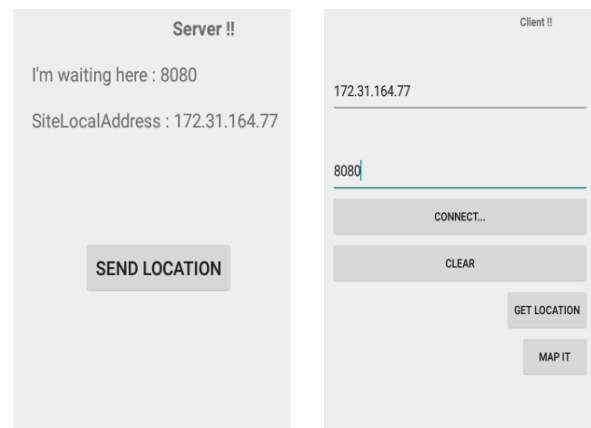
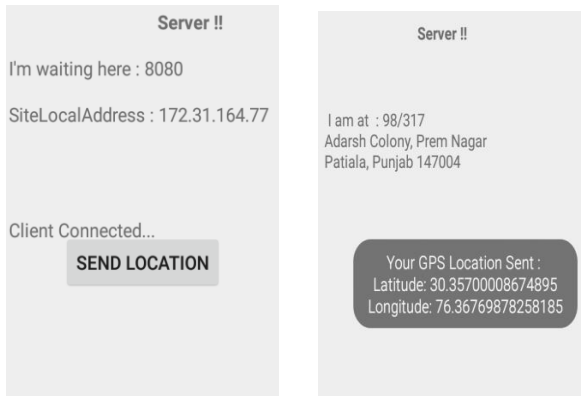


Fig 5 (a) Server Module (b) Client Module

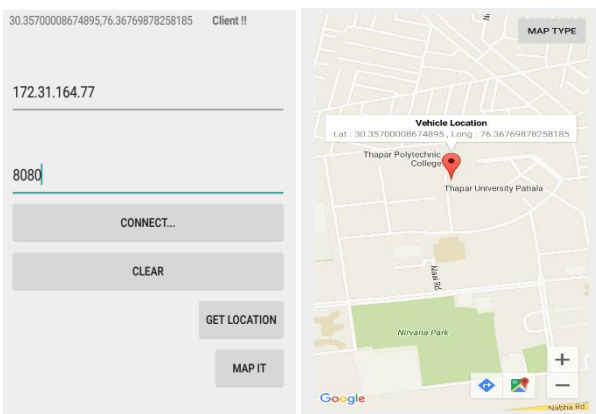
Figure 5c shows the connection establishment between the client and the server. In Figure 5d vehicle is sending its GPS coordinates to the commuter so that the commuter can trace its location using Google maps.



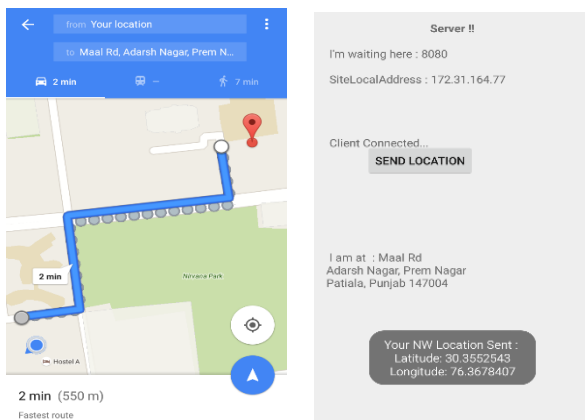
**Fig 5 (c) Client Server Connection established (d) GPS coordinates of the vehicle sent to the commuter**

In Figure 5e. The GPS coordinates sent by the vehicle are received by the commuter on the top left of its screen. In Figure 5f. The commuter can map the vehicle's location in Google map corresponding to the coordinates it had received.

In Figure 5g The estimated time and distance is calculated between the vehicle and the commuter. In Figure 5h The vehicle sends its nearest GSM network coordinates to the commuter if the GPS co-ordinates are not available.



**Fig 5 (e) Client receiving GPS coordinates (f) Vehicle's location on Google map**



**Fig 5(g) Estimated time and distance between vehicle and commuter (h) GSM Network coordinates of the vehicle sent to the commuter**

## 8. CONCLUSION AND FUTURE SCOPE

Vehicle tracking both in case of business and personal purpose improves communication medium, increases throughput, safety and security and performance monitoring [6]. Vehicle tracking system aims at reliable transportation in the city by providing passengers with the real time location of the vehicle. The system also gives the details of the estimated arrival time of the vehicle to the passenger. This system helps the passengers to make better travelling decision as passengers can decide if they should wait for the vehicle or not in accordance to the estimated arrival time. GPS based vehicle tracking system not only works on the real time position and the real time speed of the vehicle but also considers the traffic pattern on the road. This traffic pattern plays very important role in evaluating the arrival time of the vehicle.

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