

BRINGING
ACTIONABLE
INSIGHTS
INTO
BUSINESS
THROUGH
ANALYTICS

A Stragure White Paper | June, 2010

**A COST EFFECTIVE
SOLUTION TO MANAGE
YOUR TRANSPORT FLEET
USING GPS & GSM**

Shantanu Roy

As a business owner or as a fleet operator for a business enterprise, an (Educational) Institution or as for a Professional Logistics Transportation Agency, if you are regularly plagued with issues related to Fleet Predictability (Time Management) which is leading to cost overruns and subsequent lowering of customer satisfaction levels, then here is a cost effective solution for you. This solution in fact enables you to initiate/launch value-added services for your customer which can bring in additional revenue for you.

What is more, this solution enables the Fleet administrator to have real time two-way communication with vehicles on the road thereby enabling Real time Fleet Management.

TABLE OF CONTENT

A Cost Effective Solution to Manage your Transport Fleet Using GPS & GSM	1
Table of Content	2
Overview of GPS Technology and GPS Based Vehicle Tracking Systems	3
What is GPS?	3
How GPS Works	3
How Vehicle Tracking Units (Devices) work.....	4
Key Considerations for you while looking for a Solution	6
Feature Summary of a Typical GPS/GSM Based Transport Solution	8
Key Challenges.....	9
Key Operational Parameters which can be tracked using this Solution.....	11
How Stragure Can Help	12

OVERVIEW OF GPS TECHNOLOGY AND GPS BASED VEHICLE TRACKING SYSTEMS

Here is an overview of GPS as a system and how it works, courtesy Garmin Inc., makers of GPS equipments (<http://www8.garmin.com/aboutGPS/>)

WHAT IS GPS?

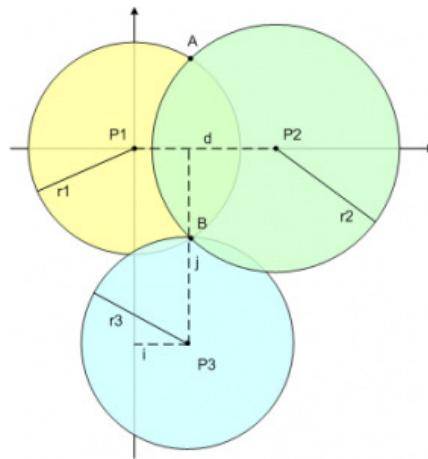
The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defence. GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day. There are no subscription fees or setup charges to use GPS.



HOW GPS WORKS

GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use triangulation to calculate the user's exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is. Now, with distance measurements from a few more satellites, the receiver can determine the user's position and display it on the unit. A GPS receiver must be locked on to the signal of at least three satellites to calculate a 2D position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the

user's 3D position (latitude, longitude and altitude). Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, sunrise and sunset time and more.



The picture above summarizes in graphical form what goes on when a GPS tracking devices goes through the process of **trilateration** which is nothing but the determination of absolute or relative locations of points by measurement of distances, using the geometry of spheres.

HOW VEHICLE TRACKING UNITS (DEVICES) WORK

Here is an overview of a typical Vehicle Tracking Unit and how it works, courtesy VisionTek, makers of Vehicle Tracking Systems in India (<http://www.visiontek.co.in/vehicle-tracking-system/vehicle-tracking-system-86vt.html>)



Vehicle Tracking Systems are electronic devices installed in vehicles to enable vehicle owners or third parties to track the location of a vehicle or an object which is moving.

The basic function of the Vehicle Tracking unit is to acquire process and transmit the GPS parameters like Latitude, Longitude, Altitude, Date, Time and speed.

The Vehicle Tracking Unit consists of a built-in GPS receiver, GSM modem and battery for back up during failure of external power. The unit is provided with **RS232 port** for configuration of the device. The unit is also provided with **voice port** for connecting headset for two-way communication and a buzzer for incoming call indication.

Microcontroller forms the heart of the unit it acquires and processes the position data from the GPS receiver. The data is locally stored in the flash memory. The frequency at which the GPS parameters to be updated can be configured. The device will then send the data to the pre-defined data centre as per the pre-configured frequency. The data is sent in the form of **SMS** or **GPRS** call which contains the GPS details.

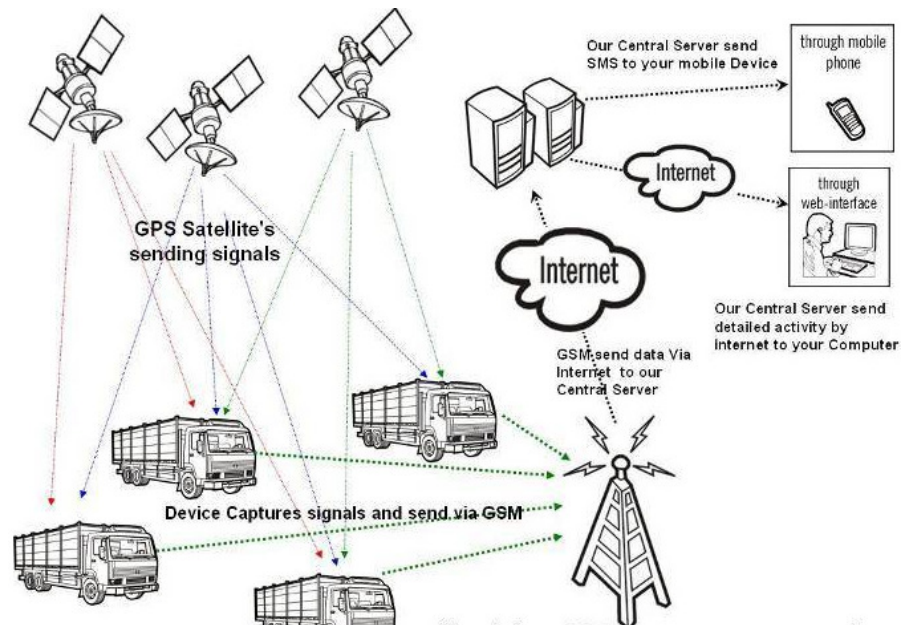
When the **GSM / GPRS** network is not available, the unit will store all the GPS details and will send the stored data to the data centre on entering into the GSM / GPRS Network.

The unit is provided with an internal battery with charging facility for back up during the external power failure. The unit also equipped with ignition On/Off detection and intelligent power management for detecting external power removal / failure. When the external power is removed or failed, SMS will be sent to the pre-defined number.

Vehicle Tracking Unit typically supports both **Active** (On-Line) and **Passive** (Off-Line) tracking. In the case of active tracking (On-Line tracking), the device not only collects the information of the vehicle like GPS location, Date, Time, Speed and Direction, but it also transmits the information in real time through cellular networks.

In the case of passive tracking (Off-Line tracking), the device simply stores information of the vehicle like GPS location, Date,

Time, Speed and Direction. This information is downloaded onto a computer when the vehicle gets back to its original destination.



KEY CONSIDERATIONS FOR YOU WHILE LOOKING FOR A SOLUTION

GPS based solutions are not that complex as some solution or product vendors make it out to be. In fact, it is no rocket science at all. In reality, the inherent system architecture for a GPS based Vehicle Tracking solution is simple and it does not take too much time to build one 'custom' for your fleet.

Only knowledge you would need to design a solution of this kind is an inherent understanding of geo-spatial calculations such as the Haversine formula (it is used to calculate distance between two points on a sphere) and a working knowledge of configuring the Vehicle Tracking Units.

Basic Infrastructure Required:

- A Vehicle Tracking Unit (procured from a GPS Equipment Provider)
- A GSM Connection (procured from your Telecom provider)
- A Server along with a Static IP (hired/leased from your hosting provider)

- A Database (Open source RDBMS solutions like MySQL or PostgreSQL should suffice)
- An SMS Gateway (if subscriber based alerts are configured)

Mentioned below are the steps you would require to set up a basic Vehicle Tracking System:

Step 1: Procure and install Vehicle Tracking Units in each of your vehicles. The Units need to be typically fitted to the vehicle battery since the unit requires a DC Power source between 9V and 30V DC.

Step 2: Procure a GSM connection from your telecom provider (one for each Vehicle Tracking Unit). Insert the chip into the Vehicle Tracking Unit and make sure that the unit is configured to send data to your server's static IP and the associated port.

Step 3: Connect the GPS Antenna to the GPS connector provided in the Unit. For good GPS coverage, make sure that the GPS antenna has a clear view at the sky preferably outdoors. Ensure that the top of the antenna is aimed at the open sky.

Step 4: You essentially need a multi-threaded (socket) server to receive real time GPS information from the Vehicle Tracking Units. This socket server would be continually polling a specific port on the server (with the static IP). This server should be capable of processing strings and transmitting/relaying the GPS information to a connected database.

Step 5: Next step is to define the Vehicle and the associated Vehicle Tracking Units in the system and then associate them with the routes.

Step 6: Next step is to procure a decent base map for plotting your Points of Interests or POIs as they are commonly referred to. Points of Interests are nothing but specific Geo-coordinates which could be used to highlight specific landmarks or touch-points en-route. Our inherent choice for a base map for plotting the geo-coordinates is Google Base Map (<http://maps.google.com>) since Google Map APIs are essentially free (unless you want to try the paid [more accurate] version) and the API keys can be obtained by simply registering for it with any valid Gmail ID and the maps are decently well detailed, especially in the urban and semi-urban areas. The Points of Interest are typically converted

into Circles of Interest or 'Proximity Circles' by specifying proximity circle radius for each 'POI'.

Step 7: Next step is to associate the points of interest (POI) with the routes.

Step 8: If you would like to provide value added services, then you can register subscribers in the system and associate the subscribers to the routes of their choice, more specifically to the individual POIs associated with the routes.

And your Vehicular Tracking System prototype is ready to be put to the test. As and when your vehicles tagged with the GPS devices go along the routes defined, the vehicles cut across the Proximity Circles as defined along the routes which are invariably recognized by the Vehicle Management system. If there are subscribers associated to these circles of Interest, then automated alerts can be triggered with appropriate information.

FEATURE SUMMARY OF A TYPICAL GPS/GSM BASED TRANSPORT SOLUTION

- 24X7 real time GPS/ GPRS based monitoring
- Vehicle Immobilization capabilities
- Pro-activity vetting and authorization facility
- Real time GPS-based tracking
- Time, distance and velocity monitoring
- Ignition and openings monitoring & control
- Real time fuel monitoring
- Fuel consumption rate
- Real time monitoring on vehicle mechanical systems
- Geo-fencing i.e. virtual fencing
- User-defined automated alerts
- Operational and statistical reports
- Allows 3rd party technologies and applications into the system
- Provides easy tailoring to customer needs

KEY CHALLENGES

When defining proximity circles with configurable radii, the inherent challenge is how to ensure that the proximity circles do not intersect with each other since intersecting proximity circles would result in conflicting alerts.

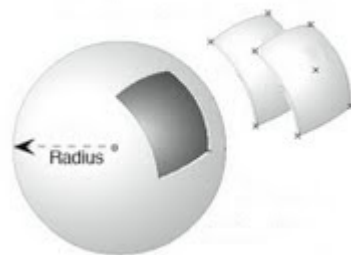
Actually, each of these so called 'proximity circles' is actually a 'Gaussian' square on a spherical surface (earth) typically identified with a centre (the POI) and its four corner points being represented thus (as geo-codes):

- [POI Latitude – Radius, POI Longitude],
- [POI Latitude + Radius, POI Longitude],
- [POI Latitude, POI Longitude + Radius],
- [POI Latitude, POI Longitude - Radius]

The non-intersecting validation challenge can be tackled thus:

Rule 1: Ensure that each of the four corners of the Proximity circle do not intersect with any of the adjoining circles.

*<Corner Point Longitude> is Between POI_MIN_LONGITUDE and POI_MAX_LONGITUDE
& <Corner Point Latitude> is Between POI_MIN_LATITUDE and POI_MAX_LATITUDE*



Rule 2: Ensure that the POI (centre of the proximity Circle) does not intersect with any of the adjoining circles

*<Centre Point Longitude> is Between POI_MIN_LONGITUDE and POI_MAX_LONGITUDE
& <Centre Point Latitude> is Between POI_MIN_LATITUDE and POI_MAX_LATITUDE*

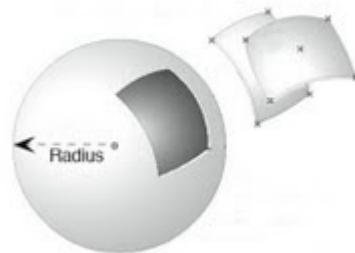


Rule 3: Ensure that each of the edges of the POI do not intersect with any of the adjoining proximity Circles.

POI_MIN_LONGITUDE Is Less Than <Minimum Longitude of the POI> AND POI_MAX_LONGITUDE is Greater Than <Maximum Longitude of the POI>

&

POI_MAX_LATITUDE is Greater Than <Maximum Latitude of the POI> AND POI_MIN_LATITUDE Is Less than <Minimum Latitude of the POI>



Where POI_MIN/MAX_LONGITUDE/LATITUDE represents the minimum/maximum longitude/latitude of each of the POIs already defined in the system
And measures in angle brackets '<>' represent the new POI which is being defined in the system against which non-intersect related validations are being triggered.

KEY OPERATIONAL PARAMETERS WHICH CAN BE TRACKED USING THIS SOLUTION

1. VEHICLE BREAKDOWN/VEHICLE ACCIDENT/TRAFFIC JAM USE CASE

If the GPS transmit remains at a particular proximity circle for a <configurable number> of consecutive hits, users can be notified for “Static Vehicle” or if the distance between 1st and <Configurable Pre-Defined Number> POI comes within the same proximity circle, then users can be notified with “Static Vehicle at POI”

2. REAL TIME INDIVIDUAL OR GROUP BROADCASTS BY THE ADMINISTRATOR USE CASE

For any specific real time broadcasts to be made to a specific vehicle or to a group of vehicles by the administrator, it is possible to do so by either broadcasting an SMS over the Gateway to the specific Mobile Number or a set of numbers or by actually calling up the number (of the GSM chip associated with the Vehicle Tracking Unit). Most of these devices are equipped with a port for a headphone jack for the vehicle driver to listen to real time broadcasts. If the Vehicle Tracking Unit is not accessible on the Driver’s dashboard, the system may maintain the individual mobile numbers of the drivers of the vehicles and the SMS gateway may be configured to push messages to their personal cell phones.

3. GEO-FENCING USE CASE

It is possible to define virtual fences or zones along the routes of the vehicles on which they ply allowing to the administrator to take immediate and effective steps any vehicle is found plying outside of its delimited area. It is also possible to immobilise a vehicle remotely by pushing through a pre-programmed message to the Vehicle Tracking Unit of the concerned vehicle.

4. TRANSPORTATION FORECASTING/MODELLING USE CASE

It is quite possible to create a data analytics based transportation forecasting model to predict when a vehicle is likely to reach its destination with a relatively high degree of accuracy (by analyzing factors such as avg. speed of the vehicle, current location, distance to destination from the current location, number of likely stopovers and by benchmarking this data against historical track record of that particular vehicle and driver) provided the vehicle is being tracked online. By leveraging a basic web services model, it is possible to publish this information as the result of a query triggered by a subscriber from a website published on the world wide web.

5. MEASURING OPERATIONAL EFFICIENCY USE CASE

It is possible to measure the operational (fuel) efficiency of each vehicle as well as benchmark driver performance from a fuel efficiency perspective by plotting the speed of the vehicle over the entire route and comparing it against other vehicles on the same route at pre-determined time intervals.

6. ONLINE REAL TIME VIEW VEHICLES ON MAP FACILITY USE CASE

It is quite possible to plot all vehicles concurrently on a Google Base map (or any base map for that matter) and provide a real time interface for the administrator to track all vehicles online akin to a real time interface visible to a Typical Air Traffic Controller.

HOW STRAGURE CAN HELP

Stragure has extensive experience in building GPS Based Transportation Management Solutions. Our solutions are built on open source technologies and frameworks. We leverage our J2EE expertise in designing highly optimized Java NIO based socket servers which have been successfully pilot tested with more than 100 concurrent Vehicle Tracking Units (transmitting data at 1 minute intervals) with minimum data queue build-up. We leverage our expertise in J2EE based RAD frameworks meant for developing business workflows to develop our

Solution Workflows. We have leveraged Google Map APIs to enable remote route plotting and for real time display of geo-codes.

For more information, you can contact the author at shantanu_roy@stragure.com and/or at +91 (80) 4084 9494.

If you would like to post your reviews on this whitepaper, please visit us at <http://www.stragure.com/ContactUs.php> and drop us a note. We will be glad to get back to you.