

Application of GIS and GPS for Vehicle Tracking and Fleet Management Solution: A Case of Satellite and GSM Communication Platforms

P. C. Nwilo*, O. A. Odujoko** and T. A. Alaka***

Abstract

Vehicle Tracking and Fleet Management Systems involve the remote monitoring of mobile and stationary assets alike as they move about in space. The systems are able to effectively provide detailed information on the status of the engine, location, speed and time/date as the equipment operates. The combination of GIS, GPS, and other communication gadgets provides a fleet management system which gives us value-added services. The use of GIS and GPS with other related technologies helps in the acquisition, organisation, management, transfer and analysis of real-time data, using an appropriate mode of communication and vehicle tracking package. A well-compiled and spatially referenced map provides the major source of information for the platform on which the whole vehicle monitoring system relies. This paper describes typical components for the set-up and implementation of base station equipment for vehicle tracking and fleet management system for the use of transportation or logistic firms. It highlights the requirements for operating these systems using both GSM and Satellite communication platforms.

1.0 Introduction

The competitive nature of our world today requires that all aspects of business are adequately managed. This includes the mobile resources and the fleet of vehicles that play an integral part in the delivery of products and services to valued customers.

Fleet management involves the remote monitoring of mobile and stationary assets as they move about in space. The fleet management system is able to effectively provide detailed information on the status of the engine, location, speed and time/date as the assets operate. It can also monitor some other parameters like battery voltage level, weight and temperature of goods via attached add-on devices. It will also equip the users with a data interface through which they can keep track of their goods and services for the overall control of their operations (Odujoko, 2006).

* Department of Surveying & Geoinformatics, University of Lagos, Lagos.

** GIS Operations, Tracking Solutions (EIF) Limited, 14, Raufu Williams Crescent, Surulere, Lagos.

*** Network Group, MTN Communications Nigeria Limited, Lagos, Nigeria.

Fleet management addresses the problem of managing fleets of trailers, containers, taxi-cabs, locomotives, business jets and other modes of public transportation. Such operations of management of a fleet of vehicles and assets, require solutions to various problems like dynamic assignment, trip allocation, dynamic routing, responding to real-time customer demands and dispatch instructions, automatic vehicle location (AVL), trip and freight reporting and monitoring driver and vehicle characteristics to attain efficient and optimised performance with available resources (Tilanus, 1997). The very basic tools that make all these new technologies possible are geographic information systems (GIS) and global positioning systems (GPS).

A GPS-GIS integrated system provides real-time meaningful location and status of the vehicles in the fleet, which can be used to plan trips, attend to real-time demands from consumers and monitor the traffic condition and driver's behaviour. These systems are an integral part of modern fleet management systems and play a vital role in providing data for logistic planning and optimisation in today's increasingly competitive scenario. This integrated system can be used for fleet assessment and management of commercial, private or utility fleets (Prakash & Kulkarni, 2001).

Transportation and Logistics Services are major parts of our national life. The road is by far the most widely used mode of transportation in Nigeria and throughout the West Coast of Africa as well. Goods and services need to be moved from one location to another over a scheduled period of time. Vehicles and mobile assets have to be monitored both while stationary and in transit to ensure their safety and compliance with existing operational guidelines. Securing the consignments of valuable goods as they leave take-off points and get to their desired destinations is of great concern to all service provider companies or organisations.

This paper describes typical components for the set-up and implementation of base station equipment for vehicle tracking and fleet management system for transportation and logistic firms. The paper highlights the requirements for such systems using GSM and Satellite communication platforms, as implemented in the company EIF Limited of Nigeria.

2.0 The Vehicle Tracking and Fleet Management System

A typical vehicle tracking and fleet management system consists of some main components. These are; Telematic devices with in-built integrated GPS, Base station software and hardware, modems, internet connection and a communication network. The system is designed to use a specific communication platform; the most common ones use either GSM or Satellite Communication options. The following are the Global System for Mobiles Communication (GSM) used in this paper.

GSM Communication System

- Gateway Location Protocol (GLP) - Portable mobile vehicle tracking device (with in-built integrated GPS receiver, a GSM cell phone and a sophisticated computer operating system which is installed on the vehicle,
- Sirius Xp Suite - Vehicle tracking software comprising four (4) different applications - JMS Server, Sirius explorer Server, Sirius explorer Gateway and Sirius explorer Client, with map interface and other tools.

- GSM Network - Communication platform for sending and receiving of data,
- iTegno Modem - GSM Modem for managing incoming and outgoing messages,
- Database Server and work stations - Base station monitoring equipment.

Satellite Communication System

- MT2000 - satellite-based communication device/mobile terminal (with in-built integrated GPS receiver, a *satellite communication device* and a *mini-processing unit* which is installed on the assets,
- Solaris GTMS (Global Telemetry Monitoring System) – Vehicle Tracking and Fleet Management software having a map interface and other tools,
- Database Server and work stations - Base station monitoring equipment.
- Wavecom Modem (Optional) – for forwarding SMSs of event notifications to certain recipients.
- Satellite Communication Network – for provision of two-way data communications on spread spectrum data transmission technology via proven and reliable geo-synchronous L-band satellites.
- Internet Connection – Required to route data from remote server to base station equipment setup.

The telematic units installed on assets collect data on Location (longitude and latitude), Speed (Km/h), Date (Year: Month: Day) and Time (Hour: Minutes: Seconds). They send these data to the base station monitoring setup through the GSM communication network. At the monitoring centre, the vehicle tracking software keeps a firm pulse on the assets, and is able to display their locations on the map as they operate. With every new message received, it is possible to know what events occurred. From the events notifications the situation can be adequately attended to (Odujoko, 2006).

All vehicle tracking solutions come with software that manages the data gathered by the units. Typically, these programs allow a manager to view maps of a vehicle location and speed, while showing the time of day and whether the engine was on or off. Each software is designed to operate using a particular communication platform (Alaka, 2006).

2.1 The Mapping Subsystem

The map is a very vital part of the vehicle tracking system. It provides graphic information on the locations of the assets. For the development of the vehicle tracking and fleet management system, a geo-referenced digital map is required to act as a base for referencing vehicle positions from time to time.

The map is usually on a particular window and the map engine can use map data in 'ESRI shapefile', 'MapInfo dat' or any other preferred formats. There is a standard well-structured database table of the features on the map which is used to reference the positioning of the assets. This too can be customised for specific client needs. The map is designed such that it is zoom-layer controlled, allowing for display of more details as you zoom in using the available cartographic tools. The scale levels are Africa, Country, Regional and Street levels. The map datum chosen for the mapping system is WGS 84.

2.2 Communication Subsystem

This part of the system connects the system administrator or fleet manager at the base station to the remote location of the vehicle. Communication of data is established in near real-time between the mobile units and the Base Station by means of SMS (short message services) via the preferred network. The software suite is designed to receive incoming and send outgoing messages in a defined format through communications protocol on which it is designed, thereby, ensuring a continuous two-way communication path of vital information.

The GPS receiver in the unit records the changes in co-ordinates (Latitude/Longitude) of the moving vehicle as well as the speed, direction, date and time at certain defined intervals. The vehicle's position is referenced as an icon against the backdrop of a geo-referenced digital map on a computer screen. This way, the movement of the vehicle is monitored.

The system can also be configured to monitor and send event notification of the vehicle's activities to fleet manager's mobile phones. Events such as ignition on/off, harsh acceleration/braking, excessive idling, zone entry/exit, above speed limit, etc., can be forwarded to the recipients' mobile phones. Fig. 2.1 shows the path through which information flows in the system.

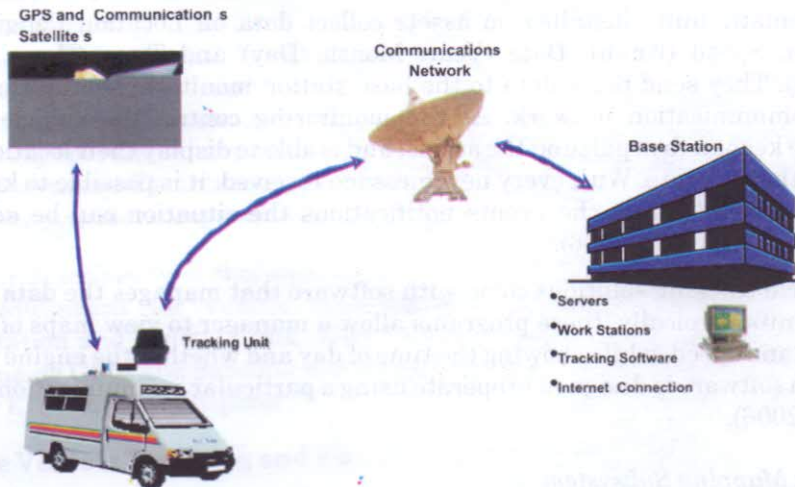


Fig. 1: Two-Way Information Path for the Vehicle tracking and Fleet Management System

Source: Tracking Solutions (EIF) Ltd.

3.0 Typical Base Station Equipment Setup and Implementation

The base station equipment serves the purpose of continuous monitoring of the activities of the vehicles/assets in the fleet.

3.1 GSM System Setup Structure

For implementing the vehicle tracking and fleet management system on a GSM Platform, a typical base station equipment includes an Hp-Proliant Application Server with an iTegno modem attached to it via a USB port. It will also include two HP destop workstations connected in a network (i.e. Local Area Network, LAN) with the application server.

