

GeoComm - A Cost Optimized Geo Intelligent Mobile Communicator and Tracker

1. Introduction

The proliferation of Global Navigation Satellite Systems (GNSS), with Global Positioning System (GPS) as its prolific example, and Global Mobile Communication System with GSM/GPRS/CDMA technologies as its prime movers, has enabled to fuel a vibrant growth globally in the various economic sectors, in particular in Transport, Utility, Asset Management, Supply Chain, Disaster Management & Public Safety through the use of what have come to be known as Geo-intelligent Solutions. These solutions provide for real time messaging, emergency communication, tracking and management of moving assets or individual objects with attendant improved economic and efficiency advantages and added safety in their operations.

These Geo-intelligent solutions variously cover, as described in the literature, Vehicle Tracking System (VTS), Mobile Display Terminal (MDT), Emergency Location Communicator (ELC), Personnel Locator (PL), Work Force Monitor (WFM), Vehicle Mobile Navigation Unit (VMU), etc.

A number of designs and products have consequently evolved and commercialised for geo-intelligent products using different components of hardware, embedded software and application software. Many of them are proprietary in nature and use proprietary tools and platforms for their implementation. These tend to make such products and solutions often expensive both in near and long term.

As the volume sensitivity of the components plays a part in cost of the product, designs have often selected components from the standard commercially off-the-shelf (SCOTS) available market. However, that addresses less than half the cost element of the product/solution. The other major part is towards embedding software in the hardware so designed and the software application that works towards the desired solution.

With a view to meet cost, quality and time-to-market targets, reuse of designs, reuse of components, reuse of manufacturing processes, and spreading over marketing opportunity channels are required. 'Componentising' the whole product life cycle will ensure that the components can be produced in volumes resulting in economies of scale. The use of SCOTS components has been resorted to. Proprietary software platforms which have often been used for a convenient realisation of application, are giving way to open platforms for programming, user interfaces, and data-base management. The challenge that continues to remain is to realise a low cost product and a solution that can cater to a wide range of applications.

GeoComm is designed to satisfy these objectives, and therefore achieve a nearly 20% cost reduction in the cost of the traditional design based VTS units.

2. Suggested Applications to be Served

A Geo-intelligent product is the one that enables its instantaneous location to be known, and serves the applications that fall in one or the other of the following categories:

- Personal/Vehicle/Asset locator – Where am I?
- Personal/Vehicle navigator – How do I reach my destination?
- Personal/Vehicle/Asset Tracker – Where are you?
- People/Fleet Tracker – Where are you all?
- Location based services – Where are the closest service points?
- Location based planning – Where are the closest available resources to carry out a job?

Each of these applications carries an attribute that require a different logic to implement. However, the common feature of all these applications is the generic requirement of 'location and time' that enable GPS derived position/speed/time data, posting the GPS data on a geo-referenced Map and tracking the moving object using the GPS data updates. The other attributes are communication interfaces, message logic, data display, external key interfaces, interface with external data files, etc. which make the application unique and different from one another.

In order to cost optimise on the product, and the solution, therefore, an approach that will draw from an optimised hardware design using minimum external components, and building a logic that will help serve several of the above mentioned applications is presented here.

3. Target Application Features

In order to service the stated applications, the following target features have been provided for GeoComm. Please see the actual product in Figure-1.



- Pocket size/hand-held design containing electronics that is close to 75 mm x 45 mm x 15 mm in dimensions
- Work with external +12V DC supply (extended range up to V available), or an internal compact battery, with power ON status indication
- Provide indications for GPS 3D fix, Call receive, Message transmit and Communication Network availability
- On board buzzer for call/message receive
- Provision for Microphone & Speaker outputs for external head-set interface
- Support GSM/GPRS communication and R-UIM based CDMA communication
- Provision for being polled to determine location in real time for tracking
- Emergency messaging of location/time by click of a button
- Instant call to pre-defined locations/numbers
- Up to four keys on board and provision to interface an external keyboard
- Interface to a Map display
- Over-the-air configuration upgrade to affect a logic change
- Data logging up to a limited memory space
- Output to a user-friendly application data base

4. Design Approach and Target Specifications

The prime consideration given in the design is the cost optimisation through reuse of components as well as, in hardware design, use of SCOTS available components, avoiding use of proprietary platform, and integrating application features in a common design.

The technical specifications for GeoComm are:

- A GPS providing a minimum of 16 satellite channels view, a high receiver sensitivity of a minimum – 150 dbm, a high position accuracy of 2.5 m CEP, a higher than 1 Hz data update rate, half-a-minute cold start
- A serial RS 232/USB output interface
- Connector for GPS/GSM antennae
- Interface to an external up to 25 keys to cater to different functionalities
- Reverse polarity protection, noise immunity, internal battery charging facility
- Provision for SIM card holder
- Analog inputs at CMOS level

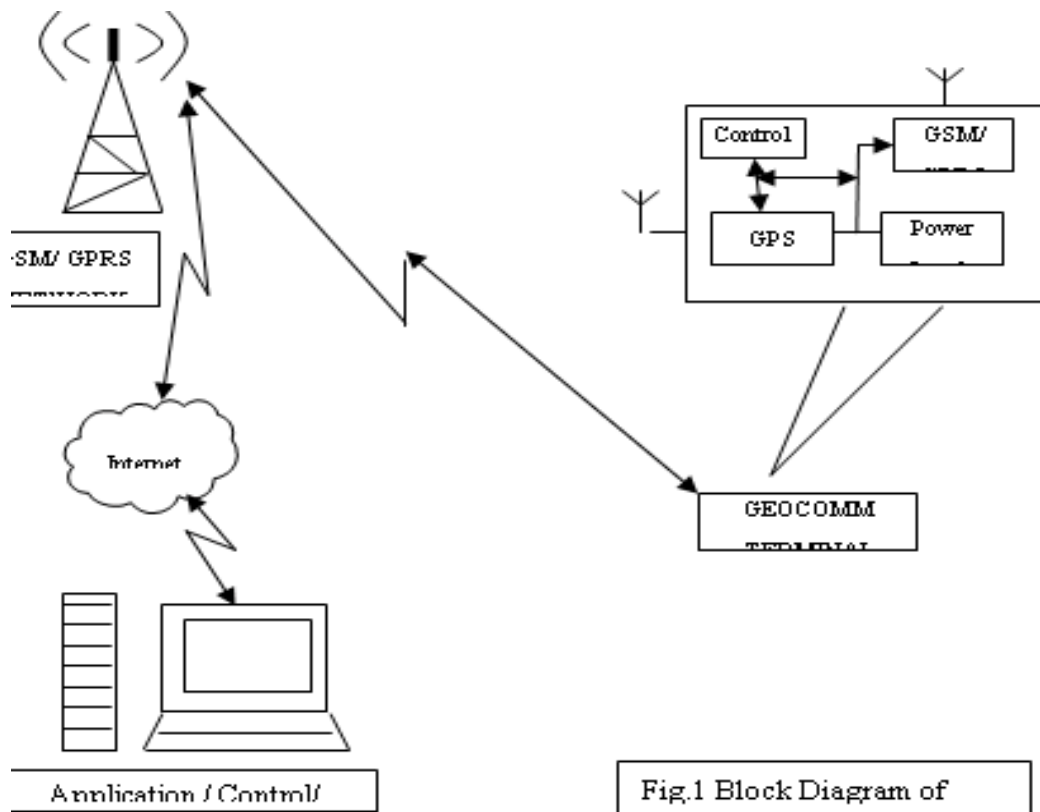
The GeoComm hardware design has minimised the use of external components by reusing the advanced ARM-7 in the GSM/GPRS module as its main control unit.

The GeoComm embedded software is written using ‘C’ language. The various software modules are: GPS management, GPRS connectivity management, Data logging, Key interface, Status indication, all neatly integrated and optimised for a small foot print.

The data from the GeoComm unit is extracted via the serial port, or can be transmitted to ASL GeoConnect via GPRS. ASL GeoConnect is a GUI based application software installed on a desk top PC. Using this, an operator can query any mobile unit equipped with GeoComm, and obtain its location with event time stamp in real time, or send/receive message. The GeoComm equipped mobile unit can be configured to report location, time, etc. at set intervals and automatically update the data base in the desk top PC. The data is readable and displayable on a digital map on the PC. The application works under LINUX operating system with My SQL data base and map information in ‘SHP’ data files.

The tracking application allows over-the-air configurability of the GeoComm for effective tracking, recording stoppages, over-speeding, emergency call/messaging, etc.

A functional level block diagram of the GeoComm system is given in Figure-2..



5. Some Test Data from GeoCom

In order to test the GeoComm system, a set up of Figure-2 was created. The application was installed in a desk top PC. It also served as a server having the IP which is connected to the GPRS service provider network. The GPS data string output from the GeoComm unit was transmitted as a packet over GPRS to be received by the GeoConnect. This data output written in a given table format is picked up for display on a geo-referred Map on the PC.

The ASL GeoConnect can output GeoComm GPS to any other user-friendly tracking application.

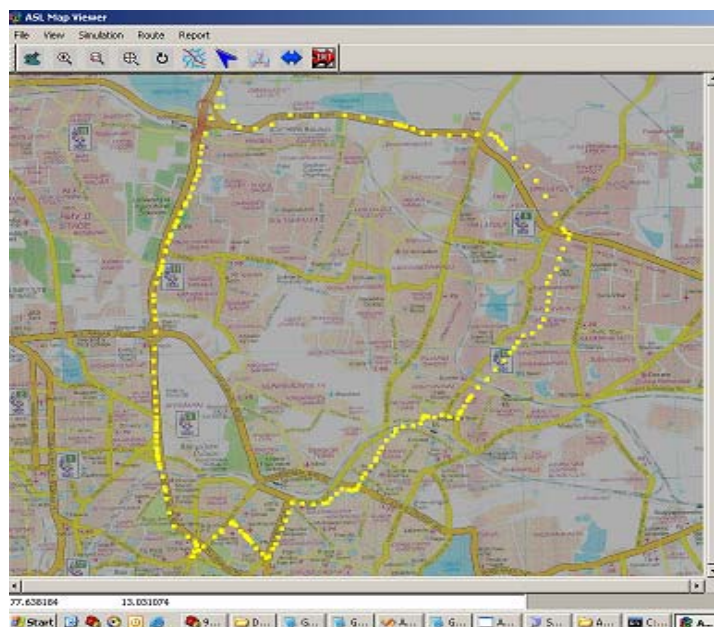
The GeoComm design has been validated at different levels as indicated below:

- i. Electronics board circuit schematic and layout
- ii. Electronics board circuit testing with simulated signals
- iii. Testing with GPS real view satellites confirming signal levels availability, and accuracy
- iv. Testing with GSM Communication Network for faithful GPS data transmission as messages over the GPRS network
- v. Integration with ASL GeoConnect and tracking application

As per these tests, the representative GPS data string outputs from the GeoComm unit can be seen in Figure-3.



A representative plot of a GPRS tracked moving asset using GeoComm against the background of a Map can be seen in Fig – 4.



As seen from this figure, the tracking was accurate, reliable and repeatable.