Integrating Web GIS and Wireless Network for Secure Transportation

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ملخّص : يعتبر الأمن عامل مهمّ في نظام النقل . يهدف هذا المقال إلى شرح النظام المترابط الذي يؤمّن نظام النقل . لهذا الغرض إستعملت الشبكة المتحركة الحالية لكشف منطقة إتجاه السيارة. تمزج هذه المعطيات التلماتيكية مع مجموعة المعطيات الجغرافية الفضائية لإيجاد المعلومة الجغرافية داخل الخزّان SIG (نظام المعلومات الجغرافية) و خزّان الخريطة الذي يستعمل GPRS أو تكنولوجيا EDGE للدخول إلى شبكة الأنترنيت. حينئذ كل المعطيات الفضائية و الغير الفضائية مرتبطة لتشكيل نظام مترابط و يرسل مخرج هذا النظام إلى جهاز الإستقبال الموضوع في مركز الشرطة المجاور أو في سيارة الشرطة في الطريق السريع الذي يساعد السلطة على التدخل فورا.

Résumé : La sécurité est un facteur important dans le système du transport. L'objectif de cet article est de présenter un système cohérent qui offre une sécurité au système du transport. Dans ce but le réseau mobile actuel est utilisé pour détecter la zone du véhicule en marche et sa direction. Ces données de la télématique sont reliées avec les ensembles de données géo spatiales pour trouver l'information géographique dans le serveur SIG (Système d'Information Géographique) et le serveur de la carte qui utilise GPRS (Service de Communication Radio en mode Paquet) ou la technologie EDGE (Evolution de la Norme GSM Modifiant le Type de Modulation) pour l'accès à Internet. Alors toutes les données spatiales et non spatiales sont reliées pour constituer un système cohérent et la sortie de ce système est transmise au récepteur localisé au poste de police avoisinant ou dans la voiture de police en autoroute qui aide l'autorité à intervenir dans l'immédiat.

Abstract : Security is an important factor in transportation system. The objective of this paper is to present an integrating system which gives an instant security on transportation system. For this purpose existing mobile network is used to detect the vehicle moving area and its direction. These telematics data are accommodated with geospatial data sets to find geographical information from GIS (Geographical Information System) server and map server using GPRS (General Packet Radio Service) or EDGE (Enhanced Data Rates for GSM Evolution) technology to access the internet. Then all spatial and non-spatial data are bind to construct an integrating system and the output of this system is sent to the receiver that resides on neighboring police station or highway police car that helps the authority to take instant action.

1. Introduction

In our everyday life we need to go long distance for different purposes by bus, car etc. On the way to journey the vehicle may be assaulted by the terrorist. So the vehicles' moving area and other geographical informations should be found out and send to proper authority to rescue the passenger. Many transportation applications can be supported by centralized location and navigation systems which utilize communication network, host facilities and other infrastructures together with on-board vehicle equipment to locate and navigate [1]. When a vehicle is attacked by a terrorist, the information of the vehicle can be found by Automatic Vehicle Location Detection system (AVLS).But the problem in this system is that, the vehicle can be recovered after certain time while informing the situation to the service provider. During these time passenger lost their valuable things and even they may attacked by terrorist. So a system should be developed to save passengers instantly. Our goal is to solve this problem.

2. Previous Technologies

Various wireless and web based GIS technologies are used in location detection, Navigation Control and many other fields. Here is a snapshot about previous technologies.

2.1 Wireless Location Technologies

There are three most commonly used location technologies: stand-alone, satellite-based, and terrestrial radio-based [2]. As examples, a typical stand-alone technology is dead reckoning. A typical satellite-based technology is global positioning system (GPS)[3],[4].AVLS system use GPS technology to find vehicles' location. But The GPS receiver is costly and if we use it in mobile phone it reduce the battery life. For wireless E911, the radio-based (satellite and terrestrial) technologies are the most popular ones. Cellular networks are terrestrial-based communications systems. Commonly studied techniques to find location of mobile device are angle-of-arrival (AOA) positioning, time-of-arrival (TOA) positioning, and time-difference-of-arrival (TDOA) positioning [5]. But all of these techniques need multiple BTS to find exact position. Multiple BTS make cumbersome to detect location. This paper concentrate on single BTS and its sectorized antenna to fetch network data such as cell id, cell broadcast name, sector id to find out the location area to overcome the problems of multiple BTS and GPS.

2.2 GIS Web Technologies

GIS Web Services [6], [7] provide commercially hosted spatial data and GIS functionality via the Internet to web applications and users. In a nutshell, GIS Web service provides GIS content and functionalities to applications without having to invest in costly GIS software and platforms. ArcGIS Server [8] provides a standard framework for developing GIS server applications. The world's most popular GIS software (ArcView, ArcEditor, and ArcInfo) is built from this same set of software objects. ArcView GIS Server's ability to leverage web services makes it ideal for integration with other critical IT systems, such as relational databases, web servers, enterprise applications servers. There are different map servers that facilitate the web GIS service. MapServer excels at rendering spatial data (maps, images, and vector data) for the web. DBMAP ASJ Runtime server, ArcIMS etc. is some Map server. ArcIMS provides high performance web geo-publishing of maps and metadata. The proposed system uses ArcView GIS and ArcIMS as GIS and map server respectively.

3. Objective

The objective of this paper is to develop an integrating system which helps the police authority to gives an instant security for the passengers of assaulted vehicle. The system is divided into five phases:

•Phase 1. Collect network data from Base transceiver station (BTS) to find vehicle's moving area and direction using a transceiver that attached to the vehicle dash board.

• Phase 2. Collect geospatial data based on network data from ArcGIS server and ArcIMS server using GPRS or EDGE technology to access the Internet.

• Phase 3. Construct an Integrating System based on phase 1, phase 2 and other vehicle related information.

• Phase 4. Send the output of this system to neighboring police station or highway police.

• Phase 5. To find the updated data refresh total system after few second or few minute.

4. System Design

The system use an onboard hardware and software which is embedded in a vehicle .To find moving area of the vehicle the system use existing GSM network and to find geographical information (like map, image etc)about that area, it use GIS web service using GPRS or EDGE technology. On basis of information provided by the system of the assaulted vehicle, the authority of particular police station or highway police may take necessary steps to rescue the people instantly.

4.1 Hardware

The system needs a transceiver that attached with dash board of vehicle to collect BTS information from network and send vehicle information to the police station. This Vehicle Transceiver (VT) should support GPRS or EDGE to access web for geospatial data from geo-database and map server. Beside this there is also need to receiver device for remote police station which shows the street address and street map of assaulted vehicle.

4.2 Database Design

The system needs two databases for storing different spatial and non-spatial data. First database namely isystem_info is designed for proposed Integrated System Software (ISS) that reside on the vehicle. It contains four tables namely vehicle_info (vid, model_no, passenger_no, start_time, start_place, destination, speed), network_info (cell_id, cell_name, sector_id, sector_direction), ps_info (ps_code, ps_name, receiver_no), and map_info (area_code, street_addr, street_map).

It stores all vehicle, telematic, geospatial and map data collected from different sources. Second database namely isystem_geo_info is designed for spatial data that reside on geo-database in the GIS web server. It contains two tables namely street_info (cell_id, area_code, sector_id, street_addr), ps_info (cell_id, ps_code, ps_name, receiver_no). It provides spatial information about the street at where vehicle is moving on.

3.4 Software Architecture

The software manages all hardware and fabricates information from network and spatial data. The implementing software works automatically after pushing the interfacing button that attached with vehicle board. No other information is provided by the user. Therefore no other user interface is needed on the software. Its main tasks are divided into four sections which implements the four phases of the total system.

• Section 1: It collects network data from the vehicle transceiver and stores it in 'network_info' table of 'isystem_info' database. Data flow is shown on Figure 1.

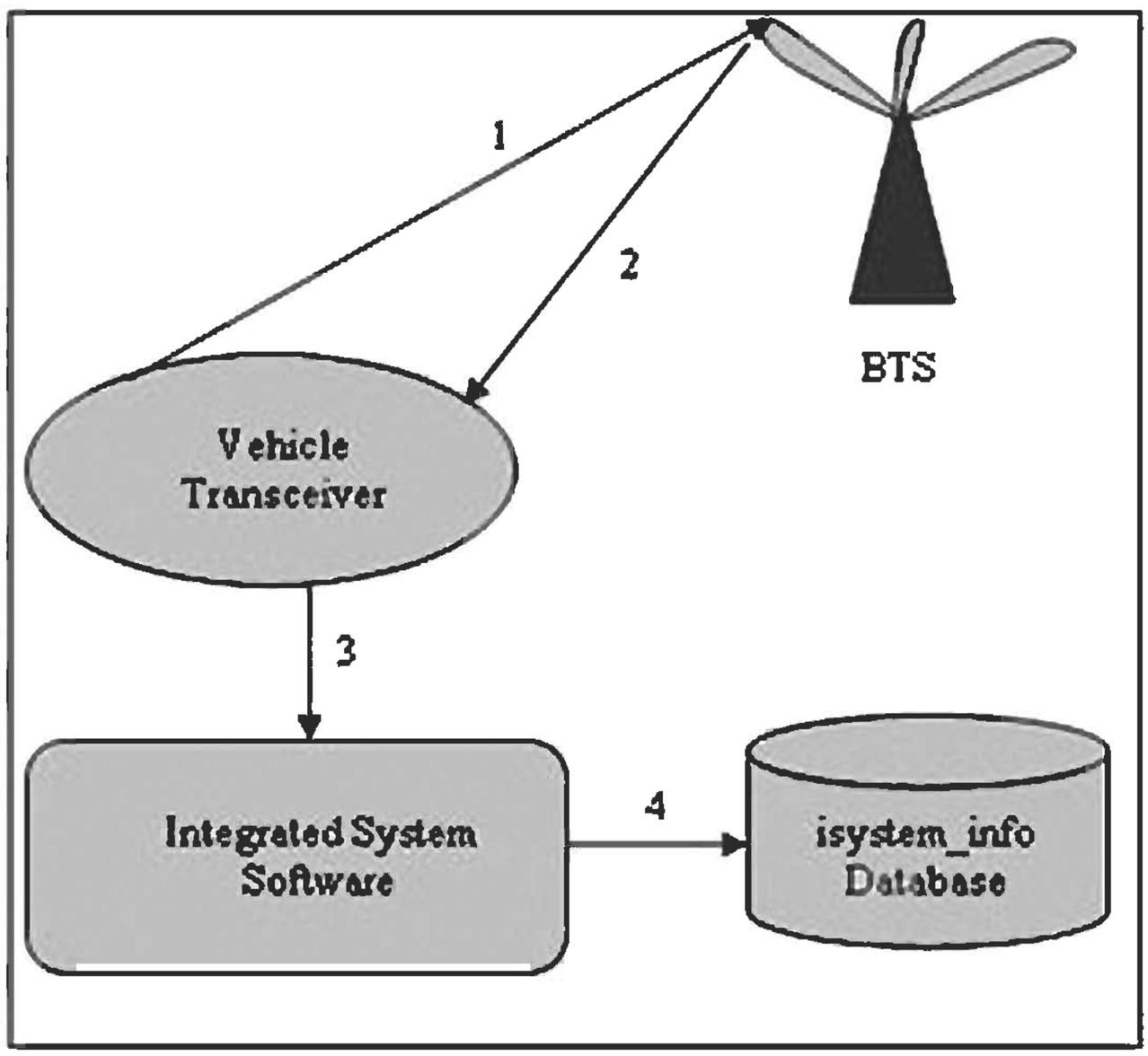

Fig. 1 Collect network data and store into isystem_info database.

• Section 2: It connects to GIS server and sends cell_id and sector_id as parameter. Using both parameter GIS server fetch street address and area code from 'street_info' table of 'isystem_geo_info' database. Also GIS server fetches PS Code, PS Name and PS Receiver No from 'ps_info' table of 'isystem_geo_info' database. Then all the street, area and PS information send back to ISS and stored in 'map_info' and 'ps_info' table of 'isystem_info' database. Data flow is shown on Figure 2.

• Section 3: After fetching information from GIS server it connect with ArcMap server and send a request for map of vehicle moving street address using 'area_code' and 'street_addr parameter'. Arc_Map server then fetches map from map database and sends back to ISS. Then update the 'map_info' table of 'isystem_info' database. Data flow is shown in Figure 3.

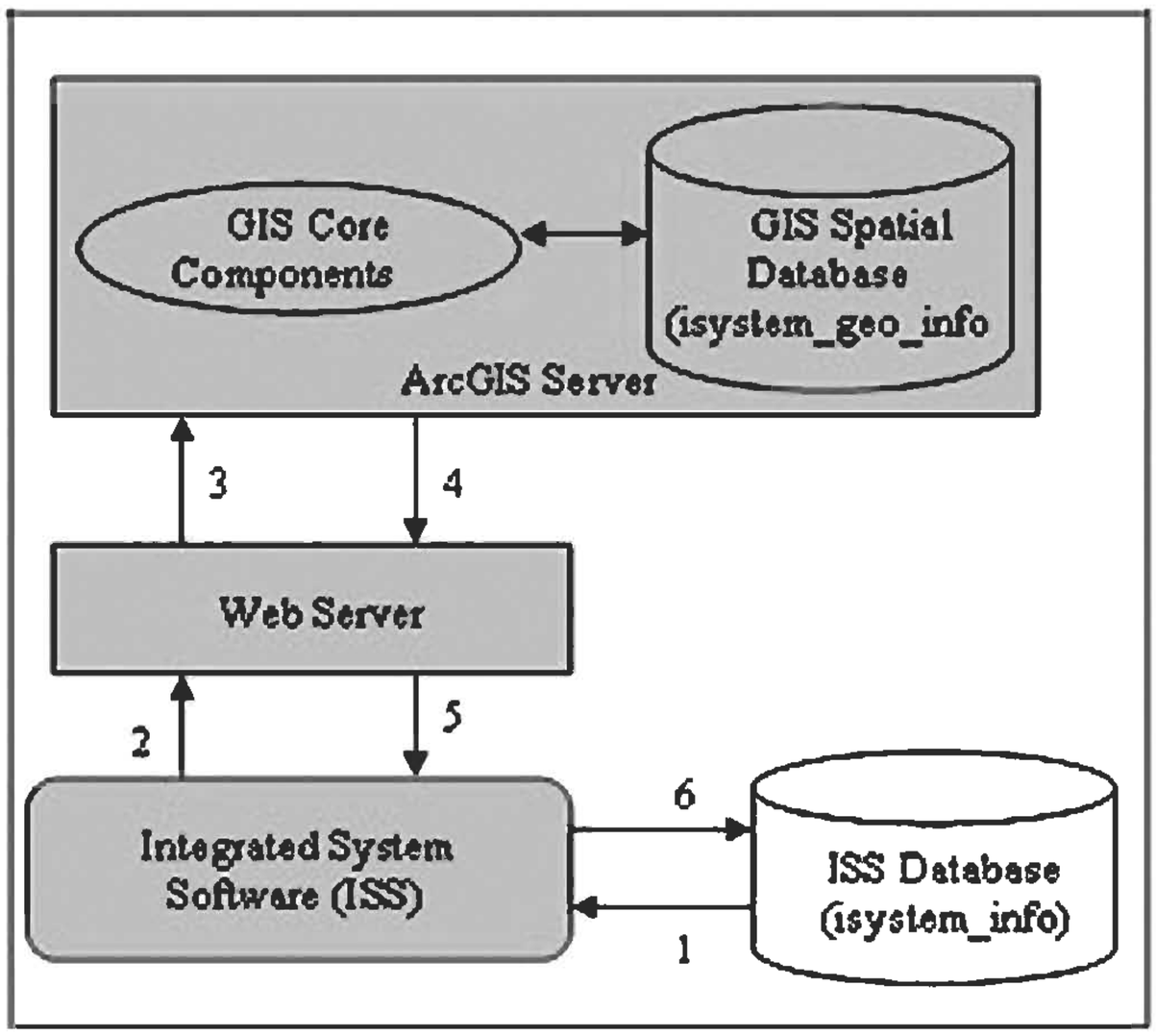

Fig. 2 Collect spatial data from ArcGIS server and store into isystem_info database.

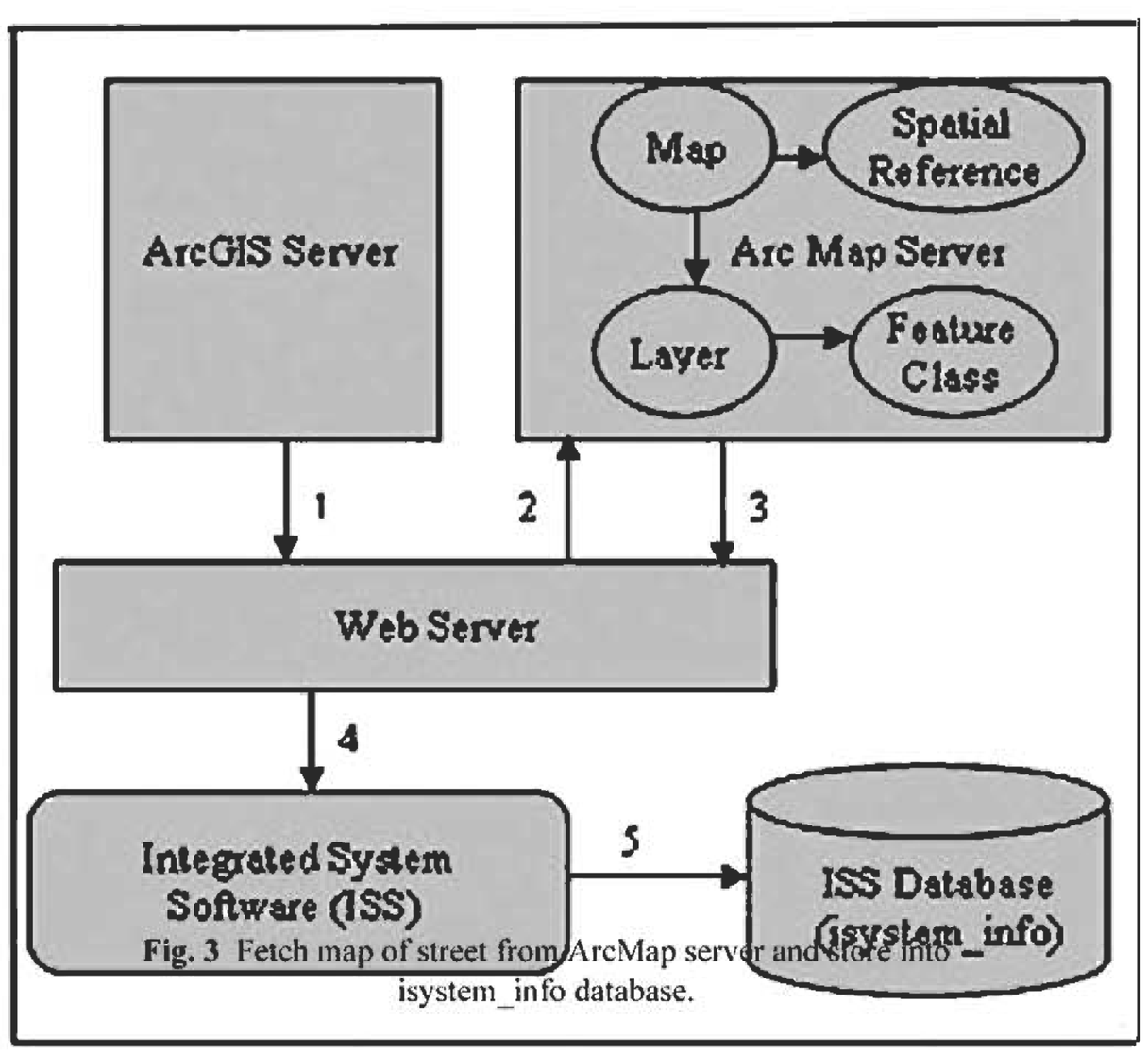

Fig. 3 Fetch map of street from ArcMap server and store into isystem_info database.

• Section 4: Finally it bind the vehicle information , street address and street map from 'vehicle_info' and 'map_info' table of 'isystem_info' database and send to receiver of particular police station or Highway police using 'receiver_no' from 'ps_info' table of 'isystem_info' database. Data flow is shown in Figure 4. While implementing section 1 and section 4, ISS uses GSM to access network and while implementing section 2 and section 3, it uses GPRS or EDGE to access the web.

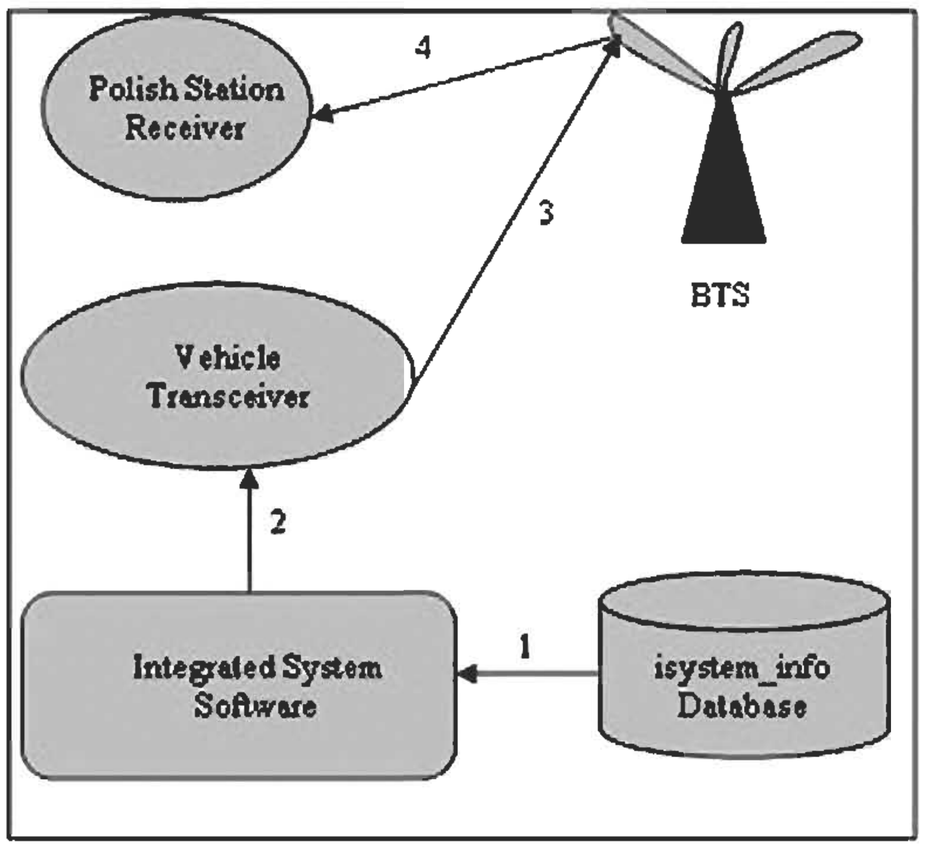

Fig. 4 Collect all spatial & non-spatial data about vehicle and send to the police station receiver.

5. Methodology

When a vehicle is assaulted by the terrorist the driver or security personnel push the button of Vehicle Transceiver (VT) that attached on the board. This transceiver connects with neighboring BTS and collects the following network data.

- Cell Id (CI) and Cell Broadcast (CB) Name
- Sector Id (SI) of GSM sectorized antenna.

After acknowledge from the BTS the system connected with GIS Server through VT to find out the geographical information (street address, neighboring police station etc) about the location where the vehicle is moving on. Then it connected with map server to find out street map. While the system connecting to map server, VT send all other non spatial data such as street address, vehicle info etc. to PS receiver to alert the authority. Then after fetching the map it bounded with other information and send to PS receiver. When the receiver alerts the authority, they will rush to the spot and save the passenger from a hazard situation.

Vehicle may reside at one position or moving continuously. While moving it change the sector of BTS also change the BTS itself. Therefore Street, Police Station also changes dynamically. So all the collected data of the system should be modify. To update all the data automatically the system refresh the software after few second or few minutes. No need to push the button again.

The Highway police or Authority of the certain police station always monitoring the receiver either it change its location or not after 1st alarm from vehicle. If the location is same for a certain time the vehicle is stopped on that street. If the location is changed they need to change their root to chase the vehicle. Two successive change of street give the direction of the vehicle. It helps them to chase the vehicle quickly. Each sectorized antenna has multiple sectors. Each sector is uniquely identified by Sector Id under a particular BTS. There are multiple BTS under a police station. Each BTS is uniquely identified by Cell Id. So while the vehicle changes the sector under same BTS and BTS under same police station it will not hamper the police authority to finish their task. But if the vehicle changes its BTS to new one which is under another PS, the responsibility is handover to that PS. The ISS stop transmitting the information to the previous PS and start transmitting the information to new PS. Then new PS takes responsibility to chase the assaulted vehicle. Thus particular police station is alerted by network automatically while moving the assaulted vehicle. Figure 5 shows the total architecture.

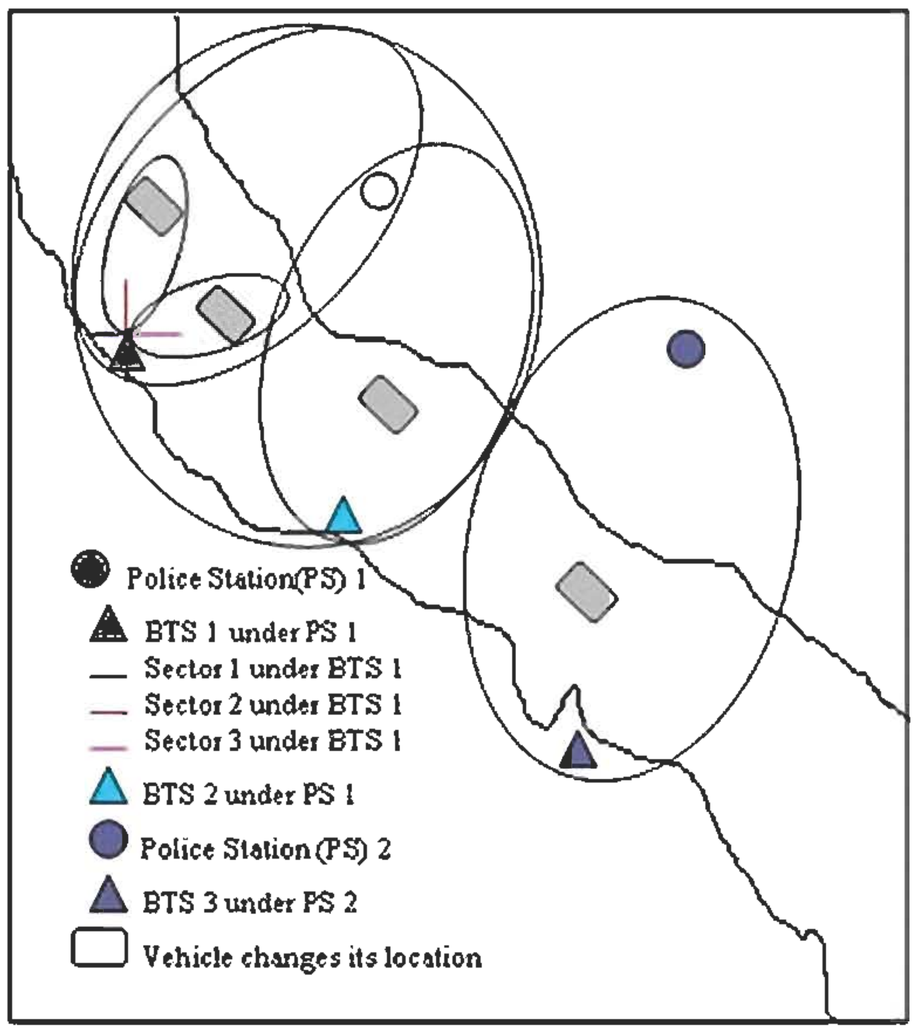

Fig. 5 BTS and Police station handover for the vehicle while moving

6. Conclusion

Many foreigners, tourist and aristocrat people rides on luxurious vehicles that move on the high ways. So the terrorist target the highways or big roads rather than small or branch roads to attack. Therefore this paper focuses on building integrating system that gives the security to vehicles on the highways or big roads. By implementing this system passengers fell more secure while roaming.

7. Limitations and Future Work

This research emphasizes an interactive system for vehicle tracking and rescue passengers are built for only high ways or big roads. Because only high ways street address are placed in geo-database.

In near future branch street address are included in geo-database. The system uses GSM antenna of three sectors. By increasing the sector (six sectors), precise location about vehicle moving area can be found. After little modification this system assures better security in transportation.

Performance is one of the most important limitations in the development of WebGIS and wireless technology. It is mainly because most spatial data including raster and vector data are large in volume [9], and also involve moving large spatial objects over the network between server and client. Though this proposed system is used GPRS or EDGE for web access for spatial data, it may slow the system if proper bandwidth cannot be found. At that case street map can not be supplied in proper time. In near future this system will be integrated with higher bandwidth wireless technology.

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