# PRE-HOSPITAL LOCATION BASED SERVICES (LBS) FOR EMERGENCY MANAGEMENT

**Alias Abdul Rahman (1) and SISI ZLATANOVA (2)**

Department of Geoinformatics/
Institute for Geospatial Science and Technology
Universiti Teknologi Malaysia
Malaysia
GIS Technology, OTB
Delft University of Technology,
The Netherlands

**ABSTRACT**

This paper reports on a large project aiming at speeding up the work of ambulance teams by via GPS, PDA and mobile phone with the base hospital. The focus of the paper is on describing the current scenario of the LBS for pre-hospital emergency and the requirement for such a system in a Malaysian hospital. Almost all hospitals are not equipped with an appropriate mobile, wireless spatial system. They still rely heavily on very manual and traditional systems. We also propose a possible architecture for the pre-hospital emergency system and discuss the numerous drawbacks because of which such a system is not easy to be fully implemented in a country like Malaysia. Finally, we describe the future works on the LBS for the much larger cases which involve many emergency related agencies.

Key words: Location-based services, User requirement analysis (URA), GeoMedia IntelliWhere.

## 1. INTRODUCTION

Tragic accidents happen every day all over the world causing injuries of different extend. The ambulance teams are the first to get to the place and provide medical help. The three basic tasks of the ambulances are: 1) to get at the site of accident in the fastest manner and 2) to provide the best treatment and 3) transport the patient to a hospital. We believe specialized location based services would greatly support the work of ambulances in completing these tasks. Location based services have already proven to be useful as people need information related to their position. Such information is especially important when there is an emergency situation, under stress and in unfamiliar environments (*Zlatanova, 2005a*). Questions like "where can I find certain assets", and "how do I get there?" are already offered and well supported by many systems. Research and initial developments are on the way toward 3D LBS systems, i.e. providing services with respect also to the third dimension (*Zlatanova and*

*Verbree, 2003, 2004, 2005*). 3D positioning and corresponding services is getting of critical importance for urbanized areas: large public buildings, tunnels and complex multi-level constructions.

With the rapid development of mobile communications and wireless technologies, more and more geoinformation applications have emerged from the field of mobile services (Montoya, 2003). Mobile GIS and LBS, both, have been largely making use of handheld devices. Most of the applications developed have utilized Pocket PC, PDAs, or handheld PC as mobile computer devices through the installation of existing mobile GIS software like ESRI ArcPad and Intergraph IntelliWhere. A wireless PC card attached to the PDA or a connection between PDA and a cell phone. Despite the developments, most of Mobile GIS and LBS systems have limited analysis functions. But analytical tools are essential for many comprehensive applications. Furthermore, LBS or mobile wireless GIS systems that are capable of supporting decision-making process are highly desirable.

This paper reports on a large project aiming at speeding up the work of ambulance teams by all-the-time wireless communication with the base hospital. The focus of the system developed within this project is the ambulance personnel working at the accident scene (e.g. traffic accidents, calamities, flooding). There are several specific characteristics within the work of medical personal on the field especially in large accidents (*Torg et al 2005*):

- The type of injuries (e.g. skin damages in fire, or breathing problems in gas leakage) are very similar, which might need large amounts of the same medicines and specialists;
- Many injuries may require immediate and simultaneous high qualified treatment (e.g. surgery), an unusual situation which may face limited capacity (in terms of equipment and teams) in nearby hospitals;
- The number of patients can rise significantly and will require mobilization of additional hospital units and equipment;
- Logistic problems, since many ambulances have to deliver several patients to more than one hospitals;
- Stress and panic among the injured people, which usually results in bad estimates of the number injures and needed treatment;
- A need for a very good real-time coordination and communication with police, fire brigade and the local authorities to speed up transportation of victims and evacuate non-injured to safe areas;
- A need for real-time communication and information to media, the public and especially relatives of injured people.

Clearly, a much better communication is required at several levels (*Zlatanova, 2005b*). Firstly, the cooperation between medical institutions and all the other organizations involved in emergency response has to be improved. Secondly, a better organization within the hospitals is urgently needed concerning the deployment of specialists, availability of medicaments, transportation, rooms and equipment. The services have to demand-driven and patient-oriented. Thirdly, the communication between the hospitals and the ambulances on the field has to be strengthened and (when needed) enhanced with a real-time supervision.

The system to be developed focuses on the third level, i.e. communication between hospitals and ambulances. This support will be in two directions: guidance ambulances to the place of accident (especially important in large urbanized city areas) and supplying information about the condition of the injured people prior their transportations to the hospital. It might happen that due to damages of roads or houses (as the disaster situation develops), the transportation of the patients has to be postponed and the injuries have to be treated locally. For a multinational country as Malaysia, personal information about patients such as gender, nationality, age, etc. appears to be of critical importance.

This paper reports on the first achievements within the project. Aspects of user requirement analysis, and interface development for the ambulance spatial subsystem form major discussions of this paper. The needs and requirements of ambulances in the region of Johor Bahru, Malaysia are focused, where most of the emergency response tasks are done manually based on the experiences of individual paramedic personnel.

The paper is organized in four general sections. The current structure and communication with the ambulances is presented in the first section. Gathered information allows concluding on directions for development of the application. The second section outlines major functionality of the application. A large discussion on initial experiments and tests highlights drawbacks and advantages compared with the casual methods of work. The last section outlines directions for improvements and further developments. Outlook of the development and future works on this newly ventured LBS application in Malaysia will be highlighted.

This project is supported by Intergraph and reveals the use of IntelliWhere in Malaysia – the first of its kind. We anticipated that the system could provide great opportunity for GIS community as well as for users on the move in the country.

## 2. The Pre-Hospital LBS User Requirements

Location-based services in Malaysia are relatively new and it has tremendous impacts on various emergency tasks such as hospital emergency unit, police, fire and rescue agency, and other "on-the-move" services and operations. The needs for these kind services and the benefits to the community have been addressed by several researchers (*Torg et al, 2005* and *Zlatanova et al 2005*).

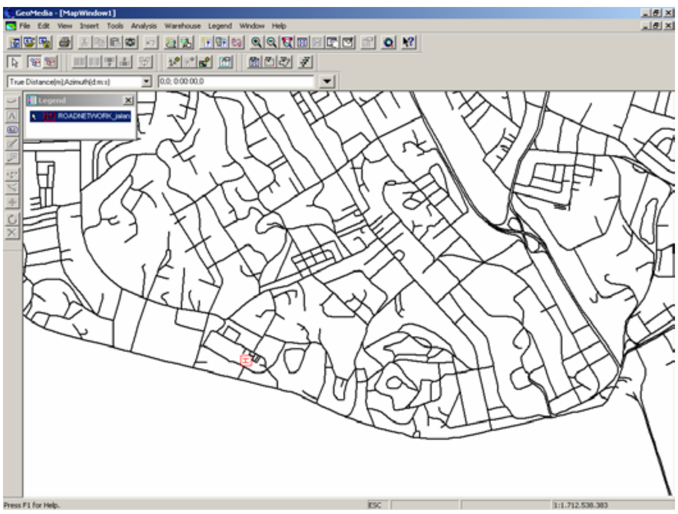

*Figure 1: The study area - Johor Bahru city.*

At the moment we are at the initial stage of introducing the LBS for a general hospital in one of the cities in Malaysia, i.e., Johor Bahru. Currently, most of the emergency response tasks are done manually based on the experiences of individual paramedic personnel. Efforts are underway to use mobile and wireless technology to support fast and timely decision making during chaotic and disastrous situations. Aspects of user requirement analysis, and interface development for the ambulance spatial subsystem form major discussions of this paper. The study area is within Johor Bahru district, south of Johor state, Malaysia, and incorporates with the *Sultanah Aminah* General Hospital. The hospital is located very close to city centre. Figure 1 (above) shows the location map of the study area.

## 2.1 The existing emergency procedures

The existing emergency system at the hospital operates quite primitive, i.e. without having proper tools like digital map, mobile communication, etc. The only available communication between ambulance unit and the base hospital is via walkie-talkie or radio-based communication. All distress calls (i.e. "911") will be channelled to a centralised unit, called "Call Centre". This centre then appoints one ambulance to the disaster location, which is equipped with only two medical personnel including one driver. In normal circumstances the injured person will be then transported to the hospital without any details information being relayed to the base hospital. This is a typical scenario of the emergency services available in most hospitals in the country at the moment. Currently the hospital is "manually" linked to a control centre at Pasir Gudang Local Authority (PGLA) which has a network of 44 participating agencies like police, military, fire and rescue, other hospitals, and factories (non and highly risk factories). High-risk factories are the majority in the network of emergency response system (i.e., the manual system).

The hospital emergency unit does have a simple procedure to manage the injuries in the field where three zones were assigned for each case. The zones are called "stable", "non-stable" and "special case". The special case is meant for very serious injury, or death. For the later zone, police team will examine the situation prior to the medical team. This is to gather all the necessary information as well as not to destroy the evidences, etc. for possible legal case. The entire system is all manual and paper-based record system.

Apparently, the emergency service will be much better and far more efficient by using a LBS-based system.

The hospital does not equipped with proper for registration system or software, and consequently they don't have any spatial data attached to the patient record. Thus basically, they don't have any useful data for spatial information system. The situation provides a good opportunity for a system like LBS to be developed from scratch.

## 2.2 The new emergency system requirements

User requirement were carried out by means of interviewing the officials of the hospital's emergency unit and investigating the current system of patient recording. The information collected was extensively analysed. The analysis resulted in guidelines to the developer like graphic user interface between medical personnel with the LBS system. The functionality of the systems, i.e. kind of services/operations to be developed was specified. Since the paramedic personal has no 'geo' background, the main requirement was to have a system that is easy to work with. The conclusions was, we need to have a simple, friendly system and yet able to provide relevant information timely.

The user requirement has helped us to specify requirements for the new system, i.e. it should be able to:

- Respond to all kind of emergencies: from traffic accidents to injuries caused by flooding
- Ensure communication between all the teams involved in the accident.
- Sending data to the hospital prior arrival for preparation of surgery teams.
- Provide access to census data or other databases which provide family information like craniofacial database, i.e. for face recognition of family members.
- Provide help at field (advises, supervision) from specialists located in the hospital.
- Navigate of cars (and people) to safe places or shelters.
- Track patients when transporting them to different hospitals.

## 3. The System Architecture

As mentioned above, the hospital does not have any system that eventually can be extended, upgraded to the specified functionality. This can be considered advantageous with respect to the design, i.e. the decisions on system architecture will not be restricted to existing systems. Apparently, two general components are needed, i.e. a on-the-move spatial subsystem, and a hospital subsystem (Figure 2). The two subsystems could be linked via cell phone or any wireless communication. Currently, the most feasible solution is using the available telecommunication networks. WLAN (Hi-Fi) or other possibilities for communication are simply not available.

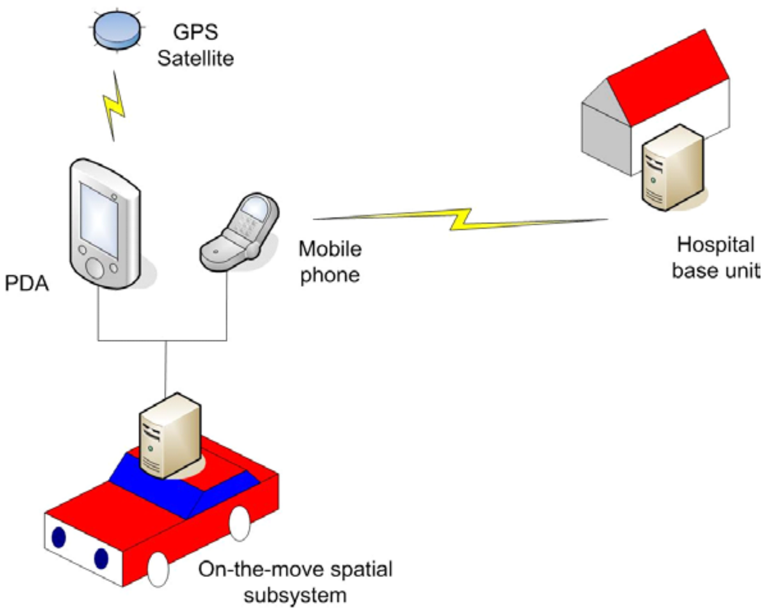


*Figure 2: The system architecture.*

For positioning, the ambulance is equipped with GPS receiver linked to the PDA. Few meters accuracy of GPS positioning is adequate for ambulance purposes as the coverage for GPS is normally good for "not so dense" city like Johor Bahru. The communication with the hospital is ensured by combination of mobile telephones and mobile devices (e.g. PDA). Via a specially designed for the purpose interface, the ambulance team can send a variety of data regarding the condition of the patient to the central in the hospital. The "on-the-move spatial" subsystem that available inside the ambulance supplies all the relevant spatial and attribute information especially, the right locations of the disaster point and the best route for transporting the patient. One of the goals is to have a map on the PDA as illustrated in Figure 3.

*Figure 3: Map on the PDA (attached to the ambulance unit).*

This gives time to the hospital teams to prepare for the appropriate treatment or operation. The ambulance personnel are able to ask for additional information if exist (e.g. a chronicle illness) from the hospital, so that most appropriate actions could be identified and taken. In both cases the teams (both at the ambulance and in the hospital) can more adequately react and quickly help distressed victims.

## 4. THE DEVELOPMENT AND IMPLEMENTATION CHALLENGES

Implementation of the pre-hospital LBS prototype is in progress. For the first prototype IntelliWhere OnDemand technology of Intergraph is used. The software was kindly offered for free by Intergraph. The software runs on PDA device with Pocket PC. In the current stage of development, the application does not yet use wireless networks in data transfer as illustrated in Figure 2. The application supports vector and raster maps that can either be polygons, lines, or points, and has some built-in functions like panning, and zooming. The user (inside the ambulance) can see their positions via crosshair and they are able to select features on the map by using pen.

To complete the prototype development for pre-hospital LBS application in Malaysia, we face several challenges:

- The spatial data transfer rate via mobile phone GPRS is expensive.
- Some of the GPS signals are not that good especially in areas of high rise buildings.
- Non availability of updated road networks and other important landmarks.

- Acceptance of the technology among the hospital personnel is very low – due to computer or IT illiterate.

Most of these challenges are beyond of our control and mean, however, they can be resolved since the mobile phone service provider is in position to reduce the rate especially for research works. Establishing or updating some parts of the city with new digital road networks. Awareness programs like discussions and workshops with the relevant hospital units especially on the benefits of the LBS system could bring the personnel and other hospital staff to the expected level of computer competency. To implement any IT applications at the units has to be done bit by bit (i.e. not so drastic).

**"The Bigger Picture" LBS for the PGLA Emergency Response System**

As mentioned in the preceding section, we intend to further develop the LBS system for disaster management that covers several important emergency related agencies as illustrated in Figure 4. Basically it is a multi-task mission, geographically covers much larger areas, more people, and demands more datasets and real-time network communication. The figure also illustrates simplified system architecture for the PGLA LBS system.

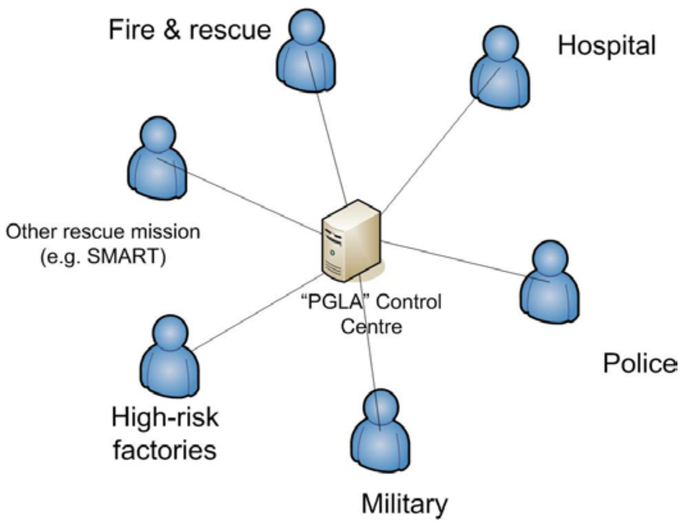


*Figure 4: The system architecture for the "Pasir Gudang" Local Authority (PGLA) control centre.*

## 5. Concluding Remarks and Future Works

We have discussed first steps and needs for the pre-hospital LBS system for disaster management in Malaysia. The paper briefly reviewed some of the important components for the LBS application. Existing status of the hospital emergency procedures and works were also briefly described where most of the works are still very manual and primitive (i.e. the existing hospital emergency system). We also highlight the needs for the new LBS system for managing the emergency situations and scenes between ambulance and the emergency unit at the base hospital. Since this is an ongoing project then a more complete prototype of the LBS system for pre-hospital emergency application could be unleashed in the near future especially on the aspect of user interface for the "on-the-move spatial subsystem", and the communication component between ambulance unit with the base hospital could be properly developed. "The bigger picture" LBS emergency system is definitely will be our future case study.

## REFERENCES

*Montoya, L. (2003).* Geo-data acquisition through mobile GIS and digital video: an urban disaster management perspective. *Environmental modeling and software*. Vol. 18, No. 10, pp. 869-876.

*Peng, Z. R. and M. H. Tsou (2003).* Internet GIS. John Wiley. 679 p.

*Togt,R., E. Beinat, S. Zlatanova, and H.J. Scholten (2005).* Location interoperability services for medical emergency operations during disasters, in: P.J.M. van Oosterom, S. Zlatanova & E.M. Fendel (Eds.), Geo-information for disaster management, Springer Verlag, Heidelberg, pp. 1127-1141.

*Zlatanova, S. and E. Verbree (2005)*. The third dimension in LBS: the steps to go, The 3rd symposium on LBS&TeleCartography, 28-30 November, 2005, Vienna, Austria. 8 p.

*Zlatanova, S. and E.Verbree (2004).* User tracking as an alternative positioning technique for LBS, in Proceedings of the Symposium on Location Based Services & Telecartography, 28-29 January, 2004, Vienna, Austria, pp.109-115

*Zlatanova, S. and E. Verbree (2003).* Technological Developments within 3D Location-based Services, International Symposium and Exhibition on Geoinformation 2003 (invited paper), 13-14 October 2003, Shah Alam, Malaysia, pp. 153-160

*Zlatanova, S., A. G. Fabbri, and J. Li (2005).* Geoinformation for disaster management – large scale 3D data needed by urban areas. *GIM International*, Vol. 19, No. 3, pp. 10-13

*Zlatanova, S, (2005a).* Crisis designs, Geospatial Today, May-June 2005, Vol 4, Issues 1, pp. 30-36

*Zlatanova, S. (2005b).* A proposed system for emergency system architecture in urban areas, Directions magazine, oct18, 2005,

## ACKNOWLEDGEMENTS

Grant received from the Intergraph as well as cooperation from Sultanah Aminah General Hospital is greatly acknowledged. We also would like to thank Drs. Pieter Jongert from Intergraph, the Netherlands as well as to Mr. Sharif Idros from Pasir Gudang Local Authority, Malaysia for their input.

## CVS OF THE AUTHORS

**Alias Abdul Rahman**, received his PhD from University of Glasgow, UK (2000). He worked on TIN data structuring at ITC, The Netherlands for his M.Sc. degree in 1992. He is an associate professor at the Department of Geoinformatics and Institute of Geospatial Science and Technology, Universiti Teknologi Malaysia (UTM). He focuses on 3D GIS, 3D visualization and 3D spatial data modeling as his research interests.

**Sisi Zlatanova** is an assistant-professor at the Institute for housing, urban and mobility study at TUDelft, the Netherlands. She has received her PhD at Graz Technical University, Austria in year 2000. She is chairing a working group within ISPRS on 'Spatial data integration for emergency response'. Her main research interests are in 3D: modeling, geo-databases, virtual reality and web GIS, and their applications for emergency response.

**CO-ORDINATES**

Dr Alias Abdul Rahman
Universiti Teknologi Malaysia
Faculty of Geoinformation Science and Engineering
Department of Geoinformatics
81310 UTM Skudai
Johor
Malaysia
Telephone number : +607-5530563
Fax number : +607-5566163
E-mail address : alias@fksg.utm.my
Website : www.fksg.utm.my/alias

Dr Sisi Zlatanova
Delft University of Technology
GIS Technology, OTB
Jaffalaan 8
2628 BX Delft
The Netherlands
Telephone number : +31-15 278 2714
Fax number : +31-15 278 2745
E-mail address : s.zlatanova@otb.tudelft.nl
Website : www.gdmc.nl/zlatanova