Wireless Location Based Services (Wi-LBS)

by

Muhammad Dhiauddin bin Mohamed Suffian

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Technology (Hons)
(Information Systems)

DECEMBER 2004

Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

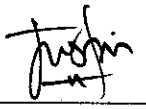
Wireless Location Based Services (Wi-LBS)

by

Muhammad Dhiauddin bin Mohamed Suffian

A project dissertation submitted to the
Information Systems Programme
Universiti Teknologi PETRONAS
in partial fulfillment of the requirements for the
BACHELOR OF TECHNOLOGY (Hons)
(INFORMATION SYSTEMS)

Approved by,

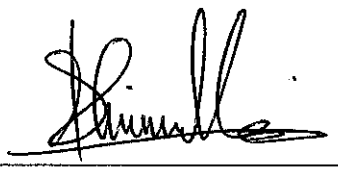


(Mr. Justin Dinesh Devaraj)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
December 2004

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



MUHAMMAD DHIAUDDIN BIN MOHAMED SUFFIAN

ABSTRACT

The needs and demands on location information have arisen rapidly. With the advancement of mobile computing technologies, many researches and studies have been conducted in providing reliable location information solution. Location based information has become an important resource for mobile users especially in giving direction or locating places. Wireless Location Based Services (Wi-LBS) highlight this scenario by explaining the application and usage of the LBS in wireless environment. Wi-LBS is introduced with respect to providing wireless method in locating places within UTP campus instead of referring to static map. The objective of this research is to integrate GIS with MMS technology as a system called Wireless Location Based Services. It is mainly focused on applying GIS elements in providing location information by utilizing the advancement of today's wireless handheld devices. Users will request for location by sending short messages using their mobile phones to the Wi-LBS system and the system will reply back sending the location information containing pictures and direction. Rapid Application Development (RAD) is used as the methodology in designing the system of Wi-LBS. This research also details the study on Multimedia Messaging Service (MMS) that covers the sending of picture messages from Wi-LBS to mobile phones and system's function in responding to the users' requests. Various references and studies have been done regarding the successful LBS applications implemented in foreign country that leads to the interest of doing the research on LBS implementation in this country. The result from the research will be the proposed framework for Wi-LBS, the discussion on the GIS and MMS as well as the system of Wi-LBS. This study proved that Wireless Location Based Services has great potential to be commercially implemented with the growth of wireless application nowadays as today's community is eager of getting more services from wireless system.

ACKNOWLEDGEMENTS

First and foremost the author would like to recite his greatest gratitude to the Most Merciful Allah for giving me the opportunity in completing this Final Year Project. High gratitude goes to Mr. Justin Dinesh Devaraj, the Project Supervisor for his guidance and assistance provided throughout the project. Thank you for being patient, motivating and sharing all the knowledge and experiences in completing this project.

Thank you to Mrs. Saadiah Saat for her support and cooperation in this project. To other Universiti Teknologi PETRONAS's lecturers and staffs, thank you for all the teachings and assistance given. Your teachings and efforts will always be remembered.

Greatest appreciation goes to the author's parents for the encouragements and invaluable advice in making this project successful. To other family members, thank you for the time and cooperation given.

Not forgotten, appreciation goes to all colleagues and friends who had contributed a lot to the success of this project. Thank you for the friendship and full support in completing this research.

Last but not least, thank you to those individuals whom their names are not mentioned here. The contributions given in accomplishing this project, whether directly or indirectly are very much appreciated.

Thank you very much.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND NOMENCLATURES

2D	2-Dimensional
3D	3-Dimensional
4D	4-Dimensional
B2B	Business to Business
B2B2C	Business to Business to Consumer
B2C	Business to Consumer
BMP	Bitmap
CASE	Computer-Aided Software Engineering
COM	Component Object Model
CPU	Central Processing Unit
DBMS	Database Management System
DVD	Digital Versatile Disc
ESRI	Environmental Science and Research Institute
GIF	Graphic Interchange Format
GIS	Geographical Information Systems
GPRS	General Packet Radio Services
GPS	Global Positioning System
GSM	Global System for Communication
GUI	Graphical User Interface
IDC	International Data Corporation
IP	Internet Protocol
IT	Information Technology
J2ME	Java2 Platform Micro Edition
JPEG	Joint Picture Expert Group
LBS	Location Based Services
MMS	Multimedia Messaging Service

PC	Personal Computer
PDA	Personal Digital Assistant
PHP	Hypertext Preprocessor
RAD	Rapid Application Development
RAM	Random Access Memory
SMS	Short Message Service
SQL	Structured Query Language
UMTS	Universal Mobile Telecommunications System
UTP	Universiti Teknologi PETRONAS
VBA	Visual Basic for Application
WAP	Wireless Application Protocol
Wi-LBS	Wireless Location Based Services
WML	Wireless Markup Language
XML	Extensible Markup Language

CHAPTER 1

INTRODUCTION

The emergence of wireless communication technologies and mobile devices has introduced new trend in accessing mobile services. Mobile phones have revolutionized the communication and drastically affected the lifestyle of modern people. The small size of mobile terminals such as mobile phones and Personal Digital Assistants (PDAs) are converging into smart phones and communicators that are more equipped with advance technology and capabilities. The intrinsic features of mobile terminals such as high portability and personal nature allow mobile users to store and access information wherever they go at any time. As for the Geographical Information Systems (GIS), we are currently observing the renaissance of GIS that emerge with mainstream IT called Spatial IT, which derives from the advancement of new spatial database, web and wireless technology. The GIS that was born in late 1960s has been actively called out to serve increasingly critical enterprise-wide roles. Realizing the needs of exploiting these technologies have brought to the establishment of Location Based Services (LBS).

Basically, the establishment of LBS is stimulated by the need for an up to date geographically sensitive information, advances in hardware size, performance and power consumption, and improvements in network bandwidth, a new breed of mobile geographic applications is being developed that promise to change forever the way we use geography in home and professional life (Maguire, 2002). This has brought to the foundation of Mobile Geographic Services that mainly focuses on integration of wireless and GIS.

Location Based Services (LBS) is defined as applications that provide location-based information when and where it is needed. It delivers geographic information and geo-processing power to mobile and static users via the Internet and wireless network in accordance with current location of users (Dragon H. Stojanovic and Slobodanka J. Djordjevic-Kajan, 2001). Thus, when discussing on Wireless Location Based Services (Wi-LBS), it is actually defines the wireless method of accessing geospatial information via mobile devices or handheld devices. Wi-LBS is characterized by their ability to support itinerant, distributed and ubiquitous computing. Itinerant provides computing capability while moving with a person, in a vehicle, or on an aircraft or ship. As for distributed, it integrates functions that are performed at different places in a way that is transparent to the user while ubiquitous delivers the same functionality independent of a user's location. Location is central to the operation of Wi-LBS. Reliable location definition ensures the efficient management and use of data both on the application and between the device.

1.1 Background of Study

The project on developing Wireless Location Based Services (Wi-LBS) is aimed to cater several purposes and needs. As LBS has become increasingly important and emerges with current technology, the study is focused on GIS side in providing location based information and also wireless part as the medium of distributing that information. Universiti Teknologi PETRONAS (UTP) is the area of study where the research on GIS and MMS is done. The research on GIS is narrowed to performing simple spatial data search, in the context of how the analysis process is performed in the GIS to come out with the location information. For the MMS part, the area of research will focus on integrating wireless system with GIS and how the result produced by GIS is distributed to users using mobile phones. The system will demonstrate how users use their MMS mobile phones by sending request to the system and retrieve the result in the form of

Picture Messages showing the buildings or places as well as roads for pathway to go to their desired location from current location.

1.2 Problem Statement

1.2.1 Problem Identification

Several problems and circumstances have been identified with respect to this project that shows the need to have wireless computerized solution of getting location information:

i) **Too many buildings**

The establishment of new academic complex and chancellor's complex has introduced new locations that consist of many blocks, rooms, lecture halls and Information Resource Centre; adding up to the existing buildings in UTP. So there is a need for visual direction in a form of picture message showing the direction to that particular location.

ii) **Possibilities of getting lost with direction**

As many new locations introduced, there are possibilities of getting confused or getting lost with direction in searching for rooms and other locations within UTP. This is due to new names of lectures halls, labs, rooms and offices. Besides, the locations of classrooms are not centralized at new academic blocks since some lectures or tutorials are still conducted at old buildings.

iii) **Needs to look for PC to find place**

Currently, there is no wireless solution for finding location in UTP, especially by using mobile phones or other mobile devices. In order to search for particular location, users need to look for PC by referring to the tables and maps provided

in UTP website. However, after certain period, the link to the UTP map's page will be removed. So, users have to find other alternative such as asking other people to know the location.

iv) **Need to bring paper maps for direction**

UTP community including staffs, lecturers and student still refer to the paper map to find respective location within UTP area. They need to bring paper map to find the particular location. Moreover, certain information in the maps is not updated and this might cause difficulties to them in finding the places.

v) **Utilize the capabilities of mobile phones**

Mobile phones have been such a need nowadays in which it is said as must for everyone to communicate with each other. Thus, it is beneficial to utilize the capabilities of this device by offering new service of finding location that is accessible via mobile phones, instead of just being used for phone calls, playing games or sending and retrieving SMS.

1.2.2 Significance of the Project

The significance and importance of this project can be expressed in various ways as follows:

i) It provides a starting point of implementing Wireless Location Based Services (Wi-LBS) through the establishment of the system for this project. This will lead to the advancement of this system into a more complete system, that is from a system for a small area to a larger system that cater the needs of larger place.

ii) It will provide and promote new method of finding location within UTP area using mobile phones that could benefit UTP community including staffs, lecturers, students and visitors.

iii) It will prove that wireless and GIS can be successfully integrated to produce a reliable location based services and has potential in the future to become new trend of mobile services.

iv) It provides a foundation for research-based studies on the elements and aspects incorporated in designing and developing location based services solution.

v) It suits the needs of UTP community in finding location in faster and efficient ways using picture messages via MMS mobile phones.

1.3 Objectives and Scope of Study

This study will cater needs of UTP staffs, lecturers and students within UTP area only. This study will benefit and provide new alternative to UTP community in which they will be able to find location within UTP campus by using their own mobile phones. In addition, the system developed from this study will serve as the system of Wireless Location Based Services for UTP campus.

The objectives of this study:

i) To introduce and provide wireless method of determining and finding the location of buildings, departments, residential colleges, academic complex and other places within UTP surrounding.

ii) To benefit users, especially students and lecturers in locating particular blocks, building and classrooms using wireless method, instead of referring to paper map.

iii) To view and display images of UTP campus on mobile phone with Multimedia Messaging Services (MMS) technology.

iv) Integrate Geographical Information Systems (GIS) with wireless technology as a system called Wireless Location Based Services (Wi-LBS).

1.3.1 The Relevancy of the Project

This study aims to establish a system of Wireless Location Based Services to cater the needs of UTP community. For this purpose, functionalities or features of today's mobile phones have been utilized by exploiting the MMS feature. The rationale of this project is actually to highlight the capabilities of Location Based Services to work with MMS mobile phones in sending and retrieving spatial data. This project deals with a large volume of spatial data, which is the vital element in GIS. Analysis is performed on UTP spatial data through simple spatial data search. Users make the request by sending plain text messages or SMS. The system will do the simple search and match the request with result. The result will be generated to images and will be sent to users. Users will receive the result in the form of picture messages via their MMS-enabled mobile phones. This project promotes a new dimension of mobile services and will benefit UTP community. It helps the visitors that are not very familiar with campus environment, to find buildings or rooms in UTP campus. Hence, it could provide a basis of new research studies on the importance of location based services.

1.3.2 Feasibility of the Project within the Scope and Time Frame

This project and study are feasible to be conducted within the scope defined and the time frame given. The project is able to prove that Location Based Services capable to integrate Geographical Information Systems (GIS) with wireless technology. This project is feasible to come out with a system that able to display UTP image in MMS mobile phone since the research only focuses on analysis of simple search on UTP spatial data and procedures of sending the image via wireless network to be viewed by users.

CHAPTER 2

LITERATURE REVIEW AND THEORY

2.1 Introduction to Geographical Information Systems (GIS)

Geographical Information Systems (GIS) is a system of computer software, hardware and data, and personnel to help manipulate, analyze and present information that is tied to a spatial location. It is a computer based technology and methodology for collecting, managing, analyzing, modeling and presenting geographic data for a wide range of application (Davis, 2001). Geography is helping people make better decisions in many disciplines, such as location services, media, natural resources, transportation, forestry, mining and earth sciences. Geographic data can be gathered and organized to support the generation of information products to help organizations run better

2.2 Introduction to Location Based Services (LBS)

Location Based Services (LBS) is defined as the ability to find the geographical location of the mobile device and provide services based on the location information (Prasad, 2000). It uses the notion of location to help generate a product or provide a service to an end-user or to another application. Location can be an absolute position in term of latitude/longitude coordinate, a recognized landmark, a relative position such as a cell boundary or within a city limit. LBS determine and transmit location of persons within mobile network by means of mobile terminals (Virrantaus, Markkula, Garmash, Terziyan, Veijalainen, Katanosov and Tirri, 2002). Mobile users can access information from the LBS by using their mobile terminals, which in this case is the mobile phones, in any time and any place.

LBS are classified by their functionality and utilization of location information. The first one is location-based information services that utilize mobile users' present location. It is well known as positioning services. It is usually combined with digital map associated to users' location, which is also called a map service. It becomes a city guide service when it is augmented with an access to some point-of-interest location information. When it includes capabilities to search for real-world physical services, it is said to become yellow pages service. Hence, it is called navigation service when it supports finding of the way to specified destinations. The other type is location-based functional services that use mobile user's present location but provide some function instead of information. Another one is location-aware services that use "push" services where the user's position or proximity to another object triggers some event or defines some condition (Virrantaus, Markkula, Garmash, Terziyan, Veijalainen, Katanosov and Tirri, 2002).

There are three (3) major components of LBS. The components are Mobile Computation Services (Communication and computations using mobile devices), Location Enabling Services (User Location Providing) and Location Aware Services (IP based applications). Basically, several conventional services are available in the area of location-based services (Sumit Sen and Smita Sengupta, 2000):

1. Wireless Service Providers (also termed as Gateway Service Providers) have provided basic Location based services to its consumers. The positioning technology involved in such offerings ranged from signal based technology to GPS systems.
2. The data interchange between each module uses proprietary formats and interfaces to the system are available at the periphery only
3. Application Service Providers who are partners to these service providers mentioned above develop LBS applications on Development platforms given to them.

4. The Application service provider rents GIS data servers and data updating to third party vendor or by them.
5. The GIS data Servers are based on proprietary or open standards based. The server is chosen based on the Application Service Provider's requirements.
6. The Mobile Device manufacturers in association with Network Gateway Manufacturer provide LBS applications capabilities on the handheld devices.

Based on researches and studies, the author found that in general, location based services provides basic services such as finding location of specified-located object, finding all located objects at a given location and measuring the shortest distance to go the desired location from initial point within specified area.

2.3 Short Message Service (SMS) and Multimedia Messaging Service (MMS)

Short Message Service or SMS as it is more commonly known, is based on the capability of digital cellular terminal to send and / or receive alphanumeric messages (Peersman, Cvetkovic, Griffiths and Spear, 2000). The messages can be up to 140 bytes in length and are delivered within few seconds where Global System for Communication (GSM) coverage is available. It is more than common paging service. The delivery of message is guaranteed even when the cellular terminal is unavailable. The network will hold the message and deliver it shortly after the cellular terminal announces its presence on the network. There are two types of SMS: cell broadcast and point-to-point. In cell broadcast, a message is transmitted to all active handsets or mobile stations present in a cell that have the capability of receiving short messages. In point-to-point services, messages can be sent from one mobile to another or from PC to a mobile and vice-versa. From this, it is possible to incorporate the capabilities of SMS in developing the system of LBS.

As the GSM technology emerges, variety of messaging services has been added with establishment of Multimedia Messaging Service (MMS). MMS is intended to provide rich content to mobile subscribers in a messaging context (Wireless Application Protocol Forum Ltd., 2001). It supports both sending and receiving of such messages by properly enabled client devices. MMS provides communication of multimedia data types such as text, image, audio as well as video (Syed, Mandal, Zeineddine and Rahime, 2003).

As the area of research narrowed to MMS, the main concern is the components in MMS system. The components are not so much different with SMS system components. MMS system consists of MMS Client, MMS Proxy-Relay, MMS Server, MMS Gateway, Email Server and Legacy Wireless Messaging System (Gratschew, Raitaniemi, Ylinen and Loula, 2003).

2.4 Integration of MMS and GIS Supporting LBS

Discussing on the integration of MMS with GIS, it brings the author to study in details on Wireless GIS. Wireless GIS allows people to access spatial information using wireless environment (Mohammadi, Alesheikh and Ghorbani, 2003). Wired GIS cannot meet the demand of the users in many situations with the new challenges in the work and life. About eighty percent (80%) of the whole information is spatial related data, thus this leads most of mobile device users access spatial information via wireless network. Wireless GIS is developed under web GIS technology, and there are many similarities between these two. However, wireless GIS has its own characteristics, because of the limitation of the mobile devices and the wireless communication network and technology.

Shuichi Takino in his paper on "GIS on the Fly – Realizing Wireless Network GIS by Java Mobile Phone" stated that wireless GIS is aimed to achieve these objectives:

- Development of GIS architecture that will resist heavy transaction workload and support constructing huge network
- Development of mobile terminal GIS architecture that is independent from career provider and terminal hardware.

GIS supports the successful development of LBS. This is based on several important aspects of GIS, which offer extra value to LBS. The aspects include geographic data collection and conversions, geographic data management, geographic data analysis and geographic data presentation (Virrantaus, Markkula, Garmash, Terziyan, Veijalainen, Katanosov and Tirri, 2002). Considering data collection and conversions, knowledge and methods of GIS can support LBS development. Different data collection and digitization methods are used and new methods are all time developed. GIS data are not only made of points, but also lines and polygons. Furthermore, from the aspect of geographic data management, nowadays, geographic databases are open and have standard interfaces, so in theory, there is no problem in distributed geo-processing and interoperability. Spatial relational data management systems and graphical / spatial extensions of standard development environments make this possible.

Considering geographic analysis, LBS get support from strong sub-component of GIS in spatial data processing since GIS analysis is making transition from simple geometry and topology based analysis tools towards more advanced computational methods and spatial modeling. The advancement of GIS data presentation has taken place from traditional visualization 2D-maps into interactive, animative, 3D and 4D virtual models that provide strong support for the development of LBS. Mobile users can benefit from LBS by viewing map on their personal terminal that consists of map drawing, sound and text. In addition, the existence of large geographic databases is major potential resource that can be utilized in LBS.

LBS and Wireless GIS are interrelated which possible for the development of Wireless LBS. LBS is anywhere, anytime mobile computing. In practical terms, it represents the merger of four (4) new technologies that are Personal Digital Assistants (PDAs), GIS for PDAs or other handheld devices such as ArcPAD for ESRI, Real time GPS positioning as well as wireless Internet and infrastructure. As GIS is merging with mainstream IT, new term has been introduced called Spatial IT that provides wider and more descriptive term that GIS. Spatial IT encompasses all aspects of collection, modeling, analysis, management and use of spatial information (Tarle, 2002). This shows the relationship between Spatial IT and LBS.

2.5 Wireless Location Based Services (Wi-LBS)

Wi-LBS indicates the way of distributing spatial data and information to users using wireless technology. This could be done via mobile phones, PDAs or any other handheld devices. The ultimate goal is to automatically provide location-based information to the wireless device, allowing users to find interesting places and events, and even alerting them to special announcements. But this vision requires not only a convenient and portable mobile wireless device, but the device must also have some sort of automatic and accurate positioning hardware (Dixon, 2000). However, the wireless location based services grow much slower than expectations. One of the major causes is the inefficiency of current geographic coordinates used to represent locations and areas. Because geographic coordinates such as longitude/latitude require about 20 characters to represent locations to the accuracy of meters, these coordinates are extremely difficult for general consumers to read, input, communicate and remember and therefore are nearly useless to users (Shen, 2003).

Wireless Map Service is an important service under Wi-LBS that many people need because in many situations, maps can be much clearer and more efficient to present

spatial information than other descriptions. It is a service that no wireless carriers afford to ignore. The map service can share the same geographic database with the driving directions service. Another important wireless service is Wireless Location Based Search Service. When people travel in an unfamiliar area, especially in a suburb area where not many people available to give helps, this wireless service will be really helpful (Shen, 2003).

Location specific information, delivered conveniently to the user, in a timely manner represents significant value by enabling informed decisions and actions. The immediate temptation is to think of location purely in terms of the graphic shapes and textual information as represented on traditional street maps. However, this is merely one representation of the underlying geographic information. Information about streets, postal codes, regional names, landmarks, building addresses also describe our geographic environment. Satellite and aerial photographic data contain geographic information. Business listings and customer databases contain geographic relevance in the form of address data. Time related events such as weather conditions or traffic information are also location sensitive. With the advent of automatic position determination technology (GPS and GSM), mobile vehicles, business users and consumer users have also become location sensitive (Appelbe, 2003).

So, no matter what the location, the important information is behind the interface, with databases of places of interest, timely updates of current information, and appropriate waiting response. These are the challenges of Wi-LBS in assembling, updating, and distributing mass of information in a convenient way to suit users' mobile device.

CHAPTER 3

METHODOLOGY / PROJECT WORK

3.1 Procedure Identification

The methodology being used in the development of the system is Rapid Application Development (RAD). RAD methodology emphasizes extensive user involvement in a rapid and evolutionary construction of working process of a system to accelerate the system development process. RAD helps in decreasing time needed to implement information systems radically through speedy development and shorter schedules. RAD aims to analyze business process rapidly, design a viable system solution through intense cooperation between users and developers as well as to get the finished application into the hands of users quickly. This methodology relies on extensive user involvement, Joint Application Design session, prototyping, integrated CASE tools and code generators.

RAD methodology consists of four (4) phases: Requirements Planning Phase (Analysis), User Design Phase (Design), Construction (Detailed design and code generation) and Cutover (Installation and Handover). This project will go through all phases in order to come out with the system of Wireless Location Based Services. The following diagram depicts the relationships between stages in the RAD process.

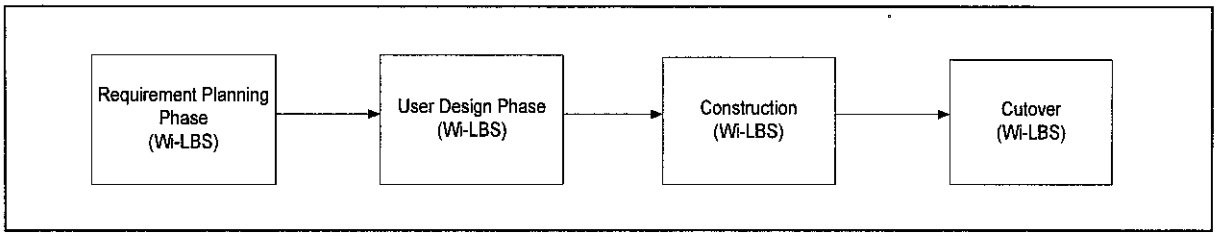


Figure 3.1: Rapid Application Development Process

3.1.1 Requirements Planning Phase (Analysis)

It is also known as the Concept Definition Stage. During this first phase of RAD, the author identified the objectives of this project and the requirement specification including hardware and software requirements for the system. The problem and related scenario were also identified and analyzed. In addition, the scope of the project was clearly identified in this phase, which is Universiti Teknologi PETRONAS itself as the area of study. Author determined the tasks and activities that will be incorporated throughout the project with respect to time frame given. In addition, the author spent a lot of time throughout this analysis phase by conducting many readings and studies on various research papers, journals, white papers, articles and relevant websites covering the location based services, MMS, wireless communication, GIS and related areas. The author also had browsed through mobile phones manufacturers' websites and reviewed several model of mobile phones. Nokia was chosen as the main reference since it offers various phone models as Nokia phones are very reliable and compatible for the project. The findings from those activities were used for completing literature review and producing desired result. The author did several studies on location based service product that existed in the market. Currently, LBS has been successfully implemented in Europe for several years. The studies focused on characteristics of particular LBS products available in the Europe market to provide initial functional and non-functional requirements for Wi-LBS

a) Functional Requirements

1. Establish desktop connection with Nokia mobile phones.
2. Establish connection of Microsoft Visual Basic 6.0 Professional Edition with Microsoft Access database through OLEDB Provider.

3. Automatic respond and data transfer from the system to the users' request.
4. Simple spatial data search in the system based on users' request in the form of plain text messages or SMS.
5. Establish view, add, remove and update functions of UTP spatial data in Visual Basic environment.
6. Establish integration of ESRI ArcGIS 8.2 with Microsoft Visual Basic.
7. Capture and generate UTP spatial data to image format such as JPEG, GIF or BMP to be sent to users' mobile phones with text messages.

b) Non-Functional Requirements

1. Fast response time to users' requests.
2. System is able to give appropriate results if no match found for the search and continue operation to handle other requests.
3. Easy to use by having simple request code sent to the system.
4. System is able to handle a large number of requests and transactions.

3.1.2. User Design Phase (Design)

This phase is also known as Functional Design Stage where design and refine involved. In this stage, the outcomes from the analysis phase were reviewed and revised in term of scope, objectives, data models and reports. Initial design using prototyping also was started. Based on findings of research and studies during analysis phase, the author had come out with system's framework, hence provides initial views on the workflows of the data transaction within the system. Furthermore, data gathering was done during this phase by collecting spatial data of UTP in the form of digitized map and related codes

that could be used for construction phase. From the UTP digitized map, only suitable layers were selected and chosen. The files obtained are in following format:

File Format	File Name
.shp	Shape File
.dbf	Database File

Table 3.1: File Structure

Below is the framework for the system of Wi-LBS:

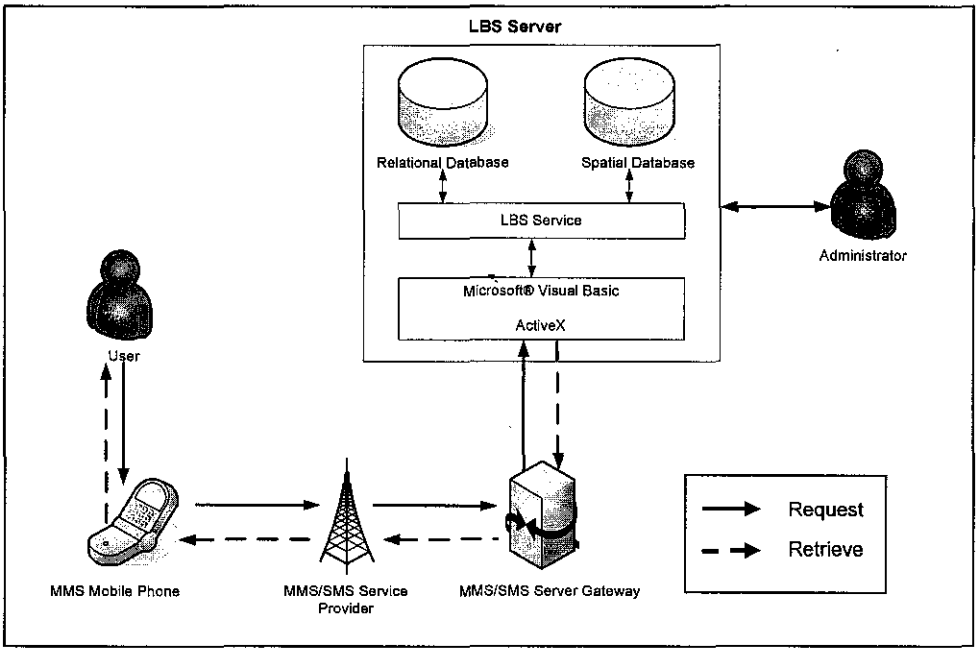


Figure 3.2: Proposed Framework for Wireless Location Based Services

The components involve in the framework consists of wireless device which is the MMS mobile phones, SMS/MMS Service Provider and the LBS Server. These mobile phones will be used by client /users and as MMS/SMS Gateway on the server side. Users will the MMS mobile phones for requesting and retrieving location information, which is the picture message. MMS/SMS Service Provider serves as the middle point to transmit request from users to the MMS/SMS Gateway and picture message or response from the gateway to users. Furthermore, as for the MMS/SMS Gateway, it functions to act as a bridge between the server and client side. LBS Server will be a standalone-based since it is not connected to Internet connection as it relies on the normal GSM network. It contains Visual Basic application and ActiveX control as the interface, basic GIS services provided by ArcGIS software and also DBMS comprises of relational and spatial database. The system will function by retrieving request by users in form of normal SMS, which routed to the MMS/SMS Gateway. The gateway will redirect the request to the LBS server. The application will do the analysis and match the request with correct respond. The result, which is in picture message, will be sent back to users via same path. Users will be able to review the result via their MMS mobile phones. Installation and configuration of software were also done during this phase including ESRI ArcGIS 8.2 and Microsoft Visual Basic. Integration between these two (2) application software was conducted. The visual presentation of the UTP digitized data is viewed using ESRI ArcGIS 8.2. This has given basic idea of what the system will look like when the construction starts later.

Initial interface has been drafted and designed. This is to give the author more focus on the basic processes common to all components in the system. The components tend to be data-intensive, so that the designs for the basic components concentrate on user interfaces for adding, deleting, editing and sending multimedia / picture messages. It is also for concentrating on user interfaces design in handling message's sending and retrieval.

Database scheme and tables was designed in this phase. The database for UTP spatial data was already generated during the creation of the layers. For the system database, there are two (2) tables involved: Direction table and Record Table. In Direction table, attributes stored are the request code, text messages and file names of the captured pictures/images. As for the Record table, attributes involved are record number, phone number, time of request and also the request messages. Below are the structure of the database that was developed using Microsoft Access 2003.

	Field Name	Data Type	Description
	code	Text	contains default request code/messages
	direction	Memo	contain location direction
▶	picture	Text	contains picture file names in BMP format

Figure 3.3: Database Structure of Direction Table in Design View

	code	direction	picture
	B01-B05	Go out from Block 01,turn left and walk straight untill see sign of Block 5	b1-b5.bmp
	B01-D	Walk passing Block 20-23 until u see block with blue colour	b01-d.bmp
	B20-CC	Exit from Block20,turn left,walk passing Block21-23,Cancelor Complex at center between Block 01 & 23	b20-cc.bmp
	D-C	Exit from Pocket D,turn right, walk passing block 19 to 16 untill see orange block	d-c.bmp
	HELP	for further details, contact helpline 019-6432654	
	HEP-RC	turn right from HEP,go straight,take 1st exit at roundabout,go straight,RC is on right side	hep-rc.bmp
	INFOAS	Mrs. Aliza Sarlan. Office: 02-03-03	
	INFOJDD	Mr. Justin Dinesh Devaraj. Office: 02-03-05	
	INFOSBR	Mrs Syarifah Bahiyah Rahayu Office: 02-03-04	
	RC-HEP	Exit to main road,take right exit from roundabout,go straight,HEP is on the left side	rc-hep.bmp
	V1-Masjid	Go out from V1 to roundabout, mosque is at your left	v1-Masjid.bmp
✎	V4-CC	Exit to main road,go straight,turn right when seeing petrol station, go straight until see Complex	v4-cc.bmp

Figure 3.4: Database Structure of Direction Table in Datasheet View

	Field Name	Data Type	Description
🔑	id	AutoNumber	record ID number
	phone	Text	phone number of the requester
	time	Text	time of request arrived
▶	text	Text	default request message/code

Figure 3.5: Database Structure of Record Table in Design View

	id	phone	time	text
▶	28	+60196432654	18/10/2004 22:56:08	d-c
	32	+60196432654	18/10/2004 23:02:49	help
	34	+60196432654	19/10/2004 0:02:09	infojdd
	35	+60196432654	19/10/2004 1:20:16	b01-d
	36	+60196432654	19/10/2004 1:22:16	b01-d
	37	+60196432654	19/10/2004 11:32:19	b01-b05
	39	+60125581385	19/10/2004 11:39:26	B01-D
	40	+60126873708	19/10/2004 16:47:02	b01-05
	41	+60126873708	19/10/2004 16:48:47	b01-b05
	62	+60196432654	21/10/2004 14:30:41	infojdd
	66	+60196432654	22/10/2004 11:39:13	b01-b05
	67	+60175789930	22/10/2004 11:48:39	d-c
	68	+60126870397	22/10/2004 20:09:50	B01-B05
	69	+60126255240	23/10/2004 13:44:55	d-c
	72	+60196432654	24/10/2004 0:09:28	d-c
	73	+60196432654	24/10/2004 0:16:25	d-c
	74	+60196432654	24/10/2004 0:50:38	B01-B05
	75	+60169339755	24/10/2004 1:52:08	d-c
	77	+60196432654	25/10/2004 8:19:16	D-C
	78	+60196432654	25/10/2004 11:04:26	D-C
	80	+60174618891	25/10/2004 11:04:59	B01-B05
	81	+60174618898	25/10/2004 12:11:48	D-C
	82	+60195602201	25/10/2004 12:43:11	Rc-hep
	84	+60196432654	25/10/2004 12:45:29	B01-B05
	85	+60126795154	25/10/2004 12:48:00	D-C
	86	+60199299081	25/10/2004 15:10:26	D-C
	87	+60199103143	25/10/2004 15:11:30	D-C
	88	+60134355900	25/10/2004 15:49:10	D-C
	89	+60126587708	25/10/2004 16:12:35	D-C

Figure 3.6: Database structure of Record table in Datasheet view

3.1.3 Construction (Detailed Design and Code Generation)

This phase is usually known as Development Stage. During the development, detailed design is done using Microsoft Visual Basic 6.0. Adjustments and necessary modifications were made. Interface was designed in which main functions of ArcObjects Control and ActiveX Control was combined into one main interface. ArcObjects Control of ESRI ArcGIS 8.2 was fully integrated into the Visual Basic environment. This was

done using Visual Basic for Application (VBA) codes provided in the ArcObjects Developer Kit. Connection to Microsoft Access database was made that contains table of the request codes, reply text and respective pictures or images. For the connection to the mobile phones, Visual Basic ActiveX is used. This connection between the desktop and mobile phone was made through COM port. During this stage, manual procedure was done to ensure that the connection to mobile phone is successful. Initial test was done to validate this connection by using third-parties program called Oxygen Mobile ActiveX Control. This program was able to read and view the data in the Nokia mobile phone. Sending and retrieving of messages using this program was done manually. The main concern was sending the picture messages to users' phones that have MMS features with appropriate resolution. The Visual Basic codes were then modified to enable it automatically search the database to match the picture messages with respective request codes sent by users.

Initial testing was done with respect to basic functionalities of the system. The system was able to add, edit and remove UTP spatial data layers. Furthermore, basic zooming functions were also functioned. The system was capable to export and convert the UTP spatial data to image format such as JPEG, GIF or BMP.

3.1.4 Cutover (Installation and Handover)

Cutover or Deployment Stage involves various activities towards the implementation fully functional system into real environment. The Wi-LBS system is put into real test in the real environment. Several requests were made by sending default request codes in the form of SMS and the results obtained were observed and identified. Several matters were taken into consideration including response time, picture resolution and also users' understanding on the picture message received. Simple survey and feedback session was conducted to determine users' understanding. The system was improved portion by

portion based on the survey's result. In this phase, the system is already fully tested as final documentation is prepared to guide end-users in using the system. The system is expected to function correctly and is capable of meeting the user requirements.

Applying RAD as the chosen methodology has provided the author with various advantages. RAD tools are easy to learn and promote good design of a user-friendly interface. Furthermore, RAD allows for quick testing and debugging of a system as it provides early visibility through prototyping. In addition, RAD also offers greater flexibility in which redesign process is done almost at will.

3.2 Tools

As the system is a combination of GIS and wireless, various software are used in order to assist and facilitate the development process. Compatible hardware is configured to ensure that the system will run smoothly and integration will be successful.

3.2.1 Software Requirement

ArcGIS 8.2 is used for the GIS part. This software is developed by Environmental Systems Research Institute (ESRI). It provides wide-variety of tools for analyzing, mapping, managing, displaying, and publishing geographic or spatial information. ESRI ArcGIS 8.2 provides tools that create intelligent digital maps that can be analyzed, query to obtain more spatial information and printed. Besides, ArcGIS 8.2 also apply the use of Database Management System (DBMS) and offers user-friendly graphical user interface (GUI). It also provides tools for entering and manipulating spatial and geographic information as well as provides extensive mapping, data use, and analysis along with simple editing and geo-processing capabilities. More important, this software also supports the development of Visual Basic for Application (VBA) by providing many

sample codes and algorithms that can assist in designing reliable GIS application in Visual Basic environment.

As RAD is chosen as the methodology, the use of Microsoft Visual Basic 6.0 Professional Edition suits the development of the system. It is used for developing the Wi-LBS application in which wireless messaging controls and ArcGIS 8.2 tools are fully integrated into one single interface and environment.

Microsoft Access 2003 is used as the Database Management Systems (DBMS) software for adding, deleting, editing and managing data. Messages and pictures that will be send to users with respect to queries or requests generated by users are stored and managed here.

3.2.2 Hardware Requirement

Hardware requirements are divided into two: Hardware for the system to function and hardware for developing the system. The hardware configuration is based on the configuration of author's computer and the configuration is not the minimum requirement. The hardware requirement is presented below in Table 3.2.

Hardware for Functional System
1. Mobile phone with Multimedia Messaging Services (MMS) features that serves as the Gateway and for end-users to retrieve the results. 2. Phone data cable for connecting the mobile phone with the computer.
Hardware for System Development
Processor : Intel Pentium 4 2.4GHz Memory : 512MB RAM Monitor : 17" with 1024 x 768 resolution Hard Disk Drive : 60GB Media Drive : 16X DVD Drive, 1.44MB Floppy Disk Drive Display Card : 64MB Operating System : Windows XP Professional Edition with Service Pack 2

Table 3.2: Hardware Requirement

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Findings

Results and several findings related to the research works are presented in this section. As the product for this project will be the system of Wireless LBS, the findings and results will cover on Request/Response Time, Integration of GIS and Wi-LBS, Wi-LBS System, GIS Analysis as well as Comparison of MMS and SMS.

4.1.1 Request/Response Time

During the testing, the request and response time of the system was recorded. It involved time taken for the request to enter into the system and results to be sent to the users. Table 4.1 shows time taken for 30 requests and responses.

	Request			Response		
	Sent	Arrive	Time Taken	Sent	Receive	Time Taken
Case 1	22:56:01	22:56:08	0:00:07	22:56:09	22:56:55	0:00:46
Case 2	23:02:42	23:02:49	0:00:07	23:02:50	23:03:36	0:00:46
Case 3	0:02:03	0:02:09	0:00:06	0:02:10	0:02:57	0:00:47
Case 4	1:20:02	1:20:09	0:00:07	1:20:10	1:20:55	0:00:45
Case 5	1:20:08	1:20:16	0:00:08	1:20:17	1:21:03	0:00:46
Case 6	2:22:09	2:22:16	0:00:07	2:22:17	2:23:02	0:00:45
Case 7	11:32:13	11:32:19	0:00:06	11:32:20	11:33:06	0:00:46
Case 8	16:46:55	16:47:02	0:00:07	16:47:03	16:47:50	0:00:47
Case 9	16:48:40	16:48:47	0:00:07	16:48:48	16:49:35	0:00:47
Case 10	14:30:35	14:30:41	0:00:06	14:30:42	14:31:28	0:00:46
Case 11	11:39:06	11:39:13	0:00:07	11:39:14	11:40:00	0:00:46
Case 12	11:48:32	11:48:39	0:00:07	11:48:40	11:49:27	0:00:47
Case 13	20:09:44	20:09:50	0:00:06	20:09:51	20:10:36	0:00:45
Case 14	13:44:48	13:44:55	0:00:07	13:44:56	13:45:41	0:00:45
Case 15	0:09:20	0:09:28	0:00:08	0:09:29	0:10:15	0:00:46
Case 16	0:16:18	0:16:25	0:00:07	0:16:26	0:17:13	0:00:47
Case 17	0:50:32	0:50:38	0:00:06	0:50:39	0:51:26	0:00:47
Case 18	1:52:01	1:52:08	0:00:07	1:52:09	1:52:54	0:00:45
Case 19	8:19:08	8:19:16	0:00:08	8:19:17	8:20:03	0:00:46
Case 20	11:04:19	11:04:26	0:00:07	11:04:27	11:05:12	0:00:45
Case 21	11:04:53	11:04:59	0:00:06	11:05:00	11:05:47	0:00:47
Case 22	12:11:41	12:11:48	0:00:07	12:11:49	12:12:34	0:00:45
Case 23	12:43:05	12:43:11	0:00:06	12:43:12	12:43:58	0:00:46
Case 24	12:45:22	12:45:29	0:00:07	12:45:30	12:46:15	0:00:45
Case 25	12:47:53	12:48:00	0:00:07	12:48:01	12:48:47	0:00:46
Case 26	15:10:19	15:10:26	0:00:07	15:10:27	15:11:14	0:00:47
Case 27	15:11:23	15:11:30	0:00:07	15:11:31	15:12:17	0:00:46
Case 28	15:49:04	15:49:10	0:00:06	15:49:11	15:49:56	0:00:45
Case 29	16:12:28	16:12:35	0:00:07	16:12:36	16:13:21	0:00:45
Case 30	17:15:02	17:15:10	0:00:08	17:15:11	17:15:57	0:00:46
	AVERAGE		**0:00:07**			**0:00:46**

Table 4.1: Request/Response Time of Wi-LBS

From the table, the average time for requests and responses has been calculated. For the request time, an average of 0.00.07 or seven (7) seconds was recorded. As for the response time, it took about 0.00.46 or forty-six (46) seconds to send the result to users. The discussion on the request and response time is explained under Discussion section.

4.1.2 Integration of GIS and MMS in Wi-LBS

Wi-LBS incorporates two main areas of studies that are GIS and MMS. These two elements are integrated into one or single environment, which is Visual Basic environment. GIS is integrated into the system by inserting these lines of codes that are suit for Visual Basic for Application (VBA). These codes are used to enable ArcObjects Controls of ESRI ArcGIS 8.2 in VB environment and create basic tools:

```
Option Explicit
Private m_pCommandCollection As Collection
Private m_ImageList As ImageList

Set m_pCommandCollection = New Collection

CreateCommand New ESRI_File.AddData, False
CreateCommand New ESRI_Layer.Layers, False
CreateCommand New ESRI_DataFrames.RemoveData, False

UpdateCommandsControl
```

As for the MMS integration, it involves several VB codes working with Visual Basic ActiveX. This is for the system to read data from the Nokia mobile phone. The following codes are for establishing connection with the phone:

```
Mobile1.Close
Mobile1.ComNumber = 1
Mobile1.ConnectionMode = 0
Mobile1.SMSCenterNumber = "+60120000015"
```

```
If Mobile1.Open = True Then
  Label1.Caption = "Service started"
```

Below are the codes for obtaining picture from the source and send it via the MMS phone:

```
strSQL = "SELECT * FROM direction WHERE code LIKE '" & strKey & "'"
rec.Open strSQL, conn, adOpenDynamic, adLockOptimistic

Do Until rec.EOF
  strDesc = rec!Direction
  strPic = App.Path & "\Map\" & rec!Picture
  rec.MoveNext
Loop

  If strDesc <> "" Then
  found = True
End If
If found Then
  'strDesc = rec!Direction
  If (FileExist(strPic)) Then
    send = Mobile1.SendSMSMessage(strNo, strDesc, 167, _
     0, 0, strPic)
  Else
    send = Mobile1.SendSMSMessage(strNo, strDesc, _
    167, 0, 0, "")
rec.Close
```

Below is the screenshot of the main panel or main screen that shows the integration of GIS and MMS:

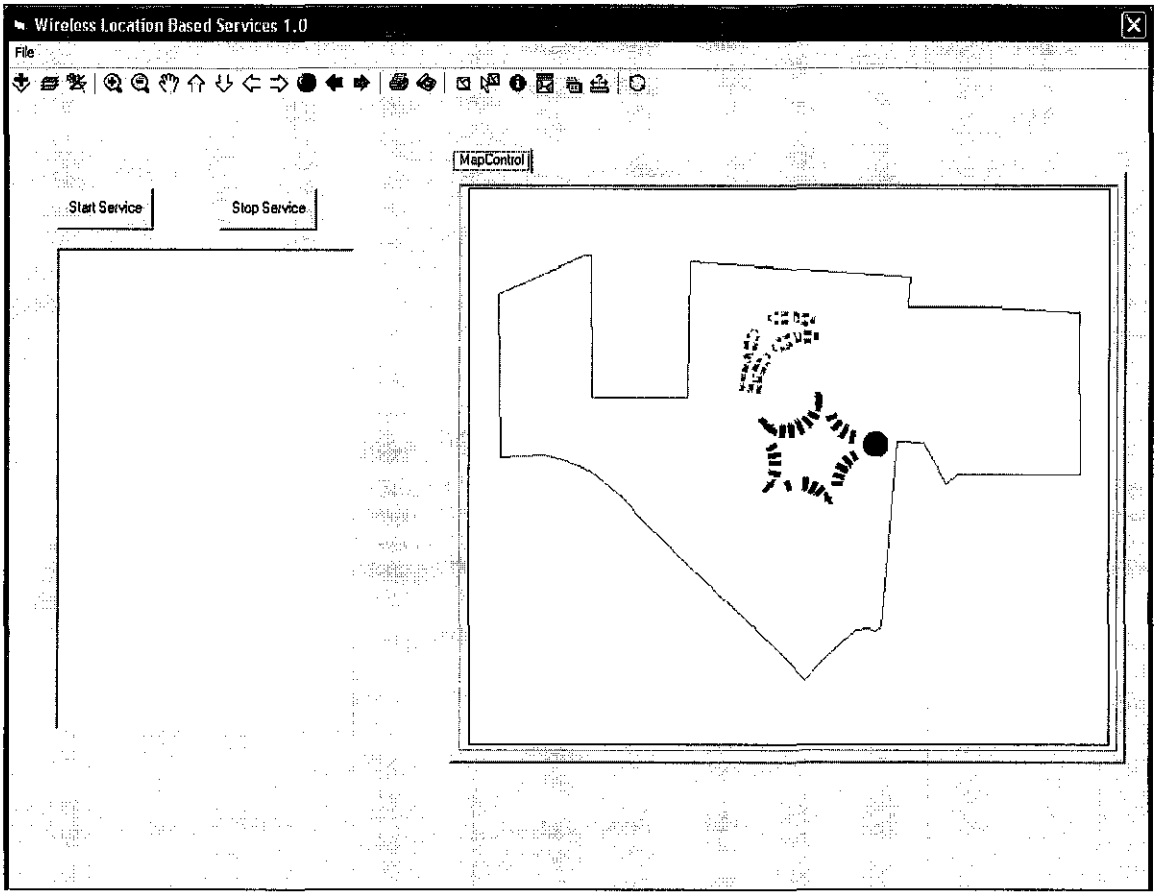


Figure 4.1: Screenshot of Wireless Location Based Services

4.1.3 Wi-LBS System

In describing the Wi-LBS system, it is important to understand the tools provided in the system. The functions or tools of Wi-LBS system can be divided into two (2) that are on the ArcGIS Controls and wireless service. The explanations of the functions are described in two (2) tables below.

Function	Description
Add Data	To add data layers to the Map Control display area
Configure Layers	To configure attributes and settings of data layers
Remove Data	To remove data layers from Map Control display area
Zooming Tools (Zoom In, Zoom Out, Zoom to Full Extent)	To enlarge and display greater detail of a portion of a geographic dataset
Pan Tools (Pan Up, Pan Down, Pan Right, Pan Left, Pan by Grab)	To move viewing window up, down or sideways to display areas in a geographic dataset that, at the current viewing scale, lay outside the viewing window
Export	Export a map document to another file type such as BMP, JPEG and GIF
Select Features	To select features from the map displayed
Map Control	To view map or layers

Table 4.2: ArcGIS Controls

Function	Description
Start Service	• Establish and open connection with mobile phone • Start service of Wi-LBS
Stop Service	• Close connection with mobile phone • Stop service of Wi-LBS
Database	To view, add, edit and delete record in the system database

Table 4.3: Wireless Tools

The Wi-LBS system operates according to process described below:

1. Administrator will execute the system and start the operation by clicking on 'Start Service' button to establish connection with the mobile phone. Notification text of service started is displayed on the list view. This means that the system is ready to receive request from users and continue sending queued response, if any.

2. Administrator adds the respective UTP spatial data layers to Map Control viewing area by clicking on Add Data icon. The respective layers are displayed. These layers are used for capturing new pictures if new requests need to be made. Clicking on Configure Layers icon allows configuration of respective layers properties such as colors and labels.

3. When request enter the system, simple spatial data search is done to match the request entered with the default request message stored in the Direction table of the system's database. At the same time, the request is automatically kept in Record table for tracking purpose and future use.

4. When match is found, the result is sent to the user's phone. Sending progress log is displayed in the list view. 'Operation successful' message is displayed in the list view after the result has been successfully sent. If no match is found, default message 'Record not available' is sent to user.

5. User will receive the result via the mobile phone in a form of picture message and plain text.

6. In the condition of new request that is still not available yet in the database, administrator who monitors the transaction will capture the new picture according to new request and entered details of the new request into the database.

The diagram for the above process is presented in Appendix I while for the screenshots of the interface are presented in Appendix II to Appendix IX. Procedure for sending the request by users is presented in Appendix X.

4.1.4 GIS Analysis

This project research is narrowed down to simple spatial data search. When user send request to the system, the request is in the form of special code that has already defined in the database. As the request enters the system, search is done to find the match. The result that matches the code is in the form of plain text messages and picture message. After the match is found, the result will be sent to the users. Example of codes and the results are as below:

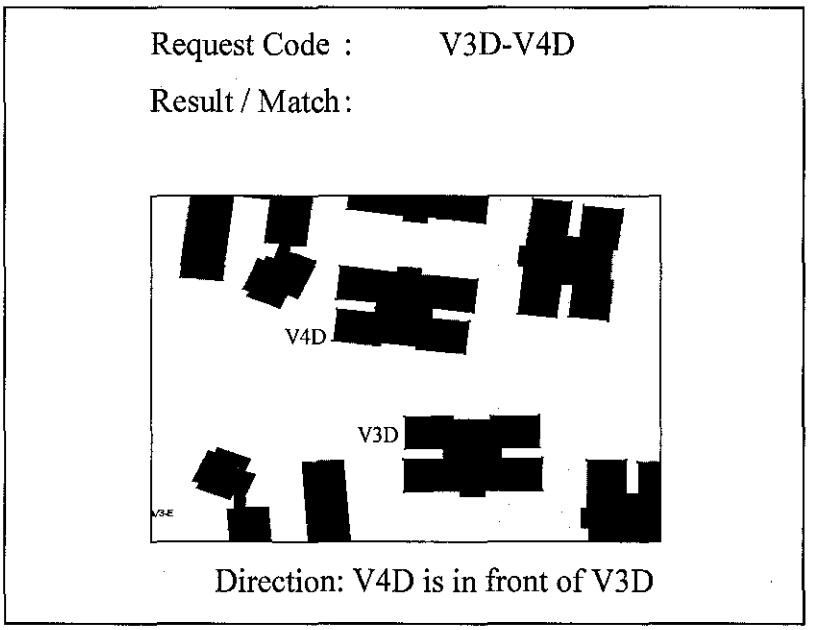


Figure 4.2: Sample of Request and Result

4.1.5 Comparison of MMS and SMS

Comparison was done to determine level of users' understanding between MMS and SMS format in serving location based information. The study was done on 20 persons who are students of UTP by determining their understanding on different format of location-based information: plain text only, picture only as well as picture and text. The result is plotted as below:

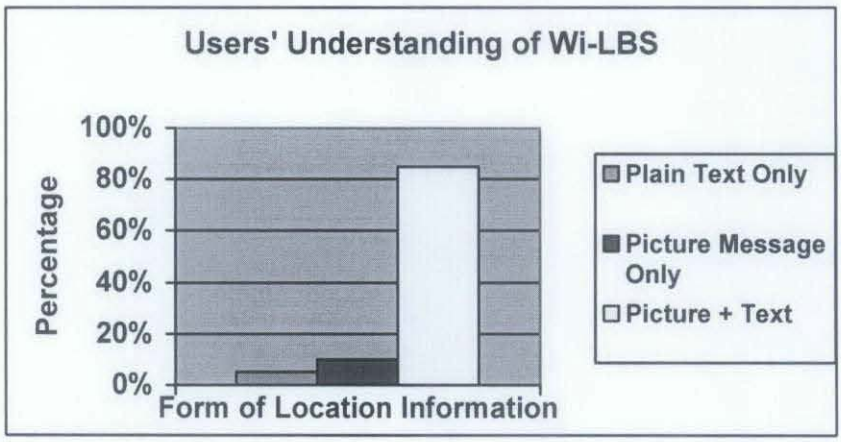


Figure 4.3: Level of Users' Understanding on Wi-LBS in Percentage

From the chart, it explains that the location based services in the form of picture and text together could give better understanding in providing clear direction from one place to another place. Further explanation is discussed under Discussion section.

4.2 Discussion

Based on the findings, several issues and matters are taken into account that generates important indicators for the successful of this project. The issues are discussed in the following sections.

4.2.1 Request/Response Time

Based on the Table 4.1, the average of Request Time is seven (7) seconds while for the Response Time; the average is forty-six (46) seconds. The graph representing the values obtained in the table has been plotted in Figure 4.4 below:

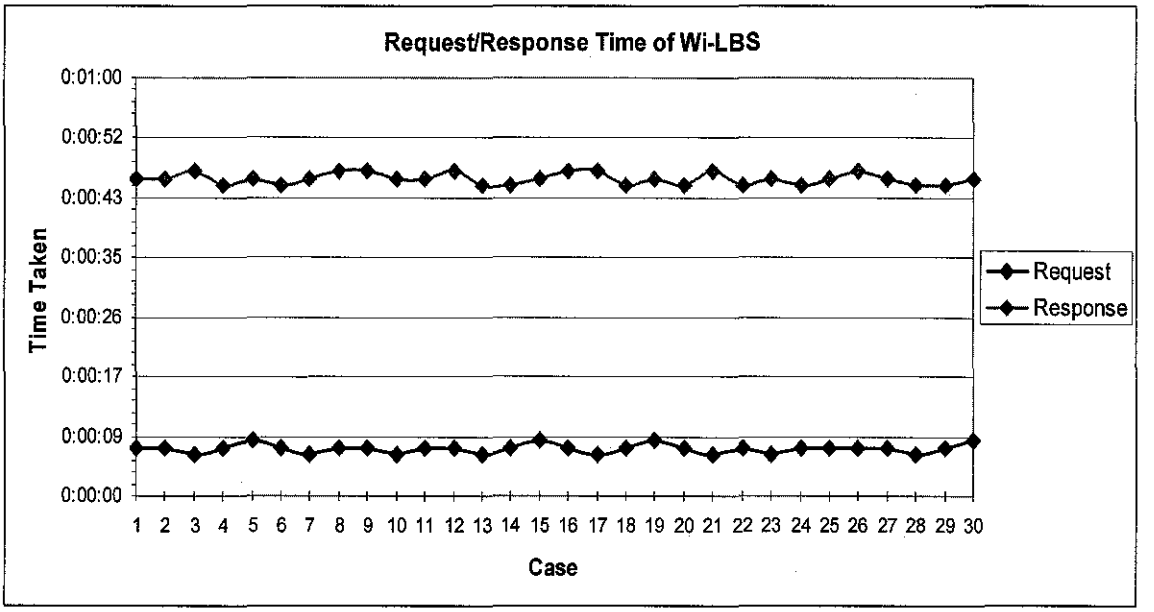


Figure 4.4: Graph Showing Request/Response Time of Wi-LBS

Based on Figure 4.4, the request and response time of depend on several factors as below:

i) Network Coverage

The network coverage within UTP is not stable depending on the telecommunication providers that the users subscribed. Higher network coverage results in faster request sent to the system and faster result.

ii) Network Traffic

Concurrent requests may result in heavy traffic accessing the systems. The system needs to process the request in sequence based on the time the requests enter the system. Many requests result in slower response time. The process of responding to the request depends on queuing rule, which means system will respond to the request that enter the system first.

iii) Default Request Message

Users need to send correct default request message that can match with code stored in the database to ensure that they can get correct result. Users must follow default request code available in the database. The default request message sent by users can be in capital or small characters. Examples of correct request code are as below:

Code	Description
D-C	From Pocket D to Pocket C
B01-B05	From Block 1 to Block 5
INFOJDD	To get info of lecturer named Justin Dinesh Devaraj
HELP	To get help on using Wi-LBS

Table 4.4: Correct Request Code and Description in the Database

When users send correct default request message such as 'D-C', the system can match it with same code in the database and send correct result to users. However, if wrong default request message such as 'DC' is sent to the system, the system will reply back sending message 'Request not available' to the users. Wrong codes or sending default request messages that are not available in the database may result in slower response or the system may not respond at all. It is important to alert users with the correct request codes so that suitable response can be sent to users and satisfy their needs. So to ensure users in sending correct default request message, they can send 'HELP' to the system and the system will response to users by sending text

messages that contains simple guidelines on writing correct request message including sample request codes.

4.2.2 Integration of GIS and MMS in Wi-LBS

Based on the findings, it is proved GIS and MMS can be successfully integrated to produce reliable Wi-LBS. The codes that have been presented shows the method that can be used to integrate GIS controls in Visual Basic environment and also method to interact with mobile phone. LBS deal with a large volume of spatial data. By incorporating MMS in LBS, it could utilize the capabilities of today's mobile phones from just being a medium of communication through phone calls and SMS to a more beneficial device. As GIS is the vital elements in LBS, LBS can be more successful if more GIS functions and features are introduced into the system. Thus, variety of services can be provided via LBS rather than just sending picture messages as introduced in this system. The system provides a basis on how the actual Wi-LBS should look like and represents the technologies that should be adhere in designing a reliable Wi-LBS.

Human-Computer Interaction (HCI) principle is applied in designing interface of the system. As usual, the main menu is put on the top left of the interface. This is to provide standard Windows-like screen representation as other program. This is shown by the use of pull-down menu. ArcObjects Controls toolbar are placed in rows at the top screen, directly under the main menu. The toolbar contains required controls for the system and each control is provided with simple description or notification informing what this control will do when pointing the mouse on the controls' icons. Furthermore, elements of wireless and GIS are divided into separate section in single interface. Wireless part is placed on the left section while the GIS part is on the right side of the interface. This is to divide the attention of the administrator of the system on the GIS and wireless

elements in the system. The use of colors is also taken into consideration in which standard Windows-like colors are used for the interface design.

Several comparisons were done to compare Wi-LBS in standalone platform with the one in web-based platform, in which web-based platform is more reliable that standalone platform. It is explained in the table below:

	Standalone Platform	**Web-Based Platform**
Programming Language	Visual Basic	J2ME, XML, WML, PHP
Network Connection	Depends on GSM network and connection between mobile phone and COM port	Relies on GSM/GPRS/UMTS network and Internet connection
Features	Limited to sending and receiving, simple search, basic GIS features and simple interface design	Variety of features and services offered such as more interactive interface, easy navigation, advanced search and support high speed sending and retrieving messages
Gateway	Use mobile phone as gateway	Use typical or advanced gateway similar as used to configure web-based application

Installation	Need to install the system in each machine that uses it	Accessible and viewable using web browser; no need to install one system for each machine
Database	Microsoft Access	Oracle9i Spatial, MySQL
Supported Device	MMS mobile phone	MMS mobile phone, PDA, notebook with wireless connection

Table 4.5: Comparison between Standalone and Web-Based Platform of Wi-LBS

The comparisons are made based on several products and existing web-based LBS implemented in United States of America and several companies in Europe. According to IDC, in a January 2002 survey of 700 U.S. wireless households, web-based location-based services scored highest in terms of consumer interest, with permission-based traffic information being second only to emergency-location service, and just ahead of opt-in location-based information on nearby businesses such as nearest movie theater and gas stations. 65% of wireless users are interested in turn-by-turn navigation assistance and are willing to pay more than $1 each time they use the service. Another proves was presented in research paper by Derek Kerton on "Location Based Services: Technologies and Applications". In the paper, he explained about the customer interest in web-based LBS. About half of wireless users and 55% of wireless Internet users were aware of web-based LBS in 2002. 32% of wireless users and 38% of wireless Internet users are willing to pay monthly fee for web-based LBS of up to $10. Research did by The Strategies Group have come out with figures on worldwide users' acceptance of Web-Based Wireless Location Based Information from year 2002 to year 2005. It is presented in the Figure 4.5 below:

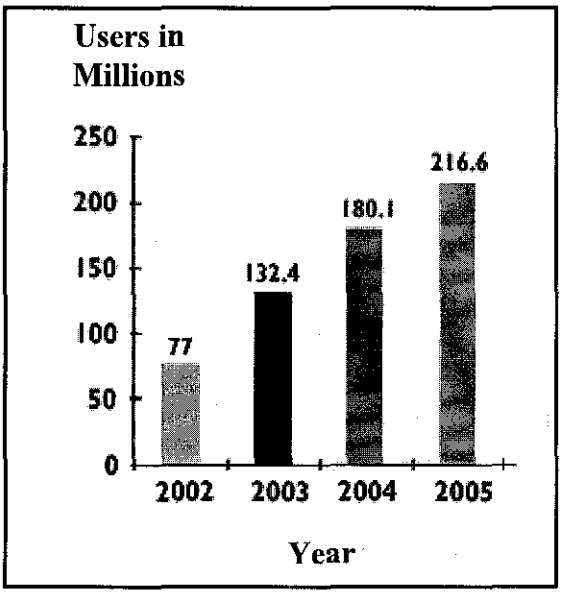


Figure 4.5: Worldwide Users' Acceptance of Web-Based Wireless Location Based Information from Year 2002 to 2005

The increase of users' acceptance from year 2002 to year 2005 is caused by the increase of customer demand on location services. Hundreds of unique applications are being developed with wireless location. Furthermore, services that are related to safety, such as roadside service and navigation are becoming the most popular services in web-based location based information. Besides that, the increase also caused by services like purchasing a ticket from a vendor and accessing lodging information, which really give great impact to the users' acceptance of web-based location services.

In addition, according to Eve Kleiman, Principal Product Manager, Geospatial and Multimedia Technologies of Oracle Corporation Asia/Pacific, the performance and capability requirements expected for wireless location based service can easily approach that of a top Internet portal - millions of queries on a daily basis, hundreds of concurrent transactions, and millisecond query response times. Thus, the required system must

support all the unique CPU-intensive location queries, and provide scalability, storage, and interoperability. Real-time, web-based location services offer several characteristics and performance. This can be referred on the table below:

Characteristics	Performance
Address verification and matching	Scalable architecture
Map rendering	Gigabytes to terabytes of data
Yellow page directory query	Multiple CPU processing
Driving directions	DBMS table partitioning
Personalization by location	Distributed processing
Proximity analysis	Native spatial data management
Standards-based location service APIs	Online services interoperability
Personal/in-car navigation capability	Millisecond location query
Voice (VoiceXML) capability	Millions daily queries
XML integration with e-business apps	25 000 user sessions per hour
Web Services Directories	Portal caching

Table 4.6: Characteristics and Performance of Web-Based Wi-LBS

As for database support, Oracle9i, Oracle9i Spatial and Oracle9iAS Wireless offers high-end features to integrate with web-based LBS. Using Oracle product offers various benefits when deploying web-based wireless LBS. The benefits are presented in the table below in comparison with typical Link-Driven and Proprietary Location-Based Applications:

Typical Link-Driven and Proprietary Location-Based Applications	Oracle9i, Oracle9i Spatial and Oracle9iAS Wireless in Web-Based Wireless LBS
File based applications	Database-centered applications
Batch/off-line applications	Real-time transactions
Simple queries used by Portals	SQL queries integrated into e-business applications
Stovepipe applications	Open architecture
Link driven - no actual content	Dynamic links to content, online services
Not integrated with e-business services	Integrated with leading e-Business apps
Not enabled for wireless devices	Integrated platform for all wireless devices
Limited location services	Unlimited support for external services
B2C focus	B2C, B2B2C, and B2B focus
Limited platform availability	Multi-platform support
Limited scalability	Proven terabyte scalability
Limited support for 3rd party tools	Supported by all leading IT tool vendors
Proprietary interfaces	SQL, XML and Java interfaces

Table 4.7: Benefits of Deploying Oracle9i, Oracle9i Spatial and Oracle9iAS in Web-Based Wireless Location-Based Services

4.2.3 GIS Search Query

As mentioned, the research focused on the capabilities of the system in performing simple spatial data search. Users send the request code and the system response back by sending picture messages. The results for the search depend on the data availability in the database. The basis for this system is that it is rule-defined in which images or pictures has already generated and stored in the database. It means the administrator needs to generate images in advance based on the request code defined. The administrator adds and view whole UTP spatial data in the system and generates particular view to JPEG, GIF or BMP image format. So, whenever the request made to the system, the data have already there in the database. For the new request that has no result or match, administrator can do it directly on that time by converting the UTP spatial data into image format according to request made. From the explanation, analysis on the UTP spatial data must be done first to make sure that the simple spatial data search can execute correctly.

4.2.4 Comparison of MMS and SMS

From the graph plotted in the Figure 4.3, the author has come out with several reasons regarding understanding of users on different kind of location based information. For the plain text format or SMS format, only five percents (5%) of users able to understand the direction given in plain text. This is because only users who capable to visualize the text into their own picture representation can understand the text. This will reduce the effectiveness and efficiency of the system. It is important to emphasize here that although the system's response is fast, but the author also felt that the time consumed by users to understand the result is crucial. So, plain text or SMS format is not a good way to represent location information. As for the second type that is MMS in the form of picture messages, about fifteen percents (10%) of user could understand the picture. It is

assumed that the picture messages are labeled. The level of understanding is slightly higher since there is visual representation of location information. So users could have clearer picture of the location and where they wanted to go. However, location information that contains picture and text together results in highest percentage that is eighty-five percents (85%). This is because by having text together with the picture, any information that cannot be represented in the picture can be explained using the text. Text plays as supplementary roles to enhance users' understanding on location information. So, in implementing Wi-LBS, it is very important to produce location based information that can be easily understood by users.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Relevancy to the Objectives

The needs for Location Based Services have increasingly rapidly and for recent years, it has been introduced into mobile telecommunication networks. Although it can be said as quite new concept in Malaysia, it has opened new dimension of mobile services offerings to mobile enthusiast. With respect to relationship between GIS and LBS, functioning LBS clearly needs GIS functionalities incorporated in the system in order to provide spatial and location information that are relevant to human life. As for the wireless perspective, it has high potential to enhancing the capabilities of GIS in realizing the establishment of wireless GIS that lead to the existence of wireless LBS.

It is proven that the project able to meet all objectives outlined. The project is able to come out with the system that benefits UTP community in obtaining location information with small-to-medium experimental area. In addition, it shows the possibility and the success of integrating wireless and GIS in Location Based Services.

As a whole, Wireless Location Based Services (Wi-LBS) is a new practical method to find and obtain location information using wireless devices. By having this system, users will be able to find desired location within UTP area via their MMS-enabled mobile phones.

5.2 Suggested Future Work for Expansion and Continuation

There are several suggestions and recommendations that can be done to this project and the system, so that it can be expanded in the future to produce more reliable and practical Wi-LBS.

5.2.1 Conversion to Web-Based Wireless Location Based Services

It is more reliable to have this system up and running in a web-based platform. This is to ensure that the system would be able to support more users and is highly available using web-based. For this, different kinds of hardware and software are required. The equipments must be high-end to support many transactions and requests. Hence, when Wi-LBS is converted to web-based platform, it is expected that it could support various handheld devices, not just mobile phones as presented in this project paper. The system should be able to work successfully with old mobile phones, Personal Digital Assistant (PDA) and latest MMS mobile phones that use Symbian Operating System.

5.2.2 Provide More GIS Analysis Functionalities

There are many more GIS features and functions that need to be incorporated. Analysis that should be included in the system for future expansion is Network Analyst and Spatial Analyst. First one is Network Analyst. It allows for creating and managing sophisticated network data sets and generating routing solutions. This tool is a powerful extension for routing, and will provide a whole new framework for network-based spatial analysis such as location analysis, drive time analysis, and spatial interaction modeling. This extension allows users to model realistic network conditions and scenarios. Various functions can be conducted using Network Analyst. This includes Drive-Time Analysis, Point-to-Point Routing, Route Directions, Service Area

Definition, Shortest Path, Optimum Route, Closest Facility and Origin Destination Matrix. It really helps in simplifying many activities such as finding the most efficient travel route, generating travel directions, finding the closest facility, or defining service areas based on travel time become greatly simplified.

Next type of analysis is Spatial Analyst. Spatial Analyst can help to derive new information from existing data, analyze spatial relationships, and build spatial models. This tool could help in finding suitable locations, finding the best path between locations, performing integrated raster/vector analysis, performing distance and cost-of-travel analyses, performing statistical analysis based on the local environment, small neighborhoods, or predetermined zones, generating new data using simple image processing tools, interpolating data values for a study area based on samples and cleaning up a variety of data for further analysis or display.

5.2.3 Use High-End Database Management Systems (DBMS)

Currently, the system uses Microsoft Access as the DBMS. However, for future expansion, it could not support as the data stored will become larger and larger. This is due to higher resolution of pictures that will be stored in the database. It is suggested that in the future, Wi-LBS uses Oracle9i Spatial as the DBMS. Oracle9i Spatial really supports the development and integration of location based services. Based on Oracle white paper "Mobile Developer Initiative - Location Based Services" released in 2002, the paper explained Oracle LBS as a component of the middle tier- Oracle9i Wireless. It is aimed at the specific spatial requirements of mobile applications, such as mobile positioning and privacy. While Oracle LBS uses Oracle Spatial internally as a component of the Oracle9i database repository, developers seeking to integrate their products and services to Oracle9i, are not required to have Oracle Spatial. Oracle Spatial as a Spatial Data Option is a component of the database server Oracle9i. It supports

spatial data and advanced geographical functionality as an integrated part of the database. Data can be transformed between coordinate systems and projections. The use of advanced multidimensional and spatial indexes enables scalable management of spatial data. Oracle Spatial functions like an actual application, including personalization and integration of spatial and non-spatial functionality. Typically, LBS is not itself very data-intensive. Rather, it processes and aggregates location-related data from many sources. Applications of Oracle Spatial (such as GIS) are very different. They tend to have data-intensive core spatial requirements with dependency on high scalability and integration of large amounts of spatial data from different sources and in different coordinate systems. The services representing LBS sources typically perform exactly the tasks supported by Oracle Spatial. However, LBS within Oracle9i is agnostic with respect to whether the external provider uses Spatial or any other technology. Many external services do, in fact, use Oracle Spatial for its excellent features and scalability.

Besides using Oracle product, MySQL also can be used as another option for the DBMS of the Wi-LBS. It is the compatible database system when developing web-based platform of Wi-LBS using PHP. It is free of charge compared to Oracle product and it also supports future expansion of Wi-LBS system due to the increase in the amount of spatial data that need to be stored in the system. Furthermore, PHP and MySQL are widely used and highly acceptable by large number of Internet users in designing and developing web-based application.

5.2.4 Integration with Global Positioning System (GPS)

When discussing about location based services, it is necessary to consider Global Positioning System (GPS). The author suggests that for future expansion, it is feasible to integrate Wi-LBS with GPS. The system presented in this paper relies on static image. By having GPS, it provides added-value to the capabilities of Wi-LBS. GPS is the most widely known satellite-positioning technology that offers high accuracy readings since the data on location information is in real time. This will help not only to find particular location but also able to determine the location of the users themselves. So, by having real time information in Wi-LBS, it will improve the reliability of the system.

REFERENCES

1. Davis B.E., 2001, *GIS: A Visual Approach*, Canada, OnWord Press.

2. Virrantaus K., Markkula J., Garmash A., Terziyan V., Vejalainen J., Katanosov A. and Tirri H. 2002, *Developing GIS-Supported Location-Based Services,* Proceedings IEEE of the Second International Conference on Web Information Systems Engineering, USA.

3. Stojanovic D.H. and Djorjevic-Kajan S.D. 2001, *Developing Location-based Services from a GIS Perspective,* TELSIKS 2001, Yugoslavia.

4. Gratschew S., Raitaniemi J., Ylinen J. and Loula P. 2003, *A Multimedia Messaging Platform for Content Delivering*, Tampere University of Technology, Finland.

5. Krishnamurthy N. 2002, *Using SMS to deliver location-based services*, Infosys Technologies Ltd., Bangaore.

6. Syed A.K., Mandal M.K., Zaineddine A.A.and Rahime F.F. 2003, *An Adaptive Framework for Multimedia Messaging Services Over Wireless Networks and the Internet*, University of Alberta, Edmonton.

7. Mohammadi H., Alesheikh A.A. and Ghorbani M. 2003, *Developing Wireless GIS: Using Java and XML Technologies*, K.N. Toosi University of Technology, Iran.

8. Mostafa M.E. 2002, *MMS – The Modern Wireless Solution for Multimedia Messaging*, Nokia Corporation, Finland.

9. Hui W. and JianXin L. 2003, *The Study of Location Based Service in WIN*, Beijing University of Posts and Telecommunication, Beijing.

10. Takino S. 2001, *GIS on the Fly – To Realize Wireless GIS Network by Java Mobile Phone*, Dawn Corporation, Japan.

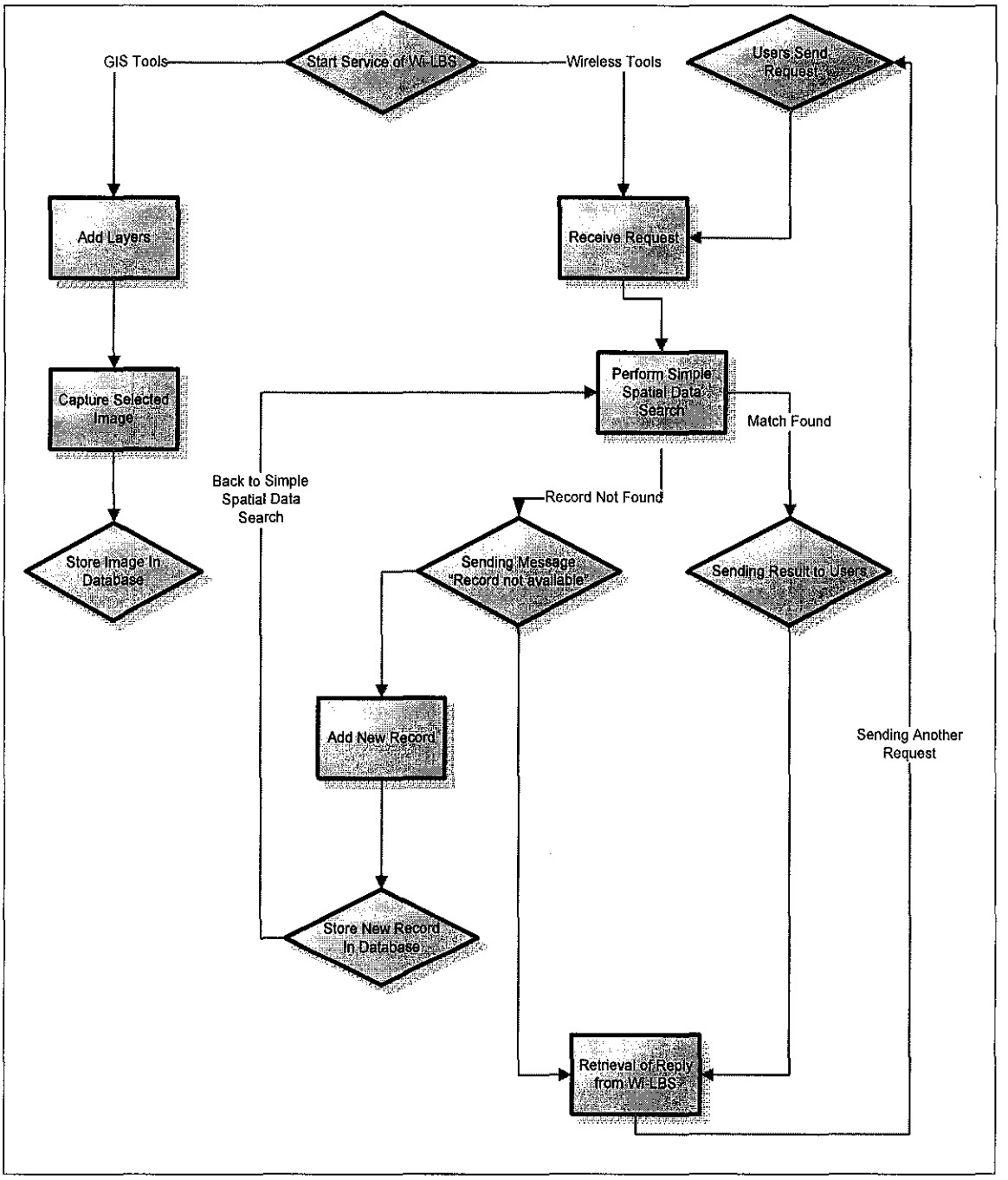
11. Tarle T.L. 2002, *Wireless GIS – Concept and Reality*, Sierra Systems Group Inc., Canada.

12. Kretschmer U. 2002, *Using Mobile Systems to Transmit Location Based Information, Fraunhofer Institute for Computer Graphics*, Germany.

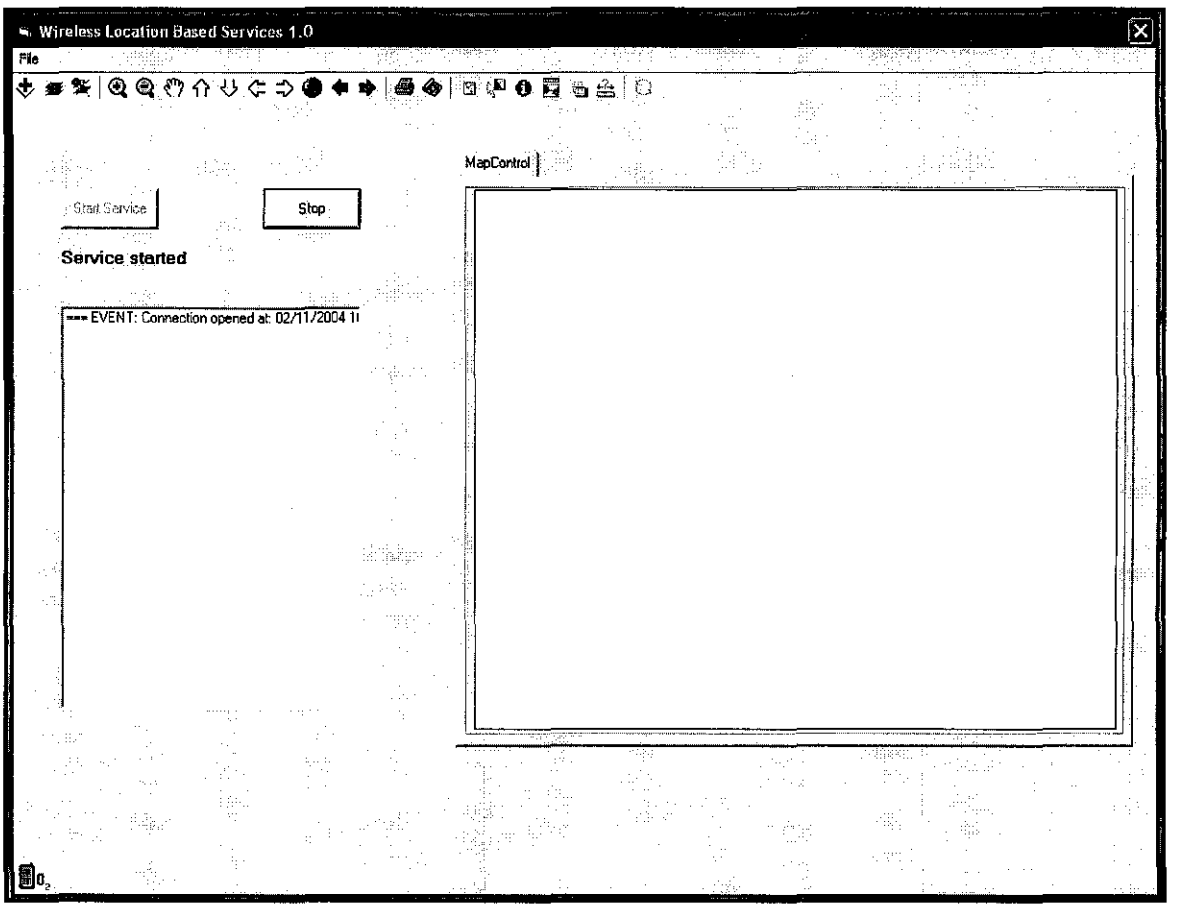
13. Escudero-Pascual A. 2002, *Privacy Enhanced Architecture for Location Based Services in the Next Generation Wireless Network*, Royal Institute of Technology, Sweden.

14. Sen S. and Sengupta S. 2002, *Open standards in location based services*, <http://www.gisdevelopment.net/technology/lbs/techlbs002.htm>.

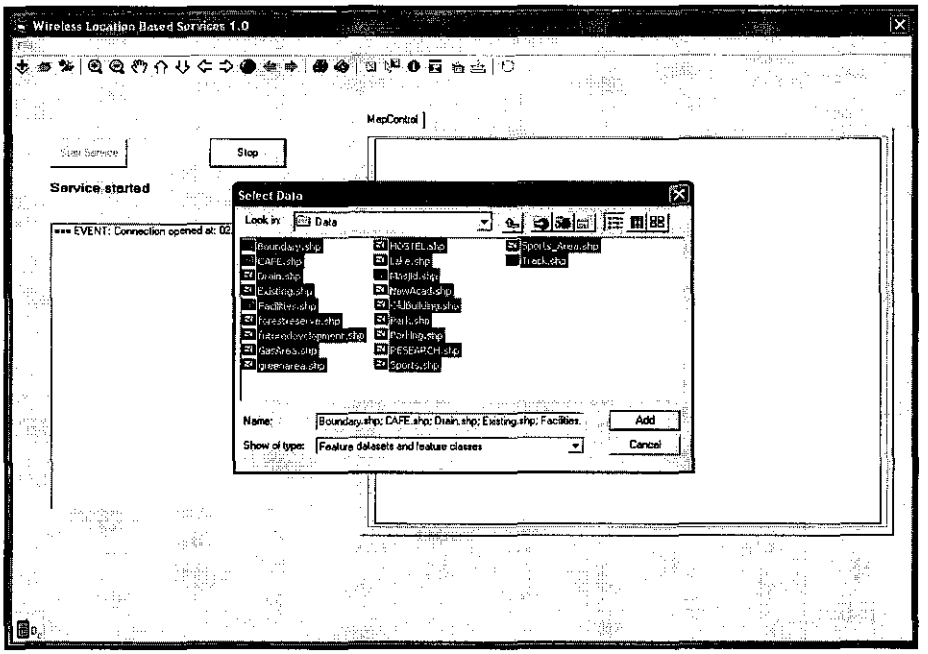
15. Boondao R., Esichaikul V. and Tripathi N.K. 2002, *A Model of Location Based Services for Crime Control,* <http://www.gisdevelopment.net/technology/lbs/ma03217a.htm>.



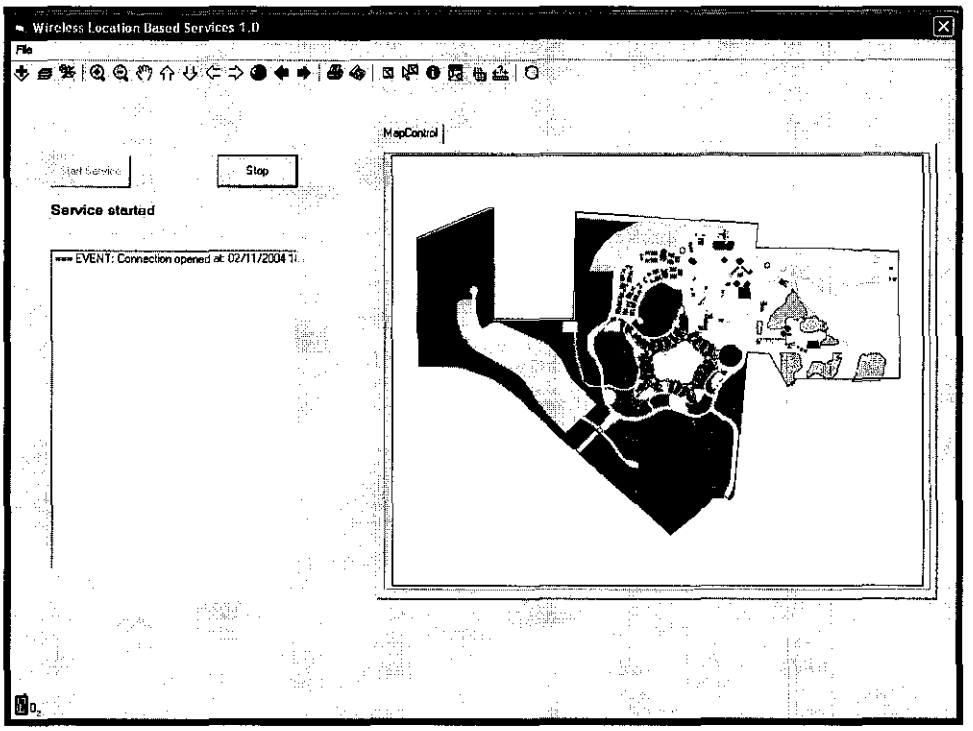
Appendix I: Process Flow of Wi-LBS



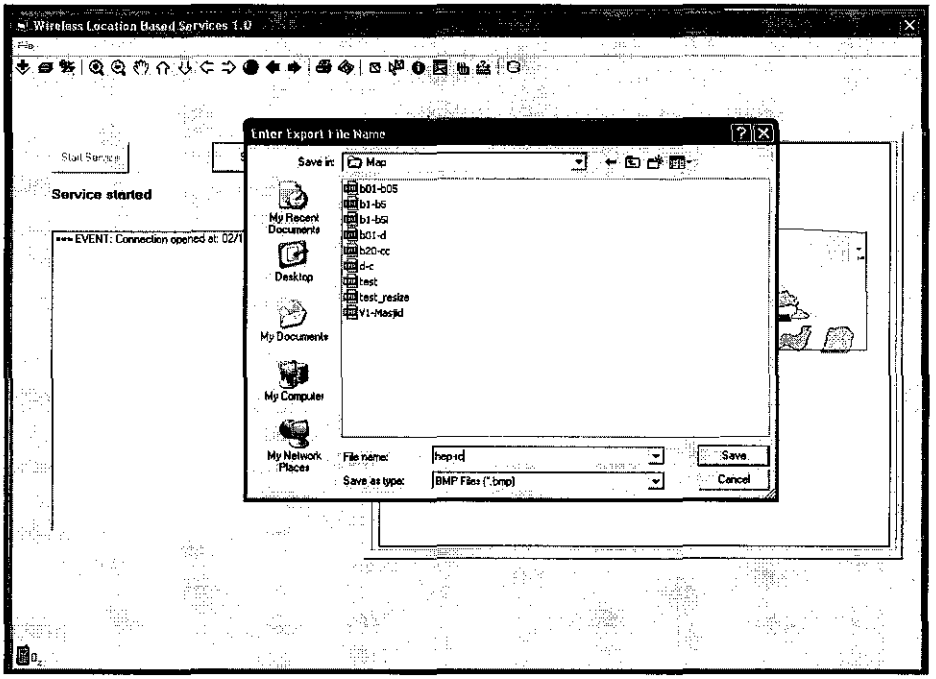
Appendix II: Starting Service of Wi-LBS to Establish Connection between the System and the Mobile Phone.



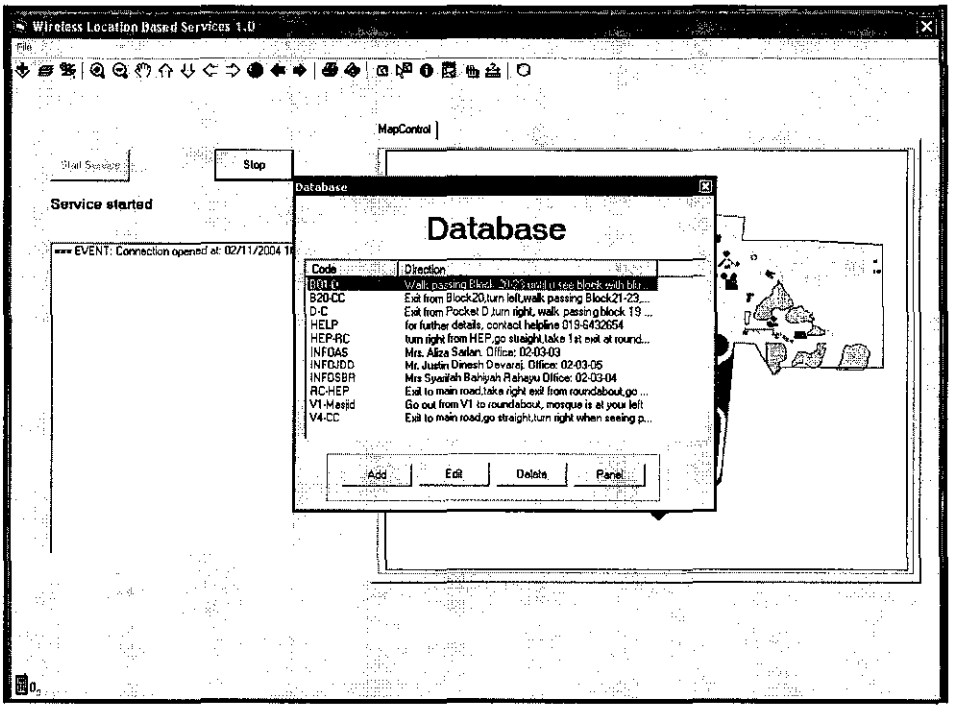
Appendix III: Adding Data Layers to Wi-LBS



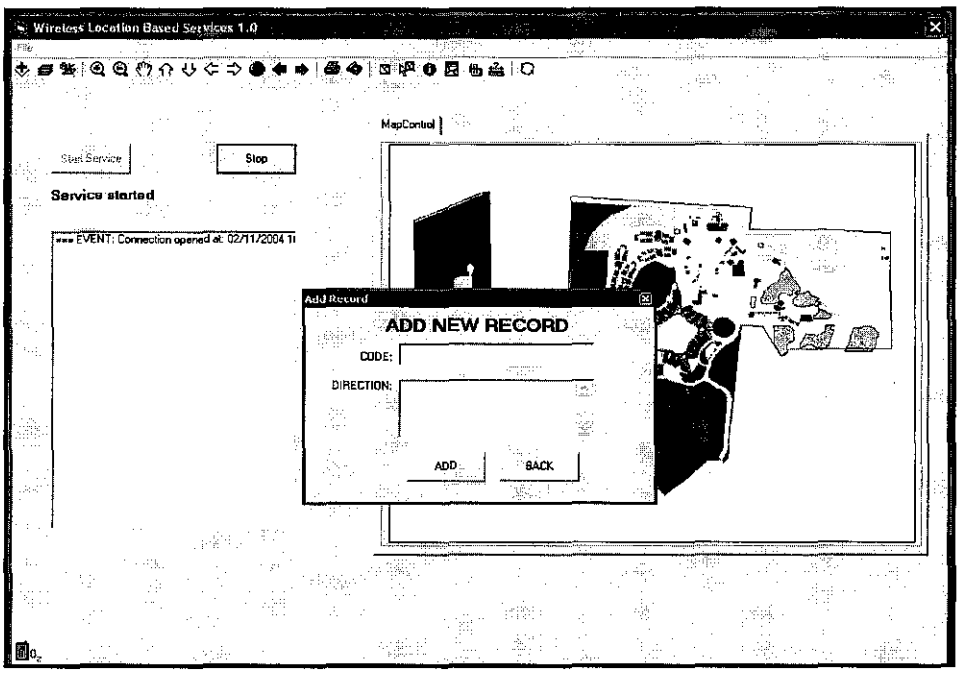
Appendix IV: Layers Have Been Added to the Wi-LBS



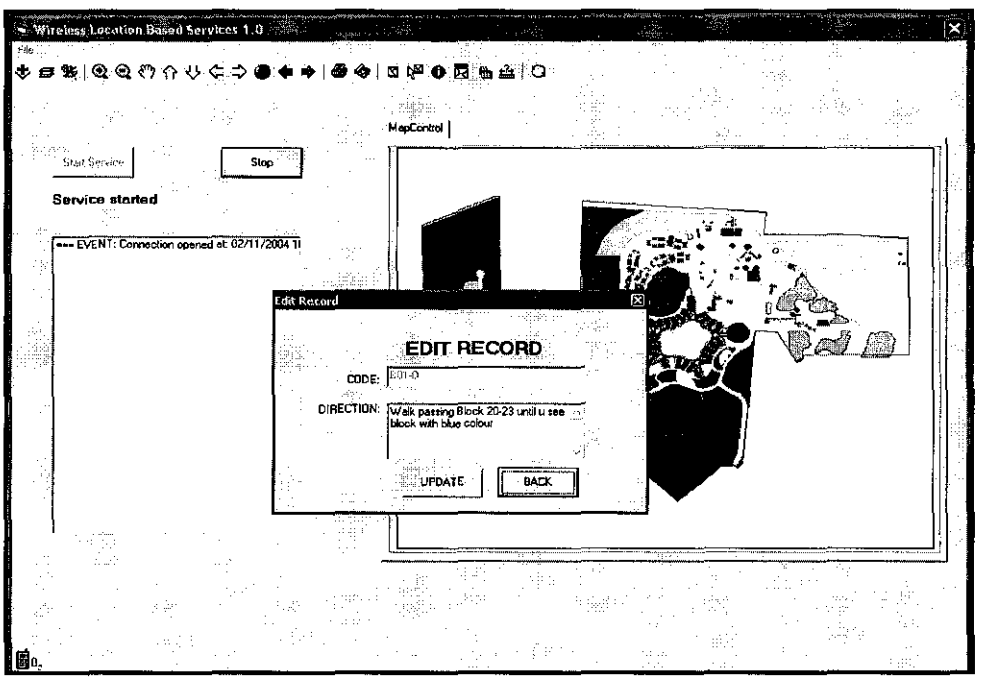
Appendix V: Exporting Images to Respective File Format



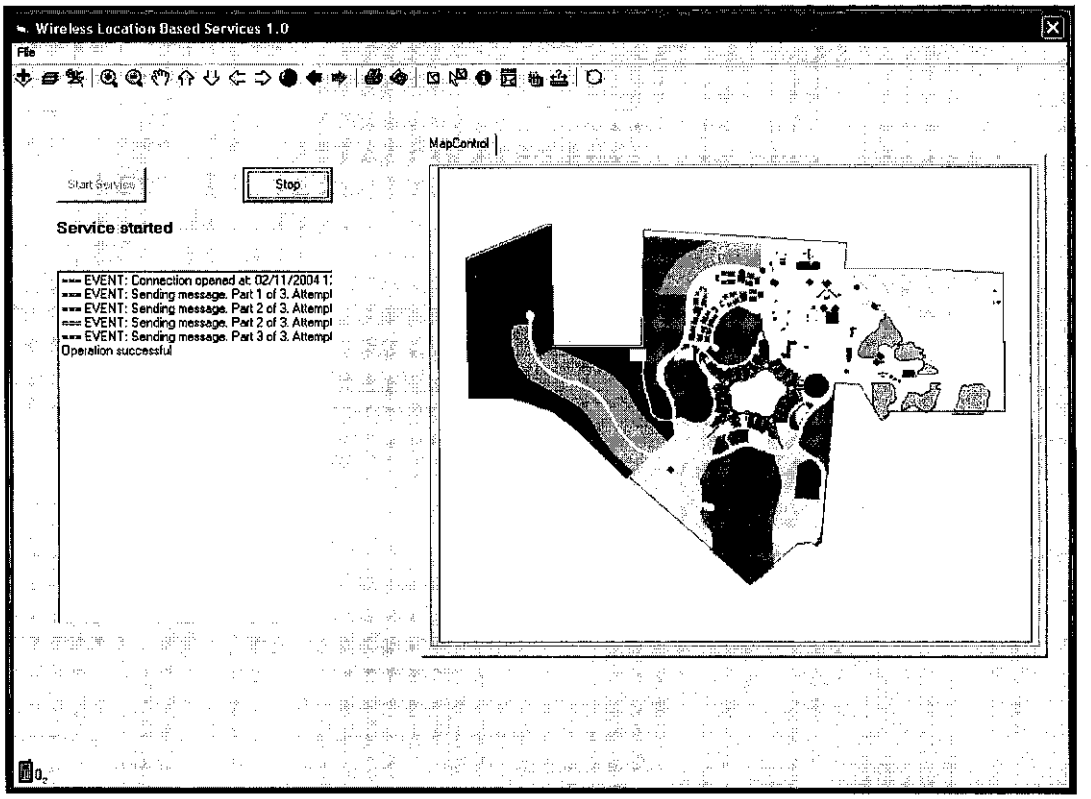
Appendix VI: Viewing the Database



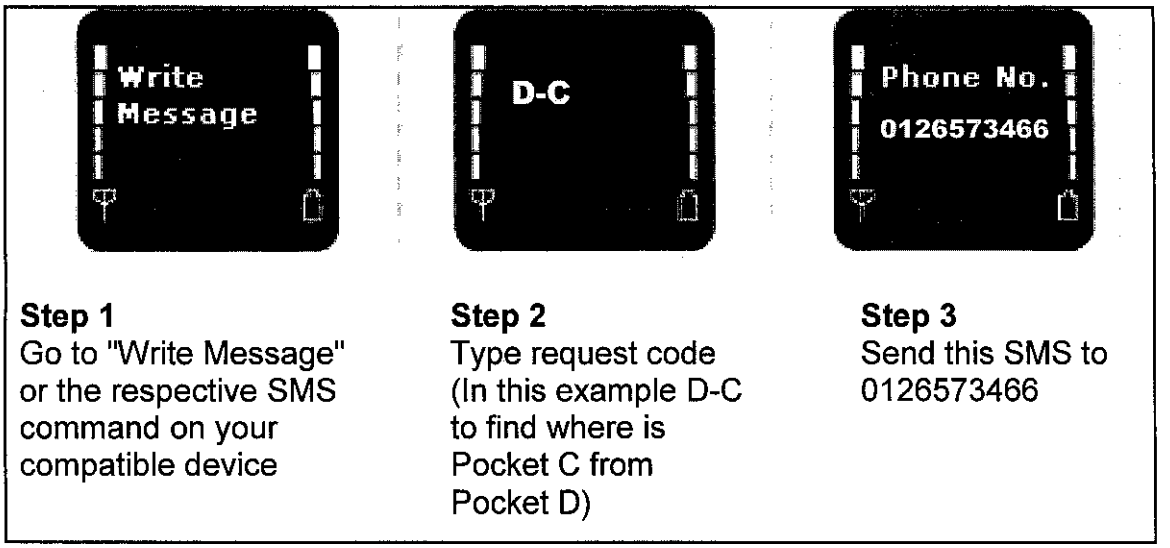
Appendix VII: Adding New Record to the Database



Appendix VIII: Editing Existing record



Appendix IX: Process of Sending the Result to User



Appendix X: Procedure of Sending Request to Wi-LBS