The Journal of GIS Association of Korea, Vol. 10, No. 4, pp. 567-578, December 2002

Design of gCRM system integrated with LBS

Key-Ho Park* , Jae-Gon Jung**, Myung-Hwa Hwang***

Abstract

The success of gCRM depends on the availability of adequate, real-time data about customers' location and the provision of diverse value-added services utilizing it. In the existing gCRM systems, however, it seems that the positional precision of customers' location is very low, and further that the services based on real-time location data are not provided. In order to overcome these weaknesses and extend the limited scope of gCRM, we suggest a new design of gCRM system integrated with LBS. We also describe in some detail the system prototype for such an integration.

Keywords: gCRM, LBS, system design, mobile middleware server, mobile commerce

1. Introduction

gCRM(geographic Customer Relationship Management) systems, which many companies in Korea are actively introducing and implementing recently, are software applications that allow companies to find, grow, retain and serve customers based on information about their location and analysis using it. For companies using gCRM system, the business strategy is to enhance customer satisfaction and profitability by providing customers with differentiated services according to their residence or activity region. The effectiveness of gCRM depends on the provision of adequate, real-time data about customers' location and a rich set of value-added services utilizing the locational data. In this respect, the existing gCRM systems have a couple of serious drawbacks: Firstly, the precision of data about customers' location is not of high level. Secondly, the services based on real-time location data are not available.

* Associate Professor, Department of Geography, Seoul National University
** Director, Mobile Platform Institute, iMobile Technology Co. Ltd.
*** Research Staff, Mobile Platform Institute, iMobile Technology Co. Ltd.

It appears that the combination of mobile computers, such as laptops and PDAs, with wireless networks and location sensing systems (such as GPS) opens up new possibilities to associate location with each customer service and to track mobile resources of the company in real-time(Alvarez et al 2002). In a general sense, Location Based Services (LBS) are defined as network-based services that integrate a derived estimate of a mobile device's location with other information so as to provide added value to the user(Samsioe and Samsioe 2002). The integration of gCRM system and LBS seems crucial in upgrading the modus operandi of business beyond what the current gCRM systems allow, and this is the motivation of our study.

We attempt at suggesting a new design of gCRM system integrated with LBS in this study. For this, the current practice of gCRM/CRM system and LBS is reviewed and a viable design for the integrated system is sought, and then a prototype is built as a testbed for our ideas. The remainder of this paper is organized as follows: In section 2, after a brief review of relevant literature, we elaborate on the necessities of gCRM/LBS integration. We then describe some of the major aspects of our system design in section 3. Section 4 contains technical issues involving our system prototype. Section 5 concludes our work with some preliminary evaluation of our design.

2. Why do we need gCRM system integrated with LBS?

In this section, we start with a brief literature review on gCRM and LBS. By doing that, we illustrate some of the problems inherent in the current gCRM systems and draw the rationale of the system integration of gCRM with LBS.

2.1 Literature review

2.1.1 gCRM

gCRM, as a combination of CRM and GIS(Hwang and Li 2002), adds to CRM the spatial or geographic dimension available in GIS. So the core concept and capabilities of CRM is inherited by gCRM. There being a wide variety of definitions for CRM, a typical one may be that CRM is a business strategy which is comprised of process, organizational and technical change whereby a company seeks to better manage its enterprise around its customer behaviors. It entails acquiring and deploying knowledge about customers and using this information across the various customer touch points to increase revenue and achieve cost reduction through operational efficiencies(Erickson and McLaughlin 2002). gCRM addresses the same issues within the context of geography of the matter. gCRM, for example, looks into the characteristics and relationships of areas/regions.

The input and output of gCRM includes the location of customers and service points, accessibility of outlets, and catchment areas, market potential of sales districts(GISMO 2000).

In Korea, a few companies such as TasTech, OpenMate are currently lead the gCRM markets. The major functionalities of the systems that are developed and deployed currently includes the following:

- Analysis of commercial areas and generation of target areas/zones
- Analysis of customers' information and segmentation of customers
- Management of stores or service points
- Creation of maps and reports presenting the results of analysis or locations of stores/customers

There are some prerequisites in implementing these functions of gCRM. Firstly, the acquisition of customers' address or location is essential. Secondly, the coupling of generic database that concerns, for example, census, personal income and lifestyles is required. The availability and quality of these data determine those of the analysis of customer information within gCRM. In reality, however, it is not easy to obtain the precise locational data of customers, and conduct meaningful analyses in the light of other geodemographic information. This is partly because most information about customers' location is collected in the form of address in questionnaire that customers fill out, and other associated data sets are not easily disclosed due to privacy protection requirements. Therefore, some viable alternatives for the task of collection of locational data are in pressing need.

2.1.2 LBS

LBS is a collection of network-based information services that integrate a derived estimate of a mobile device's location with other information so as to provide added value to the user(Samsioe and Samsioe 2002). It depends on information about mobile station's position. This positional information, to be useful, but, has to be correlated with some types of services. That is, LBS takes up the role of supplying customized information involving users' position (Ververidis and Polyzos 2002). Cellular Service Providers (CSP) who try to seek new ways to ensure customer loyalty by offering new types of services have paid much attention to LBS. However, some legal problem of protection of mobile user privacy as well as the low-performance and technological diversity of mobile phones have impeded the spread of LBS. Recently, the advanced type of phones such as the ones with built-in GPS chips get to be widely used. The legislation of 'The law about usage and protection of location information' has also been announced. As such, the industries relevant with LBS is expected to be more activated(Choi 2003).

In 2000, Gravitate Inc. published a white paper which identified three evolution steps for LBS (Koeppel 2002, Ververidis and Polyzos 2002). The first generation refers to services where the subscriber has to manually give his position information to the system. The second generation (existing services) refers to location services where the position of the subscriber is automatically discovered but with little accuracy. Finally, the third generation refers to services where the position of the subscriber is automatically discovered with accuracy and which have the intelligence to inform or warn the subscriber about events depending on his position (the subscriber doesn't have to initiate the service, the initiation depends on triggers according to his/her preferences) (Ververidis and Polyzos 2002). LBS in Korea has reached the third generation and has been applied to diverse domains.

The GSM Alliance Services Working Group[1] has defined the following types of Location Based Services: emergency (alert) services, home-zone billing, fleet management, asset management, person tracking, pet tracking, traffic congestion reporting, routing to nearest commercial enterprise, roadside assistance, navigation, city sightseeing, localized advertising, mobile yellow pages, network planning and dynamic network control. Of these various application services, routing to nearest commercial enterprise and localized advertising can belong to a wider category referred to as mCRM(mobile CRM) or mobile commerce(mCommerce).

mCRM can be described as all the activities required to communicate with the customer through the use of mobile devices in order to promote sale of products or services and the provision of information about these products and services(Siemens mobile 2002, Ververidis and Polyzos 2002). mCRM services using LBS, which promise high potential[2], are different from gCRM in that the latter tends to focus on analysis using information of stationary location while the former tends to concentrate on provision of services using information of on-the-move location. But, at the same time, they are similar in that both try to acquire and sustain company's customers by using information about customers' location. Considering the similarity of their ultimate goals and approach, thus, we conclude that their integration can solve the problem relevant with collection of location data in gCRM and may result in positive effects such as the expansion of gCRM to mobile platform context.

2.2 Integration of gCRM with LBS

2.2.1 Rationale

Our proposal is that gCRM system could and should be integrated with LBS to be

1) http://www.gsmworld.com/about/structure/serg.shtml

2) This is well demonstrated through following predictions(BWCS Consulting and Communications Services Inc. 2002, Ververidis and Polyzos 2002): ① By 2005 the 33% of a CSP's revenue will be coming from advertising and from payments and commissions from mobile commerce activities. ② Location aware advertising messages are expected to create 5 to 10 times higher click-through rates compared to Internet advertising messages.

able to cover the wider roles of CRM and provide customers with value-added services where all kinds of location data are used to a full extent. Such integration is required for the following reasons:

i) The existing gCRM systems, which have been focused mainly on analysis of information about customers, need to diversify domains of application and location information can be utilized in the areas such as management of channel or direct marketing to customers. The combination of gCRM and LBS makes this change possible.

ii) The current usage of the location information in the existing gCRM system is characterized by the stationarity and rare update. But this kind of location information is not appropriate in the gCRM where accurate information presenting activity areas of customers is required. Thus, through the integration with LBS in which data of location on-the-move are captured, the quality of knowledge which is discovered in gCRM can be improved greatly.

iii) Delivering real-time, location-enhanced information helps customers and suppliers accelerate, automate, and optimize their decision making process (Berkowitz and Lopez 2001). More than this sort of service, flexible incorporation of real-time, location-enhanced information into existing business operation is also very significant. The close interconnection and integration of gCRM and LBS can become a reference model for seamless incorporation of services on the wireless environment into enterprise process on the wired environment.

2.2.2 Effects

gCRM system integrated with LBS can help enterprises in a number of ways. Firstly, customer information in legacy DBMS is closely linked with information about on-the-move location of customers or mobile workers such as sales agents or technicians. The mobile workers, in particular, can have access through mobile devices to corporate resources, and they are also always reachable no matter where they travel.

Secondly, the quality of customer information and results of analysis can be enhanced, and the knowledge from location-based analysis can be more realistic.

Finally, by applying to LBS the results of analysis of gCRM in turn, enterprises may also improve the utility of location-aware mobile applications. For instance, we can analyze customer information collected through LBS, determine target areas for promotion of new product, and then provide customers who visit those areas with special mobile coupons. The integration of gCRM with LBS enables new business process as above.

3. How do we integrate gCRM with LBS?

In this section, technological requirements for gCRM/LBS integration will be elaborated. The overall architecture of the system and

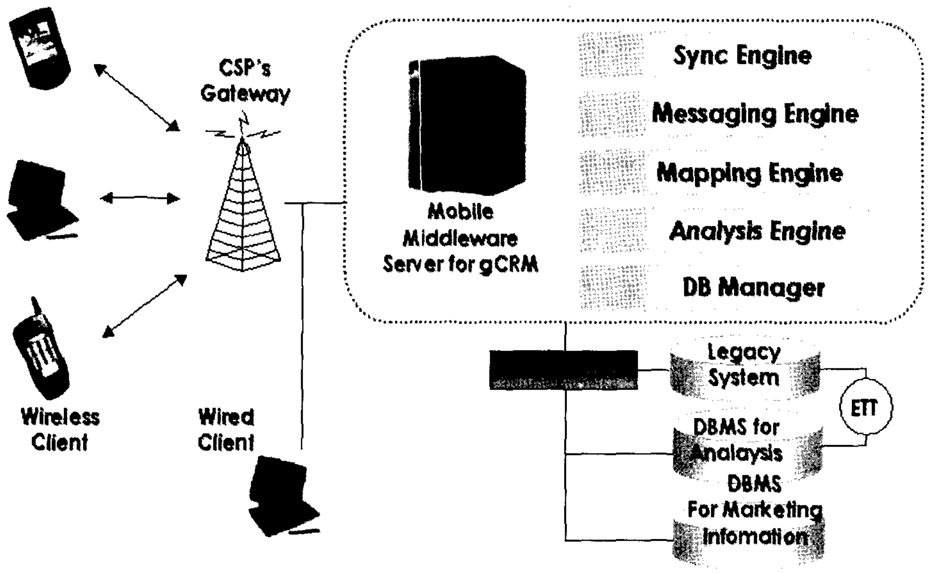

Figure 1. System Architecture

the mobile middleware server, in particular, will be sketched.

3.1 Approach

We propose a gCRM system into which data about customer's location is collected via LBS, and is then sent to database server, analyzed and according to technician or salesman's real-time location analysis results and customer information are provided with them.

For this, a method with which we can freely send and receive spatial/non-spatial data without consideration of network environment must be devised. This is because the general gCRM systems are based on wired networks while LBS services are run on wireless environment. Then, other techniques should be supported, with which technician or salesman can be located and various information that is proper for regions in the proximity of them can be pushed to their mobile devices.

In order to meet these needs, we adapt middleware components, since they have been developed to enable transparent access to heterogeneous, distributed information sources in wired or wireless networks (Pissinou et al. 2003). For this, we devise a mobile middleware server for gCRM that performs not only general processing(collection, transmission and transformation) of spatial/non-spatial data but also spatial-statistical analysis of customer information. The organization of our mobile middleware server for gCRM will be detailed in section 3.3.

3.2 System Architecture

In designing a gCRM supported by LBS, we put emphasis on scalability, distribution, and interoperability through the use of well-documented flexible ontologies and broadly accepted information access protocols(Cousins and Varshney, 2001). Scalability and distribution refers to the capability of a system to expand providing support for more users and also to the capability of autonomous management of separate parts of the available information. The information access protocols, when standardized, give the opportunity to the system designer to use already well-defined interfaces. The ontologies used to describe the available information should be based on standards, which allow the easy expansion and management of the information(e.g. XML-like ontologies)(Ververidis and Polyzos 2002). Our approach to the architectural design of the system follows the above principles.

The main architecture of our system is presented in Figure 1. This system consists of wireless/wired clients, a mobile middleware server, and a DBMS for marketing information and analysis. Wireless/wired client collects data about location and other useful information of customer and requests marketing information such as the prospecting regions in sales to mobile server, and carries out less complicate analysis of records of sales or services. It is the mobile middleware server that processes client's requests. The key components of the server are: synchronizing engine, messaging engine, mapping engine, analysis engine and DB manager. Details of these components is illustrated next.

Particularly, messaging engine of mobile server receives the data about users' current location and finds out area/region which corresponds to the data. Then, it extracts marketing information for that area/region from DBMS server, which manages various information needed in marketing and results of analysis. DBMS for analysis are created through extraction, transportation, transformation from existing legacy DBMS.

The crucial module in our system architecture is the mobile middleware server, since it is platform for the entire operation of the proposed system and plays a role as mediator that makes communications among them possible. So, its inner architecture is elaborated next.

3.3 Mobile middleware server

We designed a middleware server based on technologies of Java Virtual Machine and .Net to conform the principles such as scalability, distribution, and interoperability. That is because Java is platform independent and so we are not locked into any particular vendor for services (Berkowitz and Lopez 2001), and also because .Net makes it possible to develop application for mobile devices in the same method as general windows programming by using Smart Devices Extensions with the release of

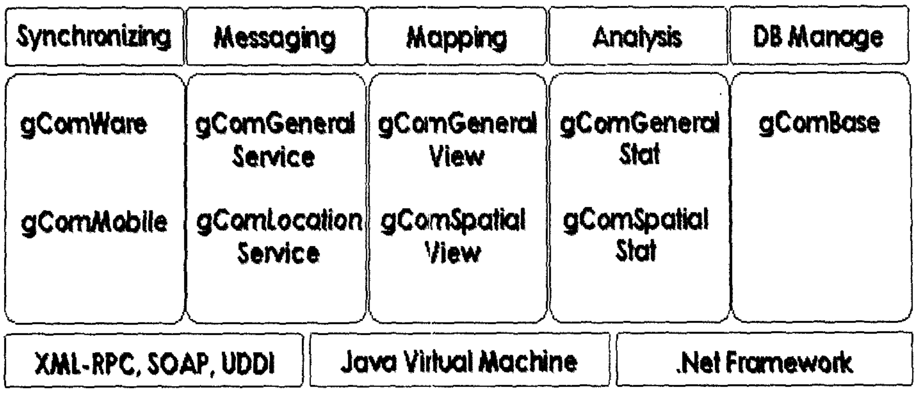

Figure 2. Components of Mobile Middleware Server for gCRM

Compact Framework (Youngjin.Com 2003). As mentioned before, mobile middleware server is composed of five main components and again each component is divided into one or two sub-components as shown in Figure 2.

Synchronizing engine serves as a consistent translator which can enable the complete exchange of data between wireless client and mobile server and is the most significant of all components in the mobile server. gComWare of Syn. engine is responsible for such translator and uses standardized ontologies such as XML-RPC, SOAP and UDDI(Universal Description, Discovery and Integration) to enhance the interoperability of the proposed system. gComMobile component executes a function of wireless communication between client and server.

gComGeneralService and gComLocation Service coalesce into Messaging engine. gComGeneralService manages transmission of SMS(Short Message Service) or e-Mail from wireless/wired clients and gComLocation Service receives data about the location of mobile devices, searches region information using the data and extracts location-based marketing information based on it.

Mapping engine, on the whole, functions as processor of graphic. While gComGeneralView deals with general graphic data to be sent to mobile clients, gComSpatialView processes graphic data relevant with map of customers and users. In the similar way, gComGeneralStat of Analysis engine is concerned with general calculations ranging from simple arithmetic operations to complex statistics computations but gComSpatialStat performs location-based analysis such as averaging by region/area and calculating various spatial indices.

Finally, DB manager serves as a synthesizer which unifies the wireless client and the wired legacy DBMS utilizing JDBC/ODBC technology.

4. System Implementation

In this section, we describe a prototype implementation following the system design presented in previous sections. The feasibility and value of our system design concepts will be tested based on this prototype.

4.1 Target application for prototyping

Our prototyping is focused on a simple target application. As the gCRM/CRM encompasses many sub-fields and the existing gCRM needs to go beyond analysis-focused stage, we chose one of sub-areas in mCRM where LBS can be utilized. That is mobile SFA(Sales Force Automation), SFA[3] system operated in mobile environment. Our prototype targets universal salesmen, who always move from place to place to sell products. The prototype, in itself, demonstrates the possibility of extending gCRM into mobile commerce.

4.2 Implementation

4.2.1 Wireless client

In our design, any mobile devices and desktops may work as a client. We have selected PDA as the client platform since PDA is most widely used in real business. In developing wireless clients, we adopted .Net Framework for the extensibility and compatibility.

Table 1. Organization of Client Functions

Menu	Functions
Schedule	o View appointments by day/month/year o Register new appointment o View and modify details of appointment
Customer	o Find customer o Register new customer o View profiles and trade information of customer o Message to customer
Product	o Find product o View detail and trade information of product
Trade	o Register new trade o Find trade information
Score	o Plan of scoring o View trend of score by table and graph
System	o Setting transfer method of data o Setting automatic alert of customer's memorial day o Find information of fellow o Manage user fellow group

The interface available in the client is composed of six main menus: The functions associated with each menu are listed in Table 1. In 'Customer' of main menus, data about customer's location is collected, saved and sent into mobile server through LBS. Users can identify location information of customers in the form of map by using functions like 'Find Customer', 'View Details'. Figure 3 illustrates map display on PDA client.

3) SFA is a type of system that automates business tasks such as inventory control, sales processing, and tracking of customer interactions, as well as analyzing sales forecasts and performance(www.whatis.com).

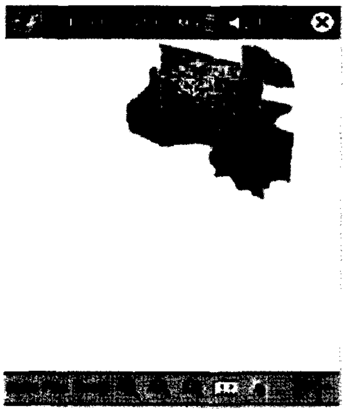

Figure 3. Map Display on PDA Client

4.2.2 Mobile middleware server

As discussed earlier, mobile middleware server consists of five components as shown in Figure 2. These components of mobile server are based on multi-platform with pure Java, which has many advantages such as portability, productivity, stability and support for database standards.

DB Manager integrates database of legacy system with that of mobile client using JDBC, a Java interface for a traditional database(Shih and Shim 2002), and ODBC. It can monitor information requested from clients in the format of SQL and support load balancing to enable many devices' simultaneous access to mobile server. For development of these functions, we provided tools for supporting CORBA (Common Object Request Broker Architecture) to enable accesses from heterogeneous information sources.

DB Manager functions on the basis of free communication. It is Synchronizing engine in our design that guarantee the free communication. In gComWare component of Synchronizing engine,

```
import java.io.*;
import java.text.*;
import java.util.*;
import javax.servlet.*;
import javax.servlet.http.*;

import com.imobile.ixml.*;
public class EchoServer extends HttpServlet {

// omitted intentionally

     public void doGet(HttpServletRequest request, HttpServletResponse response)
                  throws IOException, ServletException
     {

            iXMLServer iserver = new iXMLServer();
            iserver.addHandler("echo", new EchoHandler ());

            response.setContentType ("text/xml");

            byte[] result = iserver.execute (request.getInputStream());

            System.err.println(new String(result));

            response.setContentLength(result.length);
            OutputStream out = response.getOutputStream();
            out.write(result);
            out.flush();

     }

    protected class EchoHandler implements iXMLHandler {
            public Object execute(String name, Vector params) {
                 return params.elementAt(0);
            }
    }

}
```

Figure 4. Creation of Business Object using gCromWare

business object is made in a servlet container to process client's request. And the servlet container fully supports HTTP/XML confirming XML-RPC, SOAP and UDDI protocols. Figure 4 illustrates an example of creating business object.

Messaging component manages transmission of SMS, e-mail or location data between mobile client and middleware server. As for SMS and e-mail, Messaging component is responsible for linking mobile client with gateway of CSPs regardless of the mobile client types involved. As for location data, Messaging component sends and receives data in XML and GML.

Mapping engine converts general map data to map format proper for mobile devices. For this, we developed core classes GraphicView, GraphicModel and Controller, which were defined according to the OO pattern known as MVC(Model-View-Controller) architecture. In Analysis engine, methods for general and spatial analysis were newly reconstructed through the process of selecting from many existing functions and modifying them, to be optimized for mobile SFA.

4.2.3 DB server

DB server manages two kinds of data; source data for analysis which is extracted from legacy RDBMS and data for marketing which includes the results of location-based analysis.

To be more concrete, data for analysis is about customers, products, trades and salesmen. It is extracted from the existing enterprise DB, transported to separate DB server, transformed and cleansed in the appropriate form for analysis. Using these data, mobile middleware server discovers new patterns and knowledge such as clusters of prospecting customers and niche market. The knowledge is managed in marketing information database as information for CRM that will be delivered into sales agencies. Marketing information database also manages pure marketing data, for example, mobile coupons and information related to product promotion for particular region. As mentioned before, these DBs are connected to mobile clients with little data loss by DB Manager in mobile middleware server for gCRM.

5. Conclusion

gCRM is a challenging area of active research and development. We observe, however, that the current practice of gCRM is very limited in its scope mainly because it confines its applications to analysis-centered services. gCRM, being a spatially-enabled form of CRM, needs to be extended to the degree where it will include various sub-fields such SFA and FFA. LBS, as one of the core technologies in mobile environment, plays a critical role in such an extension of gCRM.

In this paper, we presented a new design and implementation for gCRM system integrated wth LBS. For a seamless integration of gCRM and LBS, we proposed a mobile middleware server for gCRM and it provides various functions for mobile gCRM. Our design conforms to standard ontologies such as XML-RPC, SOAP and UDDI, and guarantees extensibility by using Java and .Net Framework.

Our work, on the other hand, also suggests a generic framework for gCRM systems which can operate in mobile environment. Based on our framework of gCRM system, a variety of applications for mCRM can be implemented with little modification. Such applications include systems for management of insurance agent, sales agent, field engineer and the like. This sort of applications related with mCRM may well conducive to the expansion of gCRM.

We believe that continued researche on the application of gCRM adopting advanced information technologies is in need so that gCRM may establish itself as an integral part of CRM.

References

Alvarez P., Banares J. A., Muro-Medrano P.R. and Zarazaga F. J., 2002, Integration of Location Based CRM Systems, GeoInfomatics 2002 July/August.

Berkowitz, T. and Lopez, X., 2001, Enhancing Mobile Applications with Location-Based Services, Oracle.

Choi, J.-J.-, 2003, Previous announcement of legistration of law about the usage of location information, Korea Times, August 18, 2003.

Cousins, K. and Varshney U., 2001, A Product Location Framework for Mobile Commerce Environment, in the Proceedings of the ACM Mobile Commerce Workshop, Rome, Italy.

Erickson D. S. and McLaughlin M., 2002, Customer Relationship Management: A Pulse on the Community, Information Systems Audit and Control Foundation.

GISMO, 2000, Geo-Marketing at your fingertips with GISMO, 6th EC-GE and GIS Workshop, Presentation Document.

Hwang J-.R-. and Li K-.J., 2002, gCRM and Spatial Data Mining, Proceedings of the 2002 OGISRS Spring Meeting, Seoul, Korea.

Keoppel, I., 2002, What are Location Services? From a GIS perspective, Available at: http://www.jlocationservices.com/company/esri/What are Location Services.html.

Ovum, 2000, Mobile Location Services: Market Strategies, Ovum.

Pissinou, N., Makki, K. and Konig-Ries, B., 2003, Mobile users in heterogeneous environments with middleware platform, Computer Communications, Vol. 26, pp.700-707.

Samsioe, J. and Samsioe, A., 2002, Competitor analysis in the location based service industry, M-Business 2002 Conference.

Siemens mobile, 2002, Siemens Location Services(LCS), Mobile Phone with a sense of place, Added value through location services, White Paper, Available at: http://www.siemens.mobile.de/mobilebusiness/CDA/external/press/en/Whitepaper_Location_Based_Services_e.doc

Shih, G. and Shim, S. S.Y., 2002, A Service Management Framework for M-Commerce Applications, Mobile Networks and Applications, Vol.7, pp.199-212.

Ververidis, C. and Polyzos, G.C., 2002, Mobile Marketing Using A Location Based Service, Proceedings of the Mobile-Business 2002 Workshp, Athens.

Youngjin.Com, 2003, C# Network Programming, Youngjin.Com. www.whatis.com