GPS – MCRM INTEGRATION SOLUTION

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Computer Information System

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Dedication

This is dedicated to my family, for their encouragement and love.

Acknowledgments

First of all, I would like to thank God for his graces and for his guidance.

I would like to express my sincere appreciation to Professor Mohammad Al-Fayoumi for his guidance, assistance, scientific hints that lightened my road during my writing this Thesis.

I would further like to acknowledge all of the Information Technology faculty members at the Middle East University for Graduate Studies, for helping and encouraging my efforts especially at the beginning of the thesis.

Above all, I would like to especially thank my parents for supporting me during the time I was writing this thesis. Without them nothing of this thesis would have been possible.

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الملخص

إدارة علاقات العملاء تعرف على نطاق واسع بأنها الإستراتيجية التجارية التي تركز على العملاء حيث يجري تطبيقات و حلول جديدة في هذا المجال بالإضافة إلى أن المنظمات تطالب بمزيد من أدوات و أنظمة متطورة لتعزيز علاقاتها مع العملاء.

و نظراً لازدياد أهميتها في الأعمال التجارية وجد الباحث أن دراسة المواقف الحالية للشركات و ميولها للاستثمار من شأنه أن يحسن هذه العلاقات و بعض التقنيات الجديدة.

إن الغرض من هذه الرسالة هو تصميم تقنية تدمج بين نظام إدارة علاقات العملاء و النظام العالمي لتحديد المواقع على الأجهزة المحمولة من أجل التقليل والحد من الوقت للبحث و الوصول إلى معلومات العملاء وتحديث البيانات المتعلقة بهم في نظام إدارة علاقات العملاء و يتم ذلك من خلال الاعتماد على موقع الشخص الذي يملك الجهاز المتحرك باستخدام النظام العالمي لتحديد المواقع والإحداثيات, و باستخدام تكنولوجيا شبكات المحمول لتوفير التفاعل لتبادل البيانات بين الأجهزة النقالة والحاسوب الرئيسي للمؤسسات، وكذلك عن طريق استخدام تكنولوجيا الإنترنت وقاعدة البيانات لأداء عمليات البحث في قاعدة البيانات و حواسيب الشبكة الرئيسية.

النظام المقترح في رأي الباحث هو نظام متحرك وقابل للتوسع وكفوء و يرى الباحث من انه يضيف مزايا وقيم جديدة للنظم المتوفرة في الأسواق . لذا فان الباحث يوصي بتطبيق النظام على الأجهزة النقالة التي تستخدم نظام Windows Operating System و الحواسيب الرئيسية التي تحتوي على Net Framework.

النتائج المستخلصة ترسم صورة من أن النظام الجديد الذي يحمل العنوان:

" GPS – mCRM Integration Solution"

يمكن أن يساهم في زيادة كبيرة في إنتاجية وكفاءة المؤسسات التي تستخدم نظام إدارة علاقات العملاء الذي يحتوي على هذه التقنية.

Abstract

Customer relationship management (CRM) has been widely recognized as a customer centered business strategy. New CRM applications and solutions are rapidly being developed and organizations are demanding more powerful tools to enhance their relationship with customers.

Since customer relations is getting more important in business; the author found that it would be interesting to study current attitudes of corporations to invest in system that would improve such relations and some new trends to improve current technologies.

The purpose of this thesis is to design a technique for integrating CRM application with Global positioning system (GPS) on mobile devices in order to ease and reduce time of accessing and updating customers data through mobile CRM application depending on the location of the person holding the mobile device, by using the global positioning system to determine the location coordinates, and by using mobile networks technology to provide interaction of exchanging data between the device and enterprise servers, and also by using internet HTTP technologies and database queries to perform the transaction performed on enterprise database and web servers.

The proposed scheme is dynamic, flexible, secure and efficient and it claims to add new values and advantages to the already existing schemes in the market.

The author recommends implementing a scheme on mobile devices that uses windows operating system and .Net framework web servers.

Results are given from which the conclusion is drawn that developing a new scheme entitled "GPS – mCRM Integration Solution" can increase significantly in the productivity and efficiency of enterprises adopting mobile CRM applications with this technology.

Chapter 1
Introduction

1.1 Overview

This introductory chapter will provide the reader with an insight to the research area. The thesis begins by briefly discussing the problem definition followed by motivations and the overall purpose of the study. Demarcations and the disposition of the study are presented later in the chapter.

Business nowadays doesn't stand still, also employees in organizations such as field sales and service staff who are on the move every hour of every day, for leading-edge companies looking for an advantage in a competitive global business environment. Also mobile devices and wireless technologies have become important tools.

With today's mobile devices, wireless technologies and applications enables field and mobile professionals to keep business moving no matter where they are, with instant access to their key people, processes, information and products.

The business need to keep field professionals linked to corporate information systems due to the need to improve business gains in productivity, customer satisfaction, and real-time updates; many leading enterprises work on real-time mobile customer relationship management to provide access to corporate business applications and

data stores with information that helps field professionals work at the pace that customers and business demand.

Market and sales strategy is becoming more customer-oriented, and due to the need to gain competitive edge and more customer satisfaction; new technology trends are capable to add value and enhance on current mobile customer relationship management tools and applications.

1.2 Problem Definition

Mobile Customer Relationship Management (mCRM) is a relatively new area of research. The empirical studies that have been made within this field are merely focused on defining mCRM and finding its benefits [28].

Since customer relations is getting more important in contemporary business it would be interesting to study current attitudes of corporations to invest in system that would improve such relations and some new trends to improve current technologies [28].

However, customers today are more highly educated, under higher stress, more specialized, living longer, and more influenced by global culture. Understanding customers is now much harder, which increases the complexity of customer relationships. Therefore, fast, new, real-time and interactive technologies must be used to combat these forces [14].

In this research, we would propose a mobile customer relationship integration technique with Global positioning system, it's barriers, it's adoption benefits in the market for customer oriented companies.

1.3 Objectives

Based on the discussion above, the purpose of this research is to take advantage of new technology trends to increase the effectiveness of mobile CRM application, which can be achieved by integrating mobile CRM with GPS; so in this thesis the objectives are as follows:

- To generate a method to integrate GPS with Mobile CRM application
- To provide a way we claim to ease, enhance and automate customers information instant access to field sales representatives.

1.4 Motivations

The motivations of this study are as follows:

1. To know what are the measurable benefits for an investment of Mobile CRM and what enterprise needs to do to go mobile.
2. Due to the great interest of organizations to empower their sale forces with tools to work remotely.
3. Due to the need of real-time update of customer's information on the spot by providing access to corporate business applications and data stores with invaluable information that helps employees work at the pace that customers and business demand.
4. Due to today's technology in mobile devices, applications, and network speeds enables field and mobile professionals to keep

business moving no matter where they are, with instant, fast and automatic access to their key people, processes, information and products.

In addition to the above motivations, for many people in the field a laptop is not a realistic option for quick access to information, as it doesn't provide the same real-time or convenience level as a small device. Keeping a company mobile professionals connected to reduce downtime and keep them productive by providing them with a mobile device capable of connecting to and interacting with key corporate applications in more effective, fast, automatic and online interaction.

A Forrester research performed on 324 company in north America showed that 84% from the companies polled have equipped key personnel with handheld devices that can receive voice and data, where 30% company have equipped key personnel with handheld devices for field sales applications, so adding value and increasing their effectiveness and productivity will increase number of companies who equip their field sales representatives with mobile devices

1.5 Significance

This thesis serves both the CRM vendors and the CRM users in the following points:

1. The CRM solution vendors who will redirect their focus on customer satisfaction and more effective real-time solutions rather than focusing only on the customer.

2. The CRM users will benefit from taking CRM solutions and mobility to the next level by taking mobility seriously and integrating it into their corporate and IT infrastructure.
3. Users will benefit from increasing the performance and efficiency of field sales tasks by integrating GPS services to mCRM in retrieving customers data.
4. Wireless medium as an element of CRM is rarely taken into consideration and the literature concerning mCRM is scarce. In an attempt to fill this void, this dissertation provides insights into mCRM integration with GPS, the new trend and it's benefits to enterprises.

1.6 Thesis Delimitations

This study focus is on the technologies and tools used to integrate GPS (Global positioning system) with mCRM (Mobile Customer Relationship Management). The study does not cover discussing GPS and mCRM applications development and design due to time limitations and also since many leading information systems companies have those applications in the market.

1.7 Related Work

In this section, a brief view of research and studies done in topics related to this thesis is presented.

In year 2001 Günther Retscher and Esmond Mok [8] proposed scheme entitled "Integration of mobile phone location services into

intelligent GPS vehicle navigation systems". This research provided an integration method of mobile phone location services for temporary position determination into the intelligent vehicle navigation system. One of the main topics of the research is the integration of mobile phone location services (MPLS) into vehicle navigation systems in addition to GPS and dead reckoning for the development of intelligent land vehicle navigation and tracking system suitable for urban areas. This integration enhanced the accuracy and reliability for position determination in urban canyons where no GPS positions are available for a long period of time to update the dead reckoning system, the proposed scheme in this dissertation uses GPS location positioning and makes it relevant by using technology for improving business productivity.

In 2003 Wu Tie [27] did a research entitled "Implementing CRM in SMEs: An Exploratory Study on the Viability of Using the ASP Model", in this study the author aimed to study the viability of using the ASP(Application Service Providers) model for SMEs (Small and Medium-sized Enterprises) to implement CRM. The study involves intensive review and induction of relevant theories on CRM, SMEs and ASPs, as well as empirical research on comparing currently prominent ASPs products: Upshot and Salesforce.com. The findings in the study show that according to characteristics of SMEs and ASP products offerings, it is practically viable for SMEs to implement CRM by using ASP product offerings from business and technical perspectives, a major limitation of this study is a lack of investigation into the difference of user experience in using applications. The proposed scheme offers a new service that could be implemented in ASP products to enhance it and add more value to it.

In 2004 Mohammad AAmir Turk [14] did a research entitled "Data Mining and Mobile CRM", in this study they divide the dissertation into two segments. The first segment investigates a new data mining technique and compares it with the classification based on associations (CBA) for mining classification rules from different data sets. A new approach, LCA (Look At the Class Approach) is introduced and rules are generated with both CBA and LCA approach by using the Apriori algorithm. The LCA is very effective in terms of reducing the number of combinations of the item sets in each iteration; hence will be capable of reducing the system response time for generating rules from mobile customer opt-in database. The second segment is oriented around mCRM. The study endeavoures to build an empirically grounded framework of the initiation stage of (mCRM) in retailing. The main result of this study indicates that mCRM may be an effective element to CRM strategy, if customer relation is based on permission marketing and trust. Another result is that by collecting and maintaining useful information through data mining from the customers' database, stores can offer their customers interesting services via the mobile medium (SMS/MMS) (Short Message Service/Multimedia Messaging Service), in the proposed scheme the purpose is to retain customers not only by services via SMS/MMS, in addition to that organization members can access customers data fast and automatically from anywhere in a more flexible and reliable method. One of the main disadvantages of SMS/MMS advertising this research is proposing is that companies prediction of the customers who are willing to participate in this kind of advertising is not accurate and the prediction rules will never be a guaranteed "yes" from customers to participate in mobile advertising but those rules and

predictions can save companies a lot of time by contacting right customers at the right time.

In the year 2005 Jeff Dutrizac [9] did a study entitled "Mobile CRM Increases Productivity", in this study the author described he measurable and quantifiable benefits that a mobile CRM solution can provide workers accessing and sharing enterprise information from the field. Although those benefits vary from industry to industry, they typically include increased productivity, improved customer satisfaction, enhanced inventory management and faster revenue recognition. Also the author guides organizations to what to do in order to go mobile by describing the components of CRM solutions, the author encourages organizations to mobilize CRM in order to increase ROI. An advantage of this study that it encourages companies to mobalize their CRM solutions by expressing the many benefits for going to mobility. In addition to all mobile CRM benefits mentioned by the author, the propose scheme adds more value to using mobile CRM solutions by increasing productivity and ease in accessing and updating customers data in real time in more effective way.

In the year 2007 Yohannes Belachew, Amanda Hoang, Joseph Kourieh [28] did a research entitled "Mobile Customer Relationship Management A study of barriers and facilitators to mCRM adoption", In this study, the main focus is to find out why companies chose to adopt or not adopt mCRM systems. The authors gathered and examined theories about CRM, mCRM and the spreading of technology (The Technology Acceptance Model). Also authors used a qualitative approach and interviews were conducted in order to find barriers and

facilitators to mCRM adoption. The research resulted in several reasons for mCRM acceptance and rejection. The primary reason for investing mCRM, or considering investing in mCRM, was found to be the need to reach customers and sales force anytime and anywhere. One major obstacle to the research was finding companies willing to participate in the research. The proposed scheme in this dissertation eases and enhances sales force processes and needs to reach customers information anywhere.

1.8 Thesis Organization

This study is divided into two parts. In part one we focus on CRM, mCRM and GPS systems, and in the second part we focus on the integration technique technologies and phases. By now, the content of the first chapter is already presented and familiar to the reader, consequently, only the content of the following chapters will be briefly discussed below. Figure 1.2 visualizes the outline of the study.

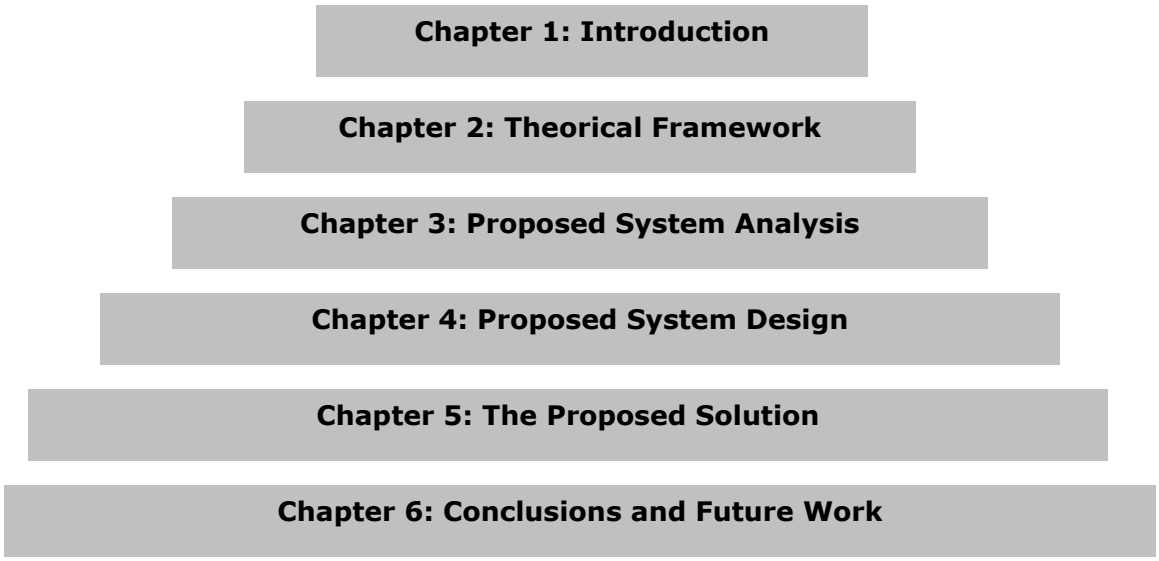

Figure 1.2: Outline of the study

The second chapter provides the reader with an overview of the literature related to customer relation ship management and mobile CRM in addition to a literature related to Global positioning system. Chapter three provides the analysis phase of the system development. Furthermore, chapter four describes the GPS and mCRM integration solution design phases including technical system components and technologies used in this research. Chapter five describes the GPS-mCRM integration technique system phases and processes. Finally, chapter six contains the overall conclusions that can be drawn form the research.

Chapter 2
Theorical Framework

2.1 Introduction

This chapter is based on the first part of the literature study in this thesis. This chapter will begin with the definition of CRM, its aspects, life cycle and objectives. In order to use CRM in a best practice scenario, there are CRM applications and softwares that help and assists in managing CRM processes, therefore mobile CRM will be discussed and its benefits for customers and organizations.

2.1.1 Customer Relationship Management (CRM)

According to Jill Dyche definition of customer relationship management (CRM) is the infrastructure that enables the delineation of and increase in customer value, and the correct means by which to motivate valuable customers to remain loyal-indeed, to buy again. CRM is about more than simply managing customers and monitoring their behavior. CRM has the potential to change a customer's relationship with a company and increase the revenues in the bargain [11].

Wu Tie, 2003, defined CRM as a comprehensive approach that integrates every business process that touches customers, namely sales, marketing and customer service and field support through

integration of people, process and technology. In other words, CRM is neither a product nor a service, but a business philosophy aiming to maximize customer value in the long run [27].

From the above definition of customer relationship management, for this research CRM can be defined as the broad category of concepts, tools, and processes that allows an organization to understand and serve everyone with whom it comes into contact. CRM is about gathering information that is used to serve customers—basic information, such as name, address, meeting and purchase history, and service and support contacts. In a supplier relationship it might be procurement history, terms and conditions, or contact information. This information is then used to better serve the clients.

2.1.2 The "C" in CRM

For the purposes of discussing CRM, we need to think of the "customer" in the broadest sense. Our definition needs to include suppliers, partners, investors, employees, and others we deal with in our definition. Each of these groups has specific and unique requirements when dealing with an organization. Customers need to be able to find out about the products and services and be able to make purchases. An Organization needs to track each customer's activity in order to make offers of complimentary products and new products that may provided. Keeping in mind that eighty percent of the company's business will come from twenty percent of its Customer Relationship Management toward customers.

Investors will have needs that relate to the operation of the business and the performance of their investment. Making some of that information available on a central customers data base will accomplish two things:

(1) Investors will be better informed, and they will be able to find out the information they require without making specific inquires that take time to provide.

(2) Investors will get the same information at the same time.

Suppliers and partners want to be connected with the organization. Creating special places where these strategic partners can participate is valuable. Providing them with information, such as product promotions, press releases, and advertising campaigns will build strong relationships.

2.1.3 CRM Aspects

Customers see the organization from outside and interact with it from their point of view as one single entity, despite often most services need interaction with a number of employees in different roles and departments. CRM is a combination of policies, processes, and strategies implemented by an organization to unify its customer interactions and provide a means to track customer information. It involves the use of technology in attracting new and profitable customers, while forming tighter bonds with existing ones.

There are many aspects included in CRM; they are all related to each other

- Front office operations: those are operations and processes that involve direct interaction with customers, e.g. face to face meetings, phone calls, e-mail, online services etc.

The proposed integration technique in this research is to assist the front office operations such as direct sales field and field services operations.

- Back office operations: those are operations that ultimately affect the activities of the front office (e.g., billing, maintenance, planning, marketing, advertising, finance, manufacturing, etc.)

- Business relationships: CRM in an organization involves interaction with other companies and partners, such as suppliers/vendors and retail outlets/distributors, industry networks. This external network supports front and back office activities.

- Analysis: Key CRM data can be analyzed in order to plan target-marketing campaigns, conceive business strategies, and judge the success of CRM activities (e.g., market share, number and types of customers, revenue and profitability).

From these aspects we notice that CRM adds and satisfies the customer, and also it adds value and benefits the organization because CRM for customers is a software that includes their information and

history, where for organizations it's strategic policies that are customer centered.

2.1.4 CRM Life cycle

CRM life cycle includes three phases, each phase has a great role is supporting and increasing the good relationship and trust between the company and its customers, these CRM phases include:

1. Acquisition: The Company acquires new customers by promoting new products and services

2. Enhancement: The Company enhances the profitability and relationship of existing customers by encouraging excellence in cross selling and up selling, thereby deepening and broadening the relationship.

3. Retention: the Company retains profitable customers for life by focusing on serving not what the market wants but what customers want.

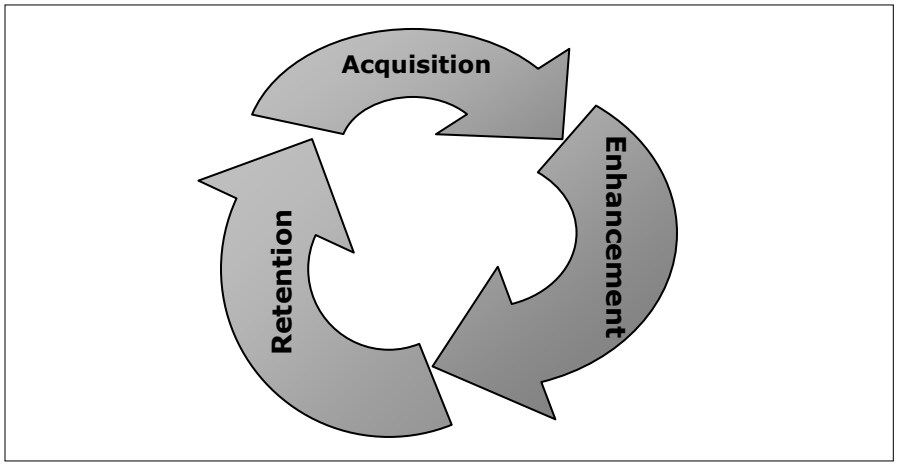

Figure 2.1: CRM Life Cycle

2.1.5 Objectives of CRM

Life cycle phases of CRM as mentioned previously in this research illustrates part of CRM objectives, the following are some of the main objectives of customer relationship management:

1. CRM main focus is the customer and enhancing relationship of the organization with customers,
2. Acquiring new customers
3. Focusing on enhancing relationships
4. Increase customers loyalty and satisfaction of the company services which will lead to the third phase of CRM life cycle in which the customer will be retained for life time.

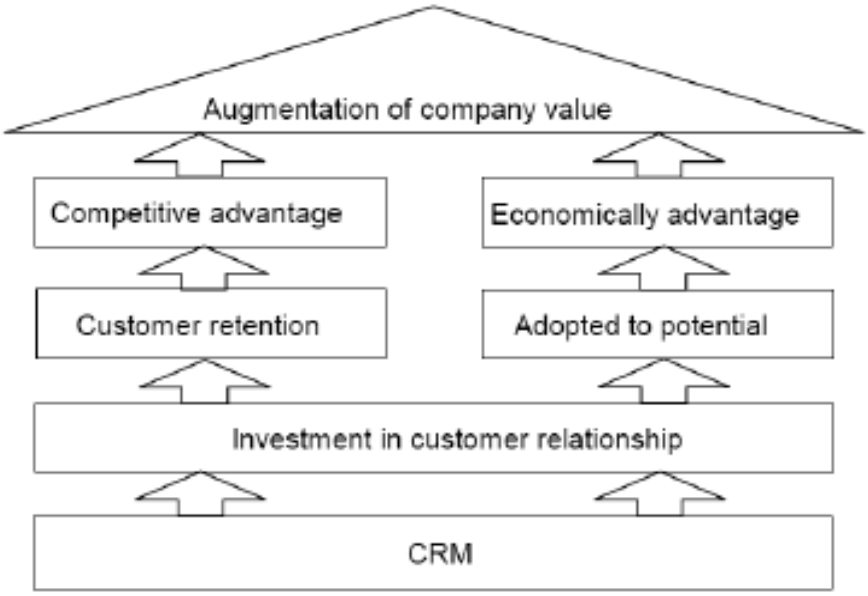

Figure 2.2: Company value through CRM [28]

More objectives for CRM are in the increasing of the economically benefit of the organization such as increasing the productivity and

gaining a competitive edge between competitors as represented in figure 2.2.

2.1.6 CRM relation with customer satisfaction, loyalty and business performance

The rationale of CRM is that it improves business performance by enhancing customer satisfaction and driving up customer loyalty. As illustrated in figure 2.3; satisfaction increases because customer insight allows companies to understand their customers better, and create improved customer value propositions.

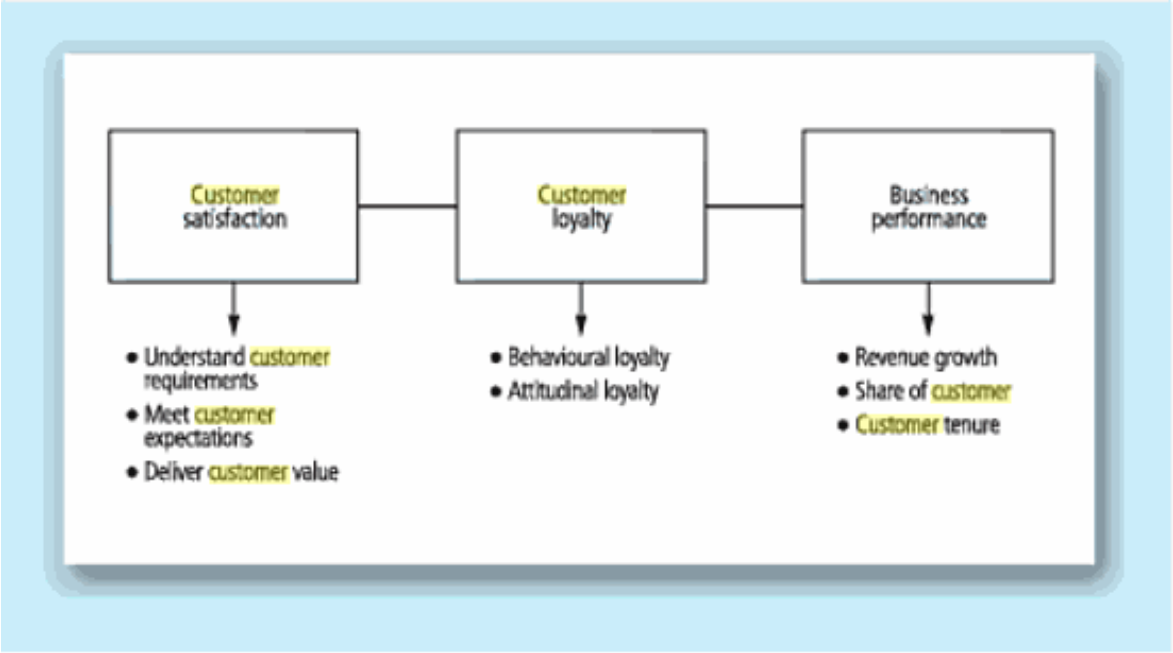

Figure 2.3: Customer satisfaction, loyalty and business performance [11]

As customer satisfaction rises, so does customer repurchase intention, this turn influences actual purchasing behavior, which has a significant impact on business performance. [11]

Author Francis Buttle, 2004, mentioned that many companies research requirements and expectations to find out what is important for customers, and then measure the customer's perception of their performance compared with the performance of competitors. The focus in CRM is on the elements of the value proposition that create value for customers. From this author's opinion Companies have to do well at meeting these important values using new technologies and trends in assisting the improvement of customer's relation [6].

2.1.7 CRM Applications

CRM application is software that helps an enterprise manage customer relationships in an organized way. For example, an enterprise might build a database about its customers that described relationships in sufficient detail so that management, sales people, people providing service, and perhaps the customer directly could access information, match customer needs with product plans and offerings, remind customers of service requirements, know what other products a customer had purchased, and so forth.

CRM software helps organizations manage their relationship customers by several applications:

- Helping an enterprise to enable its marketing departments to identify and target their best customers, manage marketing campaigns and generate quality leads for the sales team.

- Assisting the organization to improve telesales, account, and sales management by optimizing information shared by multiple employees, and streamlining existing processes (for example, taking orders using mobile devices)

- Allowing the formation of individualized relationships with customers, with the aim of improving customer satisfaction and maximizing profits; identifying the most profitable customers and providing them the highest level of service.

- Providing employees with the information and processes necessary to know their customers, understand and identify customer needs and effectively build relationships between the company, its customer base, and distribution partners.

Due to the need of providing employees which could be field sales or field services professionals with updated information about their customers, providing CRM applications on mobile devices which is the mobile CRM, and equipping field professionals with them was in the purpose of easing access to customers information and serve the customer faster on the spot.

The Bellow table 2.1 illustrates a number of recognized CRM applications throughout front office processes:

Sales force automation	Customer Service	Marketing automation
Call center telephone sales	Call centers	Campaign management
E-commerce	Web-based self service	Content Management
Field Sales	Field services	Data analysis and business intelligence tools
Retails		
Third part brokers, agents, distributors		

Table 2.1: CRM applications in CRM life cycle [27]

2.2 Mobile CRM

Rapid development of CRM applications have seen the trend that more and more enterprises are seeking to implement a much more effective CRM solutions which is **Mobile CRM** due to that mobile devices have become an important tool for leading-edge companies looking for an advantage in a competitive global business environment.

Mobile CRM is another variant for CRM; it's based on linking mobile devices to CRM applications and central customers data stores.

Wu Tie (2003) described the objective of mCRM that the aim of mCRM is to enable two-way interactivity between the customer and the enterprise continuously at anywhere, whether in an office o walking down the street. It also can be seen as a means to make CRM more powerful with utilization of advanced wireless communication tools [11].

Organizations are looking for more ease in looking up records, update records and more efficiency in using the mobile device on the field, so now market is moving toward mobility and mobilizing their processes, this reason was one of the drivers for this dissertation to develop and design a new technique that will fulfill those requirements.

2.2.1 Areas getting value of mCRM

Organization areas that are getting value of mobility and using mCRM applications on mobile devices such as (blackberry, PDAs. Windows mobile…etc) are:

1. Information users:

These will typically be sales or service managers who might be occasional or frequent travelers and want to have access to information on the road and to have the ability to respond more quickly to decisions or approvals they might need to do.

2. Field workers:

These are people who spend most of their time on the road, could include field sales representatives and service field professionals.

For that class of workers, the benefit of using mCRM is that those workers are able to have real time access to information about customers such as past customer history, customer preferences. Also they can go ahead and update information in real time as they finish a certain task whether it’s a sales call/appointment or a service request.

2.2.2 Benefits of mCRM

Extending the value of CRM through mobility by having real time access to customer's data has many benefits; these are some of those benefits:

- The enterprise can be more aware of what is going on and have more real time insight into what activities and sales calls have been completed and what interactions field representatives are having with customers.

- Way for the organization to get more accurate information due to that sales field representatives are able to update information and type information about the customer, which puts in more information and higher quality information than they are while they are waiting till end of the day or end of the week probably to login to the CRM application in the company and try to summarize all those notes.

The following figure 2.2 shows further benefits for mobile CRM:

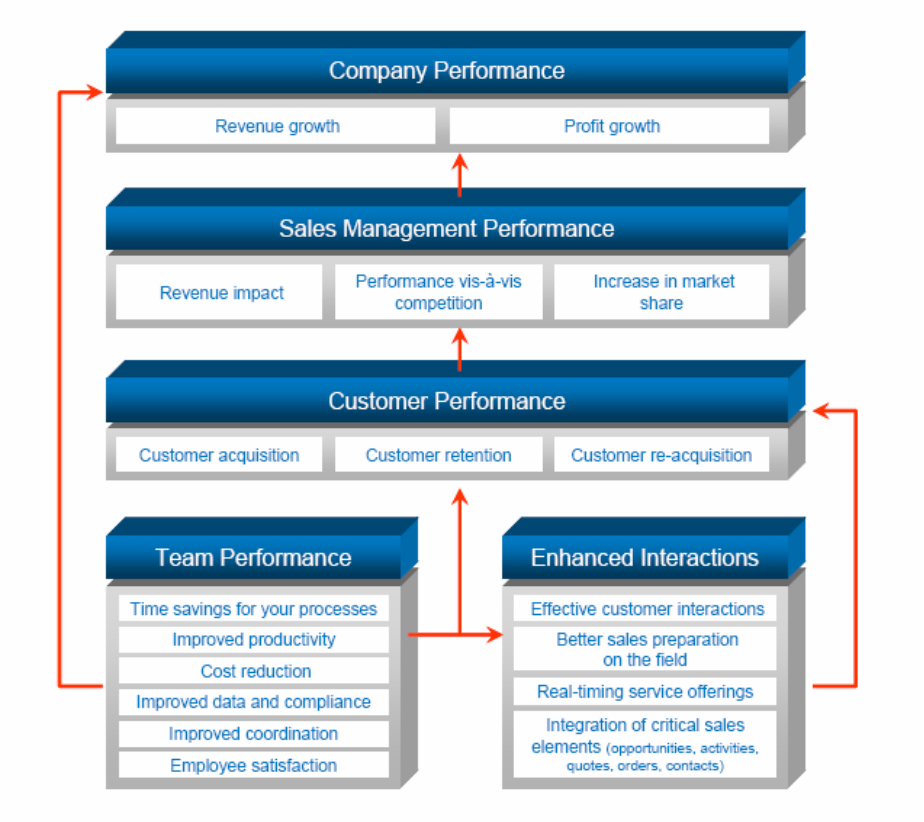

Figure 2.4: Mobile CRM benefits [9]

2.2.3 mCRM obstacles

Mobilizing CRM has several benefits for organization. However, there are certain obstacles related to mCRM adoption by companies, some of those obstacles are:

1. Security: loosing the mobile device could make is a worry since it could have a lot of important information on it and has access to the enterprise data bases.
2. Cost: cost of mobile devices needed to equip field people with it in addition to extra charges could be an obstacle to mobalizing CRM.

3. Usability of mobile devices: sometimes taking notes on a mobile device can be harder; also searching for customer in the application can take extra time sometimes due to several factors such as spelling issues.

One way to improve the capability of mobile devices to be more user friendly and ease the real time access and searching for customers in the application is the proposed schema of this dissertation in which the customer will be automatically recognized and his data will be retrieved depending on the location, which will ease the way data is accessed and updated.

2.3 GPS

The Global Positioning System (GPS) is a global navigation satellite system (GNSS) developed by the United States Department of Defense and managed by the United States Air Force 50th Space Wing. It is the only fully functional GNSS in the world, can be used freely by anyone, anywhere, and is often used by civilians for navigation purposes. [25]

The Global Positioning System (GPS) includes 24 satellites (21 active, 3 spare), in circular orbits around Earth with orbital period of 12 hours, distributed in six orbital planes equally spaced in angle. Each satellite carries an operating atomic clock (along with several backup clocks) and emits timed signals that include a code telling its location. By analyzing signals from at least four of these satellites, a receiver on the surface of Earth with a built-in microprocessor can display the location of the receiver (latitude, longitude, and altitude). [3]

GPS, formally known as the NAVSTAR (Navigation Satellite Timing and Ranging), it was developed for the military because of its popular navigation capabilities and because it could access GPS technology using small, inexpensive equipment.

Some of the interesting facts about GPS satellites are:

- The first GPS satellite was launched in 1978.
- A full constellation of 24 satellites was achieved in 1994.
- Each satellite is built to last about 10 years. Replacements are constantly being built and launched into orbit.
- A GPS satellite weighs approximately 2,000 pounds and is about 17 feet across with the solar panels extended.

- Transmitter power is only 50 watts or less.

GPS technology requires the following three segments:

- Space segment
- Control segment
- User segment

2.3.1 GPS Objective

The goal of the Global Positioning System (GPS) is to determine a position on Earth in three dimensions: east-west, north-south, and vertical (longitude, latitude, and altitude). [3]

2.3.2 How GPS work

Signals from three overhead satellites provide three dimensions (east-west, north-south, and vertical longitude, latitude, and altitude).

Each satellite sends a signal that codes where the satellite is and the time of emission of the signal. The receiver clock times the reception of each signal, then subtracts the emission time to determine the time lapse and hence how far the signal has traveled (at the speed of light).

This is the distance the satellite was from the position point when it emitted the signal. In effect, three spheres are constructed from these distances, one sphere centered on each satellite. The position is located at the single point at which the three spheres intersect. [3]

The position is displayed, perhaps with a moving map display or latitude and longitude. Many GPS units also show derived information such as direction and speed, calculated from position changes.

2.3.3 GPS Signal

GPS satellites transmit two low power radio signals, designated L1 and L2. Civilian GPS uses the L1 frequency of 1575.42 MHz in the UHF band. The signals travel by line of sight, meaning they will pass through clouds, glass and plastic but will not go through most solid objects such as buildings and mountains.

A GPS signal contains three different bits of information:

- A pseudorandom code, ephemeris data and almanac data. The pseudorandom code is simply an I.D. code that identifies which satellite is transmitting information.
- Ephemeris data tells the GPS receiver where each GPS satellite should be at any time throughout the day. Each satellite transmits ephemeris data showing the orbital information for that satellite and for every other satellite in the system.
- Almanac data, which is constantly transmitted by each satellite, contains important information about the status of the satellite (healthy or unhealthy), current date and time. This part of the signal is essential for determining a position.

2.3.4 Sources of GPS signal errors

Factors that can degrade the GPS signal and thus affect accuracy include the following:

- **Ionosphere and troposphere delays** — The satellite signal slows as it passes through the atmosphere. The GPS system uses a built-in model that calculates an average amount of delay to partially correct for this type of error.

- **Signal multipath** — This occurs when the GPS signal is reflected off objects such as tall buildings or large rock surfaces before it reaches the receiver. This increases the travel time of the signal, thereby causing errors. Figure 2.5 shows the path of signals in the case of multipath, blocked signal and correct signal.

- **Receiver clock errors** — A receiver's built-in clock is not as accurate as the atomic clocks onboard the GPS satellites. Therefore, it may have very slight timing errors.

- **Orbital errors** — Also known as ephemeris errors, these are inaccuracies of the satellite's reported location.

- **Number of satellites visible** — The more satellites a GPS receiver can "see," the better the accuracy. Buildings, terrain,

electronic interference, or sometimes even dense foliage can block signal reception, causing position errors or possibly no position reading at all. GPS units typically will not work indoors, underwater or underground.

- **Satellite geometry/shading** — This refers to the relative position of the satellites at any given time. Ideal satellite geometry exists when the satellites are located at wide angles relative to each other. Poor geometry results when the satellites are located in a line or in a tight grouping.

- **Intentional degradation of the satellite signal** — Selective Availability (SA) is an intentional degradation of the signal once imposed by the U.S. Department of Defense. SA was intended to prevent military adversaries from using the highly accurate GPS signals. The government turned off SA in May 2000, which significantly improved the accuracy of civilian GPS receivers.

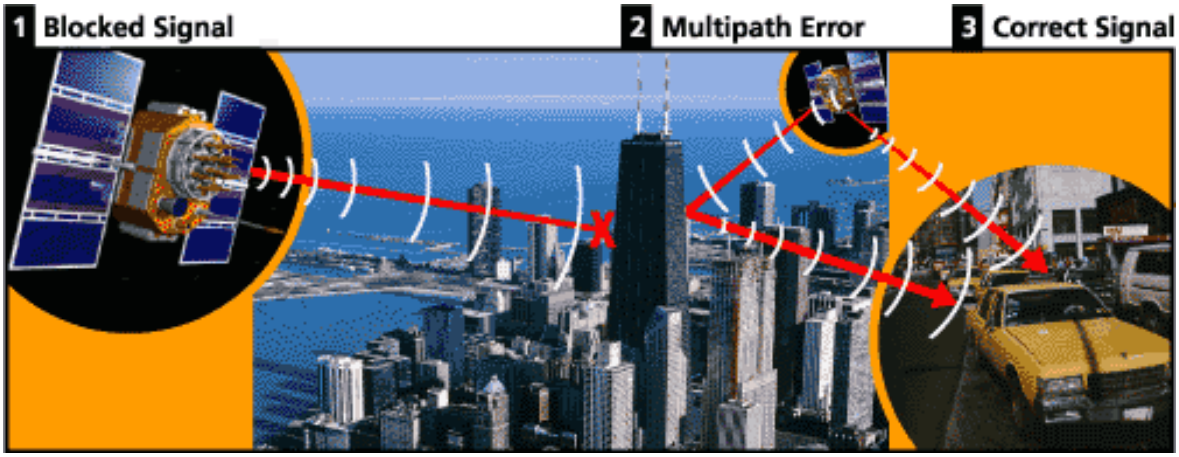

Figure 2.5: GPS Signals [7]

2.3.5 GPS Segments

GPS consists of three major segments, these are:

2.3.5.1 Space Segment

The SPACE segment consists of 24 operational satellites in six orbital planes (four satellites in each plane). The satellites operate in circular 20,200 km (10,900 nm) orbits at an inclination angle of 55 degrees and with a 12-hour period. The position is therefore the same at the same sidereal time each day, i.e. the satellites appear 4 minutes earlier each day. [7]

2.3.5.2 Control Segment

The Control segment consists of five Monitor Stations (Hawaii, Kwajalein, Ascension Island, Diego Garcia, Colorado Springs), three Ground Antennas, (Ascension Island, Diego Garcia, Kwajalein), and a Master Control Station (MCS) located at Schriever AFB in Colorado. The monitor stations passively track all satellites in view, accumulating ranging data. This information is processed at the MCS to determine satellite orbits and to update each satellite's navigation message. Updated information is transmitted to each satellite via the Ground Antennas. [7]

2.3.5.3 User Segment

The User segment consists of antennas and receiver-processors that provide positioning, velocity, and precise timing to the user.

2.3.6 GPS positioning services

GPS provides two levels of service which are:

2.3.6.1 Precise Positioning Service (PPS)

PPS is a highly accurate military positioning, velocity and timing service which will be available on a continuous, worldwide basis to users authorized by the U.S. P(Y) code capable military user equipment provides a predictable positioning accuracy of at least 22 meters (95 percent) horizontally and 27.7 meters vertically and time transfer accuracy to UTC within 200 nanoseconds (95 percent). PPS will be the data transmitted on the GPS L1 and L2 frequencies. PPS was designed primarily for U.S. military use. It will be denied to unauthorized users by the use of cryptography. [7]

2.3.6.2 Standard Positioning Service (SPS)

- Civil users worldwide use the SPS without charge or restrictions. Most receivers are capable of receiving and using the SPS signal. The SPS accuracy is intentionally degraded by the DOD by the use of Selective Availability.

- SPS Predictable Accuracy
    - 100 meter horizontal accuracy
    - 156 meter vertical accuracy
    - 340 nanoseconds time accuracy

- These GPS accuracy figures are from the 1999 Federal Radio navigation Plan. The figures are 95% accuracies, and express the value of two standard deviations of radial error from the actual antenna position to an ensemble of position estimates made under specified satellite elevation angle (five degrees) and PDOP (less than six) conditions.

- For horizontal accuracy figures 95% is the equivalent of 2drms (two-distance root-mean-squared), or twice the radial error standard deviation. For vertical and time errors 95% is the value of two-standard deviations of vertical error or time error.

- Receiver manufacturers may use other accuracy measures. Root-mean-square (RMS) error is the value of one standard deviation (68%) of the error in one, two or three dimensions. Circular Error Probable (CEP) is the value of the radius of a circle, centered at the actual position that contains 50% of the position estimates. Spherical Error Probable (SEP) is the spherical equivalent of CEP, that is the radius of a sphere, centered at the actual position, that contains 50% of the three dimension position estimates. As opposed to 2drms, drms, or RMS figures, CEP and SEP are not affected by large blunder errors making them an overly optimistic accuracy measure

- Some receiver specification sheets list horizontal accuracy in RMS or CEP and without Selective Availability, making those receivers appear more accurate than those specified by more responsible vendors using more conservative error measures.

2.3.7 GPS applications

GPS application falls in five main categories:

- Location: determining a basic position
- Navigation: getting from one location to another
- Tracking: monitoring the movement of people and things
- Mapping: creating maps of the world
- Timing: bringing precise timing to the world

2.3.8 Location Coordinates

Location coordinates format varies according to the GPS receiver that calculates the position coordinates, location of a point on the earth is referenced by latitude and longitude, the figure 2.6 shows the longitude and latitude for a point on earth

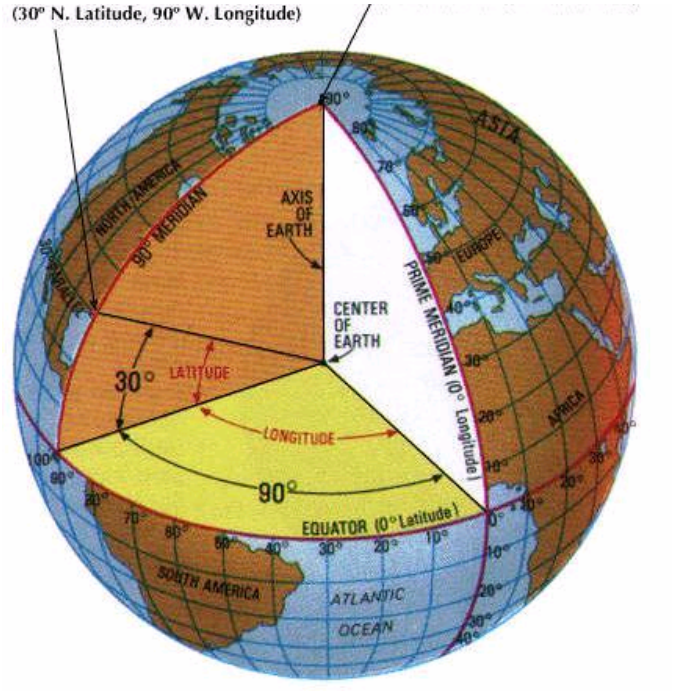

Figure 2.6: Latitudes and Longitudes [7]

GPS location coordinates format are viewed in decimal number format or in Degrees minute seconds format.

- Degrees Minutes Seconds format [N/W dd mm ss]:

The hemisphere is indicated by 'N' and 'W'

dd : is the degree

mm: minutes

ss: second in decimal formal

Example: 37°19’29”N LAT, 121°54’59”E LON

- In Decimal coordinates "South" latitudes and "West" longitudes convert to negative decimal numbers

Example: 37.3248 LAT, 121.9163 LON

Most GPS systems use the degree minutes second format, but some GPS systems can be configured to use decimal format to display the location coordinates.

To convert Degrees-Minutes-Seconds to Decimal Degrees:

Location in decimal: degrees + (minutes/60) + (seconds/3600)

Example:

Location: N24 20 10
➔ 24 + (20/60) + (10/3600) = 46.33611111

Chapter 3
Proposed System Analysis

3.1 Introduction

Before starting in developing and initializing the solution, requirements for developing such solution should be collected and analyzed, also a look to the stakeholders should be taken and how they think about and expect from the solution from their prospective.

In terms of analyzing the requirements "UML Use Case" methodology was used to show how each part of the solution is used and reacts toward the requirements. And then will break down these requirements to process level to show how the solution will work to deal with requirements.

3.2 Requirements determination

To have a full picture about the business requirement of this solution, we will start with the requirements to develop this solution which is considered as e-business solution. The requirements of the regarding solution fall into two categories:

1. Business-to-Consumer (B2C): in which the company will introduce their services to the end user.

2. Business-to-Business (B2B): in which the company will introduce their services to enterprise companies.

So, this solution is aimed to enhance the relationships with all customers, increase customer satisfaction, and Speed up their services and making these services available anywhere. The proposed solution to achieve these aims is building a system that supports both B2C and B2B services. Also the company requirement will be translated to the proposed system as shown in the next section.

3.2.1 Company requirements with respect to the system

Stakeholder's requirements regarding the solution can be summarized as the following:

1. The mCRM should have the ability to operate in the mobile regarding the mobile vendor.
2. The size of the mCRM installed in the mobile shouldn’t be big
3. When the mCRM sends traffic through GPRS it should be small traffic to avoid the high cost.
4. mCRM application should be assisted by the GPS to view customer's information based on the location of the field sales professional.
5. An integration technique between mCRM and GPS should provide customers information remotely according to the GPS location coordinates.
6. The solution carries both B2C and B2B services.

3.3 Formalizing the requirements using Use Case Diagram

The development of Use-Case diagrams will be for formalization of the requirements and description of the system.

1. Actors. There are four types of actors in the system:

   - The user of the system
   - mCRM
   - GPS
   - Web service and database

2. The use case diagram below describes the interaction between the system actors and the related use cases. As seen in Figure 3.1 , the "Mobile user" is quering using the system services . On the other hand, the "mCRM" will coordinate with “GPS” asking for the location coordinates of the user.The "mCRM" has the tasks to coordinate with the “Web Service,DB” to get the customer data and then showing this output to the “Mobile user”.

Figure 3.1 bellow shows the Use case diagram :

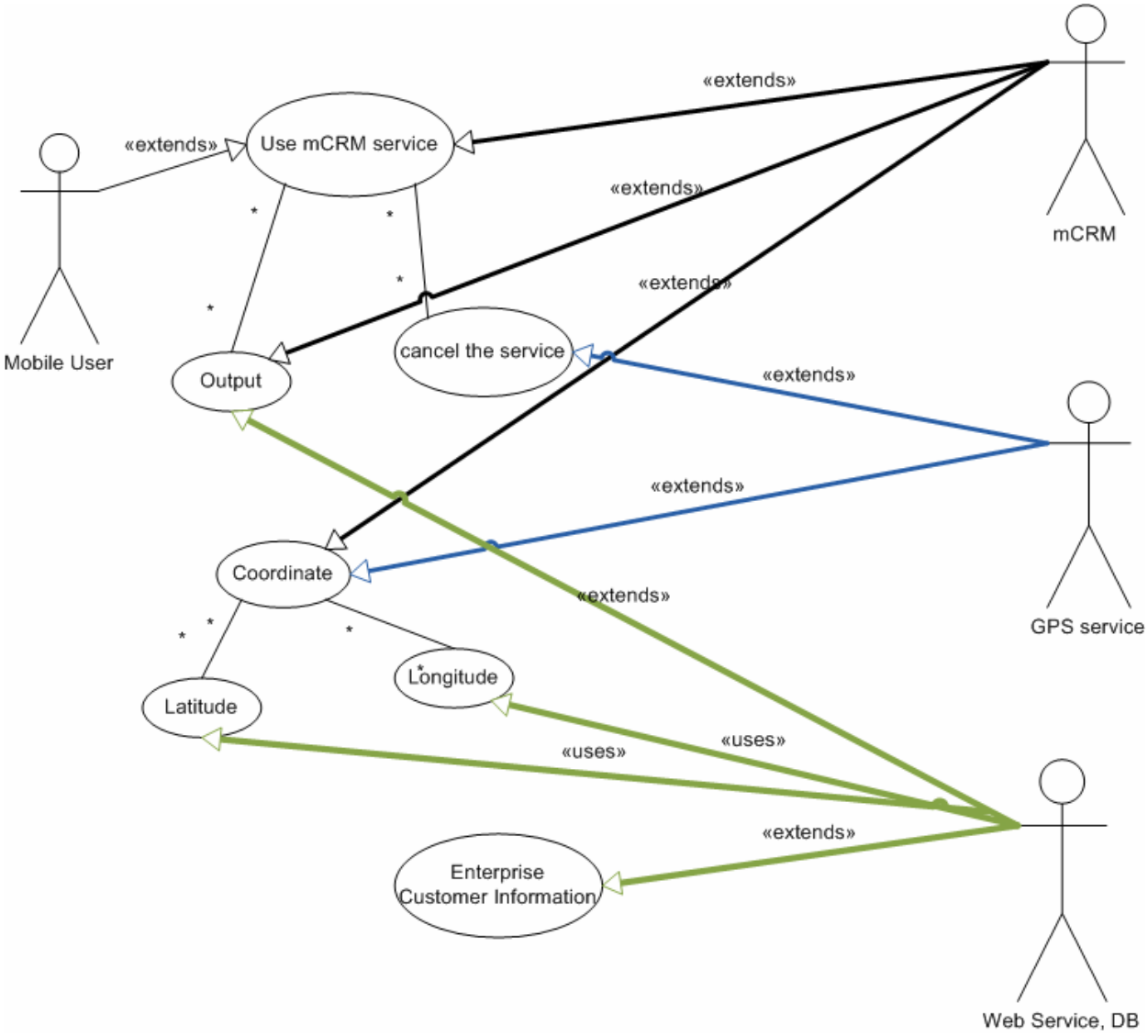

Figure 3.1: System requirements using "Use case" diagram

3.4 Process Breakdown Using UML

As illustrated in the "Use case diagram" the processes of the solution can be divided in four main modules. The processes which are carried out by each part according to the system requirement can be summarized as following:

1. Mobile user module

- This module of the solution has mCRM and deals with user regarding the services required.
- In this module the user can initiate the service or even stop it.
- This module will be used to show out the information required.
- To accomplish the processes, this part is integrated with GPS module and Web Service module.

2. GPS module

- This module contains the GPS intermediate driver API which is exposed through a native code library provided in windows mobile SDK, and contains the get location function (GPSPosition).
- The module calculates the location coordinates of the user regarding latitude and longitude.
- This part will be integrated with mobile user module and web service module.

3. Web service module

- This module works in receiving request from the above module and sends the location coordinates to the database module.

- This module integrates with database module to return the customer data to the mobile user module.

4. Database module

- This module processes a query for the customer data regarding certain values (latitude and longitude values).
- This module integrates with the Web service module only to maintain security for the database and also to return the customer's data to the mobile user module.

Regarding the above points; figure 3.2 shown below represents the breakdown process for the services that are provided by the solution:

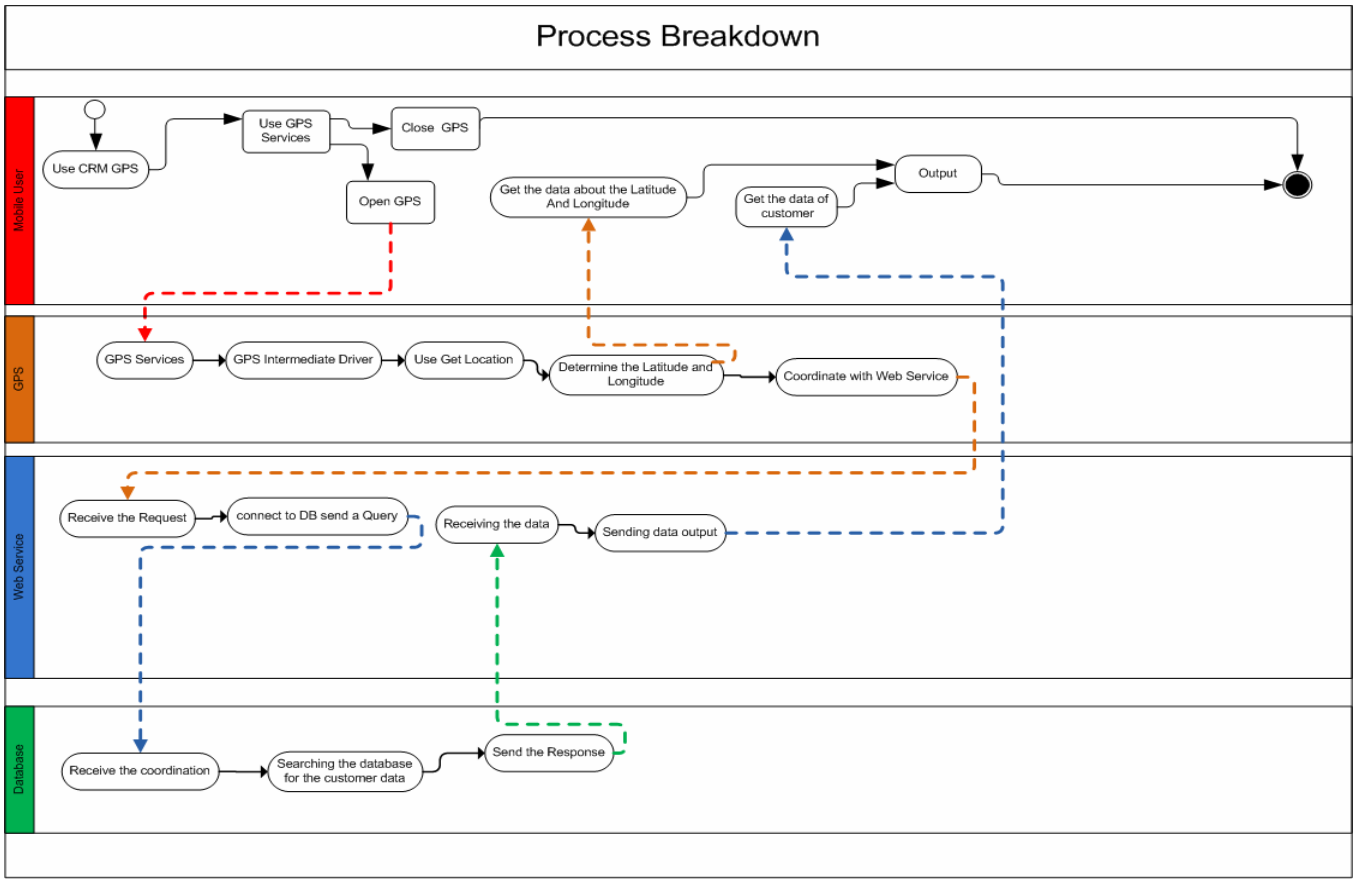

Figure 3.2: Process breakdown

3.5 Feasibility Study for the proposed solution

3.5.1 Business Feasibility

The estimated benefits that the user will get from the proposed solution illustrates in solving his/her problems quickly by give him/her the required data in an easy way, and expansion in the business scope which may lead to increase the number of the users. And accordingly these issues will get the solution good reputations. The expected added value satisfies many of the requirements that the users need,

so after the expected solution is developed it will be an important achievement and provide important profits for both users and enterprise companies that will register their data in the system , this profit includes reputation and also the money.

For the cost of the proposed solution it depends on the services, for the GPS services, web service and the system itself. the cost may be expensive because the web services and databases may be developed by a third party, not to mention that Connection with the web service needs networking levels(Firewall, Router, and Connection) and services to increase security features and this will also increase the cost of the proposed solution. It is possible to get alternative scenarios and decrease the cost; this may happen if we look for the required features without the needs for additional features.

Mentioning the risks which may face the implementation of our solution. There are many fields of risks; technology risks and business risks are the major examples. Risks in this project illustrate in time, cost, and resources. Taking into consideration the marketing risks that the project would face since not all mobile devices can use the solution which will lead to limit the user customer slice that may affect the enterprise customers point of view towards the solution.

3.5.2 Technical Feasibility

Time, quality, and resources of the services are considered critical issues for both enterprise customers and users. It is very important for the user to get a successful and high performance solution, therefore

success measures depend on the quality and validity of the output, and does the solution satisfies the user needs or not.

The interaction between the solution services and the user through the interface system is very important so the interface should be easy to use and cover all users requirements, otherwise it might be more confusing. Also the integration between the web system and the database should be clear to make it easy to search what is needed. During all processes and requirements security should be taken into consideration.

3.6 Evaluation of the proposed solution a SWOT analysis approach

3.6.1 STRENGHTS

- The geographic place for accessibility is irrelevant which means that the access can be anytime and anywhere.
- Can be used by the enterprise customer for decision making process in e-commerce.

- Investment cost is reduced since the implementation cost becomes less. For example, it might become less cost especially when a large number of users base is achieved.
- Using of mCRM has Continuous viral growth
- High user retention

- Many features can be added to the companies cross through various platforms which may be used by individuals and other companies.

3.6.2 WEAKNESSES

- Accessing all points needs high speed access, which isn't available everywhere and might be costly.
- Accessibility & Reliability, Limited to secure GPS connections.
- The solution currently only supports English which lead to limit the market where it can be used.

3.6.3 OPPORTUNITIES

- Companies can use the solution as marketing, advertisement and sales tool.
- Using the solution as e-business opens up different segments of marketing
- Companies can invest in the solution in e-marketing to increase company revenue
- Can be used to create a human resource database

3.6.4 THREATS

- The platforms may be damaged due to Security gaps, or Hackers.
- User reluctance; social, culture and technical points may prevent some people from using the solution.

- Vulnerabilities in Applications
    - The web server may be vulnerable which may affect the end users; also some applications may override privacy settings.
- Financial threat because of impending lawsuit.

Table 3.1 below shows the SWOT analysis for developing the solution:

Internal Analysis	**S**TRENGTHS 1. Geographic place for accessibility 2. decision making for enterprise customer process 3. Many features can be added 4. The using of mCRM has Continual viral growth 5. High user retention	**W**EAKNESSES 1. Accessing all points needs high speed access, which isn't available everywhere and might be costly. 2. Accessibility & Reliability, Limited to secure GPS connections. 3. The solution Currently only support English which lead to limit the market where it can use
External Analysis	**T**HREATS 1. The platforms may be damaged due to Security gaps, or Hackers. 2. Vulnerabilities in	OPPORTUNITIES 1. Companies can use the solution as marketing, advertisement and sales tool. 2. Using the solution as e-business open up different

Applications 3. Financial threat because of impending lawsuit	segments of marketing 3. Companies can invest in the solution in e-marketing to increase company revenue

Table 3.1: SWOT analysis

After the SWOT analysis is done the TOWZ strategy is developed as shown in table 3.2 below.

	STRENGTHS	WEAKNESSES
OPPORTUNITIES	SO STARTEGY Use strengths to take advantage of opportunities	WO STRATEGY Overcome weaknesses by taking advantage of opportunities
THREATS	ST STARTEGY Use strengths to avoid threats	WT STRATEGY (turnover strategy) Minimize weaknesses and avoid threats

Table 3.2: TOWZ strategy

Chapter 4
Proposed System Design

4.1 Introduction

The proposed scheme in this study can be described as a multi-tier client-server architecture where clients are mobile devices and they handle the presentation of information, where servers handle the data management and business logic. The communication between servers and between mobile clients and servers are realized using web services. This technique is further described in this chapter. Data management is accomplished using database and business logic queries in the servers.

4.2 Proposed System Architecture

Once the business solution is developed, then Web services, business logic, Database structures, and network structure need to be developed changed accordingly. The proposed system architecture consists of four main areas; the first area is concentrates on the relation between the CRM services and the GPS through specific services, and functions. In this part the user will use the mCRM in his/her mobile to get the coordinates (latitude and longitude).

The second main part is concentrated in the connection between GPS services and the web services. In this connection GPS services will coordinate with the webs services and request for the installed enterprise customers in a specific location.

The third part concentrates on the connection between the web services and the database. In this connection the web services will coordinate with the database which will create a query to search for the information of the enterprise customer and then send the output back to the web services.

The fourth part is concentrated in the connection web services and our CRM services. In this connection the web services will coordinate with the CRM and send the output which will appear on the user interface.

The points mentioned above provide a justification to the need to propose the three tier architecture for the proposed system:

1. The first Tier contains the CRM installed in a mobile device, the user will deal only with this tier
2. The Second tier contains GPS services and Web services
3. The third tier contains the database services.

Regarding the three tiers used to design the architecture of the solution, the following systems are parts of the solution:

1. Web Server: this Server will carry the Web services that will integrate between the mCRM and the database. The integration is shown in the sections below.

2. Database server: this server will have the databases related to all services and the customers data. Oracle 10g, or MSSQL 7.0 may be used for such servers that may carry huge data that are needed to be secure.
3. GPS service: this service will be responsible to calculate the user's locations coordinates.

4. mCRM: This will be the tool that will be installed in the user mobile and will send the coordinates for the web server to get the data of the customers.

Since the solution's environment will be mainly concentrated on GPS services and web service services; then many risks related to security will be facing the business architecture, many security levels will be added such as (Firewall, VPN connection,…etc) not to mention that the web server needs to have a security certificate from a high authority like VeriSign.

Figure 4.1 illustrates GPS-mCRM system architecture including technical components and technologies used.

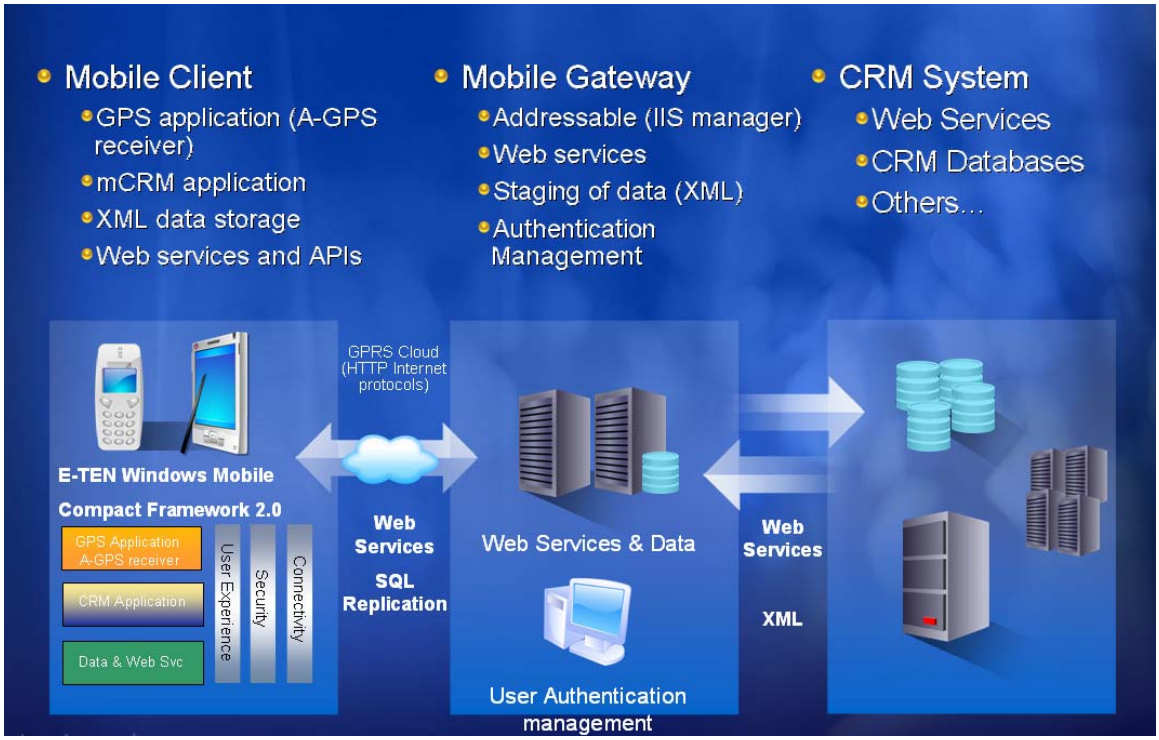

Figure 4.1: GPS-mCRM Proposed Solution Overview

After proposing the system architecture and its components, one of the important points is to know which system components are needed to be developed from scratch and which components are to be bought-in and customized based on the requirement s.

The nature of solution process and its transactions imposes to buy a mCRM tool and customize it to include all the user's requirements in addition to connecting GPS services and Web services. Regarding the web server it will not be developed from scratch but has some customization to accomplish the process carried by the web services. This point came as a result for the disadvantage that may face the solution if a new Web server was built and developed, these disadvantages are:

1. It requires more cost and time.

2. The need for infrastructure knowledge and their might be lack in experience in such field.

4.3 Service integration

Business integration is related to connect external-facing processes of the system to the processes of other system process. This can profoundly change the way business is conducted between systems that are based on different techniques and different standards . The potential benefits of business integration do not only include improvement in operational efficiency, but also greater strategic flexibility and market responsiveness.

As we discussed in the system architecture, the main integration part will be concentrated in the mCRM, and web server. The mCRM will integrate with GPS service from one side and with the Web server from the other side. The web server is also the main part of the integration since it will integrate with mCRM and the database server.

Information needs to be exchanged between mCRM and other parts of the solution step by step are as follows:

1. The mobile user runs the system service, running this services generates a request for customer data.
2. GPS calculates the location coordinates using GPS traffic

3. The web service system receives quotes from different suppliers. The communication is based on SOAP (Simple Object Access Protocol) over the Internet.
4. The web server gets information about the coordinate from the mCRM to look up in the private UDDI (Universal Description, Discovery, and Integration) registry located in the database server.
5. The location coordinates and the WSDL (Web Services Description Language) binding information for the Web Services is sent to the web server.
6. The information is then analyzed by the web server, and sent to mCRM to be outputted to the user.

4.3.1 Web services standards required for integration

UDDI (Universal Description, Discovery, and Integration) is the global registry of web services. It allows providers of web services to advertise their offerings in a standard way on the Internet. UDDI uses APIs to define a programmatic interface. The APIs used for publishing Web Services is called publication API when the one used for discovering Web Services is called inquiry API Web services. The core component of UDDI is the business registry which is an XML repository where businesses advertise services so that other businesses can find them. [17]

SOAP (Simple Object Access Protocol) is a lightweight messaging framework for exchanging data among Web services. The data are XML formatted. SOAP can be used with different transport protocols such as HTTP, SMTP, and FTP. The structure of a SOAP message is very simple structure: it is composed by an XML element which is called envelope and which has two child elements. The first element named the header includes features such as security and transactions. The second element named the body includes the actual exchanged data. [18]

WSDL (Web Services Description Language) is an XML-based language for describing operational features of Web services. WSDL descriptions are composed of interface and implementation definitions. The interface is an abstract and reusable service definition that can be referenced by multiple implementations. The implementation describes how the interface is implemented by a given service provider. [2]

4.3.2 Web Services required in the system

Specific scripting environment such as JSP, ASP, and PHP should be used, also other tools for editing the web site and the pages will used. For databases MYSQL, Oracle, and SQL Server could be used.

There are several technologies that may be used for enabling web services [18]:

- Apache Axis.
- JAVA.
- .NET
- BEA Web Logic.
- And others.

As shown in the section above, many services, tools, will be used for the integration and these tools are shown in the sections below.

4.3.3 Technical system components

The proposed solution consists of the following technical components:

4.3.3.1 Mobile Client

Wireless networking has evolved greatly over the last 15 years, communication and technological industries have a large focus on wireless mobile devices and developing wireless mobility technologies, Tablet PCs, Pocket PCs and Smart phones could be adopted in our integration technique.

Pocket PCs are versatile PDAs (Personal Digital Assistants) that act like miniaturized computers in terms of running applications on top of a mobile operating system, but they also provide the user with many key characteristics to facilitate mobile usage in the field [12]. In terms of this research E-TEN pocket PCs are adopted to illustrate and elaborate the integration technique which is the topic of this research.

E-TEN is a Windows Mobile Pocket PC Phone manufactured by E-TEN. Which is electronics manufacturing company based in Taiwan,

specializing in sophisticated handheld devices such as smart phones. The device specifications as listed in the table 4.1:

Function	Component
OS	Microsoft Windows Mobile 5.0 Pocket PC Phone Edition AKU 3.2.0 or Microsoft
Processor	Samsung SC32442 400 MHz
Memory	Flash ROM: 128 MB, RAM: 64 MB, MicroSD
Screen	2.8", 64 000 colors, TFT LCD, 480x640
Dimensions	113mm x 59.5mm x 15.5mm
Battery	Litium-Ion 1530mAH
GSM	850, 900, 1800, 1900
GPS	Integrated 20 channel SiRF Star III, A-GPS
Connectivity	GSM, Class 10 GPRS, EDGE, Bluetooth 2.0, IEEE 802.11b, IEEE 802.11g, FM
Connections	USB Mini-B, 2.5mm audio jack, external GPS antenna
Camera	2.0 Mpix, video, flash

Table 4.1: E-TEN device specifications [24]

E-TEN mobile phone has a built in **GPS application** that uses Assisted-GPS (A-GPS) receiver that locates the phone by which cell site it is connected to on the cellular network or by satellite signals it receives. This GPS receiver will locate the field sales representative and provide the coordinates to be used by the CRM application on the mobile device as will be discussed later in this research.

CRM application which will be installed on the mobile device needs .Net compact framework to be installed in order to operate; E-TEN mobile device supports .NET compact framework

4.3.3.2 Enterprise Web service server

The web service server is an intermediate between mobile device application and the enterprise DB server, by exposing a Web server running Internet Information Server (IIS) as the main mobile gateway to the corporate network, mobile devices can open secure Web connections over the wireless Internet to get authenticated and access existing systems from the field, directly or indirectly, such as backend systems, application servers, legacy systems, databases and shared repositories. [12]

4.3.3.3 Enterprise Security Firewall and Active directory

When organizations consider mobile enterprise solutions, one key evaluation point is security. Since mobility introduces more security risks and requires special security due to their portability.

Security firewall will block any unauthorized access to enterprise servers, authorization credentials for users will pass through the firewall and will be checked with the active directory software which store all users logging authorization, its necessary to know that authorization credentials will be held by the web service to authorize the mobile device to login to the corporate data stored on the servers.

4.3.3.4 Enterprise database server

The enterprise database server contains the corporate data the mobile device will be seeking to view or update, there are many database management software in market, commonly organizations which has large database data installs Oracle database management tool which has proven over the years its high efficiency in managing corporate data in securely manner.

Customers data in which CRM system processes and manipulates including their location coordinates will be saved in the database

4.3.4 Tools and Technologies used

The integration technique combines several mobile technologies to achieve the goals. Rather than creating an environment that is not widely applicable we're presenting an environment that can work on any handheld device (PDA, Windows Mobile, Blackberry…etc) since it's based on GPS software installed on a device with a GPS receiver and .Net web-based CRM application.

4.3.4.1 GPS API

GPS Intermediate Driver is a Windows Mobile DLL providing a GPS API (Application Programming Interface). Instead of accessing the GPS hardware directly via serial ports, through GPS Intermediate driver GPS functions are called to get the data via the Operating System of the mobile device [16].

The structure of the GPS Intermediate Driver consists of two functions.

Structures	Description
GPS_POSITION	Contains location information, including latitude and longitude, as well as other related information like heading, speed, the satellites used to retrieve the location information, and so on.
GPS_DEVICE	Contains information about the GPS Intermediate Driver and GPS hardware used by the GPS Intermediate Driver.

Table 4.2: GPS Intermediate Driver structure [16]

The GPS Intermediate Driver provides two main advantages: [16]

- Enable multiple applications to use GPS hardware at the same time. The GPS Intermediate Driver makes it appear that each application has its own dedicated GPS hardware.
- Remove the need for applications to parse NMEA strings to obtain meaningful data. The GPS Intermediate Driver internally parses the NMEA strings obtained from the GPS hardware and makes the parsed information available through a friendly API.

4.3.4.2 Web Services

Web services provide a simple and flexible method for transmitting and returning data between clients and data sources. If an application must access data from multiple sources, interoperate with other applications, and work frequently in a disconnected state, consider using Web services to exchange various data structures with the

server, including standard data types, objects, DataSets, XML documents and other complex data types. [13]

Web services do have their place in mobility scenarios. Their flexibility in crossing Internet boundaries for remote communications makes them ideal for mobile applications to converse with corporate servers from the field [13]. They are frequently just Internet application programming interfaces (API) that can be accessed over a network, such as the Internet, and executed on a remote system hosting the requested services [21].

Web services are used in the integration technique proposed in this research since their technology is based on open Internet standards, such as HTTP and XML and their flexibility in crossing Internet boundaries for remote.

In this proposed solution web services are built to transmit the field sales representative location coordinates (longitude & latitude) in addition to the user authentication credentials from the mobile device through the GPRS cloud to the web service server, and then returns the data which is returned from the enterprise servers database to the web service server back to the mobile device.

4.3.4.3 XML

XML stands for **Extensible Markup Language**, it is a markup language much like HTML, XML was designed to transport and store data [19]

The .NET Compact Framework on the mobile device provides basic XML functionality, including the XML Document Object Model (DOM) [12], which is an in-memory representation of an XML document. The DOM allows to programmatically read, manipulate, and modify an XML document. [15]

As previously mentioned web services are sort of a transportation method for the data sent by the mobile device to the enterprise servers and back from it, this data is stored in **Extensible Markup Language** (XML) documents, although internet and HTTP protocols are used as part of the system communication architecture; it's important to know that HTML markup language is totally different than XML, the more significant difference is that HTML was designed to display data where XML was designed to carry out data.

Using XML in mobile systems is desirable and this is the reason why it was adopted in this research, due to its independency of hardware, software and applications and its data is stored in text format makes more available and available to use in addition to its small size which will reduce cost and increases the efficiency of transmitting data between different and incompatible platforms in the mobile system architecture we are proposing.

4.3.4.4 Oracle data manipulation language (DML)

On Enterprise database servers; customers data and related information will be stored, this data will be retrieved by field sales representatives and updated in online manner so fast, efficient and secure database management system should be adopted.

Oracle is one of the world's leading software developing enterprises that has one of the most reliable collection of programs that enables you to store, modify, and extract information from a database so it's the best candidate to for an online extraction system that need data to be extracted/updated in a quick, flexible and secure manner.

Requests to retrieve the corresponding customer's data to location coordinates received by the GPS mobile device needs a query to run on the database that contains all customers data and search for needed information according to the coordinates as parameters for the running query.

Updating a current customer profile or inserting a new customer record to the database requires another type of query which updates/inserts data entered by field sales professionals for a specific customer based on the location coordinates the field sales representative GPS device is receiving.

4.3.4.5 The Haversine Formula

The Haversine formula noted that for two points on a sphere (of radius **R**) with latitudes **φ1** and **φ2**, latitude **separation Δφ = φ1 − φ2**, and longitude separation **Δλ = λ1 = λ2**, the distance **d** between the two points is related to their locations by the formula [22]:

$$\operatorname{haversin}\left(\frac{d}{R}\right) = \operatorname{haversin}(\Delta\varphi) + \cos(\varphi_1)\cos(\varphi_2)\operatorname{haversin}(\Delta\lambda).$$

$$\operatorname{haversin}(\theta) = \frac{\operatorname{versin}(\theta)}{2} = \sin^2\left(\frac{\theta}{2}\right)$$

$$\operatorname{versin}(\theta) = 1 - \cos(\theta) = 2\sin^2\left(\frac{\theta}{2}\right)$$

Knowing that:

R = earth's radius = 3956 Mile = 6.371 km

d = distance between two sphere points

Δlat = lat2 – lat1;

Δlong = long2 – long1

a = sin²(Δlat/2) + cos(lat1) * cos(lat2) * sin²(Δlong/2)

c = 2*atan2(√a, √(1−a));

d = R*c ;

➔ d = 3956 * 2 * ASIN (SQRT (POWER(SIN((orig.lat - dest.lat)*pi()/180 / 2), 2) + COS(orig.lat * pi()/180) * COS(dest.lat * pi()/180) * POWER(SIN((orig.lon - dest.lon) * pi()/180 / 2), 2)))

Where pi*() = 3.14159*

4.4 User interface design

Figure 4.2 shows the user interface screen and it specifications:

Figure 4.2: User interface design

From figure above the component of the screen as follow:

1: Exit: Used to exit the application

2: GPS: this button can be used to accomplish two services

- Open GPS services which are used to request the GPS data .
- Close GPS Service which used to cancel the GPS request

3: Output: this area is also used to show the output for the GPS data request.

Chapter 5
The Proposed Solution

5.1 Introduction

Previous studies focused on defining mCRM by detailing CRM definitions and technologies and finding its benefits, barriers and its adoption in the market for customer oriented companies. Other studies focused on defining GPS, methods of navigation, methods and integration techniques to enhance accuracy of positioning a location on the map and integrating GPS with other systems and technologies to enhance and make better efficiency of its usage.

Due to the above; in this research, an efficient method from the author's opinion was designed to integrate GPS with Mobile CRM in order to provide a way to ease, enhance and automate customers information instant (online) access to sales field representatives for large organizations.

So what was done is that an integration technique between Mobile CRM application and GPS application was designed where both are on a handheld device (PDA). This technique combines several mobile technologies to achieve the goals. Rather than creating an environment that is not widely applicable; the study presents an environment that can work on any handheld device since it’s based on a GPS software installed on a device with a GPS receiver and .Net web-based CRM application.

5.2 Field Sales and services professionals process scenario

This research assumes the following scenario which uses part of CRM processes:

An organization that has a large number of current and potential customers, back office team (group of people that supports and contacts customers indirectly) collects potential (proposed) enterprise customers in addition to currents ones and enters their information including their location coordinates into customer data base on enterprise servers.

Mainly the objective from such process is to manage, coordinate and organize customer's information such as company name, contact person (fleet manager) address, email, industry …etc, in addition to that customer relationship software helps to manage and monitor all field sales representatives visits, calls, deals, offers, services taken and contracts status.

The information part that the field sales representative's responsibility to manage is calls, visits done to the customer and the result of each communication including the customer response, time and date of the visit, offers(services) customer bought from the company, renewal/cancelling a contract with the company (information varies according to the type of services and the company's industry).

mCRM applications help the field sales representatives to manage entering all these data which avoids the mass number of paper work and working back in the office after a long day of car driving seeking customers.

Once the sales representative reaches a customer and in order to be able to view online detailed customer information he should perform a search on the customer's name, address or contact person's name, several searched could be done until he achieves the customer's profile he was seeking.

After viewing the customer's profile, necessary entries such as time of the visit and the result of it should be entered and instantly updated in the customer's data on the organization's server.

5.3 Proposed System architecture

The integration technique system combines different technical parts in order to determine the location of field sales and travelling professionals, and based on the location determined a customer will be recognized and processes (view/ update) could be performed on his profile in the customer relationship knowledge database based on the latitude and longitude coordination's of his location.

Figure 5.1 illustrates the functionality of the proposed scheme:

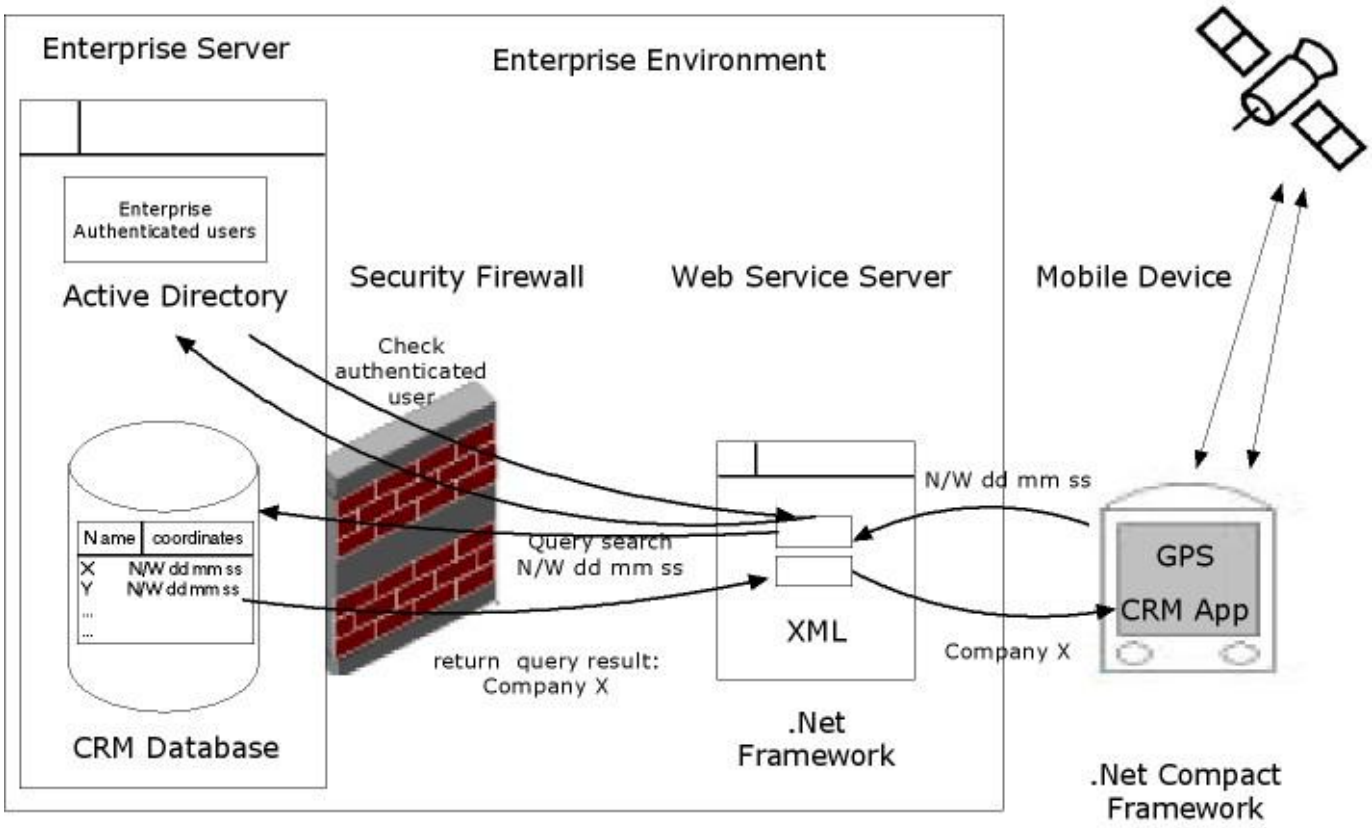

Figure 5.1: Functionality of the proposed solution

5.4 Proposed Integration technique phases

5.4.1 Introduction

Mobile devices that the enterprise will equip sales field professionals and representatives with on the road will have GPS software and mCRM application both installed on the device, as previously mentioned GPS location coordinates change according to the field sales movement and location, the new coordinates received by the GPS device receiver will be passed to the mCRM

application which on its turn will send these coordinates using web services to enterprise servers, web services will be further discussed in next sections.

5.4.2 Get field sales representative Location coordinates

As previously mentioned in this research; sales representative location coordinates will be passed by from GPS device receiver to mCRM application, but how will the GPS device receiver pass the field sales rep location coordinates to the mCRM application knowing that the two applications has different interfaces and each application is a stand-alone?

In order to pass the coordinates parameters from the GPS device receiver to the mCRM application; GPS Intermediate Driver functions are used to do this functionality since it is the software layer that sits between mCRM and the device driver for GPS hardware. This layer of abstraction allows mCRM application to invoke GPS application data and use it [16].

For windows mobiles The GPS Intermediate Driver API is exposed through a native code library.

Using GPS Intermediate Driver API from mCRM application:

In order to start using GPS Intermediate Driver API from mCRM application to get location coordinates, a reference to the GPS assembly should be added to mCRM code, the command line is as the following:

```
using Microsoft.WindowsMobile.Samples.Location;
```

Once the reference is added to the application code, GPS device can be accessed through the Gps object, both functions *GpsDeviceState* and *GpsPosition* can be accessed now too:

```
Gps gps = new Gps();
GpsDeviceState device = null;
GpsPosition position = null;
```

Field sales professionals are on the move constantly so their location will keep changing, mCRM application should know when the coordinates are changed in order to send the coordinates as parameters to the enterprise servers and inquiry if the coordinates are within the range of one of the customers location coordinates in the enterprise server database, this raises a necessary requirement to Add *event handlers for the DeviceStateChanged and* LocationChanged events of the Gps object so that the mCRM application is alerted when either of the device status or the location data is updated by the device:

```
updateDataHandler = new System.EventHandler(UpdateData);
gps.DeviceStateChanged += new
Microsoft.WindowsMobile.Samples.
Location.DeviceStateChangedEventHandler(gps_DeviceStateChan
ged);
gps.LocationChanged += new Microsoft.WindowsMobile.Samples.
Location.LocationChangedEventHandler(gps_LocationChanged);
```

To get the GPS position information the *updateDataHandler* will be invoked with the *LocationChangedEventArgs* which are predefined objects in the GPS API [16]:

```
protected void gps_LocationChanged(object sender,
LocationChangedEventArgs args)
{
  position = args.Position;
  Invoke(updateDataHandler);
}
```

In mCRM application's event handler for GPS data, the *GpsDeviceState* and *GpsPosition* helper objects are used to access the data [16]:

```
void UpdateData(object sender, System.EventArgs args)
{
  if (gps.Opened)
  {
    // verify that the device object is not null
    if (device != null)
    {
   // display device status
    StatusLabel.Text = device.FriendlyName + "Status: " +
    device.ServiceState + ", " + device.DeviceState;
    }

    // verify that the position object is not null
    if (position != null)
    {
      //The position object exposes
      // additional properties that indicate
      //which properties are currently valid.
      if (position.LatitudeValid)
      {
        // display latitude
        LatitudeLabel.Text = "Latitude(D,M,S): " +
        position.LatitudeInDegreesMinutesSeconds;
      }
if (position.longtitudeValid)
```

```
        {
          // display latitude
          longtitudeLabel.Text = "longtitude(D,M,S): " +
          position.longtitudeInDegreesMinutesSeconds;
        }
}
```

The previous event handler will get the position coordinates of the field sales representative to the mCRM application which can now check if the field sales representative is near a customer saved in the enterprise database to be alerted.

5.4.3 Transmit Location Coordinates to enterprise servers

In the previous phase mCRM application got the location coordinates of the field sales representative from the GPS; those coordinates will be saved as parameters in an XML file, user login authentication information (such as username and password) are saved in the XML file as well.

Web services as mentioned in previous section in this research is a method for transmitting data between clients and data source, in this research C# web service was implemented, to manage the interaction of exchanging data between E-TEN mobile client and the enterprise severs over the GPRS network cloud.

General packet radio service (GPRS) is a packet oriented mobile data service available to users of global system for mobile communications

(GSM), GPRS provides data rates of 56-114 kbit/s. Its data transfer is typically charged per megabyte of traffic transferred. [20]

Once the web service is hosted on the enterprise web server which is already connected to the internet; it can transmit the XML file that includes parameters sent from the mobile device through the GPRS cloud to the enterprise web server.

Web service will pass through the enterprise firewall according to enterprise security policies and so user authentication is checked to assure a secure login to enterprise servers, login information is authenticated by active directory software which stores all authentication data and on a central database. If authentication is validated the web service holding the latitude and longitude parameters will transmit those values to enterprise database servers and inform inquiry for the customer –if exists- that is within the range of 0.5 Km radius.

Web services which are responsible to get the location coordinates form the GPS intermediate driver and transfer them to enterprise servers are defined on two sides; the web service is defined on the GPS application which is on the mobile device to enable the mobile CRM application to call those web services using the location parameters. Also the web services should be defined on the web server.

5.4.4 Search for Customers in the radius of the field sales representative location

In the previous phase latitude and longitude values are transmitted via the web service to enterprise database servers. a database query will receive those parameters and search the CRM application database for customers that are in the range of 0.5 KM (0.3106855 Miles). The query calculates the distance between the latitude and longitude of the field sales representative and the longitude and latitude values for customers in the CRM application database.

To calculate a distance between two location The Haversine formula is used.

5.4.4.1 CRM Location Query:

Location parameters as received form the web service to the CRM application database:

```
Lat in decimal format (ex. Lat = 122.4058)
Lng in decimal format (ex. Lng = 37.7907)
```

According the received longitude and latitude the CRM Database query will calculate the distance between their location coordinates and location coordinates of the enterprise customers which are in the CRM database using the haversine formula, the search criteria is based on finding customers in the range of 0.5KM (0.3106855 Miles) from the sales representative location.

```
Select Customer_Name , 3956 * 2 * ASIN(SQRT(
POWER(SIN((Lat - abs(O_LAT)) * 3.14159 /180 / 2),
2) +  COS(Lat * 3.14159 /180 ) * COS(abs(O_LAT) *
3.14159 /180) *  POWER(SIN((LNG -O_LONG) * 3.14159
/180 / 2), 2) )) from CRM_Customers
Where Distance < 0.3106855
Order by Distance limit 1;
```

The result of the query will be saved in an XML file and then transmitted via the web service back to the enterprise web server and then via GPRS cloud to the mobile device.

If the customer name was retrieved then the field sales representative will be alerted on the mCRM application indicating the field sales representative that a customer is close in the area and the name of the customer will appear on the mCRM application.

On the move on the road field sales representative location keeps changing, the *updateDataHandler* will be invoked with the *LocationChangedEventArgs* in the GPS intermediate driver API and new GPS location coordinates will be determined and passed to the mCRM application to check for near customers.

Implementing this technique enables a real time and instant access from the field to the enterprise customers database, field sales

professionals who are constantly waiting and seeking for appointments with current or potential customers can now access their data online and update their CRM profiles by entering the transactions instantly, faster response will be managed by field sales professionals in front of the customers since the customer's profile is automatically retrieved without having to perform search queries on site.

Chapter 6
Conclusions and Future Work

6.1 Conclusions

In this dissertation an integration technique between two stand-alone systems on a mobile device was proposed and designed; the key tools and technologies used in the integration between Global positioning system and Mobile customer relationship management were discussed, the key technologies were GPS hardware and intermediate driver API, XML data storage files, web services, GPRS cloud and GPS coordinates distance query.

Nowadays sales and service professionals in the field must be equipped with the best possible information and access to customer-facing business processes.

This work concludes that the integration technique between global positioning system and mobile CRM application is feasible and obtained using current technologies and an organization can use it's current back end systems and networks infrastructure to deploy this technique.

Also we believe that the designed integration technique in this dissertation will add value and will be considered as an enhancement on current CRM strategy, the following are some benefits for the integration between GPS and mobile CRM applications on field sales mobile devices:

1. Help mobile professionals accomplish more in less time – Freeing up evenings and weekends that were previously spent on administrative tasks that could not be achieved in the field.

2. Enable sales and service people in the field equipped with mobile CRM integrated with GPS to find out what has happened with a customer account anytime, on-the-fly since the customer profile will be automatically retrieved on the spot.

3. Keep sales professionals connected even without them asking; reduces downtime and keep them productive by providing them with a mobile device capable of connecting to and interacting with key corporate applications constantly along when they are moving on roads.

4. When reps can answer questions and find information more quickly and automatically once they are in the location of the customer than competitors, the enterprise gains a significant competitive edge

5. Keep sales professionals connected to reduce downtime and keep them productive by providing them with customers information to every place they go and being capable of connecting to and interacting with customer relationship management system.

6. For management empowering a field force with mobile CRM that uses location coordinates as reference to customers helps monitor performance through Real-time updates.

6.2 Future work

The basis for business intelligence and performance management is that the underlying data in corporate systems such as CRM and ERP are up-to-date. The integration technique discussed in this dissertation added great value and advantages for the enterprise, this directs the focus to develop similar integration techniques with other back end systems to stay connected to and interacting with key corporate applications such as ERP and enterprise financial systems to improve their efficiency, performance and return on investment.

A potential investigation presents itself, if there was not much limitation on time, there should be a more intelligent system which provides in addition to the above illustrated integration technique between GPS and mCRM, an intelligent technique to guide field and sales professionals to the nearest customer recorded in the enterprise data base according to their position as determined by the GPS, this should be less time consuming, and more effective and reliable way of doing sales filed tasks. Also studying the benefits and the efficiency of the proposed scheme in this research on real organizations and how it would improve their field tasks is another future work for us.

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Appendix A
Source Code

This appendix provides the source code of the proposed system in this thesis:

A.1 GPS Application Code

The following is the GPS application code that uses the previously described GPS functions and event handlers to receive the location coordinates of the field sales representative, and sends the coordinates to the enterprise servers through web services:

```
static void Main()
  {
  Application.Run(new Form1());
   }

private void exitMenuItem_Click(object sender, EventArgs e)
  {
if (gps.Opened)
  {
    gps.Close();
  }

  Close();
  }

private void Form1_Load(object sender, System.EventArgs e)
  {
  updateDataHandler = new EventHandler(UpdateData);

  status.Text = "";

status.Width = Screen.PrimaryScreen.WorkingArea.Width;
status.Height = Screen.PrimaryScreen.WorkingArea.Height;
```

```
gps.DeviceStateChanged += new
DeviceStateChangedEventHandler(gps_DeviceStateChanged);
gps.LocationChanged += new
LocationChangedEventHandler(gps_LocationChanged);
  }

  protected void gps_LocationChanged(object sender,
LocationChangedEventArgs args)
{
  position = args.Position;

// call the UpdateData method via the updateDataHandler so
that we
// update the UI on the UI thread
Invoke(updateDataHandler);
}

void gps_DeviceStateChanged(object sender,
DeviceStateChangedEventArgs args)
{
   device = args.DeviceState;

   // call the UpdateData method via the updateDataHandler
so that we
   // update the UI on the UI thread
    Invoke(updateDataHandler);
   }

void UpdateData(object sender, System.EventArgs args)
  {
   if (gps.Opened)
     {
    string str = "";
   if (device != null)
   {
     str = device.FriendlyName + " " + device.ServiceState
+ ", " + device.DeviceState + "\n";
     }

  if (position != null)
   {

  if (position.LatitudeValid)
    {
   str += "Latitude (DD):\n   " + position.Latitude + "\n";
  str += "Latitude (D,M,S):\n   " +
position.LatitudeInDegreesMinutesSeconds + "\n";
```

```
    }

   if (position.LongitudeValid)
     {
  str += "Longitude (DD):\n    " + position.Longitude + "\n";
   str += "Longitude (D,M,S):\n    " +
position.LongitudeInDegreesMinutesSeconds + "\n";
     }

if (position.SatellitesInSolutionValid &&
   position.SatellitesInViewValid &&
   position.SatelliteCountValid)
    {
                          str += "Satellite Count:\n    " +
position.GetSatellitesInSolution().Length + "/" +

position.GetSatellitesInView().Length + " (" +
        position.SatelliteCount + ")\n";
    }

   if (position.TimeValid)
{
    str += "Time:\n    " + position.Time.ToString() + "\n";

     }

   valuestr= TestWeb.GetName(lat1, lng1); //str contains the
position
    PNO2 = TestWeb.GetInfo(valuestr);

      }

       //status.Text = str;
     txtlat.Text = Convert.ToString(lat1);
    txtlong.Text = Convert.ToString(lng1);
     Name.Text = valuestr;
    PNO.Text = PNO2;

    }
     }

private void Form1_Closed(object sender, System.EventArgs
e)
        {
   if (gps.Opened)
    {
```

```
    gps.Close();
      }
}

  private void stopGpsMenuItem_Click(object sender,
EventArgs e)
  {
    if (gps.Opened)
      {
    gps.Close();
       }

   startGpsMenuItem.Enabled = true;
    stopGpsMenuItem.Enabled = false;
   }

   private void startGpsMenuItem_Click(object sender,
EventArgs e)
   {
  if (!gps.Opened)
    {
     gps.Open();
   }

     startGpsMenuItem.Enabled = false;
    stopGpsMenuItem.Enabled = true;
      }
```

A.2 Web services Definition

Define Web service in GPS Application:

```
public class Service
        :System.Web.Services.Protocols.SoapHttpClientProtoc
        ol {
        /// <remarks/>
        public Service() {
            this.Url =
        "http://86.108.14.195:81/Service.asmx";
        }

        /// <remarks/>
[System.Web.Services.Protocols.SoapDocumentMethodAttribute(
        "http://tempur
.org/HelloWorld", RequestNamespace="http://tempuri.org/",
ResponseNamespace="http://tempuri.org/",
Use=System.Web.Services.Description.SoapBindingUse.Literal,
ParameterStyle=System.Web.Services.Protocols.SoapParameterS
        tyle.Wrapped)]

 public string GetName(double Lat, double LNG)
        {
            object[] results = this.Invoke("GetName", new
        object[] {
                        Lat,
                        LNG});
            return ((string)(results[0]));
        }
```

Call the web service in GPS Application:

```
Name= TestWeb.GetName(lat1, lng1); //Name contains
        the Customer Name

Phone = TestWeb.GetInfo(Name); //Phone contains the
        customer's phone number


Name.Text = Name;
PNO.Text = Phone;
```

Web service Definition on the Web Server

```
public class Service : System.Web.Services.WebService
{
    public Service () {

        //Uncomment the following line if using designed
components
        //InitializeComponent();
    }
    [WebMethod]
    public string GetName(double Lat, double LNG)
    {

        double Distance = 0;
OleDbConnection Myconnection = default(OleDbConnection);

double _dbLat = 0;
double _dbLng = 0;

/*Myconnection = new
OleDbConnection("Provider=Microsoft.Jet.OLEDB.4.0; User
Id=; Password=; Data
Source=C:\\Users\\user\\Documents\\test.mdb");*/ this is
the connection string for microsoft access database

/*OracleConnection Myconnection = new OracleConnection();
oOracleConn.ConnectionString =
    "Data Source=CRMDB;" + "Integrated Security=SSPI";*/
this is the connection string for oracle CRM database

Myconnection.Open();

OleDbCommand cmd = new OleDbCommand();
        {
            cmd.Connection = Myconnection;
            cmd.CommandText = "Select Customer_Name ,
            3956 * 2 * ASIN(SQRT( POWER(SIN((Lat -
abs(O_LAT)) * 3.14159 /180 / 2), 2) +
            COS(Lat * 3.14159 /180 ) * COS(abs(O_LAT) *
3.14159 /180) *  POWER(SIN((LNG -O_LONG) * 3.14159 /180 /
2), 2) ))
            from CRM_Customers
```

```
            Where Distance < 0.3106855
            Order by Distance limit 1";
            cmd.CommandType = CommandType.Text;
        }


        OleDbDataReader myReader = cmd.ExecuteReader();

        while (myReader.Read())
        {


            try
            {
            Myconnection.Close();
            return (string)myReader["Customer_Name"];

                }

            catch (Exception ex)
            {

                Myconnection.Close();


      return "Internal System Error, Please try later!";

            }
        }

        Myconnection.Close();

        return string.Empty;
    }

}
```