

Design and Implementation of Location Awareness and Sharing System using GPS and 3G/GPRS

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Abstract

In this age of significant telecommunications competition, mobile network operators continuously seek new and innovative ways to create differentiation and increase profits. One of the best ways to accomplish this is through the delivery of highly personalized services. One of the most powerful ways to personalize mobile services is based on location. Location is a key to provide location based services (LBS) to the user because the location information is typically useful for coverage, deployment, routing, location service, target tracking and rescue operations. One of the most obvious technologies behind LBS is positioning, with the most widely recognized system being the Global Positioning System (GPS). There are no subscription fees or setup charges to use GPS. This document provides detail on the design and implementation of a java application which provides the users current location sends this location using SMS (Short Message Service) plus sharing location with friends and family and views them on maps. Users can also take benefit of this application in emergency situations by using emergency feature of this application. To get the location coordinates, application is using GPS (Global Positioning System) as location provider. The application design has five parts: a mobile client, a web server, a database, GPS system and a map service. A mobile client application which consists of a mobile and GPS receiver finds the location of the user to get aware of his location. In order to share this location the mobile client sends this location to the web server from where other users can get this location if they have the authentication provided by the user. The mobile client is implemented using J2ME which is one of the most promising software platforms for mobile devices. Sun representatives assert that 18 to 20 million mobile phones support the J2ME platform. Analysts predict that within the next few years, this technology will become omnipresent. The web server side programming is done using PHP and database is maintained by MYSQL.

Keywords: *GPS, LBS, J2ME, 3G, Midmaps, Google maps, PHP, mysql, GSM, CDMA*

1. Introduction

Location Based Service (LBS) has been considered as the most potential part of wireless value-added services. However, the development of LBS, which needs lots of data to transmit, is strictly limited because of the limited bandwidth of wireless network. With the emergence of 3G, wireless network speed is greatly improved, which will provide more information to users easily, and hence LBS will be greatly promoted. Today mobile communication devices are becoming much more technologically advanced and offer more features than just conversation. In cell phones, global

positioning system (GPS) tracking and sharing are some of the advancements. GPS systems can be used when outdoors for activities such as hiking or camping.

According to a new report from the research firm Berg Insight; “revenues from mobile location based services (LBS) in the European market will grow by 34 percent annually to reach €622 million in 2010” [1]. This figure demonstrates how important location based services (LBS) applications are becoming to mobile users. Within the last few years, mobile phones spread like wild fire. With more than 2 billion phones around the globe and more mobile than fixed line subscribers, mobile phone industry is the most growing industry in the world. The development progressed from unhandy simple phones to small all-rounder with high resolution color display, organizer, and integrated camera and Global Position Service (GPS) receiver [2].

The main reason for rapid progress in mobile business is that the features and services that a mobile phone can provide now a days. The previous generation phones only had the capability of speech communication between several users and text messaging with few numbers of inbuilt hardware. But now a mobile has the capability of image capturing, video recording, Bluetooth, file sharing, touch screen display, low power consumption, GPS receivers to get location coordinates and many other advanced features and in-built hardware. These eye catching features attract more users. Here we are concerning only about the internal GPS receivers [3] in mobile phones. The GPS receiver is able to calculate the location using GPS satellite system [4]. For further information and access authentication about GPS refer to [5]. Location Based Services attracts more and more users to take advantages of these services. A location-based service basically answers three questions: Where am I? What's around me? And how do I get there? They determine the location of the user by using one of several technologies for determining position (such as GPS), and then use the location and other information to provide personalized applications and services. For an example, consider a wireless 911 emergency service that determines the caller's location automatically. Such a service would be extremely useful, especially to users who are far from home and don't know local landmarks. Traffic advisories, navigation help including maps and directions, and roadside assistance are natural location-based services. Other services can combine present location with information about personal preferences to help users find food, lodging, and entertainment to fit their tastes and pocket books.

This application can help users to be aware of their own location and send it to any valid mobile number using short message service. Users can also share their location with friends and family. Further, users can take advantages of emergency features which send user's current location to emergency numbers. Because of the rapid growing of JAVA enabled handhelds in the market, we liked to implement this application using J2ME, PHP and MYSQL. For mobile client we are using J2ME and for server side we are using PHP and MYSQL. Our main aim is to show the implementation of such a system so the rest of the paper is structured as follows. Section 2 gives an overview related work and Section 3 is about Related Technologies. Section 4 shows the mathematics of location estimation. Section 5 deals with the system architecture. Section 6 gives a brief overview of its implementation. Section 7 gives the result and finally in section 8, we have concluded the whole project work.

2. Related Work

This section deals with some of the existing works related to the proposed mobile solution, mainly, using tracking systems through GPS or GSM cell. In paper [21], we discussed the detailed design specifications of this system and in paper [20], we dealt with the detailed implementation of this system.

In paper [22], the author proposes an application Locating Friends and Family Using Mobile Phones with Global Positioning System (GPS) based on client-server architecture that helps the users to locate their family members and receive alerts when their friends are nearby. The mobile application was implemented using J2ME where the most recent APIs and other older APIs were combined together in order to make the application reliable on all types of mobiles. The server was implemented using PHP since PHP guarantees that the server would not be overloaded. The type of the Database used in the system was MySQL.

In paper [17], a technique is given to send GPS coordinates of a mobile through a SMS to other mobile phones. Two algorithms, Kalman Filter and Velocity Renovation, which can be used in conjunction with GPS, are used as a basis for location tracking. The first coordinates are generated from a GPS assisted mobile on Google map, this location is then sent through SMS to another person. The latter can then see the exact location of the sender on his map with an accuracy of 0.57m.

In paper [18], two techniques were described to locate and track cellular phones using digital cellular mobile telephony networks. The first technique is based on time of arrival (TOA) methods with a minimum of three base stations required, while the later uses angle of arrival (AOA) methods that require only two base-stations, though greater accuracy is possible with three. Both TOA and AOA methods were examined for a multipath fading environment.

There are already several applications in the market that offer tracking systems and anti theft applications. Anti- theft applications like mGuard. Tracking applications such as, Mobile Tracking System 1.14 [23], AccuTracking [24], and PhoneBak (also an anti-theft application) [25], are already rooted in the mobile phone market.

As it may be seen in the above-mentioned systems, most of them provide dedicate solutions using tracking methods to monitor a mobile device. Our proposal is designed for a regular mobile phone that incorporates a GPS. Unlike the systems mentioned above, the main feature of our application provides the user the ability to locate him, send his own location via SMS and share his location with friends through a web server.

3. Related Technologies

We have gathered suggestions of approaches in order to build the system described in the given sections. The proposed solution can furnish better functionalities and is very easy to deploy in a regular mobile phone with GPS receptor. For the user safety, the GPS Locator application can be useful in emergency scenarios, for instance kidnapping, hijacking, and thereby giving the user the option to send his location calls via SMS.

3.1. GPS

The Global Positioning System (GPS) [6] is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day. There are no subscription fees or setup charges to use GPS. The GPS system has three parts.

3.1.1 Satellites: GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth.

3.1.2 Receivers: GPS receivers take this information and use triangulation (method) to calculate the user's exact location.

3.1.3 Software: Application softwares are used to command the devices such as Handhelds and Computers and take benefits of the above two services.

3.2. The GPS Satellite System

The 24 satellites that make up the GPS space segment are orbiting the earth about 12,000 miles above us. They are constantly moving, making two complete orbits in less than 24 hours. These satellites are travelling at speeds of roughly 7,000 miles an hour. GPS satellites are powered by solar energy. They have backup batteries on-board to keep them running in the event of a solar eclipse, when there's no solar power. Small rocket boosters on each satellite keep them flying in the correct path. Here are some other interesting facts about the GPS satellites (also called NAVSTAR, the official U.S. Department of Defense name for GPS):

- 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.

3.3. Applications

While originally a military project, GPS is considered a *dual-use* technology, meaning it has significant military and civilian applications. GPS has become a widely used and useful tool for commerce, scientific uses, tracking and surveillance. GPS's accurate timing facilitates everyday activities such as banking, mobile phone operations, and even the control of power grids. Farmers, surveyors, geologists and countless others perform their work more efficiently, safely, economically, and accurately.

The mobile application targets JAVA platform. We have decided to develop the application using JAVA 2.0 Micro Edition. It includes large programming libraries, solutions for common problems. We develop this application under CLDC 1.1 [6] device configuration and MIDP 2.0 [7] device profile. The software chosen for the development of this application is Java(TM) ME Platform SDK 3.0. The SDK is free of cost so anyone can develop your own applications and market it.

For database hosting on server site we are using Mysql database and PHP language. We use PHP because it runs on server side and so again reducing the overhead from the mobile device. For local hosting we used WAMPSEVER software which includes MYSQL, PHP and apache HTTP server in one package. It also includes PHPMYADMIN. With the help of these we run our project locally.

To show the coordinate on map, we are using a third party Google maps API. It has several functions for handling online Google maps.

4. Location Coordinate Estimation

In a considerably simplified approach, each satellite is sending out signals with the following content: I am satellite X, my position is Y and this information was sent at time Z. In addition to its own position, each satellite sends data about the position of other satellites. These orbit data (ephemeris und almanac data) are stored by the GPS receiver for later calculations.

For the determination of its position on earth, the GPS receiver compares the time when the signal was sent by the satellite with the time the signal was received. From this time difference the distance between receiver and satellite can be calculated. If data from other satellites are taken into account, the present position can be calculated by trilateration (meaning the determination of a distance from three points). This means that at least three satellites are required to determine the position of the GPS receiver on the earth surface. The calculation of a position from 3 satellite signals is called 2D-position fix (two-dimensional position determination). It is only two dimensional because the receiver has to assume that it is located on the earth surface (on a plane two-dimensional surface). By means of four or more satellites, an absolute position in a three dimensional space can be determined. A 3D-position fix also gives the height above the earth surface as a result.

Simplified, the position determination by means of a GPS works on the sample principle as the distance of thunderstorms can be judged: the time is measured between lightning and the following thunder. The speed of light is so high that the delay between the time where the flash hits the ground and the time the observer sees the flash can be neglected. The speed of sound in the earth's atmosphere is approximately 340 m/s. This means that for example a difference of 3 seconds between lightning and thunder corresponds to approximately 1 km distance to the thunderstorm.

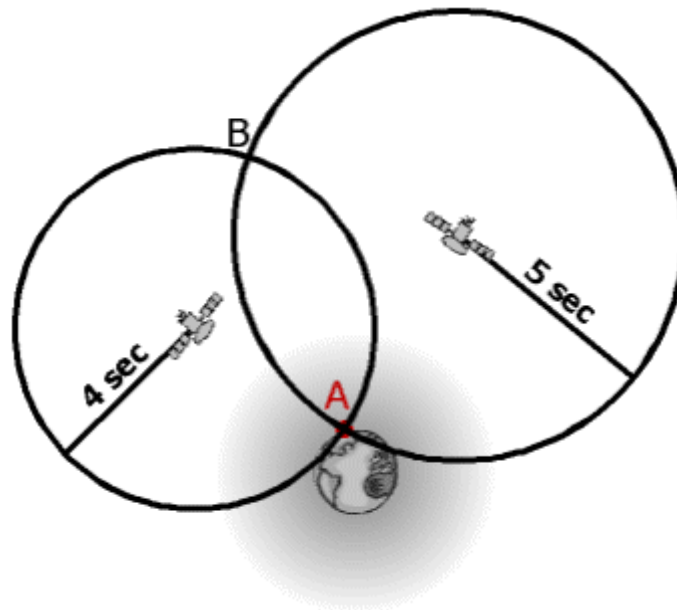


Figure 1. Location Calculation in 2D World

However, this procedure is not yet a determination of a position, but only a determination of a distance. If different people on fixed positions would determine the time span between lightning and thunder, this would allow the determination of the position where the flash hit the ground.

In the following an explanation is given, how the position determination by GPS works. For simplification, in the first step we assume that the earth is a two-dimensional disk. This allows us to do some understandable sketches for illustration. The principle can then be transferred to the model of a three-dimensional globe.

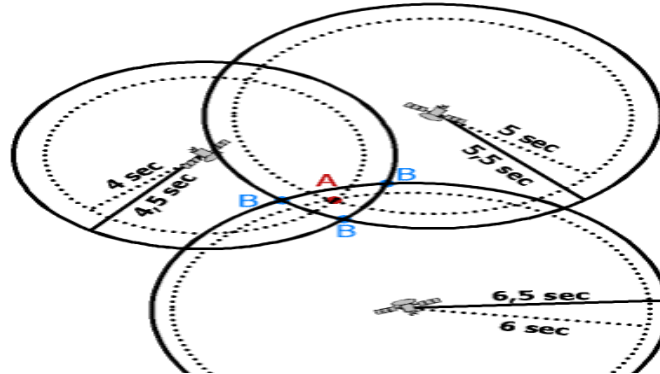


Figure 2. 2D Position Determination with 3 Satellites and Corrected Clock Error

In the example on the left, the time needed by a signal to travel from the first of two satellites to the receiver was determined to be 4 s. (In reality this value is far too high. As the signals travel with the speed of light (299 792 458, 0 m/s), the actual time span for signals from the satellite to the receiver lies in the range of 0.07 s.) Based on this information, we can state that the receiver is positioned somewhere on a circle with a radius of 4 s around the first satellite (left circle). If we perform the same procedure with a second satellite (right circle), we get two points of intersection. On one of the two points the receiver must be situated. Now we have used two satellites. But the process is called trilateration, not dilateration so don't we need a third satellite? We may use a third satellite but we could also assume that the receiver is located somewhere close to the earth's surface and not deep in space, so we can neglect point B and know that the receiver must be found on point A. The area in the picture above which shaded grey is the region in which GPS signals are supposed to be "realistic". Positions outside this area are discarded, so is point B.

If a third satellite is taken into account for the calculation of the position, another intersection point is obtained: in case that all clocks are absolutely precise, point A would be obtained, corresponding to the actual position of the receiver. In case of the receiver clock being 0.5 s early, the three intersection points B are obtained. In this case the clock error stands out immediately. If now the time of the receiver clock is shifted until the three intersection points B merge to A, the clock error is corrected and the receiver clock is synchronized with the atomic clocks in the satellites.

The GPS receiver can now be regarded as an atomic clock itself. The distances to the satellites, formerly regarded as pseudo ranges, now correspond to the actual distances and the determined position is accurate.

In practice you get a two-dimensional position determination (2D-fix) with three satellites. The position is bound to be located on the earth's surface. The fourth satellite is the geocentric; the distance to the "fourth satellite" corresponds to 6360 km (the radius of the globe). Therewith the fourth satellite necessary for the calculation is given, but the calculation is restricted to locations on the earth surface. However the earth is not a perfect sphere. The surface of the earth in this case means the earth geoid, corresponding to sea level. If the

receiver is located on a mountain, the determined position again is afflicted with an inaccuracy, as the runtime of the satellite signals is wrong.

5. System Architecture

The current location of the user is calculated using inbuilt GPS receiver in the phone. The calculated coordinates of the user is showed on the map using a third party Google maps API called MIDMAPS. Further these coordinates can be sent to any valid mobile number through a SMS. The text message cannot be edited by the user because of security reasons.

The application architecture and its working principle are centered on the use of GPS. It is the most common technology for these kinds of applications. Other possible approaches may include a combination of other LBs like GSM cell ID, wireless hot spots or via Bluetooth. Crossing data from all the LBs should provide much more accurate position of the device. Further, unlike the GPS, the GSM cell ID, wireless hot spots and tracking via Bluetooth are able to get the device's position even at indoors. The centralized database server provides a coordinate's database to the users so they can get the location of friends and relatives and updates their own location on the server. The purpose of choosing centralized data sharing is to reduce the storage overhead on each phone. Otherwise, instead of using centralized database each mobile may have its own database stored on the phone and share these databases between different users.

The internet is the medium that is used to transfer the user data and service request from the mobile to the server and then the requested information back to the user. Figure 3 shows the main 5 elements that construct the system which are the GPS system, the mobile clients, web server and the database.

5.1. Mobile clients (Mobile)

The mobile requests its location from the global positioning system periodically and sends it through the communication network to the server. The user can request the location of a family member at any time from the server. Mobile client can also send its current location via SMS to any mobile number. Mobile client also has an internal database to store application settings. The mobile client application is named as GPS Locator.

5.2. Server

The server receives users' location and updates the user about the location of family members.

5.3. Database

The database contains all users subscribed in the service with their location. The database also stores the user's mobile number along with the other user's mobile number with whom user is sharing his location. Database tuple mainly has six attributes namely who, whom, latitude, longitude, altitude and time which stores user's mobile number, mobile number of other user with whom user is sharing his location, latitude coordinate of user location, longitude coordinate of user's location, altitude coordinate of user's location and time at which user updates his location. Whenever, user updates his location the time is also updated.

5.4. GPS

Every time the mobile phone updates the user location in the server, it requests the location of the user from the GPS receiver. The GPS receiver determines the longitude and the latitude with the help of satellite system.

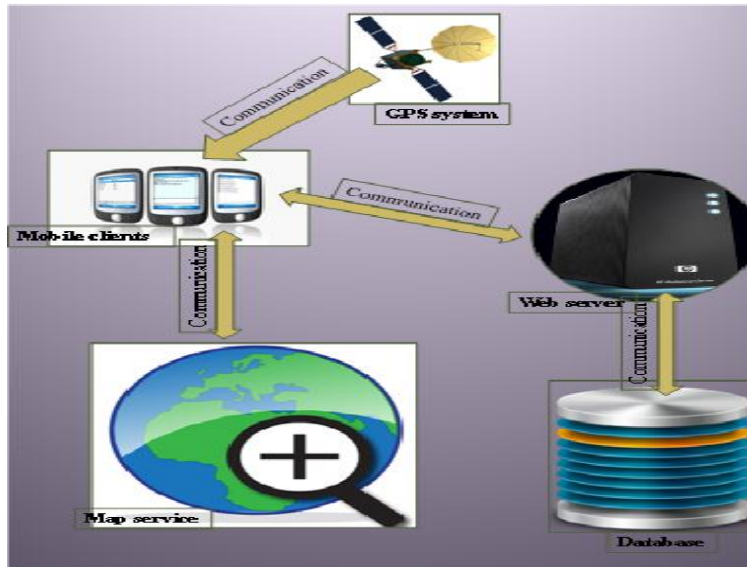


Figure 3. System Architecture

5.5. Map Service

Map service provides the Google maps and several map handling functions as required by the user. However the map service is an indirect part of this system, and it will be supplied by an external source. Then latterly sends to the mobile phone.

Data from the application settings and emergency contacts are saved in a database file. When the application is started; the data is loaded from the data file and will apply it to behave according to those parameters.

The major requirement of a GPS Locator shown in Figure 4 is the use of Location Based Services (LBs) such as GPS. The GPS Locator allows several operations such as user can get your own current location (latitude, longitude and altitude) and can view these co-ordinates on the Google maps using MidMaps api [15] for J2ME platform. Further user can send this information via SMS through a GSM/CDMA network to any valid mobile phone number anywhere in the world. GPS Locator also provides the location sharing capability between two or more people through a web server. If a user wants to share his location with one of his friend he just need to enter the mobile phone number of his friend by selecting the share me option from list and press ok button. In order to view friends, user needs to select the get friends' location option from list menu of GPS Locator. Suppose a user A and User B are sharing their location. So, A and B can view each other's location with the time at which the user updated his location and can see this location on map. The GPS Locator continuously updates the web server's database with the user's current location by using the ENABLE SHARING command. After this, the GPS Locator calculates the user's current location and sending it to the server and updates the location attributes of corresponding user in the database table. In order to reduce the battery overhead due to the GPS receiver, the developers of this application allow the application to update the database after a particular

time interval instead of calculating GPS data continuously. User can also cancel the sharing bond with any of his friend with whom user was sharing his location.

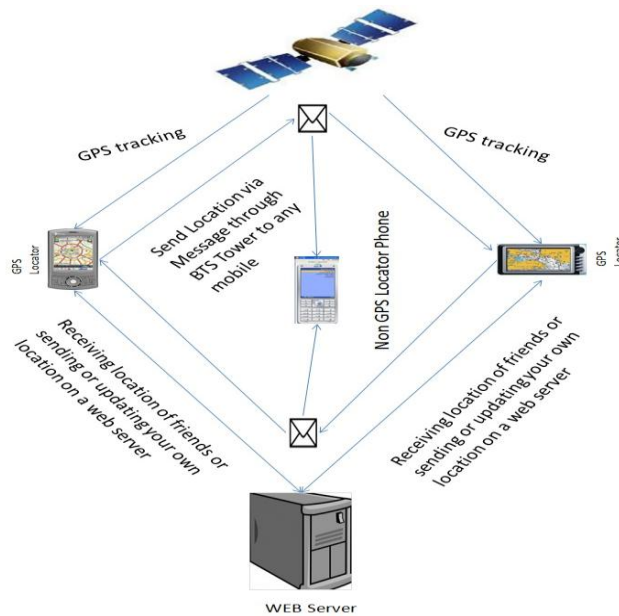


Figure 4. System Requirements

If the user doesn't want to update his location or to reduce the battery consumption he can disable the location sharing mode. If the user is in some emergency condition he can send his location to the emergency numbers which are already in the GPS Locator's database. So the emergencies can aware the user's most appropriate location to provide him the emergency services such as medical, police etc.

6. Implementation

The implementation of this application is not fully implemented that incorporates all the functionality mentioned in the previous topics. A full implementation of it was strictly not possible within the time limit for this project. Instead, the implementation will merely be a proof of concept where the goal is to show that it is possible to implement the full system.

The mobile application was implemented using J2ME while PHP was used for implementing server functions and MYSQL was used for the database. The implementation is easily understood by dividing this task into several steps. First we will see the implementation of mobile clients, then the web server and database further we will see how we are integrating external map service with our application.

6.1. Mobile Client Side Implementation

A mobile client is a JAVA supported handheld with the GPS receiver providing several features to the user. The mobile client programming language and IDE is java and JAVA ME PLATFORM SDK 3.0. Java ME platform is a collection of technologies and specifications that can be combined to construct a complete Java runtime environment specifically to fit the requirements Java ME platform has been divided into

two base configurations, one to fit small mobile devices and one to be targeted towards more capable mobile devices like smart-phones and set top boxes. The configuration targeting resource-constraint devices like mobile phones is called the Connected Limited Device Configuration (CLDC) [6]. It is specifically designed to meet the needs for a Java platform to run on devices with limited memory, processing power and graphical capabilities. For a CLDC and MIDP [7] environment, which is typically what most mobile devices today are implemented with, a MIDlet is then created. A MIDlet is the application created by a Java ME software developer, such as a game, a business application or other mobile features. These MIDlets can be written once and run on every available device conforming to the specifications for Java ME technology. See Figure 5. Several functional implementation of mobile client is as follows. The mobile client application's class diagram is represented using the corresponding UML class diagram shown in Figure 6. This diagram is made using Fujaba Tool Suite RE 4.2.0[26].

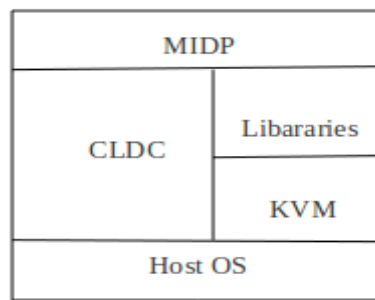


Figure 5. JAVA ME Technology Specifications

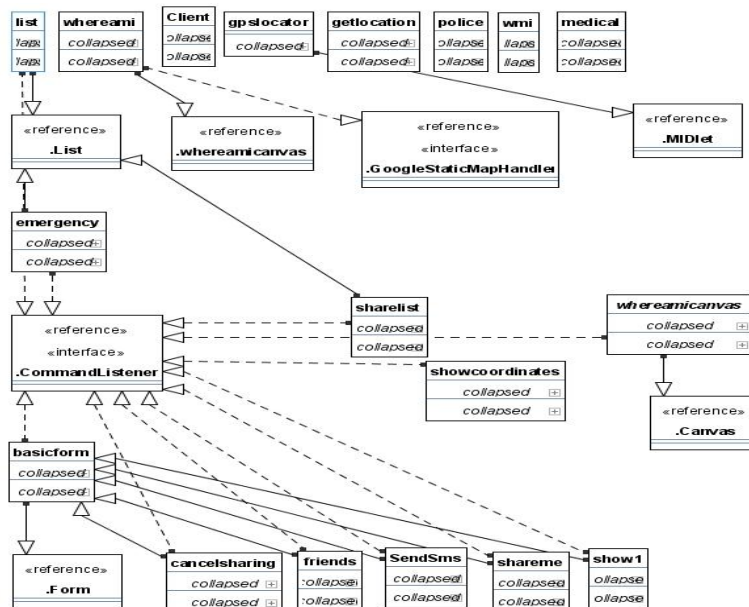


Figure 6. JAVA Class UML Diagram by Fujaba Tool Suite

6.1.1. Graphical User Interface (GUI): Graphical user interface requirements of software for mobile phones are different from those for desktop computers. For example, the display size of mobile phones is small and input devices do not always include pointing tools such as a mouse or pen input. Therefore, the user interface programming guidelines for applications running on mobile phones are not the same as for the desktop computers.

MIDP applications are expected to run on many different mobile phones without modification. This is particularly difficult in the area of user interface; Mobile Information Devices (MIDs) have got screens of all sizes, in grayscale and in color. Furthermore, for input, the MIDP is fairly open-ended. The input devices on MIDs vary widely in their abilities, from numeric keypads to alphabetic keyboards and soft keys to touch screens. The minimum screen size mandated by the MIDP is 96 x 54 pixels, with at least one bit of color depth. Below there are some important guidelines that we kept in mind while designing the application with MIDP graphical API functionality:

- User interface is kept simple and easy to use. Because novice users who probably have not used a J2ME enabled phone before may use the application.
- High-level APIs are used as much as possible, so that the application became portable across different mobile phones.
- No keys other than those defined in the Canvas class are assumed to exist.
- The application does not assume any specific screen size; instead, it queries the size of the display initially and adjusts itself accordingly.
- Choices are presented to users as lists because entering alphanumeric data through a mobile phone can be tedious.

6.1.2. Get Location: The location includes the latitude, longitude and altitude coordinates. These coordinates can be calculated using the JSR-179[8] location API available in J2ME. JSR-179 specifications define a Java 2 Micro Edition (J2ME) optional package to enable location-aware applications for Mobile Information Device Profile (MIDP) based devices. Specifically, this package provides the following two main functionalities: i) obtaining information about location and ii) orientation of the mobile device; and iii) accessing on-device landmark database.

The LocationProvider class represents a module that is able to determine the location of the terminal. Actually, each device can have several location providers installed, each related to a different positioning technique (e.g., GPS and RSS-based triangulation). The API allows to specify selection criteria to choose the most suitable LocationProvider. Upon the selection of a specific LocationProvider, the application can retrieve Location objects by means of either periodic updates or asynchronous queries. The GPSTypeLocationProvider is responsible not only for data retrieval but also for parsing the read sentences and for translating them into a set of coordinates. As for location data retrieval, the GPSTypeLocationProvider is in charge of connecting to the GPS sensor in order to get the current location data (location coordinates, altitude, date and time). Upon sentence parsing, the GPS LocationProvider can use the gathered location data to create Location objects and distribute them to JSR-179 Java applications.

6.1.3. Short Message Service (SMS): The Wireless Messaging API (WMA 2.0) JSR 205[9][10] provides a common interface you can use to enable an application based on the Mobile Information Device Profile (MIDP) to send and receive short text and binary messages, as well as multimedia messages. By using this API, the user's current location coordinates i.e. latitude, longitude and altitude is sent as text via SMS.

6.1.4. Location Sharing: To share location with the other users, the mobile client needs to communicate with the web server using General Packet Radio Service (GPRS)[11][12] over TCP/IP protocol[13][14]. To allow the application to be portable across all mobile phones, HTTP connection is used to connect the client to the server. HTTP is a request response application protocol where the GET or PUT commands are used to supply data. In this system, GET method is used where the data of the request becomes a part of (encoded in) the URL. Since the client's requests do not contain large amount of data, there is no risk of overrunning the capability of environment variables.

6.2. Web Server Side Implementation

The application needs centralized database for the purpose of location sharing. MYSQL was used for the database and PHP was used for implementing server functions to modify these data as user demands. First we fulfill this need by using local server on Personal computer (PC) .For this purpose we used software named WAMPSEVER which include PHP, MYSQL and apache web server in one package.

In this application, once a client sends its request over the network to the server, it is then up to the server to interpret the request and generate an appropriate response. The application's receiving end on the server is a PHP page which is a regular HTML page with two elements added: First, the file's name ends with the ".php" extension, so that the web server knows that it should be interpreted specifically.

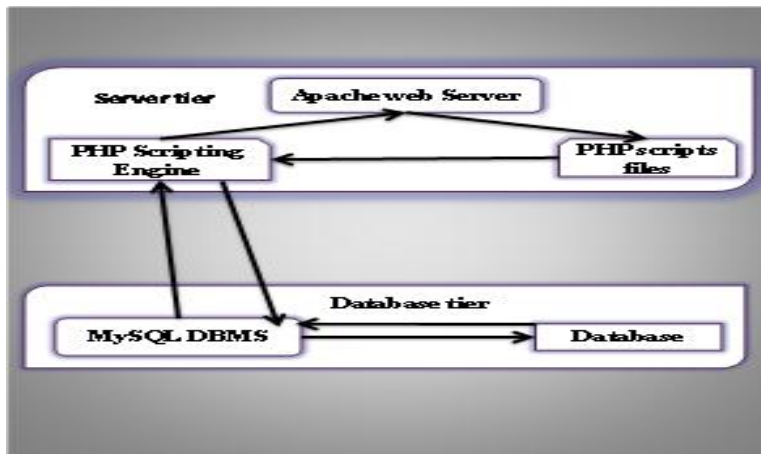


Figure 7. Web Server Architecture Including Database

Second, the file includes some server-side code instructions, such as getting the current date that the server should perform before sending the page to the client side. In the application's main menu shown to the user, lists of available layer names are displayed for the user to select. Once the user makes his selection, the client connects to the server and transmits the user's request parameters using GET/ PUT method, which fires the PHP code execution on the server. The PHP code is used to reach the database and form a dynamic HTML page with the data pulled out from the database. In the application, PHP code mostly contains SQL statements to make the queries in the database. The resulting data is then sent back to the client. Figure 7 shows the web server architecture including database. As figure shows that the server tier

communicates with the database tier using PHP script engine. The communication with web server takes place over the TCP/IP protocol.

6.3. Map Services

This part mainly provides such functions as parallel moving, zoom, geocoding and relocate center; Location service: exchanging data between client and server, displaying map information that centered by mobile terminal in real time. The MidMaps[15] is the map service which provides Google maps for our application.



Figure 8. Google Map

The Google maps server contains a vast earth image database. This method is only used for research purposes. It is not a licensed method to access the Google maps database. Google maps is latitude and longitude related [16]. Google Maps holds the world in a number of 256x256 pixel tiles. Zoom level ranges from 17 to 0. Each Google tile has corresponding latitude, longitude and zoom values. Google uses an x, y coordinate system combined with a zoom value to specify the tiles to retrieve from the server. Figure 6 is an image of the entire earth.

7. Evaluation and Validation

7.1. User Experience and Application Interface

This subsection introduces a general idea of mobile application (GPS Locator) as well as, its use in practical deployment. To ease the user interaction with the GPS Locator, the interface is made as simple as possible. The main window of the application is very intuitive.

The interface displays a list of functions that a GPS Locator can perform such as where am I, Get Friends location and Emergency etc. the left soft key allows the user to terminate the application and right soft key set the enable sharing mode.

7.2. Application Validation

The purpose of validation is to show that the implemented system satisfies the initial requirements. GPS Locator (and MIDMAPS) validation was performed, using

exhaustive running tests that were also performed in design time to collect debug information and change as necessary. We used a real device with all tests, NOKIA 5235 equipped with SIMcard and GPS receptor.

8. System Result

This mobile application system adopts Nokia 5235 as the test mobile which has inbuilt GPS receiver. Figure 5 shows the user's current location and the map positioning this location at the center of mobile screen. Users can browse the map and can also zoom /reduce the map. When zoomed, the map automatically switches to the next level maps. Fig 6 illustrates the location sharing. User needs to enter the correct password to access his friends' location. It is marked by the red pointer.



Figure 9. User's Location, Location View on Map and Location Sending via SMS



Figure 10. Location Sharing Cancel Sharing and Get Friends' Location

9. Conclusion

A Location Based Service (LBS) application for Java enabled mobile phones, using Global Positioning System (GPS) as the location provider is presented in this paper. The application provides the user with his current location coordinates and displays it on Google Maps on the mobile phone. The application is also implemented as a client server system that helps users to locate their friends or anyone with whom he wants to share his location. The location average accuracy using this system is believed to be within a couple of meters. The application works in the open space areas only as it relies on GPS. Future extensions may look at other options such as getting the location from the service provider. In this case the location accuracy will be reduced and will depend on the size of the cells where the user is located. Other future extensions can be summarized as follows:

- Better user interface design;
- External Bluetooth GPS receiver interface;
- Accelerometer, proximity, compass;
- Improved accuracy with newer algorithms;
- Emergency services using centralized databases.

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