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A Systematic Approach for Developing Mobile Information System based on Location Based Services

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Abstract

This paper describes the mechanism of some novice location based services that can be used over the Mobile Information System frame work that we have developed. In this paper, a simple and innovative network based mobile information system technique is introduced, that provides extensive flexibility at the user end. This paper discusses the methodology adopted for the design and simulation of location based friend finder and location based web tracking services. Both these services are integrated with the real-time billing system. An advance technology of using spatial triggers is introduced that results in a cost-effective solution for mobile companies.

Keywords: Location Based Services, Spatial Trigger, GSM, CDMA, LMU.

1. Introduction

Location based services (LBS) is becoming one of the most promising and challenging market for various multinational mobile companies [1] [2]. Every company is making efforts to produce a best possible solution of location based services for their customers at lowest possible cost. Research shows that the network designers, service providers, vendors and application developers should carefully consider the user requirements in order to introduce attractive location based services into the market [3]. This requires the need of making flexible and robust LBS applications, so that they can decrease the load at network end without adding much to the overall cost.

One of the best solutions of this lies in using the spatial trigger technology. This means that user is provided information services based on his location or movement. A trigger is created whenever a user enters a spatial region or between two moving users, in this case the user gets a prompt with respect to his interests [4]. Spatial trigger technology informs the LBS application whenever a certain condition is fulfilled. When this criterion is fulfilled our LBS application gets notified. An LBS supply chain mainly corresponds to the functionalities of following components namely LBS user, LBS provider, content provider, location data, position originator and the target hand set [5].

1.1 An Overview of Positioning Techniques

An important matter involves the choice between network based and terminal based technology, because it may creates a very immense impact on operators of LBS business [1] [6]. It will affect both the required investment as well as the future control of user data.

Cell ID, Cell-ID/TA, AOA and TOA are the low cost network based positioning techniques whereas TDOA require high cost. E-OTD is mainly used in GSM and it requires measurements from 3 base transceiver systems (BTS) by any other location measurement unit (LMU) embedded within the handset or connected with it as an external unit. In this case the position of mobile station is calculated by comparing the time difference between two sets of measurements [7].

A-GPS is the most advance and accurate network assisted positioning technique that is currently used worldwide for the tracking of precious assets like high value load, shipping containers, etc [7]. This technology is recently introduced in GSM handsets. Table 1 gives a comparison between different positioning techniques in terms of cost, accuracy, enhancement required and coverage [8]. It becomes evident from the table below that technologies having high accuracy require high investments. The key trend in the European and Asian countries at the moment is E-OTD for GSM operators and A-GPS for CDMA operators. But as GSM is used more frequently, so E-OTD is more dominant. AFLT/EFLT is normally use in CDMA based networks. AFLT is normally use as a hybrid with A-GPS technology whereas EFLT is use as a backup technology for non AFLT/AGPS based mobile sets.

Table 1. Positioning techniques their classification and comparison

Positioning Techniques	Characteristic	Cost	Modifications Required	Accuracy (in meters)	Location Area
Cell-ID	Network Based	Low	Network end	100-1500	Limited to within the cell
Cell-ID + Timing Advance (TA)			Network end		
Angle of Arrival (AOA)			Network end	100-500	
Time of Arrival (TOA)			Network end		
Time Difference of Arrival (TDOA)		High	Network end	50-200	Limited to within the country
Enhanced Observed Time Difference of arrival (E-OTD)		Medium	Network + Handset	100-400	
A-GPS	Terminal Based	Medium	Using GPS or any other Location Measurement Unit (LMU)	5-40	Limited in canyon location
Autonomous GPS		Medium		5-40	
Advanced Forward Link Trilateration (AFLT)		Medium		50-200	Limited to within the country
Enhanced Forward Link Trilateration (EFLT)		Medium		250-350	

2. Related Work

Currently most of the researchers have developed LBS applications which can control spatial data but are unable to run automatically [9]. Our proposed friend proximity teller service have the advantage that it is activated automatically using the spatial trigger technology.

The authors emphasize the aptness, suitability, and efficiency of SMS based emergency warning systems in [10]. As a large number of mobile subscribers particularly in Europe use SMS in their daily routine. So, these types of systems are particularly helpful for recovery from different spontaneous disasters like tsunami, earthquake and terrorist attacks. The utilization and complete methodology for designing the autonomous LBS is described in [9], [11] and [12]. Autonomous location based services have the ability of advance decision

making based on the mobile user location without their interruption. A number of problems with the recent LBS solutions proposed by various researchers namely limited interoperation, complex interfaces, static services etc are discussed in [11]. Complex interfaces means that due to small screen size it is difficult for users to focus the useful map information for complicated images. These proposed LBS systems lacks in features like context adaptive behavior, self awareness and self optimizing characteristics. In this context there is a need to develop autonomous LBS applications that not only based on user friendly interfaces but also decreases the load at the network end effectively.

3. Positioning Requests

This is one of the most important concepts that should be considered in designing a server-end application. There are three types of positioning requests as explain below:

3.1 Mobile Terminating Location Request (MT-LR)

In this case, the mobile subscriber himself makes a location request. When an application makes a location request for a particular mobile station to gateway mobile location center (GMLC), the GMLC performs verification and authentication and forwards the request to serving mobile location center (SMLC). SMLC calculates the position of the specific mobile subscriber and sends the result back to GMLC. Finally GMLC forward the calculated result to application (which is the part externally connected with it) as a response.

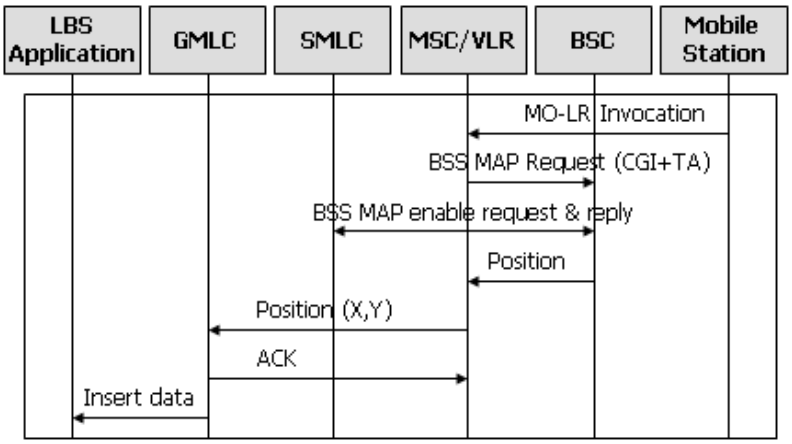

Figure 1. MO-LR Process

3.2 Mobile Originating Location Request (MO-LR)

It is the procedure where the mobile itself triggers the request for location after a specified offset. In this case a mobile subscriber can activate the network to push the positioning data

of the mobile subscriber to a universal resource locator where an LBS application is deployed, it is normally known as MO-LR with push. In a typical MO-LR process the mobile services switching center connected with visitor location register (MSC/VLR) gets MOLR invocation through base station controller (BSC) after a certain time that depends on the traffic condition on a specific handset. BSC sends the cell global identity and timing advance values to serving mobile location center (SMLC). SMLC uses the specified positioning method (in our case it is CGI+TA) to calculate the actual position (latitude and longitude) of mobile subscriber and return them back to BSC through base station subsystem management application part (BSS MAP) request and response. BSC forwards this exact location to GMLC via MSC/VLR. Finally our application gets this value from GMLC as shown in Figure 1.

3.3 Network Induced Location Request (NI-LR)

In this type of positioning request, the location request is initiated by the network which allows positioning for an emergency service call [13].

4. Proposed Framework

The overall infrastructure required to run the services is shown in Figure 2. Mobile station (MS), BTS, BSC and MSC/VLR are all part of a typical GSM network. GMLC and SMLC are the part of Ericsson's MPS (Mobile Positioning System) [14]. As we see that our application runs over the GMLC in MPS-live network. This means that over application is integrated within the GMLC, and communicate with it through signaling system 7 (SS7) protocol. In this way whenever the position of mobile subscriber changes, the GMLC gets the X and Y coordinates of client's position. Our application takes that position and updates the database. A web interface is designed to use the web based tracking service.

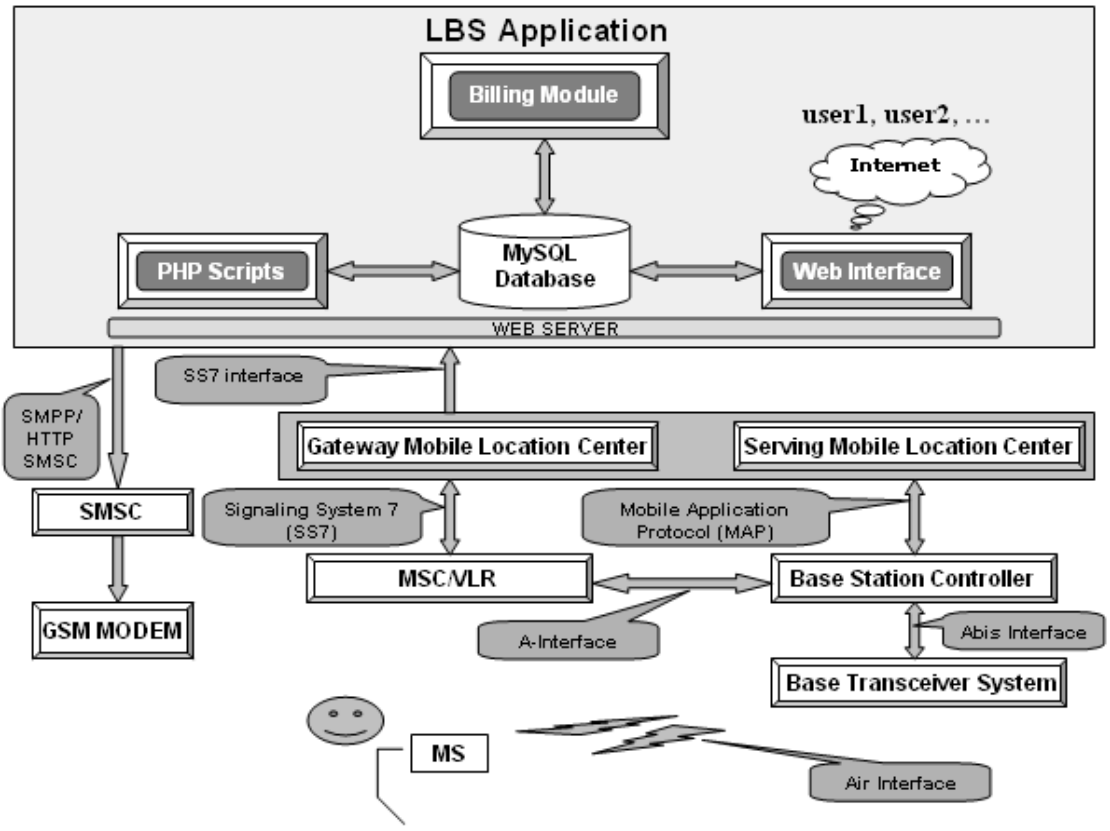

Figure 2. Mobile Information System Designed Framework.

Our LBS application is connected with an external handset through NowSMS® Gateway i.e. acting as an Inter short messaging service center (SMSC) Gateway. This SMSC requires a TCP/IP (Transmission control protocol/ Internet protocol) connection over the internet or private network with a service to send and receive SMS messages. This connection is provided by the short message peer to peer protocol (SMPP) or hypertext transfer protocol (HTTP) SMSC protocols that are configured in NowSMS® Gateway (SMSC).

By this way, we send and receive our requests and responses to clients. As shown in the Figure 2, the web interface, PHP (Hypertext Preprocessor) scripts and billing module all are connected with a central database management system (DBMS) that is created in MySQL. The updated values about the location of all the customers are stored in the database. Billing Module controls the charging of all services by deducting the specified amount from the user's account.

5. Services Launched

Today highly efficient softwares and systems are designed which helps in simulating the behavior of the overall live communication network. Once the LBS applications are successfully tested using these simulation tools, they can be deployed confidently over the

underlying live network. In this scenario, the freely available Ericsson Mobile Positioning System (MPS) provides a positioning gateway interface [15], through which our application communicate with GMLC and get location information whenever it is updated for a particular mobile user. The formulated LBS application is acting as an integral part of GMLC. All the triggers criteria's are defined inside the GMLC as it keep tracks on the position of all mobile subscribers.

5.1 Location Based Friend Proximity Teller Service

Considering the case of friend proximity teller service, our LBS application keeps monitoring the location (lat & long values) of all subscribers of this service. Whenever the distance between two friends satisfies the trigger criterion (i.e. less than 1 Km) an alert notification as an SMS is sent to both subscriber's that mentions the distance and direction of the other one. It is worth noting that we have simulated this service between a maximum numbers of three subscribers. This means that each user can use this service with a maximum numbers of two friends.

When this service becomes activated an initial messages is send to all clients that request them to reply with this format "FFS: MSISDN (Mobile Station International Services Digital Network) of 1st friend: MSISDN of 2nd friend" for the subscription of this service. Once the user replies with the specified format the database is updated and a spatial zone is defined around the subscriber of this service. PHP scripts run sequentially and check every incoming location of mobile subscriber, his subscription and calculate his distance and direction with his friend. If his subscription is valid and the distance satisfies the trigger criteria (i.e. is less than 1km), then our scripts send a response (as SMS) to the specific subscriber through the GSM modem as shown in Figure 3.

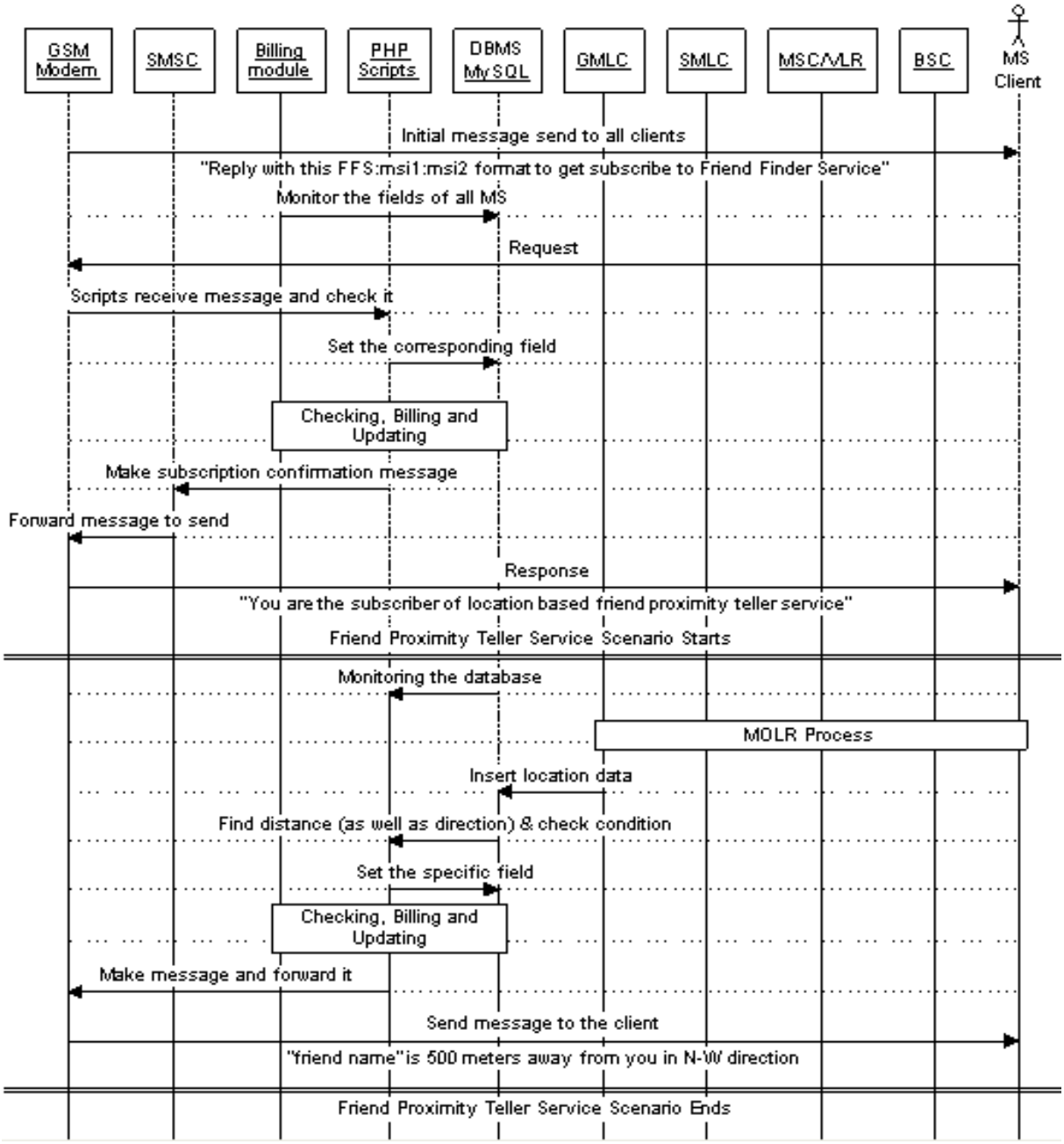

Figure 3. Message sequence flow in location based friend proximity teller service.

The overall framework for this service is divided into three modules for simplification; these are described as the user, server and billing module as follows:

5.1.1 User Module

It is worth mentioning that each user has to subscribe for this friend proximity teller service in response to a request that mention the format of response for subscription of this service. Once a user gets subscribed; he will receive timely alerts based on his friend location.

5.1.2 Server Module

This is the part where the recent position of all subscribers is stored and distance is calculated based on the specified criteria. Once the trigger criteria become fulfilled our application gets notified automatically and in response a distance is calculated and sends onto the customer handset.

5.1.3 Billing Module

This module is one of most important feature as it equipped over application with instantaneous billing capabilities. Whenever a user subscribes for a particular service or uses it, the billing flag becomes set corresponding to that particular user, in response our billing module becomes activated that deduct the specified amount and reset the flag as shown by checking, billing, and updating process in Figure 3.

This service is based on the spatial triggers but here it is between two moving objects. This service can be used among mobile subscribers through mutual understanding. So that when they come within a specified distance (1Km or whatever specified) from each other they automatically get aware by the message generated by our application to prompt the subscriber about the proximity of his friend. One of the most important characteristic of spatial triggers is that the reporting is event based. This means that whenever a particular event takes place the LBS application invoke the subscriber by a sending an alert to him.

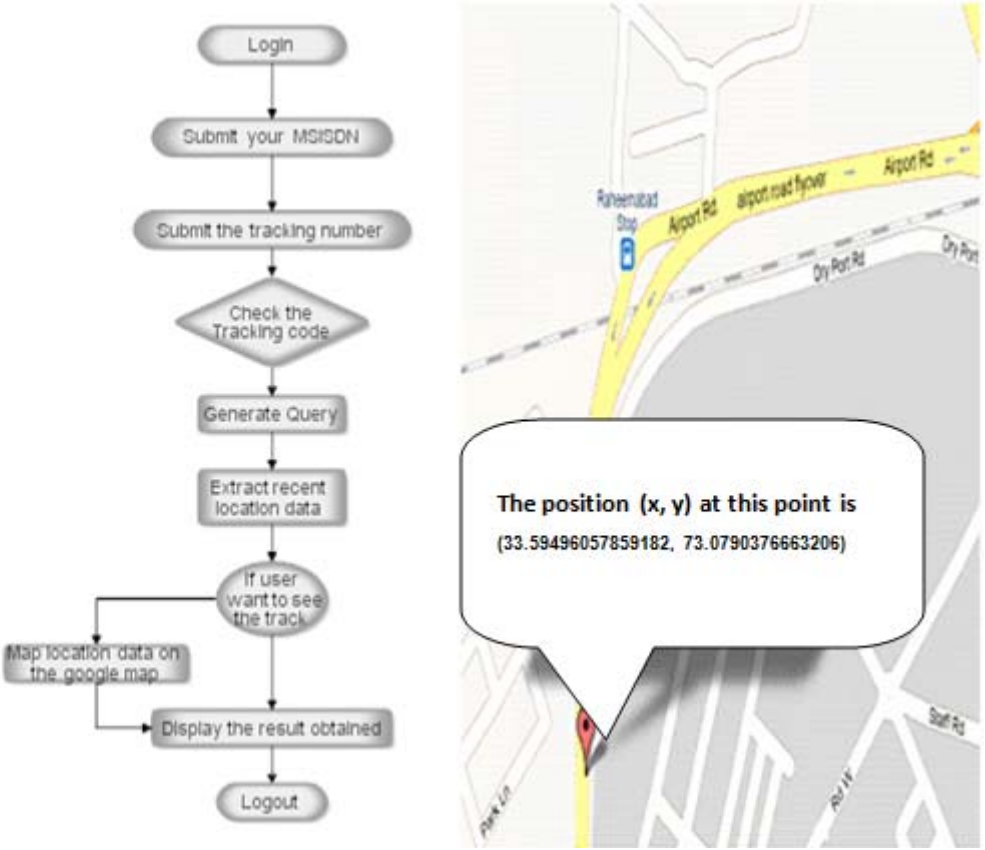

Figure 4. Web based tracking service.

5.2 Location based Web tracking Service

A web interface is designed, so that every customer has allotted an account. After signing in the account, when one submits his MS-ISDN a 9-digit tracking code is allocated to him. Now if someone wants to track his friend he should know his tracking number. In this way, the tracking number is an individual property of every person and this can only be known to others by conversation with that specific person or with the authority of that person. When someone enters the tracking number of his friend the live position of his friend comes on the map that alters with the change in his position. A general use of these services can be implemented for enterprises which need to monitor their employers in task involving mobility and to know about their progress [16]. This service is particularly useful for parents who want to track their children. Thus, they can track their children and check their daily activities by just entering their tracking code.

6. Conclusion

This system provides better features as compared to LBS applications provided by many service providers. It provides a cost-effective solution for multi-national vendors to give LBS to their customers. The present framework of mobile information system is simulated and works fine with GSM network in Pakistan. It is hoped that it will work comfortably with all others types of mobile networks. The paper, presents a smart solution that is compatible with all types of networks. We have used JAVA and PHP scripts that keep on running at the server-end, and by doing slight modifications in them; a variety of other applications can be developed. Besides all these, we have also built up a client-server billing module that provides real time payments of these services. The use of spatial trigger technology in these services plays its effective role in decreasing the load over the network end [4].

7. Future Work

This paper is the second one written in continuation of our research project “Mobile Application development for LBS”. As mentioned earlier, aside from the two services presented above, the proposed mobile information system framework can be used to develop a variety of other LBS applications as well. So, our future work is to develop more applications over the present mobile information system (MIS) framework by making some modifications in it. The next focus is to implement more LBS applications on Symbian OS based mobile phones. This mainly involves programming in Symbian C++ using the carbide IDE and examines it on the GUI of s60 emulator.

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