Provision of Targeted Push Location Based Services

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Abstract. This work presents a solution that allows the provisioning of a Location Based Push Service. The developed work appears as an answer to the lack of Push Services that exists in the current market. This solution is non intrusive, allowing the user to subscribe the reception of the service and define his own preferences, so that the distribution of information is as targeted as it can be. This solution allows users to receive in their cell phones a service that is based on their location and interests and that is not directly requested by them, as opposite to the typical Pull Services.

Keywords: LBS (Location Based Services), mobile communications, Push Services, UMTS (Universal Mobile Telecommunication System), Parlay X.

1. Introduction

The possibility of locating mobile devices, such as cell phones, brings up a wide universe of applications and services that can be delivered. This class of applications and services is commonly denominated as Location Based Services (LBS). LBS can be defined as informational services that use location information and can be accessed through mobile devices connected to a mobile network [1]. There are two distinct types of LBS [2]:

- **Pull Services**: services or information are delivered when they are directly requested by the user.
- **Push Services**: services or information are delivered without being directly requested by the user. Push Services are usually activated by an event that occurs when a user enters a certain area. This kind of services are typically harder to establish because they are not related with a direct interaction from the user.

Because Push Services are so difficult to trigger, most of the LBS delivered in the present time are Pull Services. As a matter of fact, the currently existing Push Services do not meet user’s needs. This problem was the main driver for this work. Three critical success factors for the provision of a Push LBS were identified:

- **Global**: most of the times LBS do not reach general population since they rely on not so common technologies.

- **Availability**: the technology used to provide a LBS is not always constantly working on the more frequently used mobile devices (mobile phones, PDAs and Smartphones) and, most of the times, user interaction is required to activate them.
Accessibility: Most of the technologies used to provide Location Based Services are only accessible in specific conditions as they are very dependent on the size or coverage of a certain area.

The main objective of this work is to define and specify a comprehensive and modular solution that supports the provision of a Targeted Push Location Based Service in specific areas, regardless of the type of space (closed/open, small/large) in which the user is. Thus, the solution should provide a service where a user, when entering one of the specific areas, receives an informational service accordingly to its present location and his previously defined preferences. In order to achieve the determined objectives, the following requisites where identified: the user does not have to directly request for the information; the distribution of information should be possible in different areas (small or large) and different environments (indoor and outdoor); the user must be able to select his interests and receive a service accordingly to those interests.

There are many technologies which support the location of terminal devices each one with different advantages and disadvantages. Technologies such as Infra-Red, Ultrasounds, Radiofrequency, Bluetooth and Wireless LAN (WiFi) are short range technologies and therefore are not suitable for the spatial requirements of this solution. The Global Positioning System (GPS), despite being a very precise technique, cannot be used indoors and, the mobile network techniques are usually quite inaccurate. However, this last technique has the advantage that it can be used in different types of spaces since the coverage of mobile networks is substantial.

Parlay X is a set of open telecom Web Service standards defined by the Parlay Group, a multi-vendor consortium formed to develop open, technology independent APIs that enable the creation of applications operating across multiple, networking-platform environments [3]. The purpose of these Web Services is to allow the use of mobile network capabilities in a simple way when developing applications. This allows that both mobile network operators and external providers develop, with ease, new telecommunications services. Two of these Web Services are Terminal Location and Short Messaging which allows the reception of location notifications, when a mobile phone enters a certain area, and the sending of Short Messages (SMS) to the user’s mobile phone.

2. Related Work

As stated in the previous chapter, there is more than one technology supporting location techniques. The Parlay X Web Service of Terminal Location uses all location techniques that the network has available. In worst case scenario, this Web Service will use the basic Mobile Network Location Technique.

2.1. Short Range Location Techniques

Short range location techniques are generally used in small spaces. Thus, this type of techniques is often used in classrooms, laboratories, hospitals and other small spaces where location can be accomplished in a short range [4].
2.1.1. Infra-Red Location Technique

In this technique, users wear devices, called as badges, which emit a unique Infra-Red (IR) signal (ID code) via an infrared transmitter at a regular interval. Infrared sensors placed throughout the building pick those ID codes and communicate with the location software to determine user’s location. Positions of the placed infrared sensors are previously known and the location of the user is determined by proximity to the sensors. The advantage of IR technology is that IR emitters are quite cheap. Its drawback is that it requires visual line of sight to function properly and it is limited to small spaces.

2.1.2. Ultrasound Location Technique

As the Infra-Red Location Technique, Ultrasound transmitters, known as beacons, transmit signals to receivers placed on known positions. Three receivers take the time of propagation of the ultrasound signal transmitted by the badge and, using triangulation, the position of the receiver is calculated. This technique has the disadvantage of being limited to small spaces as a line of sight is again needed.

2.1.3. Radio Frequency Identification (RFID)

In this technique, users with reflectors (Passive) or transmitters (Active) emitting a low power radio frequency signal can be detected by known receivers in the building. A transmitter normally emits a unique identifier code named radio frequency identification (RFID). If two or more receivers receive RFID signal, the user’s location is then calculated via triangulation. Radio Frequency technology has the advantage of not requiring line-of-sight. However, the strength of the signal depends upon the density of objects present in the building and hence accuracy is limited.

2.1.4. Bluetooth

Another way to locate mobile terminals through radio is using Bluetooth. Bluetooth allows the creation of local wireless networks. The big advantage of using Bluetooth is that it is embedded in many mobile terminals that are used frequently (mobile phones, smartphone, PDA). Each Bluetooth device has a unique ID (identification) that allows the calculation of mobile devices through one or more recipients.

2.1.5. Wireless LAN Location

In a Wireless Lan (WiFi) connection, wireless routers emit 802.11 radio frequency signals to Wireless devices. These signals can be used to determine precise location of any WiFi enabled device, such as laptops, PDAs or smart phones. This technique has the advantage of using a technology that is present in a significant amount of mobile devices. However, wireless communications are very energy consuming which is a big problem in mobile devices.
2.2. Global Positioning System (GPS)

Among all above systems, global positioning system (GPS) gives high accuracy and accurate precision. It is a worldwide radio-navigation system consisting of a network of 24 satellites in six different 12-hour orbital paths spaced so that at least five are in view from every point on the globe and their ground stations. GPS uses these satellites as reference points to calculate positions, through triangulation, accurate to a matter of meters. This technique has the big disadvantage of being limited to outdoors.

2.3. Mobile Location Technique

Cellular networks have to keep track of all handsets and be able to send incoming calls to any requested mobile phone. Cellular networks consist of thousands of overlapping, individual geographic areas called as cells, each with a base station. The size of the cell depends on the area of coverage that is needed and number of calls made in that area.

Mobile positioning in cellular networks can be calculated either at the network end or at the device end of the user (mobile phone). Locating the mobile phone of a user by the network requires the geographic identification of the cell that the user is in. This is not very accurate and, one way to improve accuracy is by making measurements of the distance to the phones from one or more base stations. In device-centric techniques, cell phone itself makes the calculation based on the information gathered from base stations. The latter will require additional software and hardware to install in mobile phones but gives more accuracy than network-centric based localization.

This technique, despite not being very precise, has the important advantage of being available in almost every area (small/large, indoor/outdoor).

2.4. Parlay X

The Parlay X Web Services is a standardized set of interfaces that define various high-level telecom web services. Telecom web services allow developers to create value-added applications using, in a very easy way, mobile network capabilities such as Terminal Location and Short Messaging. This allows that both mobile network operators and external providers develop, with ease, new and innovative telecommunications services. With Parlay X Web Services, application developers can focus on program logic, instead of focusing in network communication details.

The use of the Parlay X Web Service of Terminal Location allows using any location technique supported by the mobile or the network. In worst case scenario, it will be used the basic Mobile Network Location Technique which is not very precise but has really good coverage. This web service allows registering areas (using a pair of coordinates and a radius in meters) and users in those areas. This way, when a user enters one of the areas where he is registered, a notification will be sent with users location. The Short Messaging Web Service allows sending of Short Messages (SMS) to mobile phones.
3. Architecture

![Figure 3-1 - Modular Representation of the Architecture](image)

The provision of Push Location Based Services could be provided on both GSM (Global System for Mobile Communications) and UMTS (Universal Mobile Telecommunication System) Networks. However, being UMTS an evolution of GSM, it presents itself as the most promising technology in the area of mobile communications. Thus, and considering that this architectures are slightly different, for the purpose of this study, UMTS network architecture was used as support for push services delivery.

3.1. UMTS Network

The provision of services is realized using the UMTS network. Thus, it is not a component of the architecture to develop but the network that supports the provisioning of Push services and therefore it is represented in gray. It will be given importance only to the UMTS network components that interact directly with the components of the proposed architecture.

3.1.1. UMTS Terrestrial Radio Access Network

This component (UTRAN) corresponds to the radio access network of an UMTS network. It is through the UTRAN that the connectivity between the mobile terminal and the Core Network is established.
3.1.2. UMTS Core Network

It is in the core network that data flows, required for the operation of an UMTS network, are transported. This network consists of the following components relevant to the solution architecture:

- **Parlay X Web Services Gateway**: server that implements Parlay X Web Services and allows access, via Web Services, to network capabilities.
- **Gateway Mobile Location Center (GMLC)**: Provides an interface that allows exchange of information about mobile phones location.
- **HomeSubscriber Server (HSS)**: Contains information about the subscribers such as their identity, location and registered services.
- **Serving GPRS Support Node (SGSN)**: works as a router for data transfer, keeping a local copy of mobile phones registered in an area

3.2. Push Service Server

The Push Service Server is divided into three components: Data, Logical and Presentation. The component of communication presented in Figure 3-1 is, in fact, also included in the Logical Component. However, it is presented separately as a way to distinguish different calls to Parlay X Web Services: Location and Short Messaging.

3.2.1. Data Component

This component contains the Service DB database, needed to run the Push Service Server. This database contains all data on the client, areas and services use on service provisionig.

3.2.2. Logical Component

All the logic of the Push Service Server is performed in this component. The main objective of this component is, through the use of Parlay X Web Services, register different areas and users on the Parlay X Web Services Gateway so that location notifications can be received when a user enters one of those areas. These notifications are used to send a service that is related to both the area where the user is and his interests. This component is divided in three distinct sub-components:

- **Notification Manager**: registers areas and users in the Parlay X Gateway and waits the reception of location notifications. When a notification is received, the mobile phone number and the area identification corresponding to the notification are sent to the Interests Manager.
- **Interests Manager**: identifies, according to users interests, which is the best service to provide and sends the service identification to the Content Manager
- **Content Manager**: gets the content of the service using the service identification and sends an SMS, with the selected content, to the user’s mobile phone.
3.2.3. Presentation Component

The presentation Component represents the graphical interface that allows the configuration of service deliver by administrators and users. This component is divided into two parts:

- **Client Web Application**: allows the client to change his interests regarding the reception of information.
- **Administrator Web Application**: allows the management of areas and services and the relation between them.

4. Implementation

By implementing a solution compliant with the defined requisites, the main objectives were met. The implementation was divided in development and testing of all the components described in the Push Service Server architecture.

4.1. Data Component

The data component contains all information about areas, users and services as well as a history of services provided. The data base was implemented using MySQL that allows data base management and uses SQL (Structured Query Language) language as interface.

4.2. Logical Component

The Logical Component is the basis of the presented solution. It is composed by the Java classes NotificationManager, InterestsManager and ContentManager that correspond to each of the three sub-components of the Logical Component. In addition to these three main classes, there is the Properties class that is responsible for reading the configuration file that contains global information needed for the location notifications, SMS sending and data base connection. Finally, the class ServiceServer is responsible for managing all other classes.

The Java programming language was used as well as Eclipse, an Open Source IDE (Integrated Development Environment). An Ericsson SDK, the Telecom Web Services SDK, was also used as it provides a library of Java components that simplifies the use of Parlay X Web Services, allowing the use of simple plain Java in application development. This SDK also provides an emulator (Parlay X Network Emulator) that simulates mobile network capabilities and allows simple and quick application testing and demonstration [5].

The two java components of the SDK used to access the Parlay X Web Services of Terminal Location and short messaging were the StartGeographicalNotificationBean and the SendSMSBean [6].
4.3. Presentation Component

There are two distinct interfaces in the same web application: one for the users and another for the service administrators, depending on the entity that authenticates.

Java and Eclipse were again used for the development of this component. GWT-Ext was also used as it provides a powerful library of components for Web applications such as tables, grids, forms, text boxes and menus accessed through a simple API (Application Programmer Interface). GWT-Ext uses GWT (Google Web Toolkit) and Ext 2.0.2.

5. Solution Evaluation

The evaluation process consisted of a set of tests that are divided into three groups: Integration Tests, Usability Tests and Performance Tests.

5.1. Integration Tests

In order to validate the main functionalities of the implemented solution, integration tests were defined. The activities defined were setting interests, area identification, service identification, creation and sending SMS.

- **Setting Interests:** the objective of this test was to simulate the change of interests by the user. By evaluating this activity, it was intended to prove that it is possible for the user to set and change his interests and that they are properly stored in the database so they can be used by the Interests Manager.

- **Area Identification:** the objective of this test was to verify that, with a reception of a location notification, the correspondent area identification is properly determined (since a notification only has coordinates). With the completion of this test it was intended to prove that an area is correctly identified when a user enters a zone of interest.

- **Service Identification:** the objective of this test is to identify a service to send to a user that has entered in a registered area. With the completion of this test it is intended to prove that the Interests Manager identifies a service to send that is related to user’s location and interests.

- **Creation and Sending SMS:** the objective of this test is to get the content to send to the user, form an SMS and order SMS sending. By evaluating this activity, it was intended to demonstrate that the content manager can create and send a SMS message accordingly to the service identification made by the Interests Manager.

5.2. Usability Tests

The usability tests were conducted in order to prove that the solution meets the objective of the users can set their interests in a simple way. The tests were made in a universe of 40 people with a time limit of 10 minutes and the objective was the
definition of interests. In the end, a questionnaire was presented to all participants. An answer was considered satisfactory when it was above Medium (options were Very Good, Good, Medium, Bad, Very Bad). The percentages of satisfactory answers for each question were:

<table>
<thead>
<tr>
<th>Question</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use ease</td>
<td>92.50%</td>
</tr>
<tr>
<td>Presentation</td>
<td>47.45%</td>
</tr>
<tr>
<td>Information Organization</td>
<td>82.50%</td>
</tr>
<tr>
<td>Titles and Names Consistency</td>
<td>87.50%</td>
</tr>
</tbody>
</table>

As it can be observed, only the question about presentation had most answers below accepted values. However, presentation is not an essential requirement for this application because it does not prevents a user from easily change his interests.

5.3. Performance Tests

While the speed of the solution is not a critical requirement, it is important to know how long it takes to deliver the service in order to ensure that it is delivered in time (while the user is still in a registered area). Performance tests were realized over the Push Service Server 100 times.

In all tests, the Push Service Server never took more than 1 second to identify and send a service to a user who has entered a registered area. In most cases, it took just about half a second, concluding that a service can be sent by the Push Service Server in a short period of time, with very high probability that the user is still in the area where the notification occurred.

6. Conclusions

After a study of the definition of Location Based Services (LBS) it was observed that there is no satisfactory provision of Push LBS. Such a service, to succeed, must be able to: reach as many persons as possible (Global); be performed on a technology that is always active and available to users (Availability); and be distributed in any area where the user is (Accessibility).

After a survey of key location technologies, a architecture of a solution that supports the provision of targeted Push LBS over UMTS was defined. This architecture has led to the implementation of a solution that allows the reception of location notifications and sending of SMSs that are related to user’s location and interests by using Parlay X Web Services to access network capabilities (Terminal Location and Short Messaging).

In a last analysis, the tests that were performed to evaluate the solution allowed to justify the realization of this work were the proposed objectives were achieved with success.

In conclusion, the presented solution provides a service that brings innovation in the provisioning of Push LBS and brings interesting points both to users (which receive information according to their interests) and content providers (that have an
opportunity to provide a new informational service). This study was conducted in a business environment, in Movensis, allowing me to get knowledge that I believe it was important to carry out this work.

6.1. Future Work

The main aspect which should be taken into account is that currently, in Portugal, there is a high level of confidentiality about mobile operator’s networks, which makes the implementation of solutions like the one proposed very hard to accomplish. By the present time, the utilization of network capabilities is exclusive to the operator and not accessible to external providers. Nevertheless, more and more operators over the world are starting to use Parlay X Web Services and allow external service providers to develop applications using these Web Services. Another solution for this problem is to create a partnership with mobile operators and negotiate the terms for developing an application like the one proposed.

Lastly, is important to refer that, despite the tests that have been made to evaluate the application, it is important, when possible, to test the solution in a real mobile network where total time of service provision can be measured.

References


