

# An Approach to Standardize Mobile and Immobile Location-based Services: An Application based on Mobility and Geo-location

El Kindi Rezig<sup>1</sup> and Valérie Monfort<sup>2,3</sup>

<sup>1</sup>University of Science and Technology –USTHB, BP 32 EL ALIA  
16111, Bab Ezzouar, Algiers, Algeria

<sup>2</sup>Université de Sfax, MIRACL, Sfax, Tunisie

<sup>3</sup>Université Paris 1 Panthéon Sorbonne, 90 rue de Tolbiac 75634 Paris cedex 13, Paris, France

**Abstract.** Location-based services (LBSs) are being increasingly popular due to their usefulness in users' daily life, their applications include location-based advertising, location-based shopping...etc, however today's LBSs often relate to a fixed geographic location. Unlike immobile LBSs, mobile LBSs are moving services that have a changing geographic location, their applications include mobile hospitals, ambulances, mobile libraries...etc. In addition, today's LBS applications are provider-specific and can't (generally) cohabit with other LBS applications from other providers, consequently, consumers have to use different platforms and applications in order to discover and interact with different LBS applications. In our paper, we present an infrastructure based on geo-location and Web services to promote the uniformity of the way mobile and immobile LBS providers publish their services on one hand, and the way consumers discover and interact with the LBSs they look for on the other hand. Moreover, the proposed infrastructure is context-aware and promotes dynamical services accessibility by offering consumers, as they are moving, the nearest services they are interested in.

## 1 Introduction

Location based services (LBSs) [1] are offered through devices with location capabilities such as mobile phones, GPS devices...etc. These services include a wide range of applications such as looking for the closest restaurant, finding someone,...etc. LBSs have become a lucrative business for both wireless carriers and developers of location-aware applications. Today, LBSs have become part of users' everyday life, using several media as: mobile phones, PDAs...etc to find the closest clinic, to do bank transactions...etc, most of today's LBS providers propose immobile services such as restaurant, bank,....., these LBSs relate to a fixed geographic location, we called them immobile LBSs. Since a lot of services are being mobile such as libraries, hospitals, transportation...etc, it would be useful to propose mobile LBS applications that change continuously their location as they are moving. These mobile and immobile LBSs should be discoverable and consumed by clients.

Geo-location is the cornerstone of this research work. Geo-location aims to locate a user, an object, a data ... on a map with geographical coordinates. This operation is possible using a device able to be located (GPS, ...) and to publish (on real time for instance) the geographical coordinates. The location can be seen on online maps using laptops, PDAs, Mobile phones...

Moreover, we noticed that Service Oriented Architecture (SOA) [2] offers a great flexibility to Information Systems (IS) because each application owns interfaces masking implementation details. So, applications own interfaces including services and are seen as black boxes independently connected to a middleware as Enterprise Application Integration bus (EAI) with its connectors and adaptors. Moreover, Web services are based on standards and are till now the cheapest and simplest solution to support interoperability between platforms. Based on Web services, Enterprise Services Bus (ESB) [3] [4] is a kind of services Web based EAI and allows loosely coupling with low costs. However, even if Web services offer technical connection means for interoperability, they address neither adaptability nor context aware adaptability.

This paper presents a concrete design and implementation of context awareness for mobile users and an improved platform to standardize the discovery, interaction and publication of LBSs, We mainly used Web services and Microsoft .NET 3.5 to achieve this. We shall process as follows, The second section introduces Web services. The third section presents LBS. Section four proposes a case study. Section five shows a new model to describe LBSs using GML. Then, Section seven shows discusses the approach's implementation.

## 2 Web Services

Web services [5], like any other middleware technologies, aim to provide mechanisms to bridge heterogeneous platforms, allowing data to flow across various programs [6]. The Web service technology looks very similar to what most middleware technologies looks like. Consequently, each Web service has an Interface Definition Language, namely WSDL (Web Service Description Language) [7], that is responsible for the message payload, itself described with the equally famous protocol SOAP (Object Access Protocol) [8], while data structures are expressed by XML (eXtended Markup Language) [9]. Very often, Web services interfaces are stored in UDDI (Universal Description Discovery and Integration) registry [10].

In fact, the winning card of this technology is not its mechanism but rather the standards upon which it is built. Indeed, each of these standards is not only open to everyone but, since all of them are based on XML, but it is also pretty easy to implement them for most platforms and languages. For this reason, WS are highly interoperable and do not rely on the underlying platform they are built on, unlike many ORPC (Object Request Procedure Call). Web services standards are gathered in WSA (Web Service Architecture) [5].

Geographical discovery of services has improved users' everyday life dramatically, and it has made people' life easier, services include road navigation, geographical social networks, ...etc, such solutions already exist today and they are being increa-

singly popular for their big usefulness, however most of the existing geographical solutions are vertical, meaning that they are vendor-specific and can't live in the same environment because of their heterogeneity. Having Web services that can express their offers geographically improves drastically the capabilities of today's Web services, in fact, customers will be able to search for them geographically and according to their location constraints. Moreover, Web services resolve the problem of the geographical services heterogeneity.

Our goal is to design and implement a location-aware system that takes advantage of Web services with geographical capabilities, our system is able to deliver the services that the client looks for according to his current location, we mean the nearest services to the client.

### 3 Towards a Homogenous LBSs Environment

Location based services application can be described as applications that are dependent on the user's location in order to work. In other words LBS applications give information based on the device's geographical position [11]. LBSs can be divided into two categories as: Triggered and user-requested. In the triggered category, LBS relies on a certain condition to be met in order to retrieve the user's position and use it in the location-aware application, for example, when a vehicle has an accident, an automatic emergency call with the vehicle's position would be triggered. In user-requested LBS, users transmit their current location to have relevant information like driving directions, finding the nearest shopping malls...etc. LBS services can be mobile or immobile depending on the application.

Many efforts are in progress to standardize LBSs, the most popular LBS standard is OpenLS [12] defined by the Open Geospatial Consortium (OGC), it offers implementation specifications to the most critical parts of LBSs. Unfortunately, the current methods of designing LBS applications are not enough to get the most of LBS applications using open standards. This limitation is addressed in our paper using SOA and GML.

#### 3.1 LBSs Concerns Stack

Location based services providers increasingly worry about the visibility of their services to potential consumers, unfortunately because LBSs are provider-specific each editor has a discovery policy through which consumers can find it. Moreover, providers of LBSs may use different ways to access and interact with their services. Eventually, LBS providers have different ways to describe their services in terms of their locations and how to interact with them. To express all the aforementioned features we defined a three-layered stack. Layers are aspects that LBSs are concerned about: Discovery, Description, Access.

When every provider offers a different stack, users wouldn't be able to discover it as long as they aren't sticking to the provider's discovery policy; The same issue is

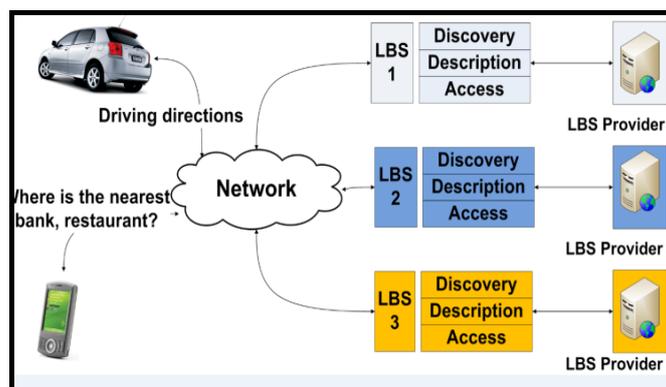


Fig. 1. LBS providers in a heterogeneous environment.

applicable to the access and description policies. The following Fig.1 shows the scenario where every LBS provider defines its own concerns stack

In order to improve the aforementioned situation, each LBS provider should stick by the same concerns stack, this following way. All LBSs use the same discovery, services description and access policies. By having this scenario, LBS providers share the same platform between each other, this helps maximizing their visibility, and consumers would have more choices to pick the most convenient LBS. In order to achieve an homogenous LBS environment, we have used Web services as they are the best way to make heterogeneous environments interoperable. Each LBS is a Web service, and with Web services we can associate standardized items to the three layers of the concerns stack as follows:

**Discovery:** We use the UDDI registry to publish and discover all LBSs.

**Description:** Descriptions of LBSs is done through the Web service's WSDL, geographical description is done through the Web service's GML profile (explained in section 5).

**Access:** All interactions with the Web services are done with SOAP.

Web services are the fitted solution for flexibility to changes and interoperability but as mentioned in previous related works [13] , [14], [15] they do not offer (context aware) adaptability.

The following Fig.2 shows the LBS providers in a homogenous environment:

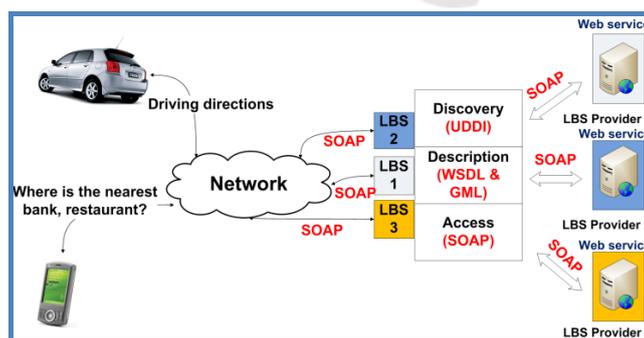


Fig. 2. LBS providers in a homogenous environment.

## 4 Case Study

### 4.1 Context

Users can ask for geographical services (LBSs wrapped in web services) via a UDDI registry. They can also use their cars, and, while driving, ask for the closest services as banks or hospitals, ... Since all the LBSs are Web services, users can interact with these services using the WS's WSDL and the WS's GML profile.

### 4.2 Technical Architecture

#### 4.2.1 First Scenario: User Accesses Geographical Services (LBS Application Wrapped in Web Services)

Let us focus on the LBSs accessibility. Fig. 3 shows two parts as client and server sides. On the client side, the user is detected by different kinds of devices to determine his location and the area corresponding to his location. Then, on the server side, a specific interface (as a gateway) provides a mapping between the area and the services corresponding to this area.

#### 4.2.2 Second Scenario: An Actor Publishes Geographical Services

This second scenario explains how to reach the UDDI registry and the correspondence between an area and a service. Then, for instance, a bank manager wants to inform potential users that his bank offers a set of services as ATM. He can ask for a service provider to subscribe an account. A contract is signed between the bank and the service provider with financial engagements. The service provider proposes a GUI pattern as a form, to be fulfilled by the bank manager to promote bank services. So, the publisher gives the Web service WSDL as well as its GML (Geography Markup Language) profile that geographically expresses the Web service. GML is an XML grammar that expresses geographical information, ranging from complex graphical representations to simple points representations, GML has been defined by the Open Geospatial Consortium (OGC). GML can also serve as an interchange format for geographical data. The accuracy of this language has led us to choose it in order to describe geographical information.

The bank manager uses the Publication module and the service provider defines the link between the services and the area including bank via UDDI Publish Interface and then via UDDI registry. Then, this module is in charge of the communication between the publisher and the UDDI registry, it publishes the information the publisher gives but most importantly, it associates the GML profile to the publisher's Web services via tModels. A tModel is a data structure representing a service type (a generic representation of a registered service) in the UDDI (Universal Description, Discovery, and Integration) registry. Each business registered with UDDI categorizes all of its Web services according to a defined list of service types. Businesses can search the registry's listed service types to find service providers. The tModel is an abstraction for a technical specification of a service type; it organizes the service

type's information and makes it accessible in the registry database.

For every published Web service, the publish module publishes a tModel that holds the GML profile information. This tModel will be used in the geographical discovery.

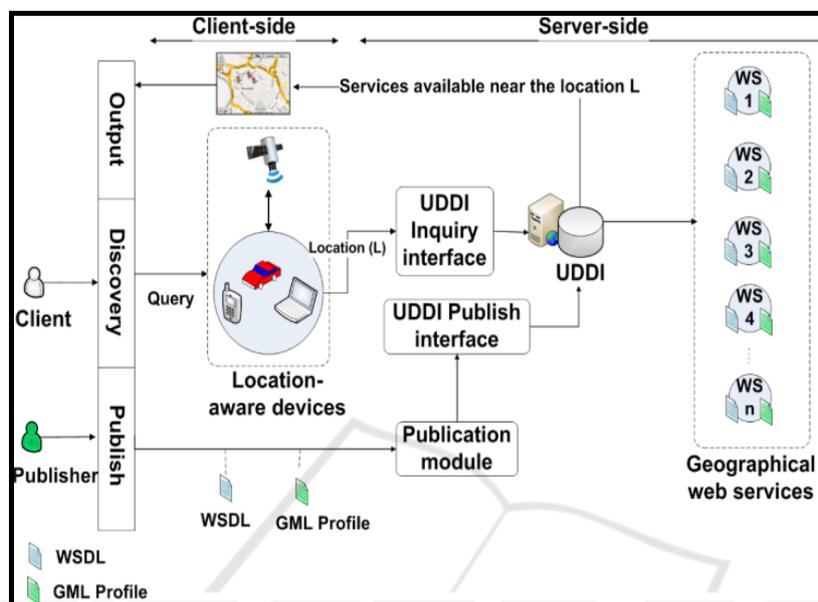


Fig. 3. Technical architecture.

## 5 A New Model to Describe LBSs using GML

### 5.1 The Web Service's GML profile

LBS providers must have a standardized way to describe their services geographically. Since most today's geographical description means are proprietary. We had to find an open standard to associate the geographical description to LBS applications efficiently. The most suitable choice to accomplish this task is GML.

Each Web service proposes a set of services that are located geographically and associated to the Web service operations. In order to express these settings, a profile must be added to the Web service in order to enumerate its geographical services and their details such as their names, operations.... We defined a profile based on GML, this profile is part of the description layer of the LBS concerns stack presented previously. It is presented as an XML document that uses the GML namespace in order to express the name of the entities through the element Gml:Name, and, most importantly, their location through the elements: Gml:Point, Gml:Pos. This profile is called a GML profile.

## 6 Implementation

### 6.1 Applicative Architecture

#### 6.1.1 Overview

The Windows 7 sensors and location platform has brought a tremendous facility in developing location-aware applications in the Microsoft .NET platform, while most existing location platforms today are vendor-specific, the Windows 7 sensors and location platform defines a uniform model for location devices, each sensor respecting this model will enable developers to handle it without worrying about the implementation details of the sensor's driver. In order to simulate a GPS receiver we use a virtual location sensor: Laptop Lojack[24], an open source virtual GPS ready to work with the Windows7 sensors and location platform.

We implemented the system as a WPF application since it offers rich and intuitive GUIs that are convenient to any user. The Windows Presentation Foundation (or WPF) is a graphical subsystem for rendering user interfaces in Windows-based applications. WPF, previously known as "Avalon", was initially released as part of .NET Framework 3.0. WPF is built on DirectX, that provides hardware acceleration and enables modern UI features like transparency, gradients and transforms. WPF provides a consistent programming model for building applications and provides a clear separation between the user interface and the business logic. We chose Microsoft .NET 3.5 for the development environment, for location awareness we used the Windows 7 sensors and location platform to make the application location-aware. To interact with UDDI registry we used Microsoft UDDI SDK. As UDDI registry, we used jUDDI [16]. The Fig.4 shows the applicative architecture of the system. The storage layer presents the persistent entities of the system. jUDDI is an open source Java implementation of the Universal Description, Discovery, and Integration (UDDI v3) specification for Web services. This project is under the Apache foundation. The core layer shows back end applications.

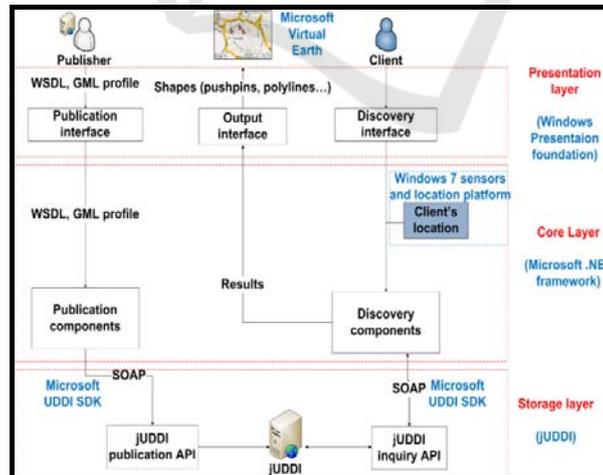


Fig. 4. Applicative Architecture Overview.

## 7 Future Works

We would like to find a more fitted solution to query geographical descriptions (GML profiles) of web services representing LBS applications, since quantity of information within GML profiles may become enormous rapidly, parsing them might be a slow process, and therefore, we should work on improving the performance of this process.

We would also like to add composition capabilities between the web services of the LBS applications, this way, all the composition of the LBS would be done through open standards and without the need of additional technologies and policies.

## 8 Related Works

Several research works aim to use meta modelling such as [17], [18], [19], [20], [21], context awareness platform as WComp [22] or other platforms to promote adaptability. [11] presents the need to standardize LBSs using open standards and the key benefits of this move, however it just focuses on the standardization of the geographical part of the LBS applications using GML, thus, no means to standardize the LBS applications globally. We did not find any research work using context aware platform in this domain. Moreover, we did not find any research work using the same approach to locate a user and to associate Web services to geographical location with GML extensions.

## 9 Conclusions

This research paper presents a new means to standardize LBS environments, on one hand this means allows LBS providers to be more visible to consumers, on the other hand consumers don't have to use proprietary mechanisms to access and interact with LBS applications. Adaptability is given by Geo-location that allows to select services according to the location context. We used web services as a technical means to standardize LBS applications, we used Microsoft .NET 3.5 for the development environment and for location awareness we used the Windows 7 sensors and location platform. We described a genuine mechanism to associate the position of a user to an area and to services (defined and subscribed in this area) via an extended GML and UDDI. We implemented the whole case study and we showed examples of code. We have now to improve adaptability to auto adaptability with reflection mechanism and to also improve Geo location data bases.

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