Integration of Similar Location Based Services Proposed by Several Providers

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Abstract.

Due to the fact that mobile devices are in widespread use, many applications including Location Based Services (LBS) had been involved to deliver relevant information to customers anywhere at any time and thus based on their profile and geographical position. However, with the increasing number of geographical data and distributed geospatial applications with heterogeneous databases, many problems may arise related to 1) the interoperability of geographical databases, 2) the integration of geospatial data / metadata of services and 3) the development of user friendly visual portals on mobiles. As many LB standards like OGC and applications were demonstrating the feasibility of portals from a unique provider, the objective of this paper is to pursue further in the approach of generating visual portals by allowing many providers to commercialize their services overlaid on a unique base-map. Furthermore, we have implemented this approach via our prototype MPLoM (Multi-Providers LBS on Mobile Devices).

Keywords: GIS, LBS, Cartography Graphic Semiology, Ontology, OWL, GML, XQuery, GUI on PDA, WMS, WFS, Web Services, Integration

1 Introduction

The field of LBS, which emerged a few years ago, presents many challenges in terms of research and industrial concerns. We mean by Location-based services (LBS), a particular type of web services used via web browsers, but those LBS's are efficiently used in applications integrating services data/metadata based on the user's location(spatial coordinates LLA: Longitude, Latitude, Altitude).

Examples of such applications include: tracking (device oriented) or information entertainment /navigation and many others (person oriented). [1]

Let us take the application to look at the nearest restaurant in your area with the navigation instructions to get there:

First of all, we might encounter the answer of an Italian restaurant listed by two different providers, not exactly located at the same place (50 meters of difference) due to the inaccurate precision from Satellite or Radio Mobile positioning systems. The same Italian restaurant is named "Carlo's Pizzeria" in the first one and "Da Carlo trattoria" in the second one, visualized by different cartographic symbols. The goal is to consider them as the same object.

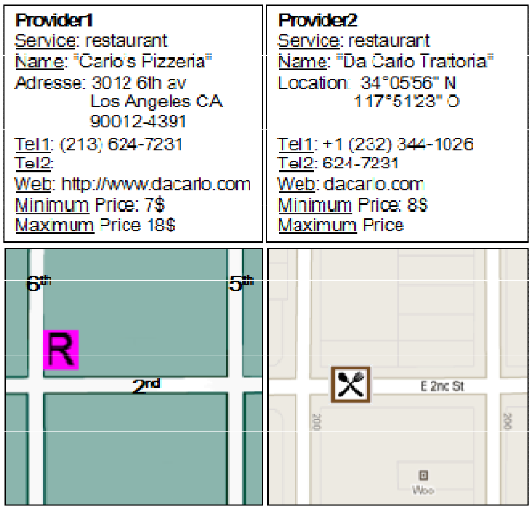

Fig. 1. Example of the same LBS objects from two different Providers (Candidates for integration)

Many techniques should be studied to solve these issues and ensure the integration of homologous objects among all the heterogeneous ones overlaid on the same map.
This paper will discuss in Section 1, the state of the art related to our subject. Section 2 will be dedicated for the service location integration and the adopted techniques, Section 3 will discuss the cartographic symbol integration and the mapping output, Section 4 will detail the architecture and the functionality of our developed platform MPLoM and finally, we will conclude and present our future work in Section 5.

2 Related Work

Currently, we can find visual portals (background map and geographic object) that can be textual, iconic or cartographic maps. Fake screenshots are given below as examples to explain the scenario we are considering:

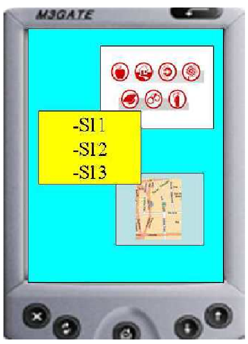

Fig. 2. PDA linked to several service providers, assigns one window per provider if no portal interoperability is envisioned

Fig. 3. Services are ranked by alphabetical order on the left and by user's profile order on the right. (Problem if long list)

Fig. 4. Example of services in which reference locations are mapped with icons, shapes corresponding to services and colors to providers.
(Problem if more services)

Another visual representation is based on a 3D perspective Street view. Facing the problem of place names' overlap in 3D and cognitive difficulties, the usage of icons instead of place names could have more accurate impact.

Fig. 5. Using street-view as a way of presenting services for a pedestrian.
(Problem of place name's overlap in 3D)

Based on what was proposed in the history of portals as described above and their problems [3] , visualizing a unique map whose components will come from various LBS providers, becomes a real challenge.

3 Location Integration

Connecting several geospatial databases for the LBS providers in charge and facing their heterogeneity in design or content could not be considered an easy job. We need what we call "Interoperability". It has been generally defined as the ability of heterogeneous systems to communicate and exchange information and applications in an accurate and effective manner. [4]

In the scope of Geographical Databases (GDB) interoperability, we can define five different types of conflicts: [5] and [6]

- Conflicts related to the data source used to constitute the geographical databases (ex. satellite images, raster, etc.)
- Conflicts based on the models and metadata
- Conflicts of class and attribute definition
- Conflicts of data, measures
- Conflict of positioning
- Etc.

Open Geospatial Consortium (OGC) is a standardization body for GIS to improve interoperability between applications by creating some common interchange languages through common standards [Tyler Mitchell, Web Mapping Illustrated].These standards are related to: 1) mapping functionality using Web Mapping Services (WMS) and 2) Retrieving Geo data using Web Features Services (WFS).[2]

In spite of successful initiatives and widespread use of standards, today's solutions do not address yet multi providers LBS integration somehow as per the visual fake portals above and their visualization's problems. Integration is the process used to match the correspondences between geographical objects from different databases that are representing the same phenomena in real world.

In this paper, we will focus on solving the conflict of data/metadata of LBS among many providers at the application layer.
We can distinguish three types of integration related to the location of objects: geographic, place name and semantic.

3.1 Geographic Integration

It consists of matching the geographical components by their position and representation. Suppose that services are retrieved from the providers as points with a difference in location due to Global Positioning Systems (GPS) tracking device precision and in coordinates due to the conflict in positioning.

How to ensure that these two points belong to the same restaurant for example and should be visualized once to avoid duplication on the screen?
To answer this question, three types of geographic integration could be adopted:

- By defining an integration zone (Epsilon zone) [5]
- By calculating the distance between the objects
- By using other geometrical characteristics for the shape of the object.

The above types could be applied separately or together.

To define whether two objects are the same or not, the distance between the two should be less than a chosen threshold by "Stricher technique" [6] (successive thresholds to eliminate so far the candidates points). In the proposed MPLoM implementation, to decide if two objects are the same, we choose a threshold of 5 meters between the candidates. For the integration of two punctual objects; the Euclidian distance dE is used. To integrate two linear objects, three types of distances could be used (average distance, Hausdorff distance [29], and Fréchet distance [30]). So as far as the distance between object 1 and object 2 is less than the threshold 5 m, a highest assumption should be set that the two objects are homologous.

3.2 Place Name Integration

The fusion technique uses the Levenshtein distance dL [26] and [27] (Levenshtein 1965) to compare the place name (string of characters) of two objects from two different providers. This distance will increase if the number of differences between characters increases as well.

3.3 Semantic Integration

The third type of integration between these two objects is related to their metadata/data. To avoid duplication of the services details from two different providers, a matching scenario had been used in the application and a semantic ontology–driven approach via Protégé and Jena API. For example, if a navigator wants to know what restaurants can offer “Hamburger”, the platform should list all the restaurants’ type American or fast food, etc. Many solutions had been proposed in the code and via Ontology creation in Protégé [28].

Finally, Belief Theory had been applied to confirm the highest weight for two homologous objects based on their separated weights from the geographic, place name and semantics reasoning.[5]

4 Cartographic Symbols Integration

After the discussion related to location integration, map symbols integration via a spatial ontology matching approach is proposed and will be elaborated in this section. Since the use of many LBS providers implies several maps , one for each, our purpose is to visualize the symbols of a common LBS service mashed up and overlaid on a user-friendly background map and thus by taking into consideration some selection rules, user’s preferences and knowledge of graphical semiology. A well harmonized integrated visual portal on mobile devices should be our goal.
To ensure this, we proposed to build a domain spatial ontology that will match all the local ontologies of the service providers (services, correspondent symbols /attributes and maps).

Based on this domain ontology, another selection criteria will be enrolled as per:
1) The user’s preferences for maps and icons, 2) The devices’ limitations, 3) The geographical /coverage zone to visualize and 4) The graphical semiology constraints. [24]

In order to achieve our proposal, a call flow is to be implemented as listed below:

1. Collection of each LBS provider’s icons from its legend

2. Saving the image of each background map for 2D/3D visualization

3. Pursuing a psycho-cognitive test via a web application including random icons and collecting the correct answers for each icon. Priorities will be assigned to the most understood ones in all cultures and nations (Icons’ Ranking)

4. Creating a common library of user friendly icons for all the services in the LBS domain used by our application and their attributes (color, size, number, shape,

abbreviation, texture, font type, etc.); these icons could be used as work around solution to solve any conflict.

5. Developing an ontology matching application to insert local spatial ontologies (cartographic symbols and maps) for each provider and the matching relations between them towards an LBS domain ontology (relations like equivalence, inclusion more general, and inclusion more specific). This application should have the capabilities to export the ontologies and import any new ontology from a new added provider in an OWL language with some extension (OWL, c-OWL) called CartOWL (Cartographic contextualized Web Ontology Language) that should list the classes, subclasses, relations and cartographic symbols attributes.[8]

6. The domain ontology could be checked in the application to generate and visualize the correspondent cartographic symbols for any specific service mashed up and overlaid on a unique background map chosen based on user's preferences and geographical zone of coverage (2D, 3D, perspective street view, hybrid, etc.)

7. Graphical semiology studies should be well respected in color schema and other adaptation/generalization techniques for a clear visual portal. [9] (i.e. keep trademark icons and colors, use each provider's proper icons in case of different objects or aggregation macro icon in case of integrated homogenous objects, common library of icons in case of conflicts, etc.)

5 Architecture and Functionalities of the Prototype MPLoM

The platform MPLoM is developed to test the feasibility of the location and map symbols integrations into a unique visual portal on mobile devices.
Phase 1 covers the location integration from two providers offering pull services (hotel and restaurant finders) and push service (weather forecast) while phase 2 covers the cartographic integration especially with other suggestions related to web application and geo web services standards for multi providers' interoperability.

A pull service is any location based one listing its details based on a user's query linked to his profile and geographic position. A Push service is any service offering to the user prior to his/her consent based as well on his profile and position. [1, 3] The pull services (restaurant and hotel) are visualized on a 2D background Google map downloaded via API key and the components are overlaid as Google markers(R for restaurants and H for hotels). The access to the providers was done directly via servlets to the concerned tables. [10]

Both of them are created in Postgresql with PostGIS feature for spatial usage. However, push service (weather forecast) is delivered as textual output to user interface via web service WSDL SOAP connection.
The User interface is shown on a S60 Nokia emulator with LBS middleware; the platform code is done in JAVA and XQuery is used to parse cGML files (compact geographic Markup Language), to integrate the details of the objects in a unified cGML file before visualizing the results on the screen.

cGML is an extension of GML used for mobile devices that can minimize up to 60% of storage capacity due to its compressed tags(i.e. GML tag=(Coordinates) v/s cGML tag= (cds)). [11, 12, 13]

A mediator database handled by the administrator is used to store the user's preferences, and the unified cGML file output that should contain all the unified details of the objects answering hotel and restaurants request from both providers.

Two scenarios describing Restaurant/Hotel finders and Weather Forecast services were developed with some of the corresponding screenshots. The user should start by entering his preferences and log in via a User Textual Interface:

5.1 Scenario 1: Restaurant-Finder Pull LBS service

Fig. 6. User Preferences /Restaurants Markers overlaid on a 2D map / List of Details

An improvement on phase 1 is currently running to ensure the implementation of a catalog in the mediator database to list all the metadata about the providers and their services so we can prefilter based on user's request before accessing the database. APIs and Geo Web Services should be developed to ensure access to the services worldwide either by contacting heterogeneous databases via specific APIs or via their web services.

Furthermore, the cartographic map symbols integration should be tested by applying an application to match all spatial providers' ontologies through an LBS domain one and presenting all the components on a unique map. Some extension could be proposed as well for cGML standards to include the attributes of each symbol (icon, visual variables, etc.) [14]

6 Conclusion and Future Work

In conclusion, our contribution can be identified at two main issues:

- The proposed MPLoM platform itself where push and pull LBS services can be integrated on a unique visual portal; this is done by defining and using ontology and other reasoning to ensure interoperability at the application layer among many LBS service providers.

- The spatial domain ontology matching application used to integrate the cartographic symbols of many providers with some extensions to be done for cOWL and/or cGML standards from the XML family to include the attributes of the map symbols with the spatial and non-spatial data.

As a future work, we will: 1) improve the MPLoM platform as described in this article, 2) propose XML extensions to describe LBS meta data(map symbols attributes, service price, SPAM, etc.), 3) advocate the creation of new geo web services based on multiple providers as the ones discussed in OGC (WMS, WFS and WCS) and 4) create dedicated APIs to ensure the retrieval of necessary information in case we don't have full access to the providers' GDB.

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