Advanced Location Modeling to enable sophisticated LBS Provisioning in 3G networks

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Abstract. Network Operators recently spotted Location Based Services (LBS) as a promising attempt to establish new sources of profit for the upcoming 3G networks (which are expected to be the main driver for real ubiquity) beside voice and video communication [1]. For the time being, LBS are based on a simple location model, which maps basic geographic position information into a human-friendly description of position that is then used as a simple filter parameter within a database lookup. As location awareness for services generally require more extensive conditioning of the location information, the existing models restrict the range of possible LBS. To allow for a comprehensive range of sophisticated Location Based Services, an augmented form of location modeling is required. In this paper we introduce an advanced location modeling system, which comprises a multi-dimensional view of the term 'Location'; far beyond just representing simple geographic positions.

1 Introduction

Today the provisioning of Location Based Services follow the simple chain of (1) determination of a position, (2) mapping this information onto a natural-language based description of this position and (3) performing the service itself. The mapping process in (2) is based on an underlying position interpretation model. This model is usually named *location model*, although it only describes simple geographic positions. The drawbacks of such location models are:

- dedication to a specific service
- restrictions on interpretation of geographic positions
- descriptions of only discrete, point-shaped locations
- dependence on the type of position-finding mechanism

Because of these characteristics, the set of accessible LBS today comprises only simple services like personal or acquaintance positioning, contextual information regarding locations of restaurants/ATMs/Taxis or direction finding services. We believe that comprehensive support for ubiquity requires the operator to provide an LBS-enabling platform, whereas the position-finding mechanism, especially the services themselves, will be developed and deployed by 3rd party service suppliers [3]. The prerequisite for such an LBS-enabling platform is, therefore, openness towards different position-finding techniques and openness towards any conceivable type of service. For the location modeling, it means that the restrictions of service-specific position interpretation must be overcome. To achieve the desired openness of the location model it is necessary to provide (1) extensions to the handling of geographic positions, (2) the integration of non-geographic position information and (3) the consideration of non-position dependent information [5].

In the following sections we outline the requirements for designing an open universal location model comprising the introduced steps of a widened interpretation of the term 'location'.

2 Considerations on advanced Location Modeling

As noted in the introduction, a location model is a pre-requisite for the interpretation of a geographic position as a location. Today the identified location still describes a geographical position and the description itself only allows for the referring of a discrete, uniformed location identifier.

Next we introduce a more convenient view on location, which first allows for more sophisticated descriptions of geographic positions and also covers non-geographic and non-position related location information. We denote this enriched interpretation of location as *location*$^+$.

2.1 'MapIt' - Location as Expressive Position Description

The transformation of position data into a location description is part of each LBS-System. Position information derived by position-finder mechanism is based on either geometric (e.g., UMT, MGRS, GEOREF, Longitude/Latitude; see [4]) or symbolic models. (e.g., *Cell-Id).*

This position information is mapped onto locations according to a location model. We can take the word 'mapped' literally in this case, as the location model typically has a 'real map' underlying the model. This map could be a street map; a tourist attraction map, a zip-code table, a floor plan or anything else depending on the service itself. The above-mentioned Longitude/Latitude data can be mapped onto a city descriptor ('New York'), a place ('Times Square'), a ZIP code ('10036'), a bus stop or something similar.

Simple mapping is state-of-the-art today. Here the new requirements on a *location*$^+$ model comprise the ability to combine different mapping rounds to get a bundle of different location descriptions out of one position. Furthermore an option to seamlessly add new 'real maps', which enables the platform to allow an any-to-any transformation, must be kept in mind.

2.2 'SpreadIt' - Domain of Validity

At present the position information processed by Location Based Service systems are typically discrete and point-shaped. This is obvious in the case of real geographic coordinates like GPS, but is also true for systems that compute expressive position data: the location 'Times Square NY' can be regarded as point-shaped as the appropriate GPS coordinates.

Very often this simple, point-shaped location does not meet the requirements of location aware services and many sophisticated services demand additional position information. In our analysis we identified *extension*, *shape* and *orientation* as indispensable for a significant number of services. This information describes what we call 'Domain of Validity'. The relevance of a domain of validity is described in detail in [5].

1. *Extension of Validity*: For the Times Square example, a theatre program service may not only provide musicals played in the Times Square area but also present the off-Broadway theatres as well playing nearby. The relationship 'NEARBY' would here be estimated as an area of 5 blocks (500 meters) around the Times Square. In contrast, late in the evening, when people leave the theatres a bus stop service should not present every bus stop within a range of 500 meters around the Times Square; here a maximum of 1 block/100m would be more appropriate. This simple example reveals that although the location is the same and the same LBS relation 'nearby' is used, the services need different interpretations of the location in terms of an *extension* of the discrete point-shaped description.

   Note: the measure of the distance to determine the extension is not necessarily based on units of length, also units of time can be much more appropriate. The location model has to be open enough to support this option in addition.

2. *Shape of Validity Domain*: To this point we have only dealt with point-shaped locations by integrating information of the extension of validity- 'circle-shaped' location areas. As several LBS demand for a location domain of validity that is different from a circle, we must add the shape of validity domain to our location model as well. One example for the usage of the shape information is that of a traffic jam service: Drivers driving on highway N^{o}1 do not want to get information about traffic jams in the adjacent towns. The shape of this validity domain would have approximately the shape of the highway here.

3. *Orientation*: The traffic jam service example shows us the third type of location data to be added to the model: the *orientation*. No driver is interested on jams behind him, but of course on jams for at least 100 miles ahead. The location domain of validity of an oncoming driver would have the same geographic position, the same expressive position, the same extension and the same shape, but will obtain a different list of jams due to the different orientation of validity.

2.3 Non-Geographic Location

A second area of consideration for a universal location model is the information on *non-geographic* positions. As those non-geographic positions are heavily application driven, it is not possible to provide a comprehensive and complete specification for a location+ model. By having a non-geographic location available, even e-mail applications could become location aware. In this scenario the method of presenting/recording e-mails changes according to the location of the user: being located in a car, the system would invoke speech synthesizer/recognition tools instead of the classic text based front- ends. Another example is that of the user located within a Virtual Private Network: she/he gains access to all company services, whereas her/his neighbor (with exactly the same geographic position) would be denied access to such information.

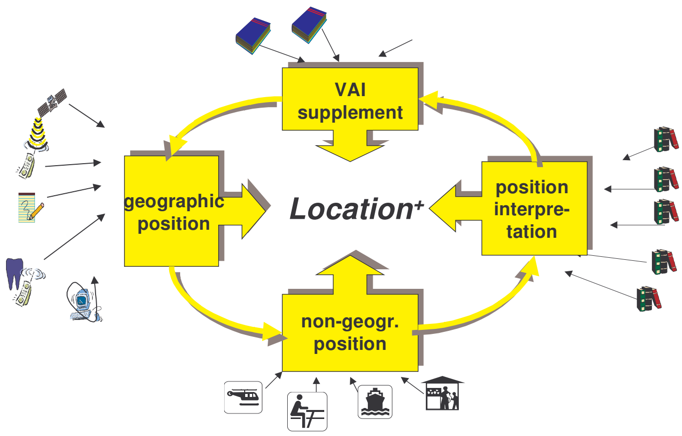

Figure 1 From Position to Location+

3 Location Add-Ons

In the previous chapter we presented a number of advanced location related information data beyond the simple position, which enables an LBS-enabling system to support a broad range of location-based services. To complement the available information and to allow performing LBS in a comprehensive way, the location+ model is supplied with location independent information. Those add-ons comprise *dynamic behavior* and *context information*.

These location add-ons are, of course, not naturally part of a location model, nor of a location+ model. But to meet the claimed openness of the location based service-enabling system, we may disregard these additional information for the underlying model. The location^{+} model enriched by location add-ons is therefore called *location^{++}* model.

3.1 Dynamic Behavior

Dynamic behavior covers the influence of changing environments. Here we distinguish:

1. *General Time Dependencies*: this class comprises information regarding, e.g., opening hours of tourist attractions (which then have to be matched with the daytime of service access, see context information).

Rate of Location Change: having this information available enables the platform to provide expectations on how the conditions could change within a certain range of time. An example is an expected decrease of a traffic jam after the rush hour, so that it is foreseeable that a jam may disappear once a driver reaches the location.

3.2 Context Information

The second non-location related information add-ons are *context related* information. Here we distinguish between *object context, user context* and *context:*

1. *Object context*: describes context of objects inside the location domain of validity. (Examples are types of building, off-limit areas etc.)
2. *User context*: describes the users characteristics (like being handicapped), the users profiles (like having activated the tourist profile), and general preferences (e.g. the maximum cost of services, the preferred food etc.)
3. *General context*: LBS often have to consider information like the time of day, the weather and others in order to perform their service.

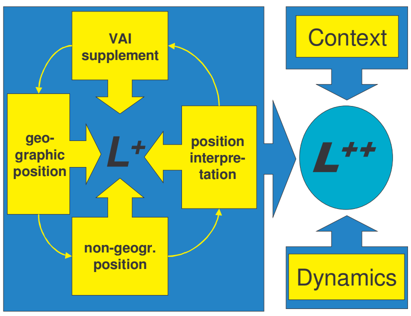

Figure 2 Advanced Location Model Location^{++}

4 Modeling

'The great thing about standards is there are so many to choose from'. This saying [6] never turned out to be as true as of the area of LBS today. For this reason, it is advisable to extend an existing approach instead of adding yet another model to the existing set of real or planned standards.

A very promising area of extension for our location model is the 'Common Spatial Location Data Set' [7]. This Internet Draft in the framework of SLoP[1] [9] aims at providing a data set for spatial location information, bridging various existing data representation formats and meeting the requirements of location aware services. Besides classic position information, the currently defined data-set already comprises advanced information like time, speed, orientation and direction of the located object. The data set is available in XML Schema providing and easy extension and enhancement. Another option [8] enables the attachment of a newly defined additional data set for a location^{++} model.

We are currently preparing a proposal how to integrate the concepts from our location^{++} modeling approach into the SLoP framework.

5 References

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[1] The group around SLoP is about to be accepted as IETF Working Group