Experiences of Expressing Location Information for Applications in the Internet

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Abstract. As part of the Spatial Location Protocol activity in the Internet Engineering Task Force (IETF) we have been working on how to express location information in an interoperable way in the Internet. The objective of this paper is to share our ideas and experiences on concepts for enabling interoperability and reuse of location information. These concepts can also be used in the area of ubiquitous computing.

1. Introduction

Location information is quite challenging, since it can be expressed in so many different ways depending on the application domain and the requirements of the application using the location information. As part of the Spatial Location Protocol (SLoP) activity [1] started at the beginning of 2000 in the Internet Engineering Task Force (IETF), we have been working on how to express location information in an interoperable way in the Internet [2, 3, 4, 5]. The activity was initiated in order to create a common standard way for obtaining location information in the Internet. In this paper we want to share our ideas and experience on concepts for enabling interoperability and reuse of location information. We think that these same concepts can be used in the area of ubiquitous computing.

2. Expressing Location Information

Location information can be expressed in very many different ways. The way of expressing the location information reflects the needs of the application domain it was planned for. With location information we understand information expressing the physical location of an object, as well as additional information that can be necessary for using the location data, for improving the location measurement, or for bringing additional value to the location data. Such information is e.g. accuracy information, object identifiers (IDs), time stamps, etc. [2].

The location can be expressed using different reference frames, e.g. as absolute spatial location, descriptive location, or relative location [2]. Absolute spatial location is the physical location of an object in the world, expressed via a 2- or 3-dimensional coordinate system in a particular spatial reference system. The spatial reference system expresses a 2- or 3-dimensional model of the earth and determines how the used coordinate system is attached to the model. Descriptive location is a location described through other means than a coordinate system. Examples of descriptive locations are e.g. street address, building number, country, etc. Relative location is a specific type of descriptive location, where the location of an object is described relative to some other object, e.g. “100 meters from the store”, “the building next to the tower”, etc. Generally, a descriptive location can be mapped to an absolute spatial location.

2.1 Existing Location Information Expressions

There are many different ways of expressing location information defined by numerous application domains and organizations. They include [2]:

- Expression standardized for GSM and UMTS (called here "3GPP") to be used internally in the GSM and UMTS mobile networks specified by the Third Generation Partnership Project (3GPP).

- An interface towards mobile networks (e.g. GSM) for providing access to location information of mobile terminals in consideration by the Location-interoperability Forum (LIF).

- The Geography Markup Language (GML) for storing and transporting geographic information specified by the Open GIS Consortium (OGC).

- NaVigation Markup Language (NVML) for describing navigation information submitted by the Fujitsu Laboratories to the World Wide Web Consortium (W3C).

- Point Of Interest eXchange Language (POIX) for exchange of location-related information over the Internet created by MObile Information Standard TEchnical Committee (MOSTEC) and submitted to the W3C.

- Geotags for geographic registration and resource discovery of Hypertext Markup Language (HTML) documents.

- National Marine Electronics Association’s (NMEA) interface and data protocol NMEA-0183 often used by GPS receivers.

- The electronic business card format VCard and ICalendar for exchanging electronic calendaring and scheduling information in the Internet include elements to specify position.

- A Means for Expressing Location Information in the Domain Name System (DNS-LOC) specified in an Internet draft by Davis et al.

- Simple Text Format for the Spatial Location Protocol (SLoP) (here called "SLoP-simple") proposing a simple text-based format to carry a minimal location data set by Mahy.

- GMML, XML-based geographical information for navigation with a mobile specified at the University of Jyväskylä.

- LandXML, an XML-based data format for exchange of data created during land planning, civil engineering and land survey processes.

- Geospatial-eXtensible Markup Language (G-XML) for encoding and exchanging geospatial data specified by the G-XML Committee in Japan.

- Common Spatial Location Data Set [3], Spatial Location Payload [4], and Common Syntax and Coding for Descriptive Location [5] developed during the SloP-activity.

In addition to these, there are several other non-public specifications of location information expressions, including those from WAP Forum Location Drafting Committee, Bluetooth Special Interest Group, ISO/TC211, etc.

3. Tackling the Challenge of the Multitude of Location Expressions

For us it appears to be a waste of resources that each and every location information application or application domain would need to create its own, probably non-interoperable way of expressing location information. At least from an interoperability point of view in the Internet, it is good if there exist common ways of expressing and processing location information. This can be tackled in several ways.

3.1 A Common Location Data Set

The idea of a common location data set is to enable location information sources and applications to express location information in an interoperable way with help of a common location data set. As part of the SloP-activity we have proposed such a set [3]. Our aim was to create a simple lowest common denominator data set that as many location information sources and applications in the Internet as possible could use.

In order to propose such a set, we analyzed different existing location information expressions, as well as the requirements on location information of different location information services [2, 3]. Based on the analysis we proposed a common location data set called "Common Spatial Location Data Set", consisting of elements for

describing the absolute spatial location of an object in geodetic latitude, longitude and altitude, the accuracy of the location measurement, time of location measurement, speed, direction, course, and orientation.

3.1.1 Encoding in Extensible Markup Language

The elements of the data set also need to be expressed and encoded in a common way. We chose to encode the data set in Extensible Markup Language (XML). This because XML enables the use of standard processing tools and is human readable. In addition, many of the existing location information expressions use XML (see Table 1). Further on, XML also enables extendibility and reuse of different location information data sets with help of XML Schema [6].

With help of XML and XML Schema e.g. the Common Spatial Location Data Set can be used as basis for other location information expressions. However, a word of reservation needs to be raised here. The flexibility that XML Schema brings for reusing and extending different data sets can lead to numerous different location information expressions, which again can be a challenge if transformations between these expressions are needed. This because we need to define the transformation rules for each pair of location information expressions we want to transform between.

Encoding	**3GPP**	**LIF**	**GML**	**NVML**	**POIX**	**Geotags**	**NMEA**	**Vcard**	**ICalendar**	**DNS-LOC**	**SLoP-simple**	**GMML**	**LandXML**	**G-XML**
XML		x	x	x	x							x	x	x
Binary	x									x				
Text						x[1]	x	x[2]	x[2]	x	x			

x[1] using HTML META tags, x[2] using GEO element in VCard and ICalender, or LOCATION element in VCard

Table 1. Encoding of different location information expressions

3.2 A Common Way of Expressing Different Location Information Expressions

The proposed common location data set was designed to enable as many location information sources and applications as possible to use it. However, we do not believe they can all restrict themselves to one common location information expression. Different location applications may need different location information. It is thus necessary to have a solution that also enables the use of different location information expressions. There are several issues regarding this.

3.2.1 Common Naming and Registering

If each location information expression has a unique identifier, the different expressions can be identified. The identifier will simplify the identification, processing and possible transformation of location information expressions. The naming scheme should be a common one in order to guarantee uniqueness and enable common processing of identifiers. It could be based on URIs (Unified Resource Identifiers). For some absolute spatial location expressions there already exist unique identifiers maintained by the European Petroleum Survey Group (EPSG) [2].

In order to enable transformations between location information expressions, we need to be able to identify them, as well as know the syntax and the transformation rules for the conversion between the expressions. For simplifying this and also for enabling the reuse of existing location information expressions, there could be a registration authority for registering location information expressions and their transformation rules for public use [2]. There could also be public transformation services providing transformations between location expressions.

3.2.2 Common Structure and Encoding

A common structure and encoding of the different location information expressions will simplify the processing and enable the use of the same processing tools. Principally a common structure and encoding can be seen as a common envelope for different location information expressions. The location data set in the common envelope could principally even be encoded in different ways. However, this would complicate the processing of the set, since specific processing tools are then required to process the contents. In [2], we have made initial considerations regarding such an envelope encoded in XML.

In order to be able to process the location information expression, it can be valuable to include parameters for describing the data. This include information, such as, location expression identifier/name, owner of the expression, version, content type (e.g. XML, binary), and encoding (e.g. UTF-8, base64, etc.). These parameters could be part of a header in the location information expression, or possibly external metadata identified by the identifier/name of the expression. A common envelope in XML with parameters in the root XML element (=header) was partially implemented in the Common Syntax and Coding for Descriptive Location [5].

3.3 A Common Location Payload for Location Information Expressions

It might not be possible for all applications to restrict themselves to the use of only one location information expression. Sometimes the application might want to use elements from several location information expressions or express the location in several ways with the help of different location information expressions. The Spatial Location Payload was designed to enable this [4]. It is principally a common container for several location information expressions. It is encoded in XML.

4. Conclusions and Future Work

We think that it is a waste of resources that each and every location information application or application domain need to create its own way of expressing location information. We need ways of enabling reuse and common ways of expressing and processing location information. For this we have proposed a common location data set that can be used between applications to enable interoperability, or be used as basis for other location information expressions. We have also considered methods for expressing different location information expressions in a common way, as well as proposed a common payload for encapsulating several location information expressions. We have used XML for encoding the different proposals. This because XML enables the use of standard processing tools, is human readable and many existing location expressions use XML. Further on, XML also enables extendibility and reuse of different location information expressions.

We will continue the work on location information expressions and improve the published Internet drafts based on feedback from other location information activities. We think that the concepts and ideas that we have developed for expressing location information in an interoperable way in the Internet can also be used in the area of ubiquitous computing.

5. References

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