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XML Map Metadata Format for Open Map Sources: A Survey and Overview

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Abstract

In the field of Geographic Information Systems, Volunteered Geographic Information (VGI) are achieving through the open source map database (DB) construction approach. Multiple map DB providers employ open source technologies in attempting to reduce unknown map information in their proprietary maps. In this paper, we survey and overview an eXtensible Markup Language (XML) metadata format for open source maps based on cloud computing and a mash-up between navigation systems and users. New road information is extracted by onboard navigation systems during travel over such roads by drivers or voluntary participants. Metadata recording the road information is generated in an XML map format that is then made available to heterogeneous navigation systems through a cloud computing environment. Specifically, map metadata is provided to various map DB providers through open source network interfaces, after which map DB providers can efficiently relay the updated map information in their proprietary map DB formats.

Keywords: *Open Map, XML, Cloud Computing, Navigation System, Mash-up, Volunteered Geographic Information, OpenStreetMap*

1. Introduction

In the field of Geographic Information Systems, open source-based map database (DB) construction has been successfully implemented by multiple map information providers who reduce unknown map information for all map users through the individual efforts of each voluntary participator. So, various mash-ups with open map APIs have been proposed. Volunteered Geographic Information (VGI) is user-generated project by voluntary participators [1]. The OpenStreetMap (OSM) project is a famous examples of a VGI project [2-6].

Several researches have considered the shared-participation approach to map DB updating using the Open Map API [7-10]. Various researches have sought to enable the updating of only the map information that is changed between DB versions [11-16].

And, the eXtensible Markup Language (XML) map metadata format for communicating open source map information using cloud computing [17-19] and a mash-up approach between navigation systems or users was proposed. The XML is a markup language that defines a set of rules for encoding documents [20]. It is defined in the XML 1.0 Specification produced by the W3C [21]. The design goals of XML emphasize simplicity, generality, and usability over the Internet [22]. It is a text data

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format that is supported by Unicode. Although the design of XML focuses on documents, it is widely used for the representation of data structures.

In this paper, we survey and overview of composing XML format map metadata for open map sources. Section 2 describes the Volunteered Geographic Information (VGI) and map DB generation and updating technologies based on cloud computing and a mash-up approach. Section 3 describes the XML map metadata format for open source maps. We conclude this paper in Section 4.

2. Volunteered Geographic Information and Map DB Generation

In the field of Geographic Information Systems, various mash-ups with open map APIs have been proposed. Volunteered Geographic Information (VGI) is user-generated content by voluntary participators [1]. The OpenStreetMap (OSM) project is a famous global road map production examples of a VGI project with a large voluntary participators [2]. OSM offers a range of possible services to voluntary participants, including rich services that enable the creation, deletion, and modification of map information through web interfaces. Many researches have proposed and contributed to OSM.

Mooney *et al.*, [3] described the results of an analysis of the OSM database for the United Kingdom (UK) and Ireland and considered "heavily edited" objects in OSM.

Haklay *et al.*, [4] reviewed the OSM project and provided an overview for the techniques and methodologies used within it.

Coast [5] reviewed many more aspects of OSM and gives an in depth feel of the past, present and future of the project.

Google Map Maker enables map information that is absent from the Google Maps DB to be added through user participation [23]. Daum and Naver are working towards an Open Map mash-up product that enables easy user interaction [9, 10].

But, in the field of Car Navigation Systems, generally, open map services can be shared only by specific platform users. So, Lee *et al.*, [24-26] proposed an automated map DB generation and updating architecture. That is, when a user drives unknown roads that do not appear in the car's navigation map, the cloud-oriented car navigation system extracts GPS and image data reflective of the unknown roads. And, in here, he introduced an XML map prototype [25], the method does not accommodate the sharing of data between map DB providers, Internet Service Providers (ISP) and voluntary participators using mash-up services due to the proprietary formatting of the map DBs employed by each user. Thus, another research was proposed the concept and architecture of open source map generation based on the cloud computing and mash-up approach, not a practical implementation of the same [27, 28]. The method is that generates metadata in the XML format for consumption by the heterogeneous navigation systems and provides this generated metadata in XML format to each map DB provider, after which each provider converts the received metadata into its proprietary DB format and updates its master map DB for each of its navigation systems.

3. Composing the XML Map Metadata Format for Open Map Sources

Min *et al.*, [11-13] proposed a mobile spatial DBMS for the partial Map Air Update (MUS) in the navigation. They defined the service protocol using XML schema for an MAU service [14, 15]. If the updating data (object) exists, the MAUS notifies the summary information of updating data to the mobile device and updates objects.

This section describes the XML map metadata format presently available to open map systems or users of mash-up services [27, 28] like the MAUS service protocol [14, 15].

The XML map metadata is created using novel map attribute information from map DB providers, the ISP and voluntary participators. Map metadata is then provided to each map DB provider.

The XML map metadata format comprises various components including OpenMapGenerationData, which is consists of the MetaDataInfo and MapData elements. MetaDataInfo expresses the basic map information through its Release and MapProvider elements.

Tables 1 and 2 show the attributes of the elements. The release element consists of FirstRelease and SecondRelease, which represent the first and final map information generation days, respectively.

The MapProvider element consists of ProviderName and Protected. ProviderName represents new map information provided by users such as Map provider, firemen, the military, Google, Yahoo, *etc*. Protected classifies the new, extracted map information as public (true value) or private.

Table 1. Attributes of Elements of Release

Element	Attribute		
	Name	**Type**	**Use**
Release	FirstRelease	xs:string	Required
	SecondRelease	xs:string	Required
Annotation	- FirstRelease represents the 1st map information generation day. - SecondRelease represents the final map information generation day.		

Table 2. Attributes of Elements of MapProvider

Element	Attribute		
	Name	**Type**	**Use**
MapProvider	ProviderName	xs:string	Required
	Protected	xs:boolean	Required
Annotation	- ProviderName is element that represents the new map information provider. (Ex: Map provider, firemen, the military, Google, Yahoo, etc.) - Protected classifies the new, extracted map information as public (true value) or private.		

MapData consists of ObjectData and GPSData, which express the road attribute information and GPS coordinates, respectively. The initial metadata can be generated in XML map format and provided to the map DB provider. ObjectData expresses road components with two elements, being ObjAttribute and Coordinate information.

Table 3 shows the attributes of the ObjectData. RoadID is a temporary identification code that captures unknown road information. The Node element classifies the attribute information as an object node (true value) or coordinate. VehicleType represents the contributing vehicle type (*e.g.*, All vehicles, Cars, Bicycles, Persons). InOutDoor classifies the object information as indoor or outdoor.

Table 3. Attributes of Elements of ObjectData

Element	Attribute		
	Name	Type	Use
ObjectData	RoadID	xs:integer	Required
	Node	xs:boolean	Required
	VehicleType	xs:integer	Required
	InOutDoor	xs:integer	Required
Children	AttrFeature		
Annotation	- RoadID is a temporary identification code of unknown road. - Node classifies the attribute information of an object as a node (true value) or coordinate. - VehicleType represents the available vehicle type (All vehicles, Cars, Bicycles, Persons) - InOutDoor classifies the information of an object as indoor or outdoor.		

Tables 4, 5 and 6 outline the attributes of each element. ObjAttribute represents the attribute of the object. In here, AttrCode is the identification code of the attribute and AttrValue is value of attribute.

Table 4. Elements of AttrFeature

Element	Annotation
AttrFeature	- The element represents the components of the road
Children	- ObjAttribute, Coordinate

Table 5. Elements of Coordinate

Element	Annotation
Coordinate	- The element represents the coordinate information of the object.

Table 6. Attributes of elements of ObjAttribute

Element	Attribute		
	Name	Type	Use
ObjAttribute	AttrCode	xs:string	Required
	AttrValue	xs:integer	Required
Annotation	- The element represents the attribute of the object. - AttrCode is the identification code of the attribute. - AttrValue is value of attribute.		

Table 7 shows an example of various ObjectData attribute type names and values that in aggregate represent particular map information. When drivers or voluntary participators travel an unknown road, they can extract information from road signs including the attribute type name, code or value of the road, as in Table 8. In case of VehicleType is 3, 4, 5, 6, and 7, the attribute value of Number of Lanes(NL) is 0. They travel an alley.

GPSData is the element that expresses the GPS coordinates of the unknown road, and GpsCoordinates is a sub-element. Table 9 shows the attributes of the GpsCoordinates element. GpsSeparator separates the coordinates, whereas GpsCoord separates the latitude and longitude.

Table 7. Example of various ObjectData attribute type names and values representing map information

Attribute Type Name	Attribute Type Value	Annotation
Node	True	Node
	False	Coordinate
VehicleType	1	All
	2	Car
	3	Motorcycle
	4	Bicycle
	5	Person
	6	Car, Motorcycle
	7	Bicycle, Person
InOutDoor	1	Indoor
	2	Outdoor

Table 8. Example of various attribute type name, code, and attribute value representing a road

Attribute Type Name	Attribute Type Code	Attribute Value
Number of Lanes	NL	0,1,2,3,…
Width of Lanes	WL	cm
Speed Restriction	SR	km
Maximum Total Weight Allowed	MT	kg
Maximum Total Height Allowed	MH	cm
Traffic Light	TL	Coordinate or 1
Pedestrian Crossing	PC	Coordinate or 1
School Zone	SZ	Coordinate or 1
Curves on Lanes	CL	Coordinate or 1
Speed Bump	SP	Coordinate or 1
Direction	DI	0,1, …, 6,7
Junction Type	JT	Coordinate or 1
U-Turn	UT	Coordinate or 1
Slow Lane	SL	Coordinate or 1
Petrol Station	PS	Coordinate or Name
SuperMarket	SM	Coordinate or Name
Hotel	HOT	Coordinate or Name
……	……	……

Table 9. Attributes of GpsCoordinates element

Element	Attribute			
	Name	Type	Use	Default
GpsCoordinates	GpsSeparator	xs:string	Required	“, ”
	GpsCoord	xs:string	Required	“ ”
Annotation	- The total coordinates of the unknown road. - GpsSeparator separates the coordinates. - GpsCoord separates the latitude and longitude			

Using the extracted map attribute information, this method generates the metadata in XML map format so that it is available to heterogeneous navigation systems in the cloud environment. The proposed XML map metadata format can be used as a standard format for the exchange of map information between map DB providers.

Figure 1 briefly illustrates the extracted XML schema of ObjectData and GPSData as it is used to record the unknown map information. Three ObjectData values are extracted. The attribute type code and the value of ObjectData indicate that the road is suitable for travel by all vehicles. The Number of Lanes (NL) value is 1, the Speed Restriction (SR) value is 30, and the Speed Bump (SP) value is 1. The coordinate value of the element is 37.488628 127.056740. The GpsCoordinates of the GPSData are also extracted.

```
<?xml version="1.0" encoding="UTF-8"?>
<Cloud xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation= "Cloud Interface.xsd"
QueryType="REQUEST" ServiceType="UPDATE-NEW"/>
    <OpenMapGenerationData>
        <MetaDataInfo>
            <BaseInfo>
                <Release FirstRelease="20120201" SecondRelase="20120210"> </Release >
                <MapProvider ProviderName="AAA" Protected="True"> </MapProvider >
            </ BaseInfo >
        </MetaDataInfo>
        <MapData>
            <ObjectData RoadID="001" Node="False" VehicleType="2" InOutDoor="2">
                <ObjAttribute>
                    <AttrCode> NL </AttrCode>
                    <AttrValue> 1 </AttrValue>
                </ObjAttribute>
                <ObjAttribute>
                    <AttrCode> SR </AttrCode>
                    <AttrValue> 30 </AttrValue>
                </ObjAttribute>
                <ObjAttribute>
                    <AttrCode> SP</AttrCode>
                    <AttrValue> 1 </AttrValue>
                </ObjAttribute>
                <Coordinate>37.488628 127.056740</Coordinate>
            </ObjectData>

            <GPSData RoadID="001">
                <GpsCoordinates GpsSeparator="," GpsCoord=" "> ……, 37.484566 127.049767, 37.484871 127.050362, 37.484871
127.050362, 37.485241 127.050873, 37.485519 127.051392, 37.485928 127.052124, 37.486301 127.052811, 37.486301 127.052811,
37.486710 127.053497, 37.486916 127.053795, 37.487175 127.054207, 37.487457 127.054695, 37.487457 127.054695, 37.487740
127.055099, 37.487934 127.055557, 37.488194 127.055954, 37.488445 127.056374, 37.488445 127.056374, 37.488628 127.056740,
……
                </GpsCoordinates>
            </GPSData>
        </MapData>
    </OpenMapGenerationData>
    ……
</Cloud>
```

Figure 1. An example of XML map metadata for open map sources *(Vehicle Type:Car)*

4. Conclusions

We survey and overview of composing XML format map metadata for open map sources between heterogeneous navigation systems or users based on a cloud computing and mash-up approach.

The XML map metadata is created using novel map attribute information from map DB providers, ISP and voluntary participators. Map metadata is then provided to each map DB provider. Thus, the generated XML map metadata format can be used as a standard format for the exchange of map information between map DB providers.

Finally, any number of map DB providers can convert the received metadata into their proprietary DB formats and update their master map DB for all participating navigation systems.

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