# Design of Spatial Data Synchronization System in Mobile Environment

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**Abstract:** In this paper, we propose a framework for synchronization of spatial data between mobile devices and a server by using SyncML(Synchronization Markup Language) that is standard specification for synchronization protocol. We used GML (Geographic Markup Language) to support interoperability of spatial data between various data sources. We also used metadata and catalog service to access and integrate distributed spatial data, considering relationships of spatial data and non-spatial data.

**Keywords:** Synchronization, GIS, GML, SyncML

## 1. Introduction

As the wireless internet and the mobile devices (e.g. PDA, notebook, cellular phone, etc.) become prevalent, the mobility of services and the reliability of data from various data sources are more emphasized. Among the services that guarantee the mobility, LBS (Location Based Service) based on GIS is the most prominent service.

However, in location based services, it is difficult to maintain consistency of spatial data between the mobile clients and the server because of various reasons: (i) the large volume of spatial data, (ii) distributed spatial data, (iii) the lack of storage in mobile devices.

In this paper, we define a synchronization protocol and the structure of a message for spatial data based on SyncML (Synchronization Markup Language). Also, we suggest a method for synchronization using GML (Geographic Markup Language) and OpenGIS Catalog Service. In addition, synchronization engine can integrate spatial and non-spatial data by using metadata and catalog service.

## 2. Related Works

Data synchronization means mediation to maintain the consistency of data between devices or applications[1]. For the data synchronization, SyncML was defined in Feb. 2000 by mobile related companies like IBM, Motorola, Nokia. Since there will be many applications that need synchronization, SyncML will be used more and more[2].

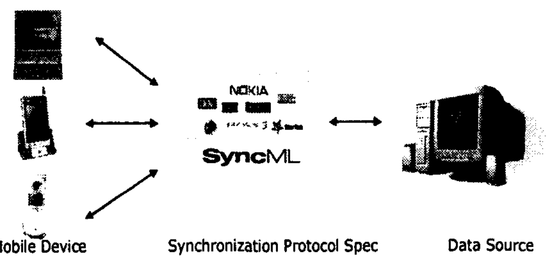


Fig 1. Synchronization using SyncML

In this paper, GML that is standard specification of spatial data based on XML is used as message format for synchronization. The research on GML started in May 2000 and reached current state through 3 years' working. In the early times, GML has been worked to encode geographic information by three organizations (OpenGIS Consortium, ISO TC/211, Japan) [3, 4, 5]. In 2001, the work on GML 3.0 specification had been made since there were needs for standardization of geographic information encoding. GML 3.0 was published in 2003[6, 7].

## 3. Structure and Protocol of Synchronization Messages using SyncML

Synchronization message is an appointment between target entities for synchronization. If synchronization message is defined using SyncML, its result is an XML document having the MIME type of application/vnd.syncml+xml, application/vnd.syncml+webxml and it complies with SyncML specification.

Since any applications using XML based data can recognize and transmit the documents, the use of the document will be widespread. The message structure that will be exchanged between the server and the client is shown in fig 2.

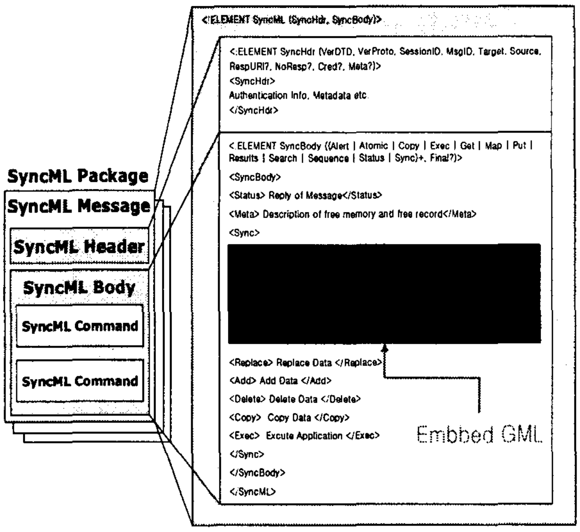


Fig 2. The Structure of Synchronization Message based on SyncML

The category of SyncML Command Message is divided into Request and Response. Request contains device information (Put/Get), Map Table (Map), routing of target synchronization data (Sync), and the result of processing all command (Status). The SyncML message structure is shown below.

### ① Identification of MetaData Namespace

Namespace definition of non-spatial data is shown below.

```
<Type xmlns='syncml:metinf>
 text/x-vcard
</type>
<Type xmlns='syncml:metinf>
application/vnd.syncml-devinf+xml</Type>
```

Namespace of spatial data can be defined separately or standard namespace definition can be used.

```
<schema targetNamespace=
"http://www.myorg.com/parcels"
xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:gml="http://www.opengis.net/gml"
xmlns:gp="http://www.myorg.com/geodeticPoints"
xmlns:pcl="http://www.myorg.com/parcels"
xmlns:iso19115="http://www.isotc211.org/iso1911
5/"
xmlns:xlink="http://www.w3.org/1999/xlink" ele-
mentFormDefault="qualified" version="2003-07-
20">
```

```
<include schemaLocation="Buildings.xsd"/>
<import namespace=
http://www.myorg.com/geodeticPoints
schemaLocation="GeodeticPoints.xsd"/>
<import namespace="http://www.opengis.net/gml"
schemaLocation="base/gml3.xsd"/>

<Type xmlns='gmll:featureinfo'>text/xml</Type>
<Type xmlns='csw:QueryType'>text/xml</Type>
```

### ② Schema of Insert Messages

```
<xsd:complexType name="InsertType">
<xsd:sequence>
<xsd:element ref="csw:AbstractRecord"
maxOccurs="unbounded"/>
</xsd:sequence>

<xsd:attribute name="handle" type="xsd:ID"
 use="optional"/>
</xsd:complexType>
```

### ③ Schema of Update Messages

```
<xsd:complexType name="UpdateType"
id="UpdateType">

  <xsd:sequence>
   <xsd:choice>
     <xsd:element ref="csw:AbstractRecord"/>
       <xsd:element ref="csw:RecordProperty"
         maxOccurs="unbounded"/>
   </xsd:choice>
    <xsd:element ref="csw:Constraint"
  minOccurs="1" maxOccurs="1"/>
 </xsd:sequence>

 <xsd:attribute name="typeName"
  type="xsd:anyURI" use="optional"/>
 <xsd:attribute name="handle" type="xsd:string"
  use="optional"/>
 </xsd:complexType>

 <xsd:element name="RecordProperty"
  type="csw:RecordPropertyType"/>

 <xsd:complexType
   name="RecordPropertyType">
  <xsd:sequence>
  <xsd:element name="Name" type="xsd:string"/>
  <xsd:element name="Value"
   type="xsd:anyType" minOccurs="0"/>
 </xsd:sequence>
</xsd:complexType>
```

④ **Schema of Delete Messages**

```
<xsd:complexType name="DeleteElementType"
  id="DeleteElementType">
<xsd:sequence>
<xsd:element ref="csw:Constraint"
  minOccurs="1" maxOccurs="1"/>
<xsd:sequence>
<xsd:attribute name=
"typeName" type="xsd:anyURI" use="optional"/>
<xsd:attribute name="handle" type="xsd:string"
  use="optional"/>
</xsd:complexType>
```

⑤ **Schema of Search Messages**

Search enables specific data satisfying given condition to be synchronized and use filter mechanism of catalog service.

```
<Meta>
  <Type xmlns='CSW:Filter'>text/xml</Type>
</Meta>
<Filter>
<ClassifiedAs>
  <EntryPoint>RECORD/<EntryPoint>
  <KeyName>/GeoClass/Continent/Country/State
  </KeyName>
  <KeValue>/GeoClass/NorthAmerica/%/Ontario
  </KeyValue>
</ClassifiedAs>
</Filter>
```

We have suggested four main message types above. In addition to the suggested message types, messages about conflict resolution, authentication, busy signal should be included.

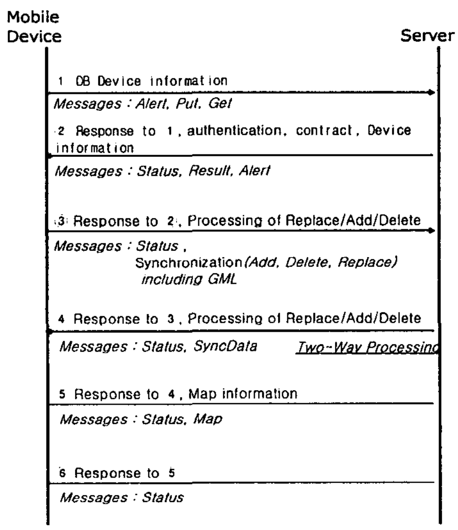


Fig 3. Synchronization Protocol using SyncML

However, conflict resolution policy is more important than defining these messages. Verification is needed whether legacy conflict resolution policy is valid when SyncML is used.

SyncML specification defines seven types of synchronization. Most frequently used synchronization type is two-way synchronization. In all synchronization types, the server becomes master except server alerted type. Push model is necessary for a server to become a master.

In this paper, we use two-way synchronization method. In two-way synchronization method, a client initiates synchronization and send response message as a format of **Status** message.

## 4. SyncML based Synchronization System

In this paper, OpenGIS Catalog Service is used to process distributed data. Open GIS Catalog Service support distributed processing of spatial and non-spatial data and are shown in fig 4.

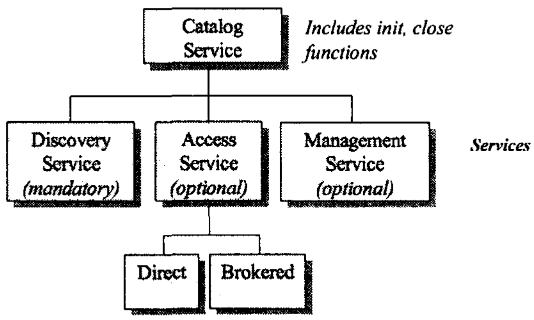


Fig 4. OpenGIS Catalog Service

OpenGIS Catalog Service consists of Discovery Service, Access Service, and Management Service. Discovery Service is for distributed searching. Access Service is for accessing distributed data, and Management Service is for managing distributed data [8].

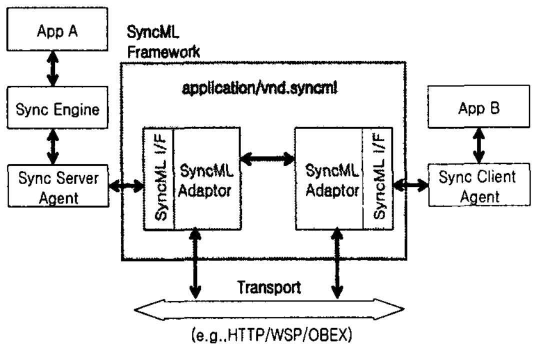


Fig 5. SyncML Framework

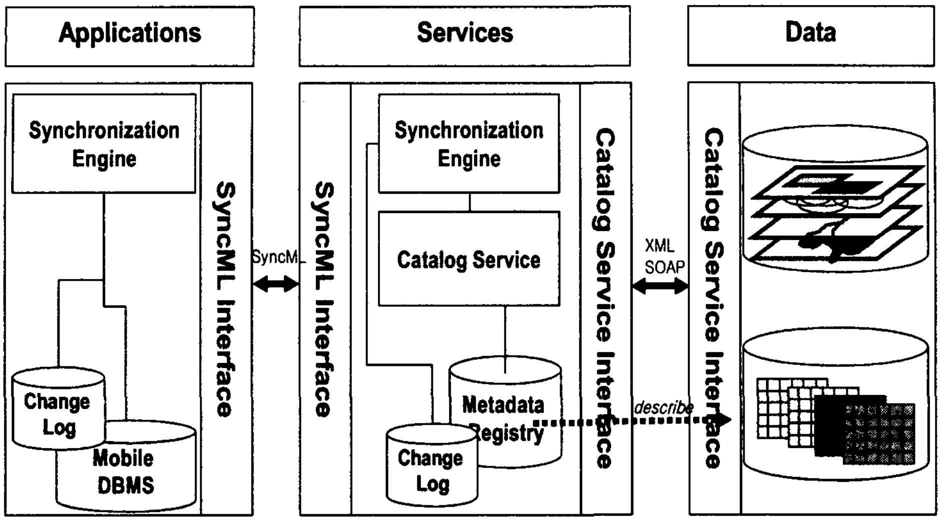


Fig 6. System for Synchronization using SyncML

In this paper, SyncML Framework support design of Spatial Data Synchronization System. The SyncML Framework is shown in fig 5.

Synchronization system provides extensibility and interoperability from various data sources, consisting of Application, Service, Data shown in fig 5. Synchronization Engine uses Metadata to process relationships between spatial data and non-spatial data. It also include Catalog Service Engine to provide standard interface for distributed data and to manage data sources [9].

Since SyncML is standard XML encoding for storing and transmitting spatial and non-spatial data, extensibility and interoperability can be obtained. Figure 6 shows the structure of SyncML based synchronization system.

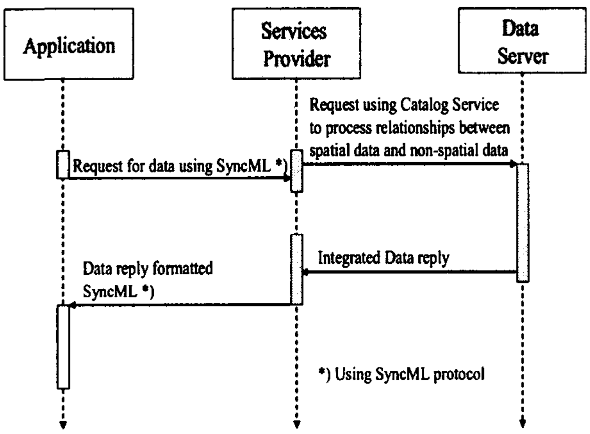


Fig 7. Process for Synchronization Message

Synchronization system is consisting of Application, Service Provider, Data Server. Application processes SyncML data in a Mobile Device. Service Provider is located between Applicaton Server and Data Server and processes distributed query. Finally, Data Server provides spatial and non-spatial data that Service Provider requested. Processing for data of layers is shown in fig 7.

## 5. Conclusion

This paper suggests synchronization method based on SyncML and GML. The proposed system can provide interoperability and make it possible to access distributed spatial and non-spatial data. Our further work is to implement system that supports conflict resolution policy and GML compressing.

## References

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