Geospatial Interoperability

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INTRODUCTION

Spatial information is an essential component in almost all decision support system due to the capability it provides for analyzing anything that has reference to the location on earth. Spatial data generally provides thematic information of different aspects over a region. Geospatial information, a variant of spatial information, is generally collected on thematic basis, where individual organizations are involved on any particular theme. Geospatial thematic data is being collected from decades and huge amount of data is available in different organizations (Stoimenov, Dordevi´c, & Stojanovi´c 2000). Information communities find it difficult to locate and retrieve required geospatial information from other geospatial sources in reliable and acceptable form. The problem that has been incurred is the lack of standards in geospatial data formats and storage/access mechanism (Devogele, Parent, Spaccapietra, 1998). Heterogeneity in geospatial data formats and access methods poses a major challenge for geospatial information sharing among a larger user community.

With the growing need of geospatial information and widespread use of Internet has fostered the requirement of geospatial information sharing over the Web. The *Geo-Web* (Lake, Burggraf, Trninic, & Rae, 2005) is being envisioned to be a distributed network of interconnected geographic information sources and processing services that are:

- Globally accessible, that is, they live on the internet and are accessed through standard Open Geospatial Consortium (OGC) and W3C interfaces,
- Globally integrated data sources that make use of standard data representation for sharing and transporting geospatial data.

Unless a standard means for geospatial information sharing is developed, interoperability cannot be realized. Without successful interoperability approaches, the realization of Geo-Web is not possible. Geo-Web is being developed to address the need for access to current and accurate geospatial information from diverse geospatial sources around the world. The *National Spatial Data Infrastructure* (NSDI) initiative has been taken by many nations for providing integrated access of geospatial information (Budak, Sheth, & Ramakrishnan, 2004). Actual data will be kept under the jurisdiction of the organization producing that data. A user will be interested in availing geospatial services through well-defined interface. Without some internationally agreed upon standards for geospatial data and computational methodology, this cannot be made into existence. This chapter discusses several issues towards geospatial interoperability and adoption of *geography markup language* (GML) (Cox, Cuthbert, Lake, & Martell, 2001; Lake et al., 2005) as a common geospatial data format. The associated technologies that can be used for realizing geospatial interoperability have also been discussed.

BACKGROUND

The need for integrated and interoperable geospatial system has been felt for long time and several methods for information integration have been adopted into geospatial domain as well (Devogele et al., 1998; Guan et al., 2003). NSDI (Shekhar, Vatsavai, Sahay et al., 2001) attempts to bring the single point accessibility of geospatial information. But the heterogeneity in geospatial data formats and access mechanism immediately puts into concern about some standard way of sharing data.

The *Open Geospatial Consortium* (OGC) (2000) is an international voluntary consensus standards organization defining standards to bring geospatial computing into mainstream computing. In OGC, several organizations worldwide collaborate in an open consensus process encouraging development and implementation of standards for geospatial content and services, GIS data processing and exchange. The standards defined by OGC are popularly known as *open GIS standards*. These are being adopted by GIS vendors, which in turn increase the possibility of geospatial data sharing. The proposition of geography markup language (GML) (Cox et al., 2001; Lake et al., 2005) as standard data transformation format and service based sharing of geospatial interoperability is going to add new dimension in geospatial interoperability.

The proposition of GML has changed the concept of sharing geospatial information among large-scale users.

Being an XML-based encoding method, GML allows users to share the geospatial information irrespective of the platform or the system in which the data repositories are residing (Badard & Richard, 2001; Zaslavsky, Marciano, Gupta, & Baru, 2000). The advancement of Web service technology and service oriented architectures (Erl, 2004) has led the further progress in geospatial information domain. Geospatial data are now increasingly becoming available on the Web (Kim & Kim, 2002) as geospatial services. The advantage is that they are capable of providing geospatial data in GML-encoded format. Thus, anybody having the knowledge about the geospatial service interface can utilize the information in their application.

GEOSPATIAL INTEROPERABILITY

The main objective of the chapter is to discuss the support that GML and its associated technologies provide towards interoperability.

Geography Markup Language

XML technology today is extremely widespread. It is the "lingua franca" of emerging e-business frameworks, and it powers the generation of thousands of Web sites[1]. Due to its text format it is easily processable across different computing platform. XML has changed the way people thought about interoperability among large-scale disparate systems. GML is based on XML with added support for spatial geometries. In GML, geospatial entities are treated as features. Each feature should have its own properties, both spatial and non-spatial. It is proposed that data has to be shared to the user in GML encoded format irrespective of the heterogeneity of their data formats (Cox et al., 2001; Lake et al., 2005).

There are several base structures defined for modelling a geospatial domain in GML like geometry, features, and so forth. A sample GML instance depicting a geospatial feature *School* is shown in Figure 1. It assigns a feature-id (say, *fid*) for the feature. The polygon geometric element describes the spatial expansion of the feature. It is also geo-referenced by spatial reference system by the element *srsName*.

GML Geometry

Several basic primitive geometry elements have been described in GML for describing the geometric properties of real world objects like rivers, roads, states and so forth. Table 1 provides detailed description of different GML geometry elements. The base schema *geometry.xsd* provides the constructs and structure for geometries. There are a number of homogeneous geometry collections that are predefined in the geometry schema[2]. The fundamental geometry element is "co-ord." All other geometry elements are derived from this basic geometric element. Some of the composite geometry structures in the geometry core schema are as follows: a *multipoint* is a collection of *points*; a *MultiLineString* is a collection of *LineStrings*; and a *MultiPolygon* is a collection of *polygons*. Many new geometric elements have been added to the geometry schemas in GML 3.0, including *curve*, *surface*, *solid* and so forth.

GML Feature

GML defines features, which are different from the concept of geometry objects. A feature is an application object that represents a physical entity, for example, a road, a river, or a forest. A feature may or may not have geometric aspects. The distinction between features and geometry objects in GML contrasts with models used in other geographic information systems.

In GML, a feature can have various geometric properties that describe aspects or characteristics of the feature (e.g., the feature's *point* or *extent* properties). The feature structure

Figure 1. A sample GML instance for a feature school

```
<Feature  fid="142" featureType="school" Description="A middle school">
  <Polygon name="extent" srsName="epsg: 27354">
    <LineString name="extent" srsName="epsg: 27354">
      <CData>
        491888.99,5458045.99,491904.99,5458044.99 491908.99,
        5458064.99, 491924.99, 5458064.99 491925.99, 5458079.99,
        491977.99, 5458120.99 491953.999999466, 5458017.99963357
      </CData>
    </LineString>
  </Polygon>
</Feature>
```

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