XML-BASED SPATIAL DATA INTEROPERABILITY ON THE INTERNET

Yumin Chen, Jianya Gong, Wenjue Jia, Qi Zhang

State Key Laboratory for Information Engineering in Surveying, Mapping and Remote Sensing, Wuhan University, 129 Luoyu Road, Wuhan, HuBei, China, 430079

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ABSTRACT:

With the development of network and information technology, the spatial data gain, sharing, issuing and analysing plays a more and more important role in the decision of each department. This article discusses the method of the spatial data interoperability based on XML; thoroughly compares two kinds of applications standard in the specialized domains of XML—GML(Geography Mark-up Language) standard and SVG(Scalable Vector Graphics) standard. Considered their different characteristic, the spatial data interoperability system based on GML and SVG has been designed and practiced. GML is chosen to take the spatial data storage and transport standard, however there is not a general tool to show the GML map, so it can be changed to SVG format and browse the map through the plug-in of SVG Viewer. The four- layer structure of the application system is designed, that is the Database Server, the Web Services, the Web application Server and the Client. The implementation system is supporting XML and the surrounding web services technology. The result is satisfied and the technology on spatial data interoperation based on XML will have wide development prospects.

1. INTRODUCTION

With the development of network and information technology, the spatial data gain, sharing, issuing and analysing plays a more and more important role in the decision of each department. A lot of database have been built base on the traditional GIS platforms (such as ArcInfo software in early stage) by all departments now. Geographic datasets are increasingly being shared, exchanged, and used for purposes other than their producers' intended ones. How to useful implement spatial data sharing and interoperability is the key problem in the GIS field.

The OGC addressed the issue of standards in GIS so that data and information from numerous sources can be integrated with the capabilities of GIS for the development of various applications. In their study, they define the specification and interfaces that are connecting GIS for data processing. Web services are building blocks for creating open distributed systems. Web services may be an evolutionary step in designing distributed applications, and communicate using HTTP and XML (Extensible Mark-up Language).

This article discusses the method of the spatial data interoperability based on XML; thoroughly compares two kinds of applications standard in the specialized domains of XML— GML(Geography Mark-up Language) standard and SVG(Scalable Vector Graphics) standard. Considered their different characteristic, the spatial data interoperability system based on GML and SVG has been designed and practiced. The spatial data come form three different platforms, that is ArcInfo software, Geostar software and GeoSurf software, can be shared and interoperated successfully.

2. SPATIAL DATA MARKUP LANGUAGE BASED ON XML

XML is the new standard for the data expression and data exchange on Internet, and also, just the character of XML makes the Web integration possible. Therefore, and device, which supports these technologies, can both host and access Web services.

GML is an XML encoding for the spatial data storage and transport standard, because it provides an open, vendor-neutral framework for the definition of reference systems and units of measure for geo-spatial information, and geographic application schemas and objects. It defines geo-spatial features with geometry, geo-spatial coverage, and allows profiles that support proper subsets of GML framework descriptive capabilities. It is enable the creation and maintenance of linked geographic application schemas and datasets, and support the storage and transport of application schemas and data sets.

SVG is a language for describing two-dimensional vector and mixed vector/raster graphics in XML. SVG allows for three types objects: vector graphics, images and text. All of the objects can be grouped, styled, transformed and composite into previously rendered objects. It has the function of nested transformations, clipping paths, alpha masks, filter effects and template objects. Other more, SVG drawings can be interactive and dynamic, and it supports the DOM interface in XML.

3. SPATIAL DATA INTEROPERABILITY AND VISUALIZATION BASED ON XML

3.1 Web Service and XML Using in GIS

There are two methods of interoperation based on XML. One is to exchange all data sets into the format described by XML, then other systems can export the data into internal schema according to the uniform specification; the other is real-time exporting data while is reading. The component for spatial data's reading, writing or querying is shown on XML or SOAP protocol. Reading spatial objects from database management system simultaneously, the system can export the spatial data into data stream defined the public interface by XML. Then other system can get the spatial data and query in real time. This can realize online data sharing and interoperation. The data stream based on interface of XML is ASCII code, which is easy to understand and realize the interoperation of the different platform.

OGC and ISO/TC211 formulate the specification for spatial data interoperability based on web service/XML together, such as Web Map Service (WMS), Web Feature Service (WFS), Web Coverage Service (WCS) and Geographical information mark language (GML) etc. In it, WMS can make a map using the data with the information of Geographical space, which defining map as the Geographical data representation. The specification defines three operations: "GetCapabilities" give the server metadata, which is a description of the service's content and the necessary parameter; "GetMap" return a map which the spatial reference and parameter are defined; and "GetFeatureInfo" (available) give the information of the special feature on the map. The flow of WMS is showed in Fig.1. At first, client gets the service metadata from GetCapabilities operation, and then client calls the GetMap interface, puts values into the specified parameters, and can get a map from server. Lastly, client calls GetFeatureInfo operation and gets the information of the appointed feature. This system realizes the WMS specification mainly.

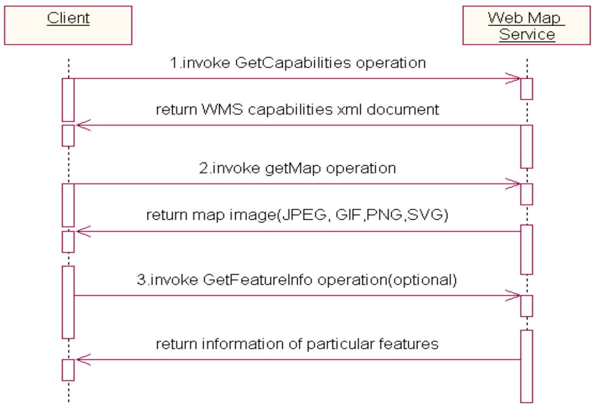


Fig.1 The flow of Web Map Service

Considering of the difference between GML and SVG, this paper discuss the model of interoperation and visibility of spatial data based on XML. For it can describe spatial object outright, GML is seemed as the spatial data storage and transport standard. But there is no common tool to show and browse the map on GML, it has to realize through programming which will add a lot of workload. SVG support the two-dimensional vector description, and it just need SVG viewer to brows Web Map page. An SVG viewer is a program, which can parse, and process an SVG document fragment and render the contents of the document onto some sort of output medium such as display or printer. JavaScript and Dom interface can do the complicated spatial operation based on SVG.

3.2 A model of the System

For implement the interoperability and visualization of the spatial data in distribute network, the system applies the four-layer structure on web services, which are the Database server, the Web Services, the Web application Server and the Client, shown in Fig.2. The Database server stores the data from different GIS platforms and has the function to exchange the data into the defined GML schema by the data exchanging components. The Web Services are according to the OGC's specification of the Web Map Service Implementation Specification. Two web services function that are "GetCapabilities" and "GetMap" function are implemented. A Web Map Service produces maps of unified geo-referenced data.

These maps are generally rendered in a pictorial format such as PNG, GIF or JPEG, or occasionally as vector-based graphical elements in SVG. Here we choice the SVG format as our web services output format. SVG documents are sent to client (with SVG Viewer) by the Web application Server. The system flow is that client sends a request, then Web application server accept the request and call the corresponding operation defined by WMS specification, and the data stored in different GIS platform has to be exported into GML documents which have to be changed into SVG format by the data exchanging components. At last, SVG is returned to the client and shown by SVG viewer.

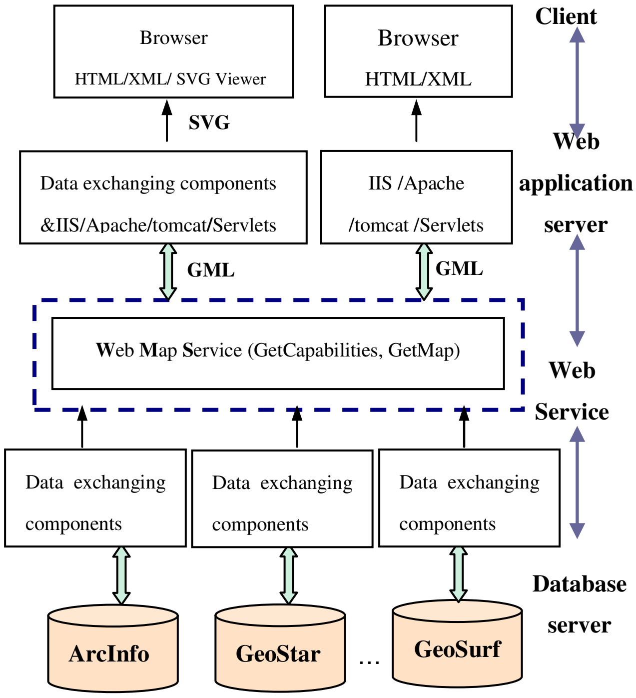
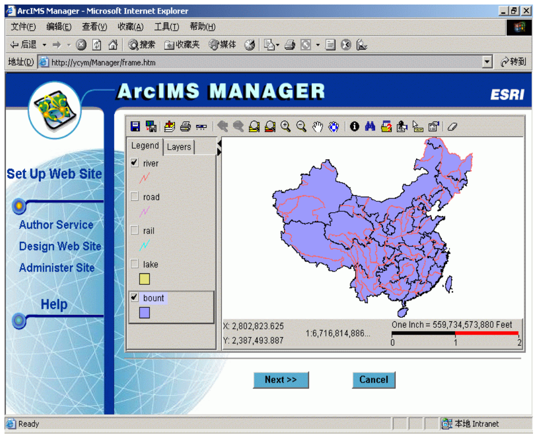


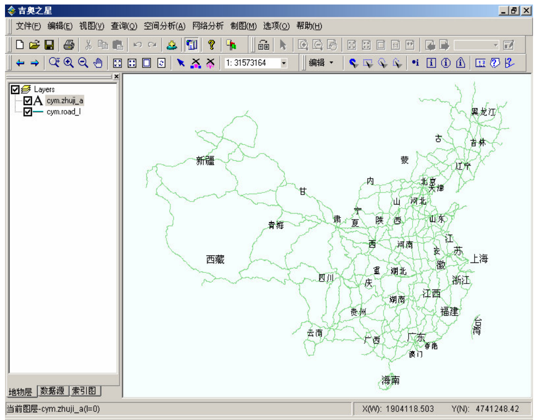
Fig. 2 The structure of XML-based spatial data interoperability system

4. IMPLEMENTATION

The data of Chinese administrative division scale at 1:4,000,000 are stored in the three different GIS software platforms of ArcInfo, Geostar and Geosurf on the data format required by respective system. But in each system the data is not integrity. The data such as BOUNT (the borderline of national provinces) and RIVER (the borderline of rivers) are stored in the ArcIMS system by the ArcInfo platform, which is showed in Fig.3 (a). The data such as ROAD (the midline of road) and ZHUJI (the Annotation of national provinces and cities) are stored in the Oracle database on the platform of Geostar, which is showed in Fig.3 (b). The data such as LAKE (the borderlines of lakes) and RAIL (the national railways) are stored in the Geosurf platform by the file format.



(a) The data stored in ArcIMS system



(b) The data stored in Geostar system

Fig.3 The data of Chinese administrative division scale at 1:4000000 stored in the different GIS platforms

The spatial data interoperability and visualization system based on XML gets GML format document by the data exporting components changing the data stored in ArcIMS platform, in Orcale database for Geostar platform and in the file system for Geosurf platform respectively. The second-development functions provided by ArcIMS can export the data into GML document, and the components of Geostar4.0 has the function to export the data stored in oracle database into GML document. JavaBean components of Geosurf4.0 have the same function. The web services and web application server are programmed by Microsoft Visual Studio .Net. The system overlaps the GML data with each other and obtains the data information within the required envelope. Lastly use SVG exporting components to change the output GML data stream into the SVG data which will be send to client for the operations such as browser, zoom in, zoom out, etc. The result is showed as Fig.4.

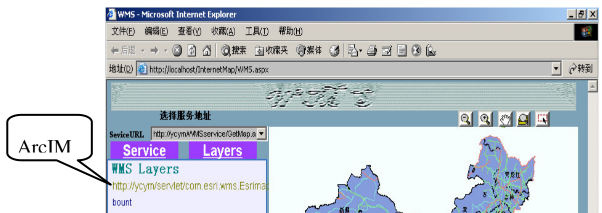
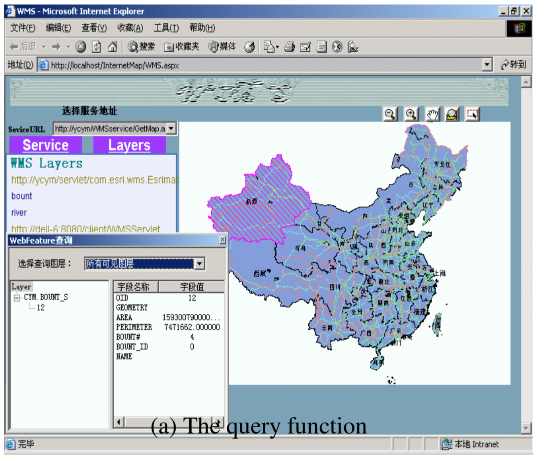


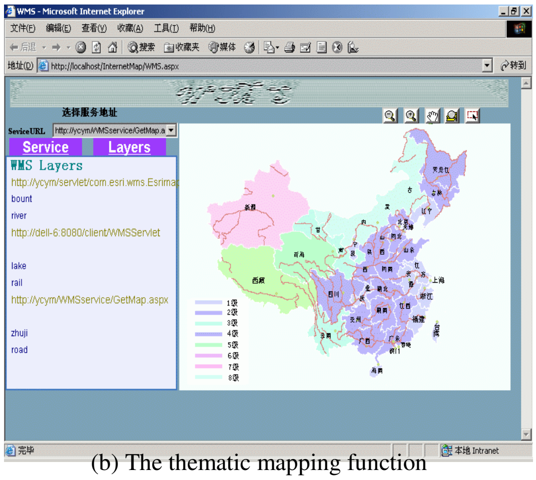
Fig.4 The data integration of three different GIS platforms at client

This system has provided the functions of the spatial data query and thematic mapping based on GML and SVG. How to realize the query function? At first, user selects the query feature by clicking with the mouse at client. In SVG every graphic element has exclusive ID number for identifying with each other. We can get the ID number by these mouse response events of being responded by graphic elements such as "onClick" event through JavaScript language. The attribute data are stored in the GML document. The ID of attribute data is corresponding with the ID of the graphic element. So the attribute data stored in GML document can be found easily from the relevant graphic ID. The result is showed as Fig.5 (a)

In order to realize the thematic mapping, it is required to ascertain the thematic range of the certain attribute of the feature. Such as Fig.5 (b), it is the thematic mapping with the "area" attribute of the layer of BOUNT (the borderline of national provinces). It is divided into eight levels. The first level is the range from zero to 15,0000 sq .km, and the second is between 15,0000 sq .km and 30,0000 sq .km, ……. We can search the "area" attribute value of each feature in the layer of BOUNT in the GML document, reset different symbol colours to the features in different interval range based on the division above while exporting GML document into SVG format, then browse the SVG format in the explore with SVG Viewer. So the thematic mapping is realized.



(a) The query function



(b) The thematic mapping function

Fig.5 The system's function of query and thematic mapping

5. CONCLUSION

As a new developing technology, XML has been used in many domains. The superiority of XML in the semantic definition, data exchange and information search make it be possible to apply XML to GIS field and to realize the spatial data interoperability from many different systems.

Comparing deeply GML and SVG specification, we can get the result that GML is a geographic mark-up language, and it has almost considered every necessary aspect of GIS application. GML object model is designed for all kinds of questions appearing in GIS application. While SVG is a common planar vector graphic description and it is not direct for the professional field of GIS. But SVG has the function to browse graphics easily by SVG viewer. Mutually combining the two kinds can completion effectively the interoperability and visualization of spatial data.

Through the system experiment, it is known that the model of spatial data interoperability and visualization based on GML and SVG is feasible. This model can resolve the interoperability and visualization of the data from heterogeneous data sources. The technology on spatial data interoperation based on XML will have wide development prospects.

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