

THE RESEARCH AND APPLICATION OF WFS BASED GML

JIANG Jun, YANG Chong-jun, REN Ying-chao, JIANG Miao

The State Key Laboratory of Remote Sensing Information Sciences, IRSA, CAS, Beijing, 100101 -
jiangjun224@gmail.com

KEY WORDS: GML, SVG, WFS, Geospatial Information

ABSTRACT:

The Web Feature Service (WFS) developed by the Open GIS Consortium (OGC) provides geographic data encoding in Geographic Mark Language (GML) on feature level. The WFS specification defines interfaces for data access and manipulation operations on geographic features using Http as the distributed computing platform. Since GML becomes more and more important in data exchange, transfer and storage, an integrated system which contains WFS will be an important part of Web GIS frameworks in the future. This paper presents a geo-spatial data manipulation system. The system can retrieve and analyze the geographic data features from a WFS server and display them in vector graphs. With this system, users can get vector data in need directly without being confused by the GML file returned from the WFS server. As a result, WFS will facilitate more users, not just those who can parse the GML file.

1. INTRODUCTION

1.1 General Instructions

With the great development of Internet, Geographic Information System (GIS) has changed from desktop, centralized systems to network distributed systems. [1] In order to solve the problem of the share and the commutative operation of the different data sources on feature level, the Open GIS Consortium (OGC) provides Web Feature Service (WFS) specification. [2]

The OGC Web Feature Service allows a client to retrieve geospatial data encoded in Geography Markup Language (GML) from multiple Web Feature Services. GML is an XML based encoding standard for geographic data on data level. GML describes the world in terms of geographic entities called features, which makes it difficult and non-figurative for general users to understand. Therefore, it is necessary to transfer the GML files to vector graphics which can be easily accepted by general users. [3]

1.2 Related Works

There are two ways to transfer GML files to vector graphics. One of them is to analyze the features directly and display them one by one. The other is to transfer the GML files to graphic format data, such as Scalable Vector Graphics(SVG), Vector Markup Language(VML) and X3D, then display them by the software which supports these graphic format data.

SVG is a vector graphic describing language based on XML. SVG features are instructions that indicate how to draw graphics. When the viewer reads these features, vector graphics can be displayed. Because SVG can display various high quality graphics on web pages and supports numerous functions such as filter, cartoon and so on, more and more users choose to transfer the GML files to SVG files in order to display the vector graphics. [4]

This paper presents a geo-spatial data manipulation system adopting such converting. The system can retrieve and analyze

the geographic data features from a WFS server and display them in vector graphs. With this system, users can get vector data directly without being confused by the GML file returned from the WFS server. As a result, WFS will facilitate more users, not just those who can parse the GML file.

2. WFS, GML AND SVG

2.1 WFS

A WFS server publishes feature-level geospatial data to the web. Instead of returning an image, as MapServer traditionally does, the client obtains fine-grained information about specific geospatial features of the underlying data, at both the geometry and attributes levels. As with other OGC specifications, this interface uses XML over HTTP as its delivery mechanism, and, more precisely, GML, which is a subset of XML. The WFS specification defines interfaces for data access and manipulation operations on geographic features, using Http as the distributed computing platform. Via these interfaces, a web user or service can combine using and managing geospatial data—the feature information behind a map image—from different sources. [5]

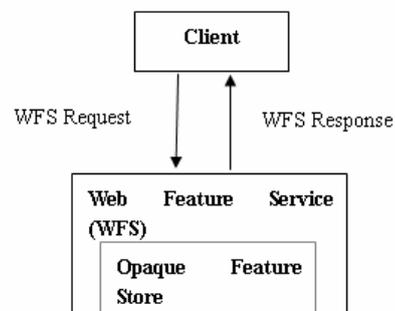


Figure 1: WFS Specification

The main interfaces provided by WFS are: GetCapabilities, GetFeatureType and GetFeature.

The operations	the introduction
GetCapabilities	Return the service capabilities such as the version, the name and the content
GetFeature	Return the features offered by the server
DescribeFeatureType	Return the feature type

Table 1: the main operations of the WFS server

2.2 GML

Geography Markup Language (GML) is the XML grammar defined by OGC to express geographical features. GML serves as a modeling language for geographic systems as well as an open interchange format for geographic transactions on the Internet. Note that the concept of feature in GML is a very general one and includes not only conventional "vector" or discrete objects, but also coverage (see also GMLJP2) and sensor data. The ability to integrate all forms of geographic information is the key to the utility of GML. [6]

The original GML model was based on the World Wide Web Consortium's Resource Description Framework (RDF). Subsequently, the OGC introduced XML schemas into GML structure to help connect the various existing geographic databases, whose relational structure XML schemas are more easily defined. The resulting XML-scheme-based GML retains many features of RDF, including the idea of child elements as properties of the parent object (RDFS) and the use of remote property references.

The advantages of the GML are:

- 1 The universal modules can use it repeatedly.
- 2 It can achieve the commutative operations in GIS.
- 3 The coherence of the web service.
- 4 The content is separated from the display, with Extensible Style sheet Language Transformations (XSLT); it can be converted to some other XML files which can be displayed with ease.
- 5 GML encapsulates the geographic information, attributes information, space coordinate system and so on, which advances the flexibility and scalability of the distributed systems.

Below are some fragments in a GML file:

```
<gml:Point gml:id="p21"
srsName="urn:ogc:def:crs:EPSG:6.6:4326">
<gml:coordinates>45.67, 88.56</gml:coordinates>
</gml:Point>
```

```
<gml:LineString gml:id="p21"
srsName="urn:ogc:def:crs:EPSG:6.6:4326">
<gml:coordinates>45.67, 88.56
55.56,89.44</gml:coordinates>
</gml:LineString >
```

2.3 SVG

Scalable Vector Graphics (SVG) is a text-based graphic language that describes images with vector shapes, text, and embedded raster graphics.

SVG files are compact and provide high-quality graphics on the Web, in print, and on resource-limited handled devices. In addition, SVG supports scripting and animation, therefore is ideal for interactive, data-driven and personalized graphics.

SVG is a royalty-free vendor-neutral open standard developed under the W3C (World Wide Web Consortium) Process.

Advantages of using SVG over other image formats (like JPEG and GIF) are:

- 1 SVG files can be read and modified by a large range of tools (e.g. notepad)
- 2 SVG files are smaller and more compressible than JPEG and GIF images
- 3 SVG images are scalable
- 4 SVG images can be printed with high quality at any resolution
- 5 SVG images are zoom able. Any part of the image can be zoomed without degradation
- 6 Text in SVG is selectable and searchable (excellent for making maps)
- 7 SVG works with Java technology
- 8 SVG is an open standard
- 9 SVG files are pure XML

Below are some fragments in a SVG file:

```
<?xml version="1.0" encoding="utf-8" ?>
<svg style="height:600px;width:400px;" version="1.1"
xmlns:myns="http://www.ttt.org/myns"
xmlns:wfs="http://www.opengis.net/wfs"
xmlns:gml="http://www.opengis.net/gml"
xmlns:ogc="http://www.opengis.net/ogc"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xmlns="http://www.w3.org/2000/svg">
<polyline points="219116.625000,3659931.500000
221269.....
....."
```

3. SYSTEM ANATOMY

With a WFS server's URL offered by users, the system gets the capabilities of the WFS via the GetCapabilities interface. When the system provides the name, the content and the bound ... of the features in the service, users can choose what they are interested in. Then the system gets the GML file of the feature users want, and finally convert the GML file to SVG to display it in vector graphic. The following figure shows the structure of the system.

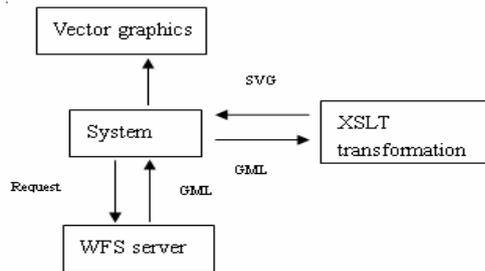


Figure2: the structure of the system

3.1 Convert GML to SVG

3.1.1 XSLT

XSLT is a language for transforming XML documents to XHTML documents or to other XML documents. In the first step of converting, the system builds a dynamic Extensible Stylesheet Language Transformations (XSLT) file. Generally, XSLT transforms each XML element to another XML element. Since each element in GML files corresponds to different elements in SVG files, the system has a database to deposit their corresponding relations. The table 2 shows the corresponding elements between the GML and SVG.

GML elements	SVG elements
Point	circle
MultiPoint	grouped circles
LineString	polyline
MultiLineString	grouped polylines
Polygon	path
MultiPolygon	grouped paths

Table2: corresponding elements between the GML and SVG

In addition, in order to find the elements in the GML files exactly, the XSLT needs to know the sequence of the elements in GML files. However, the sequence of the elements is not deterministic, so the path in which XSLT can find the objective element varies according to different orders. To figure out the path problem, the system analyzes the structure tree of the GML file. If the GML file is huge, it takes a long time to analyze. In this situation, the system will make a request via the DescribeFeatureType interface and get a XML file which describes the sequence of the elements. By parsing the returned XML file, the system can also make the paths for the elements.

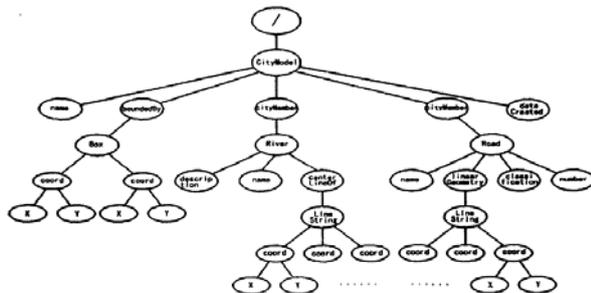


Figure3: The structures of the elements in GML file [7]: Below are some fragments about the sequence of the elements:

```
<xsl:template match="/">
<svg style="height:600px;width:400Px;"
version="1.1"
xmlns="http://www.w3.org/2000/svg">
<xsl:for-each
select="wfs:FeatureCollection/gml:featureMember/myns:prov_land/myns:msGeometry/gml:LineString">
<xsl:variable name="linearRingCoord12">
<xsl:value-of select="gml:coordinates" />
</xsl:variable>
```

3.1.2 The corresponding coordinates

The coordinates in the GML files adopt the geographic coordinate system, but SVG uses the user coordinate system. In the user coordinate system, the X direction is the same as that in the geographic coordinate system, but the Y direction is opposite. Therefore, the system needs reverse the Y direction in the transformation. In the XSLT file, when the coordinates in the Y direction is found, they need to be multiplied by -1.

Furthermore, in the SVG files, there is a view-box to specify the area of the vector graph. The view-box is usually a rectangle, and it is measured in pixels. After the system limits a scope to display the graph, it is necessary to convert the coordinates in the geographic coordinate system to the pixels coordinates. First, the system finds out the maximal and minimal coordinates in the X and Y directions. Because the response from the GetCapabilities interface describes the scope of the features, the system can carry out a circle programme to figure out the scope of all the features. Then, the system compares the maximal and minimal coordinates with the area limited in the SVG files, and calculates the scale of the two coordinate systems. Finally, when the system converts the coordinates in the GML files, every coordinate needs to be multiplied by the scale.

Below are some fragments about the scale in the XSLT file:

```
<xsl:for-each
select="wfs:FeatureCollection/gml:featureMember/myns:prov_land/myns:msGeometry/gml:LineString">
<xsl:variable name="linearRingCoord12">
<xsl:value-of select="gml:coordinates" />
</xsl:variable>
<polyline points="{linearRingCoord12}"
transform="scale(7.154182E-05,-7.154182E-05),translate(2750565,-4654497)"
style="fill:none;stroke:red;" stroke-width="1" />
</xsl:for-each>
```

After the work above, the system can build the XSLT file, and convert the GML file into the SVG file with the classes in the .Net framework. The web browser can draw vector graphs by features in SVG files, so users see figurate graphs directly.

3.2 The Filter

WFS support OGC Filter Specification. It is necessary to restrict the features returned to exactly what the subset users

want, as users are seldom interested in all the features that a WFS server provides. There are two types of filters: spatial and comparison. The spatial operations determine whether a geometry property satisfies the relation given. There are 11 spatial filter types defined in the specification, such as Disjoint, within, intersect, Bbox etc. The Bbox operations send a bounding box to the WFS server and the system gets a list of geographic properties within the envelope provided. So when the users read the parsed capabilities, they can specify a geometry box to choose the features they want, and the system will display the vector graphs they choose.

In this system, when users choose a feature name which they are interested in, the system chooses the filter that defines the feature to make a request. Furthermore, if users choose a coordinate scope, the system uses the Bbox to define the scope to make a request.

4 THE IMPLEMENTATION OF THE SYSTEM

The implementation of the crawler is carried out on the windows XP operating system, using visual studio 2003 as the develop tool and SQL Server 2000 as the database.

When the user gives a WFS server's URL, the system make a request to the server via the GetCapabilities interface. The response is a XML file with the capabilities of the server. After analyzing the XML file, the system shows the name, the content and the coordinate scope of the features... Users can choose the feature name which is interested in or the coordinate bound, then system requests to the server with the filter and then get back the GML file with the content that users want. Finally, the system converts the GML file to SVG file, and displays the vector graphs.

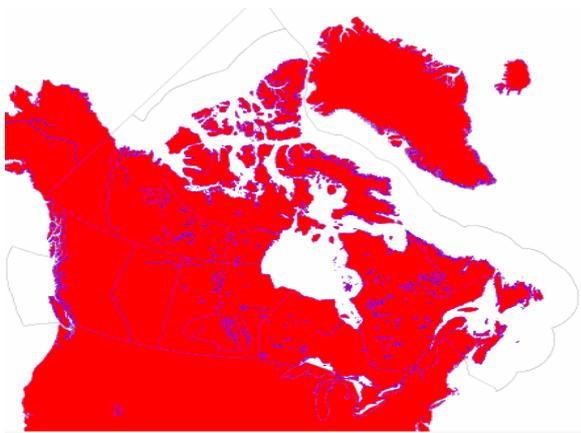


Figure 4: the vector graph by SVG file transferred from GML file

5 CONCLUSIONS

GML has become more and more common in many Geographic applications. XML has made such a great progress that many applications working with XML files are available, GML will also benefit from it. With GML, the real world spatial information can be described in feature level and it is easy to exchange or integrate data among different data providers. Today more and more geographic information are offered as GML since many new WFS servers appear form big data provide companies to diversified geography unions. The method that this paper presents is an effective way to operate on the service by WFS server, and makes it easy for users to fetch visualized geographic information. Consequently more users can take part in the spatial web and more geographic resource can be well used.

REFERENCES

- [1] The Design and Implementation of Web GIS Architecture Based on GML and SVG; CHANG Xiaohui, LI Hongwei, HUANG Haiwen, CHEN Xu
- [2]IMPLEMENTATION OF W EBGIS BY GML AND SVG; ZHANG Qi DU Daosheng CHEN Yumin
- [3] Study on The GML&SVG -Based W ebGIS Model; Chen Chuanbo, Duan Honghua
- [4] An Approach of Spatial Information Publishing Based Oil SVG +GM L; Jian Youguang,Li Yan
- [5] Web_Feature_Service_WFS_02-058
- [6]07036_Geography_Markup_Language_GML_V3[1].2.1
- [7] Implementation of GM L Document Visualization By using XSLT; Dang Wensheng LuYan sheng