Interoperability of Spatial Data through Open Web Map Server

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Abstract: Over the past few years, a number of studies have been made on web map services, which enable the GIS user to access spatial data through the web. They, however, have focused on only implementation techniques separately, such as map client implementation, map server implementation, communication between client and server, and the map data representation. Therefore, it is hard to share and practical use the spatial data, because they does not ensure interoperability in heterogeneous map servers. In this paper, we have designed and implemented the web map server with open architecture, which complies with the standard interfaces proposed by OpenGIS Consortium (OGC). In particular, we have extended the OGC's interfaces for a map server to support one or more data sources. This paper has contributed to construction and practical use of web map services by newly proposing the method of implementation of a map server, which could be reused regardless of the types of data sources.
Keywords: Web GIS, Web Map Server, OpenGIS

1. Introduction

Past related works for web map services have focused on the individual techniques to implement the map clients and map servers. For example, according to the types of map data served through the web, i.e. raster map and vector map, there are various implementation techniques. In the case of serving the raster map, it is important when and how the map server generates these raster maps. These works can be classified into two main groups; works related to statically generate raster maps before issuing any map requests, and works related to dynamically generate raster maps. In the case of serving the vector map, there have been various kinds of implementation techniques for map clients rather then map servers. This is because, without any extensions such as plug-in, active-x, and java applets, a web browser itself does not render and display vector maps.

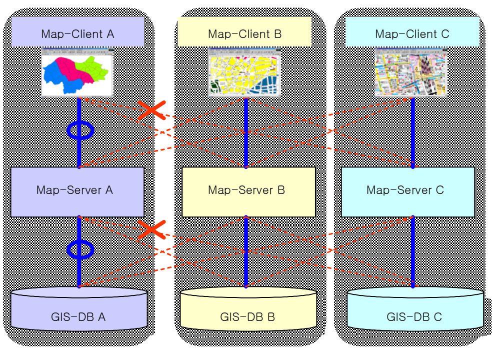


Fig. 1. Problem of previous web map services.

Problem Definition

These past works, however, have a serious problem, that map servers implemented by each technique are not interoperable with one another. As shown in Fig. 1, map clients dedicated by a specific map server, do not access any other map servers, therefore, a separate map client must be separately created for each map server. Web map services that do not support interoperability between different map servers have following problems. First, it is difficult to share and practically use the spatial data through web, because different kinds of web clients should be used according to the type of map server. Second, map clients with similar functionalities must be implemented repeatedly. Third, a map server has the same spatial data that other map servers also have, because a client do not access the spatial data included in other map servers. Therefore, it is required that an open architecture for map services should be applied to resolve the problems specified above.

Solution – Open Web Map Services

As shown in Fig. 2, in order to implement the open architectures for map services, we adjust the interfaces of map server and GIS-DB to open standard interfaces which are defined by OpenGIS Consortium (OGC). For example, the interfaces for Web Map Services (WMS) consist of three operations;

1. GetCapabilities: This provides information about what a map server can do.
2. GetMap: This provides maps as pictures (GIF, JPEG, etc.), or graphic elements (SVG, WebCGM, etc.).
3. GetFeatureInfo: This provides information about specific items on the map.

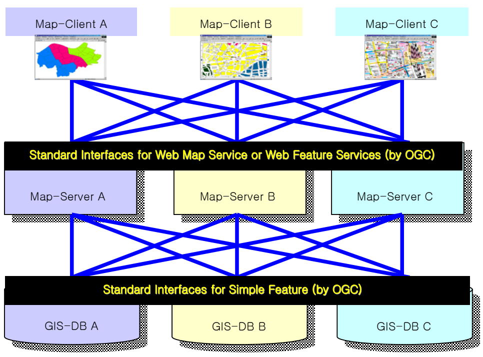


Fig. 2. Solution – Open Web Map Services.

Thus, the WMS specification describes the format of requests, the type of responses, and the way of error notifications if the requests fail. The web browser could access the spatial data from all of the map servers compliant with the standard interfaces in the same way. This facilitates the sharing of spatial data.

OGC's interfaces, however, have some other problems. In these interfaces, map client could not specify a specific data source (GIS-DB). That is, it does not discriminate among multiple data sources Therefore we have extended these interfaces to support multiple data sources. Detailed explanation is described in following section.

2. Design of Open Web Map Services

Fig. 3 shows overall architecture for the web map services which comply with the standard interfaces proposed in OGC. The map server has three kinds of roles. First, a map server could access uniformly spatial data from diverse spatial databases (data sources). That is, the map server could achieve a sense of seamless interoperability, due to the data provider, which provides the map server with common interfaces to communicate with several spatial databases. Fig. 3 shows that a map server (MS-2) could communicate with different spatial databases (DB-A, DB-B, and DB-C) through data providers (DP-A, DP-B, and DP-C, respectively) that support standard interfaces. Second, a map server generates a map from spatial data acquired from specific spatial database in suitable form according to the type of map requested. Third, a map server provides standard interfaces for web browsers. Therefore web browsers are able to use same interfaces to acquire maps from diverse map servers. It means that these standard interfaces ensure interoperability in heterogeneous map servers. Fig. 3 shows that a web browser could access maps from different map servers (MS-1, MS-2, and MS-3).

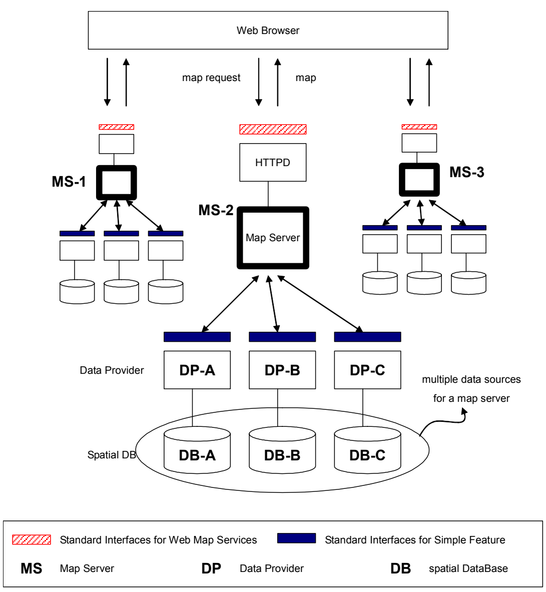


Fig. 3. Web Map Services Architecture.

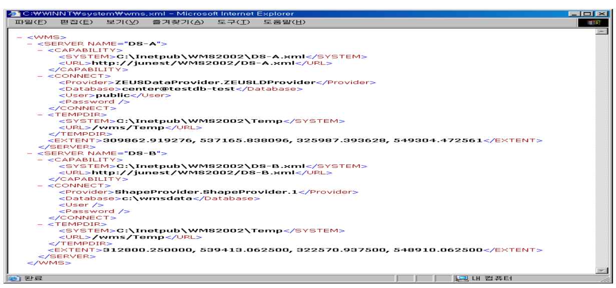
OGC's web map services support two types of spatial data. One is display element data, and the other is pictorial (or image) data. A web browser can specify the output format of the response to a map request. In this paper, we assumed that a map server could generate SVG file for display element data, and GIF file for pictorial data.

Extensions of Map Service Interfaces

In the web map services architecture proposed in this paper (see Fig. 3), the map server MS-2 could access more than one data source and theses data sources (DS-A, DS-B, and DS-C) are heterogeneous. One can search and retrieve the spatial data from several data sources, though he/she connects only one map server. This means that the map server supports multiple data sources.

According to the web map services implementation specification [10] by OGC, the map request interface (GetMap) does not specify the data source. That is, it does not discriminate among multiple data sources. Therefore, this paper extends the OGC's interfaces for a map server to support multiple data sources. GetMap request is represented by URL, and is composed of several parameters, such as WMTVER, REQUEST, FORMAT, LAYERS, STYLES, SRS, BBOX, and so on. We add the parameter 'DataSource' to inform a map server which data source to connect. For example, if "DataSource=DS-A" is specified in the GetMap request URL, a map server generate requested map from the spatial data, which is retrieved from a data source DS-A. In this paper, added parameter DataSource could be selectively used to maintain interoperability with other map servers which comply with OGC's standard interfaces. If a map client does not specify DataSource, map server connects with defaults data source among multiple data sources it maintains.

To maintain multiple data sources, a connection management component is added in map server. The connection management component maintains the list of multiple data sources, which are connected with a map server. Reading this list, the map server could know the parameters, such as Provider, Database, User, Password, and so on, to connect the specific data source. Figure 4 shows the example of connection management list. This means that the map server could connect with two different kinds of data sources, DS-A, and DS-B. DS-A is ZEUS database, and DS-B is shape file. The top element in the list is default data source.




```
- <WMS>
 - <SERVER NAME="DS-A">
  - <CAPABILITY>
     <SYSTEM>C:\Inetpub\WMS2002\DS-A.xml</SYSTEM>
     <URL>http://junest/WMS2002/DS-A.xml</URL>
    </CAPABILITY>
  - <CONNECT>
     <Provider>ZEUSDataProvider.ZEUSLDProvider</Provider>
     <Database>center@testdb-test</Database>
     <User>public</User>
     <Password />
    </CONNECT>
  - <TEMPDIR>
     <SYSTEM>C:\Inetpub\WMS2002\Temp</SYSTEM>
     <URL>/wms/Temp</URL>
    </TEMPDIR>
    <EXTENT>309862.919276, 537165.838096, 325987.393628, 549304.472561</EXTENT>
   </SERVER>
 - <SERVER NAME="DS-B">
  - <CAPABILITY>
     <SYSTEM>C:\Inetpub\WMS2002\DS-B.xml</SYSTEM>
     <URL>http://junest/WMS2002/DS-B.xml</URL>
    </CAPABILITY>
  - <CONNECT>
     <Provider>ShapeProvider.ShapeProvider.1</Provider>
     <Database>c:\wmsdata</Database>
     <User />
     <Password />
    </CONNECT>
  - <TEMPDIR>
     <SYSTEM>C:\Inetpub\WMS2002\Temp</SYSTEM>
     <URL>/wms/Temp</URL>
    </TEMPDIR>
    <EXTENT>312800.250000, 539413.062500, 322570.937500, 548910.062500</EXTENT>
   </SERVER>
  </WMS>
```


Fig. 4. Connection Management List.

3. Implementation Results

To access the spatial data from a map server, we send the map request URL through HTTP to the map server as shown in Fig. 5. The map server implemented in this paper support three format of map, such as JPEG, SVG, and GML.

(a) FORMAT = JPEG (b) FORMAT = SVG (c) FORMAT = GML

< Sample of Map Request URL >

http:// 129.254.75.50 /cgi-bin/wms.exe?WMSName=107&WMTVER=1.0.0&REQUEST=map&FORMAT=JEPG/SVG/GML&LAYERS=SP13,SC13,KN13&STYLES=default,default,default&SRS=EPSG:4301&BBOX=312800, 539413, 322570, 548910&WIDTH=600&HEIGHT=530

Fig. 5. Several Format of Map (JPEG/SVG/GML).

We have implemented two kinds of map clients, one is internet explorer version and the other is PDA version, which is shown as Fig.6 and Fig 7, respectively. Fig. 6 shows that through the open web map server, we could access several GIS-DB, such as SDE, ZEUS, and GMS, with same manner.

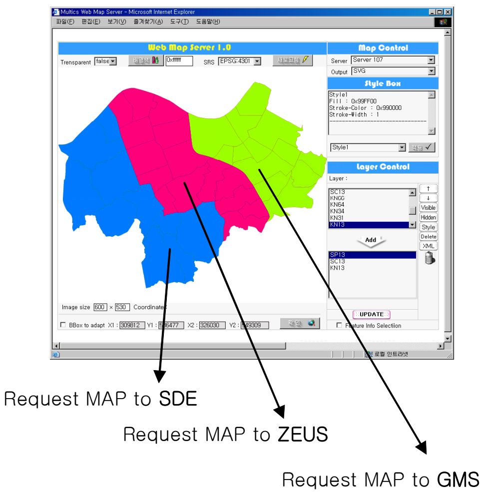


Fig. 6. Map Client (IE Brower Version).

4. Conclusions

Over the past few years, a number of studies have been made on web map services, which enable the GIS user to access spatial data through the web. They, however, have focused on only implementation techniques separately, such as map client implementation, map server implementation, communication between client and server, and the map data representation. Therefore, it is hard to share and practically use the spatial data, because they do not ensure interoperability in heterogeneous map servers.

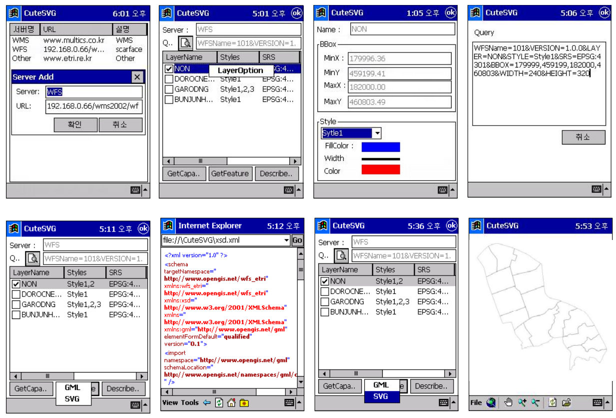


Fig. 7. Map Client (PDA Version).

In this paper, we have designed and implemented the web map server with open architecture, which complies with the standard interfaces proposed by OpenGIS Consortium (OGC). In particular, we have extended the OGC's interfaces for a map server to support one or more data sources. This paper has contributed to construction and practical use of web map services by newly proposing the method of implementation of a map server, which could be reused regardless of the types of data sources.

References

[1] A. P. Steinke, "Developing Geographic Services on the World Wide Web," ASIA-PACIFIC WORLD WIDE WEB '95 CONFERENCE, 1995.

[2] B. Plewe, "A Primer on Creating Geographic Services," GIS World Magazine, pp.56~58, 1996.

[3] D. Crossley and T. Boston, "A Generic Map Interface to Query Geographic Information Using the World Wide Web," Fourth International World Wide Web conference,1995.

[4] K. E. Foote and A. P. Kirvan, "WebGIS, NCGIA Core Curriculum in GIScience," http://www.ncgia.ucsb.edu/giscc/units/u133/u133.html, posted July 13, 1998.

[5] F. T. Fonseca and C. A. Davis Jr., "Using the Internet to Access Geographic Information: An Open GIS Interface Prototype," Conf. and Workshop on Interoperating Geographic Information Systems, 1997.

[6] J. P. Alexander and V. J. Warwick, "Writing GIS Applications for the WWW," Proceedings of the 1997 ESRI User Conference, 1997.

[7] Open GIS Consortium Inc., The OpenGIS Abstract Specification Model Version 3, 1998.

[8] OpenGIS Consortium Inc., OpenGIS Discussion Paper#01-023: Web Feature Service Draft Candidate Implementation Specification 0.0.12, 2001.

[9] OpenGIS Consortium Inc., The OpenGIS Simple Feature Specification for OLE/COM Revision 1.1, 1999.

[10] OpenGIS Consortium Inc., Web Map Service Implementation Specification 1.1.0, 2001.

[11] OpenGIS Consortium Inc., Web Map Server Interface Implementation Specification 1.0.0, 2001