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Integration of the Internet GIS components for geological analyses

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Abstract: The objective of this study is to implement geological functions on the Internet such as the visualization, search and analysis of geological data. To improve their performance and reduce the cost during development, special concerns should be given to the dynamic integration and interoperability of them. XML Web Service technologies can be adopted and OpenGIS specifications should be considered for the integration of distributed GIS components and their interoperability. Because standard Internet protocols and XML Messages are used in the Web Service, it makes the integration among different hardware and software systems possible. OpenGIS specifications also enable users to get benefits from geographic information and services across any network, platform and application. A prototype of efficient Internet GIS applications has been suggested in this study.

1. Introduction

Geological data can provide useful information about both the surface and underground condition of the target site. The vast amount of geological data can not be easily managed without using database and GIS. Recently, because of advantages of Internet GIS, most of GIS applications have been modified from desktop GIS to Internet GIS (Kraak and Brown, 2001; Plewe, 1997; Richard, 2000; Tang and Selwood, 2003). Internet GIS can support unlimited users and can be accessible from anywhere and at anytime. The Internet also has become an essential means to share geological information in the field of Internet GIS (Rohrer and Swing, 1997; Abel et al., 1998; Doyle et al., 1998; Zhu et al., 2001). However, the hardware and software systems on the Internet are very different for each GIS application. To improve the performance and reduce the cost of them, special concerns should be given to the dynamic integration and interoperability. A prototype model of efficient Internet GIS applications has been suggested in this study.

2. Implementation of geological functions on the Internet

Geological data have been frequently used in many fields such as civil construction, natural resource exploration, environmental project to supplement information about surface and underground condition. GIS can be one of the best solutions to manage these geological data especially in the field of geotechnical engineering. Recently, most of GIS applications have been modified to the form of Web-based GIS due to advantages of the Internet GIS. Thus many geological functions also should be implemented on the Internet for each complete Internet GIS application. Table 1 presents examples of GIS applications data and its geological functions on the Internet.

Table 1. OpenGIS Implementation Specifications (OGC, 2003).

Application	Geological functions	Reference
GeoLibrary	· Gazetteer service · Server catalogue · Metadata search	(Jankowski et al., 2001)
GeoFrance3D	· Metadata search · Database query · 3D visualization	(Guillen et al., 2001)
GeoVR	· 2D/3D data conversion · 3D Visualization · VRML scene generation	(Huang and Lin, 1999; Huang and Lin, 1999; Huang et al., 2001)
SwingStations	· Database query · 3D Visualization · Environmental modelling	(Sokolov and Wulff, 1999)

3. Integration and interoperability of the Internet GIS components

Most of systems and resources were centralized on one local machine in the case of desktop GIS applications. Compared to them, systems and resources of Internet GIS are usually distributed on multiple machines and one complete application can be implemented by combining these components through network. In order to improve performance and reduce the cost of development, dynamic integration and interoperability is essential to distributed GIS components.

Web Services for dynamic integration of components

XML Web Service is a kind of architecture with which one Internet application can be developed just assembling distributed services on the Internet. Because Web Service is a message-driven method using standard Internet protocols, it can be used for the integration of distributed GIS components with different hardware and software systems. The architecture of Web Service is shown on Fig. 1.

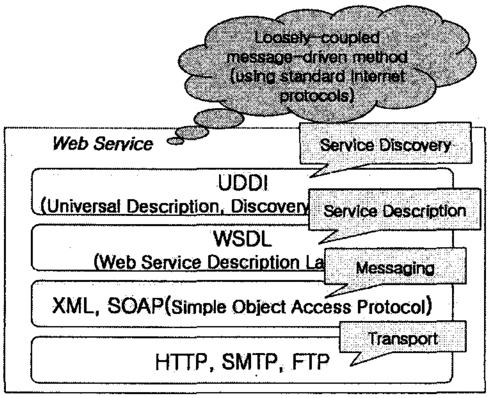

Fig. 1. Architecture of the XML Web Service.

OpenGIS specifications for interoperability among components

The objective of OpenGIS is to enable GIS users to get benefits from geographic information and services across any network, platform and application. OpenGIS models and specifications are made by OGC (OpenGIS Consortium). OpenGIS Abstract Specifications shown on Fig. 2 consist of 16 major GIS topics and these are aim at establishing implantation specifications. Table 2 presents up-to-date OpenGIS Implementation Specifications.

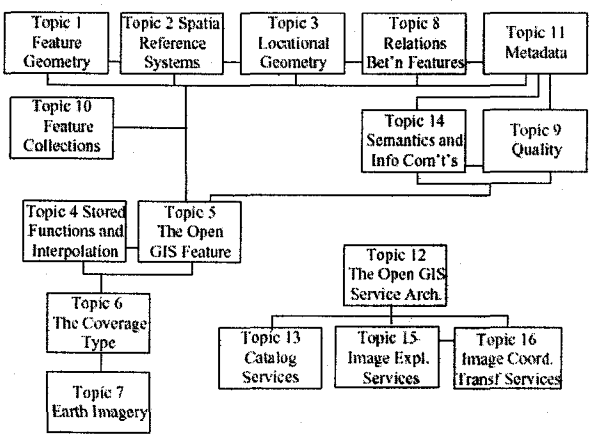

Fig. 2. OpenGIS Abstract Specifications (OGC, 1999).

Table 2. OpenGIS Implementation Specifications (OGC, 2003).

Specification	Version
Simple Features Specification for OLE/COM	1.1
Simple Features Specification for CORBA	1.0
Simple Features Specification for SQL	1.1
Catalog Services Implementation Specification	1.1.1
Grid Coverages Implementation Specification	1.0
Coordinate Transformation Services Implementation Specification	1.0
Web Map Service Implementation Specification	1.1.1
Geography Markup Language (GML) Implementation Specification	3.0
Web Feature Service Implementation Specification	1.0
Filter Encoding Implementation Specification	1.0
Styled Layer Descriptor Implementation Specification	1.0
Web Map Context Documents Implementation Specification	1.0

4. A prototype of the Internet GIS application

A prototype of the Internet GIS application using Web Services has been suggested as a possible method to integrate distributed GIS components on the Internet. In this model (Fig. 3), JSP and Servlet are wrappers of EJB components which provide various GIS functions. EJB components include Java XML APIs to support XML Web Service. Using Java XML APIs, these components can communicate with other components using standard Internet protocols. Various functions of each Internet GIS service can be exposed on the Internet and these functions can be accessed. As a result, any client user who can use the Internet can access functions of distributed Internet GIS components.

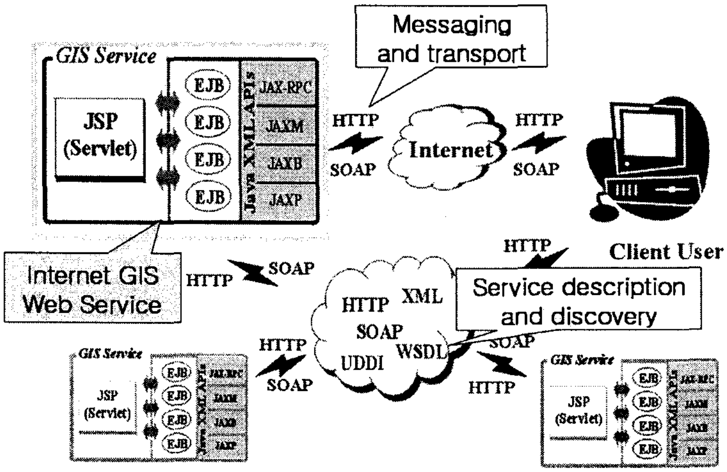

Fig. 3. A prototype of the Internet GIS application using Web Services.

5. Conclusions

In this study, a prototype of the Internet GIS application using dynamic integration of distributed GIS components has been suggested to implement geological functions on the Internet. In order to improve their performance, XML Web Service and OpenGIS specifications are concerned deeply about each for the dynamic integration and interoperability among distributed components.

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