Spatial Clearinghouse Components for OpenGIS Data Providers†

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ABSTRACT

Recently, the necessity of accessing spatial data from remote computer via network has been increased as distributed spatial data have been increased due to their size and cost. Many methods have been used in recent years for transferring spatial data, such as socket, CORBA, HTTP, RPC, FTP, etc.

In this paper, we propose spatial clearinghouse components to access distributed spatial data sources via CORBA and Internet. The spatial clearinghouse components are defined as OLE/COM components that enable users to access spatial data that meet their requests from remote computer. For reusability, we design the spatial clearinghouse with UML and implement it as a set of components. In order to enhance interoperability among different platforms in distributed computing environment, we adopt international standards and open architecture such as CORBA, HTTP, and OpenGIS Simple Features Specifications.

There are two kinds of spatial clearinghouse: CORBA-based spatial clearinghouse and Internet-based spatial clearinghouse. The CORBA-based spatial clearinghouse supports COM-CORBA bridge to access spatial data from remote data providers that satisfy the OpenGIS Simple Features Specification for OLE/COM using COM and CORBA interfaces. The Internet-based spatial clearinghouse provides Web-service components to access spatial data from remote data providers using Web-browser.

I. INTRODUCTION

Until now, various Geographical Information Systems (GISs) that can analyze, process, and manage spatial data have been developed. These GISs usually have their own incompatible data formats. During scores of years, many organizations have collected and processed a lot of spatial data by using various heterogeneous complex data types. However, these incompatible data formats result in a duplicated investment problem of spatial data, so that they cause loss of an enormous cost.

Recently, due to explosive increase of users' interest and wide spread of the distributed computing environment, users usually share spatial data through network. Therefore, there must be a spatial clearinghouse for accessing, processing, and sharing various heterogeneous spatial data without considering formats and locations of them. Furthermore, component software technology for building spatial clearinghouse is required to support reusability.

This paper outlines the prototype of spatial clearinghouse components for OpenGIS data pro-

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viders. The spatial clearinghouse components are defined as OLE/COM components, which enable users to access spatial data that meet their requests from remote computer. The spatial clearinghouse supports finding spatial datasets and accessing the datasets in the distributed computing environment.

There are two kinds of spatial clearinghouse components: CORBA-based spatial clearinghouse components and Internet-based spatial clearinghouse components. The CORBA-based spatial clearinghouse components support COM-CORBA bridge to access spatial data from remote data providers that satisfy the OpenGIS Simple Features Specification for OLE/COM through COM and CORBA interfaces. The Internet-based spatial clearinghouse components provide Web-service components to access spatial data from remote data providers using Web-browser.

II. RELATED WORKS

2.1 OpenGIS Consortium

The Open GIS Consortium (OGC) is a not-for-profit organization dedicated to open systems geoprocessing. The OGC has developed a specification for a software framework that will support its goals for distributed and open access to geographic software and data. This specification, called the OGIS (Open Geodata Interoperability Specification), is an abstract specification (Open GIS Consortium, Inc., 1998). The implementation specifications are developed to define how the OGIS abstract specification can best be implemented within a given component architecture such as OLE/COM and CORBA (Open GIS Consortium, Inc., 1999).

2.2 Development of Open GIS Component S/W

The Open GIS component software consists of data providers, base components, application components, and spatial clearinghouse components as shown in figure 1.

The data provider is the fundamental set of components that must be implemented in order to allow geographic data to be shared among different applications. These applications may be as diverse as

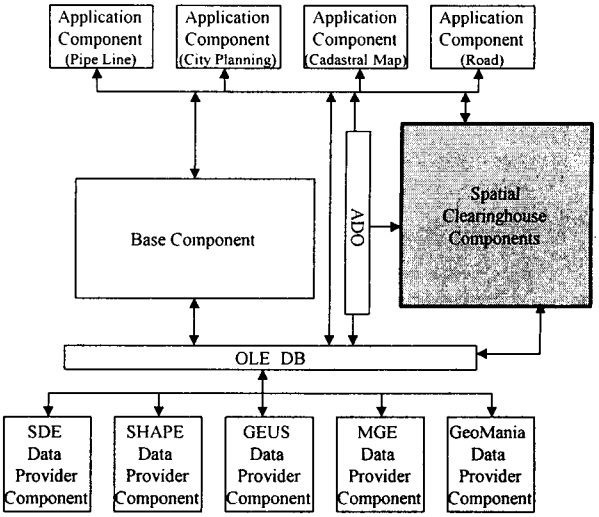

Figure 1. Architecture of Open GIS Component S/W

data collection, analysis, or simple viewing. With OLE DB interfaces to relevant spatial data, customers and other software vendors will be able to view and analyze heterogeneous collections of data from a wide range of data sources without first trying to convert them all to a compatible data format.

For consumers to access underlying GIS, the data provider components are implemented by the extended OLE DB interface which is described in the OpenGIS Simple Features Specification for OLE/COM (OpenGIS Consortium, Inc., 1999). Five data provider components are implemented: SDE, SHAPE file of ESRI, GEUS, GeoMania, and MGE data provider components.

The base component is designed to support GIS essential technology for spatial data manipulation such as map display, panning, zooming, conversion of coordinates into other spatial reference systems, etc. The base component consists of the three components: Geometry components, Spatial Reference System components, and MapBase components.

With the Open GIS component software system, diverse GIS applications could be developed. Currently, four kinds of application components and systems are under developing for local government such as water pipe line management, city planning, cadastral map management, and road management.

The spatial clearinghouse component plays an important role in sharing spatial data among other

components. In this paper, the spatial clearinghouse component uses the data providers to access spatial data in distributed computing environment and the Common Object Request Broker Architecture (CORBA) to transfer spatial data.

III. SPATIAL CLEARINGHOUSE

The primary purpose of the spatial clearinghouse is to allow producers of spatial data to describe their data and to allow users of GIS to find the datasets they need. Once the appropriate dataset is located, the system provides access the data via CORBA or Internet. Users who access the clearinghouse may search for available data and review detailed descriptions of the data. Once a dataset of interest is identified, connection is provided to access the data using data providers.

In order to find a dataset, metadata is used. The metadata is the resume of a spatial dataset, describing such information as availability, accessibility, and transferability of any spatial data (Kim, 1999). Standard metadata (information describing data) is an essential prerequisite for effective information sharing. Contributors to the clearinghouse describe their datasets using the standard for NGIS metadata (Telecommunications Technology Associations, 1999).

The NGIS metadata standard defines the schema required for describing geographic information and services such as the responsible party information, the geographic extent, the resolution level, the theme, the level of conformance, etc. This standard is applicable to the cataloguing of datasets, clearing-house activities, and the full description datasets.

The spatial clearinghouse components, CORBA-based and Internet-based OLE/COM components to facilitate search and retrieval of spatial datasets, are key part of the development of Open GIS component S/W.

To overcome the software crisis, the importance of reusability and interoperability has been increased. We design the spatial clearinghouse components using UML and implement them as a set of components for the reusability. By adopting the standard, the interoperability is provided. That is, we implement both the OpenGIS Simple Features Specification for CORBA and OLE/COM. As a result, it makes platform-independent access feasible in distributed computing environment.

3.1 Overall Architecture

The spatial clearinghouse components consist of four component categories such as query components, metadata components, COM-CORBA bridge, and Web-service components. Figure 2 shows the overall architecture of the spatial clearinghouse and how consumers (applications and Web-browser) connect to data providers which may be reside in remote machine.

The query components process a query from a user to find a list of candidate spatial datasets by searching registered metadata. A record of the list contains the full metadata attributes that include a location for connection.

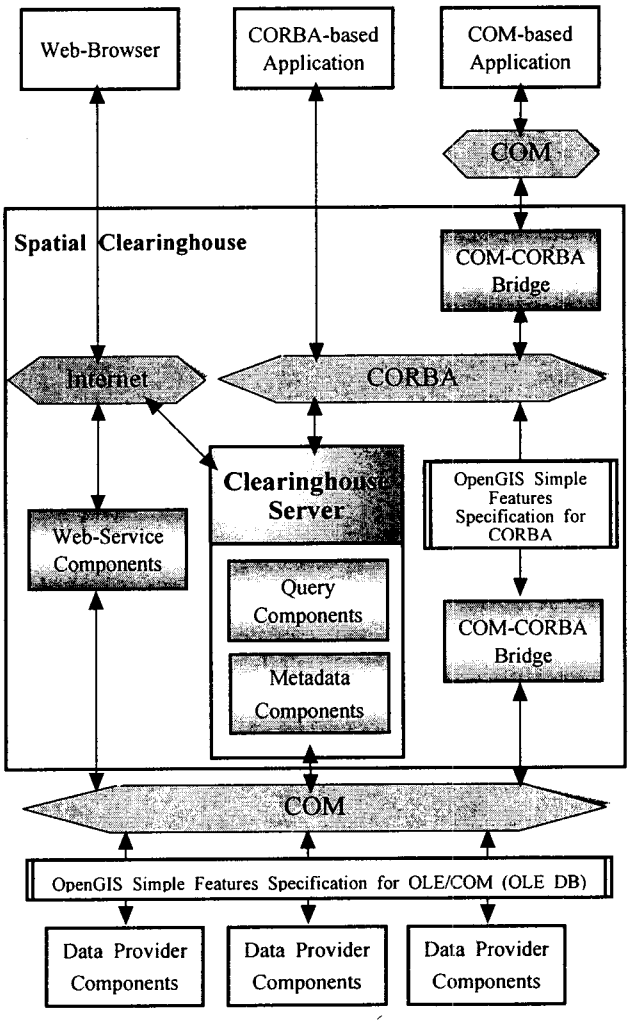

Figure 2. Overall Architecture of Spatial Clearinghouse

The metadata components manage registration, update, and deletion of metadata for each spatial dataset. A contributor of spatial data should register the metadata to a clearinghouse server for sharing them.

The COM-CORBA bridge supports interoperability among different platforms using CORBA. Since the data providers are based on Microsoft's OLE/COM environment, the interoperability cannot be supported with other operating systems such as SunOS, Linux, etc. To overcome this problem, we adopt CORBA which is a standard by the Object Management Group (OMG) for integration of applications in different platforms and distributed environment. The COM-CORBA bridge maps two interfaces symmetrically: the OpenGIS Simple Features Specification for CORBA and the OpenGIS Simple Features Specification for OLE/COM. The COM-CORBA bridge is used for the CORBA-based spatial clearinghouse.

The Web-service components enable users to access spatial data with Web-browser through Internet. It provides the Active Server Page (ASP) which is the server-side script environment for dynamic linkage with ActiveX server components. The Web-service components are used for the Internet-based spatial clearinghouse.

3.2 CORBA-based Spatial Clearinghouse

For a consumer to connect to a data provider who contains the required spatial data, CORBA and Internet can be used as a transferring mechanism. The following shows how the CORBA-based spatial clearinghouse works:

① Run a dedicated application for spatial clearinghouse
② Fill or select search options for metadata to find spatial datasets which satisfy the user's request
③ Select a spatial dataset to process from the list of candidate spatial datasets
④ Access the spatial data with interactive manipulation

There are three possible ways of the CORBA-based spatial clearinghouse:

① direct connection between a consumer and a data provider in the same machine
② connection between a CORBA-based consumer in a local machine and a COM-based data provider in a remote machine via CORBA
③ connection between a COM-based consumer in a local machine and a COM-based data provider in a remote machine via CORBA

3.3 Internet-based Spatial Clearinghouse

We support to access spatial data via not only CORBA but also Internet. A user can easily use Web-browser to search and access spatial data. Since we use ASP, there's no need of client-side additional requirement such as plug-in. The Internet-based spatial clearinghouse works as follows:

① Run a Web-browser
② Connect to a clearinghouse with the Web-browser
③ Fill or select search options for metadata to find spatial datasets
④ Select a spatial dataset to process from the list of candidate spatial datasets
⑤ Connect to the Web-service Components who maintain the spatial dataset
⑥ Access the spatial data with interactive manipulation

IV. CONCLUSION

In this paper, we described the development of spatial clearinghouse components that enable users to access spatial data that meet their requests from remote computer. We adopted the component-based software technology, the UML design, and the OpenGIS standards for reusability and interoperability.

In order to maximize reusability, we designed the spatial clearinghouse with UML and implemented it as a set of components. In order to enhance interoperability among different platforms in distributed computing environment, we adopted open architecture and international standards such as CORBA, HTTP, and OpenGIS Simple Features Specifications.

The spatial clearinghouse would be expanded to support security, to integrate with spatial data warehouse, and to cooperate with CALS (Commerce at Light Speed).

Since the clearinghouse have to be developed in

concert with the national initiatives to facilitate the exchange of spatial data, national efforts would be conducted to build national wide spatial clearing-house which could reduce cost for redundant manufacture and storage of spatial data.

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