Towards distributed e-map service

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Abstract: This paper explores a new approach towards the distributed e-map service with CORBA. The architecture of a distributed e-map service model is described. This model mainly contains a distributed map database, a database connection layer, an application service layer and a client layer. For the sake of convenient transmission of map data, a combination of CORBA and GML method is introduced. Furthermore, in order to keep the loading balance among distributed servers, object migration is implemented among servers and security is considered.

Key words: distributed e-map service; CORBA; ORB; map data

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1 Introduction

Map is an efficient language for describing geographic objects. Electronic maps (e-map) have come into being with the development of computer technology. Internet makes it easy for the public to explore maps and retrieve geographic information remotely. In our traditional browser/server architecture, map data are usually maintained in a single centralized map database, although map information covers the whole earth’s surface. The characteristics of such wide-spread map information can be better preserved in terms of distributed map databases. For this reason, a distributed e-map service based on the concept of distributed map databases is developed.

The distributed e-map service contains a number of functions ranging from map query, remote map generation to map analysis for users in a distributed networked computing environment. It helps to enhance the ability of sharing maps on different servers and integrate the geometry data with attribute data in a whole distributed database. Users can retrieve map data from the nearest map database. With the development of distributed computing technology and application of Internet, distributed map service will replace the centralized map service.

The distributed e-map service is the combination of distributed computing technology and geographic information system technology. Currently, the main distributed object computing technologies are CORBA (Common Object Request Broker Architecture), COM/DCOM (Component Object Model/Distributed Component Object Model) and EJB (Enterprise JavaBeans). CORBA is a standard object-oriented application specification by OMG (Object Management Group). It is independent of operating systems and programming languages. Established objects can be reused in various situations. Therefore, CORBA serves as an ideal distributed object computing technology among different operating systems. COM/DCOM and EJB distributed computing technologies in Windows operating system by Microsoft Corporation and in Java language based on RMI (Remote Method Interface) respectively.

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2 A brief description of CORBA

CORBA is made up of Object Request Brokers (ORBs) that can communicate with each other via the General Inter-ORB Protocol (GIOP) and the Internet Inter-ORB (IIOP) Protocol (Orfali/Harkey, 1998). CORBA facilitates a middle-tier, object-to-object infrastructure that allows one to encapsulate data from multiple sources. The language and compiler used to create the server objects, the location of distributed CORBA objects and the operating system they execute on are completely transparent to clients. CORBA therefore provides an ideal mechanism for creating 3-tier (or n-tier) distributed applications beyond the simple interoperability (Orfali/Harkey, 1998).

CORBA provides the ability to perform dynamic discovery of objects and services as CORBA objects are self-describing and introspective. CORBA’s dynamic facilities, including Dynamic Invocation Interface (DII) and the Interface Repository, are able to create particularly flexible systems that allow run-time discovery and late-binding (Orfali/Harkey, 1998). This is especially useful in the Web environment where a user desires to discover new services and then makes use of them transparently.

3 Distributed e-map service model with CORBA

The distributed e-map service model mainly includes a distributed map database, a database connection layer, an application service layer and a client layer. Figure 1 shows the whole structure of our distributed e-map service. A distributed map database is for storing and retrieving map data. By means of the ODBC (Open DataBase Connectivity) function of API (Application Programming Interface), CORBA objects can be connected to many commercial databases such as Oracle, Sybase, SQL (Structured Query Language) server, Access, and so on. The distributed e-map service is encapsulated into CORBA objects. They are map projection service, data format exchange service, map query service and application service (Figure 2). The CORBA objects are located and managed by a Naming Service or Interface Repository. The naming service locates data objects by name. Each data object, for example, a digital map or a remote sensing image, has a descriptive, recognizable name used for query. The naming service maps the name into the address and the reference of the object. Clients can access map server remotely and concurrently by IIOP protocol.

The distributed e-map service is based on the technique of a distributed map database which is growing with the development of computer architecture and database technique. In distributed systems the client/server architecture is widely used (Berson, 1996). The technique of distributed relational database based on relational data model has been applied successfully in commercial data processing (Kenyatta, 1998). However, many large database management systems have difficulties in distributed processing of data with complicated spatial relationship, such as geographic information (Laurini, 1994). GIS based on Internet, known as WebGIS, presents potentials in on-line dissemination of map information, but it has some difficulties in the realization of distributed real-time processing, spatial analysis and map data update (Yuan, 1999). The cadastral data has both spatially distributed characteristics and large quantities of non-spatial attributes. Taking the cadastral data processing as an example, we put forward a method of realizing distributed processing with the aid of distributed relational database. The distributed processing of map data can be implemented by integrating maps including their attributes and the technique of distributed system based on a relational data model.

The distributed map database includes geometries of map features, their attributes and corresponding map symbols. The geometry types of map features are defined according to the Open GeoData Interoperability Specification (OGIS) (Figure 2).

For the retrieval of map data, special access modes which rely on spatial index are necessary. Hitherto, R-tree and Quad-tree are two main spatial indexing methods.

R-trees are a direct extension of B-trees in k-dimensions. The data structure is a height-balanced tree.