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RESEARCH AND REALIZATION OF THE WEB-BASED INTEGRATION SYSTEM OF GIS AND OA

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ABSTRACT: This paper presents a study on the feasibility, mechanisms and key technology for integrating GIS and OA in the Browser/Server (B/S) architecture, on the basis of a comparative analysis of the independent development model and the integrated development model of GIS and OA. Presently, the development of GIS and OA is mainly based on the two models: Mainframe-Terminal (M-T) model upon stand-alone computer and Client/Server (C/S) model upon Intranet; and the integration of them is only on the functional level. The paper discusses various possibilities of using advanced technologies, such as ASP (Active Server Pages), ActiveX/OLE, etc. for the Web-based integration of GIS and OA in the B/S architecture. The integration system realizes the close connection and communication between spatial data (GIS) and non-spatial data (OA), and realizes both GIS and OA functions, such as query, statistics and analysis. It realizes the function integration completely and the information integration in some degree. A case study is also presented, which shows an approach for realizing the Web-based GIS and OA integration system. With this integration system, not only the working efficiency and quality are improved, but also the traditional office management model and concepts are transformed completely.

1 INTRODUCTION

Because of the rapid development of computer and network, many changes have been taken place in our lives. It becomes a tendency that the network technique must be used to improve the work efficiency in office management for many sections of government. Office automation system affords many visualizing-effective, interactive functions based on integrated, correct, faithful data. Now it is arise developing office automation system, while Intranet is built and Office work automation is promoted in many departments and enterprises.

The function of office automation system is mainly implementation of office automation and data share. It relates to a large volume of data. Mostly, office automation system manages and handles the non-spatial data based on RDBMS (such as SQL Server, Oracle, etc.). But it is very important for many sections of government (especially, Land Administration Bureau, etc.) to acquire and integrate the spatial data. It is well known that GIS is the only practical means to integrate and handle the large volume of spatial information. However, a GIS alone cannot meet all the needs in office management. This is because of that current GISs cannot replace a RDBMS for non-spatial data management and are not good for supporting the interaction among a group of end users. One of the methods to solve for this problem is to integrate GIS with office automation. (Chen Jun, 1998a)

An approach for developing the Web-based integration system of GIS and OA is discussed in this paper. The developing models of traditional GIS and OA are introduced in section 2. The feasibility, method and securities of the Web-based integration system of GIS and OA are discussed in section 3. Then a case is described in section 4.

At the end of this paper it comes to the conclusions and recommendations.

2 MODELS OF TRADITIONAL GIS AND LEGACY OA

2.1 Mainframe-Terminal Model (M-T) upon Stand-alone Computer

With the model, all assignments of computation and data management are centralized on the mainframe, and the terminal is prolongation of I/O equipment of mainframe. The management is easy in the system development on the model. But it requires that the mainframe has good capabilities.

2.2 Client/Server Model (C/S) upon Intranet

It is a mainstream that system is built on Client/Server model (C/S) based on Intranet. Generally, with the model, data management is centralized on server, and computing assignment is dispersed on clients. The communication between client and server is run on network agreement. Client requests data from server, and server transmitted data to client on which the data is computed and then the result is sent back to server. The model has many advantages. The capability of client is used sufficiently, and computing ability is enhanced enormously. The communication between client and server is a logistic relation, so each of client and server is extended easy.

2.3 Browser/Server Model (B/S) on the Web environment

It is a new way of system development that system is built on Browser/Server model (B/S) based on Web. With this model, client needs only a global browser, such as Netscape and Internet Explore, which can replace all kinds of application software; server is a Web server. The communication between client and server is run on TCP/IP. Browser requests data from server. And server gets data backstage and computes it, then sends the result back to browser. Because the software on client is a simple browser, the users need not be trained and the software on client need not be maintained. The upgrading and maintenance of the software need be don only on server. And browser and server can use various operation systems.

3 INTEGRATION OF GIS AND OA BASED ON WEB

3.1 Feasibility

The integration of GIS and OA based on Web need be built on efficient network. With the rapid development of computer and network, it is suitable developing Web-based integration system of GIS and OA with the available hardware conditions.

Component-based software development represents a revolution in software development and changes the perspectives on GIS (LI Bin, 2000). With component technology, it becomes possible to integrate GIS and OA. GIS component, such as ESRI MapObjects and MapInfo MapX, is a GIS process module which GIS manufacturers provide to handle spatial data. And OA component, such as ADO and RDO, is a processing module which other manufacturers provide to handle non-spatial data. GIS component and OA component can be integrated in a system, which handle spatial information and non-spatial information.

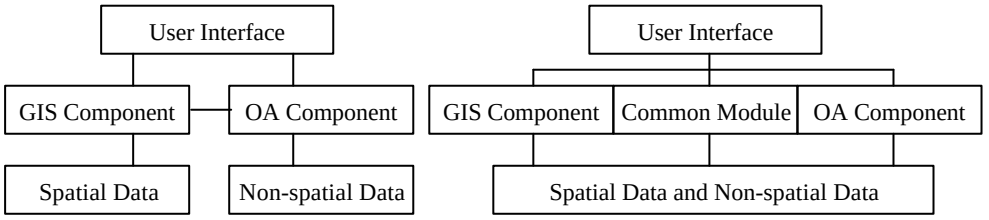
The construction of integration system of GIS and OA based on B/S architecture is concerned with the planning and

maintenance of active Web sites linked with Intranet or Internet. In comparison with common gateway interface (CGI), ASP (Active Server Pages) is more effective and flexible as a server scripts environment. Since ASP came out with its peculiar characteristics several years ago, it is applied to the construction of more and more active Web sites in the diverse fields. With HTML pages, script commands and ActiveX components, ASP can set up dynamic, interactive and efficient Web server programs (Zhang Li, 2000). It is convenient to connect database systems with ASP plug-in ActiveX components. So Web pages not only can be linked to all kinds of databases by using ADO or RDO, which provide ODBC interfaces for other programs, but also can be embedded with GIS components, which provide handling means for spatial data.

3.2 Integration Models

The integration system of GIS and OA has two models that manifest two levels. One is function integration, and the other is information integration. The function integration is low level, and it is developing towards information integration—the high level. The integration systems have been built now all belong to function integration model. (Bian Fuling, 2000)

Function integration is the model in which GIS component and OA component communicate each other in an integrated container, so that spatial information and non-spatial information can access each other. The model only affords an integrated interface in which function integration is realized. Actually, GIS component and OA component is apart. Both access objects and access means of the two components are different. GIS component access spatial data while OA component access non-spatial data. Function integration is the integration in the low level. However, information integration model is the model in which GIS component and OA component access meanwhile spatial data and non-spatial data which are managed by an integrated DBMS, common data handling module is supported except the characteristic functions of the two components. Information integration is the integration in the high level. Two Implementation Models of Integration of GIS and OA are shown in Fig.1.



(a) Function Integration (b) Information Integration

Fig.1 Comparison of Two Implementation Models of Integration of GIS and OA

3.3 Realization Method of Web-based Integration System of GIS and OA

3.3.1 OA Functions and Non-spatial Data

Non-spatial data is stored and managed in the RDBMS in server-side. With ASP technology, it can be convenient to connect database systems by using ADO or RDO. AS a result, OA function can be realized by developing ASP programs. While developing ASP programs in the integrated developing environment (IDE) of Microsoft InterDev, the function may be fulfilled by script programs running either clients or servers. Script programs, running in clients browsers, are mainly to examine forms in HTML. It can be VBScript or JavaScript involed in HTML files. And script programs, running in servers, are to access databases, process forms in HTML and so on. The result,

which is Web pages in HTML, will be sent to user browsers. As a result, it proves the confidentiality of ASP programs and the efficiency of the integration system.

3.3.2 GIS Functions and Spatial Data

Server-side Internet GIS use HTML as a form of user interface, which offers limited user interactivity. Users cannot interact directly with vector data of spatial objects such as points, lines, and polygons. These shortcomings are overcome by the browser add-ins of plug-ins, applets, and ActiveX controls, which are used to extend the browser capabilities to interact directly with GIS vector data. (Z-R Peng, 1999)

In the integration system, a map server program is built on server-side. The map server program support the functions to client browser, such as "Zoom In", "Zoom Out", "Pan" ,"Query", and so on. It can be developed with MOIMS and MapObjects. MapObjects, the geographic information services suit from ESRI, can facilitate the development of a relatively complex Internet-based Spatial Understanding and Decision Support system that has components for network communication and geographic information services (LI Bin, 2000). MOIMS includes "admin.exe", "Catalog.exe", "Launch.exe", "Esri.dll" and "WebLink.ocx". While on client, a component need be built, which response the users' operation and requesting the above functions from server. The component can be developed using Visual Basic. It can be embedded to HTML pages by using ActiveX technology.

3.3.3 Integrating of Functions and Information

The integration of system is built by connecting and communicating between spatial data and non-spatial data and intersecting and penetrating of GIS component function and OA component function. Now, spatial data is managed by file and RDBMS while non-spatial data is managed by RDBMS. Both spatial data and non-spatial data are the description of the objective entity. As in traditional GIS, spatial data and non-spatial data is connected by ID of entity, they can be connected by many items in the integration system, such as serial number, business type, and so on.

Web pages not only can be linked to all kinds of databases by using ADO or RDO, which provide ODBC interfaces for other programs, but also can be embedded GIS components, which provide handling means for spatial data. So in the ASP programs, it is convenient to integrate GIS function and OA function.

The architecture of integration system of GIS and OA is shown in Fig.2.

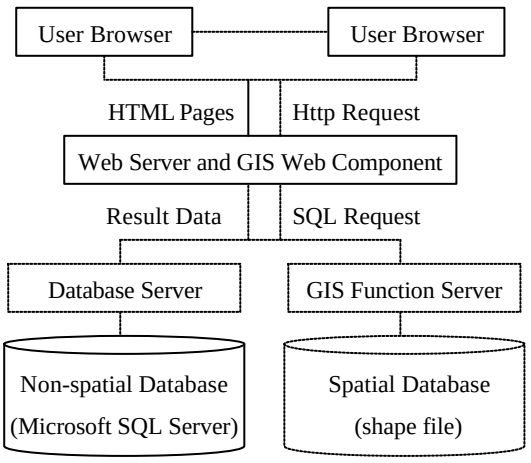


Fig.2 The integration of GIS and OA Based on B/S architecture

3.4 Security of the Integration System

3.4.1 Security of Data

It is a hard task for the management and maintenance of all the information in the integration system. The information in the integration system includes spatial data and non-spatial data. Non-spatial data is managed and maintained by RDBMS while spatial data is managed and maintained by GIS server and component.

As for popular large-scale database systems such as Microsoft SQL Server, Oracle, Sybase, Informix, security management and maintenance is implemented into four levels of "Networks-DB Server-DB-DB Object" security model (Zhang Li, 2000).

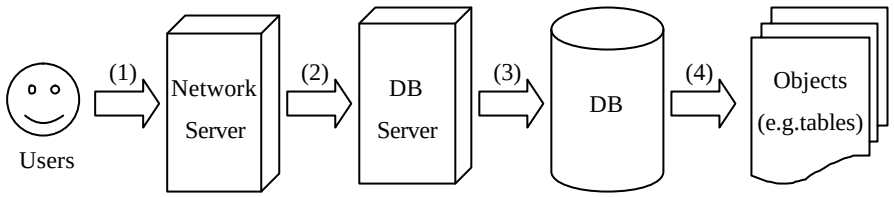


Fig.3 Security model of "Networls-DB Server-DB-Db Object"

In Fig.3, (1) Network user's login ID; (2) DB user's login ID; (3) DB user's ID; (4) access rights of DB objects.

3.4.2 Security of Components

ActiveX controls are binary codes executing directly on the local machine's hardware. Therefore, all of the changes of running unknown software from the Internet apply to them. Unknown ActiveX controls downloaded from the Internet can corrupt the client computer. How do you know that a download plug-ins or ActiveX control will not erase your hard drive? Because GIS ActiveX controls have full access to platform services, they involve greater risk to the local system. To address this concern, Microsoft adopts a verification mechanism to verify that a control comes from a trusted source. Microsoft Internet Explorer supports authenticated code-signing technology and NetScape uses Object Signing protocol. This enables vendors of ActiveX control and other software components to sign these components digitally. When they are downloaded and the digital signature is recognized, a code signature certificate is displayed on the screen. This certificate ensures that the software component is coming from a trusted source and has not been tampered with. (Z-R Peng, 1999; Chappell D, 1996)

3.4.3 Security of ASP

In the environment of Windows NT Server or Windows 2000, Internet Information Server (IIS) is in the charge of maintenance of Web sites (In Windows 98, PWS). ASP is also based on IIS. IIS supports virtual directory which is different from physical directory in hosts or servers. Virtual directory plays a great role in the security management and maintenance of Web sites. Virtual directory conceals the information about actual directory structure in the normal browsers. Administrators can assign different attributes to the directories. The attribute of directories in which normal HTML files are stored may be "Read" while the attribute of directories in which ASP files are stored may be "Execute". (Zhang Li, 2000) Thus it improves the security of ASP files.

4 A CASE STUDY OF WEB-BASED INTEGRATION SYSTEM OF GIS AND OA

In the case, the authors adopted MOIMS, MapObjects, RDO, ADO, and other common components to establish a Web-based office automation system integrating GIS and OA based on Browser/Server (B/S) architecture. In the

integration system, non-spatial data is managed with RDBMS (Microsoft SQL Server) while spatial data is managed with file management (shape file). With the securities of the RDBMS, component, ASP and operation system, system functions are developed to integrating GIS and OA, on which non-spatial data and spatial data can be accessed and handled each other in a workflow. The architecture of the integration system is shown in Fig.2. It is quite essential to enable the end user to use the system efficiently. To make complex information understandable to terminal user and to improve on the human-machine and human-human interaction, visual interfaces are developed by integrating workflow charts, fancy icons, dialogue boxes and TipWizard. (Jiang Jie, 2000)

5 CONCLUSIONS AND RECOMMENDATIONS

In short, it is very convenient and efficient to integrate GIS function and OA function through the components and ASP technologies based on the Browser/Server (B/S) architecture. The integration system will be useful and efficient for many government departments and enterprises, where staffs and administrators can process the routine work in a more logical order and with the higher work efficiency. Obviously, further research in this area needs to be carried out. Some further R&D issues in this field may include:

(1) A better understanding and modeling of the social cognitive and behavioral aspects of such a kind of office GIS where human-human interactions and causal relations between human actions and spatial objects changes are included (Chen Jun, 1998b).

(2) Adding more specialized functions such as knowledge discovery, data mining, intelligent spatial analysis, etc (Jiang Jie, 2000).

(3) Linking multimedia data from various sources and accessing them by content or by association (Nyerges T L, 1995; Shiffer M, 1995).

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