RESEARCH ON GEOSPATIAL INFORMATION SHARING PLATFORM BASED ON ARCGIS SERVER

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ABSTRACT:

ArcGIS Server becomes a complete, integrated GIS server that supports spatial data management, mapping, and spatial analysis across distributed systems. ArcGIS Server is a Web GIS which helps you take your geographic information and make it available to others. ArcGIS Server allows you to share your GIS resources across an enterprise and across the web. This paper studies the key technology and the way to implement geospatial information sharing platform based on ArcGIS Server which are necessary to develop it. We have developed new generation geospatial information sharing platform based on these technology and method to drive geospatial information sharing. This platform can integrate and manage all kinds of database effectively and achieve some function, such as exploring and inquiring map layers, overlapping map layers, editing map online, accounting, analysis, system management, and so on. This platform supplies user-friendly interface and simple usage mode. It is convenient for different government functional departments, office and social public to inquire and account all kinds of information.

1. INTRODUCTION

GIS technology has long been valued for enhancing communication and collaboration in decision making, effectively managing resources and assets, enhancing the efficiency of workflows, improving the accessibility of information, and generally offering tangible cost saving to organizations both large and small.

Over the past decade, GIS technologies have evolved from the traditional model of stand-alone systems, in which spatial data is tightly coupled with the systems used to create them, to an increasingly distributed model based on independently provided specialized, interoperable GIS Web Services.

The service-based GIS model is rapidly materializing, owing in part to advancements in general Web service technologies, and in part to focused efforts by the Open GIS Consortium (OGC) to sponsor consensus-based development of interoperable GIS Web service interfaces. It is possible to dynamically assemble applications from multiple GIS Web services for use in a variety of client applications.

Web services are Web sites intended for use by computer programs rather than human users. The W3C has defined a general-purpose Web service architecture based on a trio of standards – SOAP, the Web Service Description Language (WSDL), and Universal Description, Discovery, and Integration (UDDI) – as well as others for business processes, security, coordination, transaction, inspection, and so on (D. Booth et al., eds., 2004). In parallel with the development of these general-purpose Web services, OGC has successfully executed efforts for GIS interoperability. The OGC Web Services (OWS) initiative has undergone multiple phases – including the Web Map Service (WMS), Web Feature Service (WFS), Web Coverage Service (WCS), and OGC Web Service Architecture (J. Lieberman, ed., 2003), which support application developers in integrating a variety of online geo-processing and location services. Conceptually, the OWS technology stack is a service-oriented architecture (SOA) that includes service discovery, description, and binding layers corresponding to UDDI, WSDL, and SOAP in the W3C architecture. Rather than general issues, however, the OGC intended to specify only those issues that are specific to geographic information. Currently, OGC Web services aren't equivalent to the W3C SOAP based Web services, although the OGC is attempting to integrate the Web services standards into the OWS framework, including specifying changes to the common OWS architecture and providing WSDL descriptions in WMS, WFS, and WCS.

With the goal of enhanced geospatial data sharing within and across organizational boundaries, organizations increasingly focus on enterprise, or institutional, solutions to effective information exchange (Gordon N. Keating, 2003), thereby avoiding redundant systems and services and incompatible infrastructure (Pinto and Onsrud, 1995). Enterprise GIS is the preferred and most effective solution to these needs.
Enterprise GIS is an architecture that integrates geospatial data and services and shares them across the organization. In more general IT terms, it can also be viewed as an infrastructure that extends and enables existing enterprise systems using geospatial data and services.

ESRI offers a server-based platform from which geographic knowledge is published and disseminated within organizations, across organizational boundaries, and to the public.

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ArcGIS Server is ESRI's primary server GIS product. It is a complete and integrated server-based GIS that comes with out-of-the-box, end user applications and services for spatial data management, visualization, and spatial analysis.

This paper studies the key technology and the way to implement geospatial information sharing platform based on ArcGIS Server which are necessary to develop it. We have developed new generation geospatial information sharing platform based on these technology and method to drive geospatial information sharing. This platform can integrate and manage all kinds of database effectively and achieve some function, such as exploring and inquiring map layers, overlapping map layers, editing map online, accounting, analysis, system management, and so on. This platform supplies friendly user interface and simple usage mode. It is convenient for different government functional departments, office and social public to inquire and account all kinds of information.

Section 2 introduces the overview of ArcGIS Server. Section 3 introduces the architecture of this platform. Section4 introduces the functions of this system. Section 5 introduces the implementation of this platform. We describe the software environment, hardware environment, and process flow. The final section draws some conclusions and future work for this system.

2. OVERVIEW OF ARCGIS SERVER

ArcGIS Server is a platform for building enterprise GIS applications that are centrally managed, support multiple users, include advanced GIS functionality and are built using industry standards.

ArcGIS Server allows developers and system designers to implement a centrally managed GIS. This gives the advantage of lower cost of ownership through single GIS applications (such as a Web application) that can scale to support multiple users and saves the cost of installing desktop applications on each users machine. This, along with the ability of ArcGIS Server to leverage Web services, makes it ideal for integration with other critical information technology (IT) systems, such as relational databases, Web servers, and enterprise application servers.

ArcGIS Server allows you to share your GIS resources across an enterprise and across the web. GIS resources are the maps, globes, address locators, geodatabases, and tools that you want to share with others. You share these resources by first hosting them on your ArcGIS Server system, or GIS server, and then allowing client applications to use and interact with the resources.

On the GIS server, instead of working with, for instance, map documents, globe documents, and address locators, you work with map services, globe services, and geocode services. GIS resources which have been made available on the server are collectively referred to as services. A service is a representation of a GIS resource that a server is making available to other computers on a network. This network can be a local one or a broader network. The computers on the network that access your service are called clients.

The ArcGIS Server consists of two components: a GIS server and an Web ADF for .NET and Java. The GIS server hosts

ArcObjects for use by Web and desktop applications. It includes the core ArcObjects library and provides a scalable environment for running ArcObjects in the server. The GIS server itself is composed of two distinct parts: the server object manager (SOM) and server object containers (SOCs). The SOM manages the services running on the server. When a client application requests the use of a particular service, it's the SOM that actually gives one out for the client to use. The SOM connects to one or more SOCs. The SOC machines—also referred to as container machines—contain, or host, the services that the SOM manages. The ADF is a collection of Web controls, convenience classes and data objects, and application templates that make it easy to build and deploy .NET or Java Web applications that use ArcObjects running within the GIS server.

Developers can use ArcGIS Server to build Web applications, Web services, and other enterprise applications, such as those based on Enterprise JavaBeans(EJBs). Developers can use ArcGIS Server to build desktop applications that interact with the server in client/server mode. ArcGIS Server also supports outof-the-box use by ArcGIS Desktop applications for server administration, simple mapping, and geocoding over a local area network (LAN) or over the Internet.

ArcGIS Server administrators can use either Manager or ArcCatalog to publish their GIS resources as services. ArcGIS Server can publish some types of services, Map service, WMS service, KML service, Mobile data services, Geodata services, Geoprocessing services, Network analysis services, Globe services, and Geocode services.

3. THE ARCHITECTURE OF THIS PLATFORM

Geospatial information sharing platform based on ArcGIS Server is a distributed system consisting of several components that can be distributed across multiple machines. Each machine plays a specific role. The architecture in the pilot platform consists of 3 tiers (as illustrated in Figure 1): Client applications, GIS Server and Database Server.
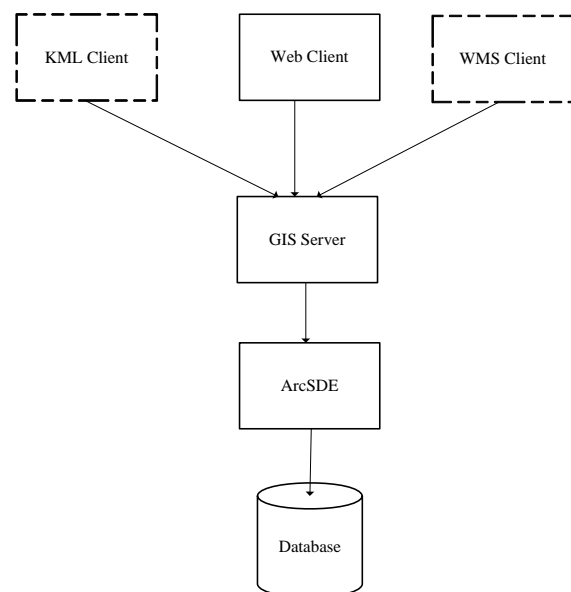

Figure 1. Architecture of this System

Client applications are KML Client, Web Client and WMS Client that connect over HyperText Transfer Protocol (HTTP) to ArcGIS Server Internet services, or ArcGIS Server Local services over a LAN or WAN.

Web client written using the ArcGIS Server API is a Web application which is hosted by Web server. The Web client uses the ArcGIS Server API to connect to a SOM, make use of services, and create other ArcObjects for use in this Web application. This Web application has been written using the Web ADF.This Web application itself makes use of objects and functionality running within the GIS server. The browser client can connect to the Web application over the Internet or Intranet, but all of the Web application's logic runs in the Web server.

This platform is interoperable with clients that read and write Keyhole Markup Language (KML). KML is the Google Earth XML specification that describes geographic features and rasters in three dimensions. ArcGIS Server can publish a map document as a map service with KML capability enabled. Google Earth and ArcGIS Exploer can consume KML services. This system can provide data sources for the Google Earth.

WMS (OGC Web Map Service, 2004) was developed by OGC (Open Geospatial Consortium) as a web-based standard for serving map images. An OGC WMS produces maps of spatially referenced data dynamically from geographic information. This international standard defines a "map" to be a portrayal of geographic information as a digital image file suitable for display on a computer screen. ArcGIS Server can create WMS services by enabling the WMS capability when publishing a map service. WMS client compatible with WMS protocol can connect to the platform.

The GIS server is responsible for hosting and managing server objects. The GIS server is the set of objects, applications, and services that make it possible to run ArcObjects components on a server. The GIS server consists of a server object manager and one or more server object containers. The GIS server mainly hosts map services, KML services, WMS services and geodata services. A map service is the most common ArcGIS service and can contain many capabilities and functions. Map services certainly support mapping and map viewing, but can also support modeling and geoprocessing, mobile GIS services, and open publishing as OGC WMS and KML. Map services must have KML capability enabled. Similarly, WMS clients exposed to WMS clients have the WMS capability enabled. A geodata service allows you to access a geodatabase through a local area network (LAN) or the Internet using ArcGIS Server. The service exposes the ability to perform geodatabase replication operations, make copies using data extraction and execute queries in the geodatabase.

The database server managers GIS resources including base terrain data, urban planning data, road planning data, controlling detailed planning data, land use planning data, transfer red line data, divest red line data and so on. Database Server provides spatial data for the GIS Server through ArcSDE. ArcSDE is a core element of any enterprise GIS solusion. Its primary role is act as the database access engine to spatial data, its associated attributes, and metadata stored within the database.

4. FUNCTIONS AND COMPONENTS

This platform can integrate and manage all kinds of database effectively and achieve some function，such as exploring and inquiring map layers, overlapping map layers, editing map online, accounting, analysis, system management and so on. This platform supplies user-friendly interface and simple usage mode. It is convenient for different government functional departments, office and social public to inquire and account all kinds of information.

4.1　View

A map is the most common view for users to work with geographic information. It's the primary application in any GIS to work with geographic information. Common map elements include the data frame containing map layers for a given extent plus a scale bar, north arrow, title, descriptive text, and a symbol legend. You can zoom in or out on the data in a map and pan your data in a map by dragging the display in any direction with mouse. You can also zoom to the full extent of a map so you can see the entire area covered by the map.

The map's table of contents helps you manage the display order and symbols properties of each map layer. The table of contents lists all the layers on the map and shows what the features in each layer represent. The check box next to each layer indicates whether its display is currently turned on or off. The order of layers within the table of contents specifies their drawing order in the data frame. We can configure the style of the map layers which include point layer, line layer, and polygon layer.

This system makes every thematic map as a service. We can overlap these services. A thematic map can be accessed according to the user's privilege. These thematic maps can be overlapped. If you click the "Layer Control" menu item, a float panel pop. This panel list all of thematic map available for the user. The check box next to each thematic map indicates whether it is selected to be overlapped.

This platform provides two map viewer. We can compare the same features of the different thematic map layers. We implement the operation coherence of the map viewer. For example, if left map viewer zoom in, right map viewer also zoom in the same extent. The same is to zoom out, pan and full extent.

4.2　Search

There are different ways to search the database for map, features and their attributes. The simple search allows users to search the map id or map name within the entire record. A map according with query condition was displayed in the working area. We can input the place name as query condition. While the features requested are being retrieved, the platform will highlight the features and show their attributes listed in a table.. You can select anyone to find the features. The advanced search option works similar to the simple search, however, you can be more specific in your search criteria. We can show all the attributes of the selected dataset. You can select more attributes and Boolean calculation as query condition to customize your search criteria further. The results of the search are displayed as a table derived from the records citing each found information item. For each feature the result shows some attributes.

4.3 Editing Online

GIS data loses its value if it becomes out of date. The database must be updated to keep it current. To minimize the cost of data development and necessary updates, it is important that the tools and workflows for data compilation be as streamlined and productive as possible. This system allow you to create and edit several kinds of data. In general terms, the feature geometry you can edit includes points, lines, polygons, text (annotations and dimensions), multipatches, multipoints, shared edges and nodes from a topology or geometric network, and tables. ArcGIS Server provide EditorTask control to edit data.

The EditorTask control provides a suite of tools for Web-based editing of feature layers in ArcGIS Server map services. The runtime dialog provides tools to modify, add, and remove feature geometry and attributes. These standard functions can be implemented without writing code by EditorTask. But we must customize and extend to filter attributes, manage tools, handle events during the editing process, and manage panels for special functions. For example, a set of survey measurements collected in the field was stored as a text file. We provide a tool to upload the file. Reading the file, we can create the features and edit the attributes of these features through these survey measurements. Finally these features can be inserted in the database online.

4.4 Spatial Analysis

GIS is designed to support a range of different kinds of analysis of geographic information: techniques to examine and explore data from a geographic perspective, to develop and test models, and to present data in ways that lead to greater insight and understanding. All of these techniques fall under the general umbrella of "spatial analysis".
This platform provide point buffer zone query and analysis functions in a simple vector data service layer.

The establishment of the buffer zone is to create a circle. We must know the center point and radius. The center point is a point the mouse clicking on the screen. The screen coordinates point need to transform to map coordinates point. The radius can be configured. This point and radius can create a circle as buffer zone graphic. According to the overlap operation between this buffer graphic and map layer, you can get the features the buffer zone covering. These features are highlighted and their attributes are displayed. When setting the buffer zone radius, the input text will be verified, which will ensure that the number of the buffer zone radius is the nubmer greater than 0, and units can be selected in the drop-down list box behind the text box.

4.5 Management

Management includes Service Management, User Management, Group Management, and Menu Management.

Service Management is to manage the services hosted in the SOCS. Although ArcCatalog can publish and manage services, ArcCatalog can not control the services that can be accessed by who. We integrate these functions to manager the services conveniently without ArcCatalog. We can create a service, and update its attribute. The service can be started, stopped, deleted and paused. We can grant the service to which group can access. Only a service is running and allowed to access by a user, the user can access the service.

We can configure the connection string to manager different GIS Server. The advantage of this configure is GIS server's IP can change and we can manage many GIS servers.

A group is a container for a set of users with common privileges regarding a service. Groups are created by users with the Administrator. Each user can belong to several groups. We can create users and configure the users.

Menu management is function management a group can operate. A menu item links to a function view. A group can be granted to access a menu item.

A user can has different profile which presents different menu items and different GIS data services.

Privileges of a service are View and Edit. View means the service can be viewed. Edit means the service can be modified. What can be done with a service depends on the service itself, the group and the privilege set.

5. IMPLEMENTATION OF THIS SYSTEM

5.1 Software Environment

Software Environment of this system is as followed. The Operation System on the server side is Windows 2003 Server 64, the one on the client side is Windows 2000 or Windows XP; Using Oracle 10g and ArcSDE 9.2 as DB management software; ArcGIS Server 9.2 is a GIS server software, which is used to edit, process and share geospatial data; The integrated development Environment is Microsoft Visual Studio .NET 2005, development language is C#. We need ArcGIS Deskdop to create GIS resource and publish the resource as services.

5.2 Hardware Environment

ArcGIS Server has a scalable architecture which allows for deployment sizes ranging from one to many machines. A distributed installation of ArcGIS Server is when components of one ArcGIS Server system reside on multiple machines in the same local network. This system provides there machines which are high performance servers. SOM and Web application reside on the Web Serve machine. ArcSDE and Oracle 10g is installed in Database Server machine. SOC is deployed in the SOC machine.

5.3 Process flow of this System

The system handles the GIS services. The data must be published as services. Before publishing a service, you need to create the GIS resource that the service will reference. GIS resource is a geodatabase which is stored in Oracle 10g and managed by ArcSDE. We use ArcGIS Desktop to create them. We can use ArcCatalog or service management function to publish the GIS resource as services.

The system administrator logs in the system using user name and password. The system administrator creates user groups, users and establishs the relationship between users and groups. They are many-to-many relationships.

Groups are granted to access many different services and functions. When a user logs in the system, the system presents

different view. Different users can access different map services and different functions. All these are dynamically established.

The group can be granted to the system administrator can grant the service to the groups.

Figure 2 shows administrator user view. Administrator can execute all functions and process all data.

Figure 3 shows service management function. You can configure a service' attribute. You can start, stop, and delete a service.
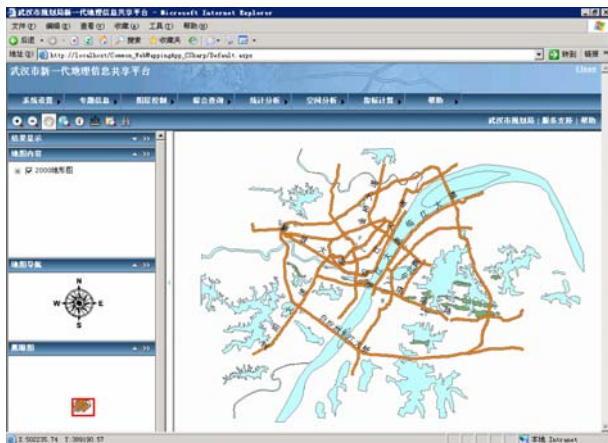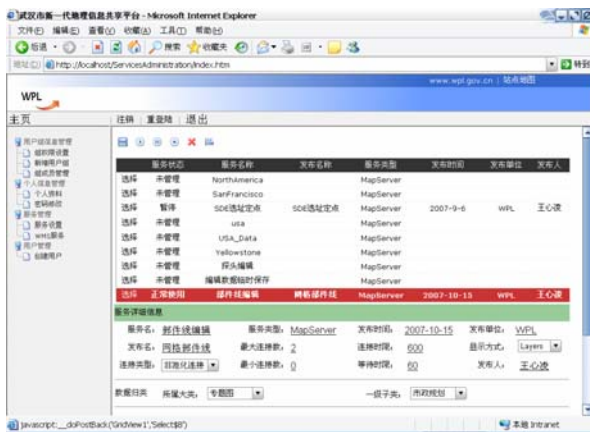

Figure 2. Administrator User View

Figure 3. Service Management Function

6. CONCLUSIONS

Geospatial information sharing platform based on ArcGIS Server is a Web GIS based on Web service. This platform is rich in functions. It is easy to manipulate and convenient to share and maintain geospatial information. The experience has proved that this platform is suitable and comes off satisfactorily.

System performance within Web Services environment may be a significant issue. GIS services often transmit very large volumes of data; geospatial query processing involves extensive GIS domain knowledge and requires intensive computation; and GIS Web services clients are traditionally heavy-duty, stand-alone software tools (Shengru, T., M. Abdelguerfi, 2006). The burden of the interoperability put on computing system and network bandwidth (Yang, Wong et al. 2005).

Embracing GIS technology within the context of an SOA (i.e., creating a geospatial SOA), enriches organizations' service offerings and provides value in overall efficiency, accuracy, and accessibility to organizational business processes. We will develop a metadata catalogue to register and find the GIS service.

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