Development of Water Resources and Environment Management Information System based on ArcIMS

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***Abstract*—This paper present a water resource and environment management information system based on GIS technology. The system select ArcIMS product as service platform, then use the EJB technology to encapsulate the map realization. The paper describes the key technology in the development of system, including the architecture of system, the class to encapsulate the map realization and the function of the system.**

Keywords-ArcIMS; WebGIS; Database; Warehouse

I. INTRODUCTION

Water resources and environment management is a complex task that is extensive in data sources scope and requires the use of a wide range of data model. With the development of computer technology, new technologies are used in water resources and environment management, GIS and database technology is combined together. Database technology can process non-spatial data and the data model assessment, GIS technology can process and analysis space data and carry on implement of visualization.

The whole system is composed of four databases and three sub-systems. Four databases are the spatial database, attribute database, methods of database, model database, including information about water resources, environment, forecasts, planning, evaluation, management etc.. Three sub systems are maintenance of water resources information management subsystem, expert decision making subsystem and intelligent information retrieval subsystem.

Three subsystems are based on ArcIMS. ArcIMS product, the WEBGIS platform, which is provided by ESRI Corporation, is considered as a simple map issue, and the price of ARCGIS Server product is very high though it has analysis function. So, in order to reduce the risk, the system use Java technology to ArcIMS to expand its analysis performance; moreover, the system encapsulate the map realization in the module, and it not only separates the service realization and the map realization but also reduces the development difficulty.

II. ARCIMS AND SECONDARY DEVELOPMENT

There are many web map publishing platforms As the mainstream service providers, ESRI companies provide the products favored by many customers. ArcIMS product is a server-based product, it provides hierarchical framework to publish GIS data and services on the web page. ArcIMS enable website to present GIS data, interactive maps, metadata catalog easily [1]. But ArcIMS is considered as a simple map issue and is unable to meet the needs of map features, such as contour, renderings, maps, and composite mark so on. ArcGIS server having good performance and analytical function is expensive. In order to reduce the risk, the system use Java technology to ArcIMS to expand its analysis performance; moreover, the system encapsulate the map realization in the module, and it not only separates the service realization and the map realization but also reduces the development difficulty.

A. Arcchitecture of ArcIMS

ArcIMS is ESRI's second generation of WebGIS platform software, used to meet the requirement to provide geographic data and services on the internet/intranet. ArcIMS architecture is very suitable for application on the Internet. It is suitable to small Intranet site, it can be expanded as needed to meet the enterprise-level system or e-commerce site needs.

ArcIMS is a distributed system, which consists of client components and server-side components. Customers send requirement from the Internet or Intranet server to ArcIMS server, ArcIMS server processes the requirement and returns to the client browser. ArcIMS architecture as shown in Fig. 1:

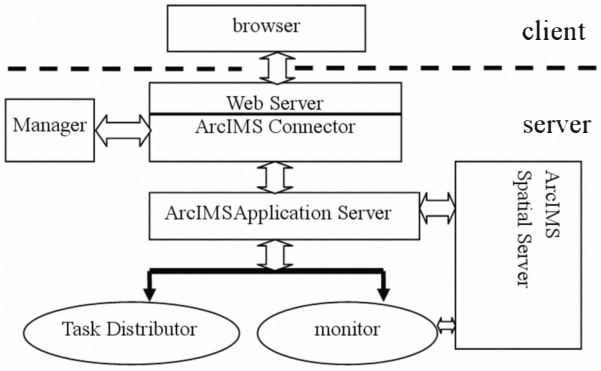

Figure 1. ArcIMS architeture.

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1 http://www.esri.com

1) Server side components:

- ArcIMS application *connectors*
- application server
- spatial *server* and *manager*
- Web server

Server-side components can process the request, create, run and manage the site map service. The core of ArcIMS is spatial server.

2) Client components:

ArcIMS support HTML Viewer and the Java Viewer. In the package of ArcIMS software, there are three Viewers: ArcXML client, HTML / DHTML Viewers and Java Viewers includes ArcExplorer 3 [1].

B. Secondary Development to ArcIMS

In process of system development, we need to implement some analysis based on GIS, such as contours. However, after consultation with the ESRI's technical staff, we learned using ArcIMS platform is difficult to achieve these analysis capabilities, only ArcGIS server has these properties. After technical research, we believe that secondary development on ArcIMS is feasible. We carry on secondary development using component technology. We built a class that encapsulate simple operation and sophisticated computing, Business developer only need to understand the interface of the class, then they can use the class to develop professional applications. That greatly improve development efficiency, and developer needn't understand ArcIMS related technologies.

Java Development on the ArcIMS has two modes [2], one is Bean, the other is the label, and these two models generally use JSP as the display layer. We will use Bean's model development. ArcIMS provides a series of class for map publishing, it also provide examples using JSP. Our aim is to package the original class, making it easy to use each feature, and add the corresponding maps features such as equivalence line, rendering map.

Below is a diagram of class. As can be seen from Fig. 2, the map has multiple layers (like layer sets), and layer has multiple elements. In other words, the map is actually the root object, the layers are the sub-object of the map, element of the layer is the sub-object of layer. All operations start from the map.

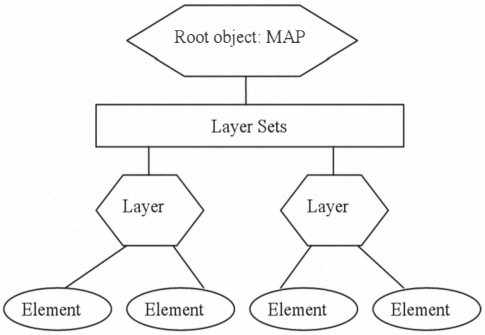

Figure 2. abstractive diagram of class

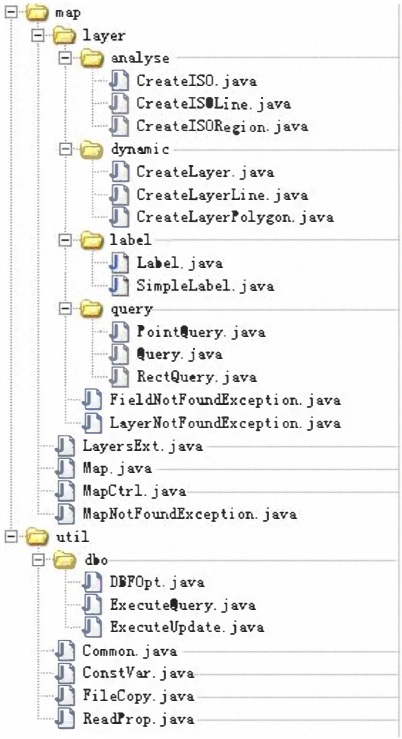

Figure 3. Diagram of class

The following is solutions to technical difficulties:

- Majority of the development depend on ArcIMS Java's API, which is Java Connector Classes API, the user must install ArcIMS Java Connector (non-default installation) for using ARCIMS-NCU kits.
- Contour and ISO-surface shape file generated using Map Objects Classes API interface.
- To solve the multi-user problem, server create a map object and open up a working directory for each client, the user's operations such as production of contour, renderings in its own directory is not affected each other.

III. WATER RESOURCE AND ENVIRONMENT MANAGEMENT INFORMATION SYSTEM

A. Architecture of System

The whole system is composed of four databases and three sub-systems. Four databases are the spatial database, attribute database, methods of database, model database. Three sub systems are maintenance of water resources information management subsystem, expert decision making subsystem and intelligent information retrieval subsystem.

System architecture is shown as Fig. 3:

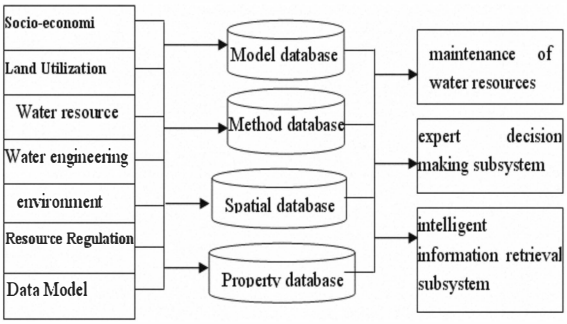

Figure 4. System architecture

B. *Architecture of Software*

The whole system is composed of three layers:

- application layer: carry on database access services, provide data throughout XML
- Application service layer: provide web services using specific features of ArcIMS application server and customized function
- System service layer: Three subsystems. Web browser access servers via the Web service, ArcInfo or client can access web services provided by the server.

Software architecture is shown as Fig. 4:

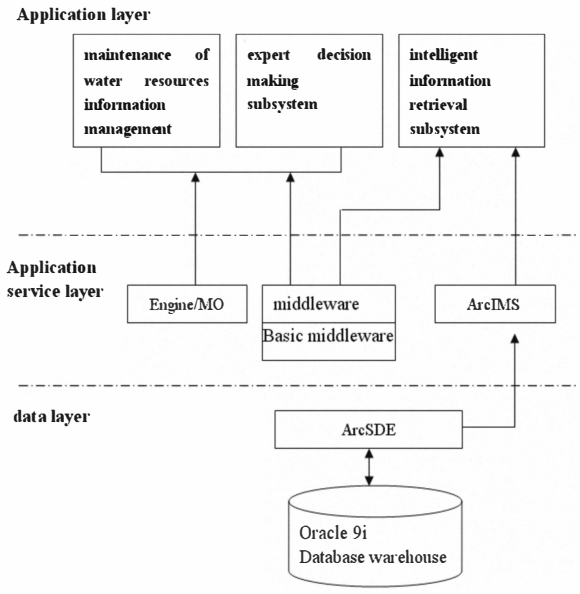

Figure 5. Software architecture

C. *System Function*

Brief functions of the system include maintenance of information, real-time monitor, early warning.

1) Maintenance:

Through GIS and database management system technology, the attributes of water resources and environment will be saved into spatial database for information management. The original data will be reorganized by maintenance software as data with geospatial features. The system carry on maintenance on e-map, including road layer, rain station layer, river layer, lake layer, building layer etc. And basic database have two types: one is attribute database, including hydrological data, climate data, socio-economic statistics etc.; one is geospatial database, include layer information.

2) Real-time monitor:

Hydrological monitoring center is an important spot, it can carry on hydrological monitor, data transfer, detection and control, data process and analyze.

3) Early warning:

Based on real-time and accumulated historical data, early warning illustrates early warning. Data mining technology is therefore applied to analyze the information.

Management and maintenance staff in the office can browse web site at any time to carry on the operation and real-time monitoring of the water resources and environment and make decision.

D. *Implement of System*

The system has been used in the china and archive good evaluation. Implement of visualization is based on ArcIMS, users can view information at e-map. The following take "early warning" as example.

The interface of "early warning" is friendly, the function of the main interface is described as following:

- map control: including enlargement, reduction, roaming, full map display, layer control;
- query features: including point queries, rectangular queries. Population, area, water conditions and other relevant information content can be found;
- map annotation features: including single (Smart) tagging, annotation and dynamic labeling compound. The map attribute information can be displayed with the cursor to move;
- contour lines and iso-surface.

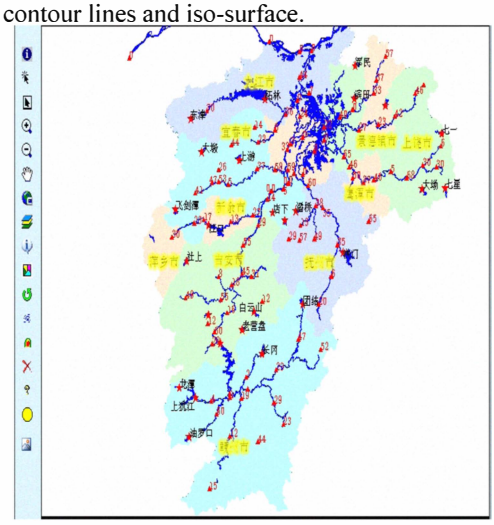

Figure 6. main interface of "early warning"

IV. CONCLUSION

The paper presents the solution of system based on GIS technology, the system can help to monitor status of water resources and environment and make decision. The paper describes the solution of WebGIS in detail. The encapsulated class is developed to solve visualization to information of B/S mode applications.

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