

A WebGIS Framework for Vector Geospatial Data Sharing Based on Open Source Projects

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Abstract—WebGISs have been developed and used extensively in real-world applications with the development of GIS and Internet technology. However, really sharing and interoperability of large volumes of geospatial data in such a complex web-based system become a challenge. In this paper, a WebGIS framework was explored to provide a practical solution for the sharing of dispersed geospatial data and visualization of vector geospatial data on the Web. The framework adopted four levels structure: application layer, service layer, function layer, storage layer, where service layer played an important role to control the interaction between the client and server. Furthermore, the development of Open Source projects was introduced. A vector spatial data management and visualization system was designed and constructed based on the framework, using Open Source software such as PostgreSQL, GeoServer, GeoTools, Openlayers, TileCache and etc.

Index Terms—WebGIS; WebGIS framework; vector geospatial data; Open Source projects

I. INTRODUCTION

The fast-paced development of GIS has triggered some researchers (Sui and Goodchild 2001) to reconsider the fundamental essence of GIS and its social implications. During the past decade or so, GIS has been widely used in various types of business, government and university projects. Large volumes of geographic data, which are valuable to various organizations, have been accumulated but in the dispersed and heterogeneous manner. In order to fully utilize the available spatial data efficiently and effectively, GIS has to play a critical role, not just in disseminating the raw data, but also in providing information and offering value-added services to potential users [1]. GIS-enabled environments have to be available to the public. It has been widely recognized that future developments in GIS will center on web-based GIS, accessing geospatial data and conducting geospatial analyses on the Web [2]. While WebGIS is gaining in popularity, an important issue should be considered: share and interoperate the heterogeneous spatial data. The emergence of Web Services provides a new WebGIS framework for dealing with this issue. Spatial information plays a more important role in the form of services in socio-economic.

In essence, Web Services can package data, message and behavior based on unified standards, without considering the specific application environment.

Different systems can achieve seamless communication, data sharing and interoperation across platforms and languages based on Web Services framework. In fact, the ultimate goal of WebGIS is to realize a real sense of sharing and Interoperability in GIS fields and guide GIS into the service stage from sharing stage. Web Services provide a very good solution in its completely open standard [3].

OGC has also provided a series of standardized interface specifications to support geospatial data sharing and interoperability among web-based GIS systems. Especially, GML is one of the important criteria that can resolve the interactive questions because of the variety of GIS data formats; Web Map Service Interface Standard (WMS) provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases [4].

OpenSource projects emerge in large numbers following the above OGC specifications: e.g. GeoServer is an open source software server written in Java that allows users to share and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards. It is the reference implementation of the Open Geospatial Consortium (OGC) Web Feature Service (WFS) and Web Coverage Service (WCS) standards, as well as a high performance certified compliant Web Map Service (WMS); OpenLayers makes it easy to put a dynamic map in any web page. It can display map tiles and markers loaded from any source. OpenLayers implements industry-standard methods for geographic data access, such as the OpenGIS Consortium's Web Mapping Service (WMS) and Web Feature Service (WFS) protocols; TileCache is an implementation of a WMS-C compliant server and can easily cache the data of WMS. It makes the response speed of WMS 10-100 times faster [5].

Consequently, this paper first constructed our proposed WebGIS framework based on Web Services. Then, corresponding spatial data services and metadata services were developed to control the interaction between the browser and the spatial data. Finally, based on the architecture and the services, a vector spatial data management and visualization system was designed and implemented using the latest OpenSource projects. PostgreSQL and PostGIS were used to manage and store

GIS spatial data and its metadata. GeoServer acted as the map server, Geotools as basic GIS develop tools, JDK as a basic environment.

II. FRAMEWORK

Fig. 1 shows the framework of our proposed WebGIS. It adopted four levels structure of application layer, service layer, function layer and storage layer.

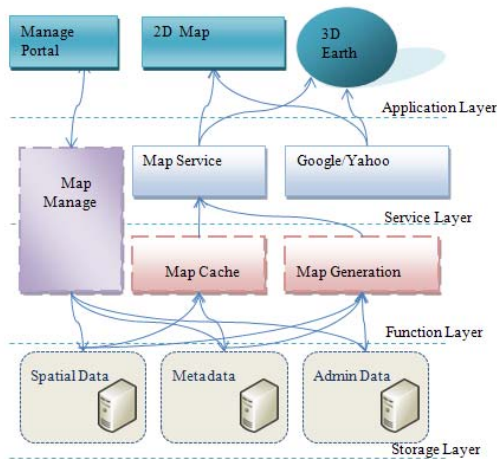


Figure 1. 1:400 million national distribution of soil sand content

In storage layer, geospatial data, its metadata and relative configuration information were stored in databases. Relational databases were created to store metadata, geospatial vector and raster databases to store spatial data, admin database to store the configuration information of the architecture.

In function layer, the framework provided two major functional modules: "Map generation" and "Map Cache". "Map generation" module supplied functions including visualizing map, searching data and generating legend. Map visualization supported a variety of ways such as 2D map (WMS), 2D vector (WFS), 3D vector (KML) and etc. "Map cache" module implemented map tile caching using latest technology and improved the respond speed in network environment. Considering the coordination and management of the entire system, "Map manage" module was added to the architecture. It provided basic manage function for the administrator and publisher.

In service layer, the services played an important role between the browser and server. "Map service" module provided metadata services and spatial data services based on function modules. Metadata services supplied the query and access of metadata in the way of REST. Spatial data services provided standard WMS in GML for the public to access spatial data. The WMS can easily interact with other WMS/WCS published by Google, Yahoo, Microsoft Earth, and etc. The service layer also provided standard service API for the integrated web application. The WMS-oriented mode greatly improved the interoperability and scalability of the structure [6] [7].

In application layer, manage portal site was developed to provide web interface to the public. The visualization

module supported 2D map (WMS) and 3D vector (KML) show.

III. APPLICATION

A. The Web Application Mode of the framework

Fig. 2 depicts the web application mode of the architecture. A user accesses the server with a Web browser and acquires an HTML form necessary for sending a geospatial data request. Next, the user clicks the responding link or inputs relative item into the form and sends parameters to the server. WebGIS applications are executed and the parameters are analyzed. According to the analysis results, the requests are transferred to relative services, map server or map cache module.

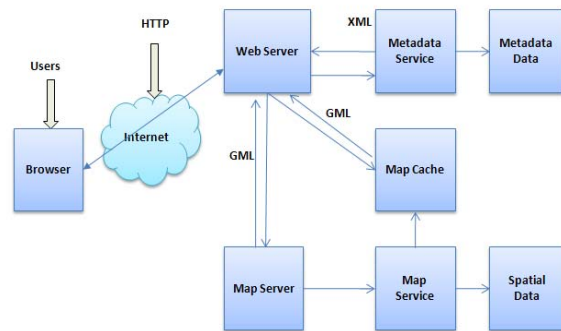


Figure 2. Data sharing site

Metadata services issue a query to RDBMS and return metadata information of geospatial data in XML.

When vector spatial data is requested, the server will forward the request to the map cache or map server. Required spatial data will be returned in GML by WMS published in map server. Finally, a dynamic Web page reflects the result of the requests.

The metadata in XML is converted into HTML and sent to the user's Web browser. The spatial information in GML will be converted into a dynamic map in the web page.

B. Implementation

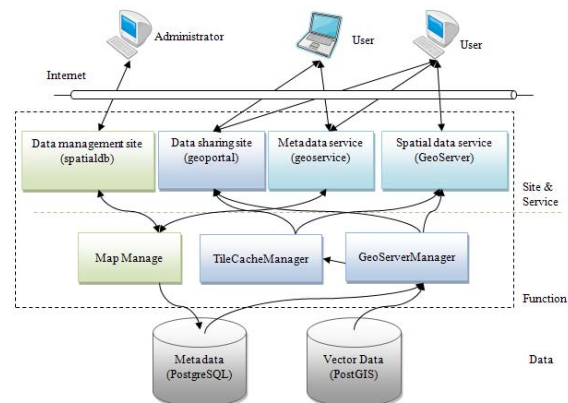


Figure 3. Function Modules and Classes

quickly and conveniently. It also provided keyword search and spatial search. The user can input the responding keywords in the textbox and click search button to find datasets. Spatial search was implemented based on the map.

The map was implemented by Openlayers adding Geoserver WMS layers. It showed the administrative divisions of China layer and the global administrative boundary layer. The user can draw a box with the mouse above the map to find requested datasets.

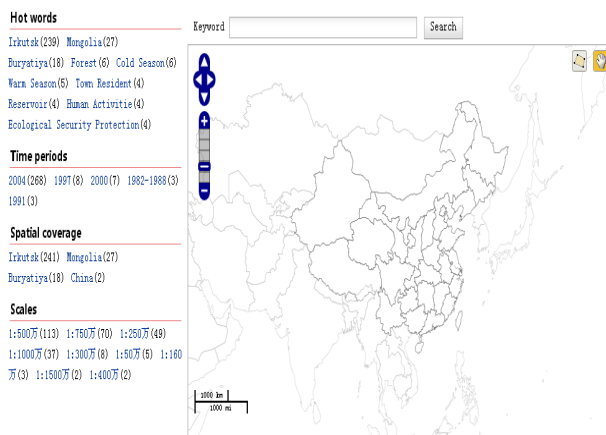


Figure 6. Data sharing site

SUMMARY

This paper provided a practical WebGIS framework combined with latest Web Services technology and OpenSource projects. Based on this solution, metadata services and spatial data services were developed to access and publish vector spatial data. The vector spatial data management and visualization system was developed to provide a new solution for the public to share geospatial data to on the web. All vector geospatial data were published to WMS, and then visualized by Openlayers. The system has been practiced in Data-sharing Network of Earth System Science Project in IGSNRR and has been proved feasible and practicable for vector geospatial data sharing. The system also shows great flexibility in the actual deployment and operation.

As the constant development of OpenSource projects, e.g. GeoServer enhances the quality and performance of

their own map and is at further support for WFS, WCS and other OGC specifications; our framework can achieve further improvement. More data services need to be provided for users to customize; they can bring greater convenience for users and easily be expanded for different types of map application on the web. It can also be used by other based-on-map service web practice for reference. If you want to publish real estate information in a certain city, only the real estate point of data and relative services are added.

The solution also has some shortcomings, e.g. this paper packages some GeoServer code modules to publish and render map, it is difficult to control the time spent in publishing overload data. Moreover, the rendering mode is single. Nevertheless, there are some limitations and issues to be resolved. The author will focus on solving these problems in future work.

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