Design, Implementation and Deployment of Grid-based Information Service and portlets.

Xiaozhu, Wu[1], Chongcheng, Chen[1], Grégory, Lucas[2], Bela, Markus[2]

[1]Key Laboratory of Spatial Data Mining & Information Sharing, Ministry of Education, Institute of Mathematics and Computer Science, Fuzhou University, 2 Xue Yuan Road
350002, Fuzhou, China
wxz@fzu.edu.cn, chencc@fzu.edu.cn
[2] Land and GeoInformation Knowledge Center, Faculty of Geoinformatics, University of West Hungary, Budai út 43,
8000, Székesfehérvár, Hungary
g.lucas@geo.info.hu, mb@geo.info.hu

Abstract: The core of this paper was developed by the Key Laboratory of Spatial Data Mining & Information Sharing (LSDMIS) of Fuzhou University (CN) and it is further developed and presented by its partner university - the University of West Hungary, Faculty of Geoinformatics (HU) - in the framework of the Science and Technology bi-lateral programme. The paper deals with the use of Grid computing services to support nature conservation and biodiversity management. The study area is located in the Wuyi Mountain, a natural reserve with the largest and most representative semitropical original forest ecosystem in China and where biodiversity preservation is a priority. At present, the research on biodiversity of Wuyi Mountain mainly focused on fieldwork and produced abundant observation data. By doing mapping and dynamic remote-sensing monitoring on biodiversity of Wuyi Mountain, and then publishing relevant information with the use of geographical information service and virtual simulation model through grid computing technology, it could provide decision support for biodiversity protection and rare species preservation. Another point is to reveal the status and characteristic of biodiversity of Wuyi Mountain, to effectively protect and reasonably utilize local biodiversity, and to promote regional sustainable development. How to share and distribute information and knowledge about biodiversity between the professionals working in this area is a key point for the protection of rare plants and animals. This paper describes how the grid-based information sharing technology can be used and introduces the GeoKSGrid platform developed by the University of Fuzhou. The geographical knowledge grid platform (GeoKSGrid) is build upon the mainstream grid middleware Globus toolkit 4. The paper explains how grid-based information services and portlets were designed and implemented. By using grid services to publish spatial data in GML and virtual models of plants in VRML format, registering and deploying services into the GeoKSGrid platform, the outcomes of research on biodiversity protection could be more easily accessed by other researchers.

Keywords: biodiversity protection, grid service, information service

1 Introduction

Biodiversity is the foundation of human beings' subsistence and development. Along with the rapid expanding of population and economy, biodiversity is facing more and more threats and much of rare plants and animals are even close to die out. An important issue for the management and protection of biodiversity is to obtain information and knowledge, including the richness and loss of biodiversity.
Wuyi Mountain natural reserve is located in the southern part of China, in the north-west of Fujian province. Wuyi Mountain has the largest and most representative semitropical original forest ecosystem in the world. It is well preserved. About 284 families, 1107 genera and 2888 species of higher plants has been found in this area. This biodiversity has an inestimable value. At present, the research on biodiversity of Wuyi Mountain mainly focuses on fieldwork and has produced abundant observation data. By doing mapping and dynamic remote-sensing monitoring on biodiversity of Wuyi Mountain, and then publishing relevant information using geographical information services and virtual simulation model through grid computing technology, it could provide decision support for the management of biodiversity and the protection of rare species. It is also important to estimate and reveal the status and characteristic of biodiversity in the Wuyi Mountain, to effectively protect and reasonably utilize local biodiversity, and to promote regional sustainable development.
The researches on species of the natural reserve mainly focus on species diversity, diversity of community and taxonomy. Few researches and applications focus on landscape diversity, unit/scene virtual simulation and network-based information service. It's a new approach to promote natural reserve management with digitalization and information systems. More precisely by taking use of

virtual reality and network-based information sharing technology it is possible to simulate the distribution of rare plants and animals community in landscape ecosystem and distribute information about spatial-temporal variation and changing process.
Recently, some researchers began to rebuild and digitalize rare plant and animal which are in natural reserve or museum. It's a new trend to remotely query and analysis spatial and attributes information of habitat of plants and animals or landscape ecosystem through network. But it has not been reported that grid computing technology was applied to construct biodiversity information service platform. Grid computing is a rising internet-based computing model in recent decade. It has been in the stage of technology standardization and application popularization. The emphasis of research and development of grid computing has began turned to global distributed collaboration, service-oriented method and information process [1-10].
The paper outlines the grid-based information sharing technology and GeoKSGrid platform where the service is hosted. The components of service and the design and implementation of its portlets are also introduced briefly.

2 Grid-based information service technology

Information sharing aims to eliminate "Information Island" especially if heterogeneous information exists in different management domain. The difficulties to cope with are how to release the data service information, how to find the appropriate data and data service, how to integrate these services in the application programs and how to control and administer the access to data [11].
Grid is a dynamic, complicated and distributed computing environment which integrates large numbers of heterogeneous resources. It deals with coordinated resource sharing and problem solving in dynamic, multi-institutional virtual organizations. Globus was developed by Argonne National Laboratory and is one of the most famous grid middleware. GT4 (Globus Toolkit 4.0) includes a complete implementation of the WSRF specification (Web Services Resource Framework) and combines more closely grid technology and web services.
In the world of grid computing, hardware, software, data and documents can be viewed as grid resources and be encapsulated and described by a unified method: the grid service. Grid service is stateful web service compatible with WSRF specification. Grid service is described by WSDL which is a XML file that can be understood by service requester. When a grid service is published, the corresponding WSDL file is also published, and then every service requester could retrieve the WSDL file and know about what the service is and what service it can supply. Grid service is requested by SOAP: a XML-based messaging format and framework. SOAP is working with HTTP protocol so that grid service could be visited from almost anywhere.

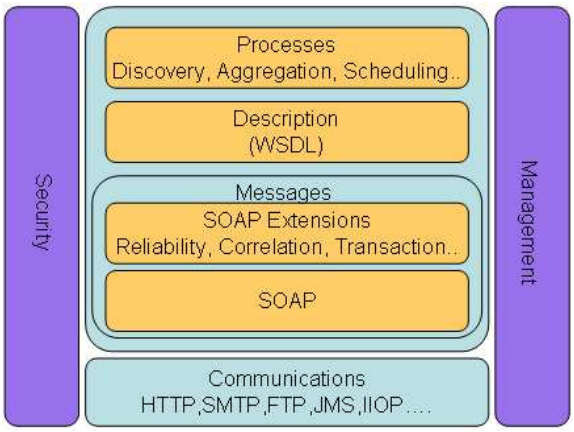

Fig.1. Grid Service Architecture (Source: W3C)

By offering grid resource to grid service, it is possible to realize cooperation between grid resource and resource sharing. It also offers a consistent access manner for users to visit grid resource. No matter where the resource exists and what the resource is. Grid conceals the difference of resource. With the support of grid security infrastructure and node self-governing strategy, resource owner could manage resource sharing policy in flexible manner [12-20].

3 GeoKSGrid platform

The geographical knowledge grid platform(GeoKSGrid) established by LSDMIS of Fuzhou University is built upon the mainstream grid middleware Globus toolkit 4, and use existing functional modules of Globus, such as information management, security management, data management and execution task management [21]. The grid-based information service on natural conservation and biodiversity in Wuyi Mountain natural reserve is hosted and running in the GeoKSGrid.
Resource unified access is an important function of GeoKSGrid. GeoKSGrid offers a portal as a single entrance to grid platform, and provides user identity verification system, unified data access interface and portlet integration mechanism to realize resource sharing and application service. The GeoKSGrid Portal consists of five service centers: grid data center, grid monitor center, grid job center, grid service center and grid management center. Each service center contains a group of portlets to interact with grid middleware and to provide GUI for grid users.

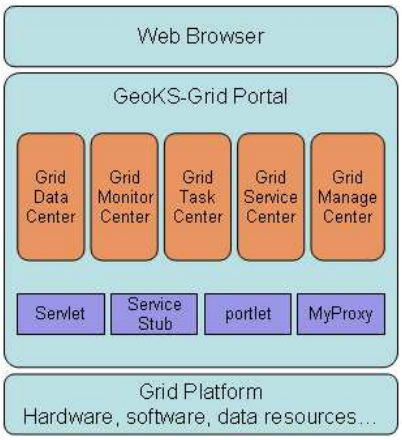

Fig.2. GeoKSGrid Portal Architecture

Grid services are the most important resource in GeoKSGrid. Users could not interact with grid services directly and the best way is by using grid portlet. Portlet is a Java based web component which acts as a client to grid service and the content produced by portlet can be easily aggregated into portal. The service center provides a mechanism to register grid service and deploy portlets. The service provider implements grid service and deploy it in his own grid node. Then the service provider uploads portlet to portal server, and then register grid service and portlet in grid service center. What should be provided during registration are the name, URI, WSDL file of grid service and URI of portlet. Then the grid portal knows about where and what is the service and integrates portlet into portal. Finally, users could visit service via portlet.

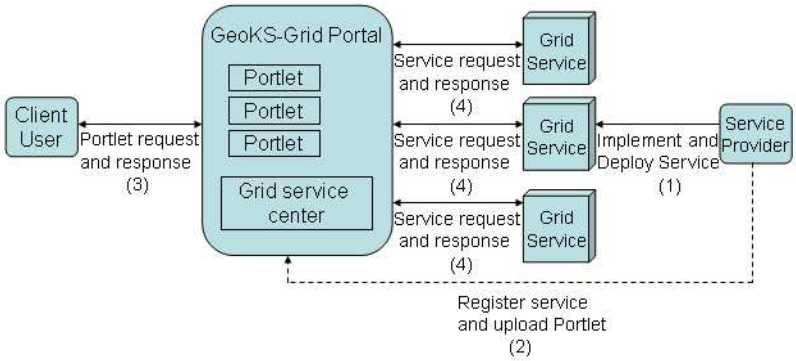

Fig.3. The Process of service deploy and register in GeoKSGrid

4 Implementation

4.1 The content

After field observation and image processing on remote sensing image, a database has been setup which stores spatial and attributes information about rare plants and animals management and biodiversity of Wuyi Mountain natural reserve. These spatial and attributes information would be encapsulated as grid service and deployed to GeoKSGrid for sharing.
The fundamental geographical information and spatial thematic data published by the service are listed in table 1:

Table 1. The list of Spatial Information offered by the service

The name of data set	Feature Type	Scale
Administrative boundaries	Line(shape)	1:50000
Residential areas	Point(shape)	1:50000
Tourist road of Wuyi Mountain (limited in natural reserve)	Line(shape)	1:50000
Road (limited in natural reserve)	Line(shape)	1:50000
Distribution of tourist sites (limited in natural reserve)	Point(shape)	1:50000
Distribution of rare plants	Point(shape)	1:25000
Distribution of rare animals	Polygon(shape)	1:25000
Functional division map of Wuyi Mountain natural reserve	Polygon(shape)	1:50000
Digital Line map of Corridor boundary	Line(shape)	1:50000
Jurisdiction division	Polygon(shape)	1:50000
Forest Sub-compartment	Polygon(shape)	1:10000

The virtual reality models of rare plants in Wuyi Mountain published by the service could be viewed by public through internet and be integrated to other system such as virtual museum [22]. By browsing these 3D models, public could learn rare plants' physiological and ecological feature in a more intuitively way. It would arouse public's passion to care about rare plants. Other researchers could deploy these 3D models to form large-scale visual landscape models to simulate the rare plants' interaction with environment. The content of 3D models is listed in table 2:

Table 2. The List of virtual reality models of rare plants Offered by the Service

Name of rare plants
Clerodendrum japonicum
Liriodendron chinense(Hemsl.)Sarg
Taxus chinensis (Pilger) Rehd
Schima superba Gardn et Champ
Tsuga chinensis var. tchekiangenesis (Flous) Cheng et L. K. Fu
Fortune Plumyew Twing and Leaf
Pinus taiwanensis Hayata
Castanopsis eyrei (Champ.)Tutch
Cunninghamia lanceolata (Lamb.) Hook
Ginkgo biloba
Podocarpus nagi
Manglietia insignis (Wall.) Bl
Twolobed Officinal Magnolia Bark
Golden Larch
Liriodendron chinense(Hemsl.)Sarg
Torreya grandis

4.2 Service design

According to the different file format and sharing, application requirement of different information resources, different service interface shall be designed.

The fundamental geographical information and spatial thematic data are spatial data that need to be queried, browsed on web and even integrated with other applications. So the format of spatial data shall be independent from the platform used, easy to store and express all kinds of spatial data. GML is a suitable format, moreover it is recommended by OGC. It is a XML-based encoding specification that could denote spatial and non-spatial information of geospatial object. Spatial data in GML format is fitting for transfer by HTTP [23, 24]. Based on such considerations, this paper chooses the open source GIS server software: GeoServer to supply spatial data service. GeoServer provides two OGC standard services: Web Feature Service (WFS) and Web Map Service (WMS) to interact with clients. Client launch request to GeoServer to retrieve map in such style: http://127.0.0.1:8080/geoserver/wms?bbox=117.39858239205375,27.569815308978793,117.85928964702698,27.922468853056497&styles=&Format=image/png&request=GetMap&layers=topp:Animal_point&width=800&height=574&srs=EPSG:4326. Then GeoServer would return map in png to client. In such conditions, the grid service is designed to have an interface: public String getMap(String URI). It receives a string as input to tell GeoServer which map it would demand, and then return map as an image. Client program uses this WFS request to get features from GeoServer: http://127.0.0.1:8080/geoserver/wfs?request=GetFeature&version=1.0.0&typename=topp:cities&propertyname=name,country,the_geom. Then GeoServer would return attributes information in GML.
The virtual reality models of rare plants are made from VRML. The model files are stored directly in the disk. Users need to use web browsers with VRML plug-in to view these models. The grid service is designed to have an interface: public String getModel(String nameOfModel). It receives a string as model name and return the URL of the model, then the client can download and view the model via the URL.

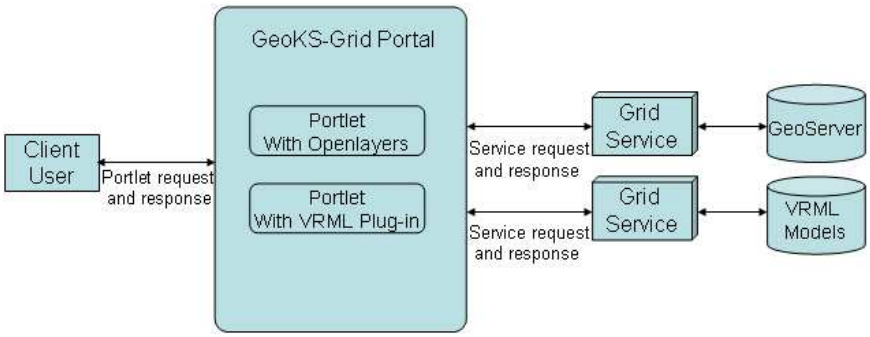

Fig.4. The services that Deployed in GeoKSGrid

4.3 Portlet design

Portlet is a web component that could be easily integrated into portal and acts as a bridge between users and grid service. User logins to portal and operates on portlet, then portlet interacts with grid service and displays result in portlet. So portlet is an important part to be implemented.
Two portlets had to be set up. One is for fundamental geographical information and spatial thematic data querying and sharing, the other is for virtual reality model viewing. These two portlets have the same UI design. A resource list is available at the left of the page and a main area is displayed in the center of the page. User clicks on the hyperlinks in the resource list, and the portlets would send URI or nameOfModel as input to launch grid service. An openLayers script client is embedded into the portlet to display map which returned by grid service, a VRML plug-in client is integrated to show VRML models. OpenLayers is a pure JavaScript library for displaying map data in web browsers, it implements industry-standard methods for geographic data access such as WMS and WFS. OpenLayers is used without extensions or patches.

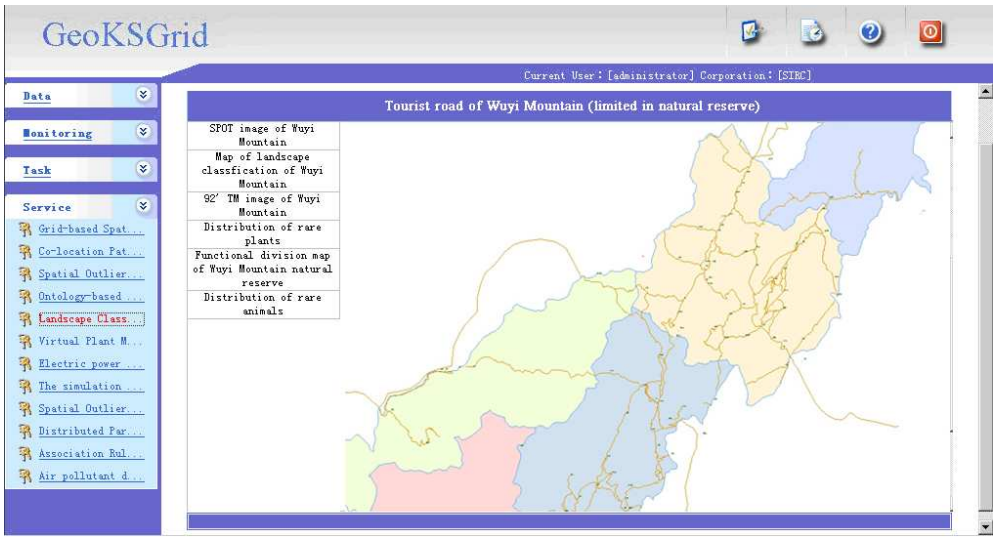

Fig.5. Portlet: Map of Tourist Road of Wuyi Mountain(limited in natural reserve)

Fig.6. portlet: VRML model of Twolobed Officinal Magnolia Bark

4.4 Services and portlets deployment

The developed information services and portlets would be deployed into GeoKSGrid platform. The first step is to let the computer which runs grid service to join GeoKSGrid and install grid service. A signed host certification shall be requested from GeoKSGrid CA. After installing Globus and the certification, the computer becomes a member node of GeoKSGrid. The grid service is packaged as a .GAR file, it could be deployed to Globus service container by launching the Globus command: globus-deploy-gar. The second step is to register the grid service into GeoKSGrid by logging into GeoKSGrid portal and providing information for registration in the grid service center. The WSDL file also shall be uploaded to grid service center, then users could find the service in the portal. The third step is to load portlet into portal by uploading portlet files into portal server and registering them in the portlet center.

5 Conclusions

By field observation and synthesizing with RS and GPS technology, the datasets of wild plants and animals' management and biodiversity of Wuyi Mountain natural reserve have been setup. A number

of virtual reality models of rare plants also have been created. By taking use of grid computing and OGC compatible technology to deploy and share these outcomes in GeoKSGrid platform, it provides a more open and cooperative mechanism for biodiversity management and research. The data owner produces and shares data on their grid nodes, the others could retrieve data at anytime and anywhere by invoking grid service under the owner's sharing policy. The data could even be integrated to other information systems such as web-based system which is a most popular system for public to visit. This method eliminates the gap between data producers and consumers. The public and researchers could access information about biodiversity more easily, and then promote the biodiversity management and protection.

Rare plants and animals management, biodiversity monitoring and information sharing is a challenging and ongoing research problem. Increasing number of new requirements has been proposed. How to dynamic monitoring rare animals and process, distribute these huge volumes of data by real time meaning, is a more complicate issue to be conquered.

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