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A Remote Sensing Grid Experimental System Using Grid Middleware

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Abstract: This research is satisfied with the needs of the remote sensing massive data real time and fast transmission and processing and developed of the grid simulated theory and methods research of remote sensing information. First, based on the generalized analysis to the concept and characters of RS grid, the RS data grid simulated processing architecture design mentality and the construction method is proposed. Second, "The RS information test simulation grid" was established by using condor-g in the multi-machine, multi-system, multi-user environment. Finally, the RS grid applications were completely deployed in the experimental grid environment and applied of which combined with experimental data. And its operating results proved that RS grid simulated applications were achieved better efficiency and velocity.

Keywords: Design and implement, grid service, grid system, middleware, remote sensing

INTRODUCTION

Grid is the third tide of the internet and also is an integrated resources and services environment. Grid has the characters that can share resource and synergy with the study of various resources such as data and computing resources (Giannadakis *et al*., 2003; Xu *et al*., 2004; Yu *et al*., 2005). The spatial information grid is a spatial information infrastructure that having the magnanimous spatial information resources which in one kind of collection and the sharing geography distributes, carrying on the integration to organize and to process, thus becomes has the formidable spatial data management and the information-handling capacity. Remote sensing data is an important spatial data source and its characteristic is large amount, sharing and interoperability deal with difficult. How to realize remote sensing data and computing recourses sharing and make fast and efficient processing becomes an important issue for researchers.

There are two status of remote sensing data analysis and application such as mass data cannot be handled quickly and efficiently, while a large number computing resources are idle. So these problems have hindered the efficient use of remote sensing data and process information (Hong-Chun *et al*., 2008). Grid has characters such as resource sharing and collaborative work, so the problem of the rapid processing of remote sensing data in heterogeneous environments and application services would be solved. The computing resources and conservation could be better used and efficient, real-time massive data transmission and processing could be realized.

This research purpose is realize remote sensing data and computing recourses sharing and makes fast and efficient processing. In this study, the architecture and processing application strategy of remote sensing information grid were researched and the new method to use data and computing resources in internet were studied. Also, the processing and application services were built in heterogeneous environment. All these were to realize better using and saving computing resources.

REMOTE SENSING GRID AND GRID MIDDLEWARE

Basic concept: The grid is a foundation structure coupling internet resources. From the thought it is a behavior way and is communication way that emphasis "the cooperation" and "the service". From the material, it is an environment which integrated the massive hardware source, the software resource, the data resources and a method resources agreement. The grid characteristic displays in: resources centralism, resource sharing as well as network cooperation. The grid distinguishes in Web and the distributional system's substantive characteristics are the resource sharing and the coordination and it emphasis resource sharing and the coordination integration, displays in the network the resources comprehensive potency (Giannadakis *et al*., 2003; Xu *et al*., 2004; Yu *et al*., 2005).

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The remote sensing information processing is a special behavior and the behavior is that operator carries on processing to the specific remote sensing data using the designing model. If this process was placed in the grid environment, it is called "the remote sensing information grid". The remote sensing information grid provides basic frame that integrated data saving, gaining, processing and application and it provides the platform and the basic application environment intellectualized remote sensing data processes (Nico *et al*., 2002; Hong-Chun *et al*., 2008).

The remote sensing information grid belongs to the application grid. Its famous products are I-WAY and GUSTO in oversea. In china, Pixel Grid, DP Grid and Image Grid are also important products in recent years.

Grid middlware: The grid middleware is the key technologies of grid facility; it provides the general service between the grid infrastructure and the grid application. And the middleware provides the unified model for developing the grid application system through solving the wide range, isomerism and distributing grid questions. The grid middleware technology's superiority is convenient and fast to design and build the grid environment. So, it provides the unified model for the development grid application system. The present famous grid middleware products are Globus Toolkit4.x, Condor, ICENI, Glite and so on Xu *et al*. (2004) and Yu *et al*. (2005).

Globus and Condor are the widespread using grid middleware products and it can provide on the foundation frame and the function module's support for the special grid construction. Using these products has its union feasibility and the complementarities in the remote sensing information grid's construction:

- Globus provided some services to support the work's submission, surveillance and control; meanwhile it can provide a security infrastructure used for resources surveillance, discovery and management.
- Condor has the task scheduling function. By being coordinated with Globus, it may carry on the submission, surveillance and control to the grid job.
- The functions which include the job management, the safety control, the resource management and the visit function would be realized though mixing two kinds of middleware.

THE CONSTRUCTION DESIGNING AND FUNCTIONAL ANALYSIS OF REMOTE SENSING INFORMATION GRID

Grid elements: The remote sensing information grid is the software and hardware environment based on the high speed interconnection communication equipment (e.g., the Internet). So, its basic integrant parts are resources which lie in grid environment, as well as all kinds of software and the agreement rule which provides the integrated servers and operates. The elements of remote sensing data grid include each kind of grid resources, such as grid hardware facility, grid software facility, grid agreement and communication mechanism, topic data acquisition and special remote sensing processing algorithm model. The description document of resources that provided the service would be submitted to the grid resources supervisor.

Overall construction designing: The remote sensing information grid system should manifest the multistage dispatches and the management thought based on the consideration of processing duty's dynamical equilibrium and the resources use's tendency. The upper is distributional system that realizes on WAN's management and the dispatch and the floor administrated local network's resources by using the central system and carried on to the upper formation submission's duty dispatches again. At the same time, its must be able to manage internal resources and the dispatcher duty effectively. Therefore, the remote sensing information grid's architecture is one open and expandable architecture. The grid elements containing in this architecture include: the grid platform environment, the physical construction module, the remote sensing topic processing grid algorithm model, as well as remote sensing data's grid provides the service (Hong-Chun, 2008). The architecture frame and grid essential factor's composition relations are shown as Fig. 1.

Remote sensing information grid environment establishment: The grid substructure is established using grid middleware Globus 4.0 in many machines environment that include Linux and the Windows XP hybrid operating system, so it realizes the integrated management and dispatch of grid resources. The management pond of grid computation duty is established using Condor 6.8 software package and it administrates processing duty execution. In the grid environment, the application program compiling environment that includes JAVA, GCC++ and Eclipse 3.5 was deployed and it carries on grid duty specifically and returns to the corresponding processing result.

The system hardware is constituted personal computers and network communication equipment such as router, concentrator. The system software is constituted grid middleware (Globus 4.0.1, Condor 6.8.8), operating system software (Linux Fedora core 2.6.18, Windows XP sp2), program compiling software (python-2.5, Cygwin, VC6.0) and grid service related software (eclipse 3.8, gt4ide, jakarta-tomcat-5.0.28).

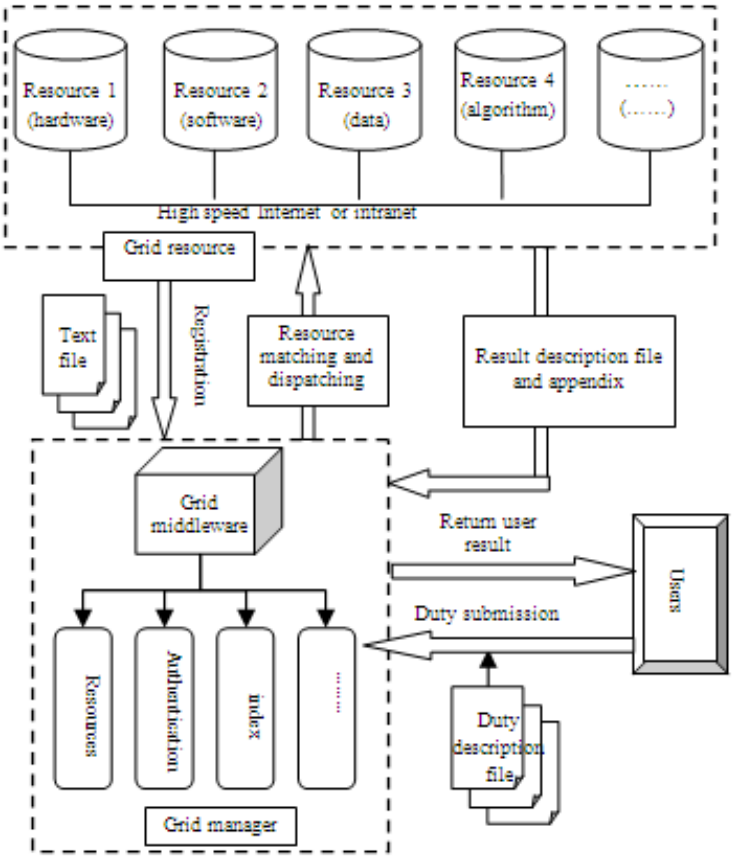

Fig. 1: The structure drawing of RS data grid

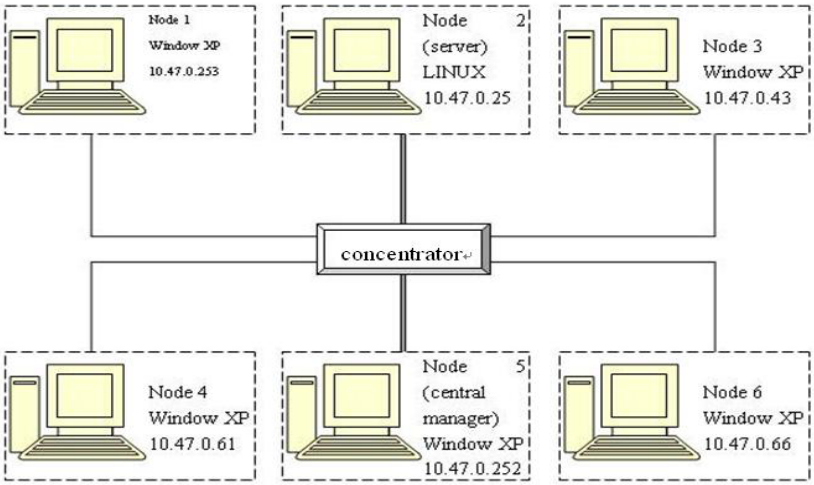

Fig. 2: The graph for RS processing simulation grid node physical constitution

The grid experiment system constructed in this research is a software and hardware computing environment. Its characters are more than one machine, multi-platforms, present the loose coupled structure characteristic and manifest interoperability and the cooperation function. The computation node's physical constitution is shown as Fig. 2.

This experiment system is constituted by 6 PC and its operating system is Linux and WinXP. The grid server node's function is carries on the grid authentication management, coordinated grid data service. The content server node's function is provides the grid service index and dynamic status of resources. The central supervisor mainly provides the response to

```
Executable = cut.exe
globusscheduler = cai.linux.com/jobmanager
universe = globus
output = cut.out
log = cut.log
queue
```

Fig. 3: The demonstration chart of duty content description script

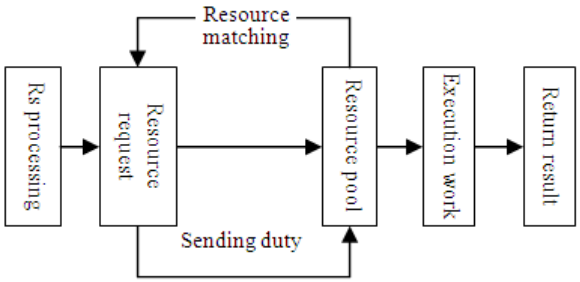

Fig. 4: The flow chart of grid job management based on resources direction

the resources monitor proxy, collects the service condition of computing resource and distributes the grid computation duty.

Remote sensing information grid functional analysis:

Girding information resources registration: Each grid node must be registered to the resources supervisor for providing the data and special processing algorithm model.

Description of grid work and duty: The information of remote sensing processing duty was written to a document. The content was shown as Fig. 3. The result description document has recorded the job task execution match process, as well as returns processing result metadata. The resources description document is recorded include the computing resource request, the status messages and the operational aspect, so its realizes the resources direction detection grid job management. The principle process was shown as Fig. 4.

Grid middleware deploying: The grid middleware must provide the safe authentication mechanism (Grid Security Infrastructure, GSI), job management service (Managed Job Service), indexing service and data service and so on. The function and service of Globus are quite complete, but its operation surface is unfriendly.

Job dispatch and management: The duty of submitted by users was classified referring the type and accepted the dispatch and arrangement by the overall dispatcher according to certain algorithm. The duty was organized in form as records. After the task being finished, it would be deleted from the job queue.

Long-distance algorithm receiving and resources condition monitoring: The long-distance algorithm receiving service of grid provided would be queuing and waiting for execution after the algorithm code having been received. The resources monitoring service was used for monitoring the computing resource condition on the grid, including current available machine, machine performance, operating system type, the task executing situation and so on. Through these tendencies and the static resources information condition collecting, the duty was dispatched and arranged by the overall situation task scheduling.

SERVICE-ORIENTED APPLICATION AND DEMONSTRATION OF REMOTE SENSING GRID

The RS grid was an application grid being took "the service" as the core special and Web Service was one of key technologies. In this grid, all resources would be provided to the user in form as services.

The basic mentality of RS grid service realized: The RS grid service was supported by the grid technology and it was applied in the grid platform according to the WSRF standard. The realizing process was shown as Fig. 5 and it was descript as follows:

- The grid service that provided from grid nodes was registered in the contents server node, simultaneously this procedure module was submit to the grid service vessel. So the vessel was started.
- The grid user's identification was authenticated and the service tabulation of remote sensing data which provided by the contents server was browsed. Simultaneously, the service content was started through client side application procedure.
- The start digital data service response client side requested that found the corresponding data resources through the registration center and gave the grid user as the result returns.

The development and realization of RS grid services: In this research, the basic physical software and hardware architecture of RS information grid environment is based on middleware technology of Globus and Condor. The basic grid resource management, service registration and monitoring were realized by Globus, thus the development and deployment of RS grid services was based on Globus. The grid service environment was built from Eclipse 3.2+GT4IDE.

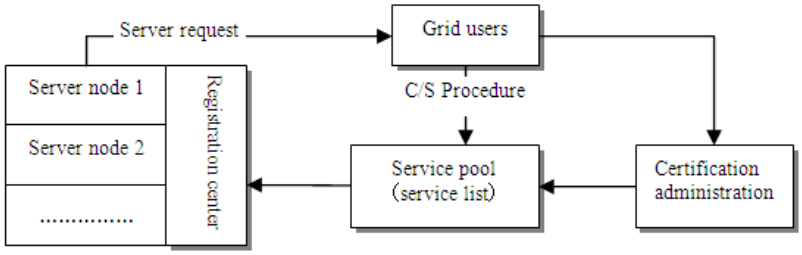

Fig. 5: The graph for grid service application

Fig. 6: The grid vessel after starting RS data service

Table 1: The comparative time of merging the great quantity RS data

Merging way	Processing node	Consume time (s)
Experimental grid system	10.47.0.25, 10.47.0.253, 10.47.0.66	58
Single computer	10.47.0.253	267

The methods and steps of RS grid service's development and design were mainly as follows:

- Through the preparation of WSDL (Web Service Description Language) file, the service interface was defined.
- Through the preparation of Java code, the service interface that defined above was completed.
- WSDD (Web Service Deployment Descriptor) and JNDI (Java Naming and Directory Interface) were deployed and the basic parameters used by the deployment of the service were defined.
- The source code which was writed in the above three steps was compiled to form executable and available service file through the ant or python, such as GAR (Globus Archive) file.
- The designing of grid services were deployed to the grid service container through the grid tool.

Based on the above steps, the remote sensing data and information processing provided by the grid packaged as web service and registered to the grid resource and directory management device in the form of service delivery and broadcasted to all the grid users at the same time. Figure 6 is a interface diagram where a remote sensing information grid services deployed to the grid nodes 10.47.0.253 in the Globus grid container and start the container (this is the simulation grid's IP, the computer's name is zhc), at the same time the services they provided registered to the grid Catalog Manager, the SearchService in the figure is a successful developed remote sensing data service.

- **RS information service component:** The main function of the information service component is to publish a GML file and to register the service to the grid service container. The RS information service component is mainly made up of WSDL interface descriptive file Search.wsdl and implemental file SearchService.Java file. The implemental class is SearchService.class.
- **RS information service-requesting components:** The Service-requesting component is responsible for receiving services instance from the service registry and obtaining data as well as specific information processing services from data server, it was complemented by the class named SearchClient. Customers get the GSH of the service by SearchServiceLocator and SearchServicePortType in order to receiving data and the corresponding processing model by acquiring the service.

The instance of RS grid service:

The data resources in grid: Every computer in the grid experiment system had the respective RS service and each service was corresponding a data origin and the concrete operation. The basic information of RS data which reiterated in grid server was contained in Table 1 and these RS data were different and continual in the space (the single data quantity was 327 MB and total data quantities were 1.6 GB).

Sometimes, the continual RS data must be carried on splicing processing sometimes to. But the grid algorithm principle of splicing processing was consistent with the algorithm principle in non-grid environment. So, the data resources service and splicing processing service must be used and the corresponding data transfer code was increased.

Grid application and analysis of splicing processing: In the experiment simulation grid environment, the grid splicing processing algorithm model of RS data were transferred for splicing the MODIS data resources which saved at different computer. Here, the process time of single computer and grid computers was contrasted. Single computer's splicing would only carried on in one machine, but the grid would act according to the resource hardware condition of each computation point and aligned dynamically splicing execution order and splicing task execution point.

By analyzed the data in Table 1, the conclusion which obtains through the experiment was that the consumed time of single computer which carries on the great data quantity remote sensing data splicing would be bigger than the grid operation. So, when great quantity RS data were processed, grid would be had a bigger superiority and the validity.

CONCLUSION

Research on the joint operation and the fast processing for magnanimous RS data based on the grid technology is a practical and feasible issue. In this study, some questions for RS grid have been researched deeply. The basic concepts of RS grid have been analyzed and the expandable and realizable architecture for simulated grid system have been designed. And then using Globus4.x and Condor6.8, the RS grid experimental systems have been established. At last, RS data and splicing service was deployed applied in the grid system. The findings proved that: it was usable strongly for RS data sharing and processing used the grid technology and the efficiency of RS data application could be enhanced. At the same time, it was emphasis that many questions such as optimization used combinable for many kinds of RS resources and the discussion for man-machine grid operation would be further studied.

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