A Study on Education Resource Sharing Grid

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Abstract

Taking into account of the difficulties in improving utilization efficiency of the larger-scale and expensive research education resources, distributed in national universities, an education resources sharing grid based on network was investigated and developed. The grid architecture, sharing mechanism and framework that address these problems by defining a resource selection service for locating grid resources that match application requirements are presented in this paper. The proposed techniques are applied in the context of the grid service system for the key research equipment supported by the "211 project" in widely scattered laboratories of universities in the country. The preliminary research and experiment for the Grid System have demonstrated its good effectiveness.

Keyword: Education resource sharing grid, service package, scheduling.

I. Introduction

With the development of higher education in China, some universities are lack enough expensive research equipment resources due to insufficient budget. Furthermore, it is not only needed for experimental equipments, measurement instruments and devices, but also requires improved research environment, qualified manpower and so on. Due to the limited education investment and increasing demands for research resources, to leverage existing resources and make sure they are fully and effectively shared among all the universities, a practical resource sharing mechanism and management system is worth to be investigated.

Many universities and research institutes are currently conducting researches on resource sharing technologies. However, the limitation by network bandwidth and server performance, user demands can not be satisfied yet. These education resources dispersed on different nodes in CERNET (China Education and Research Network) have several disadvantages: the distributed resources are sufficient interconnected, and only connected by web links; it brings management problems, such as information redundancy and storage resources waste. The stored information is isolated in the so-called information island, which makes it difficult to intercommunicate and share resources among universities. These resources are unable to filter, classify, and process the stored raw information to fit for different kinds of requirements of visitors, and all the visitors having different knowledge background now access information through the same channel **[1]**.

The emergence and development of grid computing technology provides a revolutionary way to investigate a new approach to sharing the scattered equipment resources. It can help integrate and manage current research and education resources, and share with them more widely and effectively than ever by providing highly efficient computing service, data service and information service.
Grid technology can help to realize scattered resource sharing, information management, and information service. In an information grid, the raw data from various sources is standardized, classified, and organized to be easy shared by distributed users; the grid digs out the information internal relations; uniform and transparent information service can be presented to users **[2]**.
The research on the China Education Resource Sharing Grid (CersGrid) subjects to create sharing mechanism for the enormous dispersed equipment resources, to improve the resources utilization effectively and eliminate the information island, to filter and classify the collection information, and to provide appropriate information service to users according to their knowledge levels and motivation through unified grid portal. The establishment of CersGrid will improve the education and scientific research environment in universities and promote the public infrastructure facilities development.

This paper describes a proposed system and the first results on investigation on a prototype of equipment sharing Grid System under the CersGrid system. The grid framework, service package and scheduling are discussed and analyzed.

II. Related Works

UK e-Science concerns three levels including computational and data grid, information grid, knowledge grid **[3]**. It discusses the case of automating the process from raw data to information, and further to knowledge, and it plans to create new types of digital libraries for scientific data **[4]**. The e-Science proposes to integrate distributed data, computing and storage resources, and implement further data mining and knowledge discovery in grid environment. The San Diego Supercomputer Centre (SDSC) at UCSD is one of the original research institutes, which pays attention to the information grid and relationship among data, information and knowledge. SDSC grid and network technologies support national efforts such as TeraGrid, the Biomedical Information Research Network (BIRN), the Geosciences Grid (GEON) and the George E. Brown Jr. Network for Earthquake Engineering Systems Grid (NEES IT) **[5]**. IBM has been actively involved in providing access to heterogeneous files, databases, and storage systems, and it concentrates on sharing of data for processing and large-scale collaboration **[6]**. IBM supports virtualizing data across diverse formats to solve the challenge of accessing data stored in different format, supports using of Storage Access Network (SAN) technology to solve the poor storage resource utilization, supports developing a replication solution to solve the problem of having to move a large volume of data across network to facilitate remote processing. Institute of Computing Technology (ICT), Chinese Academy of Sciences, emphasizes the information management and processing in the information grid. ICT has developed some applications based on the Vega Grid, including the Vega Information Grid (Vega-IG) **[7]**and Railway Information System **[8]**. Image – Processing Grid Environment (IPGE) is a project that aims at providing high performance image – processing platform in a grid computing **[9]**. ChinaGrid (China Education and Research Grid) is a Project supported by The Ministry of Education (MoE) of China in 2002. ChinaGrid is one of the largest implementations of Grid Computing in the world. By aggregating existing dispersed resources through CERNET (China Education and Research Network), its aims to build the largest education and research platform with 100 universities across the country to collaborate on research, science and education projects, so as to make miscellaneous distributed resources available where and when they are needed**[1][10]**.

III. China Education Resource Sharing Grid Framework

Recent advances of development evolve towards resources sharing with grid computing and service-oriented computing by web-service **[6]**. Building on concepts and technologies from these two communities, Open Grid Service Architecture **[7]** has been designed to significantly broaden the established approach of grid computing and tap into the emerging capabilities of web service. China education resource sharing grid (CersGrid) is built on existing web service technologies, OGSA standards and China Education and Research Grid Supporting Platform (CGSP), shown in Figure 1.

A. ChinaGrid support platform (CGSP)

ChinaGrid Support Platform (CGSP) is a grid middleware developed for the construction and evolution of ChinaGrid. CGSP seeks to integrate all sorts of heterogeneous education resources distributed over CERNET, and provide transparent, high performance, reliable, secure and convenient grid services for scientific researchers and engineers. In CersGrid, CGSP offers basic grid service, such as authentication, authorization, file transfer, index service, job manager, service package tool, grid parallel program interface, domain manager, etc.

B. CersGrid Portal

CersGrid portal is the entrance for users to CersGrid, which provides service environment for job submission and job information acquirement. Users utilize education resources of the grid system are

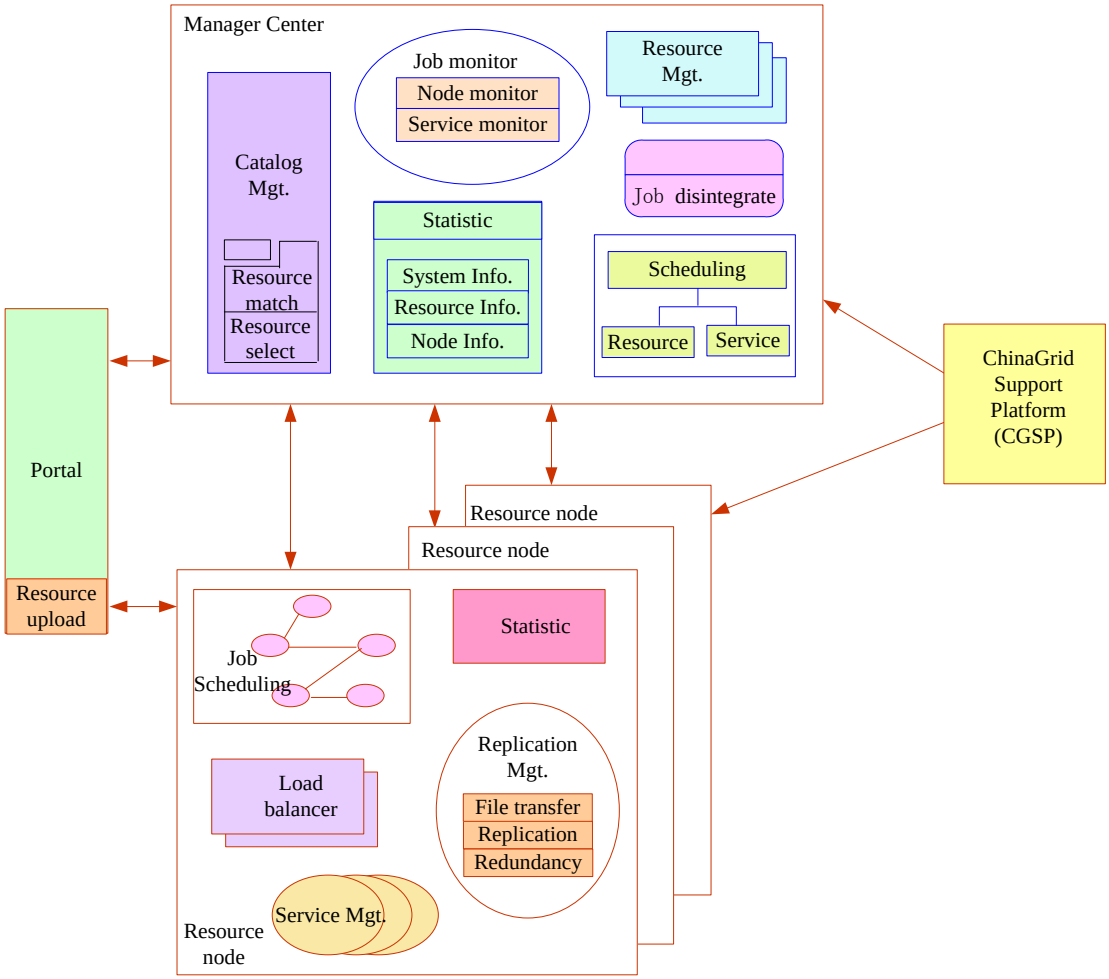

Figure 3 China Education Resource Sharing Grid Architecture

utilized by users in the form of job submitting and execution. The Job Definition Tool is the module that provides users the functionality of job definition, submitting, deploying and execution. As a part

of the user interface of the CersGrid system, job definition tool is implemented as a web application and is integrated into portal. Users can access job definition tool in the portal, construct workflow on the web page, and submit completed workflow definition to the Job Manager for deployment and execution.

There are 4 main aspects of functionality needed by users during the job definition procedure: (1) selecting services and defining atom nodes, (2) defining control flow, (3) defining data requirements and other parameters needed in the job, (3) submitting the job and performing the user-required operations, including saving the job, deploying the job and running the job.

When a user starts to define a job, an empty project is created for him/her, and an empty temporary folder is created on portal server for the empty project. The interface description document of every registered service is stored in the local database of information center. When a new atom job is created, this document is acquired by the job definition tool from information center, via the web service interface provided by information center itself, and saved in the temporary folder in the form of wsdl file. Therefore, every atom node in the job project corresponds to a unique wsdl file in the temporary folder.

C. Manager Center

Manager center is composed of six parts such as catalog manager, Job monitor, statistic system, resource manager, job disintegrate, and scheduling, as illustrated in Figure. 1

Catalog manager stores the mapping information from logical file name (LFN) to physical file name (PFN) and provides resource match and select service. Job monitor system is designed and developed as a distributed monitoring and management architecture not only to track resource facilities, networks, services and users' activities, but also to provide analysis, forecast and management support for the running of CersGrid and to provide maintaining and optimization support in terms of grid resources and of web service executions. Job monitor composed of Grid Security Infrastructure (GSI) **[13]**, monitors the status of CersGrid system and the procedure in job processing. It provides information feedback when requested by resource node. Statistic system collects the status of CersGrid system and the information of the procedure in job processing. Resource management comprises information service module and replica management module. The functions of resource management are to provide resource information for match-making, resource organization, replica management, etc. Job disintegrating system takes charge of job disintegrating according to the request.

D. Resource Node

Resource node is composed of five parts such as job scheduling, load balancer, statistic system, replication management and service management.

Job scheduling takes charge of job processing control and management in the workflow**[14]**, including three modules: Job Submission Interface, Job Scheduler & Match-maker, and Job Processing Controller.

Load balancer: Grid resources are geographically distributed and resource performance can change quickly over time. Grid users submit tasks with different resource and quality of service (QoS) requirement **[15]**. For management and scheduling to be effective, load balancer must develop intelligent and autonomous decision-making techniques. Load balancer applies the load balancing algorithm to find the best resource for each task. The objective function of the load balancing algorithm is to minimize the completion time of the application. The decision is based on the application and system characteristics, run time system load, placement of the other tasks, and the dad on the task to be executed.

Statistic system gathers statistics on the system load and application executions, which is essential for the load balancer. It monitors the traffic on the resource node, the load on the individual node, inter-task communication volumes, the task based I/O intensity, and the CPU time for each application and task **[16]**. It communicates the accumulated information to the manager center periodically, or when specifically required by the manager center.

Replication management provides transparent access to distributed data and improves the efficiency of data accessing and the quality of information service. The Replica is managed in several domains, each domain comprise five modules: replica catalog, replica manager, replica catalog query, replica selector and consistency manager. Replica manager executes actual creation and deletion of replica within its domain and updates the replica catalog.

IV. Service package

Service package is a component of CersGrid development Toolkits and should be deployed in all administrative domains. The working flow of service package tool is shown in Figure 4.

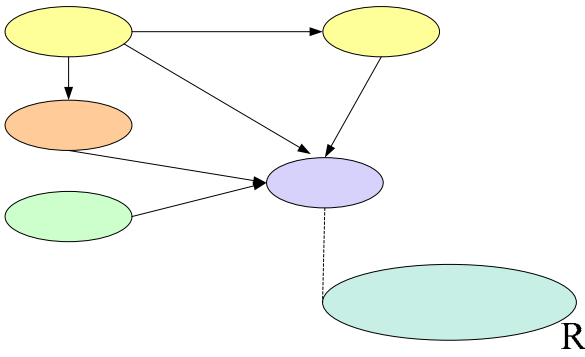

Figure 4 Working flow of service package

Currently the objective of service package is packing equipment and information resource. To guarantee the flexibility and generality of resource package, we present general running service, which is a wsdl description scheme compatible with standard WSRF service. Services according with this scheme, including all services packed with service package tool. What we should be noticed is that CersGrid can support normal web service and normal WSRF service, services of these types packing need not pack with service package tool and can register, deploy and invoke as normal service.

V. Scheduling

The user must submit a task list containing names of jobs on which the user has an account. For each resource node, manager center collects resource node information such as CPU speed, available physical memory, and bandwidth between hosts **[17]**. This information is retrieved from resource information providers such as the Network Weather System (NWS) and the Monitoring and Discovery Service (MDS). The job scheduling architecture is shown in Figure 4. The resource searcher is responsible for identifying schedules that are appropriate to the target application and then selecting the ‘‘best’’ one.

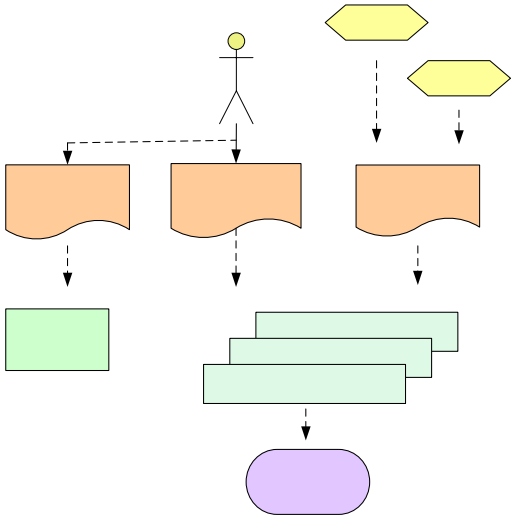

Figure 5 Job Scheduling

VI. Conclusion

This research contributes to develop an information grid infrastructure in the CersGrid system with concentration on the education resources sharing grid and its system framework, service package working flow and scheduling scheme. An approach to solve the information island problem and education resource sharing is introduced and explained in this paper. The CersGrid as a next generation information service infrastructure for resource sharing will play an important role in the fields of learning, teaching, and public education.

The research is just at the beginning and needs continued efforts on the key technologies, such as architecture, scheduling method, replica management, resource information service, and the implementation.

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