ShanghaiGrid as An Information Service Grid: An Overview+

Minglu Li[1], Min-You Wu[1,#], Ying Li[1,2], Jian Cao[1], Linpeng Huang[1], Qianni Deng[1], Xinhua Lin[1], Changjun Jiang[3], Weiqin Tong[4], Yadong Gui[5], Aoying Zhou[6], Xinhong Wu[7] and Shui Jiang[8]

[1]*Department of Computer Science and Engineering, Shanghai Jiao Tong University, Shanghai 200030, China*

[2]*Computer Science and Technology School, Soochow University, Suzhou 215006, China*

[3]*Tongji University, Shanghai, China*

[4]*Shanghai University, Shanghai, China*

[5]*Shanghai Supercomputer Center, Shanghai, China*

[6]*Fudan University, Shanghai, China*

[7]*Shanghai Urban Transportation Information Center*

[8]*East China Institute of Computer Technology*

{li-ml, mwu, liying}@cs.sjtu.edu.cn ingli@suda.edu.cn

Abstract

The goal of the ShanghaiGrid is to provide information services to the people. It aims to construct a metropolitan-area information service infrastructure and establish an open standard for widespread upper-layer applications from both communities and the government. This paper introduces the Information Service Grid Toolkit in detail.

1 Introduction

The ShanghaiGrid is a long-term project sponsored by the Science and Technology Commission of Shanghai Municipality for $6 million from the government and other participants [1]. It aims to construct a metropolitan-area Information Services Grid (ISG) and establish an open standard for widespread upper-layer applications from both communities and the government.

Different from other Grid projects in China that are designed mainly for scientific usage, the ShanghaiGrid focuses on information collections and services, it is application-driven. First, there are the needs of the Shanghai Municipality to improve the efficiency of the government and its emergency response. Second, there are the needs of enterprises. Enterprises want to use the Grid to reduce the Total Cost of Ownership (TCO), to increase the utilization of IT resources, and to build Business Process Solutions (BPS). Enterprises can build a local Grid to reduce the TCO and resource usage. Third, there are the needs of communities. Currently, Shanghai has a population of 16 million people. In 2003, Household PC penetration rate reached 60.4% and Internet user penetration rate reached 32% [2]. Citizens want more services from the Internet, services that may need a lot of resources such as networks, storage, computing, information, and so on. The Information Service Grid could stratify these needs in an integrated way.

2 Background and Overview

The Shanghai is a municipality of eastern China at the mouth of the Yangtze River. Today, it has become the largest economic center and an important port city in China, with a land area covering 6,340 square kilometers and a population of 16 million people. It is the entrepreneurial city of the 2010 Shanghai World Expo. The municipal government is working toward building Shanghai into a modern metropolis and into a world economic, financial, trading and shipping center by 2020. Information technology is a key approach to achieving these goals. The Grid is regarded as the Next Generation Internet. Building the City Grid can improve the government's efficiency, build a platform

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Min-You Wu currently is on leave from The University of New Mexico, USA.

for enterprise, provide citizens with various services, and can keep Shanghai at the top of the world information technology as well. The municipal government has always paid attention to the development and establishment of the information industry and society.

The potential services that ShanghaiGrid could provide are shown in Fig. 1.

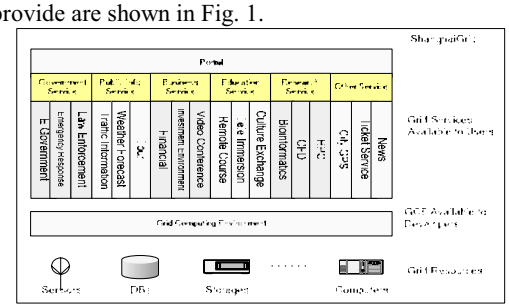

Fig. 1 shows the different perspectives of ShanghaiGrid.

The ShanghaiGrid project is one of five, top, grand Grid projects in China. It is based on the current, four, major computational aggregates and networks in Shanghai.It is planned to enable the heterogeneous and distributed resources to collaborate into an information fountain and computational environment for Grid services, seamlessly and transparently [1].

The goal of ShanghaiGrid is to provide information services to people. To achieve this goal, the project consists of four, interdependent sub-projects: research and investigation on the requirements, protocols and standards for the information grid infrastructure; the development of system software and the establishment of major grid nodes; the development of a decentralized, virtual research platform; and research on metropolitan grid applications. Relying on the growing network infrastructure and abundant scientific research resources, the ShanghaiGrid project will construct the first metropolis-area information grid to provide tremendous data manipulations and ubiquitous information services for a variety of organizations. The TIG application is especially planned to take advantage of grid computing to integrate traffic-data collection, traffic monitoring and supervising, taxi-supply information and traveler guidance to make the traffic system run more efficiently and enable people to travel easier inside the city.

3 Information Service Grid Toolkit

The Information Service Grid Toolkit (ISGT) provides core middlewares for ShanghaiGrid. Fig. 2 shows the global architecture of the ShanghaiGrid. Since the potential resources and services in Shanghai are enormous, it is ideal to organize these resources into a tree-like structure for management purposes. For example, SJTU and SHU are the main Grid nodes in ShanghaiGrid, and can be managed as two different domains.

We have developed an Information Service Grid Toolkit (ISGT), which provides more middleware services and tools to satisfy the needs of ISG. Moreover, the ISGT hides the complexity of the Grid technique for developers building Grid applications.

ISGT could be regarded as an Information Grid service development kit that may include: Portal design tools; Resource encapsulation tools; Job and workflow design tools; A set of middlewares and high-level services (Information Service, Workflow Service, Accounting Service, etc.); ISG management tools, and Service package tools. Fig. 3 shows the role of the ISGT in an ISG environment. We will introduce the middlewares in detail.

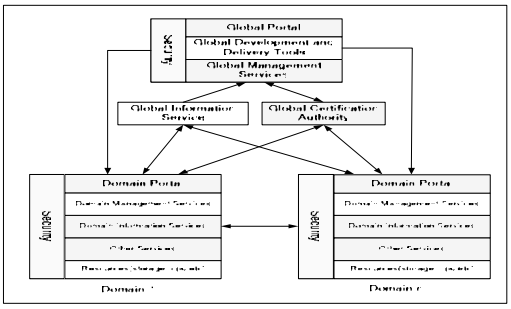

Fig. 2 shows the global architecture of ShanghaiGrid. The domain can be regarded as a VO providing Grid Services or resources.

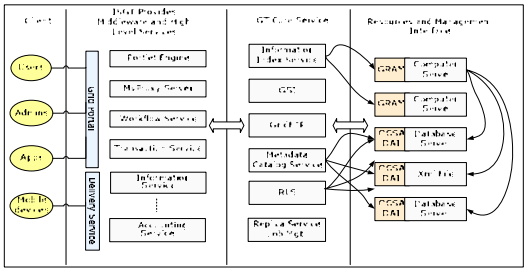

Fig. 3 shows the position of the ISGT in ISG environments.

3.1 ISGT Information Service

From the development point of view, the information in ShanghaiGrid can be divided into two categories: user-defined information and system-level information. The system-level information comes directly from the information providers (IP), which includes

computational resources, database and storage resources, instrument resources, and network resources such as CPU-static information, CPU-workload information, memory-static information, memory workload, network information, etc. The user-defined information is provided by users through the Information Service (IS). This means, on the one hand, that the IS serves as a "Yellow page" providing a way to search for information; on the other hand, it provides a way for users to register, publish, update and unregister their "self-defined services." The user-defined information mainly includes: Web Services information, Grid Services information, Domain information, and service provider's information. Fig.4 shows the detail.

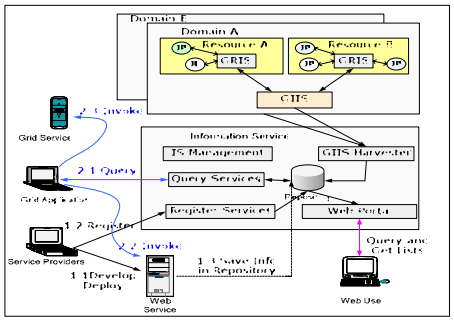

Fig. 4 shows the main components of the IS.

3.2 ISGT Workflow Service

Workflow is defined as "The automation of a business process, in whole or in part, during which information or tasks are passed from one participant to another for action, according to a set of procedural rules" [3]. In ShanghaiGrid, using a workflow, SPs can easily and dynamically compose existing services into a new value-added service, enterprises can build business process solutions, and scientists can build their scientific processes. The workflow description language is extended from BPEL4WS [4], which supports parallel jobs. Fig. 5 shows the detail.

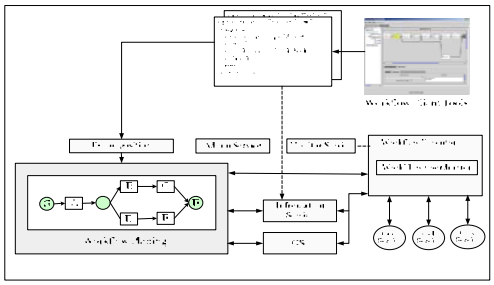

Fig. 5 shows the main components of the workflow engine.

3.3 ISGT Application Delivery Toolkit

In ShanghaiGrid, Grid portals provide a web interface for the user to get information from various Grid Services or Web Services. At the same time, the primary goal of the ISGT Application Delivery Toolkit (ADT) [5] is to provide a facility for delivering the Grid Services to various digital devices to support Ubiquitous Computing.

There are several approaches available through which a mobile digital device can access Grid Services. Currently, we use the Java Network Launching Protocol (JNLP) [6]. In order to pack the Grid Service into a JNLP supported application to be downloaded by the JNLP client, we use ADT to develop a JNLP-enabled application (a jar file) and store it with a Delivery Service (DS). The mobile device will query the JNLP application through the DS and download a suitable one. After downloading the jar file, the JNLP client can execute it on the mobile device.

3.4 ISTG Accounting Services

The accounting system is a basic component for any practical Grid. Because of the heterogeneous nature of the grid, we have to build special accounting middleware for ShanghaiGrid to provide uniform accounting services, which shield the heterogeneity of the various local environments, as shown in Fig. 6.

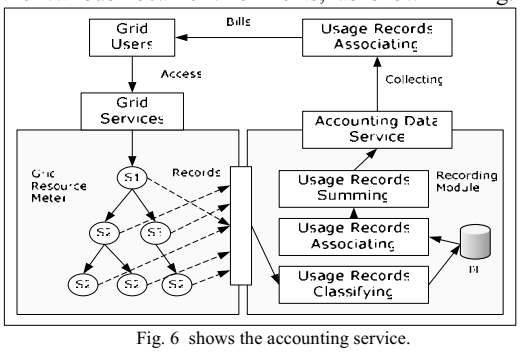

Fig. 6 shows the accounting service.

A Grid accounting system consists of three functional parts: the usage information-collecting system, the records-processing system, and the bill-charging system. Fig. 8 illustrates the architecture of the accounting system in ShanghaiGrid. It can be noted that an accounting node has a Grid Resource Meter (GRM) [7] and a Usage Recording Module (URM). The GRM is responsible for sensing the access of resources and creating the original usage records. The acquired usage information of various heterogeneous resources is then translated into usage records with a

uniform format by the GRM. Then the formatted records are passed to the URM, where further processes are carried out.

4 Case Study—Traffic Information Grid

Traffic Information Grid （TIG） is a typical domain Grid in ShanghaiGrid, providing people with traffic information and guidance. It utilizes grid technology to integrate traffic information, share traffic data and traffic resources, provide better traffic services to traffic participators, help to remove traffic bottlenecks, and resolve traffic problems.

Fig. 7 shows an example of the TIG services in ShanghaiGrid. Traffic data are distributed, dynamic, and of great volume, and could be collected by various kinds of sensors, GPS systems, video cameras, etc. All these data would be collected, transferred, stored and aggregated by all kinds of resources and services. To analyze and forecast traffic status, we need even more massive amounts of information, which includes weather conditions, digital maps, historic data, GPS systems, traffic-light information, etc. Meanwhile, huge computational power would be needed to do map mapping, route planning and traffic guidance using various algorithms. The TIG services shield all the complexities, provide traffic information on demand and publish traffic status to the communities, vehicles and passengers. The detail implementation could be found in [8].

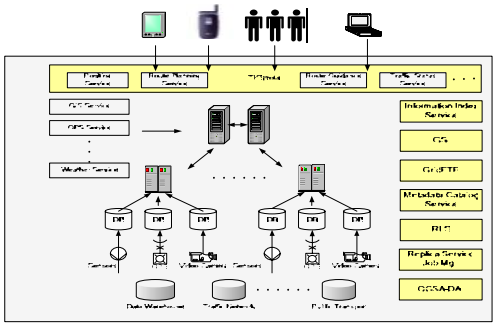

Fig. 7 shows the conception of the TIG system.

After the TIG services are placed in the ShanghaiGrid, other service providers could use these services to compose new value-added services. For example, taxi services can use TIG services to reduce their cost and response time, thereby increasing efficiency.

5 Conclusion

ShanghaiGrid is an ongoing project aimed at constructing a metropolitan-area information service infrastructure. The Information Service Grid Toolkit facilitates the development of services and applications and includes a set of middlewares, high-level services, design tools, package tools, etc. Based on the ISGT, a Traffic Information Grid is implemented in ShanghaiGrid providing traffic information and guidance to the public using the computing power of the Grid. The Information Grid will push the information construction of Shanghai and meet the requirements of its citizens.

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