IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

FORMATION OF CIVIL STRUCTURES EXPERIMENT GRID WITH RESPECT TO INFORMATION MANAGEMENT

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Abstract: **In Structural Engineering Experiment Grid (SEE-Grid), there are immense measures of heterogeneous information disseminated in various exploratory destinations. This paper sums up an applied model of the exploratory information, and dependent on this theoretical model, Structural Engineering Experimental Data Management Framework (SEEDMF) is proposed to deal with the organized information and unstructured. Likewise, the heterogeneity of organized information, which can be overwhelmed by SEEDMF, is talked about in detail. At long last, the entryway of Engineering Experimental Data Management System (SEEDMS) which is a piece of SEE-Grid is illustrated.**

Index Terms **-** ***structural engineering; information management; grid; civil engineering;***

I. INTRODUCTION

Structural engineering experiments always generate huge amounts of data, and most of these experimental data are difficult to share real-timely by the researchers widely distributing. In addition, many experimental data are important not only for the researchers, but also for the future related researches. So how to manage these experimental data effectively and make them be shared and used conveniently has been the big concern in the structural engineering data management [1, 2].

In the field of structural engineering, along with the deepening of scientific research, the diversification of research methods as well as the increase of complexity, large-scale simulation, data analysis and research collaboration has played an increasingly important role. And then a new technology was required to turn the sharing of distributed experimental equipments, data and human resource into realize. Grid technology has been adapting to the requirements of resource sharing constantly during its continuous development and self-improvement in recent years. And the function of the data management in grid environment is just to organize and manage the data distributing in different sites, and make users can access and use these valuable data through the network. The experimental data in the field of structural engineering can be well managed and integrated with grid technology, and then the resource sharing and collaborative work among researchers can be supported.

This paper designed a general-purpose data model oriented to structural engineering experiments by analyzing the features of the experimental data. The model contains core data concepts involved in structural engineering experiments. Based on this model, this paper proposed Structural Engineering Experimental Data Management Framework (SEEDMF), which makes management and integration on the heterogeneous data in SEE-Gird by grid technology and gives a solution of the sharing of these heterogeneous experimental data. And then the details of heterogeneous solution were introduced. At last, the data management system based on SEEDMF was introduced.

II. RELATED WORK

Grid technology has been applied to data management in many fields and has achieves great success. One of the most representative is Network for Earthquake Experiment and Simulation (NEES) project in America. NEES established a virtual research community focuses on the field of earthquake engineering, and aimed at the establishment of a central data warehouse to store and share data in earthquake engineering. Through the data management in NEES, users can discover and access the data related to their research. Moreover, NEES supported data reuse and supplied semantic support for secondary utilization of experimental data [3, 4].

The Earth System Grid (ESG) in the field of meteorological research also uses grid technology to solve the problem of data sharing among meteorological researchers and institutes. Through ESG, meteorological researchers widely distributing can work more effectively, and can get new knowledge faster from a large number of data dispersed. In addition, the sharing of research results would be easier.

III. DATA MODEL IN STRUCTURAL ENGINEERING EXPERIMENTS

Structural engineering experiments always generate huge amounts of data, which can be divided into two types:

- Experimental management information: It is the information managed the experimental process, and includes the basic description of experiments submitted by users, the configuration information generated by experimental manager and the information about experimental sites. This information can be stored as structural data by analysing the common features of management process of experiments.
- Experimental results information: It is the result data collected by observation equipment's during experimental process. Because these data have no general structure and always be large, they are usually stored as files. In SEE-Gird, the users who use result data must know how they are generated, or the result data will has no means. So these result files must be connected with their corresponding management information.

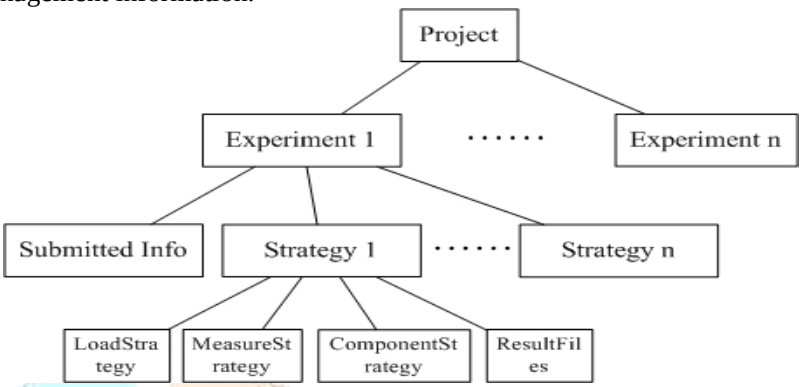

Figure 1. Conceptual model of experimental data

Based on the above analysis, this paper summarizes a conceptual model of the data in structural engineering experiments. Fig. 1 depicts the details of this model. The structure in different sites may have small differences, so this model only contains core concepts related to structural engineering experiments. As shown in Figure 1, the result files are associated with its corresponding Strategy which is one part of Experiment.

IV. OVER VIEW OF SEEDMF

According to the features of experimental data in SEE- Gird, a data management framework named SEEDMF was proposed in this paper. This framework uses GSI Authentication as a means of security, and transports data by GridFTP. The Experimental management information are stored in relational database and result files are stored in file system, both of them can be accessed by the corresponding services. Figure 2 depicts the details of SEEDMF.

A. Structural Engineering Experiment Grid Portal (SEEGPortal)

SEEGPortal is the entrance of access, and has two main capacities which are Data Access Portal and File Transfer Portal. Data Access Portal is responsible for the interactive of business logic between data management system and user, and its main functions include file searching, replica location, data upload and data download. File Transfer Portal is responsible for data transfer and the conversion from GridFTP to HTTPS. The authority partition among different users and security authentication are completed by GSI Authentication.

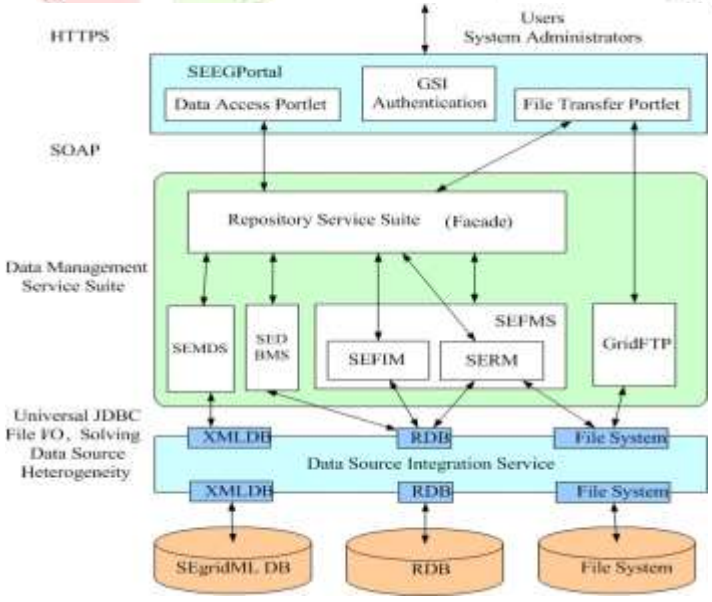

Figure 2. Architecture of SEEDMF

B. Repository Service Suite (RSS)

RSS makes the access of portal to services transparent by Façade pattern. The function interfaces of the inner system are unified into RSS, and are managed centralized. RSS makes use of these function interfaces to generate application interfaces which are exposed to portal, and then hides the details of how the services work.

C. Structural Engineering Metadata Service (SEMDS)

SEMDS is responsible to create, update, manage and validate the metadata and metadata schemas. SEE-Gird provides SEML, an XML format for defining metadata schemas for user to describe the real-world objects. SEML makes it possible for users to retrieve data distributed among different sites and upload metadata objects into the metadata database SEgridML DB. By the mapping between SEML and different database schemas, the heterogeneity on data structure can be shield.

D. Structural Engineering Database Management Service (SEDBMS)

SEDBMS is responsible for the access to relational database. It provides unified interfaces for accessing databases, and the upper layer needs not to care about the details about how to connect databases.

E. Structural Engineering File Management Service (SEFMS)

SEFMS is responsible for parsing the user data requirement and gathering data files from distributed sites. Two main capacities of SEFMS are Structural Engineering File Indexing Manger (SEFIM), which is to define the file naming space, and mapping the logic file name to the physical replication; Structural Engineering Replication Manager (SERM), which is responsible to create, update and manage the data file replications.

F. Structural Engineering Data Source Integration Service (SEDSIS)

SEDSIS is responsible for shielding the heterogeneity of data resource and enabling users to locate the experiment data file without aware of where and how they are stored.

V. The Solution of Data Heterogeneity

The heterogeneity of data in SEE-Gird is caused by different database management system (DBMS) and data models. Firstly, this paper shields the heterogeneity on different database management systems by OGSA-DAI, and makes users can access different database management systems pellucid. Then the heterogeneity of data models is overcome by XML.

A. Data Heterogeneity of DBMS

In SEE-Gird, different experiment sites may use different DBMS to store experimental data. In data access, different types of DBMS need to connect with different method, which causes a great deal of inconvenience on unified access to data. In order to solve this problem, this paper designed Structural Engineering Data Source Integration Service (SEDSIS) based on OGSA-DAI.

OGSA-DAI, which is Open Grid Services Architecture- Data Access and Integration, accords with OGSA-based grid standards, and was developed in Globus Toolkit 3.0. It supports many DBMS, such as DB2, Oracle, Xindice, MySql and so on. OGSA-DAI project is committed to the construction of middleware which can be used to integrate and access different data sources in grid environment. OGSA-DAI provides unified service interfaces for data integration and access, and by these interfaces, multiple heterogeneous data sources can be considered as a single logical resource [8]. The services in OGSA-DAI provide basic operations that complete complex functions, such as data sharing alliance, distributed query in virtual organization, but they hide the technical details, such as database drive, data format and transmission mechanism.

Based on OGSA-DAI core, SEDSIS supplies the necessary functions and corresponding interfaces for data integration, such as the registration of data source, data access and the management of data source. Figure 3 depicts the architecture of SEDSIS.

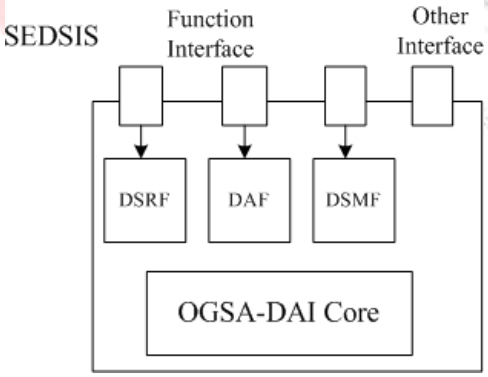

Figure 3. Architecture of SEDSIS

Data Source Registration Function (DSRF) is responsible for accepting the registration of data source, and auditing the validity of the information submitted by data source. DSRF generates description file for each registered data source, and makes the registered data source can be identified and used by other functions. Table.1 is an example of description file which used MySql as a data source.

Data Access Function (DAF) is responsible for accessing all the registered data sources and provides unified interface for data access. Data Source Management Function (DSMF) is mainly responsible for the management of the description files and monitoring the status of data sources.

B. Data Heterogeneity of Data Model

Besides the heterogeneity of DBMS, the data models may also have differences in different sites. It is difficult for users or applications to access data with a unified method. The users or the applications in upper layer must consider all the models in SEE-Gird, when they access data. For accessing the model heterogeneous data transparently and unitedly, this paper proposed a metadata model oriented the field of structural engineering based on XML.

The metadata model includes two aspects, which are the metadata described the data and the metadata described the connection among data. The former is the information related to the data, such as identification information, generation time, quality information, release information and so on. The latter describes how the datasets constitute an organic whole. Figure 4 depicts the architecture of the metadata model.

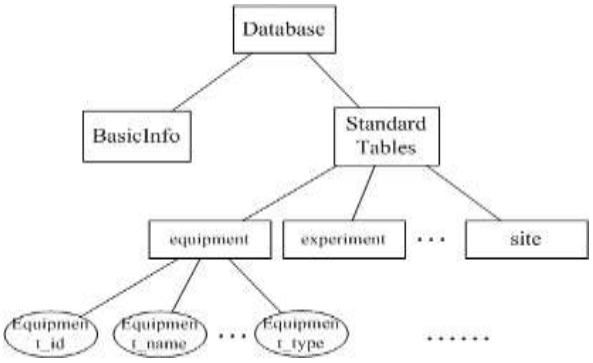

Figure 4. Architecture of the metadata model

As shown in the figure, there are standard tables included in the metadata model. The tables are built by experts in the field of structural engineering, and contain relatively comprehensive data concepts about structural engineering experiment. Each registered data source must generate its corresponding file to describe its tables and the mappings between these tables and the standard tables. These information are stored in SEGridML DB in XML format.

Based on the metadata model, Structural Engineering Metadata Service (SEMDS) is designed to manage the metadata model and the access of metadata. Figure 5 depicts the architecture of SEMDS.

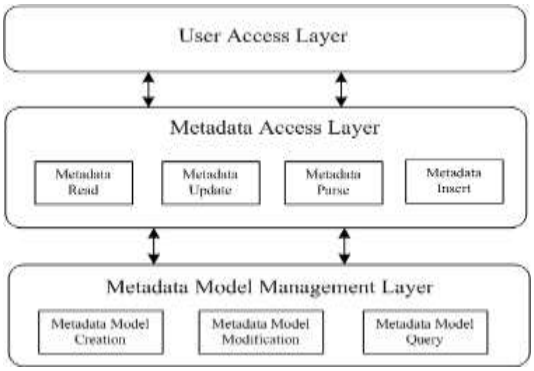

Figure 5. Architecture of SEMDS

1) Metadata Model Management Layer

It is responsible for the creation and modification of the metadata model. The operation on this metadata model must be presented by experts in the field of structural engineering and be executed by system administrator.

2) Metadata Access Layer

It is responsible for the reading, update, parse and insert of metadata. The functions in this layer are used by users. When a data source is registered, the metadata about it and the mapping relation with metadata model will be stored by the function named Metadata Insert. Metadata Read and Metadata Parse are used to get the tables and fields, which are corresponding with standard tables in metadata model, in heterogeneous data sources.

3) User Access Layer

It provides unified interfaces of service for users.

VI. DATA MANAGEMENT SYSTEM IN STRUCTURAL ENGINEERING GIRD

Based on SEEDMF, the data management system named Structural Engineering Data Experimental Management System (SEEDMS) was implemented in Structural Engineering Gird. Through the portal of SEDMS in SEE-Grid, users can access heterogeneous experimental data distributed in different experimental sites pellucidly. The portal of SEE-Grid is demonstrated in Figure 6.

Figure 6. The portal of SEE-Grid

Through Data Center, users can query experimental data by many conditions, such as the equipments used in experiment, the type of experiments, the time of experiments and so on. Users can submit query request via the portal shown in Figure 7.

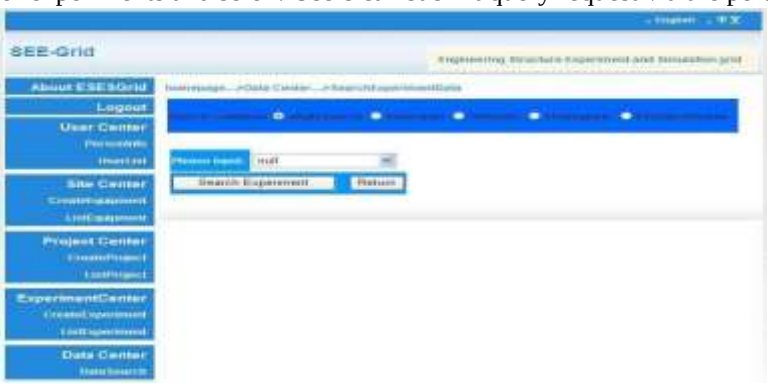

Figure 7. Query submit in SEEDMS

When user finds the data meet his request, he can download the data via the portal shown in Figure 8.

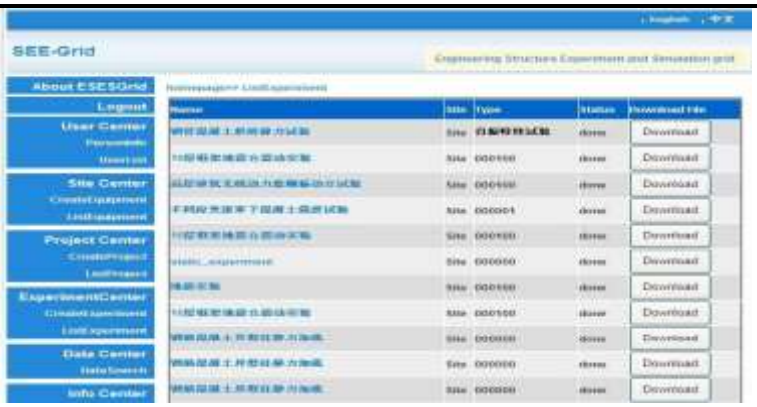

Figure 8. File download in SEEDMS

VII. CONCLUSION AND FUTURE WORK

Aiming to the management and sharing of experimental data in SEE-Grid, this paper proposed a grid-enable framework named SEEDMF (Engineering Experimental Data Management Framework) based on the model of experimental data. By SEEDMF, the heterogeneity of experimental data can be hidden. A data management system was built based on SEEDMF, and through which users can access the heterogeneous experiment data easily. In the future work, the data management system will be improved and the query speed will be optimized; the semantic-oriented data management mechanism will be adopted.

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