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Research on Cross-domain Heterogeneous Resources Management Mechanism for Information Grid

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Abstract. Cross-domain heterogeneous resources management mechanism and system implement Oriented Information grid is introduced in this paper. It has researched on the design of extensible heterogeneous resources description model, configurable register publish model and general query description model, and provided the general architectural model of the information grid resource management for every business field. On that basis, a proto-type system of hierarchical cross-domain Information grid resource system is introduced. It provides the supporting technology for the effective sharing and comprehensive utilization of the grid resource.

Keywords: Information Grid, Heterogeneous Resources, Cross-Domain, Register & Discover

1. Introduction

Grid system is the complex heterogeneous distributed system. It makes all geographically distributed computing resources, which are linked up by high speed networks, together as the integrated computing and resource environment, and thereby it can provide the high performance computing, managing and servicing resource capabilities. Information grid is able to solve the problem of the information isolated island in the building of the information system through using the flexible resource integration and sharing technology. [1][2] And it is used to enable to efficiently process, share and use the information resource. There is a great deal of distributed resource in the information grid, and these resources have following characteristics: large-scale, geographically distributed, heterogeneous, cross-domain, dynamic, autonomy and so on. [5] Therefore, how to describe and manage all the resource is the key point to share and integrate the grid information resource.

However, the requirement and the focus of the resource's description and management is different due to it is used by different organization, different item and different personnel. So far, there is no general resource description and manage method to support all kind of business applications and dynamic task demands. This paper puts forward a method of the layered heterogeneous resources management mechanism oriented information grid. This mechanism provides the general information grid resource management underlying framework for each business area upper application, by researching and designing the extensible heterogeneous resources description model, configurable register publish model and general query description model. So, the applications which are built up with this mechanism can conveniently construct distributed grid resource management system just for their own task only by defining their business rule.

2. The Design of the model

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The cross-domain heterogeneous resources management mechanism mentioned in this paper, in order to hold the various heterogeneous resources in current grid, and in order to adapt to the expansion of the unknown resources in future grid, puts forward the general resource register & discover model. Based on this model, the heterogeneous resources management system architecture is realized in the paper, which is cross-domain, layered, and dynamically adjustable, And in this chapter, the model description of heterogeneous resources is introduced first. There are three major models: heterogeneous resources description model, general register publish model and general query description model.

2.1. Heterogeneous Resources Description Model

HRDM, heterogeneous resource description model, standardizes a sequence of the configuration information which defines the position, type, lever and so on of the heterogeneous resources in the directory services. It can dynamically adjust or expand to accommodate different field application requirements according to business application rules and mission needs. HRDM is a group of resource description template collection. Each type of resource corresponds to one description template. The name of description template is distinguished by the unique identification of the resource type. The concrete definition is described in the Table 1.

As previously mentioned, HRDM is a set of description template, and each description template is composed by Business Logic Model (LM), Physical Storage Model (PM) and Relation Mapping Model (RM).

Table 1. An example of a table

name	expression
Heterogeneous Resource Description Model	$HRDM = \{(LM, RM, PM)_i \mid i \quad N\};$
Business Logic Model	$LM = \{LogicalClass, (AttriName,\ AttriValue)_i \mid i \quad N\};$
Physical Storage Model	$PM = \{ObjectClass, AttriType_i \mid i \quad N\};$
Relation Mapping Model	$RM = \{LogicalClass,\ RDM\};$
Relation Description Model	$RDM = \{B \text{ 共 } P \quad M \text{ 共 } G \quad F\};$
Base Point	$B = \{BaseDN\};$
Physical Storage Resource Type	$P = \{PysicalClass\};$
Mapping Info Set	$M = \{MapInfo_i \mid i \quad N\};\ MapInfo = \{La, Pa, Rf\};$
Grade Info Set	$G = \{GradeAttr_i \mid i \quad N\};\ GradeAttr = \{Pa, Gm, Rdn\};$
File Info Set	$F = \{FilePair_i \mid i \quad N\};\ FilePair = \{Fna, Fa\};$

LM is the business logic model. It is composed of logical type identification of the resource and a set of key-value combinations. It offers reference for users to register and publish their resource.

PM is physical storage model of the LDAP directory. It is composed of the LDAP class object type and the attribute list. It indicates the LDAP object class which is mapping to the resource type.

RM is LM and PM's relation mapping management model. It is composed of LDAP logical object class and RDM.

RDM, relation description model, builds up the mapping and transfer relationship between resource logical model and LDAP directory storage model. It makes the information management system upon this can adapt the new type of heterogeneous resource in the future. It has realizes the hierarchical storage management dynamically and automatically. RDM includes five element sets, as $B \cup P \cup M \cup G \cup F$. B is indicating the resource type base DN in the LDAP directory. P is the physical storage type of the resource. M is the set of attribute map. It describes the relationship between logical attribute and physical attribute and defines the key attribute in the set. G is a set of catalogue classification attribute description. It defines the physical attribute, classification level and tree node symbol of the first, second, third and so on catalogue classification. F shows the correspondence of the file attribute pair. For example, as web service resource, it needs to register its WSDL description file. So it will depend on the file pair defined in F to associate the file name attribute and file content attribute in LDAP storage. All defined in F will help system to upload and download files automatically.

The theory of mapping and transferring is as Fig. 1.

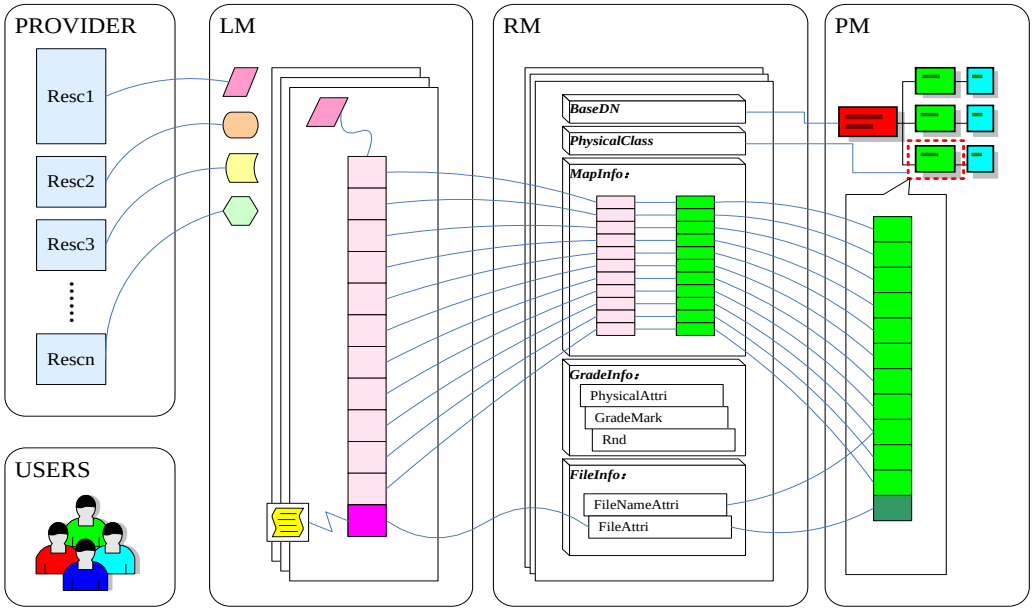

Fig. 1. HRDM's mapping and transferring theory figure

2.2. General Register Publish Model

General Register Publish Model (GRPM), can be represented by the triple form as GRPM = < O, R, A >, among them, O shows register operation flag; R shows register type identification, including real-time information resources, document information resources, streaming information resources, format message resources, data service resources, web service resources and all types of resources, the resources included in the information grid system of this paper will have a unique type identification; A shows a set of key-value pairs, it will require providers to describe the detail of sharing resources meta information according to the model. The specific parameters are defined as Table 2.

Table 2. The definition of GRPM

name	expression
General Operation Flag	$O = \begin{cases} OPT\_ADD\_TAG; \\ OPT\_DELETE\_TAG; \\ OPT\_UPDATE\_TAG; \\ OPT\_MOVE\_TAG; \\ OPT\_RENAME\_TAG; \end{cases}$
Register Publish Type	$R = \{RegClassID\};$
Resource Metadata Description	$A = \{AA_i \mid i \quad N\};$
	$AA = \{AttriName, AttriValue\};$

GRPM has regulated the interactive format in times of registering and publishing sharing resources. According to GRPM, the general software interface can be designed.

2.3. General Query Description Model

GQDM, general query description mode, is composed of four elements: GQDM = < C, S, Q, N >. C shows the query type identification, it is same as the register type identification defined in the GRPM. S shows the search scope, it will be four categories, as base search, one level search, sub-tree search and subordinate search. Q shows the query condition group which is defined by the user need according to the model. N is the attribute group which is the need return for users. The specific parameters and model defines are described as Table 3.

Table 3. The definition of GQDM

name	expression
Resource Type ID	$C = \{SearchClassID\};$
Domain Info ID	$S = \begin{cases} SEARCH\_SCOPE\_BASE; \\ SEARCH\_SCOPE\_ONELEVEL; \\ SEARCH\_SCOPE\_SUBTREE; \\ SEARCH\_SCOPE\_SUBORDINATE\_SUBTREE; \end{cases}$
Query Info Set	$Q = \{QA_i \mid i \quad N\};$ $QA = \{QueryName, QueryOpt, QueryValue\};$
Demand Info Set	$N = \{SN_i \mid i \quad N\};$ $SN = \{SelectName\};$

GQDM has regulated the interactive format in times of querying and searching the useful resources in the information grid. According to GQDM, we can design the general query interface for the applications.

3. The System Design

The generality of the heterogeneous resources; the expansibility and the distributed of system architecture are the main difficulties during designing the information grid resource management system. In order to resolve these problem, a new local domain general management mechanism and the multi-domain collaborative operation dynamic expand way are introduced in the paper.

3.1. Local Domain Operation Mechanism

Local domain operation architecture mainly divides into two parts: the public user interface management and the local domain resource manage agent. It is shown in Fig. 2.

The public user interface management provides the universal register & found interface and the unified network message transmission management mechanism to the upper level's application in the grid.

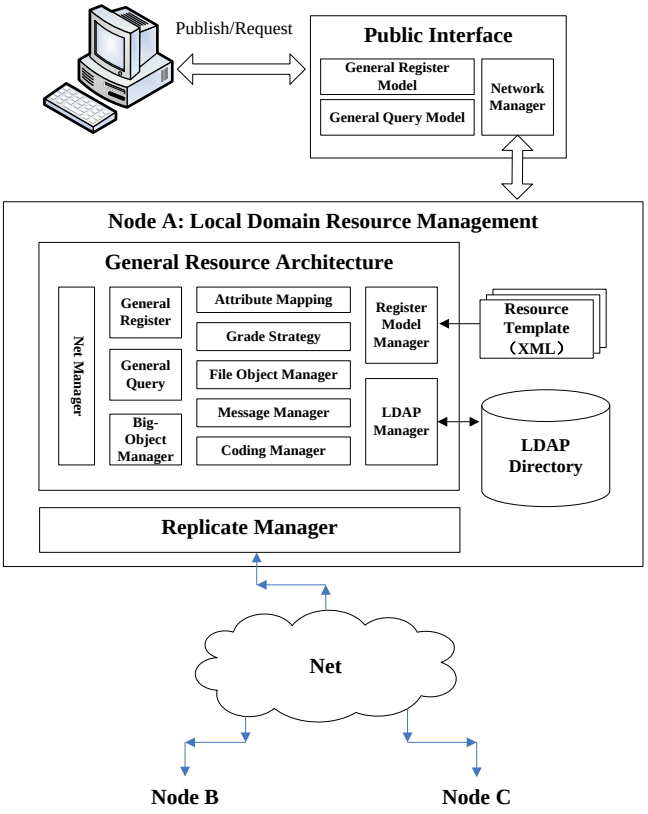

Fig. 2. Local Damain Operation Framework

The universal register module is designed and realized based on general register publish model (GRPM). And the universal query module is based on general query description model (GQDM). The network

message transmission manage module is mainly used for unified handling the packaging and the transport controlling of the register & found request messages.

The local domain resource manage agent is mainly used for processing the registration and inquires of all kinds of resources in its own domain. It is also responsible for collaborative operating with other domain's agent and replicating the metadata. It is divided into four parts: the set of the resource templates, the universal resource manage framework, LDAP directory storage manager and replication manager.

The set of the resource templates is used to store template files of the all types of resource. The template file is described by the XML. And each type of resource has its own template file. The content and framework of the template file is due to heterogeneous resources description model (HRDM). When a new type resource comes into being, the new template file will be added to describe this type resource. The new template file will also be stored in this set.

Resources in XML is mainly used for template sets of each type of information stored template file, the entire template Description of Heterogeneous content and structure Model based on coordination of Resources Description on the Description, when a new resource types, will add a new resource template, stored in this set.

The universal resource manage framework is responsible for adaptively and automatically handling the various register & found requires for the upper applications. It is mainly divided into template management module, LDAP manage module, network transmission manage module, general registration manage module, general query manage module, the big object manage module, attribute mapping manage module, grade strategy manage module, file object manage module, message manage module and coding manage module.

When the upper application submits a register request, the work procedure of the framework is as follows:

- The network transmission manage module receives the requesting message, it will distinguish whether the request is for register or for query. And if it is the register request message, it will call the general registration manage module.
- The general registration managing module calls the message manage module to parse the request message. Then it can achieve the register resource type, operation flag, and a set of key-value pairs, which describes the resource. In order to resolve Chinese character coding, the coding manage module is used during parsing the message.
- According to the register resource type, the template management module will get the resource template file from the file set, read it and analyze it.
- Based on the content of the template file, the attribute mapping manage module can map the key-value pairs to the LDAP store's object class and attribute, the grade strategy manage module can confirm the tree grade node to store, and the file object manage module can distinguish whether it has the file to store.
- Finally, the LDAP manage module will connect to the LDAP database and add, update, delete move or rename the resource, according to the request.

When the upper application submits a query request, the process is similar to the register process, the only difference is the general query manage module is working in order to deal with the searching problem, instead of the general registration manage module.

All upper applications of this domain will use its own domain's resource management agent in order to ensure the efficiency and stability.

LDAP directory storage manager is as a database to store the registered metadata directories.

The replication manager is the most important component to connect to the agents of other domain. It makes the distributed system operate normally. The collaborative operation mode is introduced bellow.

3.2. Global Domain Layerd Architecture

The cross-domain resource management architecture defined in this paper, is adopting the method of logic concentrations and physical distribution, i.e. the user as long as deploys from one entry point and use this node's the resource management service, it is able to traverse all resource management services in global

domain and search all sharing resources in the information grid. The whole deployment structure is layered and crossed the domain. Each layer will have several domains. The higher layer domain and several lower layer domains form the one-to-many relationship. The globe distributed deployment architecture is as Fig. 3.

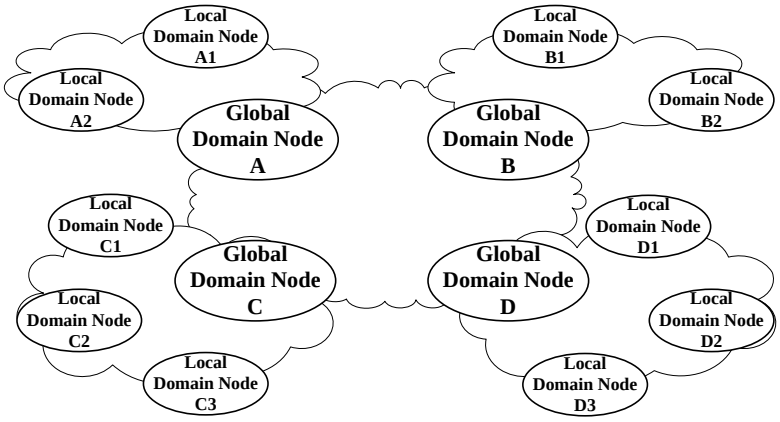

Fig. 3. Global Distributed Deployment Framework

According to it, the entire architecture of the information grid system is the layered classification divergent framework based on the network. In our system experiment platform, we adopt two layers distributed architecture, the top-level domains, is divided into four nodes. Four top-level domain nodes will be the master of the subfield local domain, and the subfield local domain will also be divided into several nodes. Among the top-level domain nodes, or, between higher level node and several lower level nodes, the synchronization mechanism is actualized to make all nodes in management. There are two kinds of synchronous mode:

- Equivalence Synchronization

The equivalence synchronization makes every node the same as the others. It takes the n-way multi-master equivalence replication to synchronize the nodes. When updating occurs, the node will push the update information to all the other nodes. And at the regular intervals, each node will pull the content in other nodes to renew its own according to the timestamp.

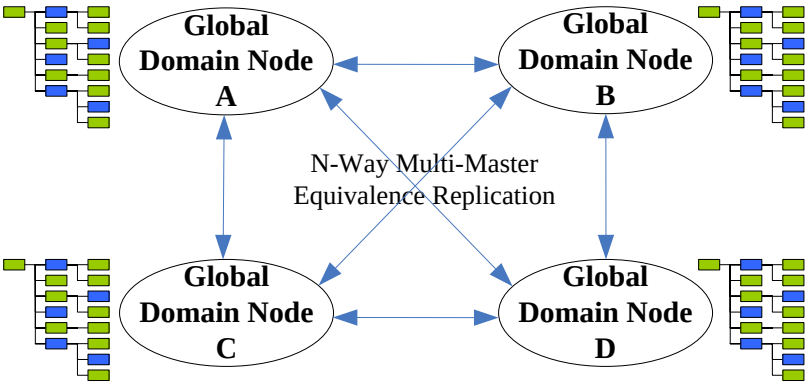

Fig. 4. Equivalence Replication

- Classification Synchronization

The classification synchronization can make the higher level node and several lower level nodes well regulated replication. As shown in 错误！未找到引用源。 the lower level node, such as local domain node, it only control the update in its domain, and it just pull its domain's updating information to the higher level node, such as global domain node. And the higher level node can push all the updating information to the lower level node, or, just push what the lower level node has the privilege updating information.

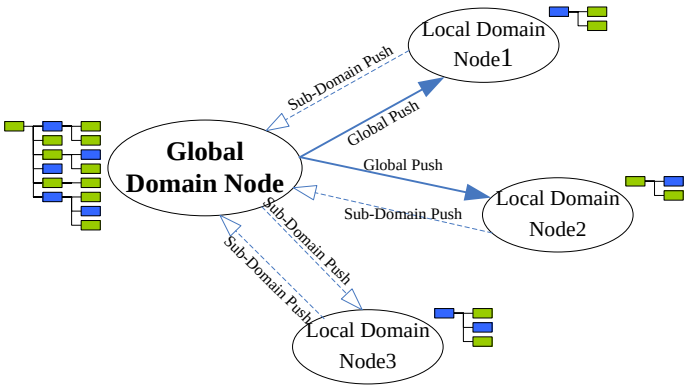

Fig. 5. Classification Synchronization

And both synchronous modes are designed in the paper to make the sharing resources in the grid can be discovered anywhere. Among top-level global domain nodes the equivalence synchronous mode is put in practice to make all metadata directories the same as the others. And each top level domain node will respectively connect to several lower local domain nodes. Among them, the classification synchronization strategy is carried into execution. The local domain maintains the registered resources in its own domain and pushes its own domain's updating information to the top level domain node to keep sub-domain replication. And the top level domain will push the special updating information to the local domain nodes, this special updating information can be the total or the sub, just due to the privilege of the local domain nodes. The hybrid synchronous mode make the framework constantly expand in order to meet the user's needs.

4. Conclusion

The paper explores the information grid oriented universal heterogeneous resources management mechanism. By researching on the design of extensible heterogeneous resources description model, configurable register publish model and general query description model, the universal architecture of the information grid resource management for every business field is realized. It can resolve the generality expansibility of grid system.

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