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Research and Development of Net-Centric Information Sharing Platform

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***Abstract*—**Compared with traditional distributed environment, the net-centric environment brings on more demanding challenges for information sharing with the characteristics of ultra-large scale and strong distribution, dynamic, autonomy, heterogeneity, redundancy. This paper realizes an information sharing model and a series of core services, through which provides an open, flexible and scalable information sharing platform.

***Keywords*—**Net-centric environment, Information sharing, Metadata registry and catalog, Cross-domain data access control.

I. Introduction

NET-centric environment [1] is a networked environment, including infrastructure, systems, processes, and people, that enables approach to business operations. Net-centric environment brings on more demanding challenges for information sharing with the characteristics as follows.

A. Ultra-Large Scale and Dynamic

Net-centric environment is an ultra-large scale network which connects huge amounts of information resources and users. These resources and users are dynamic changing all the time, and many unanticipated resources and users need to join the environment and share information. In this environment, traditional tightly coupled information sharing mechanism is not suitable, so we need to search a new loosely coupled mechanism.

B. Strong Distribution and Redundancy

In net-centric environment, the information resources and users are distributed all over the world. Although they are connected by network, the transmission cost for information sharing is often great. At the same time, the information resources and network link is often redundant, i.e., the same information exists on many different network site and there are many network path to access information. So the information sharing must face up to the great challenge of quality of service.

C. Heterogeneity and Autonomy

In net-centric environment, the information resources are various on data schema, format, semantics and query capability, and new type of information is continually emerging. So it is challengeable to enable information visible, accessible and understandable. Moreover, the information resources belong to different security management domains which own native data access control and authority strategy. Therefore, a cross-domain data access control mechanism should be explored and established.

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II. Information Sharing Model

In response to these characteristics, this paper realizes an information sharing model (Fig. 1). The model is mainly composed of data resources, metadata catalog, metadata base, core services and application library. Data resources exist with data entities or services. Data entities include messages, files, databases, and other types of data. Data services are software services which support users to access data. Metadata catalog provides a global view which enables data “visible” through recording the keyword, content and access methods of data. Metadata base provides semantic support for data access which enables data "understandable" through storing the models, vocabularies and ontology information of data. Core services are a series of necessary common services to support information sharing. Application library includes reading and parsing tools for data access which enables data “accessible”. The model has advantages as follows: (1) Any departments and user groups can create their own shared space according to information sharing requirements; (2) The theme and scale of shared space is flexible, the data resources may change at any time, and the shared space can be established or revoked at any time in the needs of the mission; (3) Any unexpected users which is permitted, can view, understand and access data without predefined interface.

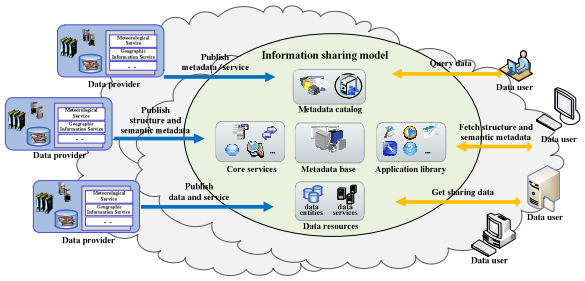

Fig. 1 Information sharing model

III. Framework of Information Sharing Platform

The information sharing platform is composed of data resources environment, application and management environment, core services environment (Fig. 2). Data resources environment provides data storage and management functions. Data resources environment includes data resources and meta-data center. Data resources are physical or virtual

storage files, databases, etc. Meta-data center stores and manage the theme, content and structure of data resources. Application and management environment provides portal functions such as publish, query, access, subscription, download, and system management functions such as user, service, data, security management, etc. Core services environment provides methods for data sharing which include metadata registry [2] and catalog service, cross-domain data access control service, multiple data sources routing service, data query optimization service and publish-subscribe services, etc.

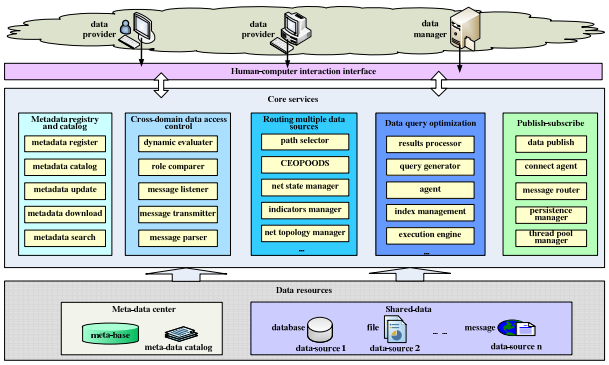

Fig. 2 Information Sharing Platform Framework

IV. Core Services

A. Metadata Registry and Catalog Service

Metadata Registry and Catalog Service (MRCS) provides registration, delete, and query functions, which can be used to manage and access themes, content and semantic information in metadata base and metadata catalogs (Fig. 3). Users can discover and understand data resources via this service. The service is composed of metadata registry, search and management modules. Supported by metadata registry module, users can register data model, ontology, theme and content information in metadata base and metadata catalogs according to existing metadata model. Based on metadata catalogs, metadata search module can provide the location information of data sources by content matching and reasoning. Metadata management module manages namespace, version, and life-cycle of metadata and provides metadata storage, update and download functions.

B. Cross-Domain Data Access Control Service

Cross-domain Data Access Control Service (CDACS) provides the security control for data access across multiple domains, and efficiently avoids typical problems of violation of security constraints induced by role mapping across domains [3] (Fig. 4). This service is composed of message listening, parsing, transmitting and dynamic evaluation, role authorization modules. Message listening module listen the requests of establishing role mapping, joining or leaving neighbor domains, and updating historical role mapping paths. Message parsing module parses requests and acquires information such as original domain, period of validity, and role mapping path. Dynamic evaluation module judges the security of mapping path with evaluation criterions. Message transmitting module broadcasts the secure mapping request messages to the neighbor domain according to neighbor domain mapping and historical path table. Role authorization module compares role mapping paths and selects the most suitable path with the "Least Privilege Theorem".

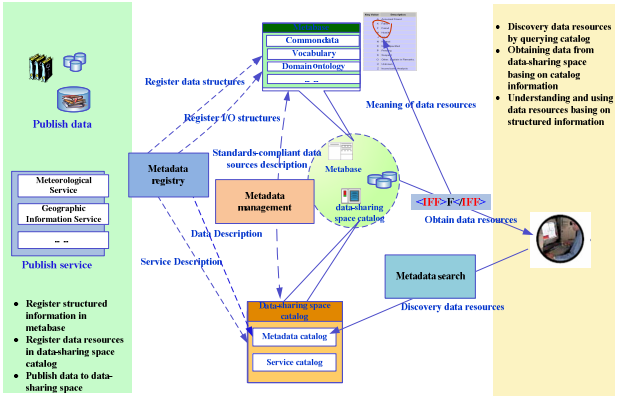

Fig. 3 The Functional Structure of MRCS

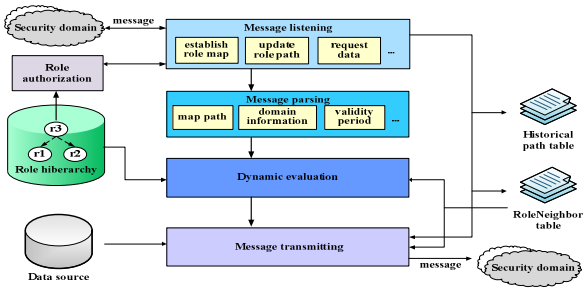

Fig. 4 The Functional Structure of CDACS

C. Multiple Data Sources Routing Service

Multiple Data Sources Routing Service (MDSRS) achieves the optimal path under the present of redundant data sources and network links, thus improving the efficiency of data sharing [4] (Fig. 5). The service is composed of computation engine for optimal path originated from one data source (CEOPOODS), indicators management, network topology management, network state management, constraint and preference information management, candidate paths generator, online computation engine, and path selector modules (Fig. 6). CEOPOODS gets the optimal paths for each data source by path pre-searching with current network topology and link state information from modules. Candidate paths generator gives the candidate paths set by comparing the optimal paths from all data sources. Path selector select the optimal path from the candidate paths set using quantified constrained information and preference information. Online computation engine will perform searching once again when the paths found by Path selector cannot meet the constraint requires.

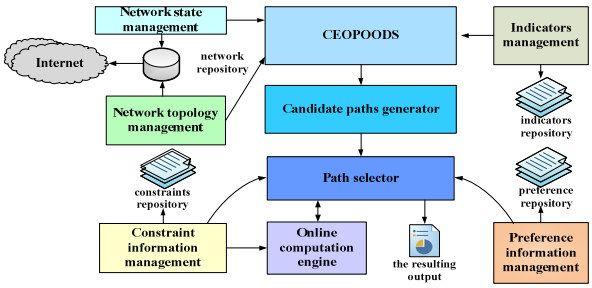

Fig. 5 The Functional Structure of MDSRS

D.Data Query Optimization Service

Data Query Optimization Service(DQOS) achieves the optimal sequence of semi-join operations when join query across many distributed data sources, which effectively reduces the cost of data transfer across data sources and improve data query performance [5] (Fig. 6). The service is composed of query optimization engine, query preprocessor, query generator, query execution engine, and execute agent, query synchronization controller, query results processor, indicators management and network transmission interface modules. Query preprocessor is in charge of parsing sub-query. Query optimization engine executes calculations for the minimized data transfer costs and obtains the optimal query operation sequence, with the input of sub-query and connection cost evaluation indicators provided by indicators management module. Query generator generates connection query based on the optimized query sequence and sends the connection query to execute agent via query execution engine. Query synchronization controller synchronizes the joint operation throughout the whole processing of query.

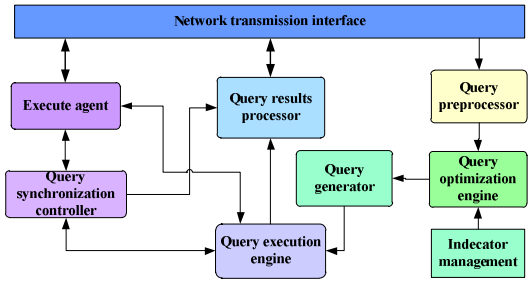

Fig. 6 The Functional Structure of DQOS

E. Message Publish and Subscribe Service

Publish and Subscribe Service (PSS) provides effective processes and reliable message transmission for users publish/subscribe requests (Fig. 7). The service is composed of publish agent, subscribe agent, channel management, buffer management, persistence management, thread management, service monitor and topic management modules (Fig. 7). Publish agent validates the data published with data models stored in metadata base and allocates channels. Subscriber agent monitors events related to subscription requests and sends subscribed data to users when events occurred. Channel management module establishes and maintains channels according to change of topics, and schedules the operations of users. Buffer management module allocates and manages buffer for every channel. Persistence management module applies persistent storage management for messages and context sessions. Thread management module allocates thread resource for service sessions. Service monitor checks the active status of service.

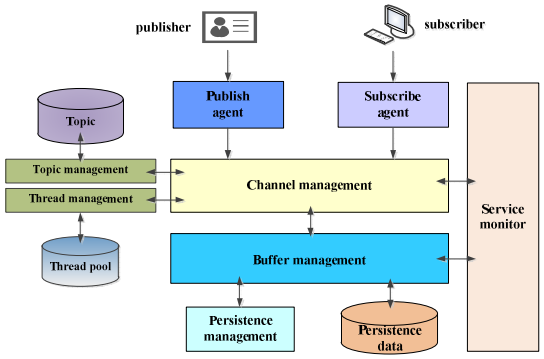

Fig. 7 The Functional Structure of PSS

V. Conclusion

According to the characteristics of net-centric environment, this paper realizes an information sharing model and a series of core services, through which provides an open, flexible and scalable information sharing platform. What needed points out is, the service realization involves a series of complex algorithms which are not to be described in this paper because of space restriction. Readers may refer to the authors' relevant papers [2]-[4].

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