The Extended Model Design of Non-Metallic Mineral Material Information Resource System Based on Semantic Web Service

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Abstract Non-metallic mineral materials information resource system provides users the based information about the physical, chemical and functional properties of non-metallic mineral materials, and some application information about the technology, formulation and application fields, and non-metallic mineral-related patents and some key technical standards for non-metallic Mineral industry, it mainly solve the user requirements from the perspective of research and development. But it does not satisfy the more personalized or integrated service needs. This paper proposes an extended model which is based on Non-metallic mineral material information resource system, and uses semantic Web service discovery technology to present an implementation mechanism. The system gives Chinese Non-metallic mineral industry a more optimized platform for information services, and also helps the value chain of non-metallic mineral industry being extended.
Key words Non-metallic mineral; Information Resource system; Extended system; Semantic web service

1 Introduction

In view of the non-metallic mineral industry development, national "Eleventh Five-Year Plan" to support science and technology projects set up special task, "technology of preparation for high performance non-metallic mineral materials" [1], Chinese non-metallic minerals information resource system is the ninth project of the task, the construction of the system is very important[2]: (1) It covers the basic information and properties, application information of the non-metallic mineral material, and guides the rational exploitation of mineral resources and efficient and deep processing and the users precise choice of materials. (2)It forms a number of common key technological standards and specifications of the industry, and accelerates the industry's technological progress, contributing to efficient development of non-metallic mineral material processing. (3) It changes a chaotic situation of non-metallic mineral materials application performance parameters, provides information related to scientific research personnel, promotes integration between research and producing. But the information inquiry service and some professional requirements provided by the original system is mainly to meet research and development of mineral materials. The system just provides some professional standards and basic information. But the users' needs are so many, including some personalized service or other comprehensive service needs. Therefore, the original system are not well satisfied customers from a business point of view， and can not solve the issue of information exchange between enterprises in the non-metallic mineral industry, from the long term, openness, scalability, and interoperability on such a system is not satisfactory, it is difficult to meet the higher requirements for the user, this is the limit of system. Therefore, to meet more personalized service needs and comprehensive service needs, let the user through the system access to a variety of related Web services and resources to meet their needs. Now, there are many services Web site related Non-metallic minerals industry, for example, China non-metallic minerals information network, Chinese non-metallic minerals Industry Association, China non-metallic minerals international network, etc. These sites also provide many Web services related non-metallic mineral. If it will cooperates with these service providers, the system allows users access to more Web services met personalized or comprehensive needs. In addition ,to solve all non-metallic mineral data exchange between business users, information spread, or business collaboration issues of the system, we must make the system greater integration of Web services ,and let it be a platform which can be an intermediary function to access Web services, enterprise information communicate and business collaborate. This requires the system to achieve Web service discovery, and the semantic Web service discovery technology compared with traditional discovery technology to have an advantage, providing a higher recall rate and precision, to discovery what we need among a variety of cross-platform and heterogeneous resources to meet the practical needs of the system.

Under the semantic Web service discovery and the related principles of system construction ,this paper proposes a extended model design of non-metallic mineral material information resource system based on semantic Web service discovery, and explores how to implement the model. It is an extension

of the original system, and achieves a more optimized access to Web service and information sharing and exchange, in order to solve issues of the system that meet the demand of personalized and comprehensive.

2 Semantic Web Service Discoveries

Semantic Web services are provided by the fusion of Semantic Web technology and Web services. It is based on the concept of Web services with semantic elements, which is using the specific rules to explain the meaning of concept in order to achieve the purpose of explaining Web services [3]. Semantic-based Web service discovery is achieved Web service discovery in the semantic level, which is the structure based on the original Web service system with the method of ontology, semantic reasoning, OWL-S (Ontology Web Language for Services) and other technologies. Using OWL-S description of the semantic Web services can enable users to understand the functional details, enhance the intelligibility of machines for service descriptions [4], and get more accurate results by matching the semantic request and semantic service descriptions.

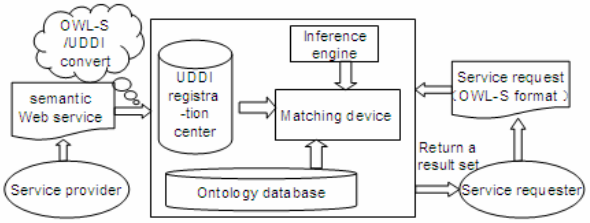

Figure 1 Semantic Web Service Discovery Framework

Semantic Web Service Discovery Framework is shown in figure 1. When Service providers publish semantic Web services, they need change the semantic Web service description to meet the UDDI (Universal Description Discovery and Integration) format according middleware, then posts service to the registry. Service requester sends service requests, then matching device can identify the service request in OWL-S format, it makes a semantic reasoning process combined with ontology database, and returns the final matching result to the service requester.

In the view of Semantic Web Service Discovery framework, semantic Web service matching is the nature of the process of semantic Web service discovery. The semantic Web service matching is compared the request description with advertising services on semantic level. In this paper the basic idea about semantic Web service matching is: first of all, we make a service category match that can filter off the irrelevant advertising services; then make the matching between the input parameters output, after that, make a QOS(Quality of Service) match among the candidate services which meet the requirements, Finally, it sorts the candidate services on the results list according to the similar degree of service and returns the matching result set. Semantic Web service matching process is shown in Figure 2.

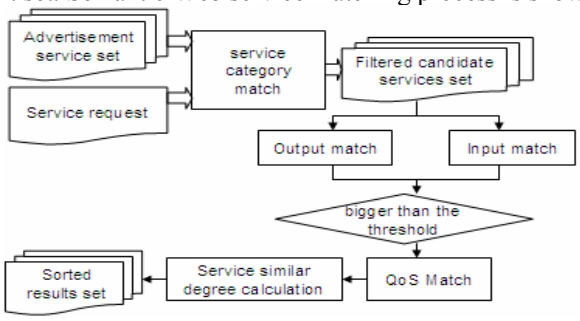

Figure 2 Semantic Web Service Matching Process

3 The Extended Model of Non-metallic Minerals Materials Information Resource

3.1 The extended model based on semantic web service discovery

The goal is solve the problem of personalization and comprehensive demand which the extended model of non-metallic mineral materials information resources system based on semantic Web service discovery want to realize. The users' service demand is so different because of their different identity. The Web services provided by original system are limited, which is mainly on-metallic mineral materials basic information inquiry services. But users' demands are not limited to this, they might want

some non-metallic minerals transaction management services, or want to check into their interested enterprises to some of the external supply of information, etc., and there are many different demands on the service. How to solve this issue is worth considering, the traditional approach is to continue to optimize general system functions, adding more systems Web services, but it will be not only arduous tasks, efficiency is not high, but also can not quite satisfy user changing demand for services. Therefore from the system integration of direction to consider, the system was expanded into a service integration platform, the user can through the reconstructed system to access more Web services, but these Web services do not require system own them, they come from different service providers (including professional service providers, and some non-metallic mineral enterprise). The problem is transformed how users find Web service that they need through the system. Therefore, the most important task of extended model is to achieve related Web resources discovery, specifically to solve enterprises users' demands about non-metallic mineral related services, as well as data exchange between enterprises users, information spread and business collaboration issues, and system would play an interactive role as a bridge of resource sharing among enterprises. In the face of the resources from the Web and the distributed heterogeneous enterprise resources, and semantic Web service discovery is better than the traditional Web service discovery, allowing users to more accurately find the services they need. Combined with previously proposed semantic Web service discovery framework and strategy, the paper proposes the extended model of non-metallic mineral material information resource system based on semantic Web service discovery as shown in Figure 3.

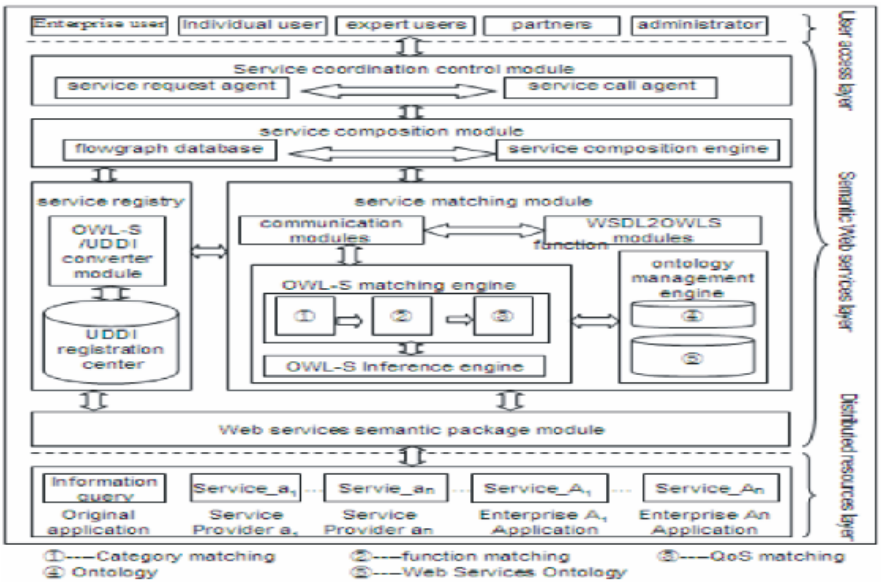

Figure 3 The Extended Model Based on Semantic Web Service Discovery

System extended model is divided into the following three layers:

(1) User access layer is the entrance of system, which is used for visual users' interface to access system, and the user service request is sent from here. The users of non-metallic mineral materials information resources system is divided into five categories: enterprises and individual users in non-metallic minerals industry, the expert users to engage non-metallic mineral material, the system partners and the system administrator. The five categories of users constitute the group of users of the system, the user could have multiple identities, and they can be either a provider of Web services or the Web services requester. Through this system, they can provide or request the Web services, and spread information, exchange data and other activities to meet their own individual needs.

(2) Semantic Web services layer is the core functions layer of the extended system. It includes semantic Web services package module, service registry (OWL-S/UDDI converter module, UDDI registration center), the service matching module (communication modules, WSDL2OWLS modules, OWL-S matching engine, ontology management engine), service composition module (flow graph database, service composition engine), service coordination control module (service request agent, the service call agent). This layer implements the semantic Web services packaging and distribution and the semantic Web service discovery process. The paper will explain the details of the layer working principle and function.

(3) Distributed resources layer mainly includes a variety of Web resources provided by the system. The extended model will package the non-metallic mineral material information query service with semantic technology, and publish that. Extended mode allows non-metallic minerals related professional services providers and non-metallic minerals enterprises provide a variety of distributed heterogeneous resources, after semantic packaged and published, all resources could be discover and called through the user's access layer in this system. These distributed resources can be entered into an agreement in the form of paid services to implement from the management point of view. For example the services could be paid for how many times the service is called or how long the authorized period is.

Some applications for the enterprise or some database information services can be entered into data sharing and security provisions and compensation for the use. However, from implementation of the point of view, for to achieve system function, it needs the modules of semantic Web services layer work together to conduct a series of service discovery and call.

3.2 Main modules in semantic web services layer

In the three layer structure of this extended model, the semantic Web services layer is the core of the system; there are mainly previously described 5 major modules. The workflow among the modules is: semantic Web services package module makes each service package, and then carried out registered release by the Service registry. When the user sends service request, the service agent will send it to the service matching module to match service requests and advertisements have been registered and the return results, if not directly match, taking service request sent to the service composition module to try whether services composition meet the service request or not. Finally, service call agent is responsible for implementation. From the perspective of semantic Web service discovery to research, service composition aspects will not be discussed.

(1) Web services semantic package module. Web services semantic package module package the application resources of distributed resources layer with semantic technology. As the applications provided different providers often use different programming languages and databases running on different operating system platforms. Semantic Web layer can not make unified, efficient access application resources on distributed resources layer. Therefore, in order to enable the system in unified approach to interact with these applications, application need for the necessary package. In this model, all applications are described in the semantic Web services description model to be services in the face of the system, including application of the original system packaging with semantic technology. Thus, packaged services registration issued in UDDI registry. (2) Service registration center. Service registration is a prerequisite to achieve system function, only the service providers publish semantic Web services packaged in register，users could discover and use the services.(3) Service matching module. Service matching is the most important part of non-metallic minerals information resources system and an important functional module. Service matching module includes communication module, inference engine, and OWL-S matching engine and Ontology management engine. These sub-modules are basis of service discovery, service matching module receives the user's service request, it will use the logic of matching strategy and the matching algorithm for service discovery, and send the final match results to the user through the communication module, thus the whole process of service discovery end.(4) Service coordination control module. It includes service request agent and service call agent. Service request agent is an entrance which system receive service request. The service call agent is the export which system calls service.

3.3 Semantic Web service matching

(1) Concepts modeling

Web service description model [5]: simply said, Web service is the service to support the abstract description of an operation, it can be defined as a four-topple, including the service's basic property (Proporty), input parameter set (In), output parameter set (Out), quality of service(QoS).

WS = <Proporty,In,Out,QoS>.① Proporty means service basic properties, including service ID (ID), category information (Category), service provider ID (PoviderID), service name (ServiceName), service provider name (Provider Name), service versions (Version).② QoS is non-functional properties of service. Including service response time (Time), service price (Price), service reliability (Reliability). Reliability = s / t, s means the number of successful operation; t means the total number of calls indicated.

Service request model: the user's abstract description on interface requirements, as Web services,it can be expressed as four-tuple.WS = <Proporty,In,Out,QoS>.① Proporty means basic properties required by service request;② QoS means the quality of service required by service request , which

content is the same to QoS in Web service model.

(2)Service matching steps

According to the matching strategy, Semantic matching of Web services need to go through several stages to find the result set to meet user's requirements:①Web service category filtering, which in fact is a filter filtration process. After analysis, it can be found that if the category required by service request and advertisement service is not matching, they will not be similar. When the advertisement service has nothing to do with the service request category, it will be filtered out. Finally, we get candidate services set after the first matching.② Web services function semantic matching, because users are more concerned with service output, so Web service discovery algorithm in this paper first according to output parameters of user's service request and the candidate service set semantic matching calculation, then remove the candidate services which can not be able to meet a certain threshold, get the intermediate results, intermediate results of the service sorts based on output items semantic similarity [6] between service requests and candidate service; then make the user service request input parameters and the candidate services of intermediate results input parameters matching, and remove the candidate services of intermediate results which input matching can not be able to meet a certain threshold and then get the service set which meet the user's requirement. The semantic similarity of input parameters will be recorded as SemSim(RS.In,WS.In),and the semantic similarity of Output parameters will be recorded as SemSim(RS.Out,WS.Out).③quality of Web service matching, QoS match is the third step of the service match ,in order to select the best service from a large number of similar functions. This paper selects service response time T (in seconds), the price of services P (in yuan), service reliability R (Reliability= the number of successful implementation / call number) three factors to evaluate the quality of a service. Through these three indicators of quality of service match to get the QoS matching degree which is recorded as QoSMatch(RS,WS).④ Web service similar degree calculation, through the above matching steps, integrateing input and output parameters similarity and the similarity of QoS, users give preference degree on each match,which is as W_P， $W_1+W_2+W_3=1$;then it can calculate the Web service similar degree between the service request and advertisment service ,final return the result set ordered in Web service similar degree. Web service similar degree calculates as follows:

$$\text{Degree}(RS, WS) = W1 * \text{SemSim}(RS.Out, WS.Out) + W2 * \text{SemSim}(RS.In, WS.In) + W3 * \text{QoSMatch}(RS, WS)$$

4. System Case

(1) User registers Web service

The first step, before the service provider obtains permission to have access to registration services, is that it must be registers UDDI users. Service registry users can post new services and manage services (revise, cancellation service). Service providers send service registration requests, using semantic Web service description model for semantic description of services, and get services semantic description document, matching module is responsible for receiving by communication module. Second step, the communication module send the Semantic Web service to OWL-S/UDDI converter module, converter translate the semantic Web services to UDDI service description format. The third step is sending the UDDI service description format to UDDI registration center to register, getting the service identity ID after registration ends. Fourth step, system sends the service identity ID which is bound to the original OWL-S description to ontology management engine in order to saving this advertisement Web service.

Taking non-metallic mineral material information inquiry service as an example, it is released in the system after carrying out semantic Web services package. System development should get UDDI user registration, then send the registration requests after obtaining permission to have access to registration services. The system through semantic Web services package module makes Semantic description of the services with Web service description module, including:①Service ID: ID; service category information (Category): NAICS (North American Industry Classification Standard); Service Provider ID: PoviderID; service name: MineralQuery; Service Provider Name: Non-metallic Minerals system; service version information: Version.②the input parameter set (In): MineralName (mineral name).③Output parameter set (Out): ProPlace (origin), GeologicalCauses (geological origin), Reserves (reserves), Sort (type), ProAppePicture (Mineral appearance chart), MineralPicture (mineral map), CryStrPicture (mineral crystal graph), MineralChemical (chemical properties).④Quality of Service (Qos): Time=4second, Price=50RMB, Reliability=0.98. Input parameters and output parameters which need to be well in the definition of ontology database. After service package and publish, then the user can find the service through the system and perform service calls.

(2) The user requests Web services

Firstly, when communication Module in the service matching module identifies that information is requester's service request, if the request is based on WSDL (Web Services Description Language), then system transfers it to WSDL2OWLS Module [7] for semantic change, otherwise send service requests to service matcher for implementation of the service matches. Now it is an example that user request non-metallic mineral materials information search service, according to the service request model mentioned, the user should provide the following service request information:①service request name (ServiceName): MineralSerach;②service category information (Category): NAICS (North American Industrial Classification Standard)code;③input parameter set (In): The first input parameter called MineralName (mineral name), it is Mineral Name concept coming form the non-metallic mineral resources ontology.④output parameter set (Out): Output Parameters are ProPlace (produce place), Reserves (reserves), Sort (type), these are ProPlace,Reserves and Sort concept coming form the non-metallic mineral resources ontology;⑤Quality of Service (QoS): Time <5 second, Price <100RMB, Reliability> 0.9. The user's service request information can be the default some items in the service request description model, the number of input parameters and output parameters do not need be completely same, of course if not same, it will owe service similar degree in the service matching.

Secondly, when the communication module send the non-metallic mineral material information query service request to the OWL-S matching engine, the matching process and methods as noted above, the final output set for the user to choose, or system directly select the service which has highest service similar degree, that is the most satisfying service, and then return the result to user, the user can call the service through the service call agent. Otherwise, if not directly matches, taking service request sent to the service composition module to try whether services composition meet the service request or not. In this case, it is on doubt that the information about information query service provided by the system could match the user query service request, of course, if the service similar degree is the highest including input parameters, output parameters and QoS matching between non-metallic mineral material information inquiry service and non-metallic mineral materials information search service quest, it will be scheduled in the first recommendation to the user.

Thirdly, system will return the result of (Web service description documents and UDDI parameters ID) to the user through the communications module and the service call agent performs service.

5 Conclusions

Chinese non-metallic mineral materials information resource system is built to meet the information demand of non-metallic mineral industry, while the current system provides a platform from which enterprises, personal and expert in non-metallic mining industry can get information. It plays an important role in promoting non-metallic mineral industry. But in the long run, the system's existing capabilities can not fully meet the users future needs of more services. This paper proposes a extended model based on previous studies in the background for this application, it allow users access to more Web service related non-metallic mineral materials. The program use the semantic Web service discovery technology to achieve a good Web service discovery ,then realize Web service and business information integration related non-metallic mineral materials to meet user personalized and comprehensive demand. Of course, as a new area of research in semantic Web services also has many unresolved issues, this paper just explore the service discovery lightly and do not research Service composition in the model deeply. That is all we need to do next. Besides, combining with Specific application background, this work is still stuck in the model design phase, while the specific issues of non-metallic mineral industry is also changing, many practical problems also need to solve, these are the following research tasks to be completed.

Acknowledgement

This research was supported by Key Projects in the National Science & Technology Pillar Program during the Eleventh Five-Year Plan Period, under Grant 2008BAE60B00 and 2008BAE60B09.

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