Research on Semantic-Based Web Services Registry Federation*

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Abstract. Meta modeling is an effective approach to implement interoperability among distributed and heterogeneous information sources on Web. MMFI (Framework for Metamodel Interoperability) is a set of meta objects and Metamodel constructs to be used in the development a metamodel in actual implementation of information registry and repository. As a scalable solution to requirements of semantic interoperation between heterogeneous and autonomous Web services registries, we provide an ontological metamodeling approach to combine MMFI with technologies from the federated information management to create an architecture for Web services registry federation. A software component service registry prototype system implemented based on these methods is introduced.

Keywords: Web service registry, ontological metamodeling, federated information management.

1 Introduction

With the development of computer networks, sharing and utilization of accumulated information resources are difficult to be retrieved, shared and utilized on account of dynamic, heterogeneous and autonomous characteristics of these distributed resources[1]. That makes it necessary to constructs federated virtual organizations across organizations and individuals via open and interoperable network service. Web Service (WS) has brought enormous revolution to the existent Web application pattern. As a result, the Websites will no longer stay in a passive position [2]. With the help of standardized data formats and protocols such as SOAP, UDDI, WSDL and etc., WS provides a middleware platform to integrate existent applications and business procedure into the compound application in a kind of loosely collaboration. However, the semantic interoperability of WS registration limits more automatic and intelligent interoperation [3].

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Presently, there are several common or user defined registration standards for the WS registration such as UDDI and ebXML [4, 5, 6]. Comprehensive service publishing and discovery require a more compatible and scalable infrastructure to integrate information from multiple distributed, heterogeneous and autonomous registration repositories and keep the information integrity and consistency in different registration repositories at the same time. Therefore, we propose the WS registration federation built on the basis of semantic interoperability so that users to different registration systems can publish and discover each other's registration information transparently.

The research on federated information management has already been around for about 20 years. The federated information system was defined as the next generation information integration infrastructure to cover the need for online real time information integration of the trans-enterprise virtual organization [7, 8]. A kind of scalable federated data management architecture based on CORBA was proposed in [9]. However, CORBA integration does not go up to the height of semantic, and not fit for the need of loosely coupled service collaboration in the Web environment. In addition, various registered objects are not limited to structured database object. The traditional federated data model integration should be greatly challenged.

Standardization is base of the network application. From 2003, ISO SC32 has organized to realize the information registering in semantic Web repository's MMFI (Framework for Metamodel Interoperability) standardization project [10]. By our research, we found that the ontological metamodeling method works well with the WS platform and becomes the core mechanism of the semantic Web Service. A scalable WS registration federation that combines ontological metamodeling method with federated information management technique can extend the WS platform.

2 Architecture of the Web Service Federation

2.1 MMFI

A Web based environment is faced with transorganizational complex systems that need to share and interchange various complex business objects. Only if we extract and analyze the metamodel, meta data and meta service, are we able to conceal the semantic and structural heterogeneity effectively, accomplish automatic integration transparently.

MMFI provides a framework for meta data registration by integrating meta data registration standards at the meta model level. MMFI is composed of 3 parts now, namely, the core model of MMFI, MMFI for ontology registration and MMFI for mapping [11]. Figure 1 illustrates the architecture of MMFI. The Core metamodel directs other parts. There is correlation between the ontology registration and the metamodel for mapping.

MMFI Core Model is the core part of MMFI. It provides common description mechanism for entire metamodel framework [12]. MMFI Core Model is constructed by integrating MOF (Meta-Object Facility) and the international standard for meta data registrationISO11179 (MDR).

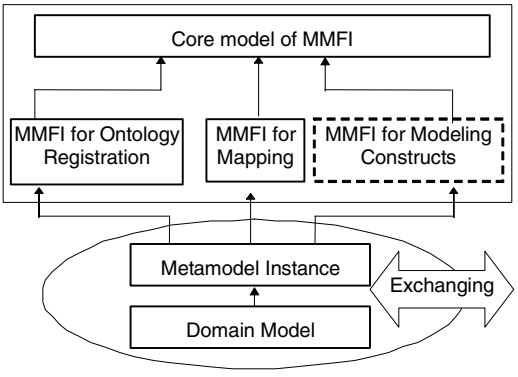

Fig. 1. Architecture of MMFI(citing from [12])

MMFI for Ontology registration inherits from the Core Model, and mainly used for providing a common metamodel framework for ontology registration so that ontology (especially classifying pattern) definition from every metamodel could be unified [10]. As the ontology is predominant in knowledge representation, it is a model rich in semantic. At the same time, ontology is also the basis for the semantic Web service, and the OWL (Web Ontology Language) under developing is one of the important standards.

2.2 Web Service Registration Federation Architecture Based on MMFI

Service registration in Web environment has its own characteristics in distribution, heterogeneity, autonomy and dynamics. Among them, the distribution problem is mainly caused by the huge size of the Web and its loose relation as well as the balancing problem in logic; heterogeneity focuses on the semantic heterogeneity; autonomy is manifested in the design and execution autonomy; dynamics need to solve the scalability and evolution problem of the overall system throughout its lifecycle. To treat all these, we proposed a WS registration federation architecture based on metamodel interoperability framework. This system is divided into 3 layers: the federation management layer, local agent layer and the member system layer (shown in Figure 2).

(1) Federation management layer. Federation management layer is the core of the system. It provides the registered semantic mapping between registered members and the mapping between registered models. Ontology server maintains federation ontology, and federation ontology provides the mappings between different registered ontology to ontological metamodeling. The contents include properties concerning WS registration and relations between registrations; thus, realizing the semantic mapping between different registered members. When the member system changes in the federation, ontology server is responsible for updating the federation ontology. As a result, the semantic interoperability of dynamic service publishing and discovery of the heterogeneous member systems in the Web environment is solved.

Because of the structural complexity of the WS registered objects, a global registration metamodel providing mapping between different registered models is needed. The mapping metamodel provides interoperability assurance at metamodel level for different WSs to compose a complex WS. The mapping mechanism between registered structures can adopt techniques in federation data management.

(2) Local agent layer. Local agent layer carries out the communication mechanism between federation management layer and registered member systems. A local agent not only works as query agent with the identity of system user and accomplishes the query transformation between different information models, but also maintains the registration ontology of registered member ontology and implements the registered ontology's semantic description of WS. In addition, if global transactions are needed in the registered member system, a local agent is also responsible for transaction management in order to ensure the serializability and semantic integrity control of global transaction. Because the local updating of registered member system will affect the integrity of the global information, the local agent has to sense and monitor local operations, and report the updates to the federation management layer in time; it assumes the validity checking, authentication and access control operations and works as the security agent in the information transformation process.

(3) Member system layer. Every member system is an autonomous field, which has its own local users and follows its usual working process. When a user need to deal with WS publishing or discovery in the registration federation, he will become a global user and his registration request will be accepted and processed by local global agents.

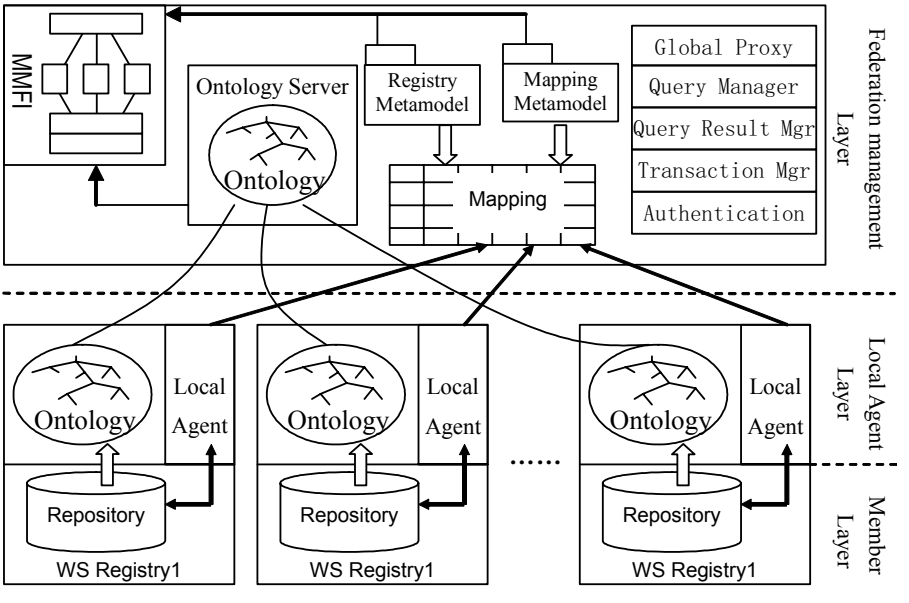

Fig. 2. Web Services Registry Federation based on MMFI

3 Software Component Web Service Registry Federation

To verify the architecture and runtime mechanism, we first develop a software component repository platform (WHCRP) [13] as the base of further software component service registry federation. The system is based on J2EE architecture, and the messages delivered between client and server adopts SOAP.

The system is made up of client side and server side. Client side is responsible for providing client with flexible, convenient registering, searching interface. SOAP subsystem is responsible for packaging messages from client into SOAP format and transferring them to server side through Internet. The response from the server is also interpreted by the SOAP subsystem. Server side is made up of SOAP dispatcher, ontology server, query manager, metadata register manager, repository manager, etc. Several kinds of interfaces are provided by the repository including database, file system, WS. Repository is made up of database and files system, with the database responsible for persisting metadata and file system for files relating to software component.

We construct a common software component ontology based on the analysis and abstraction. The software component ontology is a consistent knowledge representation including software component's attribute, object, relationship, constrains, etc. For now, WHCRP implements the interoperability with ebXML registry and repository.

4 Summary

This paper deals with the cross point research between data management and software engineering, synthesizing newest research result from both fields. It proposes combining federated data management and theory of ontological metamodeling to settle the problem results in distribution, semantic heterogeneity, and dynamic organization of WSs. It describe a framework of semantics-based WS registry federation, based on the ISO standardized MMFI. Some research and development has been done in Web service's registering and management in the field of software component. We construct the software component attributes ontology to registry and classify software component, verifying the support from MMFI for WS registry. Future works will focus on the implementation of our theory and method to construct WS registry federation in different fields.

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