Framework of Semantic Web Services and Service Mediation

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ABSTRACT

Semantic web services provide a syntactic and semantic description about the capability of web services, so that users can discover and compose adequate services effectively. Semantic web services have a framework describing web services, support the ontology which is a base technology of data model, and were defined by semantic technology like WSMO, OWL-S, and SAWSDL. But interoperability of web services has heterogeneity problems because there were structural and conceptual inconsistency in describing ontology and capability of web services. Therefore, service mediators aim to resolve mismatches among differently used terminologies, in how to communicate between web services and on the level of combining web services. In this paper, we define the framework of semantic web services. Also we survey the service mediation approaches of WSMO, OWL-S, and SAWSDL and propose the architecture and function of data mediation. Ontology based data mediation can ensure the semantic interoperability of web services and provide the advanced discovery result.

Keywords: semantic web service, WSMO, OWL-S, SAWSDL, ontology, service mediation

1. INTRODUCTION

Web service is self describing software component, so that service providers and users can discover, compose, and execute the web services using service description. The web service descriptions like WSDL(Web Services Description Language)[1] provide the syntactic description of service function and there is a limit to find web services that satisfy the user’s requests more accurately. Therefore the semantic descriptions of service are necessary.

The semantic web services provide syntactic and semantic descriptions of requirements and capability, so that they facilitate the discovery, selection, and composition of services. The semantic web services have a framework describing web services, support the ontology which is a base technology of data model, and were defined by the semantic descriptions for automation of web service process. Communication between web services has heterogeneity problems because there were structural and conceptual inconsistency in describing ontology and capability of web services. Therefore, service mediators aim to resolve mismatches among differently used terminologies, in how to communicate between web services and on the level of combining web services.

In this paper, we present the framework of semantic web services. Also we survey the service mediation approaches of WSMO, OWL-S, and SAWSDL and propose the architecture and function of data mediation.

This paper is organized as follows. Section II defines the framework of semantic web services. In section III, we survey the service mediation approaches of WSMO, OWL-S, and SAWSDL. And section IV proposes the architecture and function of data mediation. Finally, in section V, we bring to conclusions.

2. FRAMEWORK OF SEMANTIC WEB SERVICE

The automatic discovery and composition of web services rely on the service description which is annotating of the service functionalities semantically.

There are 4 types of semantics in web services: data semantics, functional semantics, non-functional semantics, and execution semantics.

Data semantics are the formal definition of data in input and output messages of a web service. They are used in service discovery and interoperability between web services. Functional semantics are the formal definition of the capabilities of a web service. They can help the discovery and composition of web services. Non-functional semantics are the formal definition of quantitative or non-quantitative constraints like QoS (Quality of service) requirements like minimum cost and policy requirements like message encryption. They are used in discovery, composition and interoperability of Web services.

Execution Semantics are the formal definition of the execution or flow of services in a process or of operations within a service. They are used in process verification and exception handling.
Ontology is a common terminology by providing concepts, and relationships between the concepts. WSMO web service is a formal description of the web service’s functionality, in terms of capability, and the method to interact with it, in terms of an interface. Goal describes aspects related to the requirements of the end user. Mediator describes elements that resolve interoperability problems between different elements, e.g., between two ontologies or two services.

There are 4 types of mediator according to the purpose of mediation. OO(ontology to ontology) Mediators resolve mismatches between source ontology and target ontology. GG(goal to goal) Mediators connect goals to one another and can create the new goal from existing goals. WG(web service to goal) Mediators links a web service to a goal and resolves terminological mismatches. WW(web service to web service) Mediators are used to establish interoperability between web services.

WSMO mediators aim to resolve heterogeneity problems at the data, process, and protocol levels i.e., in order to resolve mismatches between different used terminologies(data level), in how to communicate between web services (protocol level) and on the level of combining web services(process level)[4].

WSMO mediation is composed of data mediation and process mediation. Data mediation generates and saves the mappings between source ontology and target ontology in design-time and then applies them during run-time process.

Process mediation means the match of communication patterns between source and target. It finds the mismatches in message exchange pattern of the two and eliminates them[5].

OWL-S(Semantic Markup for Web Services) is an ontology of service concept for describing the properties and capabilities of web service based on OWL(Web Ontology Language). It organized a service description into three conceptual areas: process model, profile, and grounding.

Service Process model describes how a service performs its tasks. It includes information about inputs, outputs, preconditions, and results. Service Profile is related to service annotation and provides a general description of a web service, intended to be published and shared to facilitate service discovery. It includes information of functional semantics, such as a service name, contact information, service category, service classification, service product, and text description. Service Grounding provides the details of how to access the services, by mapping from input/output parameters to message part of WSDL. In OWL-S, ontology is defined before the service definition, and it is used in service definition.

OWL-S doesn’t explicitly consider the heterogeneity problem, so mediator is not element of OWL-S. But OWL-S broker, algorithms, or web service descriptions can be represented in mediation functions[6] [7].

SAWSDL(Semantic Annotation For WSDL) is a set extensions for WSDL, which provides a standard

![Figure 1. Framework of semantic web services](image-url)
description format for web services. SAWSDL accesses data mediation with XSLT(Extensible Stylesheet Language Transformations) according to ontology level.

SAWSDL extensions take two formats: modelReferences that point to semantic concepts and schemaMappings that specify data transformations between messages' XML data structure and the associated semantic model. Lifting schema mapping is called the up cast mapping and transforms a XML data from web service into a concept of ontology. Lowering schema mapping is called a down cast mapping and it transforms a concept of ontology into a XML data from web service.[8][9].

In mediation technology of semantic web services, WSMO has a more concrete approach than OWL-S and SAWSDL. WSMO data mediation can be implemented ontology management, such as transformation and alignment of ontology. WSMO process mediation can be realized Abstract State Machine.

4. ARCHITECTURE OF DATA MEDIATION

In a semantic environment data is described by ontologies and ontology mapping has become a crucial aspect in solving the heterogeneity problems of semantically described data. This means that alignments between ontologies have to be created during design-time, and used in various run-time processes. Such alignments describe a set of mappings between the source and target ontologies, where the mappings show how instance data from one ontology can be expressed in terms of another ontology [10].

We propose the architecture of data mediation as shown in Fig.2. It is composed of Mediation Rule Generator and Data Mediation function. Mediation Rule Generator is for the purpose of creating data mediation rule in design time. It creates the mapping rule and save it to files using UI. It can be included in service description tool, such as WSMT(Web Service Modeling Toolkit). In run-time, Data Mediation function mediates the service mismatches between service provider and user by using mapping rules.

Figure 2. Architecture of Data Mediation

We can apply data mediation to the customer serving service in enterprise domain. We defined ontologies, web services, goals and mediators by using WSMT.

In ontology, we defined UC ontology and collaboration ontology. In service, we defined twitter search, google search, yahoo search services, etc. In goal, we defined a goal to find search service. In mediation, we have an ontology mapping between UC ontology and collaboration ontology as shown in Fig. 3. The multimedia instance defined in UC ontology can be mapped to image, movie, and music of collaboration ontology.

When service provider or user wants to discover the web service which is searching a music related product, our semantic web services framework discovers search services. And then, it finds the best matched services by using ontology mapping between the source and target ontology. In case one service supports music and others support multimedia, the services supporting multimedia product subsume a service supporting music product. So we can find multimedia search service to be discovery result. In this way, data mediation supports semantic explanation of similar concept.

Ontology based data mediation can ensure the semantic interoperability of web services and provide the advanced discovery and composition result.

5. CONCLUSIONS

In this paper, we presented the framework of semantic web services. Also we surveyed the service mediation approach of WSMO, OWL-S, and SAWSDL. In service mediation technology of semantic web services, WSMO has a more concrete approach than OWL-S and SAWSDL, that is, mediator which is intended to resolve heterogeneity problems at the data, process, and protocol levels.

And we proposed the architecture of data mediation. At design time the mappings between ontologies have to be created, while these mappings are applied at the run time. Data mediation can be implemented to the ontology management, such as mappings, information transformation, inferences, and alignment of ontology. Ontology based data mediation can ensure the semantic interoperability of web services and provide the advanced discovery and composition result.

For further study, we have a plan to provide how to improve the discovery and mediation result by using ontology mapping.
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