SEMANTIC SERVICE DESCRIPTION TO SUPPORT EDUCATION AND TRAINING

An easy-to-apply service description model and service registry

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Abstract: This work describes a semantic service description model based on and inspired by existing service description approaches like WSDL-S and OWL-S and a service registry to support the creation of service oriented applications in the area of education and training. Our service description is based on an OWL ontology and combines a simple message- and state-oriented approach in order to reduce the effort for the creation of the descriptions which is a major drawback of a lot of existing, powerful semantic service description approaches. Furthermore, the proposed service description enables the matchmaking algorithm of the service registry to use not only the data-oriented input and output parameters to identify suitable services but also considers the preconditions and effects of a service. The usage of the service description model and the search capabilities are discussed against the background of the education and training area.

1 INTRODUCTION

The importance of service-oriented architectures increased particularly with the availability of web services as a platform independent technology. Especially in scenarios in which different business units have to cooperate in order to achieve a common purpose, the service-oriented approach is well suited and can deliver significant benefits (Adam et al. 2005). In the area of education and training, scenarios of this kind are very common. E.g. the teaching unit has to cooperate with the course material authors to get appropriate material, with the IT provider to get the technical equipment needed for each lecture and with the administration to arrange the registration of learners for examinations and to capture the examination results. As the teachers apply very different teaching approaches their specific need for IT support is much diversified. A service-oriented approach can ease the implementation of the needed IT support by increasing the reuse of existing functionality in the area of education and training (Westerkamp 2006).

To support the reuse of existing services a service registry is needed that enables the users to define their needs and to get a list of available services that fulfil these needs (at least partially). To enable this search, the service registry needs to be based on suitable service descriptions.

The two main contributions of this paper are: A new service description model (Chapter 3) that eliminates deficiencies of the existing approaches (Chapter 2) and a service registry architecture and its implementation (Chapter 4) that allows to efficiently search for services based on our description.

2 RELATED WORK

The semantic service description should at least cover input and output of the service and two sets of conditions: the preconditions which have to be met before executing the service properly and the effects that are conditions that hold after the successful execution of the service (Jaeger et al. 2005). These four service description elements are often referred to as IOPE (Input, Output, Precondition and Effect).

Current standards from the web service area like UDDI and WSDL can form the basis for a service description and retrieval solution but are not sufficient. A WSDL description provides the information that is needed to invoke a web service in a syntactically correct manner and can therefore be used for the (technical) integration of available services into the IT solution. WSDL does not provide a standardised way to describe precondition and effect of a service call and the semantics of the terms used to describe input and output of the service can only be included in the description by using appropriate terminology.

The explicit semantic annotation of the services is a very important step towards the exploitation of the full potential of the service-oriented approach (Patil et al. 2004). Different approaches try to provide this by adding semantics to conventional service descriptions like WSDL-S (Akkiraju et al. 2005) or by creating completely new descriptions like OWL-S (Martin et al. 2004) or Diane Service Description DSD (Klein 2004). All mentioned service descriptions include the possibility of defining all four IOPE service description elements.

Approaches like OWL-S have the deficit, that it is not easy for the description author to create such a quite complex description (Patil et al. 2004). This problem could be reduced by using less complex description languages that have adequate expressiveness for certain scenarios.

Service description approaches like WSDL-S reduce this description creation problem as well, as they contain less new description elements. It adds the two missing service description elements precondition and effect and enables linking to an ontology to enrich all four service description elements with semantics. Unfortunately WSDL-S neither provides an ontology nor gives any information how the referenced ontology should look like.

Generally all four types of service description elements can be used to identify suitable services. But in many approaches preconditions and effects are not considered by the matchmaking algorithm as they are not sufficiently standardised (Jaeger et al. 2005). This leads obviously to less powerful search capabilities.

The DSD solves this problem by treating the two condition description elements precondition and effect the same way as the two data description elements input and output, thus enabling the matchmaking algorithm to use all four IOPE elements for the search (Klein et al. 2005). The conditions are modelled as states that are represented in the ontology by concepts inheriting from the top-level concept "state" (Klein 2004). The DSD uses a state-oriented service description, which is less common and intuitive than a combined message- and state-oriented service description like OWL-S. The DSD ontology language is proprietary which reduces the reuse capabilities in other scenarios.

3 SERVICE DESCRIPTION

The service description needs to support the search of existing services and the integration of the found services. To support these requirements we propose a description model that consists of two parts: A service profile supporting the semantic search and the service grounding supporting the technical integration of a found service.

The description of the service profile is based on a set of ontologies as shown in Figure 1. The composition of ontologies has some similarities with the one proposed by (Klein and König-Ries 2003).

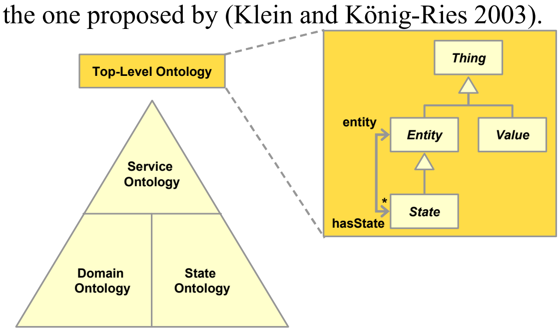

Figure 1: Service Description Ontologies.

An excerpt of the very simple top ontology is shown in Figure 1. The concept "state" is later used to define a services preconditions and effects while "entity" and "value" are used for input and output.

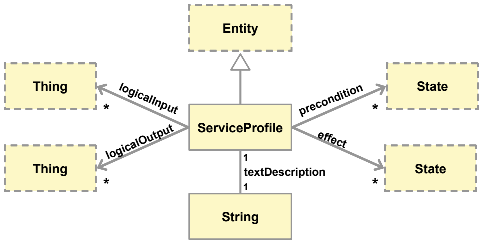

Figure 2: Service Profile.

The service profile is situated in the service ontology. Its input and output parameters have references to concepts in the domain ontology, while preconditions and effects are defined by references on state concepts in the state ontology. Furthermore the service profile contains a textual description of the service operation that can be used by a human reader to finally decide whether a service fits his needs or not. The dashed boxes represent concepts that are defined in another ontology (the top-level ontology).

The domain ontology and the state ontology, contain the specifics of the domain of education and training as shown in Figure 3.

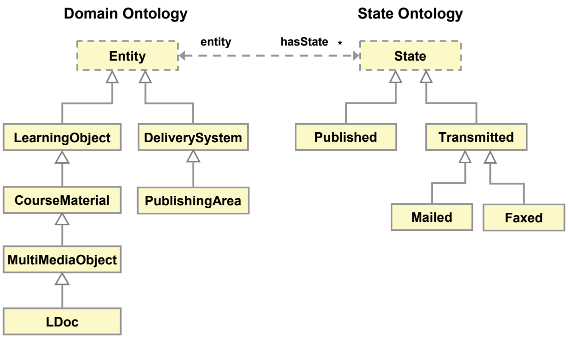

Figure 3: Extracts of the Domain and State Ontologies.

The service which will be used as an example for a semantic service description has the functionality to publish a specific multimedia course material called Living Document (LDoc) to a specific publishing area. The service profile of the example service "LDocPublishingService" has two input parameters referenced as "logicalInput" and as effect the state "LDocPublished", which is a subclass of the state "Published" with the restriction that the entity needs to be an "LDoc". The technical representations of the inputs are linked using the concept "Represented". The service ensures that a given LDoc is published in a given publishing area after the execution of the service.

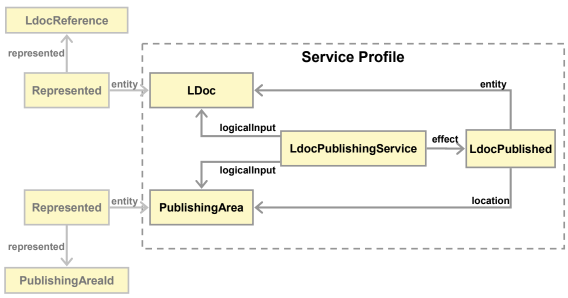

Figure 4: Example Service Profile.

The link from the technical representations of the input parameters to the interface description which is called grounding is realized using WSDL-S. In WSDL-S the specification of the structure of message objects are enriched by a semantic annotation using a so called "modelReference" as link towards the ontology.

4 SERVICE REGISTRY

In order to store and search for the service profiles and the service groundings a service registry was created based on existing software components.

The service registry is divided into a server and a client part. The server contains a UDDI registry which is used to register the WSDL-S descriptions. Furthermore the server provides access and reasoning functionality to the four OWL ontologies that are needed for the service profile descriptions.

In the service registry server the UDDI implementation jUDDI was used based on a mySQL database and a Tomcat J2EE server. The OWL ontologies were created using Protégé 2.1 as ontology editor and are provided using an Apache webserver. As reasoner the product RacerPro 1.9 was used and the access to the reasoning functionality was provided using DIG Description Logic Interface 1.1.

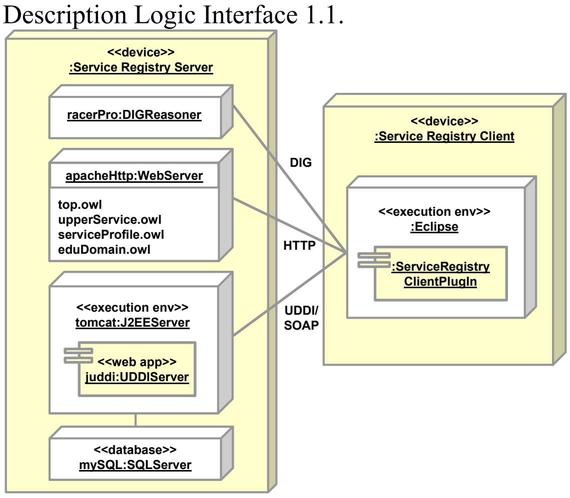

Figure 5: Deployment Diagram of the Service Registry.

On the client side a GUI interface realized as Eclipse plug-in enables a user to enter his queries and get access to search results.

The retrieval process that is supported by the service registry starts with a user's need for a service. The user tries to represent his need using the query syntax that is supported by the retrieval process (Stojanovic et al. 2003). In the retrieval step, the query is matched against the repository using a retrieval model such as Boolean or probabilistic model (Baeza-Yates and Ribeiro-Neto 1999). The output of this step is a list of service instances.

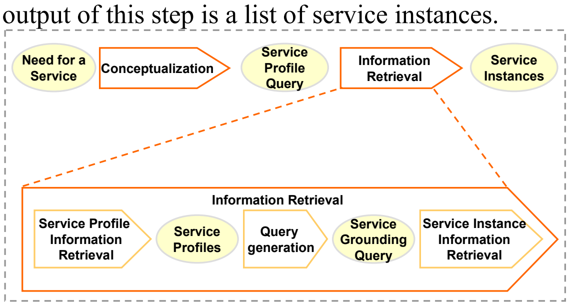

Figure 6: Semantic Service Retrieval Process.

The retrieval step starts with a service profile search query created by the user. This query is defined on a quite abstract (business-)level but can also contain technical restrictions. The first activity generates a list of fitting service profiles that represent types of services that meet the needs defined in the query. One very important feature is the query refinement which is used to get optimized queries for recall and precision enabling the user to get more results that are potentially relevant to him. In the second activity a list of service instances is generated that provide the functionality defined in the service profiles of the first retrieval's result list.

5 DISCUSSION

If a specific publishing service like the one in Figure 4 is needed, the corresponding query will probably use a specific concept as input. The service repository can find not only exact matches but will use the hierarchic structure of the domain ontology and might find a compatible service with a super class as input. This usage of an inheritance hierarchy can be applied to increase the recall as much more potential services descriptions match these queries.

Synonymous terms in search queries and service descriptions can lead to no search results even if a matching service would be available. Due to the common terminology of the domain ontology the usage of synonymous terms can be prevented.

The possibility to specify the functionality of a service makes it possible to prevent search results with matching operation signature that do not provide the needed functionality.

Compared to OWL-S the proposed service description is much less complex which can lead to decreased effort for the creation of service descriptions and service queries.

The support of the business and the technical layer enables linking these two terminologies.

6 SUMMARY

The paper has introduced an easy-to-apply semantic service description for web services and demonstrated its usage in the area of education and training services. The introduced service description is based on a combined message- and state-oriented approach and the matchmaking algorithm can use all four IOPE attributes to identify suitable services. As the approach is based on a domain and a state ontology it enables query modifications that lead to higher recall of the search. Compared to OWL-S the complexity of the service descriptions is low and reduces the effort required for the creation of service descriptions and search queries.

Apart from the service description a service registry based on UDDI and OWL was introduced that enables publication and search of service descriptions created using the proposed service description in an efficient manner.

One of our next steps to enable the description of a broader area of services targets the refinement of the currently available domain and state ontologies for the area of education and training.

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