



AN ONTOLOGY-BASED SERVICE DISCOVERY FRAMEWORK FOR AN ENTERPRISE

N. Arunachalam¹, R. Swarnalakshmi², R. Sangeetha², B. Pradheepa²

¹Asst Professor, IT Department, Sri Manakula Vinayagar Engineering College
narunachalam85@gmail.com

²Students, IT Department, Sri Manakula Vinayagar Engineering College
rswarna08@gmail.com
rsangeethasmvec@gmail.com
bpradheepa@gmail.com

Abstract

Enterprise service architecture creates an IT environment where standardized components can aggregate and work together to reduce complexity. Service Discovery mechanism is used for discovering one or more documents that describes a particular service. Since there is no clear understanding regarding the behavior of service, ontology is used for providing appropriate service to the end user. Ontology is a generic knowledge that represents agreed domain semantics that can be reused by different kinds of applications or tasks. This is an efficient method to provide clear notion of service. This paper proposes a generic service discovery framework for an enterprise using ontology and a knowledge based agent to get a clear view about the service provided and its functionality.

Keywords – Enterprise Services; Service Discovery; Ontology; Semantic web and Service Description

I. Introduction

The enterprise services architecture allows deployment of Web services to create applications within the current infrastructure, increasing business value. Web service discovery is used for locating, or discovering, one or more related documents that describe a particular service. In today's economy, cooperation between organizations tends to be highly subject to change. Service providers interact with service consumers by offering them services. In this interaction, both parties have certain expectations of each other's responsibilities. In order to provide an



appropriate service to the consumers ontology is used. Ontology is comprised of concepts, concept properties, relationships between concepts and constraints. It is defined independently from the actual data and reflects a common understanding of the semantics of the domain of discourse.

Ontology is an explicit specification of a representational vocabulary for a domain; definitions of classes, relations, functions, constraints and other objects. To specify a conceptualization we need to state axioms that put constraints on the possible interpretations for the defined terms. The Enterprise Ontology is a model of an organization which includes collection of terms and definitions relevant to business enterprises. This paper proposes to validate a generic service discover framework for an enterprise that has a large amount of services using ontology. It enhances reuse of services for various applications.

II. Literature review

The survey for service discovery using ontology for an enterprise is done and some of the examples are given as follows; Linda I. Terlouw and Antonia Albani [2013] proposed An Ontology-based approach to Service Specification. This paper provides an ontology based service definition and specification framework [1].

Hui Xiong, J. Vaidya, B. Shafiq, A. V. Paliwal and N. Adam proposed Semantics- Based Automated Service Discovery [2012]. This paper provides an approach to semantic-based web service discovery involves semantic based service categorization and semantic enhancement of the service request [2].

Meditkos and Georgios proposed Structural and Role-Oriented Web Service Discovery with Taxonomies in OWL-S [2010]. This paper describes and evaluates a Web service discovery framework using OWL-S advertisements, combined with the distinction between service and Web service of the WSMO discovery framework [3].

Yimin Shi, Guanyu Li, Jiayan Li and Yanxia Li proposed Framework of Semantic Web Services Discovery Based on Ontology Mapping [2009]. This paper states that a framework of Semantic Web service Discovery based on Ontology Mapping (SWSOM) is proposed, and a mechanism for ontology mapping processor is elaborated [4].

Changjun Hu, Huayu Li, Xiaoming Zhang proposed a Framework of Web Services Description and Discovery Based on OWL-S and Domain Ontology [2008]. This paper presents a framework of Web Services description and discovery using OWL-S and domain ontology by which semantic information is extracted to help convert WSDLs into service profile files describing how service works semantically; then mappings from profiles to UDDI are built to reconstructed data structures of UDDI for supporting semantic services discovery [5].

Linda Terlouw proposed towards a Business-Oriented Specification for Services [2008]. This paper states that taking the enterprise ontology as a starting point for specifying the tasks [6].

M. Stal proposed using Architectural Patterns and Blueprints for Service-Oriented Architecture [2006]. This paper uses software patterns and blueprints to express a service-oriented architecture's fundamental principle that supports the efficient use of SOA technologies for application development [7].

F. Colasuonno et al [2006] proposed A Semantic Web Services Registry Enabling Semantic Discovery and Composition which states an extended version of UDDI registry for semantic-based automated web service discovery and composition, compliant with semantic web technologies [8].



Jyotishman Pathak, Neeraj Koul, Doina Caragea and Vasant G Honavar proposed A Framework for Semantic Web Services Discovery [2005]. This paper describes a framework for ontology-based flexible discovery of Semantic Web services. The proposed approach relies on user-supplied, context-specific mappings from user ontology to relevant domain ontologies used to specify web services [9].

D. Bianchini, V. De Antonellis and M. Melchiori proposed An Ontology-Based Architecture for Service Discovery and Advice System [2005]. This paper presents a novel, ontology-based approach to service discovery, which exploits domain knowledge and semantic service descriptions to guide the service discovery process and provide advice on service selection and instantiation in interoperable adaptive information systems [10].

Umesh Bellur, Harin Vadodaria and Amit Gupta proposed semantic matchmaking algorithms [2008]. This paper proposes a service discovery based on an abstract query, selection of service from discovered pool, service binding and invocation, quality of service and negotiation of service [14].

Zhang Xiankun, Du lei, Gao Shan proposed A semantic web service matching algorithm based on the nearest ancestor node [2012]. This paper proposes the classic semantic web service matching algorithm based on the nearest ancestor node. It improves the rate of recall and precision of web service discovery [15].

III. Existing system

The existing system is a framework for automatic web service discovery based on semantic and NLP technique aims to enable efficient discovery mechanism for appropriate web services according to a user query. The diagram for the existing framework is shown in the Fig1. A graphical user interface is used to facilitate the discovery process. Web services are described and published in the service registry by the service providers these descriptions are parsed and useful information is extracted using matchmaking process some NLP and word sense disambiguation is performed to sense each word [13]. A semantic matchmaking process is done to map the services in the registry and ontology.

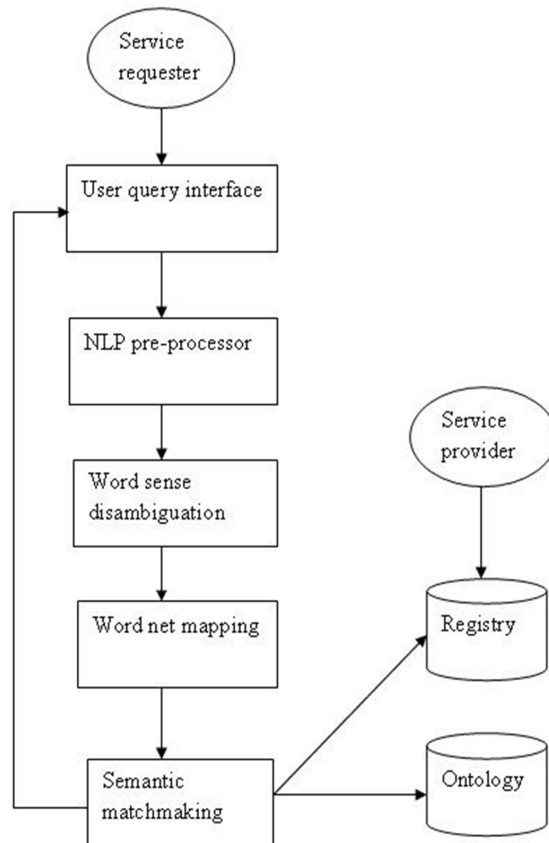


Figure1: A semantic web service discovery framework

Service-oriented approaches are gaining more and more attention since they claim to provide new and flexible ways of supporting the activities in an Enterprise. However, the current ways of implementing these approaches often lead to additional overhead and additional costs without delivering the expected advantages. Two major problems can be identified. First, there is no complete and clear understanding of the notion of service. As a consequence, it is unclear what functionality should be implemented as a service.

The function of the specification of a service is to give all stakeholders the information about the service they need, e.g., for service discovering, selection, and usage. Solely by specifying the input and output aspects of a service, as is the current practice, the service consumer does not get sufficient information to determine whether the service fits his needs. These specification aspects only reflect part of the total externally visible behavior of a service. This often leads to a serious mismatch between the provider's intent and the consumer's expectations concerning the functionality of the corresponding service.

IV. Proposed framework

In an Enterprise there are several services available to specify the appropriate functionality and behavior these services a generic service discovery framework is proposed for an enterprise using ontology. It represents complete and clear notion of service.

In Universal Discovery Description Integration (UDDI) where the services are described, there is no mechanism to store ontology. Hence a generic ontology is introduced where various services are described. Ontology is an explicit shared specification of various conceptualizations in a particular domain. It plays a vital role in the semantic web and tries to capture the semantics of a domain by deploying knowledge representation primitives, enabling a machine to understand the relationships between concepts in a domain. On the other hand, registries stores meta-data.

OWL-S is an Ontology web language for services, which supplies web service providers with a core set of markup language, constructs for describing the properties, and capabilities of their web services in unambiguous and computer interoperable form [11]. An OWL-S description is composed of three parts which are Service Profile, Service Model, and Service Groundling. The Service profile describes service capabilities and it is the part used in the discovery process. The Service Model describes how the service works (internal process), and the Service Grounding specifies the details of how the service can be accessed [12].

Initially the service providers advertise the services in the service registry. The registry serves as the services repository for service advertisements, against which the service request queries are matched. When service registration is done the service requesting API parses the Ontology Web Language Service (OWL-S) descriptions and converts the OWL ontology into a set of facts which is stored as triples (i.e., <Subject, Predicate, Object>) in the knowledge base.

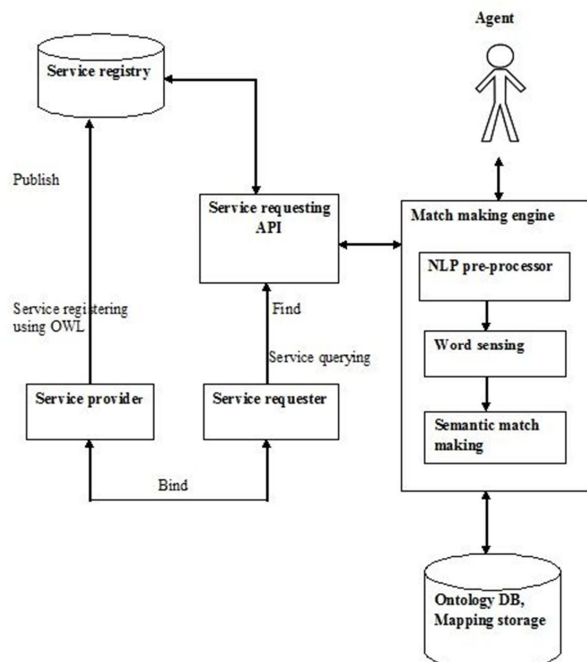


Figure2: Ontology based service discovery using agent

The queries requested by the service requester are searched in registry. If the services are available in the registry it is provided to the requester. As shown in Fig2. If the requested services are not available in the registry, then the semantic meaning of the service is obtained using semantic web. Based on the meaning of the service an appropriate service which is related to the query is provided to the service requester by knowledge based agent. Thus a clear notion of service is provided to the user and avoids mismatch between the provider’s intent and consumer’s expectation related to the functionality of the services.

IV.1 Ontology based service discovery

Module 1: Requesting for services

The service requestors also known as end users request for a particular service and search in the registry for the availability of particular service. The server that processes the request is acknowledged to the requestor. Now the location of web service is known but how to invoke a service is unknown. For instance, consider a method to invoke weather forecast in India. The method is “string getCityForecast(int CityPostalCode)”. It can also be specified as “string getINDCityWeather(string cityName, bool isFahrenheit)”. The server will respond to requestor in WSDL whereas the actual invocation is done in SOAP language as in Fig3. A *SOAP request* for weather forecast of certain city is requested. The server will respond to the requestor by *SOAP response* which includes the forecast. If the requested service is not available then service discovery mechanism using ontology is used.

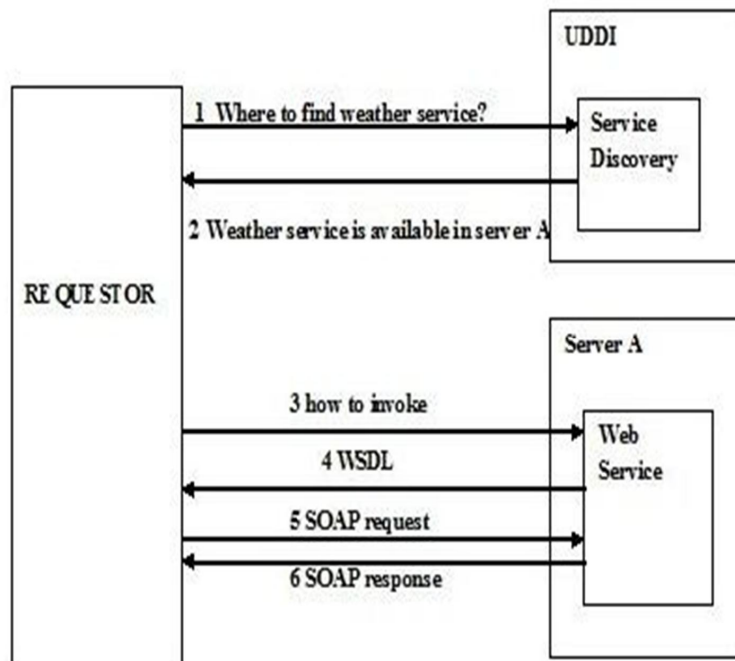


Figure3: Invoking a Service



Module 2: Publishing services in Registry

The service providers are the servers who make the availability of services in the registry which can be provided by them to the end users. The services are published in the registry using WSDL along with the description and documentation of the service.

Step 1: A service is specified and a key for the service is given to find the web service in the registry.

Step 2: For authentication of service user name and password is given.

Step 3: Details about the system that provides the service is entered.

Step 4: Select the service state and classify the service.

Module 3: Matchmaking engine

The match making engine is used to extract the meaning of the service queried by the requestor and map it with the description of services offered in the registry. The matchmaking engine includes the following

NLP Preprocessor

Natural Language Processing is a field of computer science and linguistics concerned with the interactions between computer and human (natural) languages. Some techniques in NLP processor are

- Splitting of word by parsing concatenated text to infer where word break occurs.
- Using stemming algorithm reduce the words to the root word. For example words like connections, connective, connected and connecting are reduced to the root word connect
- Identifying the parts of speech such as nouns, verbs, adjectives and adverbs.

Word Sensing

The context of words received from the pre-processor results in a set of sense each representing single meaning of the words. This process involves two steps:

- To determine different senses for each word.
- Assigning each occurrence of the word to their appropriate sense.

Semantic matchmaking

In semantic matchmaking, assume that both, advertisement (published service) and query are defined in OWL-S format then an advertisement Adv_t and query Query match if [14],

1. For every input parameter in Adv_t, there is one input parameter in Query. Let Query_{in} and Adv_{t, in} represent the list of input concepts of query and the advertisement respectively. The service can correctly perform the task if all the input concepts defined in the advertisement are satisfied by the requester. Hence, matching of inputs exists if

$$\forall c \in \text{Adv}_{t, in}, \exists d \in \text{Query}_{in},$$

$$s, t, \text{match}(c, d) \neq \text{Fail}$$



2. For every output parameter in Query, there is one output parameter in Advt. Let $Query_{out}$ and $Advt_{out}$ represent the list of output concepts of query and the advertisement respectively. The service can be used by the requester if all the output concepts defined in the query are satisfied by the advertisement. Hence, matching of outputs exist if

$$\forall c \in Query_{out}, \exists d \in Advt_{out},$$

$$s,t,match(c,d) \neq Fail$$

3. For every precondition in Advt, there is one precondition in Query. Let $Query_{precond}$ and $Advt_{precond}$ represent the list of preconditions of query and the advertisement respectively. The service can correctly perform the task if all the preconditions defined in the advertisement are satisfied by the requester. Hence, matching of preconditions exist if

$$\forall c \in Advt_{precond}, \exists d \in Query_{precond},$$

$$s,t,match(c,d) \neq Fail$$

4. For every effect in Query, there is one effect in Advt. let $Query_{effect}$ and $Advt_{effect}$ represent the list of effects of query and the advertisement respectively. The service can be used by the requester if all the effects defined in the query are satisfied by the advertisement. Hence, matching of effects exist if

$$\forall c \in Query_{effect}, \exists d \in Advt_{effect},$$

$$s,t,match(c,d) \neq Fail$$

Module 4: Mapping ontology with registry

The literal meaning of the query is obtained by the matchmaking engine and is mapped with the service that has similar functionality in the registry using ontology.

Algorithm: If $outR$ represents output of the requested service R , and $outA$ represents output of the published service A , then the degree of web services matching between services output can be calculated as follows:

degreeofMatch($outR$, $outA$) {

if $outA = outR$ then return exact

if $outR$ subclassof $outA$ then return exact

if $outA$ subsumes $outR$ then return subsumes

else return fail

}

The degree of web services matching between services input can be calculated as same as output. It is not difficult to find that if $outR$ is equivalent to $outA$, or $outR$ is the subclass of $outA$, that is to say content of published service output is equal to or more than the requested service, then the degree of matching is exact; if $outA$ includes $outR$, it is to say content of published service output include the requested service, and there is no inherited relation between them, then the degree of matching is plugIn; if $outR$ includes $outA$, it is to say content of requested service



output include the published service, then the degree of matching is subsumes; in addition, the degree of matching is fail [15].

Module 5: Service Discovery using agent

A knowledge based agent is used in the service discovery framework to provide an appropriate service using ontology for an enterprise where there are lots of services available. Using a knowledge based agent improves the efficiency of discovering the services that are requested.

V. Conclusion and future work

This paper has proposed an Ontology based service discovery framework for an enterprise for an efficient way of discovering the services requested. A generic Ontology is constructed that contains various concepts defined for a particular domain. It facilitates service discovery by semantic matchmaking process with the help of a knowledge base agent which provides appropriate services to the requester. In future work an Enterprise Ontology is needed so that the services can be predefined and the provider need not register or publish each and every service one by one and also more importance must be given to the specification of each service.

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Authors' Biography



N. Arunachalam received the B.Tech degree in Computer Science from Sri Manakula Vinayagar Engineering College in 2006 and M.Tech degree in DCS from Pondicherry Engineering College in 2009. He is working as a Lecturer of department of Information Technology in Sri Manakula Vinayagar Engineering College for the past three years since June 2009. He published "**A Centralized Multi- Agent Architecture for an Intelligent Tutoring System,**" *International conference on Sensors, Security, Software and Intelligent System (ISSIS 2009)*. "**An Ontology Based web service architecture for agricultural product supply chain information sharing system**", *International Conference on recent advances in e – Communication and I – Technology (REACT – 10)*. "**Embedding Agents in**

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R. Swarnalakshmi pursuing final year in the degree of Bachelor of Technology in the stream of Information Technology from Sri Manakula Vinayagar Engineering College of Pondicherry University [2010-2014]. She has an interest in Service Oriented Architecture and Service Discovery.



R. Sangeetha pursuing final year the degree of Bachelor of Technology in the stream of Information Technology from Sri Manakula Vinayagar Engineering College of Pondicherry University [2010-2014]. She is interested in Enterprise Ontology and Service Innovation.



B. Pradheepa pursuing final year in the degree of Bachelor of Technology in the stream of Information Technology from Sri Manakula Vinayagar Engineering College of Pondicherry University [2010-2014]. She is interested to work on Semantic Web and Service Engineering.