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A Comparative Study on Semantic Web Service Discovery Approaches

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***Abstract*— Nowadays web services play an important role in pervasive computing. Web services are loosely coupled, interoperable and standard based software entities. Semantic web services are keen in providing dynamism and automation to the existing web services environment. Discovering most suitable web service for a given domain is crucial and time boundary matters. Traditional web service discovery methods were keyword based where users needed to select desired web service manually. Semantic web services are automated services where sites exchange information dynamically based on demand and user does not have any role in selecting a particular web service. In this paper, we present an overview of different existing semantic web service discovery methods. We also summarize, in nutshell, their key features and limitations in a tabulated form.**

***Keywords*— Semantic Web Services, Pervasive Computing, Web Service Discovery.**

I. Introduction

Web services are language agonistic, self contained software entities used for dynamic communication between electronic machines over internet [12]. Moreover, they are XML based interfaces for communication. The primary advantage of Web services is its capability to create applications through the use of loosely coupled, reusable software components. It has the fundamental suggestion in both technologies and business applications. The software can be paid and redelivered for as flowing streams of favour as conflicting to packaged products. To accomplish automatic and dynamic interoperability is possible between systems to achieve business tasks. The business administration's could be completely decentralized and flowed over the Internet and got to by an extensive variety of specialized gadgets. Organizations could be free from the trouble of lavish, low and complex programming combination and center as an option on the estimation of their offerings and mission basic errands. Then, the Internet will become a global common platform where organizations and individuals communicate with each other to carry out various commercial activities and to provide value-added services. The dynamic enterprises and dynamic value chains develop into achievable and may be even compulsory for competitive advantages [1].

This paper is organized as follows: section II gives a brief about web service discovery process. Section III describes seven different service discovery approaches and present key features and limitations in a tabular form. We conclude the paper in section 4.

II Web Service Discovery

A web service discovery process is carried out in three major steps. First step is advertisement of web service by developers. Providers advertise web services in public repositories by registering their web services using web service description file written in WSDL [3]. Second step is web service request by user. User sends web service request specifying the requirement in predefined format to web service repository. Web service matcher which is core part of web service discovery model, matches user request with available web services and finds a set of web service candidates. Final step is selection and invocation of one of the retrieved web services. Discovery of correct web service depends on how mature web service matching process is. i.e. how actual requirements of user are represented in formalized way and how they are matched with available services. Following figure-1 describes the process of web service discovery.

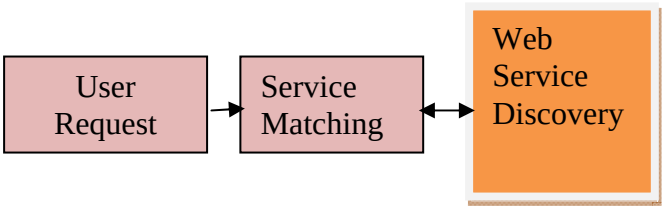

Figure 1: Web Service Discovery Process

III Survey Of Semantic Discovery Of Web Service Methods

3.1 Discovery of Context aware web service

Information can be ambiguous and unambiguous which may influence the user's web service demand generation. According to this method [5], Context is divided into two classifications. They are Unambiguous and ambiguous. Unambiguous context is openly provided by the user through the process of matchmaking like question and answer details. Ambiguous context is composed of either automated or semi automated approach. Ambiguous context is further appropriate to discovery of

web service because the user is never openly necessitated. The context awareness will be separated into four classifications rely on how context is composed. They are usage history oriented context, personal profile oriented context, and process oriented context and other context. Under circumstances in which a particular web service is not enough to complete the user request, composition of various web services can be carried out. Here in this case, context should be built allowing for composite discovery of web service procedure. This proceeds towards the improved conventional keyword matching.

3.2 Publish Subscribe Model

This model was proposed by Falak Nawz, Kamram Quadir and H.Farooq Ahmad [6]. A semantic is found in web service matching and it is used here. Service descriptions are matched using OWL-Sand concept matching. Depending on the scores, Web services are ranked. The system is divided into two phases. They are subscription phase and notification phase. When a user contributes, the contribution details along with the user's location and web service requirements are stored in contribution of knowledge support. These details are stored in the knowledge base in OWL format can be used later for service matching. The preeminent matching web service is determined by matching user requirements to OWL-S representation stored in the registry. Matching is possible in one of the six levels as Exact, Plug-In, Subsume, Enclosure, Unknown and Fail.

3.3 Layer based semantic discovery of web service

Guo Wen-yue, Qu Hai-cheng and Chen Hong [7] have suggested a Layer based approach for semantic web service discovery. By this method, search is divided into three layers by applying filters at each layer. Applying filters reduces the search area. The three layers for service matching are service category matching, service functionality matching and quality of service matching. Semantic web service discovery is done based on OWL-S. Service functionality matching degree is calculated in the service functionality matching layer. The attributes - hasInput, hasOutput, hasPrecondition and hasResult are matched against the user service request. QoS is decided based on the response time and reliability of the service discovery system.

3.4 Service advertisements in MANETs (SAM): service discovery in heterogeneous networks

A method was proposed by F. Johnsen, T. Hafsoe, A. Eggen, C. Griwodz and P. Halvorsen [8] for web services discovery in hetrogeneous networks. Service discovery gateways are used so that the different networks can continue to use different protocols. A gateway periodically queries all services in the WS-Directory. Available services are then looked up in the gateway's local service cache. If a service is deleted from a domain, it is removed from the local cache.

3.5 Agent based discovery considering QoS

Rajendran and P. Balasubramanie suggested a web service discovery method based on QoS parameters [9]. These parameters are response time, availability, throughput and time. This contains an agent for ranking the various web services available based on the QoS certificates received from service publishers. Two main entities in the proposed method are verifier and certifier. The service publisher component is accountable for the registration, updation and deletion of web service information in UDDI. Service publisher is supplied by the service providers with QoS values related to business and performance of web services. Verification and certification of these QoS values is then done by web service discovery agent.

3.6 Service request expansion

A. Paliwal, N. Adam and C. Bornhovd [10] suggested a method where they expand service requests by combining ontologies and latent semantic indexing. In this method, they build the request vector and training set of the LSI by combining service request and latent semantic indexing. This method utilizes the cosine measure to determine similarities and to retrieve relevant WSDL service descriptions. Ontology linking is done using semi automated approach. It is done by mapping domain ontologies to upper merged and mid-level ontologies. Service request is expanded by acquiring associated concepts related to initial service request with semantic matching and assembling of concepts and enhanced service request is achieved.

3.7 Structural case based reasoning

Georgios Meditskos and Nick Bassiliades[11] describe semantic web service discovery framework using OWL-S. They proposed a web service matchmaking algorithm which extends object-based matching techniques used in Structural Case-based Reasoning. It allows retrieval of web services not only based on subsumption relationships, but also using the structural information of OWL ontologies. Structural case based reasoning done on web service profiles provide classification of web services, which allows domain dependent discovery. Service matchmaking is performed on Profile instances which are represented as objects considering domain ontologies.

Web service discovery is done by measuring similarity at three levels as taxonomical similarity, functional similarity and non-functional similarity. Four hierarchical filters for matching are defined as exact, plug-in, subsume and sibling. Functional similarity is calculated based on input and output similarity (signature matching) of advertisement and query. Non-functional similarity is measured by directly comparing values of data types and objects.

The following table gives an appraisal based analysis of existing semantic web service discovery methods discussed above along with their key features and limitations.

Table 1: A Comparative study on existing semantic web service discovery methods

S.No.	Name of the Technique	Key Features	Limitations
1	Layer based semantic web discovery	i) In this approach, there are three layers for service matching such as service category matching, service functionality matching and quality of service matching. ii) Semantic web service discovery is done based on OWL-S, using Service Profile documents for service matching. iii) Quality of service is decided based on response time of service discovery and reliability of service discovery system.	• Complexity is involved in calculating the matching degree at each layer.
2	Service request Expansion	i) This approach expands service requests by combining ontologies and latent semantic indexing. ii) It builds the service request vector according to the domain ontology, build the training set of the LSI classifier by extracting features from selected WSDL files, and then project the description vectors and the request vector. LSI includes Singular Value Decomposition (SVD). iii) By using cosine measure similarities are found and linking of ontology is done by semi automated approaches. iv) Service request is expanded by acquiring associated concepts related to initial service request with semantic matching and assembling of concepts and enhanced service request is achieved.	• The cost of computing LSI and string SVD is high.
3	Context aware web service discovery	i) As format for sending user information is fixed, it is lost when we want to convert into formalized one. This can be avoided by this technique. ii) It is useful for request optimization, result optimization, personalization and superior than keyword matching techniques. iii) Context is any information that influence users web service request and there are two types of context, namely, Explicit and Implicit. iv) Explicit context is directly provided by the users during matchmaking process and the implicit context is automatic or semi automatic and not directly provided by the user. v) According to context collected it further divided into profile oriented context, usage history oriented context, process oriented context and other context.[18]	• It makes system architecture more complicated when new attributes and constraints are introduced. • It expects the user to provide information related to suitable services.
4	Publish Subscribe Model	i) Service request is provided with notifications prior to discovery. ii) It adapts Semantic based web service matching technique and by using concept matching it rank the services. At applies Ranking, six levels of matching as Exact, Plug-in, subsume, enclosure, unknown and fail. iii) Information is used from the knowledge base and matching is performed. iv) Time required for web service discovery is minimized with this approach as search area is reduced to specific category.	• It adds overhead in developing and maintains new components in system architecture. • Information in knowledge base is stored only in OWL format.
5	Service discovery in Heterogeneous networks	i) This is also called as Service Advertisements in MANETs (SAM), a fully decentralized application-level solution for web services discovery. ii) This approach tries to provide a web service discovery solution which can fulfill the requirements in military networks. iii) As same protocol cannot be used in heterogeneous networks, they suggest using of service discovery gateways, so that each network domain can employ the most suitable protocol.	• Service is removed from the local cache if it deleted from its domain. • Synchronization between the services available in the domain and the local cache is a difficult task.
6	Agent based discovery considering QoS	i) This method contains separate agent for ranking web services based on QoS certificates achieved from service publishers. ii) By using Qos parameters such as response time, availability, throughput and time, one can select best service among multiple services. iii) Time required for selecting web service with best QoS values eventually decreases.	• In Real time situations, there are also other QoS parameters such as reliability, efficiency, security, robustness, accuracy etc. They are not considered in this framework.
7	Structural case based reasoning	i) It presents a web service matchmaking algorithm which extends object-based matching techniques used in Structural Case-based Reasoning. ii) Service matchmaking is performed on Profile instances which are represented as objects considering domain ontologies. iii) Web service discovery is done by measuring similarity at three levels as taxonomical similarity, functional similarity and non-functional similarity.	• This method Performs only domain dependant discovery.

IV CONCLUSION

Traditional web service discovery methods makes manual selection of suitable web services from the existing list of web services. This leads to time consuming and in-depth processing. In this paper we have focused on different semantic web service discovery methods, their key features and limitations. Most of the approaches differ in the way the web service matching is carried out. For example, Layered Based Semantic Web Discovery approach divides the search into three layers by applying filters to discover the accurate service. Service Advertisements in MANETs uses gateways for interoperability among heterogeneous networks. Agent Based Discovery considers QoS parameters to discover the best service among available services. From the analysis of above semantic web service discovery approaches, it is found that key issues of semantic web service discovery approaches such as dynamism, negotiation, context-awareness, security, privacy, trust, QoS attributes etc. should be addressed to strengthen this field.

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