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Ranking Web-services Based on QoS for Best-fit Search

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ABSTRACT

While creating web applications using web service technology, there is a need for selecting a web service which best suits the need of application. As the number of web services available over the web has increased, the service consumers are always offered large number of services performing similar functionality. There is the need of sophisticated mechanism for quantifying these web-services based on Quality of Service (QoS). In order to find the best fit web-service in response to the service discovery request, the consumer needs to know quantized QoS ranking and the reliability of this ranking. The Current UDDI registries do not provide a method for service providers to publish the QoS information of their services. In this paper, we propose a model to facilitate web service usage monitoring, evaluating QoS of web service depending on consumer feedback, ranking qualified web services and publishing this quantized ranking in UDDI registries. This ranking will help selecting the best-fit web service according to service consumer requirement.

Keywords: Web Services, Quality of Web Service, UDDI Registry, WSDL, QoS, SOAP, XML, HTTP, WSAF, DAML-S, DAML-QoS

1. INTRODUCTION

Web services are application components that communicate using open protocol such as HyperText Transfer Protocol (HTTP), Extensible Markup Language (XML) and Simple Object Access Protocol (SOAP). They are designed to support interoperable machine-to-machine interaction over a network.[15]

Current Web services architecture consists of 3 roles: Web service provider, Web service consumer and UDDI (Universal Description, Discovery and Integration) registry. The current UDDI registries only support Web services discovery based on the functional aspects of services[12].

However, service consumers are interested in not only the functionalities of web services, but also their quality of service (QoS) which are non-functional attributes (e.g. response time, availability etc.) that may have impact on the quality of service provided by Web services.[7][12][14] If there are multiple web services providing the same functionality in UDDI registries the QoS ranking specified can be used to refine the search. If the QoS claims made by service providers are trustworthy, the service selection is simple, either the service with lowest response time and highest availability is selected. But the problem is that the services provider may publish inaccurate QoS information to attract more customers, or the published QoS information may be out of date. To resolve this problem, it should be allowed to rate the QoS of the web service selected by the consumers and the aggregation of these service ratings over a specific period of time should be taken into consideration in ranking process of web services so that the probability of finding the best service for a customer can be increased.

2. RELATED WORK

Many researchers work on how to take QoS information for Web services into consideration in the service discovery process to find services that best meet a customer's requirements.

Ran [12] proposes a model in which the service discovery model is extended with a new role called a Certifier, in addition to the existing three roles of Service Provider, Service Consumer and UDDI Registry. The Certifier verifies the advertised QoS of a Web service before its registration. The consumer can also verify the advertised QoS with the Certifier before binding to a Web service. This system can prevent service providers from publishing invalid QoS claims during the registration phase, and help consumers to verify the QoS claims to assure satisfactory transactions with the service providers.

Gouscos et al. [2] propose a simple approach to dynamic Web services discovery that models Web service management attributes such as QoS and price, and discuss how this information can be accommodated within basic specification standards such as WSDL and exploited within the Web service deployment and application life-cycle.

Maximilien and Singh [9] propose an agent framework and ontology for dynamic Web services selection. Service quality can be determined collaboratively by participating service consumers and agents via the agent framework. Service-based software applications are dynamically configured by agents. QoS data about different services are collected from agents, aggregated, and then shared by agents. This agent-based framework is implemented in the Web Services Agent Framework (WSAF).

Zhou et al. [g] propose a DAML-QoS ontology as a complement for the DAML-S ontology to provide a better QoS metrics model. QoS requirements and various constraints can be specified explicitly and precisely using this novel ontology.

Majithia et al. [6] propose a framework for reputation-based semantic service discovery. Ratings of services in different contexts, which either refers to particular application domains, or particular types of users, are collected from service consumers by a reputation management system. A weight is attached to each particular context. The weight of each context reflects its importance to a particular set of users.

Wishart et al. [16] present SuperstringRep, a new protocol for service reputation. This protocol uses service reputation scores that reflect the overall quality of service in order to rank the services found in the discovery process. An aging factor for the reputation score is applied to each of the ratings for a service, thus newer ratings are more significant than older ones.

Maximilien and Singh [8] propose a model of service reputation and endorsement. The reputation of a service is the aggregation of the ratings of the service by service consumers based on historic transaction records. New services that have no historical data can be endorsed by trustworthy service providers or consumers even before their reputation is established. No details are provided as to how the reputation score of a service is computed based on the consumers' ratings and endorsements.

Maximilien and Singh [10] also propose a multi-agent approach of service selection based on user preferences and policies. A matching algorithm is presented to match consumer policies to advertised provider service policies. Although reputation for the QoS is mentioned in the algorithm, no details regarding how the reputation affects the service selection process are provided.

Major efforts in this area include Web Services Level Agreements (WSLA) [3][4][5] by IBM, Web Services Policy Framework (WS-Policy) by BEA, IBM and SAP, and the DARPA Agent Markup Language (DAML) Program. These efforts have considerable industrial support. Most of these efforts represent a complex framework focusing not only on QoS specifications, but on a more complete set of aspects relating to Web services.

In the current Web Services architecture, the UDDI registry stores descriptions about Web services in a common XML format and functions like a "yellow pages" for Web Services. However, the UDDI registry does not include QoS information. This information can be added to the UDDI, but the challenge of how to express and match the provider's QoS advertisements and the consumer's QoS requirements remains.

3. OUR APPROACH

Web service provider provides the QoS initially at the time of service registration. Service consumers rate the services after its usage. The web-service ranking will be the aggregate of initial QoS information provided by web service provider stored using *tModels* in a UDDI registry in XML format and the feedback ratings by the service consumers. The initial QoS information and feedback ratings can be averaged to derive the ranking for the web service to be published. Using this QoS ranking selection of appropriate web service in business-to-business interactions can greatly benefit.

A. The UDDI Registry

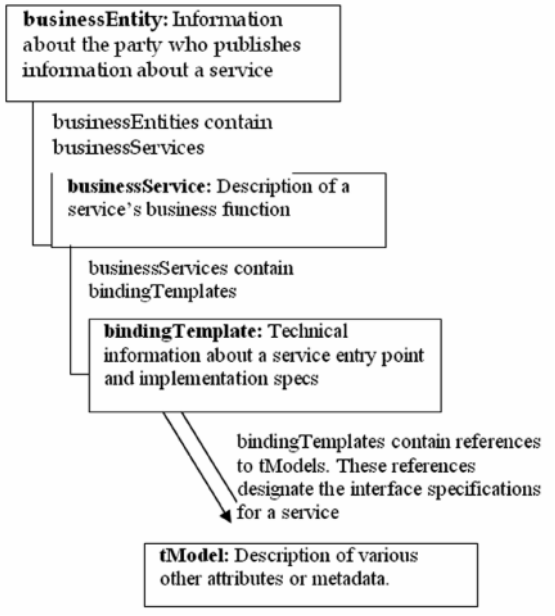

Fig. 1 : UDDI Core Data Structures

A UDDI registry is a directory for storing information about web services. The information about web services in a UDDI registry includes a description of the business and organizations that provide the services, a description of a service's business function, and a description of the technical interfaces to access and manage those services.[13] A UDDI registry consists of instances of four core data structures including the *businessEntity*, the

businessService, the *bindingTemplate* and the *tModel*. The four core structures and their relationships are shown in following Figure 1. This information comprises everything a user needs to know to use a particular web service.

B. QoS information

Quality of Service, or QoS, is "a combination of several qualities or properties of a service"[11]. It is a set of non-functional attributes that may influence the quality of the service provided by a Web service[14]. Some QoS parameters are given below:

Availability is the probability that system is up and can respond to consumer requests.

Reliability is the ability of a service to perform its required functions under stated condition for a specific period of time.

Performance is the measure of the speed to complete a service request. It is measured by latency, throughput and response time.

Cost is the measure of the cost of requesting a service.

C. Storage of QoS in UDDI Registry

In UDDI registry, the *tModel* is used to store published QoS information of Web Services. When a service provider publishes a service in a UDDI registry, a *tModel* is generated to represent the QoS information of the service. It is then registered with the UDDI registry and associated to the service deployment. Whenever the provider needs to update the QoS information of the service, it retrieves the registered *tModel* from the UDDI registry, updates its content and saves it with the same *tModel* key.

```
<tModel
tModelKey="HKBC.com:CreditValidateS ervice: Primary
Binding:QoSInformation">
<name> </name>
<overviewDoc>
<overviewURL>
 http://<URL describing schema of QoS attributes>
<overviewURL>
</overviewDoc>
<categoryBag>
<keyedReference
 tModelKey="uddi:uddi.org:QoS:Price"
 keyName="Price Per Transaction"
 tModelKey="0.05" />
<keyedReference
 tModelKey="uddi:uddi.org:QoS:ResponseTime"
 keyName="Average ResponseTime"
 tModelKey="0.05" />
<keyedReference
 tModelKey="uddi:uddi.org:QoS:Availability"
 keyName="Availability"
 tModelKey="99" />
</categoryBag>
   </tModel>
```

Fig. 2 : The *tModel* with QoS Information

For example, a company publishes its Credit Validation service in a UDDI registry with the following QoS information:

The company creates and registers a *tModel* that contains the QoS information for this service before publishing the service with the UDDI registry. To update QoS information, the service provider searches the UDDI registry to find the *tModel* that contains QoS information for the service it published before, updates the QoS information in the *tModel* and then saves the tModel with the same tModelKey assigned previously for the tModel.

4. PROPOSED ARCHITECTURE

Web service providers register their web services in UDDI registry. In the proposed model Web service providers while registering their web services with Web Service Broker will provide QoS information. A service consumer sends a service discovery request to the Web Service Broker, which then contacts the UDDI registry to find services that meet the customer's requirements. If services are found to match both the functional and QoS requirements and ratings requirements have also been specified, then the Web Service Broker ranks the services based on consumer's QoS and ratings requirements. Service consumer then selects the web service with the highest rank.

Web service consumer uses the web service broker interface to discover web services. In response to their requests along with the result, the web service consumer can also view the QoS rank associated with each response and then select the most appropriate web service from the available result.

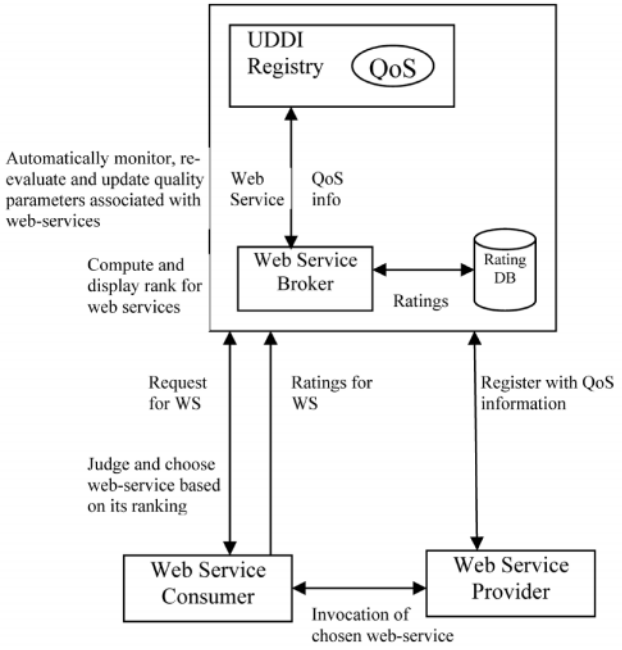

Fig. 3: Architecture of Proposed Model for Web Service Discovery with QoS

5. ALGORITHM FOR WEB SERVICE MATCHING, RANKING AND SELECTION

Figure 4 shows the high level algorithm for service matching, ranking and selection which is to be implemented by Web Service Broker.

funMatch returns a set of services meeting the functional requirements.

qosMatch returns the services that meet the QoS requirements.

ratingMatch returns the set services whose ratings are equal and above than rating requirements, from those returned by method qosMatch and sort them in descending order.

qosRank computes the QoS ranks for those services returned by method qosMatch and sort them in descending order of QoS rank.

selectService returns a set of services depending upon the maximum number of services to be returned in response to the discovery request.

```
/* Algoritm for web service matching, ranking and selection */
discoverServices(funReq, qosReq, ratingReq, maxServices)
{
//discover services meeting the functional requirements
funMatches = funMatch(funReq);
if QoS requirements specified
qosMatches = qosMatch(funMatches, qosReq);
else
return selectService(funMatches, maxServices, "byRandom");
if Rating requirements specified
Matches = ratingMatch(qosMatches, qosReq, ratingReq);
return selectService(Matches, maxServices, "byQoS&Rating");
else
Matches = qosRank(qosMatches, qosReq);
return selectService(qosMatches, maxServices, "byQoS");
}
```

Fig. 4: High Level Algorithm for Service Matching, Ranking and Selection

6. CONCLUSION

In this paper, we have proposed a model for Web Service Discovery based on QoS and a high level algorithm for matching, ranking and selection of services should be implemented by the Web Service Broker. We are using tModels, a recent feature in the UDDI registry for storing QoS information of web services. QoS information published by service provider at the time of service registration and can be updated by them at any time. Depending on the service requirements, QoS requirements (optional), ratings requirements (optional) specified by the service consumer, Web Service Broker respond with the set of services meeting corresponding requirements. As part of the future work, we propose to work on accountability of those providing ratings as we have assumed here that the service ratings are all trustworthy.

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