Egalitarian based Negotiation model for QoS based Web Service Selection

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***Abstract*— In service oriented computing, services are the basic constructs that aims to facilitate building of business application in a more flexible and interoperable manner for enterprise collaboration. To satisfy the needs of clients and to adapt to the changing needs, service composition is performed in order to compose the various capabilities of available services. With the proliferation of services offering similar functionalities around the web, the task of service selection for service composition is complicated. Therefore, it is vital to provide service consumers with facilities for selecting required web services according to their non-functional qualities (QoS) or characteristics. To resolve the conflicts or divergent view of service consumers and service providers on quality of service for web service selection, we propose an egalitarian based negotiation model that aims to select a required service for service consumers by achieving the egalitarian principle.**

Keywords- Service Selection, Web Service Negotiation, QoS based Service Selection

I. INTRODUCTION

Web services are the prominent technology for software application development and deployment based on the emerging Service Oriented Computing (SOC) paradigm. With technologies such as SOAP a simple XML-based lightweight protocol that to let applications exchange information over HTTP, WSDL an XML-based language for describing Web services and how to access them. UDDI is a repository for dynamic service publication and discovery. Web services offer a powerful mechanism for integrating existing software applications over the web, independent of programming language, execution platform or transport protocol. Web Services keep on emerging at an every increasing pace. As Web services increases, many businesses are providing similar services with overlapping functionalities. Therefore, it is very difficult for users to select an appropriate service among the sea of services. With recent advancement of Web 3.0 heading to semantic web, Web Service Selection (WSS) has caught attention recently. The functional specification and interfacing aspects of Web Services deals with the issues of service provisioning and service discovery. The issue of service selection is not addressed by the initial functional specification. Service discovery deals with the process of locating or discovering related service descriptions that describes a particular web service using the Web Service Description Language (WSDL). Whereas service selection deals with choosing a service implementation among the located services to satisfy the customer need. To make the process of service composition more appropriate service selection can be automated. Not only the automated system should produce an optimized composition, but it should also do so in an efficient manner. Efficient here means the non-functional quality of the services as specified by the user as their preferences. The QoS can represent the total time taken for a service to execute, the cost of a particular service or even the available security features and many others. Several attributes can be taken into consideration at once [2]. Depending on the user's need, several quality attributes might be of importance, such as cost, response time, availability, reliability, security, throughput, reputation and so forth. For emerging e-commerce business, the selected services are aggregated to form composite services. The composite service is a service produced by a composition of other services to complete the desired service activities [1]. For example, Google research application is accepted as a web service and it is integrated with other services, such as Gmail, AdWords, Picasa, Orkut, You Tube and Google Maps service, to provide an integrated environment for service consumers. The other example is a hotel booking application that can be exposed as a web service that is integrated with other services such as flight booking or car-rental in order to provide an integrated environment for service consumers. However, there exist large number of (hotel booking) services which provide similar functional characteristics. Consumers not only expect the service to meet functional aspects but they also require and demand good quality of services (QoS) such as service reliability, security, trust and execution cost, etc. It is therefore important to formulate techniques on selecting services based on non-functional properties which induce the researchers to provide QoS based service selection solutions [9]. Web Service Selection is also widely used in many applications such as e-learning and Digital libraries [10,13,14].We have formulated structural metrics for effective web service categorization [12] and we have also proposed an evaluation scheme and specification criteria for QoS based web- service selection techniques [11,15].

To address the issue of selecting web services based on quality of service, we have proposed negotiation models for achieving QoS and context aware web service selection schemes [21,23]. In this paper we have extended our previous work and proposed a negotiation model that achieves egalitarian principle among service consumer and service provider. Egalitarianism is a French word meaning equal, is defined as a political doctrine that holds that all people should be treated as equals and have the same political, economic, social, and civil rights or as a social philosophy advocating the removal of economic inequalities among people. To our context in the process of web service selection, a negotiation broker does the task of offering equal profit and benefits among the service participants. The negotiation broker implement various service selection policies and its selection decisions are based on information about the Quality of Services the customer posted and the QoS of the available services published by the service providers. To illustrate the process of the proposed system, we develop an online course selection prototype model which addresses the above said egalitarian principle. A number of mechanisms for web service selection have been carried in the literature. Simplest among them is the keyword based selection. This selection mechanism searches the exact match for a service request in the UDDI registry. The working principle is similar to searching for some information in search engines (eg. Google, yahoo). The search for “Apple iphone” in Google search engine retrieves nearly 47,200,000 results including Apple iphone stores, user reviews, games and other applications etc. The keyword based service selection process works exactly like this. The existing syntactic-based service selection technologies are insufficient for building a full-fledged composite service. However, this keyword search paradigm cannot always precisely locate Web services for the selection process. The limitations of using this mechanism in Web service is, retrieving irrelevant services to the consumers.

A number of techniques for overcoming these issues are proposed. The most common approach among this is ‘matchmaking’ technique. It is used in a situation where services with semantic descriptions for their functional attributes are needed. Several service matchmaking techniques have been developed to meet the needs of both consumers and providers. [4,26] addressed this issue of selecting web services by maximizing user satisfaction expressed as utility functions over QoS attributes[8,22] developed a goal oriented and interactive composition approach that uses matchmaking algorithms to help users filter and select services while building their composition service. In [3] functional semantics is taken into consideration thereby avoiding inappropriate results that does not satisfy the customer’s interest. They proposed a composition method that explicitly specifies and uses the functional semantics of web services based on domain ontology. Here the authors have defined the functional semantics of a service as describing what a service actually does. In [18] a hybrid semantic Web service selection of semantic services in SAWSDL based on logic based matching as well as text retrieval strategies are proposed.

Most of the existing techniques rely on syntactic descriptions of service interfaces to find web services with disregard to non-functional service parameters. K. Kritikos, et al,. [7] demonstrates how this situation generates major problems. To solve this issue, Web service descriptions are enhanced with annotations of ontological concepts, semantic matching and by considering non-functional properties. Several service selection techniques based on non-functional qualities are presented. In order to enable quality-driven web service selection, [25] proposed an open, fair, dynamic and secure framework to evaluate the QoS of a vast number of web services. The three key aspects they achieved are Extensible QoS model, Preference-oriented service ranking, fair and open QoS computation. In order to rank the web services, they prefer normalization. The purposes of normalization are: (1) to allow for a uniform measurement of service qualities independent of the units; (2) to provide a uniform index to represent the service qualities for each provider and to set the threshold values. The number of normalizations performed depends on how the quality criteria are grouped. Ping [20] proposed a QoS-aware service selection model based on fuzzy linear programming (FLP) technologies. In order to identify their dissimilarity on service alternatives, this assist service consumers in selecting most suitable services with consideration of their expectations and preferences. Optimal service selection based on a given set of service requests interacted with a set of service candidates using fuzzy linear programming (FLP) is presented in this model to overcome the issue of consensus on QoS between service provider and consumer.

Negotiation has long been recognized and studied in the academic research since 1950s. Negotiation has been studied in the various disciplines starting from social psychology to multi agent systems. With the growth of internet technologies, research has been showing interest on developing automated negotiation process. Web Service selection based on negotiation process has also been addressed by researchers in the literature. Michael Parkin ., et al., [19] proposed a specification for a domain independent, symmetrical, two-party negotiation protocol to reach binding agreements between services based on the principles of contract law. Marco Comuzzi., et al., [16] proposed an automated approach to web service QoS negotiation. The negotiation process is performed by a negotiation broker. The broker is notified the preferences on QoS attributes and negotiation strategies by service provider and consumer. Negotiation engine in this approach performs both semi-automated and fully automated negotiation scenario. In the first scenario it simulates the behavior of service provider according to its decision model. In fully automated scenario, the entire negotiation process is simulated without taking into consideration the other negotiation parties. Marco Comuzzi., et al., [17] also addresses the issue of coordination of different web service negotiations during web service selection. In our proposed work, we present a negotiation model for web service selection to achieve egalitarianism among service consumers and providers.

The rest of the paper is organized as follows: Section 2 illustrates the ontology of Quality of Services. In Section 3, the proposed negotiation model to achieve egalitarianism is described. Section 4 discusses the experimental results of the proposed model. Finally, Section 5 illustrates the conclusion and serves as a direction for future work.

II. ONTOLOGY OF QUALITY OF SERVICES

A. *Modelling QoS Characteristics*

To provide QoS aware service selection, modelling QoS characteristics of services is necessary. We use Web Service modelling Ontology (WSMO) for modelling QoS characteristics. WSMO with its associated language, the WSML (Web Service modelling Language) provides a formal syntax and semantics to describe the QoS characteristics of services. The WSMO defines four main elements as the main concepts of semantic Web service. This includes Ontologies, Web Services, Goals and Mediators. Ontologies are formal explicit specifications of a shared conceptualization [24]. They define a common agreed terminology by providing concepts and relationships between the concepts. Goals are descriptions of web services that satisfy the user's desires when conferring with a service in terms of functional specification, behaviour and quality of service. Web Services are description about services. The description consist of functional, non-functional and the behavioural aspects of web services. Mediators address the heterogeneity issues between different WSMO elements. The Web Service Modelling Language is a formal language for describing ontologies, goals, web services and mediators. It is based on logical formalisms of WSMO namely description logics, first – order logic, and logic programming [5].These formalisms are the basic point to describe the variants of WSML. The variants includes, WSML – Core, WSML – Flight, WSML – Rule, WSML – DL and WSML – Full. The current support for QoS modelling in WSMO is based on Dublin Core Metadata Initiative. DCMI is an open organization engaged in the development of interoperable metadata standards and provides a wide range of non functional properties. These non functional properties can be included with the descriptions of services. The non functional properties supported by WSMO for building and characterizing each element includes Contributor, Coverage, Creator, Date, Description, Format, Identifier, Language, Owner, Publisher, Relation, Rights, Source, Subject, Title, Type, Version [6]. Two types of non functional properties are supported by WSMO. (1) specifies the QoS characteristics which includes reliability, performance, security, reputation etc., which define the functional and behavioural aspects of services; (2) includes Coverage, Identifier etc., that are used to provide additional information about service identification but do not tell what a service can do and how it can do. The second category is called as QoS characteristics in general and collectively called as non functional properties as a whole. Using WSML, the simplest way of modelling is done by assigning a simple value to non functional properties of WSMO elements. The data value assigned to non- functional properties is used as an identifier during service publication. To specify QoS characteristics in particular it can be modelled separately with the use of building and defining QoS Ontology. Figure 1 depicts the QoS ontology with the assumed identifier value. W3C defines various QoS attributes such as performance, reliability, scalability, capacity, and so on. Here the Figure 1 covers ontology of characteristics such as interoperability, capacity, integrity, environment, performance, reliability, security, business and availability. When a new service is published, the value of QoS characteristics in service description is matched with the value assigned in QoS ontology. By this way, the newly published services are aligned. Upon receiving the request from the customer, the system extracts the required services and QoS characteristics specified and match with the QoS ontology to locate its appropriate match.

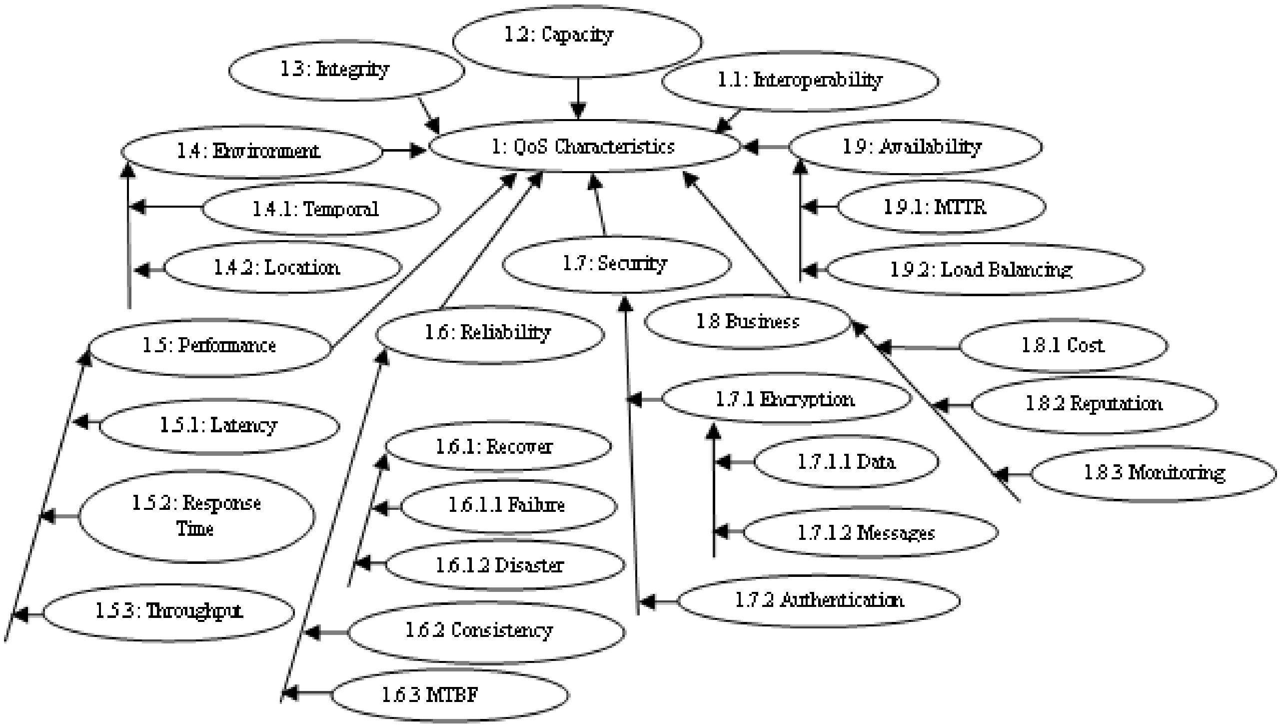

Figure 1: QoS Ontology with Assumed Identifier Value

B. *Service Selection Process*

The selection of most appropriate web services regarding QoS properties is an important factor in the field of web to ensure the satisfaction of the customer. The preferences on QoS characteristics may vary among different users participating in the selection process. For example, a user may concentrate or require service that is rich in response time while satisfying constraints in terms of reputation and cost. While another user may concentrate on getting the service that is rich in reputation characteristic than to the response time. Therefore, a QoS aware approach to service selection is needed which satisfies the preferences and constraints of the customer. Both static and dynamic process for web service selection is carried out in the literature. Static web service selection is based on information about behaviour of the system. It does not rely on the current state of the system at the time of decision making. Dynamic web service selection reacts to changes in the system state. Dynamic process is better to respond to system changes and avoid decision that result in poor performance. The disadvantage of this process is that, there involves communication overhead. Figure 2 portraits the involvement of various components for the process of web service selection. Service Discovery Engine is concerned with the detection of usable web services for a specific task. Service Selection Engine is where the actual selection process takes place. The services published by providers and ontologies are managed by the Service Registration Manager. One of the key tasks in the service selection on web is to locate the services that can fulfil the business or customer needs. This we call it as service discovery. Service discovery is the process from where the customers learn that there exist web services and where to find the XML Web service's description document. The Service Discovery Engine in the figure 2 consists of three main components namely QoS evaluator, Web Service specification matchmaker and Query processing manager. During service publication by service provider, the QoS evaluator evaluates the quality of services defined in the service specification. The service specification holds service id, service name, providers name, provider’s id, service description, QoS details etc. The quality of service described in the specification is evaluated by the QoS evaluator with the QoS ontology. Figure 4 depicts the graphical representation of QoS evaluation process. By this way, each services published by service provider is analysed. Query processing manager on the client side, performs the process of matching the client query with the domain ontology. . Domain ontology provides a conceptual structure of a problem domain that holds information collected and processed in a classified manner. Query processing manager identifies the services requested by service consumer or client from the query and does the task of matching it with the domain ontology. Figure 3 depicts example domain ontology of books.

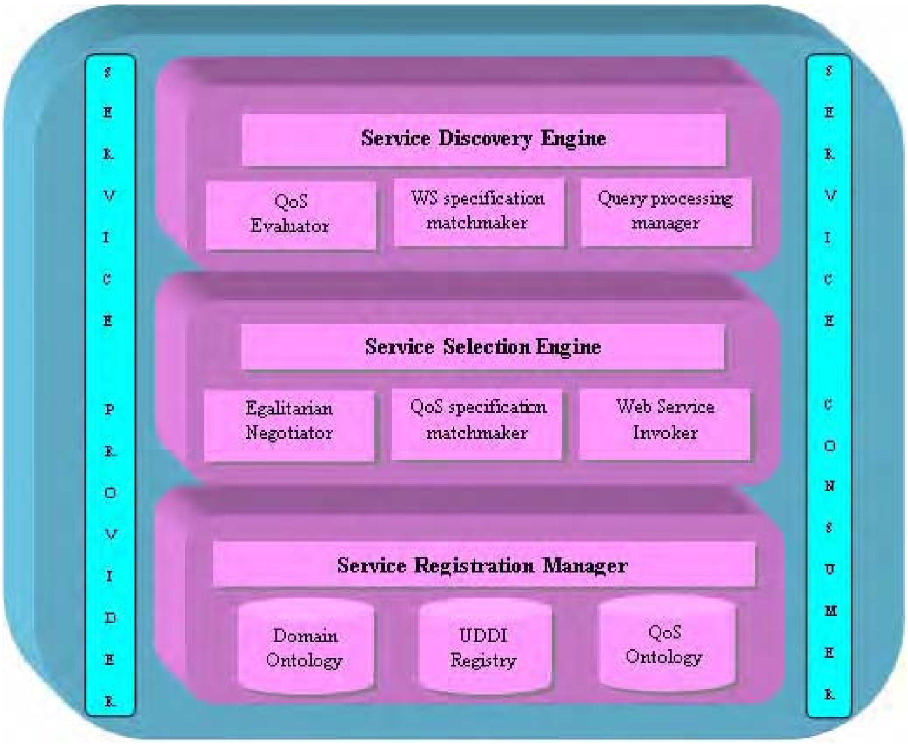

Figure 2: Service Selection Process

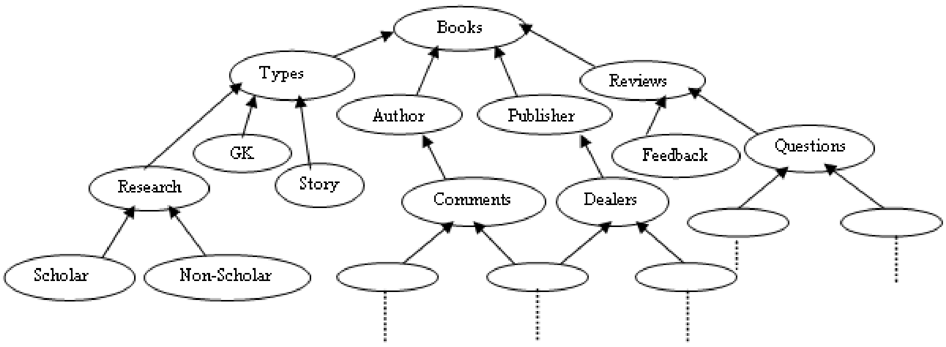

Figure 3: Domain Ontology for Books

The root node of this ontology is Books. The subclasses of root node include Types of books, Author details, Publishers and Reviews about the books. Each class has its corresponding properties. The class book holds properties namely number of pages, size of papers (height and width), ISSN number etc. The OWL (Ontology Web Language) specification of this domain ontology is used by Query Processing component to identify the service request from the consumer. With OWL specification, the semantic information embodied in the request can be identified and automatically processed.

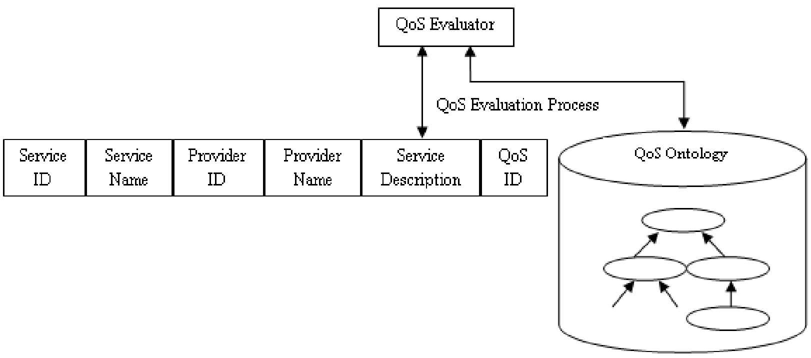

Figure 4: Graphical representation of QoS Evaluation Process

Web Service specification matchmaker does the task of locating related services after the QoS on provider side and Query processing on client are completed. Service Matchmaking finds the service that has the best match with the service request. Figure 5 portraits the graphical representation of query processing task. The task of how to specify the functionality of the services semantically and how to understand such semantic specifications and match services semantically are issues in matchmaking process. All these works in service discovery engine is again a complex task and each has to be carried out in a more intelligent way to locate the services. The processes discussed above are the preliminary factors for the service selection process.

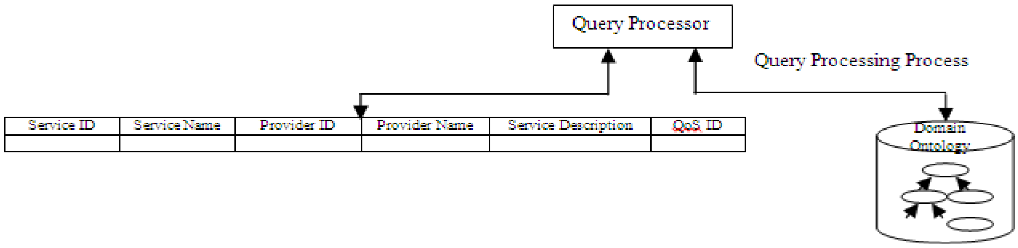

Figure 5: Graphical representation of Query Processing

III. PROPOSED NEGOTIATION MODEL

Negotiation process is classified based on the number of negotiating parties. Negotiation can be between two parties (bilateral) or between two or more parties (multilateral). The parties communicate using specific rules until they reach a common consensus or the conflicts on the value of different issues are resolved. Negotiation in case of Web Service Selection is bilateral, that is between the service consumer and the service provider. There involves many issues in the service selection process. Our aim is to reach consensus on QoS characteristics during the service selection between the service consumer and the service provider. To do so, we propose a negotiation model that also achieves egalitarian principle on the negotiating parties. The negotiation model in figure 5 illustrates how to select services that equally distribute the profit or benefits to service consumers and service providers. The proposed negotiation model comprises of three components namely policy manager, protocol analyser, decision support and a look up manager. Various negotiation protocols for web services have been presented in the literature [17,19]. In the proposed model, the protocol analyzer analyzes and controls the communication between consumer and the provider. It carries the information sent from both the parties and acts as a convener. For example, Send Request (SR) is used to request a service from the provider. QoS (QR) proposal is used to request for a particular quality of services from the provider. QoS (QA) approval is to accept the offer provided by the provider. Accept egalitarian (AE), requests for the acceptance of egalitarian strategy of services on both parties. Non - Acceptance egalitarian (NE), response to non acceptance of egalitarian strategy of services by any one or both the parties. Successful egalitarian (SE) to indicate that the both the parties accept egalitarian strategy and the termination of successful negotiation.

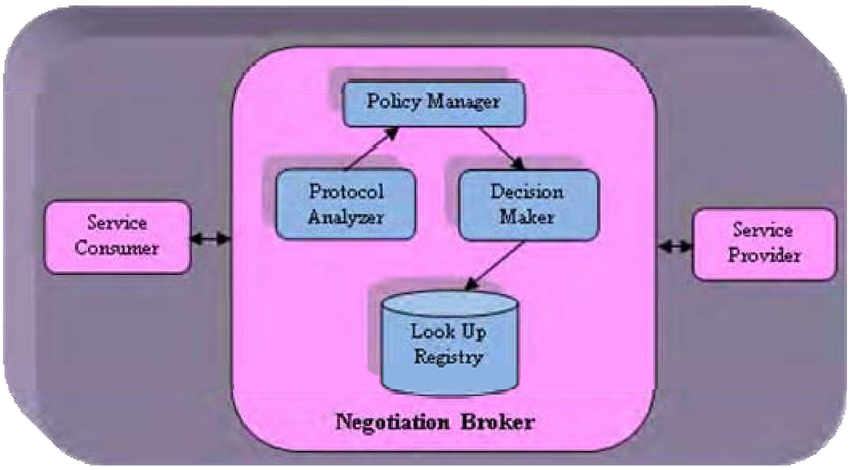

Figure 6: Egalitarian based Negotiation Model

The negotiation policy manager handles a set of governing rules and takes necessary action when certain conditions are met. For example, when strategy on QoS is not accepted by any of the parties, the negotiation manager generates an action and the values on certain QoS characteristics is maximized or minimized on the request to achieve the egalitarian principle. The negotiation policy manager by this way guides the Decision maker to take automatic decision on all issues corresponding to QoS of service selection process. Our model also keeps tracks of all kinds of negotiation history in a look – up component. This look up component helps the decision maker in taking decisions by making use of the previous negotiation history.

IV. EXPERIMENTAL SETUP AND RESULT ANALYSIS

A. *Distribution of Profits*

The definition of egalitarian principle in web service selection process for service consumer and service provider is defined as follows:

Definition 1: Profit in customer's point of view

The profit for service consumer is the quality of the service. That is, how effective and efficient the service is for building an application (takes into account both the functional and non-functional properties).

Definition 2: Profit in provider's point of view

The profit for the service provider is the amount or cost per service. That is, the cost of selling a service. The cost per service is assigned based on the effectiveness and efficiency of the service (taken into account both the functional and non-functional properties). Service trust is also considered to be the QoS parameter. Multiple QoS characteristics are involved in service selection process. Therefore, the profits of consumer and provider are quantified with numerical values in order to measure the degree of satisfaction. Let $w \in R$ be the multiple consumer (I) profits to be distributed consumer and provider (denoted i, j). We say $x \in R^d$ is an allocation, i.e., the distribution of profits among parties. x_i denote the profits attributed to party I under allocation x. Preferences of individual i are represented by utility function,

$$u_i: R^d \rightarrow R$$

A vector of utility functions, $\{u_i\}_{i=1...n}$ one for each individual, is denoted by u, and called a utility profile. The distribution of profits is defined as (w, u); x is said to be feasible allocation of profit distribution (w, u) if,

$$\Sigma ixi \leq w$$

A selection of service x' is said to achieve egalitarian principle for a profile u if, for all parties (service provider and service consumer) i, j

$$u_i(x') > u_j(x') \Rightarrow x' = 0$$

B. *Example Scenario*

An example scenario is presented here to show the working of proposed negotiation model to achieve egalitarianism. Consider a withdrawal service request from a service consumer A with the following QoS characteristics such as Response time 3ms and Price 10$. Getting this input, the negotiation broker searches, and selects the related services from the registry. It looks for withdrawal service that matches the non-functional properties Response time 3s and Cost 10$.

The broker is responsible for providing equal profit to service consumer and service provider. If a withdrawal service with Response time 2s and Cost 12$ is available, the negotiator broker initiate negotiation with the service consumer to achieve equal profit. The service consumer and service provider should cooperate to reach equal profit. In the negotiation process the policy manager looks after the interaction proposal between service consumer and provider to negotiation broker. The protocol analyzer generate an action aiming to convince service consumer that he could provide a withdrawal service with better quality than what the consumer asked but with cost 12$. Upon accept or reject message from the consumer side, the decision maker component takes decision to achieve equalism on profits and thereby achieve egalitarian principle. Figure 6 depicts the sequence diagram of negotiation process to select a withdrawal service.

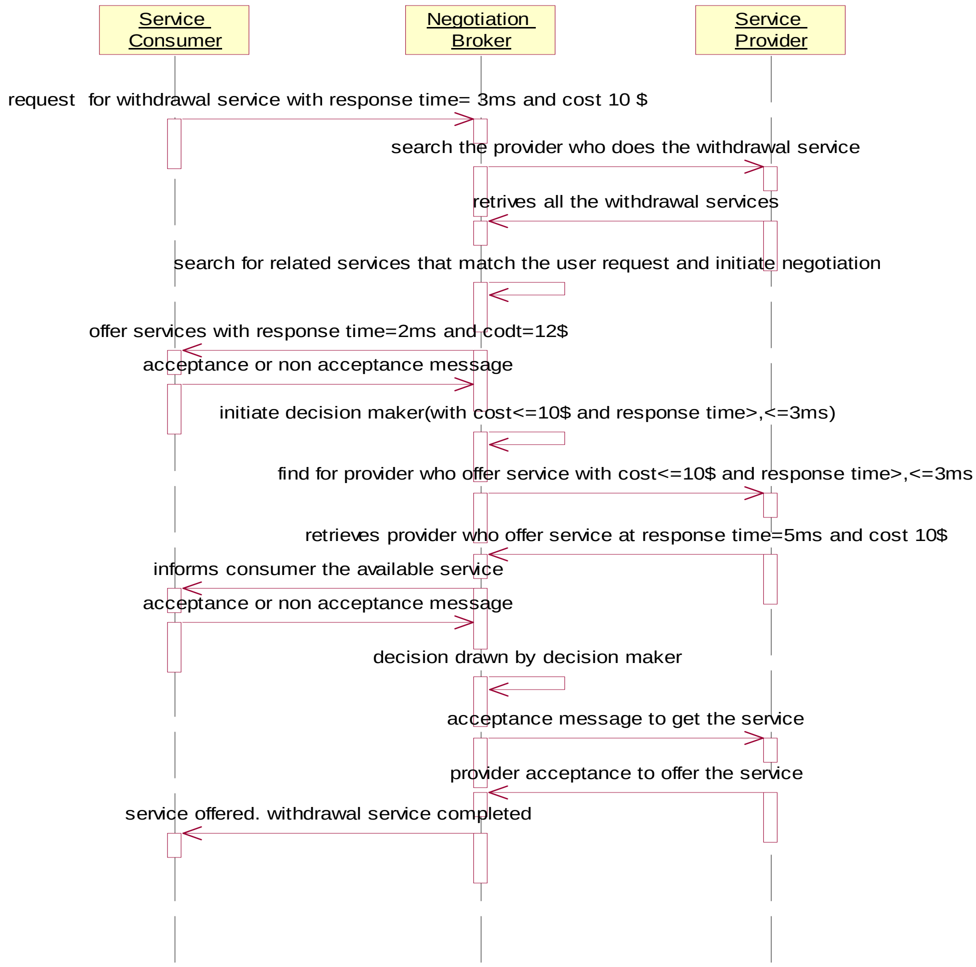

Figure 7: Sequence Diagram showing the Negotiation Process

V. EXPERIMENTAL RESULT ANALYSIS

We develop a small prototype to test the proposed negotiation model. The application domain is applied to online course selection system. In this system, the consumer entered his course along with the preferred QoS characteristics. As the first stage, our prototype supports only three QoS characteristics namely time, cost and response time. After the query has been given by the user, service discovery engine locates the related services and the process of negotiation starts. The components in the negotiation model automatically analyses the availability of services and selects the best one to satisfy the needs of the customer taking into consideration the achievability of egalitarianism among the service provider and the customer. After the decision taken by the decision maker component of negotiation model, the acceptance for service is send to the customer and the provider. Upon acceptance satisfaction, the service is offered and thereby achieving or providing equal profit to service provider and customer. Otherwise, the negotiation process iterates until the equal profit is accepted by the parties. In the experiment, the performance of our model is tested first with 100 services and the service is selected in the second negotiation round. With 130 services we obtained the best result in the second negotiation, and with 160 services in the third negotiation.

Table I
The process of Negotiation rounds with services

S.No	Number of services	Negotiation rounds
1	100	2
2	130	2
3	160	3

VI. CONCLUSION

In this paper we have proposed a negotiation model to select the best service that matches the customer's need in terms of QoS characteristics and satisfying the egalitarian principle in which both the parties namely service provider and service consumer are given equal profits. The model proposed in this paper focuses on achieving a goal to search for a service with WIN – WIN situation between service consumer and servicer provider. The components in the negotiation model work collaboratively and the decisions are taken automatically. The performance of the model is tested with number of services and negotiation round results are found. Only three QoS characteristics are taken into account in the first stage of our prototype implementation. In future, we aim to consider all of the available QoS characteristics. Future work aims to provide mathematical solution for the proposed model. Future enhancement also aims to apply intelligent techniques (Neural networks) to achieve egalitarian principle and thereby to provide a more effective service selection mechanism for web service composition.

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