SLA Negotiation for Web Service Consumption Based on Analytic Hierarchy Process

R. Raju, D. Dhivya, R. Saranya, S. I. Abbinaya

Abstract- The effectual use of services to compile business processes in service computing stresses that the Quality of Services (QoS) convene consumers' outlook. The service consumer need to request for the service. The service provider will provide service to the consumer. When manipulating services, a service provider need to define the quality of service levels that will be offered to customers. Automated web-based negotiation of Service Level Agreements (SLA) can aid describe the QoS requirements of vital service-based processes. We propose a trusted Negotiation Manager (NM) framework that performs adaptive and intelligent mutual bargaining of SLAs between a service contributor and a service purchaser based on each party's high level business necessities. We also define an algorithm for adapting the decision functions during an enduring negotiation to conform with an opponent's offers or with simplified purchaser preferences. The NM uses intelligent agents to conduct the negotiation locally by choosing the most appropriate multi criteria decision making method known as Analytic Hierarchy Process (AHP).

Index Terms — Analytic Hierarchy Process, Multi-criteria decision making, Quality of services, service-level agreement, negotiation, intelligent agents, adaptive negotiation, web services.

I. INTRODUCTION

The advancement of web technologies, leads to the effective online negotiation system for e-business. Many researches are carried out to prove that automated negotiation system is valuable in Service Oriented Architecture(SOA). In SOA the negotiation is carried out through the Service Level Agreement(SLA) between the service constructor and service purchaser. Negotiation is conducted in order to ensure that there is no conflict between the service provider and consumer in reaching an agreement. The SLA document includes information about the parties involved in the negotiation, time period over which the SLA is valid, level of services that both the parties agree on, penalties for not meeting the specified service, specification of what is not covered in SLA, and so on.

Manuscript received on February, 2013.

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The definition of an costing function that maps each possible SLA template to a scalar scoring value that can be interpret efficiently. The function is based on procedural description and capabilities of the service provider, and gives a business-relevant appraisal of the SLA template. Hence, the appraisal function combines technical and business parameters from each SLA template into a single scoring value. In general many SLA templates will result in the same score, and a landscape of scoring values is formed. This setting and its idea provide a useful decision support for the selection of SLA templates that are actually offered to possible customers. The final decision of the service provider is based on additional information like market situation and analysis of competitors which is outside of the methodology.

Service Oriented Architecture (SOA) is having a key impact on the progress of software systems because of its potential for increased business dexterity, compliance of applications, interoperability between systems, and reuse of bequest resources. In general an SLA is used to develop a contract between the service provider and the service consumer. It is usually formed either through implementation of concurrence from the provider, or by negotiation between the two[1]. Stakeholders purpose is to determine whether predefined characteristics and quality attributes of services are met. Negotiation is carried out between the service provider and the consumer before any kind of agreements can be established. This negotiation is likely to raise conflicts because of difference in Quality of Service (QoS).

Negotiation approach reins the experience of access rule policies and identification based on negotiation counterparts' trust value, which is the value of attribute Trust Degree of the trust record. During the negotiation sessions, the system will get the values of Trust Degree automatically and select the rule control policies dynamically[3]. If a user of Adaptive system has no trust documentation, the system will give the user a default level of trust that is the initial trust. The initial trust means that the user neither been trusted nor not been trusted. Negotiation strategy is a dynamic negotiation strategy. It is a balance of eager strategy and economical strategy, and it makes Adaptive system has a high security level.

Many of the negotiation techniques have been applied for SLA such as game theory, time based decision making functions, machine learning, genetic algorithm, intelligent agents etc. In view of the significance of a rapid, effortless, and useful negotiation service for the emerging service cloud, we suggest an negotiation service provisioning system for web services SLAs using Analytic Hierarchy Process(AHP) . Using AHP we addressed the issue of delivering the determinant service based on the preferences gained from the service consumer.Rest of the paper is organized as follows:

Section II deals with the prior research related to service negotiation and AHP, Section III is about the Analytic Hierarchy Process, Section IV describes the system architecture ,Section V explains the working model of the AHP.

II. RELATED WORK

The related work can be divided into three categories service consumer, service provider and service level negotiation. service consumer will consume for the particular service. service providers can provide several service types and different levels of service[4]. A protocol for service level negotiation which uses Web Services and includes both quality of service and security in its negotiation[6]. This paper[8] presents a tradeoff-based automated negotiation approach to support Web service procurement.

SLA negotiations lies in the monitoring and controlling of the fleet of local agents negotiating single services from multiple service provider[9]. An SLA is used to develop a formal contract between the service provider and the service consumer in negotiation towards service level agreements[1]. In our earlier model a time-based decision making system is used. In this paper we propose a multi-criteria decision making system using Analytical Hierarchy Process(AHP).Using analytical hierarchy process, decision are taken from the criteria, sub-criteria and alternatives. Analytical hierarchy process based on three criteria Information Security, Interoperability & High availability[10]. To achieve our objective we have presented the problem as hierarchy, established the priorities, criteria and performed mathematical computing to prove our analysis.

In paper[11] an improved ranking approach to AHP alternatives based on variable weights is given by the way of constructing a variant analysis structure of AHP evaluating problems and its corresponding value system for evaluating alternatives. The paper[12] illustrates the availability and efficiency of the hybrid model. In paper[13] the decision was taken fully by experts opinion and met real decision-making thinking custom. The LP and QP based methods are used to determine decision making under interval criteria[14].The data indexes, such as completeness, smoothness and consistency, are defined differently to incomplete, noisy, and inconsistent in data cleaning [15].In contrast multi-criteria decision making system is used to perform multiple services. From those multiple services a better service will be chosen and it should be returned to the consumer.

III. RESEARCH PROPOSAL

Analytic Hierarchy Process (AHP) is one of the Multi Criteria decision making methods that were originally developed by Prof. Thomas L. Saaty. Service negotiation is an important activity in web service after all the services has been configured and composed. Service negotiation is purely based on decision making. This is the reason why we bring out Analytic Hierarchy Process (AHP) in our project. AHP deals with many large, dynamic and complex real world problems. The advantages of AHP over other multi criteria methods are its flexibility, spontaneous appeal to the decision makers and its ability to check the inconsistencies. In general, users find the pair wise comparison form of data input as straightforward and convenient. AHP method has the distinct advantage that it decomposes a decision problem into its constituent parts and builds hierarchies of criteria. At this point the importance of each element (criterion) becomes clear.

To process the preferences of an individual or group in decision making is the main mathematical objective of the AHP. Primarily, the AHP facilitates the method of rising priorities for alternatives and the criteria used to judge the alternatives. Initially, in order to achieve the goal priorities are derived for the criteria and then priorities are derived for the performance of the alternatives on each criterion. Based on pair-wise assessments using judgments these priorities are derived or ratios of measurements from a scale if one exists. At last, a weighting and adding process is used to attain overall priorities for the alternatives.

IV. SYSTEM ARCHITECTURE

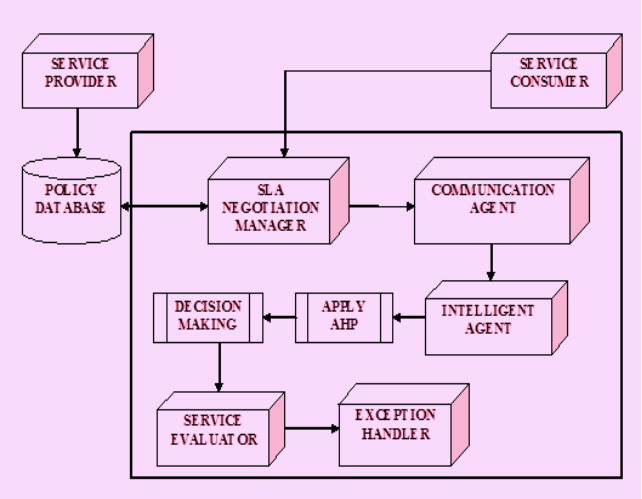

Fig. 1. The Negotiation Manager Framework

The Negotiation Manager framework, as shown in Fig. 1. is described in detail below. The service consumer can approach SLA negotiation manager and request for the service negotiation by providing their own policy. The NM will request the service provider for their policy if it is not already available in the policy database. The parties involved in negotiation can also send the updated policy to the NM.

An SLA is an understanding between the service contributor and the service purchaser regarding the guarantees of delivered services. It describes common understandings and prospect of a service between the two parties. The SLA template may include the parties involved in the negotiation, time period over which the SLA is valid, level of services that both the parties agree on, penalties for not meeting the specified service, specification of what is not covered in SLA, and so on. The Service level objectives may include service availability, customer response time, service response time, service outage resolution time etc. The communication agent then establishes the negotiation link between the service provider and service consumer and invokes the intelligent agent .

The intelligent agent (IA) is responsible for conducting the negotiation locally between the parties involved in it.

The IA implements Analytic Hierarchy Process(AHP) by applying the multi-criteria decision making approach in which the factors are arranged in hierarchic structure. This type of decision making will ask for the preference from the service consumer based on the criteria included, then the comparison matrix is constructed and the percentage is evaluated for each criteria. Likewise the sub-criteria is also evaluated and finally the values are substituted in the chosen alternatives in order to identify the determinant service. The exception handling and service evaluation process are done in the background during the ongoing decision making process.

V. AHP IN WEB SERVICE NEGOTIATION

Analytic hierarchy process is very valuable in decision making and hence we applied AHP for service negotiation in web service. Service negotiation ensures the flat relationship between the parties involved in the web service negotiation. AHP is evaluated based on the preferences gathered from the service consumer. The algorithm for AHP is given below:

Function WS _*AHP*

// The various criteria and sub criteria along with the alternatives(A) for a particular problem are arranged in a hierarchical tree structure with level 1 indicating the problem, level n indicating the alternatives and the intermediate levels representing the various criteria and sub criteria

for *level* := 1 to n - 1 do

preferences :=get the number of criteria and sub criteria for the web service at current level

sub_preferences[i] := number of criteria and sub criteria for the web service at (level + 1)thlevel or number of alternatives if level is n – 1 for choice i

for *i* := 1 to preferences do

j := sub_preferences[i]

// number of sub_preferences[i] *for preference i*

// pcm[i] represents pairwise comparison matrix for preference i

// pcm[i] is of dimension j x *j*

read pcm[i] for preference *i* containing paired comparison of j sub_preferences

end for *i*

for i := 1 to preferences

calculate the local priority of the sub_preferences of preferences i

compute the global priority of the sub_preferences by multiplying the local priorities with the global priority of preferences i

end for *i*

end for *level*

k := number of alternatives

for i := 1 to k do

ranking[i] := sum of global priorities of alternative i under different covering criteria

end for *i*

determinant_alternative := choose alternative with the highest ranking value

return determinant_alternative

end function WS_*AHP*

A. Working Model Of AHP

AHP model is based on getting the preferences from the service consumer. It evaluates both the non-functional (quality parameters) and functional Qos. Initially the number of criteria and sub-criteria are read. Then based on this, it decides the number of pair wise comparison to be done. After the matrix computation of the criteria and sub-criteria the percentage values are substituted in the alternatives chosen. The highest ranking alternative is selected and delivered as the determinant service to the consumer.

n = number of criteria and sub criteria are read

read the criteria : (C_i, C_j,C_k)

read the sub criteria : $\begin{Bmatrix} S_{i1} & S_{j1} & S_{k1} \\ S_{i2} & S_{j2} & S_{k2} \\ S_{i3} & S_{j3} & S_{k3} \end{Bmatrix}$

Comparison Formula: ((n*n)-n)/2

Pairwise Comparison of the Criteria:

Comparing C_i with C_j : W_i

Comparing C_i with C_k: W_j

Comparing C_j with C_k: W_k

Comparison Matrix: C_i C_j C_k

$$\begin{array}{c} \\ C_i \\ C_j \\ C_k \end{array} \begin{bmatrix} 1 & W_i & W_j \\ 1/W_i & 1 & W_k \\ 1/W_j & 1/W_k & 1 \end{bmatrix}$$

B.Calculate the percentage of the criteria:

Step1: Summation of the column values

X= Σ ($[C_i][C_j]$ + $[C_j][C_i]$ + $[C_k][C_i]$)

Y= Σ ($[C_i][C_j]$ + $[C_j][C_j]$ + $[C_k][C_j]$)

Z= Σ ($[C_i][C_k]$ + $[C_j][C_k]$ + $[C_k][C_k]$)

Step2: Dividing the individual column values with the summation values

$$C_i = \left[\frac{\Sigma([C_i][C_i]/ X + [C_i][C_j]/ Y + [C_i][C_k]/ Z)}{3} \right] * 100$$

$$C_j = \left[\frac{\Sigma ([C_j][C_i]/ X + [C_j][C_j]/ Y + [C_j][C_k]/ Z)}{3} \right] * 100$$

$$C_k = \left[\frac{\Sigma ([C_k][C_i]/ X + [C_k][C_j]/ Y + [C_k][C_k]/ Z)}{3} \right] * 100$$

Similarly the percentage is evaluated for the sub-criteria (S_{i1}, … S_{k3}) and substituted in the alternatives (A_i, A_j, A_k) in the order to determine the efficient service.

V1. CONCLUSION

This paper enhances a service level agreement between service consumer and service provider for user satisfaction based on the QoS(Quality of Service) parameters. A service negotiation for web services uses a mathematical policy-mapping model, an adaptive algorithm, and an intelligent negotiation strategy selection algorithm for agent-based negotiation in a trusted negotiation broker framework. During negotiation process the negotiation broker allow negotiation parties to provide feedback to their agents. In existing system time based decision function has been implemented.

The time based decision function consists of exponential, polynomial, and sigmoid functions are calculated. Using these time based decision function the service requested by the consumer can be offered in short period of time. In our proposed system Analytic Hierarchy Process(AHP) is applied using multi-criteria decision making system. By applying AHP certain criteria, sub-criteria and alternatives can be evaluated, so that better service will be given to the consumer in short period of time.

VI. FUTURE WORK

We have done survey about the service negotiation and Analytic Hierarchy Process. In regarding to Analytic Hierarchy Process several decisions are taken from multiple service. Our algorithm describes how the services are delivered with ultimate efficiency and time preservation . In future ,the Negotiation Manager(NM) framework can also be extended to support multilateral negotiation to apply it to grid computing and parallelize negotiation with multiple providers based on Analytic Hierarchy Process(AHP).

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