OPTIMIZATION OF WEB SERVICE QUALITY CONTROL THROUGH GOAL PROGRAMMING

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Abstract: As business environment is changed and become complex, a more efficient and effective process management is needed. More and more enterprises and organizations are recently trying to build flexible and integrated information systems with web services in order to satisfy the changing needs of the customers. The web service can currently recognized as a new alternative for integrating the scattered information assets within an enterprise or an organization. Due to the increasing number of web service applications and the service suppliers, however customers were confronted with the problem of selecting the most suitable web service. In this chapter the new methodology for marshaling the composite web service satisfying web service Quality of service (QoS) goals are suggested. This provides theoretical basis from which a goal programming model is identified by which web service QoS can be quantified.

***Keywords* – Goal Programming Model, Web Quality of Service, Optimization techniques**

I. Introduction

The experimental scenario is devised as shown in Figure 1. The purchasing process is executed Web Services, and each process has 1.1 tasks.

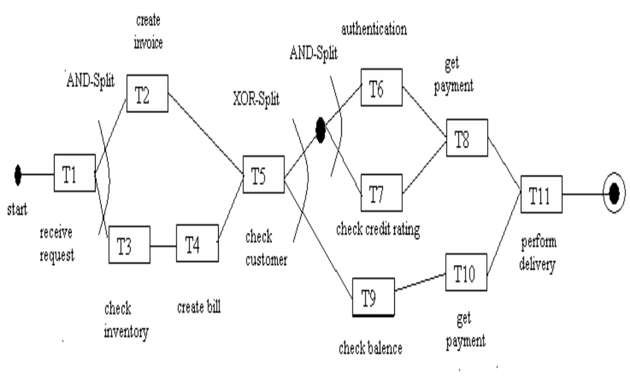

Fig 1 Purchasing Process for Simulated Scenario

After receiving the orders form customers (T1), invoice is issued (T2), inventory is checked and the bill is prepared(T3). After all previous tasks are confirmed (T5). If the payment is to be processed by credit card, the customer's identification is verified (T6), and credit status is checked (T7), then the payment is approved (T8). If the payment is to be processed by bank account , the balance is checked(T9) and the payment is approved (T10). If the product is delivered to customer after the payment is confirmed(T11). The customer, Who are involved in this purchasing process, is assumed make SLA (Service Level Agreement) Shown in Table 1 with the service supplier of purchasing process.

Table 1: SLA for QoS

	SLO (Service Level Objective)	Penalty
Execution Duration	60s	5/s
Execution Costs	800	Over costs
Reliability	95%	100
Availability	95%	50
Reputation	8	50

The goal of this experimentation is to evaluate the plausibility of Goal programming. If the service suppliers are chosen the execution cost will be exceeded by 0.6 and the reputation is lowered by 0.1after composition.

Table 2: QoS Foe Web Service Suppliers QoS

		Duration	Cost	Reliability	Availability	Reputation
Task 1	X_{0101}	6.3	91.5	0.993	0.9985	10
	X_{0102}	9	75.4	0.9942	0.9948	6.1
Task 2	X_{0201}	19.8	156	0.9945	0.9967	7.4
	X_{0202}	17.5	195.2	0.9909	0.9973	6.1
Task 3	X_{0301}	8.4	91.2	0.9973	0.9985	7.1
	X_{0302}	8	94.4	0.9969	0.9924	9.1
Task 4	X_{0401}	9	80.5	0.995	0.9948	7.9
	X_{0402}	10.3	89.5	0.992	0.9987	6.5
Task 5	X_{0501}	7.6	91.6	0.995	0.9928	8.2
	X_{0502}	8.2	74.5	0.9976	0.9974	8.2
Task 6	X_{0601}	8.7	82.5	0.9961	0.9939	9.7
	X_{0602}	7.5	91.4	0.9947	0.9923	7.3
Task 7	X_{0701}	7.4	83.4	0.9932	0.9919	8.8
	X_{0702}	9.4	73.4	0.9999	0.9929	8.6
Task 8	X_{0801}	7	81.2	0.9948	0.9917	8.9
	X_{0802}	6.5	70.4	0.9917	0.9918	7.3
Task 9	X_{0901}	14.7	149.1	0.9984	0.9984	7.1
	X_{0902}	10.2	133.8	0.9971	0.9915	9.6
Task 10	X_{01001}	12.8	121.5	0.9904	0.9985	9.5
	X_{01002}	12.8	104.4	0.9912	0.9909	7.2
Task 11	X_{01101}	6.8	93.5	0.9994	0.9994	6.8
	X_{01102}	9.3	90.4	0.9919	0.9927	6.7

II. QoS FOR WEB SERVICES

Process structure is said to be the ordered relation defined between the units task consisted of process. In this chapter, SWR (Stochastic work flow reduction)Algorithm, which is the approach to reduce the predefined process structure into single task to estimate the process quality, is opted. Workflow process structure is classified as serial and parallel block. Serial block has one path along which no branching and combining is not happened. Parallel block has multiple paths between the branching unit task(a_s) and combining unit tasks (a_m).

2.1 QoS Requirements for Web Services

The requirements of Web Service QoS proposed by IBM include the non-functional Attributes like the process time of Web Service, cost, reliability, etc. In this chapter, the criteria for selecting the Web Service partners is set based on the QoS of Services Requested by consumers, which can be evaluated quantitatively as follows.

Execution Duration – is the time elapsed from the customer request of service to the receipt of response from the Web Service supplier. Hence, it may be composed of the request time, service time and the needed for sending the results.

Execution Cost – is defined as the cost to be paid for the execution of Web service

Reliability – is the probability of the processing result within the expected duration Time set randomly, when the Web Service is requested. It may be considerers the Measure to guarantee the message transmission between customer and service supplier.

Availability – is the criteria for evaluating the immediate availability of web service. It can be computed as the ratio of the service time to the total time of the observation.

Time of observation.

Availability =<Total time> (< Up time>+<Down time> <u><UP time ></u>==<u><UP time</u>

Reputation – is the factor for evaluating the service reliability based on the Customer's experience. In this chapter, it is defined as the average of the final Customer's evaluation on the Web Services.

$$\text{Reputation}=1/n\sum_{i=1}^{n} < userratings >.2$$

2.2 Hypothesis

The plausible selection of Web Service suppliers is set up as the determining variable from this perspective, AND Structure and XOR structure are taken into consideration in the case of parallel structure of web service process. The evaluation criteria for QoS can be formulated according to the each process structure, then the results are combined. Each QoS criteria can be an objective function, so there come out multiple Objective functions, which the constraints of goal programming to minimize the deviation from the QoS demanded by customer. The formulation of criteria is done under the following assumptions .

Independency: all tasks resided in process are mutually independent.

Trustfulness: the quality level of services is reliable

Active Selection: Web Service customer can arbitrarily select a path among the

Paths characterized by XOR branching.

2.3 WS QoS MODELLING

2.3.1 Notation

The problem defined in this chapter is to find optimal Web Service supplies to perform the task in process, when composing the complex web services. Hence the determining variable can be characterized by plausibility of selection of particular web service suppliers.

X_{ij} : The selection value j^{th} supplier among i^{th} task (0: unselectd,1: selected),
S_{ij} : The set of all service suppliers in i^{th} task
S^{XORn} : n^{th} XOR set
S^{XORn} : the set of all service suppliers in the i^{th} task within n^{th} XOR set
The qualities characterized by service suppliers performing particular task is represented as follows;
r_i : reliability of i^{th} task
c_{ij} : The cost of i^{th} task performed by j^{th} service supplier
t_{ij} : The execution duration of i^{th} task performed by j^{th} service supplier
r_{ij} : The reliability of j^{th} service supplier in i^{th} task
av_{ij} : the availability of j^{th} service supplier in i^{th} task
re_{ij} : the reputation of j^{th} service supplier in i^{th} task

Reliability, Availability and Reputation are nonlinearly expressed and formulated by regarding the quality of service suppliers to the quality of selected task. So the quality of the task is represented as follows:
r_i : the reliability of i^{th} task
av_i : the availability of i^{th} task
re_i : the reputation of i^{th} task
T_i : the execution duration process of i^{th} task
T_{start} : the initial time of process
T_{end} : the ending time of process

The level of QoS demanded by customer is represented as follows:
C: The execution cost of complex web service requested by customer
T: The execution time of complex web service requested by customer
R: The reliability of complex web service requested by customer
Av: The availability of complex web service requested by customer
Re : The reputation of complex web service requested by customer

Based on the structural information mentioned above, the web service is defined as below
Definition 1 All web services existent from the n^{th} XOR set S^{XORn} to k^{th} path is $\Phi^n(k)$
In case of XOR set S^{XORn} ,there exists k paths. The possibility of selection of each path is defined as w_k^n . That is if w_k^n is set to 1,the k^{th} path in n^{th} XOR set is selected. Otherwise it is set to zero
(not selected).Based on the definitions above, the additional constraints within XOR structure are as follows:

$$\sum_{j \in S_i^{XORn}}^{n} x_{ij} = w_k, \text{ where for all xij} = 0 \text{ or } 1 \text{ and xij belongs to } \Phi(k) \ldots\ldots\ldots\ldots\ldots\ldots \quad (9.3)$$

$$\sum_{i=1}^{k} w_i = 1 \quad \text{, where for all } w_k = 0 \text{ or } 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(9.4)$$

2.3.2 Nested XOR Structure

In case of the nested AND structure or XOR structure, the nested structure is preferred depending on the resultant selection of the nested paths. This can be theorized as follows:
Theorem 1: If the and structures are nested within the k^{th} path $\Phi^n(k)$ of XOR structure, the execution of task in the AND structure is performed depending on the resultant selection of nested paths ($\sum_{j \in S_{i_i}}^{n} x_{ij} = w_k^{\;n}$)

Theorem 2: The n+1th XOR structure is nested within the k^{th} path of n^{th} XOR structure is performed depending up on the resultant selection of k^{th} path of n^{th} XOR structure ($\sum_{i_{i}} w_i^{\;n+!} = w_k^{\;n}$)

If another XOR structure is nested within XOR structure,the execution of n+1th XOR structure is performed depending on the value $w^n(k)$ of by theorem 2.Hence the additional constraint imposed on the n+1th XOR structure is as follows:

$$\sum_{i}^{3} w_i^{\;n+1} = w_k^{\;n} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

2.3.3 Quality Driven Web Service Selection

As mentioned above, Goal Programming is used for minimizing the QoS deviation. The deviation variable and its penalty are described as follows:
S_i^+: Amount by which we numerically exceed the i^{th} goal
S_i^-: Amount by which we numerically exceed the i^{th} goal
P_l = The penalty for un- fulfillment of i^{th} goal
Optimal web service suppliers which are process-independent are picked using the following equations under consideration of QoS.
Minimize $S_1^+ + P_2 S_2^+ + P_3 S_3^- + P_4 S_4^- + P_5 S_5^-$

$$\text{Subject to : } \sum_{i} \sum_{j \in S_I} a_{ij} x_j + S_1^{\;-} - S_1^{\;+} = C \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \quad (6)$$

$$T_{end} - T_{start} + S_2^- - S_2^+ = T \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

$$\prod_i r_i + S_4^- - S_4^+ = R \ldots\ldots \quad (8)$$

$$\prod_i av_i + S_3^- - S_3^+ = R \ldots\ldots \quad (9)$$

$$1/n \left(\sum_i \sum_{j \in S_I} re_{ij} x_{ij}\right) + S_5^- - S_5^+ = R_{ei} \ldots\ldots \quad (10)$$

$$\sum_{j \in S_{I_i}} x_{ij} = 1, \forall x_{ij} = 0 or 1 \ldots\ldots (11)$$

$$n = \sum_i \sum_{j_I} x_{ij} \ldots\ldots // \ldots\ldots (2)..$$

$$\sum_{j \in S_{I_i}} x_{ij} = 1$$

$$\ldots\ldots w_k^{n-1}, where..x_{ij} \in \phi^{n-1}(k) \ldots\ldots (13)$$

$$\sum_{i_i}^{n} w_i = 1$$

$$.w_i^{n-1}, where..S^{XORn-1} \in s^{XOR^{n-1}} \ldots\ldots (14)$$

$$\forall x_{ij} and w_i^n = 0 or 1 \ldots\ldots (15)$$

Equation (6) computes the execution cost by summing the total cost after selecting a service supplier from each task. The execution time in sequential structure corresponds to the execution time of task taken by the selected service supplier. The equation is modified as equation (7) by considering AND structure, computing the execution time elapsed along the critical path using PERT/CPM algorithm. Equation (8) and (9) computes the reliability and availability, multiplying reliability of particular service supplier performing task with availability. Equation (10) represents the reputation of the web service ,averaging the reputations of tasks. Equation (13) claims that only one service supplier should be selected for performing task and the result comes out depending on the resultant selection of the path that is the only path in XOR branching. Equation (14) claims that only one XOR structure should be selected and the result comes out depending on the resultant selection of the path which is nested in XOR structure.

IV. RESULT AND ANALYSIS

The solution is obtained by using QSB+ computer software as follows.

Table 3(a): Service Provider

Task 1	2nd SP
Task 2	1st SP
Task 3	2nd SP
Task 4	1st SP
Task 5	2nd SP
Task 6	1st SP
Task 7	2nd SP
Task 8	2nd SP
Task 9	
Task 10	
Task 11	2nd SP
Task 12	

Table 3(b): Result Analysis

	Customers requirement	result
Duration	60s	59.7s
Cost	800$	800.6$
reliability	95%	96.88%
availability	95%	95.35%
reputation	8	7.9%

V. CONCLUSION

The requirements of web service QoS proposed by IBM include the non fuctional attributes like the process time of web service cost, reliability etc. The criteria for selecting the web service partners is based on the QoS services requested by consumers. The web service can be currently recognized as a new alternate for integrating the scattered information assets within an enterprise or an organization. This model provides the critical basis from which Goal Programming Model is identified by which web service QoS can be quantified. The model is extended for the composite web service satisfying the problem of selecting the most suitable web services.

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