A Semantic Model of Web Service Choreography with Space Based QoS

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ABSTRACT

Web Services are interacting to meet the business objectives on the Internet. These interactions are modeled using standard language and called as Web service choreography language. The successful interactions are dependent on functional as well as non functional feature of these services. The non functional features are based on time and space related values. The space related values may be considered as location preferences of the web service. These location preferences have been considered as location affinity. This location affinity plays an important role in the successful completion of web service choreography.

In this paper, the operational semantics of web service choreography has been proposed with the location affinity which is derived from the web service. A methodology for computation of Location Affinity of a Role and Web Service Choreography has proposed.

Keywords - Web Service choreography, QoS, Semantics.

Date of Submission: Feb 17, 2021                             Date of Acceptance: Mar 24, 2021

I. INTRODUCTION

Internet facilitates automation of business enterprises. These automations are implemented by autonomous software component which are called as web services. These automations require standards. Standard for describing the service is known as WSDL (Web Service Description Language) and SOAP standard is used for defining the message exchange protocol. The UDDI standard is used for hosting the services. Automation of business enterprises requires more than one service. The external interactions between these services are modeled through a language which is known as web service choreography. WS-CDL is one standard language which describes observable behavior of web services. Web service choreography consists of set of roles, interactions, and channels. One role may implement more than one service. These roles are participated in interaction of choreography.

More than one web services may present for implementing any business activity. The only functional feature of a web service may not provide guarantee for successful composition in runtime environment. Non-functional feature plays an important role for improving guarantee for successful composition. These non-functional features may be categorized on the basis of time and space factors. Time based non-functional attributes are cost, reliability, availability etc. While space based non-functionality feature is location affinity as proposed in the paper [1].

The motive of this paper is to show the effect of space based non-functional feature (Location affinity) in the web service choreography execution which comes from the web service. The operational semantics provide mean to show the behavior of programs during execution. Z. Liu et. al. [14] have already used to resolve execution related issues of WS-CDL using operational semantics. They have used operational semantic to resolve to differentiate multiple participants which provide the same kind of service collaboration. In this paper same operational semantic is used for illustrating the role of space related QOS in the web service choreography.

This paper is organized in five sections. Section-2 illustrates the related work. Section-3 presents my location affinity model of choreography. This section also contains location affinity model for a role, effect of location affinity in operational semantics of choreography, operational semantics of basic activities and effect of location affinity for structural activities. The section-4 is used to illustrate my model with an example. Last section is used for concluding remark for my research.

II. CONTRIBUTION & OUTCOME

This paper has proposed a web service choreography model along with space related QoS. Web service choreography dictates the integration of web services to meet a business objective. This model improves the reliability of web service integration which is implemented by web service choreography. The web service selection involve in implementation of web service choreography on the basis of location/pace improves the success in autonomous environment in service integration.

The outcome of this paper is to show the changes in space related QoS during service collaboration. The operational semantics captures the changes during any action in collaboration.

III. SIGNIFICANCE OF WORK

The Internet is evolving day by day using the new technologies. The service oriented architecture facilitates automatic integration of web services on Internet to execute a new business objective. The web service choreography is used to describe the collaboration of these web services using their individual operational features. The successful integration depends on functional features
as well as non-functional features. The location affinity is important non-functional feature which plays important role in success of service integration. The service interaction description should also incorporate this quality of service. The operational semantics provide the dynamics involve during the execution. This paper, has demonstrated how the location affinity changes during the collaboration of web services. Mathematical foundation helps to remove opaque in consistency in the theory.

IV. RELATED WORK
Several researches have been made [1, 2, 3, 4, 5, 6, 15, 16] to incorporate quality of services in web service choreography. All they have suggested quality of services (QOS) parameter based on time like reliability, availability, cost etc. [4] has proposed a formal model of web service choreography which includes QOS in choreography. They have proposed an estimation technique for computing main/max/average/cost of a role and choreography. [2] They have also used QOS attributes for service web composition. [2] They have proposed a choreography model for computing the cost of role and choreography based on cost of participation role using the operational semantics of choreography which differentiate between participating role and their types. [3] They have proposed a new QOS based on structural properties of the choreography. This QOS attributes are dominant role, dominant choreography and dominant interaction. The basic composition of these attributes are again based on time based parameters like expected availability, time to repair, time between failure, expected failure for computing service availability and service reliability. Other QOS parameter belongs with operations named as operation latency service time and turnaround time as given in [6].

[7,8,9,10,11,12,13] they have proposed the methodologies for incorporating the quality of service parameters at the level of web services and choreography. They have also illustrated the usage of this quality of service parameters in the web service compositions and choreography. G. Denaro et al.[7] have developed a interaction protocol of a web service which captures the operation invocation order. This invocation order improves the guarantee in successful composition of web services as QoS play role. Le-Hung Vu et al. have [8] also given a model for web service discovery using QoS. San-Yih Hwang et al.[9] have proposed a methodology for selecting web services in choreographic environment using quality of service parameters. Mohamed Sellami et al. [10] have proposed architecture for usage of QoS through recommendation of web services in a distributed registry environment. They have recommended registries of web service on the basis of QoS derived from the user history. Natallia Kokash et al. [11] have proposed a method for usage of QoS which they have taken from the users past history. [12,13] have suggested a model which incorporate QoS in ranking web services which help during dynamic selection of a service.

Web service choreography captures the observable behavior of web services. It declares set of rules for governing the message order of message exchange. It also captures the collaborative pattern between the interactive participants which are mutually agreed. This WS-CDL language describes information about only accepting and requesting role type. In this there is no mechanism to specify the specific web services which are implementing the role type. In general within a collaboration it is possible that two different service providers may participate which have same role type. In [14] they have proposed CDLs language with concept of role reference and denote the specific web service.

In my affinity model space related QOS (Affinity) is also service based. To incorporate this QOS the concept of the role reference is also required. I am using the language to illustrate the effect of affinity at the choreography level.

V. A CHOREOGRAPHY MODEL
Web service choreography may contain one choreography or set of choreographies. One choreography must act as root choreography. The root choreography is the choreography which does not have finalize block. The all participating role references are declared in the root choreography. The non root choreography is called as sub-choreography. In the sub-choreography only current participating role references are declare which are responsible for the sub collaboration. Every role reference must be bind with global participants define in the root choreography. R. S. Pandey et. al. [2] have proposed a choreography semantics including the concept of role references. In this section I present abstract syntax and semantic of the choreography which include affinity based QOS attribute.

Choreography ::= c(A, RDec, E Handler, F Block ,AFTree)
RDec ::=={p : r}+
F Handler ::=={et : A}*  
F Block ::=={f : A}*
RType = {(p,l,o,at)|p ∈ RTName, l ∈ P(Var), o ∈ P(Oper), at ∈ P(Affinity_Tree)}

In my choreography semantic model a choreography consists of c choreography name, set of activities A, role description RDec, set of exception handler EHandler, finalizer block Fblock and affinity tree of choreography AFTree. The affinity tree accumulates the affinity from affinity of roles. The role affinity is derived from the participating web services who implement this role.

5.1 A Location Affinity Model for a Role:
Web service consists of set of operations and messages. Any operation of a web service may be preferred for a particular location by the web service user. In this model the operations with their probability of location preferences have been considered. Oj is the jth operation, pj is the probability of jth operation for location preference and lj is the location. The location affinity computational model has been proposed in [1]. They have proposed the
probabilistic tree data structure for storing the location affinity of a web service. The $T$ is the location affinity tree of a W web service. This tree consists of root node as world, which has continents as children nodes, each continent has children nodes as countries, each country has children nodes as states and each state has several district as children nodes. In this paper they have updated their affinity tree as their usage for a particular location. They have used probabilistic model for computing the affinity of a web service on the basis of usability of a web service for a particular location. They have also updated older affinity values on the basis of current affinity values.

$W = \text{name}(o_i,p_j,l_j,T)$

Web service choreography may contain set of roles. Every role is implemented by one or more than one web services. The location affinity of a role is also a affinity tree and it is computed using the merging the affinity tree of web services who implement this role.

$\text{RAT}=\text{merge}(w_1.t_1,w_2.t_2,\ldots,w_n.t_n)$

**Merge**: The merge function takes affinity tree of different web services which are implemented for the same role. If the roots of the both trees are not equal then higher root is the root of affinity tree of a role and other root compares with the next level of the child node of the previous tree. If matches the level then adds it on that level otherwise repeat the algorithm. In the below example the three web services affinity tree have been taken. In the first web service affinity tree has affinity at district level Allahabad, state level Uttar Pradesh, country level India and continent level Asia. Similarly in web service 2 affinities differs only at district level and value is Kanpur and third web service affinity differs state level and district level as Jharkhand and Ranchi. The Affinity of a role is computed after merging of implementing web service affinity. In this example the web service w1 and w2 up to state level affinity is same. In this case only district level affinity is added as one child node in the W1 affinity tree as shown in Fig.-1. The affinity of second and third web services is shown in Fig.2& 3.

$\text{Role} = \text{name}(o,m,w),\text{RAT}$

The Affinity of a role is computed after merging of implementing web service affinity. In this example the web service w1 and w2 up to state level affinity is same. In this case only district level affinity is added as one child node in the W1 affinity tree. The affinity of third web service is different at state level. The new child node is added in W1 web service at state level along with the lower order affinity tree. The RAT role affinity tree is shown in Fig.-4 as below.

Figure-1: Web Service Affinity Tree W1.t1

Figure-2: Web Service Affinity Tree W2.t

Figure-3: Web Service Affinity Tree W3.t3

Figure-4: Role Affinity Tree
5.2 Operational Semantics of Choreography:

Choreography configuration is defined [1] by a tuple 
\( <A,\sigma> \) where \( A \) is an activity and \( \sigma \) is state of choreography which is a composition of state of a participating role of a choreography. They have given a relationship between state of choreography and state of a participating role as below.

\[
\sigma = (\sigma_1, \sigma_2, \ldots, \sigma_n)
\]

where \( \sigma_i \) is the state function which takes role variable name and returns the value of the variable. In this model they have address only the functioning of requesting and accepting role types. They have not given any method for specifying a specific role instance or concrete web service. Z. Liu et al. [14] have given the concept of role reference for specifying the concept of role instance or concrete web service. They have presented a configuration to describe the operational semantics of a choreography using the concept of a role reference and context of choreography. They have considered the configuration which includes activity, context, choreography instance and state as shown below.

\[<A, id, \sigma, CA>\]

The affinity of a web service is also going to dictate the successful composition of a web service. [1] have considered the affinity as quality of service which is based on the location preferences. This affinity will also play important role in choreography execution. They have considered time based QoS and discussed the impact of time based QoS in choreography operational semantics. In this paper, I have proposed the operational semantics of choreography with the choreography affinity and impact on the execution of choreography.

I have considered configuration which consists activity (A), context(C), instance number (id), state (\( \sigma \)) which has two components state of a choreography (\( \sigma C \)) and state of affinity (\( \sigma A \)) and affinity of choreography(CA). The configuration is shown below.

\[<A, id, \sigma, CA>\]

Where

- \( \text{Context}=\text{CIns}\times\text{CName}\times\text{CIns}\times\text{CState}\times(\text{RRef}\times\text{RRef})\times\text{CAFfinity} \)

Figure 4: Role affinity tree

5.3 Operational Semantic of Basic Activity:

Web service choreography contains roles and these roles are interacted to perform an activity. The role contains one or more operations. As per my model, these operations may prefer for a locations. I am using these preferences as affinity indicator. Each operation of a role has three parameter operation name, location and frequency of usage. The model for role is given below.

\[ R=[\text{rolename}(op, l, f)] \] where op is operation, l is location and \( f \) is frequency usage.

\section{Skip:}

It makes no effect on affinity tree.

\section{Silent:}

In this activity the operation of a role is executed. In this case only frequency of a location is increased in the affinity tree of a role.

\[ \text{AP}(r, \text{silent, first}) = l; \] location of silent operation of a role.

\[ \text{CA}(r, \text{silent, Tr}) = \text{Tr}; \]

\[ \text{Inc}(\text{Tr}, l); \]

\section{Assignment:}

Only frequency of a location is increased.

\[ \text{AP}(r, \text{assignment, first}) = l; \] location of assignment operation of a role.
Interaction:
Interaction is executed between two roles toRole (r1) and fromRole(r2). In one way interaction r1 is requested for executing the activity to r2. The role r2 is preferred for r1 so the location affinity tree of r2 is updated by the location affinity tree of r1. In this affinity of r1 is not affected. While in two way communication affinity tree of both roles are updated by each one.

One Way:
AP(r2, onway, second) = l2;
CA(r1, oneway, Tr1) = Tr1;
Merge(Tr1, l2);

Two Way:
AP(r1, onway, second) = l1;
CA(r2, twoway, Tr2) = Tr2;
Merge(Tr2, l1);
AP(r2, onway, second) = l2;
CA(r1, Tr1) = Tr1;
Merge(Tr1, l2);

Operational Semantics of Structural Activity:
My model supports following transition labels B = {a, √} as given in [14]. a ∈ {α, τ} and √ is invisible terminating event. α is a visible event represents communication events oneway/twoway. τ is for internal transition. Ω represents terminating activity.

Skip: This activity does not contribute in location affinity tree state CA.

Silent: This activity is invisible activity on the same role. In this there is no role of location, so state of affinity does not change.

Choice:
The affinity tree changes as per the activity executed either by activity A or by activity B.

Guard:
The guard activity only increases the frequency of location in the affinity tree.

Sequence:
In sequence activity first the affinity tree updated due to activity A then by activity B.
Parallel: In parallel both activities are executed in same

time. The CA is modified by A and by B.

<\(A,C,id,\sigma,CA\)'\> \(\tau\) \(<\Omega,C',id',\sigma',CA''\)>

VI. EXAMPLE

In this section the proposed model has been

illustrated using the example of choreography

PurchaseOrderChor. This choreography has four roles

buyer, seller, credit and Inv. An abstract model of the

purchase order choreography is given below.

PurchaseOrderChor[(buyer, seller, credit, inv), purchase

OrderChor]. The buyer role is implemented by web service/role

reference Buyer which has variables and operations and

their locations and affinity tree of the web service T1.

buyer=Buyer[(PO,poAck,poResp,poRej,ccReq,ccResp,ccReq

,icReq,icResp,icReq,icState,ccState,icState

), (POHandleOP,Agra),T2]

The credit role is implemented by Credit web service

which has locations Delhi and Australia. This web service

affinity tree is T3 and has variables.

credit=Credit[(ccReq,ccResp,ccState),(CreditCheckOP,

Delhi, Australia),T3]

The invoice inv role is implemented by Inv web service

which locations are Kanpur and Australia. It has also some

variables and affinity tree T4.

inv=Inv[(icReq,icReq,icResp,

icState),(InvCheckOP,austrelia,kanpur),T4]

The purchase order choreography has following activities

which are executed in following order.

purchaseOrder=poRequest||poCheck||poRespond

poRequest:

s1(PO,poAck,poState,T1)\(\rightarrow\)c(purchaseOrderChor.Buyer)\(\rightarrow\)

s2(PO,poAck,poState,T2)\(\rightarrow\)(purchaseOrderChor.Seller)

<RR(buyer.po\(\rightarrow\)seller.po,buyer.poAck

\(\leftarrow\)seller.poAck,POHandleOP,\(\rightarrow\)),id,\(\leftarrow\),sigma

<sip,buyer.poState\(\rightarrow\)"sent",seller.poState\(\rightarrow\)

"received"],\(\left\{\right\}Buyer.T1\(\rightarrow\)CA'\(\rightarrow\)Buyer.oneway,T1\),

Seller.T2\(\rightarrow\)CA''\(\rightarrow\)Seller.oneway,T2\}

CA(Buyer.oneway,T1)=T1

\(\left\{\right\}\)

AP(Seller.oneway,second)=l2(Agra)

CA'(Buyer.oneway,T1)=\text{Merge}(T1,l2)

The value of l2 is Agra. The updated affinity tree of buyer

and seller are given in fig.-5&6.

CA(seller.oneway,second)=T2

AP(Buyer.oneway,second)=l1

CA''(Seller.oneway,second)=\text{Merge}(T2,l1)

The seller role is implemented by web service Seller

which has location Agra and affinity tree is T2. This web

service has operation purchase order handling

(POHandleOP) and variables.

seller=Seller[(PO,poAck,poResp,poRej,ccReq,ccResp,ccReq

,icReq,icResp,icReq,icState,ccState,icState

), (POHandleOP,Agra),T2]
creditCheck:

\[ s_1(\text{ccReq}, \text{ccResp}, \text{ccState}, T_3) = \text{c}(\text{purchaseOrderChor.Credit}) \]
\[ s_2(\text{ccReq}, \text{ccResp}, \text{ccState}, T_2) = \text{c}(\text{purchaseOrderChor.Seller}) \]

\begin{align*}
&\text{Guard:} \\
&\text{if } j < k \text{ and } (\text{Seller.ccResp} = \text{"ok"}) \land \neg (\text{Seller.icResp} = \text{"notok"}) \text{ then } \tau \\
&\text{Guard:} \\
&\text{if } j < k \text{ and } (\text{Seller.ccResp} = \text{"notok"}) \text{ then } \tau \\
&\text{Guard:} \\
&\text{if } j < k \text{ and } (\text{Seller.icResp} = \text{"ok"}) \text{ then } \tau \\
&\text{Guard:} \\
&\text{if } j < k \text{ and } (\text{Seller.icResp} = \text{"notok"}) \text{ then } \tau
\end{align*}

\begin{align*}
&\text{poResponse:} \\
&s_1(\text{poResp}, \text{poState}, T_1) = \text{c}(\text{purchaseOrderChor.Buyer}) \\
&s_2(\text{poResp}, \text{poState}, T_2) = \text{c}(\text{purchaseOrderChor.Seller})
\end{align*}

\begin{align*}
&\text{poReject:} \\
&s_1(\text{poRej}, \text{poState}, T_1) = \text{c}(\text{purchaseOrderChor.Buyer}) \\
&s_2(\text{poRej}, \text{poState}, T_2) = \text{c}(\text{purchaseOrderChor.Seller})
\end{align*}

\begin{align*}
&\text{poRespond:} \\
&\text{Guard:}
\end{align*}
Affinity Tree of Roles:
Buyer role is involved in interaction with Seller in poRequest, poResponse, and poReject activities with 11,12,13 location affinities. Seller role is involved in poRequest, creditCheck, invCheck, poResponse, poReject, and poRespond with location affinities [14,15,16,17,18,19]. Credit role is involved in creditCheck and invCheck activities with location affinities l10,l11. Inv role is involved in invCheck activity with location affinity l12. The affinity trees of above roles are given in fig. 7,8,9,10.

VII. CONCLUSION
Web service choreography is used to model the external interactions of a set of web services which take place during the execution of composed web service to meet a business objective. WS-CDL is web service choreography language which captures the behavior of the web service. This is the XML based language which does not differentiate role type and the web service which is going to implement the role type. Z. Liu et al [14] have proposed a new version of WS-CDL CDL0 with a new concept called as role reference. This role reference facilitates to differentiate between participants which are providing same kind of services. They have used operational semantics to depict the behavior of the activities in terms of the transition between two configurations of choreography.

This paper has defined a choreography model to include location based QOS attribute in the choreography model. I have also used operational semantics to illustrate the effect of the activity in computation of the location affinity of the participating roles and location affinity of choreography. To illustrate my model I have used an example for computation the location affinity of participating role of choreography. In the future plan to develop a model for web service substitutivity on the basis of location affinity of a role of choreography.

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