Negotiation towards Service Level Agreements: A Life Cycle Based Approach

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***Abstract*—Service Based Systems (SBSs) are composed of loosely coupled services. Different stakeholders in these systems, e.g. service providers, service consumers, and business decision makers, have different types of concerns which may be dissimilar or inconsistent. Service Level Agreements (SLAs) play a major role in ensuring the quality of SBSs. They stipulate the availability, reliability, and quality levels required for an effective interaction between service providers and consumers. It has been noticed that because of having conflicting priorities and concerns, conflicts arise between service providers and service consumers while negotiating over the functionality of potential services. Since these stakeholders are involved with different phases the life cycle, it is really important to take into consideration these life cycle phases for proposing any kind of SLA negotiation methodology.**

In this research, we propose a stakeholder negotiation strategy for Service Level Agreements, which is based on prioritizing stakeholder concerns based on their frequency at each phase of the SBS development life cycle. We make use of a Collaxa BPEL Orchestration Server Loan service example to demonstrate the applicability of the proposed approach. In addition, we simulate the negotiation priority values to predict their potential impact on the cost of the SLA negotiation.

Keywords- Service Based Systems (SBS); Stakeholders; Roles; Development Life Cycle; Service Level Agreement (SLA); Quality of Service (QoS); Loan Flow example

I. INTRODUCTION

Service Oriented Architecture (SOA) is having a major impact on the development of software systems because of its potential for increased business agility, adaptability of applications, interoperability between systems, and reuse of legacy assets [1]. SBSs involve different activities, e.g., requirements management, adaptation and monitoring, rules, policies, testing, and management. Generally, there are three key types of stakeholders involved in SOA [17]: the customer, the business or sales organization, and the operations or delivery organization.

These stakeholders are assigned different roles, for example creation and maintenance of development activities and work products is the responsibility of different internal stakeholders, e.g., analysts, architects, developers, testers, and managers [2]. Due to the distributed and loosely coupled nature of the constituent services, external stakeholders also come into play directly in the form of service consumers, as they are the potential users after the services have been developed and deployed. Therefore, an SBS life cycle has to support the involvement and presence of these different types of stakeholders, and, the development life cycle must incorporate stakeholders' concern [3]. Normally, an SLA is used to develop a formal contract between the service provider and the service consumer. It is usually formed either through adoption of agreement from the provider, or by negotiation between the two. Their main purpose is to determine whether predefined characteristics and quality attributes of services are met [20]. 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) priorities. It is really important to mitigate these conflicts so that SBS stakeholders, who contribute towards the business value, can mutually agree upon an SLA.

Opposing concerns of stakeholders on the provider as well as on the consumer side, across different phases of the life cycle, may raise conflicts on negotiating QoS capabilities (such as *response time*). This raises a number of questions, which specific stakeholders are involved in this conflicting situation? What life cycle phases and activities are involved in potential QoS capabilities whose negotiation leads to the occurrence of these conflicts? How can we methodically resolve these conflicts by assigning priority to a certain group of stakeholders who are working towards SLAs? How can we observe the potential effect of assigned priority on QoS capabilities of the potential service, e.g. *response time*?

Recent research in the area has not focused on stakeholders at different phases of the life cycle and their potential role in the negotiation process which eventually leads to SLAs. As they are the most common mechanism used to establish agreements on the quality of service between the service provider and the service consumer, the importance of negotiation cannot be underestimated [8]. In addition, it is important to take the stakeholders into account considering that SBSs are developed, owned, and used by different stakeholders with different perspectives, i.e. developer and provider, broker and composer, and consumer and end user respectively.

In this paper, we identify stakeholders and roles associated with them based on their key responsibilities at each phase of the SBS development life cycle. Then, we identify how conflicts may occur between the service provider and the consumer while negotiating towards SLA. An example scenario is presented using the Collaxa BPEL *Loan Flow Service* to demonstrate the potential conflicts which can occur between the stakeholders. We prioritize the stakeholders in the negotiation process based on the frequency of their involvement at each phase of the life cycle. We use a simulator to predict stakeholders' impact on cost of the SLA negotiation by means of assigning them priority rotating.

The remainder of the paper is organized as follows: Section 2 describes our Research Methodology. Section 3 consists of related work and Section 4 contains background information on our research project and Service Level Agreements. Section 5 describes our contribution in terms of identification of stakeholders, the study design with an example scenario, mapping stakeholder roles at each phase of the SBS life cycle, and the simulator. Finally we discuss Conclusions and Future Work in Section 6.

II. RELATED WORK

In order to conduct this research, our literature review had to focus on three topics: the interaction of stakeholders in accordance with life cycle phases, negotiation on SLAs, and the role of development life cycle and corresponding stakeholders in this negotiation process.

Conflict negotiation has been addressed for both conventional [23] as well as for service based systems [24][6]. In addition, SLAs have been a focus of researchers. Some negotiation based conflict resolution methodologies have been proposed [5][6][7][8][9][10], but in general, their focus has been on run time adaptation and composition of services only. Studies involving stakeholders and their roles have mostly focused on the requirements engineering phase of the traditional software development life cycle [4][5][6][7]. There are some methodologies for identifying the total number of stakeholders which make it is easier to identify the project critical stakeholders [25][26]. In addition, there has been some work on the interaction among stakeholders [10][11][12][13]. But since these related works do not take into account involvement of different life cycle phases, they cannot be applied to the case of SBSs. [21] has proposed a method for conflict resolution but the context is limited to conventional software systems only.

In terms of web services, there is some research on SLA management. For example, [14] has proposed a methodology on SLA negotiation but it is among anonymous service providers and the consumers, and does not take into account the situation in which a provider and consumer are already tied into a business link. In addition, a contract Net Protocol tool [10] has been developed which sends the contract request information to potential services. The corresponding services bid on those options. The user then selects a specific supplier, rejecting all other offers. The scope of our research is somehow different. We focus on a Business-to-Business (B2B) scenario in which a *provider-consumer* relation already exists between the two and the goal is to customize the negotiation over a potential service provision. In short, in our review we have not identified methodology addressing the stakeholder negotiation by incorporating the SBS life cycle phases, before Service Level Agreements can be made.

Our literature review suggests that the use of stakeholder roles, taking into account life cycle phases, and SLA negotiation has been mutually exclusive in the existing research. Moreover, researchers to date have not studied the potential impact of their proposed SLA negotiation methodologies on the cost associated with Service Level Agreements. Therefore this paper addressed this gap.

III. RESEARCH METHODOLOGY

Figure 1 represents an overview of the research methodology. Our research question is How can we make use of the phases in an SBS development life cycle phases and stakeholders involved in them to facilitate negotiation towards SLAs. The plan is to thoroughly investigate the steps and stakeholders involved in development as well as adaptation of web services in service based systems. We target negotiation between two types of stakeholders, service providers and service consumers.

We carried out a literature review to understand the phases involved in the development of SBS. We then mapped them to the S-Cube life cycle [17] which ensured Development as well as Adaptation phases of the SBS development. A quantitative stakeholder identification template is used to identify relevant stakeholders of the project, and the corresponding life cycle phases where their activities resided. Each participant was advised to answer the questionnaire according to his interest and the best of knowledge considering in mind the generic activities performed at each phase of the life cycle. The questions were selected specifically after the literature review to facilitate the proof of the research question. The template included 10, mostly close-ended, questions. It was distributed among the 15 project partner universities across Europe to identify the potential stakeholders. We mapped these stakeholders to the S-Cube life-cycle (Figure 2). Once stakeholders' types and count were identified, we distributed them into two different roles, such that:

Total number of Stakeholder Roles (T_R) = C_R + P_R

Where $C_R = \sum$ (All stakeholder roles which are involved in consuming services, or in making use of them, e.g., application clients and end users. $P_R = \sum$ (All stakeholders roles which are responsible for providing these services, e.g. application builders and service composers. We used a *Loan Flow* service example to identify a scenario which may lead to conflicts on QoS between service provider and the service consumer. The identified conflicting node

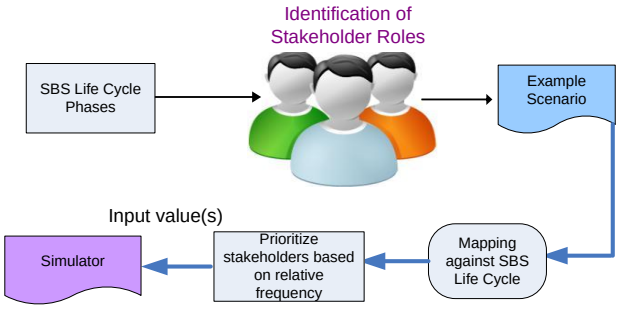

Figure 1. An overview of the research methodology

was mapped back to the SBS life cycle [17] to investigate the potential involvement of each life cycle phases. This mapping helped us to identify the potential participation of the stakeholder roles, in terms of their frequency, on the conflicting node of the loan flow service. Using this information, we measured the preference of a stakeholder's role on the conflicting node by calculating its relative frequency in comparison to the other roles. The greater the relative frequency value is, the more importance that stakeholder category has in the SLA negotiation process. These priority values were simulated to observe the potential impact of the corresponding stakeholders on the cost of the SLA negotiation.

IV. BACKGROUND INFORMATION

A. *S-Cube Project*

The objective of S-Cube project [4] is to create an integrated European research community which focuses on software and service engineering. This template was designed for two affiliations. It is based on the fact that engineering and management of SBAs is quite different to traditional software applications as they are built by combining different services which may be provided bythird parties with whom there should be a service level agreement.

A reference lifecycle for service based systems has been developed by S-Cube project researchers (Figure 2). It is composed of two cycles. The evolution cycle depicts classical application design while the adaptation cycle reflects the adaptation of the SBSs. These systems need to accommodate many changes at run time. The service life cycle model envisioned by the S-Cube framework captures an iterative and continuous method for developing, implementing, and maintaining services, in which the feedback is continuously cycled to and from phases in iterative steps of refinement and adaptations of all three layers of the technology stack [4]. The method accommodates continuous modifications of service based systems and its quality (e.g. QoS) at all layers. Once service based systems (or parts thereof) have been adapted, they will be redeployed and re-provisioned and put into adaptation.

B. *Service Level Agreement (SLA)*

An SLA addresses an agreement between a service provider and its consumer, can be between two parties as well as among multiple ones [20][15], and becomes valid after it has been signed by the contracting parties [5]. No customization occurs in these contracts, the possibilities for service requirement-capability matching are severely limited and negotiation is carried out through meetings between the client, the service and legal aid. Since the negotiation process is continuous, it emphasizes the importance of involvement of stakeholders at different phases of the life cycle. Normally, SLAs are defined using predefined templates in plain text, which makes them open to inconsistencies and conflicts. An SLA may have the following information [12]: pre specified elements, fixed Information, negotiable elements, and their Choices (choices of parties, or, choice of the elements).

These are the negotiable elements which are likely to give rise to conflicts as opinions of service providers and service consumers may differ. An SLA is authored once an agreement has been made between the Service Consumer and the service Provider. This authoring process can be

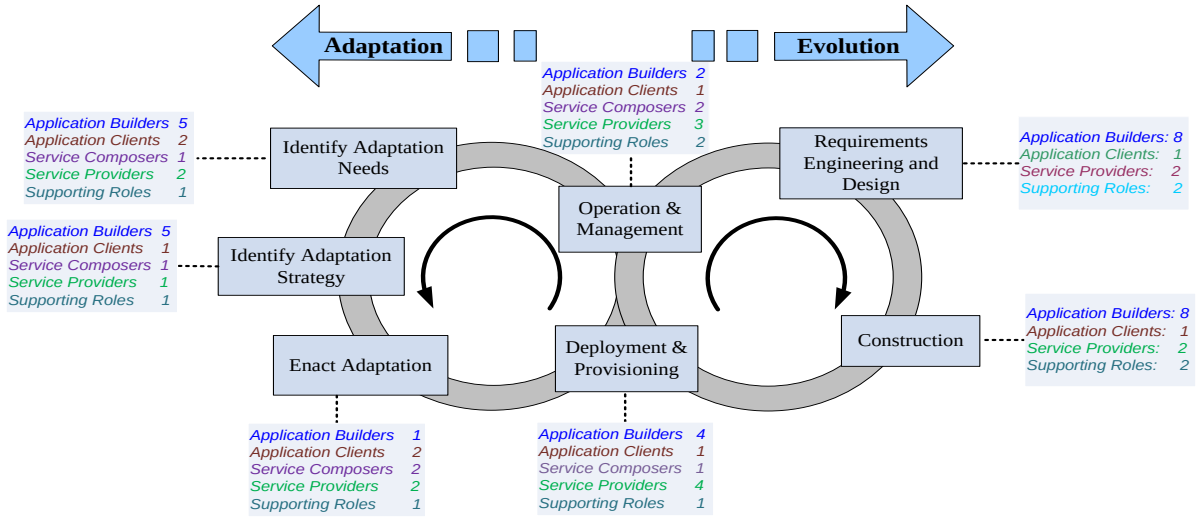

Figure 2: S-Cube Reference Life Cycle [17] with Corresponding Stakeholder roles and frequency at each Phase

offline, where the information is exchanged between the parties via e-mail or other human communication mechanisms.

The SLA is defined via WSLA (Web Service Level Agreement) language. For flexibility, certain terms of the contract can be negotiated [7][15]. Importance of negotiation in even increased because any type of WSLA authoring tool uses an SLA template to present graphically various input fields and choices to be made by an author [7], but information on this template is not finalized until both parties agree on QoS parameters of the potential service. The provision of the service depends on SLA and negotiation plays an important role in the formation of these agreements because the life cycle of an SLA starts with its negotiation [7].

Conflicts which arise during the SLA negotiation are likely to be overcome either by going for an alternative service provider, or by renegotiation among stakeholders. The former one may not be a good idea as it could involve more overheads in terms of looking for a new provider and finalizing the agreement with it. Besides, negotiating with existing provider regarding newly evolved requirements is a non-trivial task because both the service provider and the service consumer can take advantage of the existing business link between them, which would preclude the service consumer changing its provider. This is exactly the situation we are targeting in this research.

V. STUDY DESIGN

A. Identification of Stakeholder Roles

Two major categories of stakeholders were identified during previous research conducted in the S-Cube project [17]:

- Consumers and users of service based applications including experience and inexperienced end users
- Service composers and users involved in the system design, such as software engineers, system integrators and architects, business experts

SEI's Capability Maturity Model Integration (CMMI) [18] specifically proposes that stakeholders be selected among customers, final users, developers, producers, test staff, suppliers, marketing staff, maintenance staff, and anyone who may affect or be affected by the software process and the final product. The stakeholder identification from S-Cube fulfills these criteria. Another reason for using the term stakeholder is that it is more generic and can involve different types of users within it [17]. Figure 3 shows the stakeholder identification template [17] we used to identify stakeholders at each phase of the SBS life cycle. The Service Providers category is the one who is the owner of the service(s) and develops and publishes them. Service composer composes existing services for achieving certain business goals. The

Service Engineering Stakeholder Specification	
Contributor	*Who filled in the table*
Type of Stakeholder	*e.g., service developer, business analyst*
S-Cube Lifecycle Phases	*In which phases of the S-Cube lifecycle is this stakeholder involved?*
Activities	*In which activities (within the phases above) is this stakeholder involved in?*
Description	*Description about the responsibility of the stakeholder within the activities above*
Peculiarity to Service Engineering	*What are the characteristics of stakeholder participation in service engineering, e.g., in comparison with the participation in conventional software engineering approaches? In other words, what does this stakeholder do differently than traditional software engineering?*
Interactions with other Stakeholders	*Any interactions exist? For what purposes?*
References	*e.g., in any service engineering methodologies, S-Cube deliverables, case studies, publications…(full citation)*
Glossary	*Terms from S-Cube Knowledge Model*
Related Research Challenges	*Any gap between this stakeholder specification and the support from existing service engineering methodologies could be identified? How to fill the gap?*

Figure 3. Stakeholder identification template [17]

application builder integrates services into systems which fulfills user requirements. The application client is an end user who uses the service based applications to achieve certain goals. *Supporting roles* refers to a category of stakeholders who is not directly involved with the service life cycle (or we can say that it is one of the internal stakeholders), e.g. project managers or service legal advisers [17]. These different types of stakeholders are involved at each phase of the life cycle in order to perform their respective activities. Each type of these stakeholders has a value and dependency associated with each phase of the life cycle.

B. Example Conflicting Scenario

The example scenario we used to elaborate our conflict example is a Loan Flow service was provided by Collaxa [9]. The functionality of the system requires that a user enters a social security number as an input into the system. The system returns an integer number as credit rating by means of *Check Credit Rating* service. One loan service LoanApp is responsible for receiving loan application documents. The other service StartLoan is responsible for returning the loan offer documents.

As part of our example scenario, we assume that a service consumer is negotiating with a service provider over the provision of an SBS (Figure 4). In addition, the figure shows the conflicted node using shaded rounded rectangle box. The conflicting situation triggers when the service consumer demands the system to check for the user's credit rating in 5 seconds but the provider cannot make that available in less than 10 seconds. It is important to identify and negotiate these conflicts as they are likely to propagate among stakeholders, across different phases. For instance, the conflict between the service end-user and the service broker influences negatively the agreement between service broker and the credit rating service.

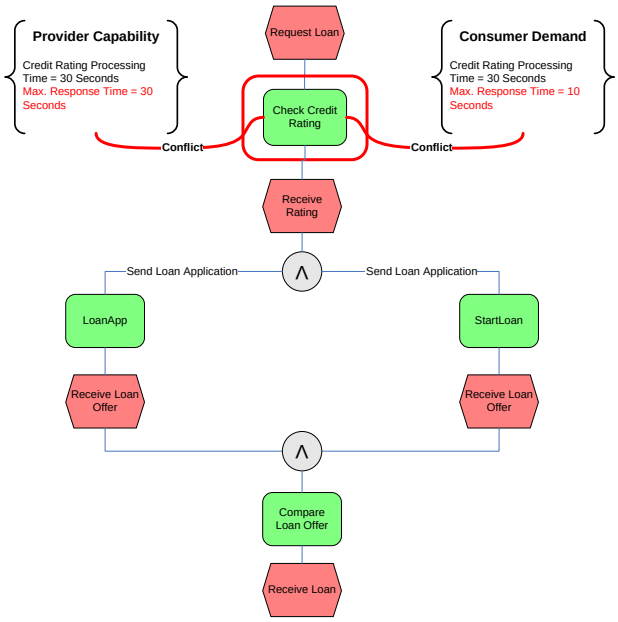

Figure 4. Example Conflict in the Loan Flow Example

Figure 5 highlights the QoS requirements constraints filled in by the service consumer, in terms of efficiency and availability. It wants the credit rating to be calculated in no more than 30 seconds, response time should be 10 seconds, and service must be available on June 1st 2011 from 08:00 to 20:00 to December 31st 2011 (Figure 5). The service provider agrees with these QoS constraints except the service response time.

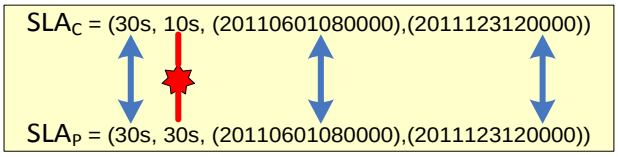

Figure 5. Conflicting SLA parameters between the two parties

As part of our solution, we investigate the involvement of types and numbers of stakeholders on this conflicting node *Check Credit Rating*. In order to do so, we consider the life cycle phases in the development of the SBS system depicted in Figure 4, which consequently would give us the types and number of stakeholders involved at each of its phases. Table I shows the relevant information in this regard. In the third column from left, we have listed the potential phases from the SBS life cycle, for the development and adaptation of the *Check Credit Rating* service. The notable thing is that couple of phases like *Deployment & Provisioning* and *Identify Adaptation Strategy* are not listed. The reason is that these two phases does not seem to be specifically involved in the service development and adaptation of the service, as service deployment and adaptation strategy is not confined solely to a single service only. Also, these phases do not seem to have anything to do with the negotiation on service QoS requirements and its functionality.

TABLE I. INVOLVEMENT OF PHASES & STAKEHOLDERS IN LOAN FLOW EXAMPLE

	Reason of Conflict	**SBS Life Cycle phases involved**	**Stakeholder Roles Involved**
Check Credit Rating	Non - functional requirement (Service Response time)	Requirements Engineering and Design, Construction, Operation and Management, Identify Adaptation needs, Enact Adaptation	Application builders, Application clients, Service providers, Supporting roles, Service composers

The next column lists the types of stakeholder roles involved in the conflicting Node. These stakeholders have been categorized into two main roles, service provider and service consumer. The corresponding number of each type of stakeholder role is counted and categorized into their respective category.

This stakeholder frequency information is used to help us prioritize and weigh the stakes of corresponding stakeholders in the SLA negotiation process. Using probability theory we can provide a quantitative description of the likely occurrence of a particular event, and is conventionally expressed on a scale from 0 to 1. We can also calculate the probability of an event by calculating its relevant frequency [14] (which is obtained by dividing the number of times an event occurs by the total number of times an experiment occurs). This means that the relative frequency of a stakeholder role can be calculated by dividing its individual occurrences by the total number of occurrences in that phase. We have considered relevant frequency as the probability of occurrence of a stakeholder role in each phase of the life cycle. These relevant frequency values are considered as a priority mechanism in the negotiation process for that specific stakeholder role; i.e. if relevant frequency value is greater than its counterpart, that specific stakeholder role is assumed to have more preference in the negotiation process. Table II shows the probabilistic values of each stakeholder role based on its relevant frequency at each phase.

TABLE II. RELEVANT FREQUENCY OF THE STAKEHOLDER ROLES AT EACH PHASE OF THE SBS LIFE CYCLE

Phases	**Stakeholder Roles**				
	Application Builders	***Application Clients***	***Service Composer***	***Service Provider***	***Supporting Roles***
Requirement Engineering & Design	0.61	.08	0	0.15	0.15
Construction	0.38	0	0.12	0.38	0.12
Operation and Management	0.2	0.1	0.2	0.3	0.2
Deployment &Provisioning	0.36	0.09	0.09	0.36	0.09
Identify Adaptation Needs	0.45	0.18	0.09	0.18	0.09

These relevant frequency values are calculated using the total frequency of the different roles each type has in that specific life cycle phase. These values are further summed up into two main categories, i.e. service provider and service consumer (Table III). We consider *Application Builders* and *Service Composer* roles to reinforce service provision. *Application Clients* seem to be the only consumer role involved at each phase, but we count on *Supporting Roles* towards the service consumers because they may serve as managers as well as technology consultants and legal officers [13]. The involvement of each stakeholder is influenced by the collective sum of its corresponding roles at each phase of the life cycle, thus providing the relevant frequency.

TABLE III. INTEGRATION OF RELEVANT FREQUENCIES INTO TWO MAIN CATEGORIES OF STAKEHOLDER ROLES

Phases	**Stakeholder Roles**	
	Service Provider (P_R)	***Service Consumer*** (C_R)
Requirement Engineering & Design	0.77	0.23
Construction	0.88	0.12
Operation and Management	0.7	0.30
Deployment and Provisioning	0.81	0.19
Identify Adaptation Needs	0.72	0.28

C. Simulator

Cost is one of the measurable qualities of SLAs as defined in [19]. We have built a simulator to validate our approach by observing the trend in this variable in response to the assigning priorities to both types of stakeholder roles, one by one. Studies show that one way of measuring *cost* is to quantify it in terms of stakeholders' fulfillment [14]. So in our case, it is measured as dissatisfaction between the two types of stakeholder roles, i.e. the provider and the consumer, such that high cost between both types of stakeholder roles would imply lower satisfaction, and the vice versa. Table IV shows equations of our simulation model.

While building our model, we follow a systematic approach as outlined by [22]. Also, our formulation of the problem is quite clear, as we want to observe the trend in SLA cost by investigating the effect it undergoes in response to assigning priority to both stakeholder roles in turn.

TABLE IV. COST EQUATIONS FOR SIMULATION

Total Cost of all stakeholder roles(C_{CP})	$= C_p + C_c$ $= [((Pr_p \times Rf_{pi}) + \ldots + (Pr_p \times Rf_{pn})) +$ $= ((Pr_c \times Rf_{ci}) + \ldots + (Pr_c \times Rf_{cn}))]$
Total Cost of service provider roles (C_p) when assigned priority Pr_p	$= (R_f \times Pr_p)/R_{fp}$
Total Cost of service consumer roles (C_p) when not assigned priority Pr_c	$= (R_f \times Pr_c)/R_{fc}$
Total Cost of service consumer roles (C_p) when assigned Priority Pr_c	$= (R_f \times Pr_c)/R_{fc}$
Total Cost of service provider roles (C_p) when not assigned priority Pr_p	$= (R_f \times Pr_p)/R_{fp}$

Where

C_{CP} : total cost of all roles (consumer and provider)
C_C : cost of service consumer roles
C_P : cost of service provider roles
Pr_c : priority of service consumer roles
Pr_p : priority of service provider roles
R_f : total relative frequency at each phase of the life cycle
R_{fp} : relative frequency of provider roles at each phase
R_{fc} : relative frequency of consumer roles at each phase
Rf_{pi} : relevant frequency of a provider role at i^{th} life cycle phase
Rf_{ci} : relevant frequency of a consumer role at i^{th} life cycle phase

As far as the availability of quantitative data is concerned, it has already been made available (Tables II & III). Finally, the results are represented in the form of graph plots to make the findings more conducive.

By analyzing Table IV, equations for assigning and negating priority to a stakeholder role appear to be the same. But their outcomes are different as different priority values for the same stakeholder role, results into different outcomes. We use the priority scheme used by [14] to associate high and low priority values with both cases. Table V contains these value settings, in the form of priority values for both cases. First, when priority is assigned to service provider roles; second, when priority is assigned to service consumer roles. The order of life cycle phases is same as shown in Table III.

TABLE V. PRIORITY VALUES FOR BOTH HIGH & LOW CASES

Stakeholder Role	**High Priority**	**Low Priority**
Service Provider	$Pr_p = 10$	$Pr_p = 5$
Service Consumer	$Pr_c = 10$	$Pr_c = 5$

The values in Table VI are obtained by inserting the relative frequency values into the corresponding simulation cost equations, using both high and low priority values (Table V) for each type of stakeholder roles.

One way of validating a simulation model could be the demonstration of difference between previously existing research works and the proposed approach [14], but currently no life cycle based SLA negotiation approach exists. So, our validation of the model consists of the investigation of both types of *cost* results; that is, effect on *cost* when each one of service providers and service consumers roles are given preference in the negotiation process, turn by turn. Also, we demonstrate both types of results using graphs, which is another form of credible validation approach for a simulation model [22].

TABLE VI. PRIORITY COST VALUES FOR BOTH ROLES

Provider roles are given preference		**Consumer roles are given preference**	
Cost of Service Provider Roles- (C_p)	***Cost of Service consumer Roles-*** (C_c)	***Cost of Service Provider Roles -*** (C_p)	***Priority of Service consumer Roles-*** (C_c)
13.0	21.70	6.50	43.50
11.40	41.70	5.70	83.30
14.30	16.70	7.10	33.30
12.30	26.30	6.20	52.60
13.90	17.90	7.0	27.1

Also an output data which closely resembles to the potential actual outcome should be considered as another validity test for the model [22]. For example, in our case, assigning preference to the service provider roles is likely to reduce the cost, and the graphical demonstration of the output of our model confirms this likely result.

First Case: Figure 6 shows the comparison of SLA cost with higher preference given to the service provider. Using simulation cost equations, when priority is assigned to service provider roles, which is the likely case (on the basis of higher relevant frequency values, Table III), the cost of SLA negotiation for the case is far less and stable as compared to service consumers'. Also, the graphical curve of the latter is quite abrupt and instable, which denotes that cost of assigning priority to service consumer roles will be far higher and inconsistent across different phases of the life cycle.

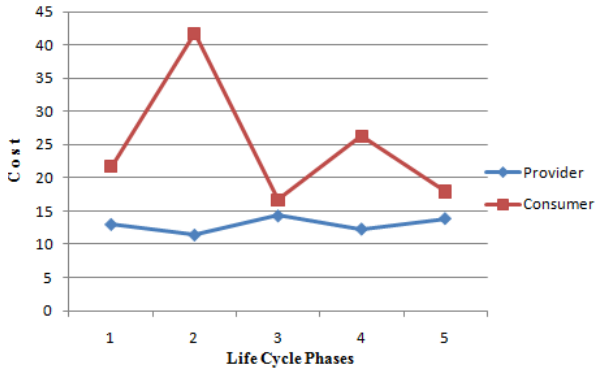

Figure 6. Cost curves with high preference on service provider roles

Second Case: Figure 7 shows the comparison of SLA cost with higher preference given to the service consumer. Using simulation cost equations, when priority is assigned to service consumer roles, (which is the unlikely case on the basis of lower relevant frequency values, Table III), the maximum cost of SLA negotiation is even higher, with somehow similar abruptness and instability as identified in the previous case. But in comparison, the cost of SLA negotiation is still far less stable than the service provider roles. This trend in the graph testifies to the fact that trying to assign priority to service consumer roles will not serve the purpose, considering the fact that their relevant frequency is too small.

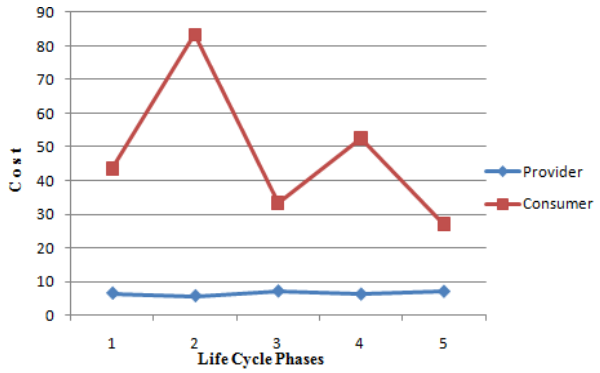

Figure 7. Cost curves with high preference on service consumer roles

***Discussing threats to validity*:** Our simulation comprises a small set of input and output variables. We described the straight forward algorithm exploiting stakeholder frequencies and stakeholder priorities in order to compute the output values, i.e. the cost-values. Based on the clear relation between the input and output variables we can exclude side effects and unfolded dependencies, thus excluding threats to the internal validity of the experimental results. When discussing the external validity it must be noted, that a simulation model can only be an approximation to the actual system, as a model, an abstraction of a potential real world situation. Moreover, validation of the simulation model itself remains as another challenge but as discussed by [22], a few factors help to establish credibility for a model. One of them is understanding and agreeing with the model's assumptions, while the other one is ownership and involvement with the task. We fulfilled both of these criteria while building our simulation model. Furthermore the acceptance is influenced by the applicability of the presented approach to similar settings. Forecasting based on different proportions of the stakeholder involvements could be useful for similar scenarios which fall within its boundaries. To support this, our work uses an external, commonly used service for the simulation, by applying common standards. As our work is reproducible and applicable to a broader area of similar problems, threats to external validity are considerably lower. Finally, to work against threats to construct validity, the simulation model was continuously tested during constitution. Additionally, the simulation results were checked against independently computed results.

VI. CONCLUSIONS AND FUTURE WORK

It is important to understand and implement a good negotiation process as it leads towards a formal agreement between the two parties in the form of the SLA. We have proposed a life cycle based methodology for negotiation between service providers and service consumers. The first phase of this negotiation scheme is to identify the type and number of stakeholder roles involved in the SBS life cycle. This information helped us to calculate their relevant frequencies at each phase, which in fact was used as a corresponding ratio of their participation in the negotiation process. Based on this information, an example conflicting situation was analyzed using the potential number and types of the involved stakeholders. Finally, the identified stakeholder information was simulated to successfully predict the SLA cost associated with assigning priorities to both types of stakeholders; service providers and service consumers.

The distribution of our number of stakeholder roles may look partial, for example, the *service provider* seem to have more roles associated with, thus increasing its priority in the negotiation process. Using the stakeholder role information we gathered across different SBS development life cycle phases is shown in the example.

The information may differ across different environments but the basic theme for assigning priority to any of the stakeholder involved in the negotiation process remains the same. It should be noted that we did not include service consumers as application users as it is rather impossible to predict the exact number of the potential service users. Also, exclusion of the stakeholder role information from the two phases *Deployment & Provisioning* and *Identify Adaptation Strategy* would have changed the results slightly, but the main purpose of this research is to demonstrate the usefulness of the approach.

In our future work, we plan to implement the proposed approach with automated contract negotiation. This will allow us to measure cost as well as other quality attributes associated with electronic contract negotiation. Furthermore, we are planning to expand the present set of equations used to compute the output values. The equations could be refined based on case studies. This should increase the approximation of the simulation to the simulated system thus increasing the fine grainness of the simulation results.

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