



Advance strategies to understand the SLA's (Service Level Agreement) with specific Issues on Requirement Gathering

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ABSTRACT— *Key point of Business is whether Quality of services (QOS) meets consumer's expectations. Service level agreement (SLA) can help to define QOS. The main aim of this research is to explore SLA related issues. We propose interaction strategies between SLA Negotiation and SLA Monitoring. Then, we find approaches to fulfill gaps between SLA and Requirement engineering. Frequency of stakeholder role at each phase defines importance of Stakeholder in SLA Negotiation process. Our aim is to provide an approach for creating a simulator which can define cost of Stakeholder role at each phase of lifecycle. Some projects fail or quality is not up to mark because of problem in requirement gathering. The goal is to make requirement gathering process effective by replacing the issues with respective solutions. We propose methodology to form SLA by considering the requirement engineering. Then we propose interaction of requirement engineering with SLA which provides assurance of the project success.*

Keywords— *Service Level Agreement, Requirement Gathering, SLA Negotiation, SLA Monitoring, Stakeholder Roles, Quality of services, SLA violation.*

I. INTRODUCTION

Quality of services (QoS) meeting Consumer's expectation is a key point of business. SLA (service level agreement) can help define QoS. So understanding of SLA process is necessary. SLA is shaped to obtain official contract between service supplier and client i.e., service purchaser. The steps included in the SLA process is as follows: 1) SLA negotiation, 2) define the requirement for services, 3) prepare the SLA documents, 4) obtain approval (SLA Agreement), 5) SLA monitoring, 6) SLA management, 7) SLA renegotiation.

A. SLA Negotiation

Main purpose of Negotiation is check whether quality attributes and predefined characteristic is met. SLA Negotiation may occur between multiple parties or mostly between two parties. In SLA negotiation both the parties negotiate on the quality attributes and parameter. The two main reasons why negotiations are important are customer has varying needs and Demand and supply requirement constantly changes.

Both the parties try to maximize the profit and the value of SLA by using their knowledge and assumption during the negotiation phase. Fig .1 illustrates the multi round negotiation process for establishing the SLA. Here initiator may be producer i.e., seller or may be consumer i.e., customer. Mostly initiator is producer and responder is consumer. Producer proposes offer with precondition and then consumer apply their knowledge and give response. Possible responses are 1) accept proposal that is provided by provider with precondition. 2) Abort offer. 3) Propose revised offer to producer with precondition made by consumers. In response, consumer may accept proposal if requirement can be fulfilled within threshold value (cost). If proposal is not acceptable, producer may propose revised proposal to consumer with revised precondition or may abort bargaining. This process is called the negotiation process. Bargaining is on cost or quality attribute or on conflicting requirements. This negotiation process continues between both parties: producer and consumer till both parties validate all quality parameters and SLA agreements. Negotiation process plays a key role in SLA life cycle. So SLA negotiation is done very carefully by organizations.

After completion of negotiation process producer starts requirement gathering. Requirements can be categorized as functional requirements and non-functional requirements. After finishing this process producers (organization) prepare SLA documents. These documents are signed by both the parties; SLA Agreement document that is signed formally becomes an approved document.

B. SLA Monitoring

After finishing SLA Agreement process, Producer organization starts SLA management and SLA Monitoring. Consumer organization only does SLA Monitoring. In SLA monitoring process, the consumers mainly concentrate on SLA violation. If any SLA violation occurs, then SLA renegotiation takes place. SLA violation database is created during the SLA monitoring. This SLA violation database will help in upcoming future SLA Negotiation process

C. SLA Renegotiation

SLA renegotiation is needed when SLA violation occurs. Mostly consumers focus on violations that are candidate for penalty. Renegotiation provides a more realistic deadline for consumer. Renegotiation helps producer and consumer to alter SLA in that way by which SLA violation could be removed. Renegotiation approach potentially reduces any penalties that would be imposed on producer. Here multi round negotiation can be used for Renegotiation Process.

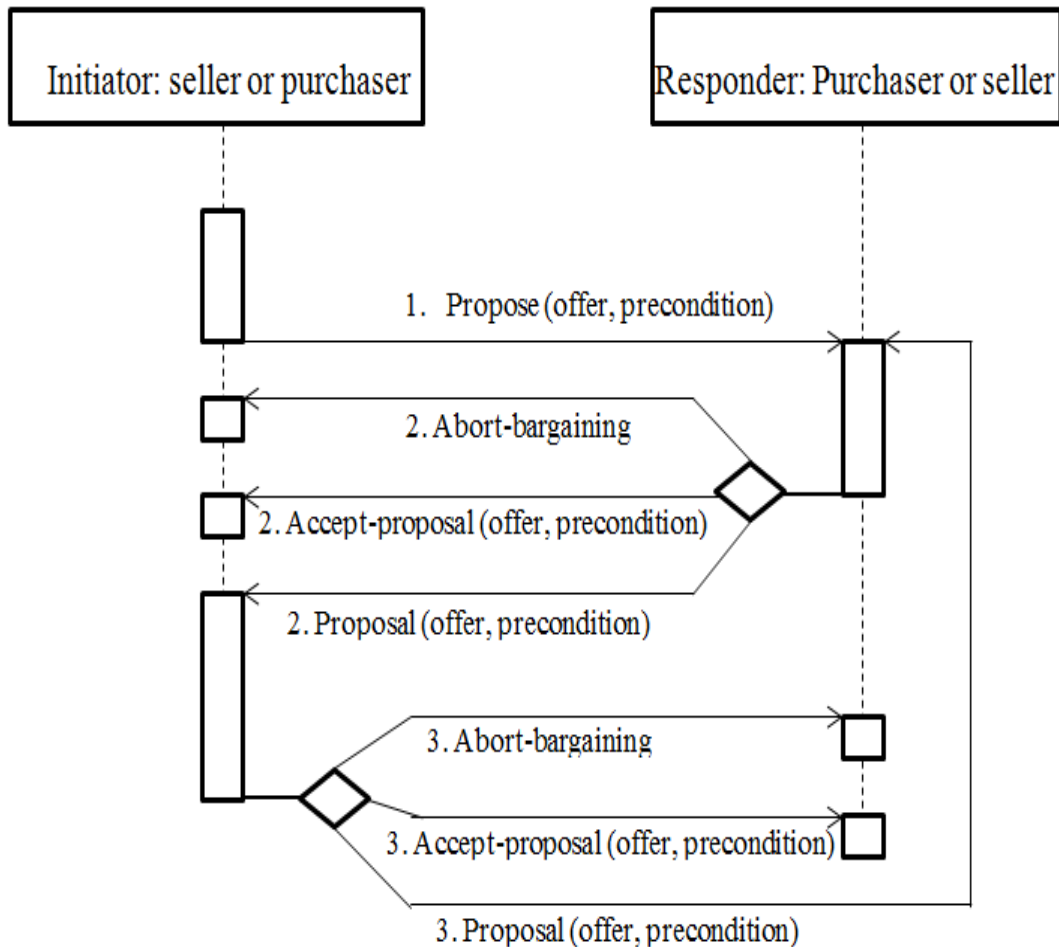


Fig. 1: Negotiation process

II. RESEARCH METHODOLOGY

Key point of business is whether quality of services (QoS) met Consumer’s expectation. SLA (service level agreement) can help define QoS. 1st aim of this research is to understand SLA negotiation, SLA monitoring, SLA management, SLA violation that has already discussed in introduction part. No research paper exactly identifies the interaction between SLA negotiation and SLA monitoring. So give approach to identify interaction between SLA negotiation and SLA monitoring. Then Correlate SLA with requirement engineering & fulfill gap between SLA and requirement engineering. After define roles of stakeholder in SLA. In requirement engineering requirement gathering phase have greater importance. Some of project fails or quality is not up to mark because of problem in requirement gathering. We will find potential Issues on Requirement Gathering (as especially nonfunctional requirement) & give efficient solution.

III. DESIGN

A. Interaction between SLA Negotiation and SLA Monitoring

Main purpose of negotiation is check whether quality attributes and predefined characteristic is met. In SLA negotiation both the parties negotiate on the quality attributes and parameter. Sometime SLA parameter conflict happens between produce and consumer which are shown in Fig. 2. In Fig.2 second parameter ‘response time’ is conflicting

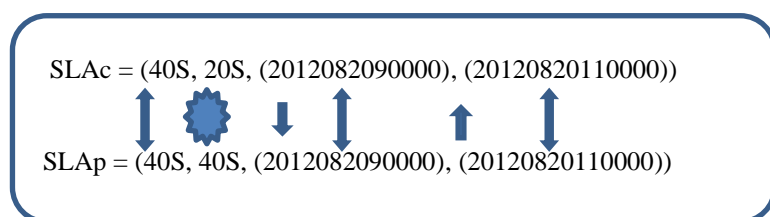


Fig. 2: conflicting SLA parameter

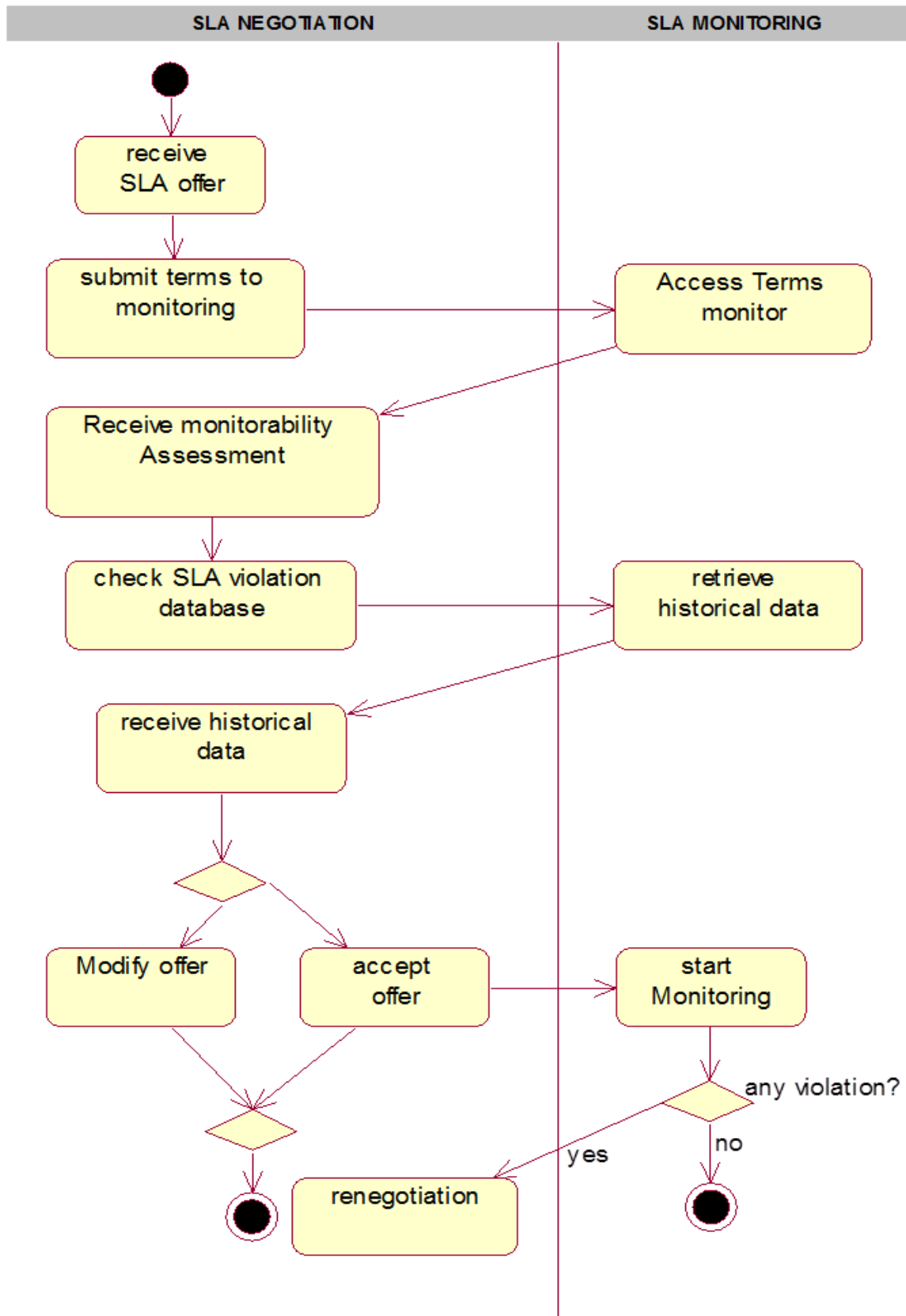


Fig. 3: Interaction between SLA negotiation and SLA monitoring

Consumer wants response in 20 second but producer is not able to provide response within 20 second; producer can provide response time 40 second. So now both parties apply their knowledge and find intermediate solutions, that are 30 second. 3rd and 4th parameters tell service must be available at October 20th 2012 from 09:00 to 11:00.

When SLA parameter is conflicted, both the parties apply their knowledge to resolve this conflict. If resolving this conflict of SLA parameter is costly then both parties may cancel SLA agreement and abort bargaining. Both parties try to resolve conflict parameter and after multi round of negotiation both parties come to one decision for conflicting parameter. This decided parameter is validating by both the consumer and producer. But there may be chance of violation of this conflicting parameter is high. so monitoring of this conflict parameter is rapidly monitoring by consumer. This is real-time practice of monitoring conflicting SLA parameter. In real practice mostly this conflicting parameter is the candidate for violating SLA agreement.

But main question is: 'what is the interaction between SLA Negotiation and SLA Monitoring. Theoretically SLA monitoring starts after finishing of SLA negotiation. But in real practice SLA Negotiation and SLA monitoring starts parallel. Fig. 3 proposes interaction between SLA negotiation and SLA monitoring. SLA Monitoring is needed during SLA negotiation is clearly given in fig. 3. Here service receive SLA offer, SLA monitoring term is generated which is subjected to monitor term validation. SLA monitoring monitors Access term and validate monitor term generated during SLA Negotiation. This validated monitor term Assessment is received. Now SLA negotiation process checks for SLA violation database. This SLA violation database is created during the monitoring of other SLA in past. SLA monitoring maintain SLA violation database because at SLA negotiation process no one can predict that this SLA parameter will violate SLA. Because of no mechanism to find SLA violation at SLA negotiation phase, past SLA violation database helps a lot. SLA violation database contain SLA violation list, violating parameter and root cause of SLA violation. If SLA monitoring is consider parallel with SLA negotiation then there is less chance of SLA violation. It helps producer to prevent unnecessary penalties pay. Considering this historic data consumer make decision whether modify offer or accept offer. After offer is accepted we start monitoring SLA. SLA monitoring process mainly concentrates on SLA violation. If any violation occurs then renegotiation process is initializing to resolve this SLA violation. This approach gives best way to lessen the number of SLA violation; this approach makes SLA process more efficient for both the parties. For producer this approach lessens the due or penalties, for consumer this approach saves time.

B. Interaction and Fulfil Gap between SLA and Requirement Engineering

There are lots of research going on SLA and requirement engineering separately. But no one gives interaction between SLA processes And Requirement Engineering. So I propose here two interaction approach 1) Interaction of Requirement Engineering with SLA. 2) How Requirement Engineering uses in SLA process.

C. Interaction of Requirement Engineering with SLA:

This approach focuses on how SLA effects on Requirement Engineering. Requirement engineering phases are: 1) requirement elicitation, 2) requirement Prioritization, 3) requirement validation, 4) requirement documentation. At every Requirement Engineering phases SLA is considered. At Requirement gathering phase, requirement engineer should take care about the SLA. If any requirement is not met with SLA agreement then refinement of requirement is necessary. At the time of requirement Prioritization higher priority requirement must be check for SLA violation. Higher priority requirement may have complex parameter. This complex parameter is candidate of conflicting SLA parameter which leads to SLA violation. Low priority requirement very rarely affect the SLA.

In Fig. 4 we propose interaction between SLA and service base life cycle, and our focus on Requirement Engineering phase. After SLA Negotiation and SLA Validation, SLA monitoring is started. At each phase of service base life cycle SLA monitoring is necessary. If any SLA violation occurs then SLA renegotiation is mandatory. In this case multi round Renegotiation is used by both parties. As we find SLA violation in earlier phase of service base life cycle, effort needed to resolve the SLA violation is less. SLA violation occurs at Analysis and design phase then there are possibility of two cases: 1) consumer ready for renegotiation 2) consumer refuses for renegotiation and wants previous SLA only.

In first case renegotiation happens between consumer and producer. New SLA agreement is signed by both parties. Producer organization applies his knowledge and goes for redesigning of application. This approach cost less to producer organization even if some penalties charges by consumer to producer. In second case, consumer refuses for renegotiation and wants previous SLA only. so producer have no way rather than going for re-correction of application. Re-correction of application starts from requirement gathering phase to design phase. Producer organization has to go through the whole phases of life cycle.

It cost more than previous case. so SLA violation monitor is very sharply done by producer at each phase of service base life cycle. Most of candidates of SLA violation are found during Requirement Engineering phase and organization resolves it as early as possible. Any Adaption or enhancements propose by consumer then renegotiation is approached and refined SLA is established, then according to refined SLA, SLA Monitoring is started on each phase of life cycle for enhancement of application.

D. How Requirement Engineering useful in SLA process.

The steps include in the SLA process: 1) SLA negotiation, 2) define the requirement for services, 3) prepare the SLA documents, 4) obtain approval (SLA Agreement), 5) SLA monitoring, 6) SLA management, 7) SLA renegotiation. After SLA negotiation done between producer and consumer, Requirement engineering team activated. Requirement engineering team defines the requirement for services. Requirement gathering helps to identify SLA parameters. These SLA parameters are functional requirements. If non-functional requirements are also consider then chance of SLA violation during later phases of life cycle is very less.

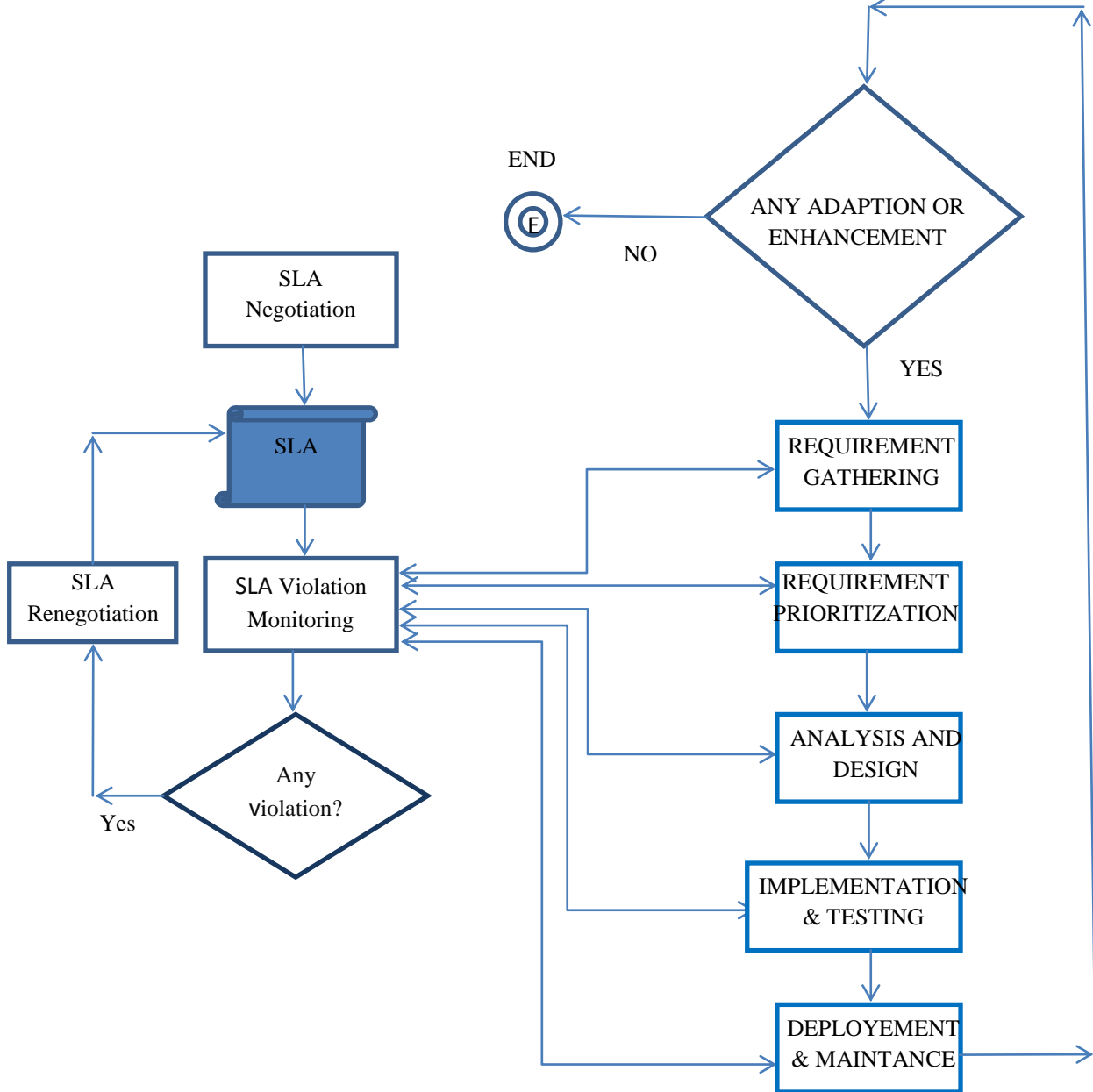


Fig. 4 Interaction of SLA with service base life cycle

Requirement prioritization assigns high priority to important parameter of SLA. Requirement Engineering helps to identify parameters and their priority in SLA process. Then requirement engineering team produces requirement documentation. This document is submitted to SLA Department. This SLA department prepare SLA document which is validate and signed by both parties. This validated SLA document is called SLA Agreement.

IV. EVALUATION RESULTS

A. Stake holder role

When any SLA violation occurs organization investigates who is responsible for this SLA violation. To find root cause of SLA violation organization maps this violation parameter to service base life cycle. Ascertain the stake holder responsible for that SLA parameter violation is determined by the mapping. For this purpose, identifying stake holder and its role at each phase of life cycle is essential. Different Stake holders are: requirement engineer, designer, developer, provider, consumer, broker, end user. Mainly categories stakeholder roles in 1) service producer 2) service consumer.

TABLE I
INTEGRATION OF RELEVANT FREQUENCY OF STAKE HOLDER WITH PHASES OF LIFECYCLE.

Phases	Stakeholder Roles (in term of relative frequency)	
	Service Provider	Service consumer
Requirement engineering and Analysis	0.78	0.22

Design and implementation	0.86	0.14
Process and Organization	0.71	0.29
Maintenance after Deployment	0.79	0.21
Adaption Demands	0.70	0.30

Here stakeholder role is taken in term of frequency. Importance of stakeholder in negotiation is determined by value of comparative frequency. So stakeholder frequency at every stage of life cycle determines the candidate for SLA negotiation. There is great importance of Stakeholder roles in SLA process. ‘Relevant frequency’ of stakeholder role is given by individual occurrences of frequency divided by total occurrence in that stage. In Table-1 we divide Stakeholder role into service supplier and service purchaser. The Value is given in term of relative frequency.

B. Simulation

Important assessable quality attribute of SLAs is determined by cost. We can build simulator for finding cost of Stakeholder roles at each stage of lifecycle. Stakeholder role is categorized in service supplier and service purchaser. In the simulation we assign priority to service provider and service consumer. Base on relative frequency and this priority we find cost of service supplier role and service purchaser role at each phases of life cycle. Table-2 provides high and low priority value for both stakeholder roles.

TABLE II
PRIORITY FOR STAKEHOLDER ROLE

Stakeholder Type	High significance(high preference)	Low significance(low preference)
Service supplier	Pp = 10	Pp = 5
Service purchaser	Pc = 10	Pc = 5

TABLE III
EQUATION FOR SIMULATOR

Total Cost of all Stakeholder(COSTt)	COSTs+COSTp
Cost of Service Supplier Roles (giving high priority to producer)	$(TRf * Pp)/RFp$
Cost of Service Purchaser Roles (giving high priority to producer)	$(TRf * Pc)/RFc$
Cost of Service Supplier Roles (giving high priority to consumer)	$(TRf * Pc)/RFc$
Cost of Service Purchaser Roles (giving high priority to consumer)	$(TRf * Pp)/RFp$

Where COSTs: cost of role of Service Supplier. COSTp: cost of role of Service Purchaser. TRf: Total cost of role of consumer and producer (all roles). Pp: Priority of Service Producer Role. Pc: Priority of Service Consumer Role. RFp: Relative frequency of Producer Role. RFc: Relative frequency of Consumer Role.

Here we categories our observation in two category base on priority 1) giving higher priority to producer and find the cost of producer role and consumer role, 2) giving higher priority to consumer and find the cost of producer role and consumer role. After that we can plot the graph and come to conclusion by comparing it. We can obtain observation using cost equation given in table-3 and frequencies of stakeholder role (given in Table-1) and priority (given in Table-4). So we can approach the cost of individual stakeholder role as well as total cost of all stakeholder roles for SLA Negotiation process. At last we can come to determination which case give less cost and more stable behavior. Cost values for both service producer and consumer are given in Table-4 by giving high preference to producer and then to consumer

TABLE IVV
OBSERVATION-COST VALUES FOR SERVICE CONSUMER AND SERVICE PRODUCER

Giving high priority to service supplier roles		Giving high priority to service purchaser roles	
Service Supplier Roles Cost (COSTs)	Service Purchaser Roles Cost (COSTp)	Service Supplier Roles Cost (COSTs)	Service Purchaser Roles Cost (COSTp)
12.82	22.72	6.41	45.44
11.63	35.71	5.82	71.42
14.08	17.24	7.04	34.48
12.65	23.80	6.32	47.60
14.28	16.67	7.14	33.34

Case 1: assign higher priority to producer

Here we provide more significance to provider. Cost of SLA Negotiation for Service supplier is less. Graph of service supplier become stable compare to service purchaser .services consumer graph is instable and abrupt compare to service provider.

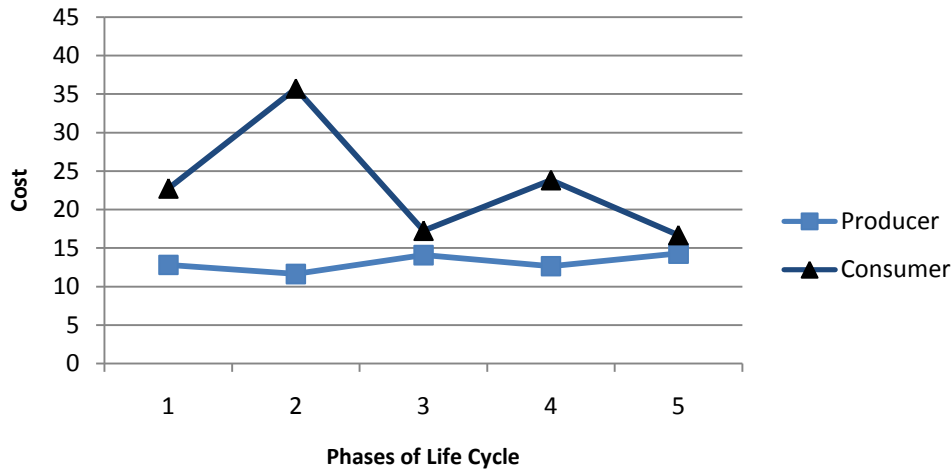


Fig. 5 Cost graph giving high priority to service producer.

Case 2: assign higher priority to consumer:

Here In fig. 6, we provide more significance to consumer. . Cost of SLA Negotiation for Service supplier is far less. Graph of service supplier become stable compare to service purchaser Services consumer graph is instable and abrupt compare to service provider.

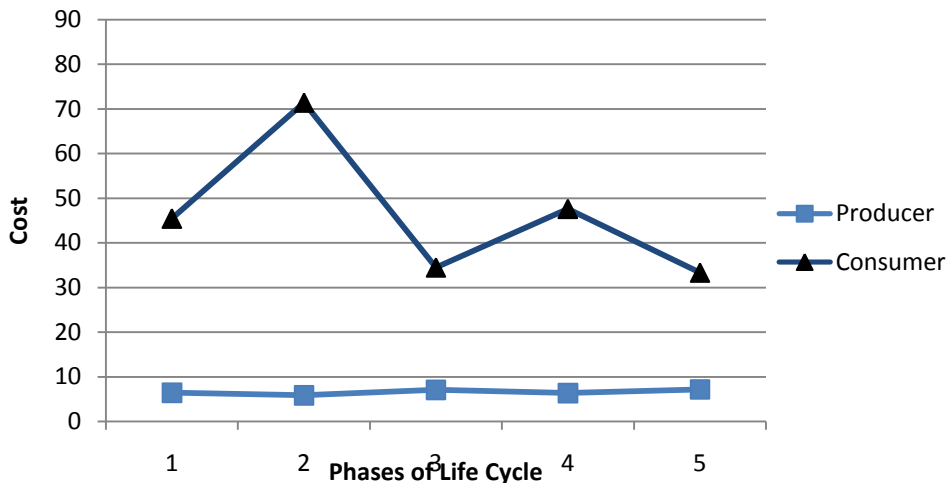


Fig. 6 Cost graph giving high priority to service consumer.

Here cost of negotiation for consumer is almost double than the case1. In case 2 by providing more priority to consumer, cost of service provider role become more stable and Cost of SLA Negotiation for producer become less but cost of service consumer become very high and instable.so by comparing both the case, we can conclude that assign high priority to producer give stable and cost effective Approach for SLA negotiation.

V. ISSUES ON REQUIREMENT GATHERING

Table- V

ISSUES AND SOLUTION HINTS ON REQUIREMENT GATHERING.

Index No.	Issues	Statement	Solution & approach
1	Integration of Nonfunctional Requirement(NFR) and Functional Requirement(FR)	Integration of Nonfunctional requirement with functional requirement is very tough task. Very experience person may fulfill this task.	Goal oriented approach, Goal –driven framework for integration of NFR with FR.
2	Neglecting NFR at Requirement Gathering	Some of project fails or quality is not up to mark because of not considering NFR at requirement gathering phase. Companies identify NFR at design or implementation	Companies must identify NFR at Requirement Gathering phase of life cycle.

		phase.	
3	Identify NFR of customer or users.	Most of projects are not met the nonfunctional requirement because NFRs are not directly mentioned by customer.	A detailed checklist approach for elicitation of NFRs.
4	Interaction of SLA with Requirement Engineering	No approach is proposed by any author on this issue. Interaction and Fulfill Gap between SLA and Requirement Engineering is essential	We already propose this approach in this paper at part 4.2.
5	Customer Requirements change rapid	If customer requirements are changing rapidly then identifying Requirements are tough and results in ambiguous requirement.	Agile Requirement Engineering approach, Rapid Prototype approach, SLA agreement
6	Friction between customer and developer.	Because of misunderstanding and unnecessary delay of meeting causes friction between customer and developer.	Maintain skilled staff, Define and Maintain Schedule in stepwise manner.
7	Missing Requirements	Missing requirements leads to failure of project.	Validation and verification of requirement by client before design phase starts.
8	Conflicting requirements	Requirements may conflict when requirement is gathered by two different stakeholders.	Goal-oriented approach, View-oriented requirement approach, Use tools to resolve conflict.
9	Privacy and security Requirements	There are lots of Issues identified for Privacy and security Requirements but effective solution is not discovered.	Pattern based solution for Security Goals, Feature oriented domain analysis. Efficient security algorithms, find reusable security and privacy goals.

VI. CONCLUSION AND FUTURE WORK

In this research paper, better understanding of SLA process is given in depth. We proposed an excellent approach for Interaction between SLA Negotiation and SLA Monitoring. The approach makes SLA process more efficient and fulfill missing links between SLA Negotiation and SLA Monitoring. We exclusively found an approach to fulfill gap between SLA and Requirement Engineering. We found that Frequency of stakeholder role at each phase defines participation of stakeholder in SLA Negotiation process. We proposed approach for a simulator which can simulate cost of stakeholder at each phase of lifecycle. From this simulation we can conclude that cost of total stakeholder is less when we are giving higher priority to service producer rather than service consumer.

At last, we proposed list of Issues on requirement gathering and solution hints. In future work, we will find the effective solution of these Issues. We will extend our work that is SLA and Requirement gathering process on cloud based services. We will also find real time Issues and propose effective solutions on SLA and requirement gathering for Cloud Computing.

REFERENCES

- [1] Palacios, M.; Garcia Fanjul, J.; Tuya, J., "Design and Implementation of a Tool to Test Service Level Agreements," Latin America Transactions, IEEE, vol.12, no.2, pp.256, 261, March 2014
- [2] Xiaoyong Li; Junping Du, "Adaptive and attribute-based trust model for service level agreement guarantee in cloud computing," Information Security, IET , vol.7, no.1, pp.39,50, March 2013
- [3] Serral-gracia, Y Labit, J D Pascual, P owezarki, "towards an efficient Service level Agreement assessment". IEEE 2009, pp: 2581-2585.
- [4] Sajid Ibrahim Hashmi, Rafiqul Haque, Eric Schmieders, and Ita Richardson. Negotiation towards service level agreements: A life cycle based approach. In SERVICES'11, pages 1–8, 2011.
- [5] M Comuzzi, C Kotsokalis, G Spanoudakis, R yahyapour. "Establishing and monitoring SLAs in complex Service Based Systems". IEEE international conference on Web Services, 2009, pages: 783-790.
- [6] M Mattsson, C Makridis, Evaluating SLA Management Process Model within Four Companies. The Third International Conference on Software Engineering advances, IEEE 2008. Pages: 158-165.
- [7] E Marilly, O Martinot, S Brezets, G delegeue. "Requirements for Service Level Agreements management", IEEE 2002, pages:1-7.
- [8] S Brezets, O Martinot, G delegeue, E Marilly. PRO-Active SLA Assurance for next generation network. Alcatel CIT 2002. Pages: 1-6.
- [9] H NAZ, M N Khokhar, "Critical Requirement Engineering Issues & their solution". International Conference on Computer Modeling and simulation IEEE 2009. Pages: 218-222.

- [10] S Ullah, M Iqbal, a Khan, a Survey on Issues in Non-Functional Requirements Elicitation. IEEE, 2011, Pages: 333-340.
- [11] N Jailani, M Mukhtar. Agent Based Negotiation Framework for Web Service's SLA. 7th International conference on IT in Asia (CITA), IEEE (july 2011). Pages: 1-7.
- [12] Software Requirement Engineering: What Why Who When How By Linda Westfall, 2006. [13] C Menon, T Kelly. "Eliciting Software Safety Requirements in Complex System" IEEE 2010. Pages: 616-621.
- [14] S Asghar, M umar. Requirement Engineering Challenges in Development of Software Applications. International Journal of Software Engineering (IJSE), Volume (1): Issue (2), 2010. Pages: 32-49.
- [15] Vassev, E.; Hinchey, M., "Autonomy Requirements Engineering," Computer, vol.46, no.8, pp.82, 84, August 2013.