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A Comparative Model for Tradeoff Analysis of QoS Attributes in SOA

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ABSTRACT

It is inadequate to just assure the functional requirements. Quality of service (QoS) must also be satisfied. An important challenge for developing efficient Service Oriented Architecture (SOA) is to maintain the QoS attributes because of compositional and dynamical environment of SOA. It is significant to scrutinize how quality attributes are supported by SOA. However, implementation of SOA presents complex challenges to achieve preferred QoS objectives. Developing the efficient ways to integrate the quality of service attributes with system's architecture offers a basis to take decision regarding trade-off. This paper proposes a comparative model to analyze the trade off among the QoS attributes in SOA. Our major goal is to trade off among the various QoS attributes to achieve an improved system as a whole because it is unrealistic to achieve the full set of QoS requirements in any particular domain.

KEYWORDS: Service Oriented Architecture, QoS, Tradeoff, Quality Attributes.

I. INTRODUCTION

In Software Engineering, QoS includes both functional and non functional quality attributes as security, performance, reliability, availability and scalability etc. The most critical and important challenge is to deliver QoS over the internet because of having erratic and dynamic nature [1].Service Oriented Systems must satisfy QoS requirements. SOA has attained great appraisal since 2005 because of its promising benefits which include: return on investment (ROI), interoperability and tremendous flexibility.SOA is the emerging paradigm in distributed environment having aim to develop loosely coupled software systems which can be extended by using legacy systems. SOA is founded over web services and they are dependant on XML. Hence, it is feasible for any programming language and platform to develop software applications by utilizing these web services [2].

SOA is a famous mechanism to achieve interoperability among systems and for the purpose of functionality reuse. SOA is facing various challenges of implementation associated with verification and validation in SOA and particularly of QoS attributes. [3]. SOA is accepted due to its probability in various areas. It provides the capable solution to address the interoperability issues of platforms that are experienced by various integrators of software system. It also helps in composing a service by utilizing the already existing web services, supporting the reuse which was the dream of software engineering [4]. SOA assists the dynamical nature organizations providing various services working as a system, each service communicating with other by the exchange of messages [5]. An architecture presented by SOA is flexible that combines various business processes through modularization of big applications as services. From any computer, operating system, and in any language we can get access to SOA service [6]. Specific realization of SOA is the web service; various protocols have built for the web services. Every web service provider uses WSDL (Web Service Definition Language) protocol which describes the web services and their location .Web service provider is connected with UDDI (User Description Discovery and Integration) Registry.UDDI Registry is web service directory where all service providers register and search for the services. Web Service Consumer search for the service into UDDI Registry if it finds the service here then it directly communicates with Web Service Provider using SOAP [7].

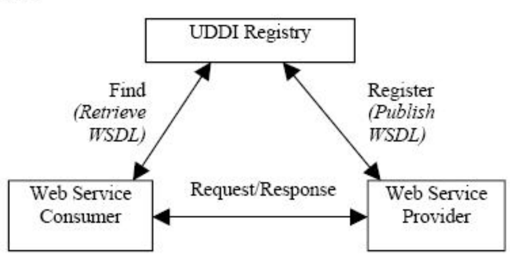

Fig. 1. Basic Web Service Model

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An important challenge for developing efficient Service Oriented Architecture (SOA) is to maintain the QoS attributes because of compositional and dynamical environment of SOA. It is significant to scrutinize how quality attributes are supported by SOA. However, implementation of SOA presents complex challenges to achieve preferred QoS objectives. Developing the efficient ways to integrate the QoS attributes with system's architecture offers a basis to take decision regarding trade-off.

A tradeoff is the mechanism which refers to the condition where losing the one quality attribute or aspect in order to gain the other. It involves making a decision by understanding both positive and negative aspects of the specific choice [8].In Figure 2, few typical relationships between QoS attributes are illustrated, although we might meet exceptions in these. In cell plus sign shows that if we increase the attribute in the subsequent row it has positive impact on the quality attribute in the given column and negative sign shows that if we increase the attribute in subsequent row it has negative impact on quality attribute in given column.

	Availability	Efficiency	Flexibility	Integrity	Interoperability	Maintainability	Portability	Reliability	Reusability	Robustness	Testability	Usability
Availability								+		+		
Efficiency			–		–	–	–	–		–	–	–
Flexibility		–		–		+	+	+			+	
Integrity		–			–				–		–	–
Interoperability		–	+	–			+					
Maintainability	+	–	+					+			+	
Portability		–	+		+	–			+		+	–
Reliability	+	–	+			+				+	+	+
Reusability		–	+	–	+	+	+	–			+	
Robustness	+	–						+				+
Testability	+	–	+			+		+				+
Usability		–								+	–	

Fig.2. QoS Attributes Tradeoff

To assure the users requirements, software designers are required to observe the tradeoff between varieties of contradictory attributes. The final goal is the capability to perform quantitative evaluation and tradeoff various QoS attributes to achieve as a whole an improved system. Moreover, tradeoff analysis is the method that helps software engineers to foresee the extra functional end results of substitute design decisions and then choose the best architecture without expensive prototype. Designers do not need to attempt to achieve just a solitary metric but they must effort for quantifying the attributes and for the tradeoff among these various metrics by taking start with the sketch of software architecture [9].To implement software activities in SOA, a match is required among the functionality that is required and the other that is to be provided by SOA. During the service selection to meet the required functionalities of business, only constraints are measured. Contrarily, customer requirements over QoS are not hard and therefore they permit tradeoffs [10].

II. RELATED WORK

Shuping Ran [4] has proposed novel model for web service which used both functional and non functional requirements for discovery of services. In this model as shown in Figure 3, service provider requires to provide information regarding company, functional characteristics of service which is demanded by the UDDI registry and also provides QoS information. Provider of web services first requires communicating its QoS claim to quality of service certifier of web service. This certifier examines the claims and even certifies or relegates the claim. It sends the result to service provider with identification of certification. Repository of certifier also registers this information along with Id called Id of certification. Certifier supplies variety of services to those parties which are interested to contact its repository to verify the claims of QoS. When certifier issues certification of QoS, then supplier registers itself with registry of UDDI.

This registry communicates/interacts with certifier to ensure the presence of certification. Upon successfully examination, registry records web service in its own repository. Consumer seeks out registry (UDDI registry) for getting service according to desired functionality and can add up any constraint on the searching process e.g. constraint can be to search and provide only the demanded QoS .If there are various web services in registry that provide same functionality then QoS requirement will impose a better-quality search. If web service with required qualities is not available, service consumer will be informed about it. Then service consumer can lessen its QoS constraint or to consider tradeoff for the desired QoS. Once the service is discovered, consumer will get WSDL and information about QoS that is certified.

Consumer can ensure the claim of QoS via the certification Id through certifier. If consumer is satisfied with the findings, it can call up the services by using this model.

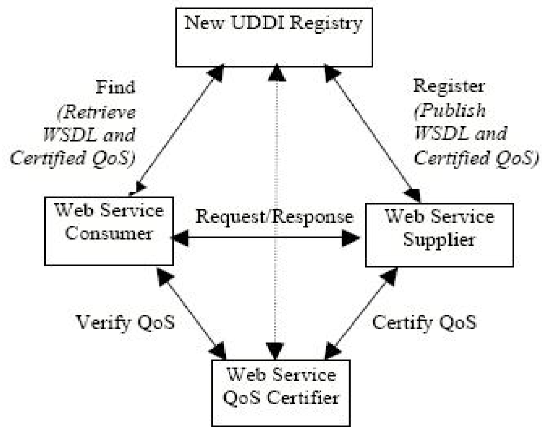

Fig.3. New Model for Registering and Discovery of Web Services

In [11] V.Deora et.al. have considered the problem of assessing QoS in SOA. It is significant problem because it is quite possible that several providers of web services provide similar web services but with variant qualities. It is important that agent only select that service which meet the needed capability with least cost and also fulfill the requirements of quality. These problems are addressed by the authors of the paper by launching the novel model for gathering and computing QoS. They attempted to collect ratings for QoS and expectations from web service users, so that they can calculate QoS in proper way. On the basis of expectations of users they also intended to compute QoS dynamically at the moment when QoS evaluation request is issued and used that rating which has same expectations. Therefore, they presented a QoS assessment model that can incarcerate the reason of ratings. It permits to carry out QoS evaluation, by utilizing the ratings which have identical expectations.

They introduced certain score that regulates rating and it is made by evaluating the behavior of past rating of user about web services. Their experiments showed that the technique they proposed can produce result in terms of more significant and trustworthy assortment of services. In their proposed model an agent called "Quality Assessment/Evaluation Agent" is responsible for collecting the ratings and to use them into calculating QoS based on user's expectations. The fundamental architecture of agent is given in Figure 4.

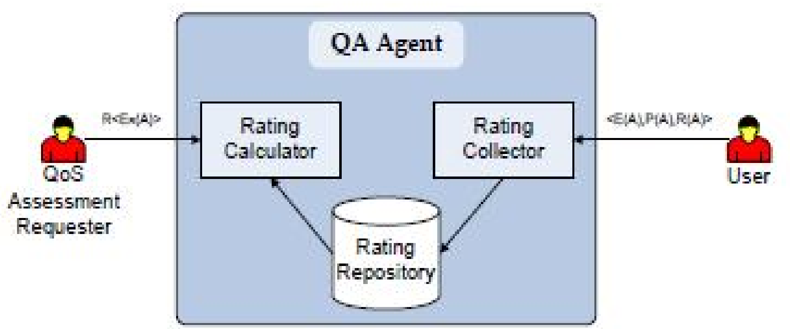

Fig.4. Architecture of Quality Assessment Agent

This agent consists of two components including "Rating Collector" and "Rating Calculator". Collector is inclined to collect ratings for quality and Calculator is liable to compute quality of service from the ratings that are gathered. In [5] authors have presented an adaptive model to perform tradeoff among the security and performance in environment that is service oriented .It is used to fine-tune the configurations of security to supply adequate protection and to assure the performance related requirements for service oriented systems. To construct the tradeoff model requires developing the metrics for the quantitative measurement of the security and performance. They combined both security and performance metrics together with two weight factors. These factors show the priority on security and performance. They have also illustrated how to attain the maximized security and performance and optimal balance among security and performance by modifying the weight factors.

BangYu Wu et.al. [12] have addressed pragmatic facets for the selection of service and to perform tradeoff. They proposed a model for service selection on the basis of QoS and examined two algorithms for selection. Practical results showed that their model can offer better tradeoff among selection time of services and metrics for QoS. They suggested the idea to utilize variables of operational environment for modeling of QoS in selecting the services that are dynamic with the help of quality of service reference vector. They are described algorithms for selection and also compared them. One of them is used to achieve exact service that match with the QoS condition of users and the policies of selection. Second is used to make up the service that satisfies the constraints of QoS imposed by the users with the greatest speed. Their results proved that the computational cost for the exact selection and dynamical programming is suitable when the tasks, services and metrics for QoS are not much large. The results have also shown that the exact selection mechanism guides towards improved QoS with higher duration for execution, which is reverse case in dynamic programming.

III. PROPOSED METHODOLOGY

SOA has grown up as an architectural style for e-government and this shift towards SOA is two folded: e-government wants to narrow down the gap among people and the different federal agencies. We have considered an example of e-government system and have identified few QoS attributes in this domain e.g. security, interoperability, availability, performance, usability and reliability (see **Table 1**).

Table 1. QoS Attributes (Goals) in E-Government SOA.

QoS Attributes (Goals)	Description
Security	Purpose of e-government is to make it possible that services provide safe transactions and communication among the participants. Security includes safeguard of network, data and computational power.
Interoperability	It deals with how the information is used/exchanged between public authorities and how system is developed.
Performance	Performance means to provide the services to its users efficiently and with minimum response time so that the users are not hanged on for the services
Usability	It ensures the ease of use, enough and usefulness of information and better understandability so that maximum people can get benefit from services offered by e-government
Reliability	It deals with the capability of e-government services to provide transparent, reliable and fault tolerant services to its users.

We have treated these QoS attributes as goal or soft goals and further break down these into sub goals. Rounded circles represent the goals and arcs represent the relation between the goals. Relation among goal and sub goals can be OR/AND .If the relation is AND then goal will be fulfilled, if it's all sub goals are satisfied. When relation is OR then goal will be satisfied, if any sub goal among the various sub goals is satisfied. Security is one of the QoS attributes in e-government SOA, because the services provided by e-government must be secured, this is depicted by top goal in Figure 5.

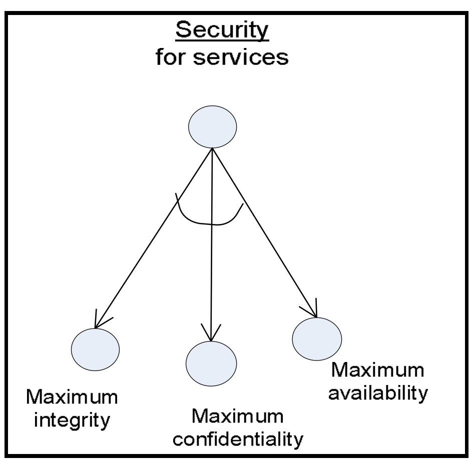

Fig.5. Subdividing Security Goal

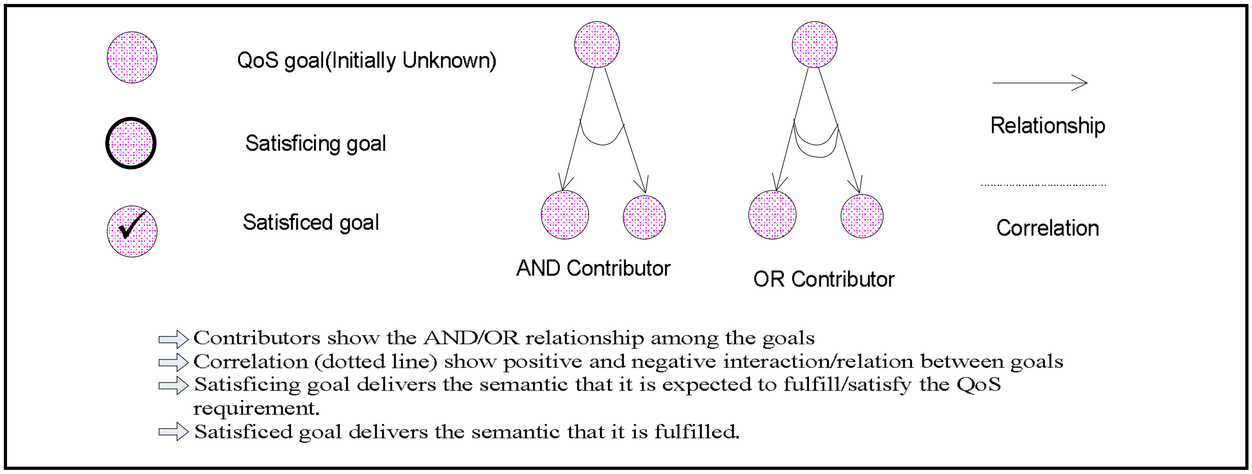

Fig.6. Notations

The top goal "Security" is further divided into three sub goals as Integrity (protection against unauthorized access and updation), Confidentiality (hiding the data from unauthorized individuals) and Availability (protection against service disruption).This process of dividing the goal into sub goals will continue until there is no goal/sub goal left which can further be able to sub divide or need to refine. Sub goals "Maximum integrity" and "Maximum Confidentiality" are further divided. Integrity is divided into two more sub goals "Consistency" and "Encryption" .Furthermore, an alternate technique" Use cipher text" relevant to assure the integrity is also suggested.

In case of confidentiality in Figure 7, the alternate technique to assure the confidentiality is "Authorized accessibility to services". Repeating the process, this technique is more refined to be goal for "User access authentication", "User identification" and "User access validation against rules of eligibility". To achieve the authentication of user access the alternate techniques are "Verify password", "Compare digital signature" and "Additional personal information". The relation between these alternatives is OR therefore, among these alternatives the alternative "Compare digital signature" is selected because it is considered to be more reliable and efficient method to authenticate the access of user.

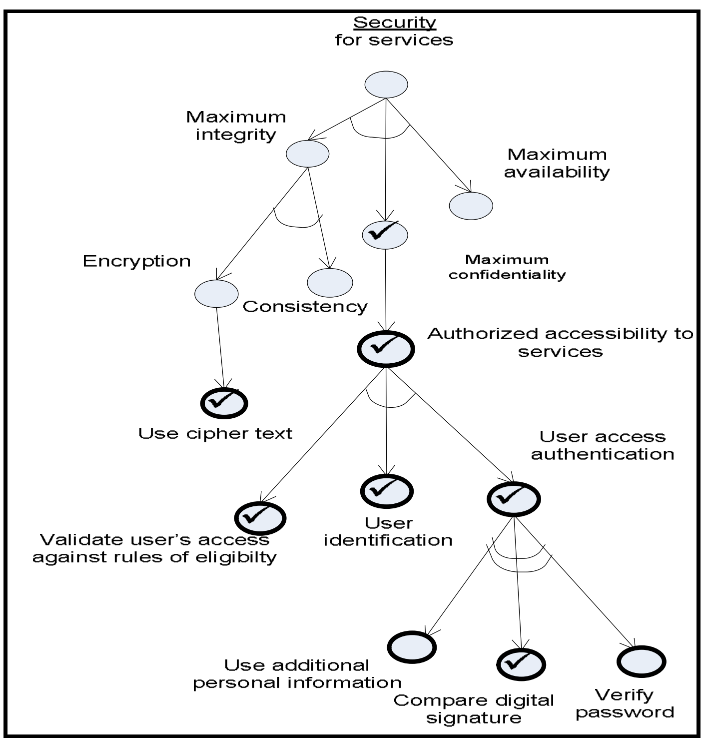

Figure-7: Subdividing and Selecting Alternative Techniques to Achieve Integrity and Confidentiality Goals

Second goal identified in e-government SOA is “Performance”; e-government should provide the services to its users efficiently and with minimum response time so that the users are not hanged on for the services. Moreover, the services should be easily accessible by the people. Performance goal (shown in Figure 8) is sub divided into two sub goals “Easy access” and “Minimum response time”. “Minimum response time” is achieved by alternate technique provided i.e. “Load balancing”. Interoperability in Figure 8, is subdivided into “Easy data exchange” and “Platform Independence”. Easy data exchange can be achieved by alternative “Use standard data format”

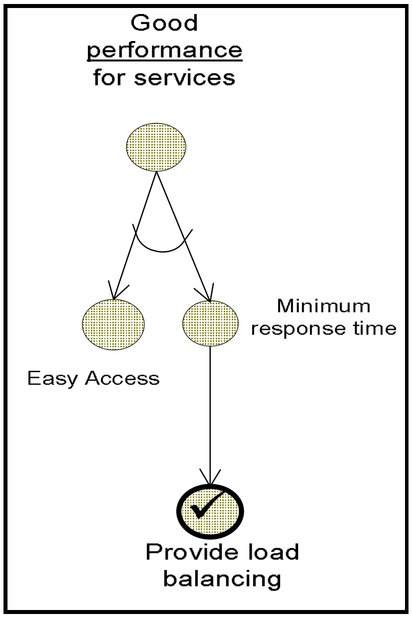

Fig.8. Subdividing and Selecting Alternative Technique to Achieve Performance Goal

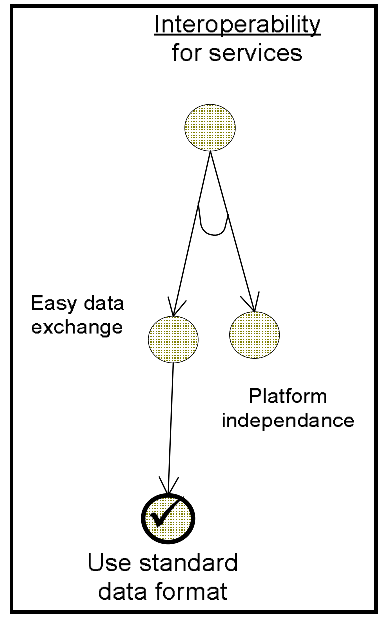

Fig.9. Subdividing and Selecting Alternative Technique to Achieve Interoperability Goal

Usability is also very important goal so that users can easily utilize the services provided by e-government and get most of the benefit from them. Usability goal (see figure 10) is subdivided into “Usefulness of contents”, “Ease of use” and “Adequate information” sub goals.

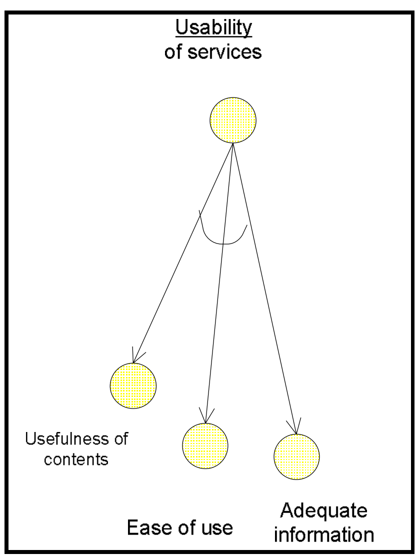

Fig.10. Dividing Usability into Sub Goal

Similarly, Reliability goal is broken into two sub goals as “Fault tolerance” and “Trustworthiness”. To achieve the fault tolerance different alternatives including “Process migration”, “Roll back recovery” and “Proactive detection” are provided. Proactive detection is selected to meet the fault tolerance sub goal as it is considered the good alternative approach so that fault is detected before occurrence. In the same way, Trustworthiness is achieved by providing the alternative techniques as “Transparency of information” and “Efficient services” and both are selected to meet the trustworthiness.

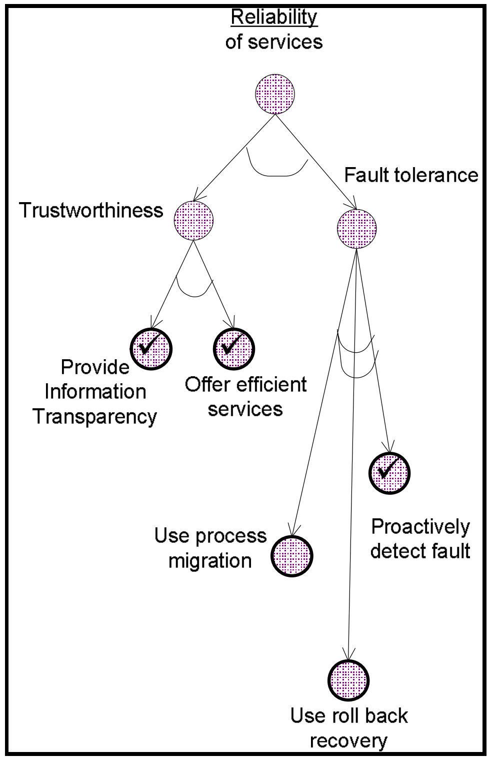

Fig.11. Subdividing and Selecting Alternative Technique to Achieve Reliability Goal

IV. PERFORMING QOS TRADEOFFS

We have made a comparative model for performing the tradeoff analysis of QoS attributes .Tradeoff among various attributes is shown in Figure 12. Positive and negative correlation linkage is showed by dotted line. The negative correlation linkage between “Minimum response time” and “Use cipher text” demonstrates that increasing the integrity by using the encrypted techniques will hurt the response time because system will go through various layers of encryption which will increase the response time. Therefore, it is showing tradeoff as by using cipher text, response time will increase.

Similarly negative correlation link between “Minimum response time” and “Validation of user access” shows that user’s validation has negative impact on response time as to provide the security of e-government services it is needed to insure the validation of user’s access against the rules of eligibility which is a bit time consuming process and will maximize the response time. On the other hand, positive correlation linkage between “Information transparency” and “Ease of use” indicates that if the services provided by the e-government are transparent and there is transparency of procedures and communication with its citizens then it will be easy for the citizens to use the services.

Likewise, correlation link between “Easy data exchange” and “Efficient services” is positive which shows that if the efficient services are provided then it is easy to exchange the data between different public authorities, it means by providing the efficient services, easy exchange of data is possible.

Correlation link between “Ease of use” and “Additional personal information” is negative which indicates tradeoff because users can only access the services if they provide all personal information and pass through the authentication mechanism successfully, it has negative impact on ease of use as it is not easy to use the services by all the users until they do not provide their personal detail. Another tradeoff is shown between “Easy data exchange” and “Use cipher text” .By using encrypted techniques the data exchange becomes difficult it requires encoding and decoding mechanisms which hampers the easy exchange of data.

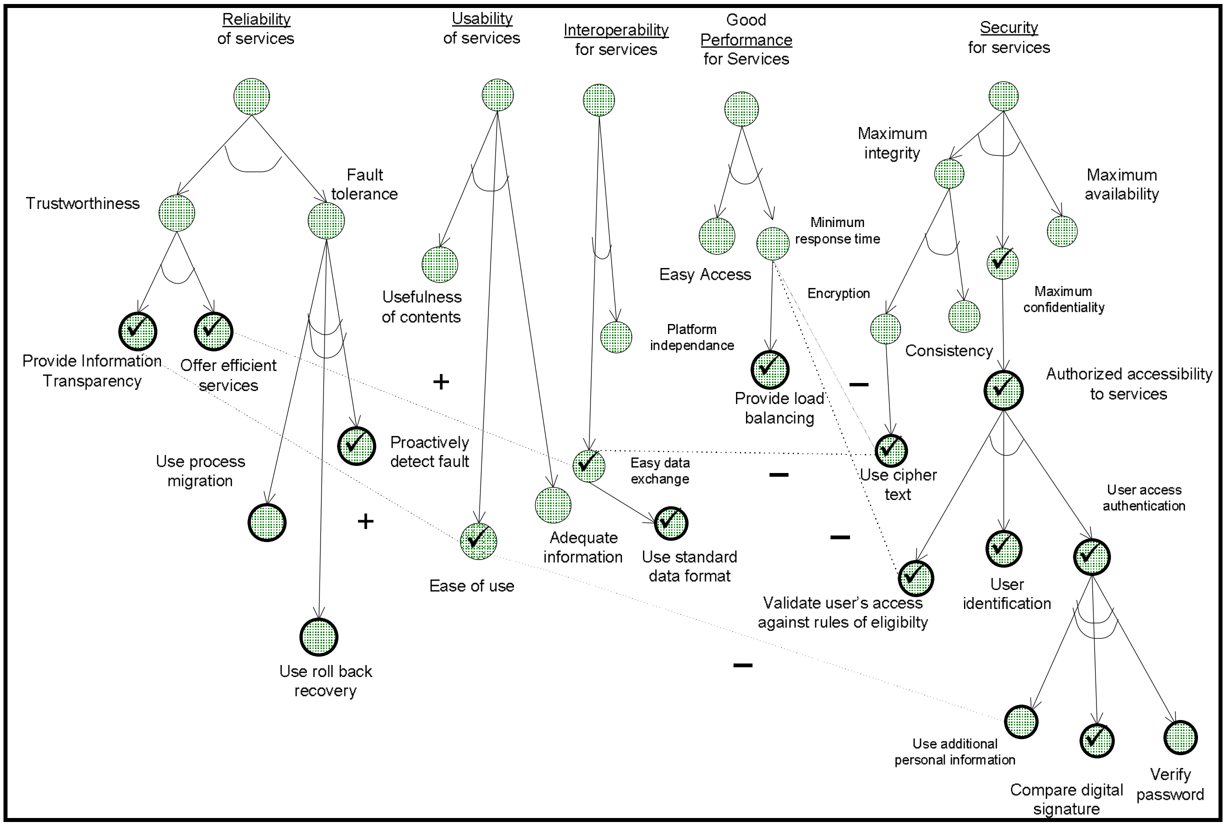

Fig.12.Performing QoS Tradeoffs

V. STATISTICAL ANALYSIS

Since a tradeoff is the condition which involves lose/drop one aspect or quality attribute to gain other quality attribute because it is unrealistic to achieve the full set of QoS requirements in any particular domain. In Table 2, the tradeoff among QoS attributes in SOA of e-government is illustrated in tabular form; plus sign shows that if we increase the attribute in the subsequent row it has positive impact on the quality attribute in the given column and negative sign shows that if we increase the attribute in subsequent row it has negative impact on quality attribute in given column.

VI. DISCUSSION

SOA is the current approach addressing the difficulties of architectures of information technology(IT).SOA has been debated in scientific society and business people have initiated to implement it in organizations. However, SOA development faces various challenges and developers require being certain that services will surely meet up the quality requirements of user. Moreover, to deal with these challenges software developers must have to acquire information regarding QoS attributes. In our work, we have proposed a comparative model for performing the analysis of QoS attributes in SOA. Therefore, we have identified few QoS attributes: security, performance, interoperability, usability and reliability in SOA of e-government because these QoS attributes are most widely addressed in e-government domain. These QoS attributes are treated as goals and then decomposed into further sub goals. This process of decomposing the goals is continued until no goal is left which can further be able to sub divide or need to refine. Moreover, we have also provided the alternative techniques to satisfy these goals.

VII. CONCLUSION AND FUTURE WORK

In this paper, we have proposed a comparative model to analyze the trade off among the QoS attributes in SOA. Our major goal is to trade off among the various QoS attributes to achieve an improved system as a whole because it is unrealistic to achieve the full set of QoS requirements in any particular domain. This paper has explored deeply the QoS attributes in SOA and has taken the example of e-government domain and identified few QoS attributes in it and has suggested a comparative model for performing the tradeoff. Further research is recommended to identify more QoS attributes in e-government system. Moreover, relationship among all QoS is not considered in our proposed model. Few other QoS attributes (goals) in e-government domain will be identified and the relationship among all QoS attributes will be developed.

Table 2. Performing QoS Tradeoffs in E-Government SOA

	Minimum response Time	Use cipher text	Validate user's access	Additional personal information	Easy data exchange	Efficient services	Information transparency	Ease of use	Proactively detect failure
Minimum response Time									
Use cipher text	-				-				
Validate user's access	-								
Additional personal information								-	
Easy data exchange									
Efficient services					+				
Information transparency								+	
Ease of use									
Proactively detect failure									

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