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Investigations on user's Perspective Evaluation of SOC System for Selecting an Efficient Framework for Building e-Services

Subhash Medhi[1], Abhijit Bora[2] and Tulshi Bezboruah[3]

[1,2,3]Department of Electronics and Communication Technology, Gauhati University, Assam, India
E-mail:[1]medhisubhash72@gmail.com,[2]abhijit.bora0099@gmail.com,[2]zbt_gu@yahoo.co.in

Abstract—*In this paper, we have proposed to design and develop a prototype e-ATM service using multiple service oriented computing frameworks for selecting an efficient technology to develop web service based e-services. The mass information expansion and integrated web services have enabled the internet as emerging computing system. An empirical study was conducted over Microsoft web services building frameworks implemented in a prototype e-ATM service and a relative investigation is carried out to make a choice over the better web service building technology. We emphasis in this study to give an overview of web service testing framework, testing procedure, statistical analysis of QoS metrics for estimating the service quality of web services.*

1. INTRODUCTION

Service-oriented computing (SOC) is an emerging paradigm for distributed computing system that changed the way of software applications design and consumptions. The set of concepts, principles and methods in SOC is characterized by widely adoption of many forms of technology by the IT industries. The Web services (WS) is the heart of SOC that provides autonomous, platform-independent, computational elements which is described, published, discovered, and invoked over a network. WS are the services incorporated over the internet for sharing resources and processes for business perspective. The WS messages are prescribed over standard communication web protocols using a special message format SOAP designed by World Wide Web Consortium (W3C) as shown in Fig. 1&2. The SOAP message has three components Envelop, Header and Body. Envelop- it is the mandatory element that defines the start and end of the message. Header-contains any optional attributes used in processing the message, Body- contains the mandatory element XML data comprising the messages being sent. The WS enabled the internet to become a platform for applying business services such as e-services as components in IT applications. E-services are the services that are produced, provided and/or consumed through the use of ICT-networks such as Internet-based systems and mobile solutions. The electronic shopping, online auction, banking services, travel booking, tourism advertising and booking are the major role of WS today that pervaded our daily lives due to ease of use, flexibility to redesign, reuse and reduce cost of deployment. WS is a software system designed to support interoperability between machine to machine, identified by Uniform Resource Identifier(URI) whose interfaces and bindings are described by machine process able format using web standards and protocols[1]. WS is a software component comprised of specific business methods that is published, described, invoked over web and exchanges information using Extensible Mark-up Language (XML) based on open standards [2]. Windows Communication Foundation (WCF) is a Microsoft's unified programming model for building service oriented applications. The existing technologies Active Server Method and XML (ASMX), .NET Framework remoting, Microsoft Enterprise Services and Microsoft Messages Queuing(MSMQ) are unified in one umbrella of WCF. WCF is designed to provide manageable approach for distributed computing, interoperability and service operation within disparate systems maintaining security and reliability of services [3].The quality properties such as availability, reliability, security, scalability are the important metrics of WS to be assured by service provider for wide acceptance of service consumers. The reliability of WS refers to the quality aspects of services that represent the degree of being capable to maintaining the service and service quality [4]. Reliability is one of the predominant qualities of a service application that effects in overall WS performances of a system. Thus the reliability of software becomes a major concern of any business enterprises as unreliable software may lead to huge economic losses. The software reliability is a probabilistic assessment that can be defined as the probability of failure free operation that does not cause a failure for specified period of time for a specified environment [5].

2. RELATED WORKS

In the year 2004, H.Joshep Wen et.al [6] had proposed a WS technology adoption model in three contexts. They provided the insight into the decision making process of enterprise application developers to adopt the WS technology.

In the year 2006, Qi Yi et.al [7] had performed investigations on different research problems, solutions and directions to deploy the WS that are managed by an integrated Web Service Management System (WSMS). The investigations identified the key features of WSMS and performed a comparative study on how current research approaches and projects fit in.

In the year 2007, PP.Chan et.al [8] had surveyed and addressed the applicability of replication and design diversity techniques for reliable WS and suggested that the temporal redundancy and spatial redundancy are the important approaches to improve the reliability of the WS.

In the year 2011, Mohammad Ibrahim Ladan [9] had carried out a survey over existing WS metrics and their usage and benefits. According to the author the WS introduced new and challenging software metrics problems due to their distributed and high degree of service autonomy nature and ability to use application object components from hundreds or thousands of sources.

In the year 2012, G.Delac et.al [10] had given an overview of existing reliability modeling techniques for SOA system and proposed a model for reliability estimation of service compositions using cyclic graphs.

In the year 2015, Bora.A et.al [11] had proposed a quality evaluation framework for multi service multi functional SOAP based WS. In this framework, the authors have evaluated the performance metrics and reliability aspects of WS at different stress levels.

In the year 2017, Subhash Medhi et.al [12] had performed investigations on the reliability estimation and prediction of e-ATM services. In this study the authors mentioned that the reliability of WCF service is reduced with the increasing number of consumers.

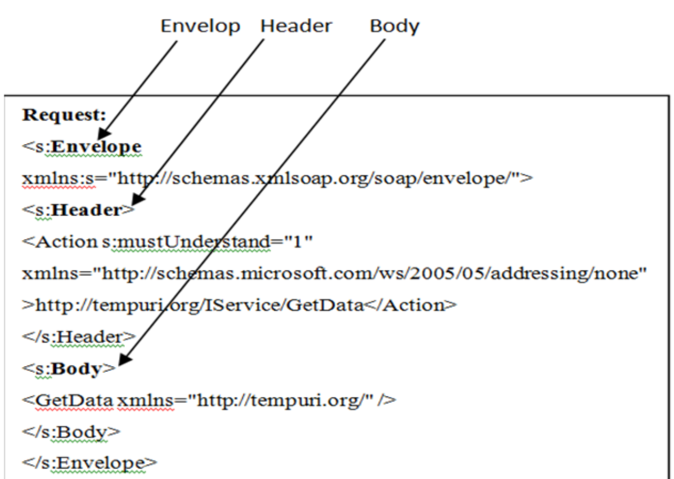

Fig. 1: SOAP Request message in XML

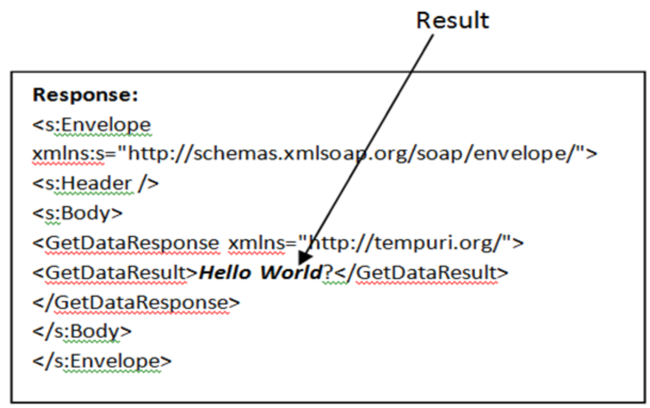

Fig. 2: SOAP Response message in XML

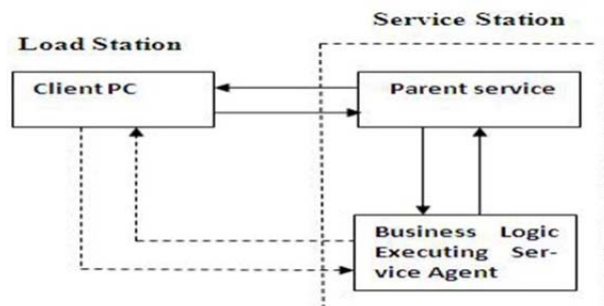

Fig. 3: The e-Service Architecure

3. THE PROPOSED WORK AND METHODOLOGY

The objective of the proposed work is to implement a service application, based on financial model of e-ATM service by using Microsoft's WS building technology ASMX and WCF and evaluation of the two frameworks for choosing the right technology for building the efficient service based applications.

A financial e-ATM model as presented in Fig. 3 has been developed by using ASMX and WCF to facilitate user invoked queries. The authenticated users are allowed to access the service till the services failed to serve the concurrent requests and recorded the service responses through a software testing tool Mercury LoadRunner. We have implemented the services by using the software C#, IIS, MSSQL, MS Visual Studio 2012, and JDK 7.1

4. EXPERIMENTAL SETUP FOR TESTING

The goal of the experiments presented in this work is to evaluate the QoS metrics of the e- ATM services using two technologies ASMX and WCF so that the service providers and consumers can migrate to the more efficient technology from their existing systems. The experimental set up consists of two hosts, Client and Server remotely connected each other through a LAN connection. The software and hardware specifications used in the experimental settings are presented in table 1.

Table 1: Software and Hardware Specifications

System component	.Net Technology	
	Client	Server
OS	Windows XP	Windows server 2008
Processor	2.20GHz	CPU E5620, 2.4 GHz
RAM	1GB	8GB
Software	Internet Explorer, Mercury LoadRunner,	IIS 7.5,MS Visual Studio 2012, C#, Microsoft SDK, v7.1, EasyFit, v6.5, Minitab17®.
Database	-	SQL 2005
Hard Drive	150GB	600GB

Software testing is a method of testing a program to find errors and to examine whether it is functioning correctly as per specifications [13]. WS testing is a way to establish the degree of trustworthiness between the service provider and consumer so that both can feel secure in the use of WS [14]. Mercury LoadRunner, a software testing tool was deployed to test the proposed e-ATM service. The mercury LoadRunner is industry standard testing software for predicting system behaviour, performance and potential bottlenecks. It facilitated the enterprises to gather a clear picture of end-to-end system performances before the deployment of the system. During the test, a user was set for think time of 30s for performing successive operations and the average steady state period of 300s was set for all the experiments. The service is deployed to serve the workloads of VU and monitored the system behavior by gradually increasing the level of VU. In this test we have monitored the successful and failure HTTP transactions of the system.

5. RESULTS AND ANALYSIS

We have conducted the experiment at different levels of virtual users (VU) that accessed the service application concurrently such as 30, 50, 150, 1000, 1500 and 2000. In this context a test case for select operation was created for testing the service. The entire load test was conducted with a ramp up schedule with 1VU operated for every 15s and then phased out simultaneously at the end of the steady state period.

The proposed service application built in ASMX and WCF was tested under different stress levels of VU and the performance metrics were monitored for investigating the quality aspects of the services. The class width and range for 10 VU responses time(s) for the ASMX and WCF are given in table 2. To determine the distribution of response time, we plot the parameters in the histogram which is shown in Fig. 4 &5. It is seen that both the histograms are right skewed which is a pattern of normal distribution and hence the data distribution in the two services are normally distributed. The response time observed in the two services as given in table 3 is increasing with the higher number of VU. The response time in ASMX is rapidly increasing with the elevated number of VU and in WCF; the response time is considerably more consistent and stable at higher number of VU.

Table 2: Bin and Frequency of ASMX and WCF

ASMX		WCF	
Bin	Frequency	Bin	Frequency
15.5490	1	10.715	1
15.5614	15	10.9502	10
15.5738	9	11.1854	4
15.5862	1	11.4206	6
15.5986	1	11.6558	3
>15.5986	3	>11.6558	6

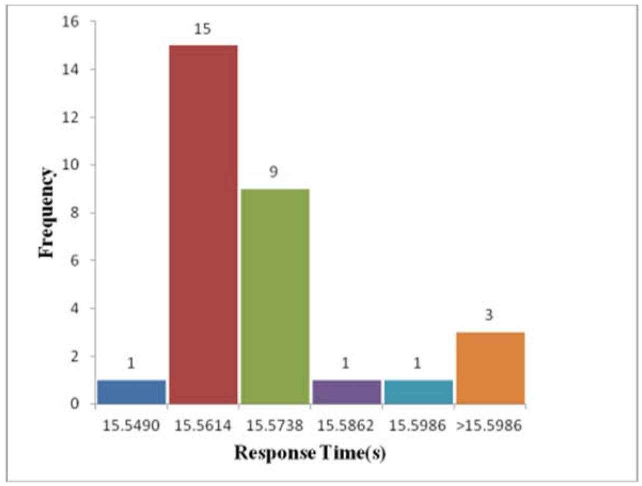

Fig. 4: ASMX Response Time(s)

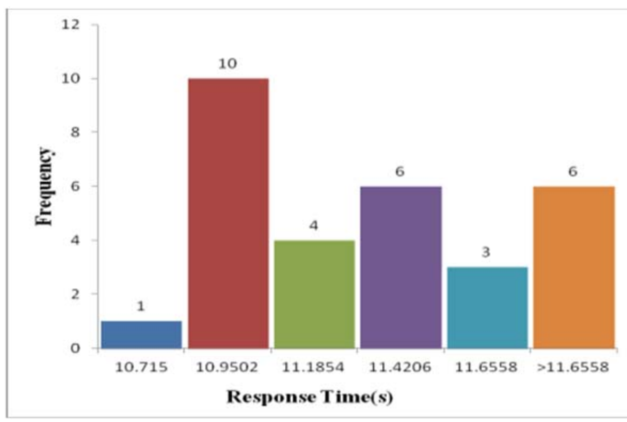

Fig. 5: WCF Response Time(s)

Table 3: Response Time(s) in ASMX and WCF

VU	Response Time(s)	
	ASMX	WCF
5	8.30	5.62
10	15.56	11.22
30	36.925	16.84
50	37.15	28.50
100	45.033	35.14

Table 4: Reliability on ASMX vs WCF

VU	Failure (%)		Reliability (%)	
	ASMX	WCF	ASMX	WCF
30	0	0	100	100
50	0	0	100	100
100	0	0	100	100
150	0	0	100	100
500	0	0	100	100
1000	37	26	63	74
1500	75	36	25	64
2000	85	39	15	61

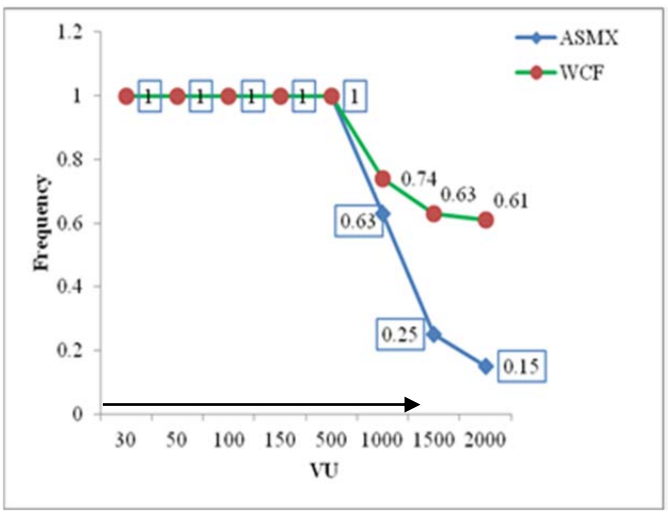

Fig. 6: Reliability vs VU

6. RELIABILITY ESTIMATION

Reliability of a system is estimated over phases of time that a system executes without failure in the specified time and stated environment. The reliability can be estimated from the equation 1[15]

$$R=1-e^{\lambda} \quad (1)$$

Where λ is the failure rate that is a probability density function of operational time is λ (t). The unit of execution time is one day, so if we set t=1, the reliability becomes $R= e^{\lambda}$. In practice reliability can be measured approximately using the equation 2.

$$R=1-\lambda \quad (2)$$

Using the equation 2, we have observed the following reliabilities at incremented values of VU:

For ASMX platform: R (1000) =1-0.37=63%, R (1500) =1-0.75=25%, R (2000) =1-0.85=15%

For WCF platform: R (1000) =1-0.26=74%, R (1500) =1-0.36=64%, R (2000) =1-0.39=61%

From the reliability analysis and estimation as given in table 4 and Fig. 6, both the ASMX and WCF based services were performed well enough as user's expected up to 500VU and the service performances of ASMX is reducing sharply with the higher number of VU. The reliability is 63%, 25%, 15% respectively at 1000, 1500 and 2000 VU. In WCF, the reliability values are reducing gradually with the higher number of VU such as 74%, 64%, 61% at 1000, 1500VU and 2000VU respectively. The higher reliability indicates the correct responses to the user's requests and lesser reliability suggests that user's are getting degraded services from the WSs. among the two services, it is observed that WCF service is outperforming the ASMX service in terms of reliability and scalability.

7. CONCLUSION AND FUTURE WORK

In this paper, we proposed to develop a prototype e-ATM service application, using two SOC technologies ASMX and WCF and carried out a relative evaluation over the performances of the two technologies in terms of response time and reliability. The response time of both the systems were retrieved from the empirical test. It is observed that the response time in the ASMX service is more than the WCF service at same level of workloads and getting higher with the higher values of VU. The ASMX services were observed slower than the WCF services and this may be attributed due to data serialization processes adopted in WS, because ASMX generally use XmlSerializer where as WCF used DataContractSerializer to translate classes into XML for communication purposes.

In the reliability analysis, it was observed that both the services based on ASMX and WCF were performing well up to 500VU and decreased reliability values with the higher number of VU. It was observed that the WCF based services were performing better and consistent than the ASMX based services and as a whole WCF based services had outperformed the service quality of ASMX based services which indicates that the WCF technology is better and reliable technology than the ASMX technology.

As part of the future work, we propose to carry out a detail investigation on the quality aspects of HTTP service building framework WebAPI and WCF, so that users can switch over to the best technology to build intelligent e-services.

8. ACKNOWLEDGEMENT

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