



Performance Evaluation of Web Services in C#, JAVA, and PHP

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ABSTRACT

Web Services integrates Internet and Web Technologies. Individuals or industry place their core business processes on the Internet as a collection of Web Services. Command Line Interface (CLI) and Graphical User Interface (GUI) are the two approaches used to develop the Web services. The Web Service development Languages and Tools performance varies one from another. This paper presents the performance evaluation of the GUI based Web Services developed in C#, JAVA, and PHP by investigating to improve the web service usability. Quantitative and Qualitative methodologies are applied for performance evaluation. Comparison of languages is evaluated using Calculator Web Service developed in C#, JAVA, and PHP. The value of each criterion is analyzed manually with the Calculator Web Service to identify the better language for the Web Service development.

Keywords

Web Service, Performance, Evaluation, Methodologies.

1. INTRODUCTION

. Internet provides plenty of services for the information society. The power lies in the fact that it holds and encourages everyone to contribute their creative ideas, knowledge, and works and make them available to others interactively on the Internet [1]. The internet has distributed environment and access the service everywhere and every time. Extensible markup language (XML) is used to represent data in the Internet. Any application written in any language running on any platform can process XML data [2].

Web services communicate using XML, a text based protocol that all applications can understand. Before the arrival of Web services, other technologies and architectures met the functionality of today's web service. Microsoft's version of these technologies is called Component Object Model (COM), and consequently Distributed COM (DCOM) and WinDNA. Software industries work with various vendors, suppliers, contractors and other entities who have developed software system in homogenous platform



with huge investments. It is almost impossible for any of them to change their system compatibility for heterogeneous platform. So, software developer/software industry needs to use an independent, network-accessible application that is called web service [3]. A Web Service provides functionality to a consumer through Internet or intranet, programmable Uniform Resource Locator (URL) and functions called over the Internet. CLI and GUI are the two approaches used to develop Web Services with different languages and tools.

The web services performance can vary from one language to another, the users will be looking for the best service from the available services. Hence, the user has to go through the various web services and find out the better service suitable for their domain. It would be better to compare the web service performance developed in different languages and tools. This paper has taken few GUI languages and designed a specific service, evaluating the web service performance.

The earlier research work in this area is discussed in section 2. The proposed framework is presented in section 3 and section 4 describes the evaluation of web services. The calculator application versus calculator verses Web Service application comparison is presented in section 5. The analysis and results are briefed in section 6. Section 7 provides the conclusion and future work.

2. RELATED WORKS

The web service development and its usability have grown greatly. The various research works done in the performance comparison of Web services are summarized in the following section.

In 2005 Sanjay P. Abuja and Raquel Clark have focused on evaluation of the performance of several web service technologies [4]. They took the quantity elements such as time to market, availability of plug-in software, maintainability, language support, portability, scalability and cost.

Chen Wu and Elizabeth Chang discussed the Web Service Architectures Based on quality properties in 2005. This property has two styles such as broker based and peer to peer. These styles have qualitative and quantitative elements such as loosely coupling, inoperability, scalability, simplicity, and extensibility, performance, security, reliability, visibility and compatibility. Finally, they evaluated the web service architecture performance [5].

In 2008 Toyotaro Suzumura *et al* explored the web services development based on few languages of GUI and CLI. They compared the web service languages such as PHP, JAVA and C. They reported that the PHP performs better than the other two languages based on qualitative and quantitative



elements. They incorporated GUI based languages for the development of web services in a domain [6].

Tommi Aihkisalo and Tuomas Paaso focused on performance comparison of web services in object marshalling and unmarshalling solutions in 2012. They described the performance of the underlying service or business logic, which is usually stabilized and evaluated the web service object performance [7].

3. CJP FRAMEWORK

C-sharp Java Php (CJP) framework is developed for heterogeneous platform web services using GUI languages C#, JAVA and PHP as shown in Figure 1. GUI languages reduce the designing time and increases end user interaction. Generally, web service developing languages and tools performance vary from one to another [8]. To test the performance of the web service, researcher has taken a simple calculator web service application and compared it with calculator web services designed using GUI languages of this framework.

CJP process framework [9-10] developed three web service separately in above mentioned languages. The C# calculator web service is developed in .NET framework and published in IIS server. C# web service application development is not only standalone application for the client, but also it can access web service application through URL by generating the proxy.

Java calculator web service is developed in eclipse IDE and published in Apache-Tomcat server. The Location of Service is created and compiled to run java web service by Ant tool. This tool compiles Java code, to locate the service in directory to add Java Application Archive (JAR) files which are build manually and creates web service deployable package. This package is deployed in the Apache-Tomcat server. This web service uses an URL to verify the proper running and generates the output in SOAP message format.

The PHP calculator web service is developed with HTML and published in Wamp server. Wamp server provides www workspace folder and the developer copies .php file in the workspace to run with the server. Now the service is ready to be accessed by the client through the URL.

The building and deployment of C# and PHP web services are very easy compared to JAVA web service. These web services are similar in the functionality but their performances vary one from another. CJP process framework evaluates the above mentioned web services performance.

The performance of the web services are evaluated based on the quantitative and qualitative elements. The quantitative measured data are time flexibility, memory footprint, soap message comparisons and line of program. The qualitative measured data are testing methodology, scalability, security and



maintainability. These element values are measured manually with calculator web service.

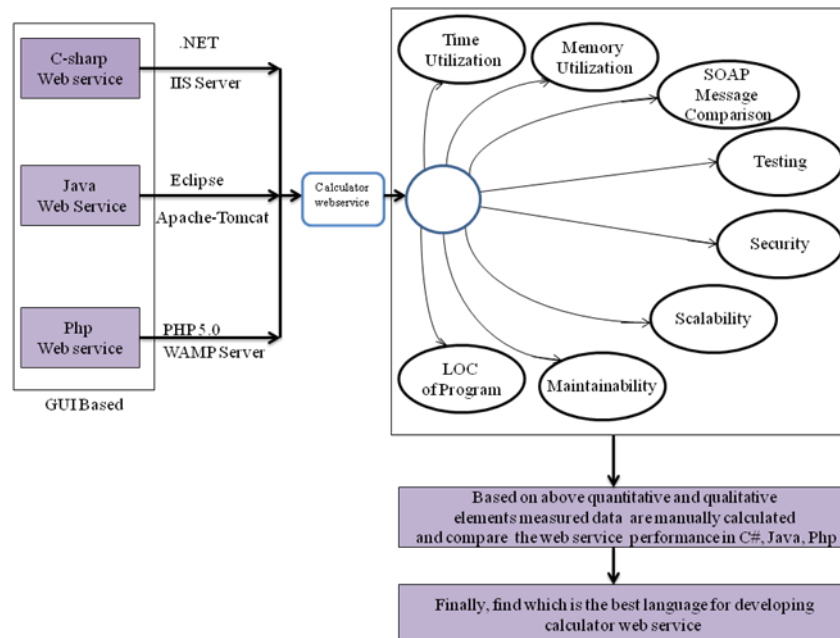


Figure 1. CJP web service process framework architecture

4. EVALUATION OF WEB SERVICES

Web services are evaluated based on the quantitative and qualitative elements. These elements are depicted in Figure - 2. Each element value varies from one service to another. The evaluation compares the web services variations in these languages.

4.1 Quantitative Elements

Quantitative is the representation of measure. The measure presents the collection of data or number [11]. The data calculated from measurement of different fields to analyze particular field is called evaluation. The quantitative elements are evaluated in the following section.

Time Utilization [12] - Each web service takes time to run and deployed in different environments uses various web service developing languages are compared.

Memory Footprint [13] - The memory footprint measures web services memory usage and compares this element on web services developed in these languages.

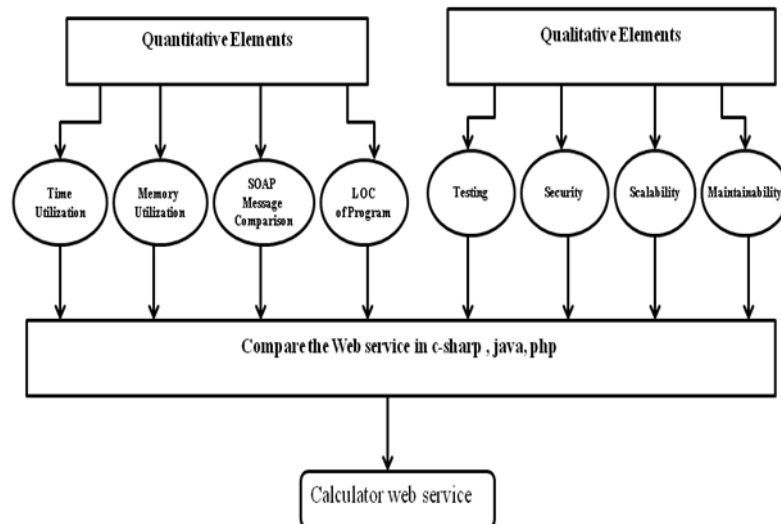


Figure 2. Comparisons of Web Services in C#, JAVA, PHP

SOAP Message Comparison [14] - This comparison is based on input and output soap message tags. The soap message provides communication between web services.

Line of code (LOC) [15] – Compares the number of code lines taken for the calculator web services.

4.2 Qualitative Element

Qualitative is the representation of excellence which is presents the merit of different fields and to analyze a particular field [16]. The qualitative elements are evaluated in the following section.

Testing [17] – To check validation and verification testing and the results are compared on web services.

Scalability [18] - Developer adds one or more methods in calculator web service and compare the scalability based on CPU utilization.

Security [19] – After publishing in the server, Web services security is checked and compared.

Maintainability [20] – Web service development languages uses syntax from java and C. Developers can compare the maintainability of these web services.

5. IMPLEMENTATION

Computer performs complex calculations and series of calculations. Before the commercial computers, calculators dominated the world of calculations



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and business. To test the performance and evaluation the developer has designed a simple calculator web services. The calculator web services provided addition, subtraction, multiplication, division and modulus operations. For the proof of concept the researcher compares the performances between simple calculator and calculator web service user interfaces are discussed in the following sub-section.

5.1 Calculator Application

The calculator application allows the user to perform five basic mathematical operations. This application consists of 17 Buttons and 1 Textbox as shown in Figure-3.



Figure 3. Calculator Interface

5.2 Calculator Web Services

Calculator web services are developed in C#, JAVA, and PHP that allows the user to perform the five mathematical operations as per the following steps:

- Projects are created and name as Cal.aspx, Wsj.JAVA, and ws.PHP.
- Addition, subtraction, division, multiplication and modulus methods are created. Each web service is deployed and published in the following URLs:

<http://localhost:2773/cal/Service.asmx>

<http://localhost:8081/Wj/services/Wjs>

<http://localhost:8080/ws.PHP>

- User enters the input in the text box and clicks calculate button.

5.3 Comparison between User Interfaces

Three web services and calculator application are compared based on user interface. C# web service interface is shown in Figure – 4 and JAVA web service interface is shown in Figure – 5 both have one invoke button, two text boxes and one submit button. PHP web service interface includes two text boxes, five option buttons and one submit button as shown in Figure – 6. The output of these web services are XML or text based. The three web services have reduced number of components in user-interface compared to



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calculator application. The interfaces of calculator application and three web services are compared in Table – 1.

Table 1. Interfaces components of Calculator application and Calculator web services

Sl. NO	Services	Interface Format	
		Input Buttons	Output Buttons
1.	Calculator Application	17 Buttons	1 Text Box
2.	C# Web Service	1 Invoke Button, 2 Text box	Xml Format
3	JAVA Web Service	1 Invoke Button,2 Text box	Xml Format
4	PHP Web Service	2 Text box 5optional button	Xml Format / Text

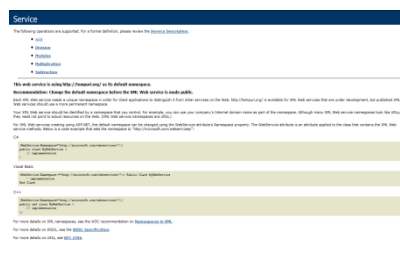


Figure 4. C# Calculator Web Service

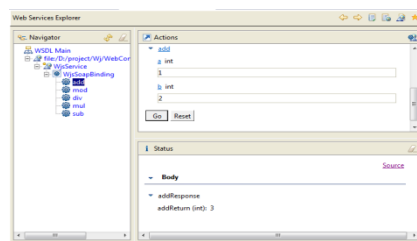


Figure 5. JAVA Calculator Web Service



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CALCULATOR

Number 1: 2

Number 2: 4

Operation: ☒ Addition ☐ Subtraction ☐ Division ☐ Multiplication ☐ Modulus

Calculate

Figure 6. PHP Calculator Web Service

6. ANALYSIS AND RESULTS

The analysis compares the performances of the three web services and finds out the better language for the web service application development. The results obtained manually from the quantitative and qualitative measured data are captured from the calculator web services implementation. Web services performance are compared based on the following measured data.

6.1 Time Utilization

The deploying time of calculator web services are obtained and compared against other web services. The evaluation time utilization of web services is depicted in Figure – 7.

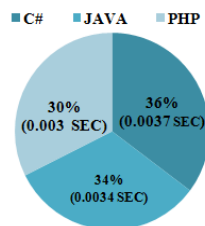


Figure 7. Time utilization

The time utilization of calculator web services deployment in C# is 0.0037 sec, JAVA is 0.0034 sec and PHP is 0.0030 Sec. Figure -7 concludes that the better web service language in time of utilization is PHP web service.

6.2 Memory Footprint

Memory footprint obtains memory utilized by calculator web services and compared. The memory footprint for the various web services are shown in Figure -8. The memory footprint for the calculator web service developed in C# is 400MB, JAVA is 375 MB and PHP is 380.2MB. From these data the best programming language in memory usage is JAVA web service.



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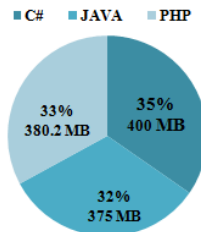


Figure 8. Memory Footprint

6.3 Soap Messages

The soap messages input and output tags are identified for calculator web services and compared. The calculator web services utilize two input and one output soap message tags in C# and JAVA. PHP calculator web service utilizes three input and one output soap message tags. The C# and JAVA languages are better than the PHP language in soap message tag utilization.

6.4 Line of Code

LOC for the calculator web services are estimated and compared. The LOC for calculator web services developed in C# is 10 lines, JAVA is 10 lines and PHP is 28 lines. From these the C# and JAVA web service language are better in terms of LOC.

6.5 Testing

Three web services are tested and their results are compared. C# web service is developed in .NET IDE which provide validation and verification. The developer need to write bit of code for testing. Java web service is developed in eclipse IDE and PHP web service is developed in HTML does not provide validation and verification. The developer writes methods and spends much time in testing these web services. C# calculator web service spends less time on testing compared to other services.

6.6 Scalability

The scalability of web services has been estimated based on the CPU utilization by adding methods in calculator web services and compared. The scalability of web services is shown in Figure -9. The C# and PHP calculator web service scalability are equal and less than the JAVA calculator web service scalability.

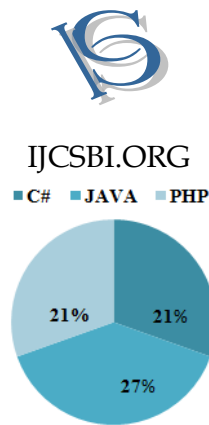


Figure 9. Scalability

6.7 Security

After publishing the web services in the server, the security aspects are identified and compared. Table -2 compares the web services security. In C# and JAVA web services, code is not editable in the server. PHP web service code is editable. So, C# and JAVA are the languages that provide better security.

Table 2. Security on Calculator Web services

Sl. No	Calculator Web Service	Security
1.	C-SHARP	After service published in the server and code is not editable in the server (Good)
2.	JAVA	After service published and code is not editable in the server (Good)
3.	PHP	After service published in the server (Average) and code is editable in the server

6.8 Maintainability

Maintenance of the web service is based on the syntax of the languages. C# includes the syntax of C++ and java, Java derived its syntax from C and C++ and PHP includes C and C++ syntax. C#, Java and PHP supports client and server programming which is easier to maintain by the developer knows these base languages. Hence the maintenance of these languages are good for all three languages.



The comparisons of quantitative and qualitative elements are presented in Table-3. The C# calculator web service fulfills the six attributes out of eight attribute values and JAVA calculator web service fulfills four out of eight and PHP calculator web service fulfills three out of eight attribute values. Web service languages ratio [21] of analysis is 6:4:3 and the percentage [22] is 75%: 62.5%: 37.5%. The outcome of comparison proves that C# language is better among all the three languages.

Table 3. Analysis of Quantitative and Qualitative elements

Sl. No	Measured Data	Calculator Web Services		
		C#	JAVA	PHP
1	Time Utilization	0.0037 Sec	0.0034 Sec	0.0030 Sec
		-	-	✓
2	Memory Foot Print	400 MB	375 MB	380.2 MB
		-	✓	-
3	Soap Messages	3 Tags	3 Tags	4 Tags
		✓	✓	-
4	Line of Code	10 Line	10 Line	23 Line
		✓	✓	-
5	Testing	Good	Average	Average
		✓	-	-
6	Scalability	Good	Average	Good
		✓	-	✓
7	Security	Good	Good	Average
		✓	✓	-
8	Maintainability	Good	Good	Good
		✓	✓	✓
Total Full Fill Attributes		6	5	3

7. CONCLUSION

The web service manages the complexity and maximizes the reuse of code of web services. Construction of software systems with reusable web services, bring many advantages to industry/individuals. Cost, efforts and time get reduced in testing, security, scalability and maintainability by reusing web services. So, these web services are easy to handle in all the



platforms which reduce the components when compared to existing calculator application. This paper focused on quantitative and qualitative measures of data for the performance evaluation on web services. The measured data helped the developer to reason out how differently web services are developed in C#, JAVA, and PHP are used to identify the better web service. After analyzing the results, C# is the better language for implementing the simple web services. This paper explains only the performance evaluation of development and usability of web services for C#, JAVA, and PHP. The future research work can integrate the web services as application and to add more modules in different domains to obtain the quantitative and qualitative elements. The data from these elements are collected manually can be automated.

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