

Functional Based Testing in Web Services Integrated Software Applications

Selvakumar Ramachandran, Lavanya Santapoor, and Haritha Rayudu

MSc in Software Engineering, Blekinge Institute of Technology, Sweden
rrselvakumar@gmail.com, lavanyas87@gmail.com,
haritha.rayudu@gmail.com

Abstract. In this paper we analyze the distinct features of web-based applications and testing done to ensure security and efficiency in the communication of data between client and host. Most work on web applications has been on making them more powerful, but relatively little has been done to ensure their quality. Important quality attributes for web applications include reliability, availability, interoperability and security. The SOAP protocol is used as a communication protocol between XML and HTTP. Based on the analysis done functional based testing is used to ensure different level of quality control of web services applications in various circumstances.

Keywords: Functional Based Testing, Integrated Software Applications, Web services, Service oriented Architecture.

1 Introduction

Web services are popular way of implementing service oriented architecture (SOA) which has earned fast adoption and support from leading companies in the industry. Testing web services helps in assuring correctness and robustness of a web service. A web service provides good communication or connection from one software application to the other. Communication between the two is done over private intranets or internet. The mostly used communication protocol can be SOAP and which uses XML over HTTP. Web services are mostly extensively used in distributed applications. They are used in business critical applications. The quality, functionality and performance are the key elements which help in the acceptance and wide spread use. Testing of web services is essential as implementation of web services is very complex and hard to implement, although the syntax is written in XML format. Therefore testing of web service assures interoperability and correctness of a web service. A web service is a URL addressable resource that gives reply to a client's request. Web services are integrated into other web sites although they are on other servers. Testing of web services helps in detection of errors that were left undetected which requires complex and costly repairs.

2 Background and Related Work

Functional testing of real time software applications can be done at different iterations during the development phase. The primary concern of functional testing to occur at different level is to figure out the bugs and rework on these to overcome the impact of these on the execution of real time applications. Functional testing for real time applications is performed at many functional areas including execution, application's load handling statistics and response to the storage areas during the execution of complex procedures and queries.

As real time applications mostly works on some scheduled execution plans set up by the user's so it is very much important to handle the unseen or strange behavior of the system during the actual execution process. For such scenarios different methodologies of functional testing can be used that diagnose and test the major functional area of application and figure out the basic errors and resolve the most basic bugs. One of the examples of such applications is working with web services by integrating them in software applications. These web services can be developed by one company for their business process and then are broadcasted to other companies or clients to be used. The involvement of clients or end users for utilization of web services is concerned with business cases.

Web services are service oriented structures and have no graphical user interface so testing of the embedded functionalities can be performed by the developers. Due to the reason that composition of web services and testing for the functionalities implanted are directly concerned with the deployment stage testing so it is required to implement certain functional based testing patterns [11]. Moreover these patterns also direct us to gather some statistical test evaluation data related to the quality attributes in concern with data/application communication between the software application and web service host [8]. Integration and adaptation of web services in enterprise solution is on large scale as web is maturing so rapidly for application development platforms. These web services can be utilized in building of architecture of other composite services [2]. The web service technology provides the gateway to the new age of real time applications wrapped in web technologies, which are capable of efficient data processing with high degree of intelligence and security [3]. However the main concern related to the composition of web services in real time is the secure data transition between the application acquiring web service and the host of that particular web service [3]. Performance is another concerning attributes which is related to the testing of web services based on different SOAP implementations [4]. Since web services are on global access to clients so there is more chance of multiple scenarios to be tested. In order to work on these test cases functional based testing patterns are followed which direct the service consumer to experience and then evaluate the problem within effective effort [5].

3 Problem Discussion

Web services oriented applications are emerging architectures under development these days. Most of the e-commerce applications are developed by embedding certain business process oriented web services within the application [6]. The web services

oriented applications are developed to promise the standards to support the web service discovery, decomposition and interfacing related issues. Performance and adaptability are important attributes need to be kept in consideration during the development of service oriented software system [7]. Following the traditional approach of testing it is assumed that after the development of application some specialized team from within the organization or some third party testing tools are used to verify the service composition and execution issues, however specifically for web service oriented software application the scenario for testing need to be in different way. Some of the other issues like web service adaptation during the passage of time for software application and real time response to the client from the web service owner are also concerned with the customization of web service within the application and impacts on the working of complex service oriented software systems [7]. Moreover it is apparent that web service oriented software applications are in attachment with the development stake as well as the owner of that particular web service, so testing of service oriented application after the development might affect the adaptability attribute of software architecture. In order to minimize the issues concerning to the web service adaptation and compatibility between client and service owner there is a need to inspect for functional based development scenarios which can be implemented in order to achieve the effective performance and reliability estimations than conventional Test after Development approach for such software systems.

4 Aims and Objectives

The aim of study is to highlight the methodology for functional based testing scenarios in web service configured real time applications. Following objectives are set to meet this goal.

- To highlight the design test scenarios required for performance analysis of web service enabled software applications.
- Setting up and working of test frames to achieve proficient mechanism of test based automated development for real time applications.
- Techniques used to gather statistical test data for quality and performance attribute in web service enabled real time applications.
- Adapting functional based testing procedure to achieve effective data communication between the real time application and the web services hosts.

5 Research Questions

Below are the research questions on which we need to focus.

- What basic design patterns can be used to integrate web services in complex real time software systems in order to implement efficient and secure data communication over the network link between host and client?
- How to enhance the web service adaptability within the application architecture by providing distributed service operations recommendation and discovery criteria.

Web services applications can be visualized as modular applications that are designed for some specific business process and then will be utilized in some real time applications by locating and invoking across the internet [6]. In order to permit flexible and reliability concerns of web services, different areas of this technology need to be work on. This includes service execution transaction and data security. In order to composite the web services according to the software configuration, specific schemas are used for message transmission to the service host and application. Mostly XML mapping is used to create a message envelope with some specific SOAP standards [12]. Since message envelop communication is very important in web service integrated application so implementing functional based development scenarios can let the software to work efficiently and smoothly.

6 Research Type

The selected topic requires inclusive and general study regarding the techniques followed in software application environment. Applied research methodology for selected topic facilitate us to resolve the practical problem by acquiring and applying the knowledge that tackle to the problem area and to fulfill the needs related to scope of the entity. By analyzing the observations gathered from the knowledge related to the functional based testing scenarios in web service enabled real time applications, design architecture will be anticipated for web service oriented software applications. The validation process of proposed scenario in this paper will be conceded by the comparative examination with the existing software application adopting web services or other composite web services.

7 Research Methodology

7.1 Applied Research Methodology

Service oriented software applications are visualized as integrated modules which are published and consumed over some specified protocol layers. According to W3C web services can be described as software architecture exposing some methods to the client's applications for execution of business process embedded in these. XML based data exchange are supportable formats for communication links between the client and the web service owner. Hence it is required to implement the fault free and maximum performance oriented structure at client application which is consuming web service.

Objects of study

The objects studied are as follows:

1. Study of design patterns which can be followed in order to integrate the web service oriented structure with associated business process with n complex or minor software applications
2. Web service adaptability with in software application architecture to validate and implement the discovery criteria.

7.2 Challenges Associated for Testing Web Service Integrated Software Systems

In order to test the web service oriented software applications following scenarios must be kept in view to create the initial test data and test case procedures to test the application.

1. Functionality of web service in oriented software application must be correct in concern to the reliability attributes so that it can fully functional and responding to each and every single request if multiple requests hitting the specified WSDL. Mean while the application consuming that particular web service must send request and process response without any error or garbage in data communicated.
2. Scalability and performance must be promised by the web service oriented application so that a standard response time should be in consideration by each and every associated client. Hence if more than one client's are connected to a particular web service the architecture of client applications should get and process the response data from web service server in specified time slice.
3. If web service oriented application is a server application for some client server distributed structure, then the data payload and request to response should be managed in order to maintain the software crash issues and not responding states.

8 How Functional Base Development Done at Different Levels of Development of Soa Systems

8.1 Functional Based Testing during Development Approach

Web service oriented software applications are asynchronous in nature hence testing of such system needs some specialized procedures to be followed [8]. Hence in order to maintain the stability in the performance as well as quality attribute of such system, testing of each and every module is proceeded during the development phase by exchanging some data messages from client to server [9]. Following points should be kept in consideration while performing the functional base scenarios on service oriented software system. Embedded web services within the software application haven't any user interface or interaction GUI.

1. Based on the utilization of the business process embedded in the web service, predictions should be made in concern with the usage in software system in context of work load, performance, scalability and adaptation.
2. Functional testing regarding to the security concerns of web service embedded within the application should be tested with major testing areas and scenarios.

8.2 Guidelines for Functional Based Testing of Web Service Oriented Software Applications

Perspective selection

The aim of these guidelines is to present some strategies which can be followed to perform the functional based testing process in web services oriented software

applications. Proposed guidelines and traditional testing approaches are set as the objects of under consideration software systems. Explanation of functional base testing scenarios for service oriented software systems can be discussed in more detail by further integrating the testing process to sub testing levels.

A. Component level Service testing

Component level service testing for web service oriented software systems is carried out by the application developers at modular or functional level. The basic aim of such type of testing is to generate certain automated testing scenarios by using some test data in order to verify and validate the base line functionality of the integrated web service. These automated or functional based testing scenarios presents some statistical test analysis figures that justifies the execution functionality in comparison with the expected functionality of the software module having certain web service embedded in it. However in order to work out the component level service testing following test scenarios should be kept in view.

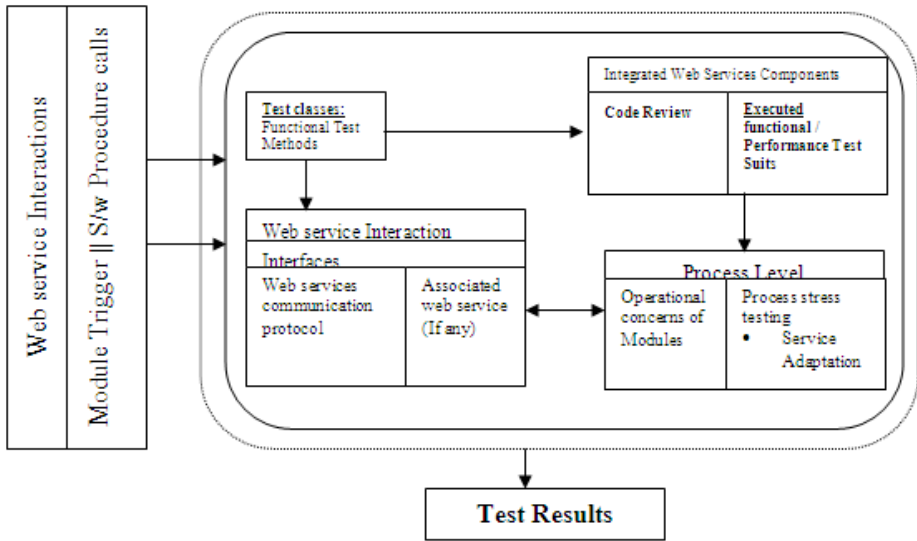
1. Proper code review to certify it compatibility and adaptability in accordance to the standards declared for software application at modular levels.
2. Execution of functional and performance test suits related to the integrated web service.

B. Functional testing at web service Integration level

Functional base testing of service integrated software application is performed to validate the modular data execution in accordance to the web service interface interaction with the hosting system and its adaptability in context of data formats and validations. The functional test cases should be generated by keeping in view the issues associated to the communication layers and protocol on which web service methods are being accessed by the application. Moreover testing of external services associated with the integrated web services are also included in the functional tests at integration level.

C. Functional testing at web service Process level

Functional base testing for process associated with the integrated web service within the software application is to validate the operational concerns related and business processes associated with these. Major area of business concerns, service transformation to the host and process composition over the communication link are associated with the functional testing for the process level area of integrated web service. For this functional test cases should be generated which can tests the software application at modular level for the process associated and their response to the activation state of integrated web service.



D. Functional Testing on formulated test levels:

For web service integrated software applications, functional testing phase for each module associated to the service are categorized as under in table 1:

Table 1.

Testing Phase	Test Environment
1. Test WSDL file for well formed	Modular level service testing
2. WSDL interaction from client to host	Modular level service testing
3. Test web service for response against submitted request (Interoperability).	Modular level service testing
4. Sample invocation by passing the parameters to web service.	Service level testing.
5. Response validation	Module Parameter testing

9 Data and Analysis

9.1 Testing Software Integrated Web Service

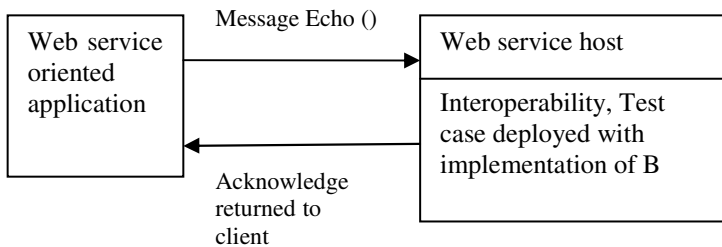
During the development of web service oriented software applications, application developers configure the modules by assuming that the test results against the test data will as same as that of the expected outcome from the functionalities embedded in the consumed web service. But in real scenario these assumptions produce different results when services are in communication during the method call to the hosts. Figure a. shows the functional base scenario for web service integrated software development. According to this scenario each of the modules developed with the automated test case generator. The test case generator comprises of specialized classes having abstract methods which generates some automated inputs for the functions calling them. Each

of the testing phases as described in the table 1 are associated to the components associated to the integrated web service modules. Hence each time when these test classes objects are created automated test cases are generated in accordance to the web service requirements related to them. Test data values are generated in randomize way so that these will be use in the testing phase as described in the table 1 to check the outcome from the web service exposed methods. As shown in the figure these functional test methods are also associated with the process level as well as web service interaction interface level so that the operational concerns modules and associated web service module if any exist should be test during the functional testing of software.

9.2 Functional Testing for Web Service Interoperability between Client and Host

In web service oriented software applications the effective communication of the service depends upon the full operability and reliable exchanging of messages from client to server. So in order to generate functional level test cases for interoperability testing of such applications following concerns should be kept in view.

1. The server should be able to parse and decode the message data sent from the client.
2. The server should be capable to decrypt the encoded parameter embedded in the SOAP envelope message containing the actual message sent by the client.
3. The client should be able to decode the SOAP response sent by the server.
4. The client should be able to decrypt the encoded parameter embedded in the SOAP envelope message containing the actual message sent by the client.



9.3 Functional Testing of Software Module for Load Testing

In web service integrated software applications functional based testing scenarios must be created in order to identify the performance and adoptability statistics of integrated web service. Test cases are designed by identifying the associated modules related to the service functionality work load in context of performance. In functional testing of such modules multiple requests are submitted to the consumed web service and statistical analysis of related parameters including the time to connect to service and response time are analysed [10]. Based on these statistics verification process will be performed for specific functionalities of modules. In order to generate the functional level test cases for load testing following concerns should be kept in view:

1. Identify and state the actual number of users operating the web service oriented modules of software application.
2. Identify the web service host WSDL and message syntax associated to it.

3. Attach a test request generator to broadcast the test messages simultaneously and associate a listener to lookup and process the response from the host.
4. Execute the test case with some valid test cases to check out the response as well as work load from the integrated web service host.

10 Conclusion

This report contributes to figure out and implement the functional oriented test cases in web service oriented software applications. The study provided above consists of applied research methodology to figure out the functional base test scenarios in service oriented software applications. The functional based testing approach can be followed to validate the interoperability of embedded service with the host system. In order to visualize the scalability and performance functional base testing will be performed at modular level by designing some specialized test classes that generate test data. This test data can be used by other associated modules embedded in the web service integrated software application for efficient and reliable functionality of service. Moreover functional base testing also promises the effective adaptation of web service within the software modules so that related stakes can utilize the integrated business process. The functional based testing also can be customized in accordance to the structure of consumed web services.

References

- [1] Zhu, L., Gorton, I., Liu, Y., Bui, N.B.: Model driven benchmark generation for web services
- [2] Lertphumpanya, T., Senivongse, T.: A basis path testing framework for WS-BPEL composite services
- [3] Salomie, I., Chifu, V.R., Harsa, I.: Towards Automated Web Service Composition with Fluent Calculus and Domain Ontologies
- [4] Ng, A., Chen, S., Greenfield, P.: An evaluation of contemporary commercial SOAP implementations. In: Proceedings of the Fifth Australasian Workshop on Software and System Architectures, Melbourne (2004)
- [5] Dan, D.D., Kearney, R., Keller, R.K.A., Kuebler, D., Ludwig, H., Polan, M., Spreitzer, M., Youssef, A.: Web services on demand: WSLA-driven automated management. *IBM Systems Journal* 43(1), 136–155 (2004)
- [6] Djamel, Bensaber, A., Malki, M.: Development of semantic web services: Model Driven Approach
- [7] Bertolino, A.: Approaches to Testing Service-Oriented Software Systems
- [8] Tian, J.: Software quality engineering: testing, quality assurance, and quantifiable improvement. Wiley, Chichester (2005)
- [9] Dustdar, S., Haslinger, S.: Testing of service oriented architectures: A practical approach. In: Weske, M., Liggesmeyer, P. (eds.) *NODE 2004*. LNCS, vol. 3263, pp. 97–109. Springer, Heidelberg (2004)
- [10] Patil, V.R.: Introduction to Testing Webservices
- [11] Yu, Q., Liu, X., Bouguettaya, A., Medjahed, B.: Deploying and managing Web services: issues, solutions, and directions
- [12] Rezgui, A., Bouguettaya, A., Malik, Z.: A Reputation-based approach to preserving privacy in Web services. In: *VLDB Workshop on Technologies for E-Services (TES)*, Berlin, Germany (2003)