

Research on Web Service Interoperability Testing Framework with Conformance Testing

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Abstract—In this paper, we design a web service interoperability testing framework with conformance testing method. It uses redirection-supported non-invasive interceptor technology can ensure the quality of implementations of web service. Experimental results validate the framework and demonstrate that it can effectively improve the interoperability of the web-service based information system.

Keywords—conformance test, interoperability test, interceptor, web service

I. INTRODUCTION

WEB service is widely used as the best way of realizing service-oriented architectures (SOA). Being a cross-platform technology, they can be implemented on the different platforms with different programming languages. They provide a means for wrapping existing applications so developers can access them through standard languages and protocols.

As a programmable application logic, web service can be visit by standard internet protocol, it can construct a technology layer with common platform and independent language which based on various heterogeneous platform, various applications in different platforms developed by different information system can realize the connection and integration among themselves using the technique, the kernel thought is to pursue communicating seamlessly and data sharing in different systems, which means realizing interconnection and interoperability in the system.

As the interaction of web service obeys the same standard, one of the advantages of the distributed software system based on the Web system structure is the interoperability among web service. However, there are some fuzziness problems in the certain standard and incompatible problems in different standards, which may cause the interoperable problems in realizing different web service. Therefore, this paper proposes a testing method which corresponds the interoperability standards of web service □ designs and implements the testing tool corresponding to the interoperability web service which is based on the basic outline of WS-I, then verifies the interoperability realizing of web service and the corresponding situation to the

demand of WS-I standard, so as to ensure the correctness and effectiveness of realizing the interoperability standards.

II. WEB SERVICE INTEROPERABILITY TESTING METHOD

There are four main layers in web service protocol stack which based on network transmission layer, SOAP, WSDL, UDDI and BPEL4WS, and the SOAP layer together with the WSDL layer are the most two basic layers. SOAP layer is used to transmit messages among applications, WSDL layer defines service semantic for web service interface, such as operating, agreement binding and message types, etc. As the important function of testing web service' interoperability, almost all of the web service' interoperable problems can be attributed to the description of web service, therefore, this paper proposes a testing method based on consistent standard, verifies the corresponding degree of realizing web service interoperability and the demand of WS-I standard, as to ensure the correctness and effectiveness of realizing the interoperability standards.

This method is based on the basic outline of WS-I, tests and analyses the UDDI registry, WSDL document and SOAP message of web service which realized by IUT (Implementation Under Test), finds out the disconformities to the basic outline of WS-I, thereby locates the interoperability problems in the web service, then it can improve the overall performance of the web service, its testing process is mainly divided into four stages as shown in figure 1:

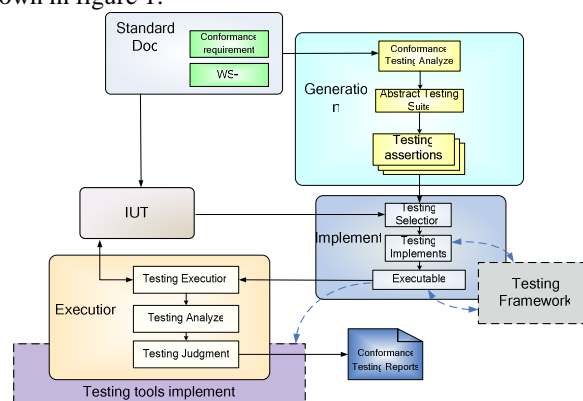


Fig. 1 The procedure of web service interoperability testing with conformance testing

The first stage is testing generation, it is based on the basic outline of WS-I, extracts the grammar rules from web service' protocol stack standard which related to the interoperability of web service, describes an abstract testing suite which separates

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from all the realized entities for the interoperability specification of web service, produces documents of grammar rules including multiple testing sequences which used for different testing purpose. Its purpose is to generate a testing suite from standard text description, the testing suite is independent of specific standards, described with strict definition testing language, suitable for standardization and it can test every aspect of the standard. The testing suite is the foundation of interoperability standard corresponding testing, all activities of interoperability standard corresponding testing are starting from testing suite, every test case in the testing suite has its' own testing target, it can make the judgment to its' behavior according to the realizing of web service, the content covers Messaging, Service Description, Service Publication and Discovery, Security, Business Process, etc.

The second stage is testing realizing, means generating executable testing sequences according to the abstract testing suite. According to the content of testing sequences, the testing sequences in abstract testing suite are transformed into a testing case that can execute in a real testing equipment or testing system, namely testing assertions document. This stage need to consider the specific situation of testing environment and IUT. Testing choice is the main content of testing implementation, it chooses testing cases from abstract testing suite according to the standard consistency statement of web service realization(PICS, document form of the realizing entities' ability specification provided by the tested side to the test side), removes the meaningless testing. Testing assertions document describes the content of each test sequence in the form of XML format, including input type, testing type, the prerequisite and corresponding testing sequence, etc.

The content of XML testing sequence content is as follows:

```
<testAssertion id="1011" entryType="requestEnvelope"
type="required" enabled="true">
<context> Envelope in request message</context>

<assertionDescription>The Content of Envelope match
the definition of WSDL document. If binds doc-lit
SOAP:BODY element must be a instance of element
WSDL:PART. If the message have a parts, then the
sequence of parts elements in SOAP:BODY must be as
same as WSDL:PARTS, and this sequence should be
generated by the every WSDL:PART and the
SOAPBIND:BODY in Envelope.
</assertionDescription>

<failureMessage> The Content of Envelopemus do not
match the definition of WSDL document. The sequence
of parts elements in SOAP:BODY not be as same as
WSDL:PARTS, and this sequence should be generated
by the every WSDL:PART and the SOAPBIND:BODY
in Envelope, or the element in SOAP:BODY not be the
instance of global element - WSDL:PART
.</failureMessage>
```

```
<failureDetailDescription>Doesn't match the operation of
WSDL or Envelope. </failureDetailDescription>

<additionalEntryTypeList>
<wsdlInput>operation</wsdlInput>
</additionalEntryTypeList>

<prereqList>
<testAssertionID>1701</testAssertionID>
<testAssertionID>1308</testAssertionID>
</prereqList>

</testAssertion>
```

The third stage is testing executing, it forms the executable testing suite and corresponding testing tool according to the testing cases which go through the choice and parameterization, thereby, we can test in a real testing equipment or testing system, the testing cases specified by tested implementation, put testing assertions document to the protocol stack of web service, observe the external responsible behavior realized by web service, record the executing results of each testing sequence. In the process of testing execution, testing tool provides a unified framework, read the corresponding contents in testing assertion document through the abstract method provided by the framework of realizing validation and fields' obtainment, thus realizes the interoperable standard consistency testing based on testing assertion document.

The last stage is testing deciding, it verifies and analyses the results of testing executing, obtains the decision corresponding to the standard of web service protocol stack interoperability which is realized by tested web service, then makes the ICTR (Interoperability Conformance Testing Report).

III. WEB SERVICE INTEROPERABILITY TESTING FRAMEWORK

The testing tool for web service interoperation is used for the interaction between users and services, it realizes the testing corresponding the standard of Web service interoperability by invasive black box testing method, can monitor the SOAP messages of web service in real-time, generates the monitoring statistic report including HTTP head, message content, etc. It also supports the analysis corresponding to the standard interoperability of UDDI registry, WSDL document, SOAP messages in web service, and then generates the consistency report about the interoperable problems in web service.

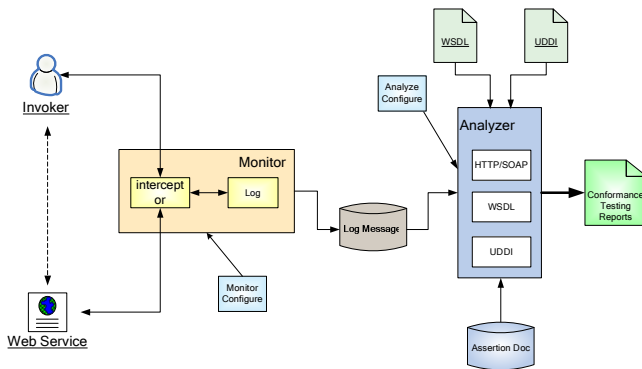


Fig. 2 Architecture of the testing framework

As shown in figure 2, testing tool includes two modules: Monitor and Analyzer. Monitor intercepts the messages between service requester and web service in recessive method, transforms the interceptive message into standard format and then outputs it to message logs. Analyzer judges whether the components of web service meets the requirement of the interoperable standards using a suite of testing assertions.

As an independent process, Monitor can start multiple socket threads at the same time, listen and relocate the server port, transmit and store the SOAP messages and eventually generates the log files. Monitor uses socket connection to get the service requesting response message, and monitors the SOAP communication between listener and client. The Host value is modified to listener port when the requesting SOAP messages are intercepted, the response SOAP messages have the same situation. Then monitor analyzes the connect type, message content, timestamp, coding method from the intercepted SOAP message and sends the results to log service. Finally, it send the SOAP message to original request point and response point, and ensures the normal proceed of business processes, which will realize the hidden information intercepting in a non-intrusive way.

Analyzer realized the interoperability consistency analysis based on testing assertions document, uses running testing assertion document as testing case. It can test and analyze UDDI registry, WSDL document, SOAP messages in web service, and then generates the consistency testing report.

After the consistency analysis, analyzer generates the consistency report in fixed template and makes the initialization at first, then it calls the validateUDDI □ validateWSDL □ validateMessages functions to analysis various input sources, and writes the results to consistency report document . Finally, analyzer will make the conclusion that whether the last generation goes through the testing. The report contains the WSDL package about the important data of web service described in WSDL file (web service interfaces, data type information, binding information and address information), XML package used for XML document processing (reading and writing XML elements, generating XML document object model, processing XSL files), and provides the assist toolkit modules which have effective function support for other packages in the testing tool.

IV. CONCLUSIONS

Web service solve the problems of traditional middle component technology, it makes the framework which is in different platforms or uses different object techniques removing the differences in realization and platforms, unifies the frameworks in the same technical level, and the guarantee of its interoperability is the key point to call web service successfully. This paper uses the basic outline of WS-I to analyze the web service interoperable problems. It designs and implements the testing tool corresponding the standard of web service interoperability which is based on the basic outline of WS-I, put forward the testing method corresponding to the standard of web service interoperability, design and implement the testing tool to test and analyze automatically.

The next step of work is focused on making the interoperability problems haven't covered by the basic outline of WS-I as the extend points of the software testing, so as to expand the corresponding testing tool.

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