Embedded System Software Testing Based On SOA For Mobile Service

Myung-Hee Lee[1], Cheol-Jung Yoo[1], Ok-Bae Jang[1],

[1] Computer Science
Chonbuk National University
Jeonju, Korea

leemh@kopo.ac.kr,{ cjyoo, okjang}@chonbuk.ac.

Abstract. Recently, the need for accessing information from anywhere at any time has been a driving force for a variety of mobile applications. As the number of embedded systems increases rapidly, there has been a growing demand for the use of Service Oriented Architecture (SOA) for various applications. Embedded system service offers a systematic way to classify and assess technical realizations of business processes. But embedded system has restricted range of utilizing services in computing environment and more, a mobile computer is envisioned to be equipped with more powerful capabilities, including the storage of a small database, the capacity of data processing, a narrow user input and small size of display. This paper present embedded system software testing based on SOA to overcome mobile restriction. To improve embedded system efficient we analyzing mobile application requirement, writing service specification, optimizing design, providing extended use case specification which test use case testing and testing service test case which derived from service specification.

Keywords: SOA, Embedded system software, Testing.

1 Introduction

Recently, a various approach based on service is developed to connect services. The main idea of SOA(Service Oriented Architecture) is to provide loose-coupled components between software components in a view of service implementation and to realize business services in a view of enterprise goal.

As the number of embedded system applications increases rapidly, there has been a growing demand for the use of Service Oriented Architecture (SOA) for various applications. Mobile based SOA offers a systematic way to classify and assess technical realizations of business processes. But embedded system has restricted range

of utilizing services in computing environment and more, a mobile computer is envisioned to be equipped with more powerful capabilities, including the storage of a small database, the capacity of data processing, a narrow user input and small size of display. This paper present embedded system and testing based on SOA to overcome embedded system restriction. To improve embedded system efficient we analyzing mobile application requirement, writing service specification, optimizing design, and testing service test case which derived from service specification.

We discuss a mobile application testing that uses a SOA as a model for identifying, specifying, implementing and testing.

This research consists of 5 chapters. In chapter 2, we review related research which is corresponds with embedded system testing. In chapter 3, we suggest SOA based mobile interoperability testing. In chapter4, we design and test mobile SOA application. A mobile interoperability testing is present. In chapter 5, we explain the result and discuss the future works.

2 Related Studies

This study starts from SOA requirement specification. We review a SOA requirement and specify a requirements specification. We walkthrough mobile SOA applications and discuss future works.

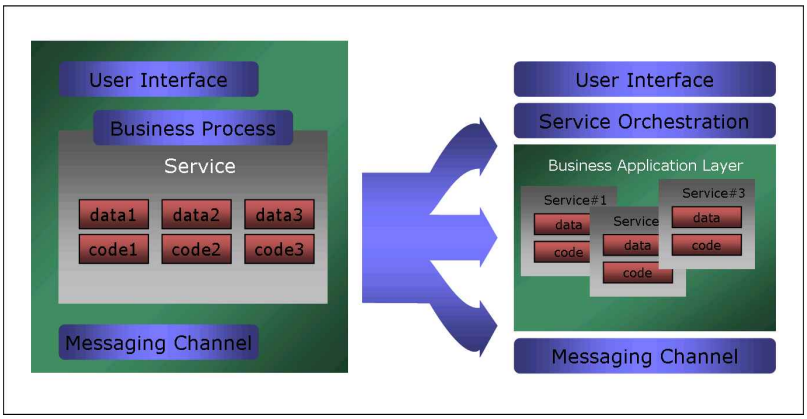

Figure 1. Basic SOA Architecture

Figure 1 shows the basic SOA architecture which operate from user interface to message channel.

2.1 SOA Service Specification

Service specification is corresponds with requirement engineering. It use MDA(Model Driven Architecture)[1] which realize the model and UML(Unified Modeling Language) which specify the requirement.

SOA service specification has two sequence which are system driven specification and business driven specification[2]-[7].

To integrate and to specify the service specification, we using UML modeling tool which use MDA modeling and unified modeling.

2.2 Mobile Service Design

As in this embedded system service design, Do Van Thanh[8] and Glaschick, R.[2] has researched about mobile and embedded service. It proposes mobile agent architecture which utilizes service in mobile. It provides artificial and efficient mechanism using mobile device, but it is not lies at the origin in service. We consider that we make analysis of mobile service from business requirement to user interface.

2.3 Testing SOA

As referring from Hans-Gerhard Gross[10], CBD testing(Component Based Development testing) in service has some trouble[10]. In CBD based service testing, there are two approach which were interoperability testing[11] and use case testing[12]. Noh proposed component based interoperability testing which is behavior modeling technique based on EFSM for interoperability testing[13]. We use EFSM approach to specify service test case generation. Test case specification includes some information which is test case specification identifier, test items, input specification, output specification, environment needs, special procedural requirements and inter-case dependencies[14].

3 Testing of SOA based Embedded system Application

In this chapter, we describe testing process of mobile service which starts from business requirements, service specification to service test case elicitation and testing. Whole process are :

- Business model analysis
- Mobile service identification and specification
- Application service identification and specification
- Testing design
- Test and Implementation

We start from business model analysis which makes a service boundary from business requirement and makes initial business use case and actor. Because of SOA's service providing mechanism which is loosely-coupled component and a form of service component, to analyze mobile service, it considers functional requirement as well as non-functional mobile restriction.

Mobile service specification describes service details including main flow and restriction. It is origin to test case design, implementation and testing. Using service specification, we define EFSM rule and design state transition diagram for service interoperability testing. We make test case specification from diagram which test service testing.

3.1 Business Model Analysis

Enterprise has a business model of its own. In business environment, It is analyzed both information architect view and business operator view with service expose and service consumer. It makes integrating view which between information and business in phases. It produce business context diagram between stakeholders.

Requirement analysis embodies business context diagram with system view. It derives basic foundation of functional business requirement, system requirement, non functional mobile restriction and deployment.

It produces system level requirement and initial implementation context diagram.

3.2 Embedded System Service Identification and Specification

Service identification and specification is made of use case, technical requirement, asset analysis, industrial standard analysis. SOMA(Service Oriented Modeling and Architecture) is proposed by allam[15]. We extend SOMA to adapt mobile service application.

We decompose model which use three approaches that is top-down approach, bottom-up approach and middle-out approach. We identify sub systems, flow of subsystems and analysis messages and events.

Service specification traverse requirements with consumer view which focus on consideration with traceable, stateless, discoverable, reusable and mobile restriction. In this process, it produces service specification.

3.3 Embedded System Service Interoperability Testing Design

By Using service specification, we design test case which is proposed by Noh[13].

Testing design step is:

Step 1. EFSM definition

Step 2. Specify attribute identification table

Step 3. Attribute value definition

Step 4. Specify state transition table

Step 5. Test case specification.

Step 1. FSM definition :

It define EFSM(Extended Finite State Modeling) rule which extend FSM for interoperability testing.

From-State

{Input}{Output}{Predicates}{Actions}{Color} To-State

Step 2. Specify attribute identification table.

As following above rule, it specifies attribute identification table from use case to distinguish service specification which makes interoperability test case specification. Table 4 shows Attribute identification table.

Table 1. Attribute Identification Table

Step No	Correspond Service	Behaviors	Alternative Condition	Attributes
:	:	:	:	:

Step 3. Attribute value definition

We define attribute value from attribute identification table. The table show service ID, attributes and attribute values.

Table 2. Attribute Value Table

Service ID	Attributes	Attribute Values		
:	:	:	:	:
State No.		S1	S2	SN

Step 4. Specify state transition table

We specify state transition table by EFSM specification. It shows state transition information. Table 3 shows state transition table.

Table 3. State Transition Table

No	FromState	Precondition	Input	Postcondition	ToState
:	:	:	:	:	:

Step 5. Test case specification

Test case specification is shows test case identifier, state transition, test item which include information of service use case ID, interoperability and behavior, input, output, procedural requirements and inter-case dependencies.

4 Implementation and Testing

4.1 Embedded System Service Implementation

Embedded system is implemented by using web service and BPEL(Business Process Execution Language).

```
<?xml version="1.0" encoding="UTF-8"?>
<definitions name="ViewReservation"…/ViewReservation"...">
        <types>
:
        </types>
 <message name="ViewReservationRequestMessage">
       <part name="payload" element=" "/>
    </message>
    <portType name="ViewReservation">
         <operation name="initiate">
              <input message="client "/>
         </operation>
    </portType>
:
    <plnk:partnerLinkType name="ViewReservation">
```

Figure 2. Example of WSDL

Figure 2 shows xml based WSDL description which includes service type, message information, port type, partner link type and etc.

Information of Business process execution is described by BPEL based on specification.

```
<process name="ViewReservation" targetNamespace=" "    ... ">
  <partnerLinks>
    <partnerLink name="CreateReservation"
                partnerLinkType="client:ViewReservation"
                myRole=" " partnerRole="ViewReservationRequester"/>
    <partnerLink myRole=""
               name="System"    partnerRole=" " partnerLinkType=" "/>
  </partnerLinks>
    <variable name="reservID" type="ns1:int"/>
    <variable name="reservCar" type="ns1:string"/>
:
<!-- ORCHESTRATION LOGIC    -->
:
   <assign name="asign_uid_to_requestUid">
```

Figure 3. Example of BPEL

Figure 3 shows BPEL description which includes namespace of process, business partner, variable, orchestration logic and etc.

The capture of mobile service is presented in Figure 6.

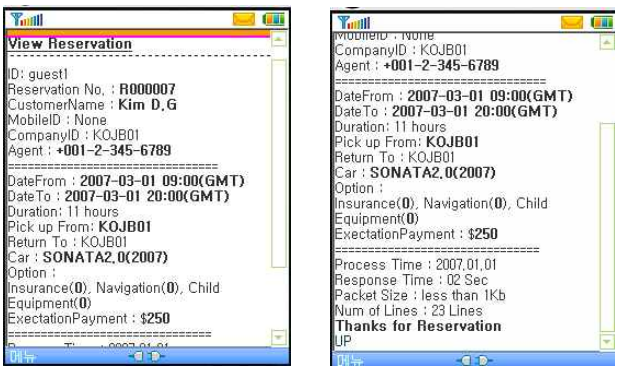

Figure 4. Capturing Mobile Screen

Figure 4 shows capture of mobile screen which displays the reservation service. It displays functional requirements as well as nonfunctional requirements.

4.2 Embedded System Service Testing

Quality of test case is depends on test case completeness and test case optimization. Test case completeness is method of test case measurement which indicates how many errors detect with test case. Test case optimization means how many test cases which are not expecting one is included during testing.

Table 4. Result of Interoperability Testing

Completeness	Number of method which has Interoperability	Number of method which include test case
	27	24
Test Case Optimization	Number of transition before rule definition	Number of transition after rule definition
	22	11

Table 4 shows the result of interoperability testing. The result means highly completeness and optimization.

5 Conclusion

This paper present mobile service implementation and testing based on SOA to overcome embedded system restriction and to test service interoperability. To improve mobile efficient, we propose service testing process using interoperability testing. We present mobile application requirement analysis, write service specification, optimize design and we test service interoperability which derived from test case specification.

This paper show how can implement embedded system service from business requirement to test case. We propose mobile service testing process using test case specification. In service interoperability testing, Results show highly completeness and optimization.

Moreover, the idea of service interoperability test process can extend the application testing to develop cost efficient and optimized mobile services.

References

1. Alarcon, M.P.; Fuentes Fernandez, L.; Troya Linero, J.M.,“Using MDA to develop Component and Aspect Based Applications,” Latin America Transactions, IEEE (Revista IEEE America Latina), Volume 3, pp. 1-1, 2005.
2. R.M. Dijkman, and S.M. Joosten, “Deriving Use Case Diagrams from Business Process Models,” 2002.
3. S. Stolfa, I Vondrak, “Using the Business Process for Use Case Model Creation,” ISIM ’03, 2003.

4. A. Brown, “An introduction to Model Driven Architecture Part I: MDA and today’s systems,” IBM, January 2004.
5. S. Mellor, K. Scott, A. Uhl, D. Weise, “MDA Distilled: Principles of Model-Driven Architecture,” Addison-Wesley, 2004.
6. Object Management Group, “Extensible Metadata Interchange,” http://www.omg.org/technology/xml/ .
7. T. Gardner “UML Modeling of Automated Business Processes with a Mapping to BPEL4WS,” In Proceedings of the European Workshop on Web Services and Object orientation, ECOOP July 2003.
8, Do Van Thanh; Jorstad, I., “A Service-Oriented Architecture Framework for Mobile Services,” Telecommunications, Advanced Industrial Conference on Telecommunications/Service Assurance with Partial and Intermittent Resources Conference/ E-Learning on Telecommunications Workshop. AICT/SAPIR/ELETE 2005. Proceedings, pp. 65-70, July 2005.
9. Glaschick, R.; Oesterdieckhoff, B.; Loeser, C.,“Service Oriented Interface Design for Embedded Devices,” Emerging Technologies and Factory Automation 2005. ETFA 2005. 10th IEEE Conference on Volume 2, pp. 8-8, September 2005.
10. Hans-Gerhard Gross, “Component-Based Software Testing with UML,” Springer, 2004.
11. N. Griffeth, R. Hao, D. Lee, R. K. Sinha, “Interoperability Testing of VoIP Systems,” Global Telecommunications Conference, Vol. 3, pp. 1565-1570, 2000.
12.Kwang Ik Seo; Eun Man Choi; “Comparison of Five Black-box Testing Methods for Object-Oriented Software,” Software Engineering Research, Management and Applications, 2006. Fourth International Conference on pp. 213-220, August 2006.
13. Hye-Min Noh, Ji-Hyun Lee, Cheol-Jung Yoo, and Ok-Bae Chang. “Behavior Modeling Technique Based on EFSM for Interoperability Testing,” ICCSA 2005, LNCS 3482. pp. 878-885, 2005.
14. IEEE. “IEEE Standard for Software Test Documentation,” IEE Std 829. 2000.
15. Allam, A.; Arsanjani, A., “Service-Oriented Modeling and Architecture for Realization of an SOA,” Services Computing, 2006. SCC '06. IEEE International Conference on pp. 521-521, September 2006.
16. Margaria, T.; Steffen, B. “Service Engineering: Linking Business and IT,” Computer, Volume 39, pp. 45-55, October 2006.