Service Oriented Architecture based Embedded System Software Testing for Mobile Service

Karunakar Pothuganti[1] and K.Arun Kumar[2]
[1]Asst. Professor. Madawalabu University/ECE Department, Bale.Robe, Ethiopia
Email: karunakar.pothuganti@mwu.edu.et
[2] Asst. Professor. CVR College of Engineering/ECE Department, .Hyderabad, India.
Email: arun.katkoori@gmail.com

Abstract: **In recent years, for a range of mobile applications, the need for getting data or information from one place to another has been a driving force. There is huge demand for the usage of Service Oriented Architecture for different applications, if the number of embedded systems is increased. To distribute and estimate technical realizations of business tasks, embedded system provides a systematic way. But there are some limitations for embedded systems in computing environment- a mobile computer is equipped with more powerful capabilities. It maintains a small database, capacity of data processing, a narrow user input of user and small display. This paper presents how to overcome mobile limitation using embedded system software testing based on SOA. For further improvement of embedded system, it is first analyzing mobile application requirement, then write down the service specifications, enhancing the design providing extended use case specification which test use case testing and testing service test case which is derived from service specification.**

Index Terms: **Service Oriented Architecture (SOA), Embedded system software, Testing, Business Process Execution Language (BPEL).**

I. Introduction

To connect different services, a new approach based on service is developed. The principle thought of SOA- Service Oriented Architecture is to give free-coupled segments between programming parts in a perspective of administration execution and to acknowledge business benefits in a perspective of objective of big business.

A service is a discrete unit of usefulness that can be gotten too remotely and followed up on and refreshed freely. For example, recovering a credit card record on the web [1]. There is a huge demand for the usage of SOA for different applications, if the number of embedded systems is increased. Even though embedded system gives a systematic way to distribute and estimate technical realizations of business tasks, there are some limitations for embedded systems in computing environment. To overcome the embedded system's limitations, this article presents embedded system and testing based on SOA [2]. To improve efficiency of embedded system, it will analyze mobile application requirement, writing service specification, optimizing design, and testing service test case which is derived from service specification.

A. Definition of SOA

A definition is provided below:

Oasis (www.oasis-open.org) defines SOA as -- "It is an architecture, which provides loose pairing among different services."

Arasanjani, Borges and Holley define SOA as follows: "It is an architecture, that backs loosely paired services to empower business adaptability in an interoperable, innovation skeptic way [3]. SOA comprises of a composite arrangement of business-adjusted services using interface-based service portrayals that support an adaptable and progressively re-configurable end-to-end business tasks."

B. *SOA Benefits and Implementation Principles*

SOA provides advantages in the following four basic classes:

- Decreasing integration cost
- Increasing reuse of resource
- Increasing agility of business
- Decreasing the business risk

These four core benefits actually offer return at many different levels and parts of the organization, depending on the set of business problems the company is applying SOA to. This research article consists of five sections [4]. In section 2, the related research which corresponds with embedded system testing is reviewed. In section 3, SOA based mobile interoperability testing is suggested. In section 4, design and test mobile SOA application is discussed. In section 5, the results are explained.

II. Literature Survey

In this section, the requirement of a Service Oriented Architecture (SOA) is reviewed, and requirements specification is obtained.

The following figure 1 shows the basic SOA architecture which operates from user interface to message channel.

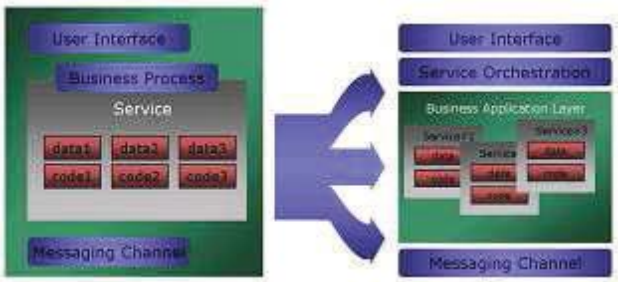

Figure 1. Basic System Oriented Architecture

A. Service Oriented Architecture Service Specification

Service specification of system of Architecture use MDA (Model Driven Architecture) [2] which realizes the model and UML (Unified Modeling Language). Unified Modeling Language specifies the requirement. System of Architecture service specification has two programs. They are system business driven specification and driven specification [4]-[9]. The UML modeling tool, which uses MDA modeling and unified modeling to integrate and to specify the service specification.

B. Designing of Mobile Service

As in this embedded system service design, Do Van Thanh [10] and Glaschick,R [4] has researched about mobile and embedded service. It proposes mobile agent Architecture which utilizes service in mobile. Mobile Agent architecture provides artificial and efficient mechanism using mobile device, but it does not lie at the origin in service [15]. We consider that we make analysis of mobile service from business requirement to user interface.

C. Testing of System of Arhitecture

As referring to Hans-Gerhard Gross [10], CBD testing (Component Based Development testing) in service has some trouble [11]. In CBD based service testing, there are two approaches which were 'interoperability testing' [12] and 'use case testing'. No proposed component based interoperability testing which behavior is modeling technique based on EFSM for interoperability testing [14]. We use EFSM approach to specify service test case generation. Extended Finite State Modeling based case specification includes some information about test case specification identifier, test items, input specification, output specification, environment needs, special procedural requirements and inter-case dependencies [15].

III. TESTING OF SOA BASED EMBEDDED SYSTEM APPLICATION

In this section, the process of testing of mobile service which origins from business requirements, service specification to service test case elicitation and testing is explained.

Whole process is:

- Analysis of Business model
- Identification and specification of Mobile service
- Application service identification and specification
- Testing design
- Test and Implementation

It starts from business model analysis which makes a service boundary from business requirement and makes initial business use case and actor [9]. Because a System Architecture's service providing mechanism is a 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. This architecture 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 [8]. We design test case specification based on diagram which test service testing.

A. 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. This approach 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.

B. Identification and Specification of Embedded System Service

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 alam [16]. We extend SOMA to adapt mobile service application. We propose a model which is a decompose model. It uses three approaches that is top-down approach, bottom-up approach and middle-out approach. In this paper we recognize 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.

C. Interoperability Testing of Embedded System Service Design

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

Testing design steps are:

1. EFSM definition
2. Attribute identification table
3. Attribute value definition
4. State transition table
5. Test case specification

1. EFSM:

It characterizes EFSM (Extended Finite State Modeling) Control which expands FSM for testing of interoperability [13].

From state to state, following parameters may vary—{Input}{Output}{Predicates}{Actions}{Color}

2. Specify the table of attribute identification:

As following the EFSM rule, from utilize case to recognize service specification which puts forth interoperability test defense detail, it specifies table of attribute identification [12]. Following table I shows attribute identification table.

TABLE I
TABLE OF ATTRIBUTE IDENTIFICATION

S. no.	Corresponding	Behavior	Alternative circumstances	attributes

3. Attribute value:

It is defined from the above table of attribute identification. The following table II shows attributes, attributes values and service ID.

TABLE II
TABLE OF ATTRIBUTE VALUE

Service ID	Attributes		Values of attributes		
State No		S1	S2	S3	S4

4. Specify table of state transition:

This table is derived from EFSM specification. Table III shows the table of state transition.

TABLE III
STATE TRANSITION TABLE

S. no.	From state	Prerequisite	Input	Post-condition	To state

5. Test case specification:

Test case identifier, test item, state transition are shown here. Also it includes information of service use case ID, interoperability, behavior, I/O, procedural requirements and inter-case dependencies [14].

IV. IMPLEMENTATION AND TESTING

A. Implementation of BPEL

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

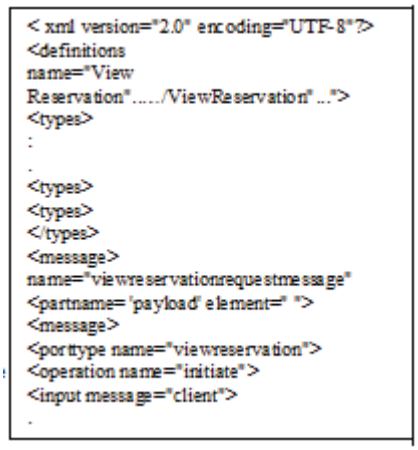

Figure 2. Example of WSDL

Figure 2 WSDL descriptions which include type of service, message information, type of port, type of partner link, and so on [11]. Information of Business process execution is described by BPEL based on specification.

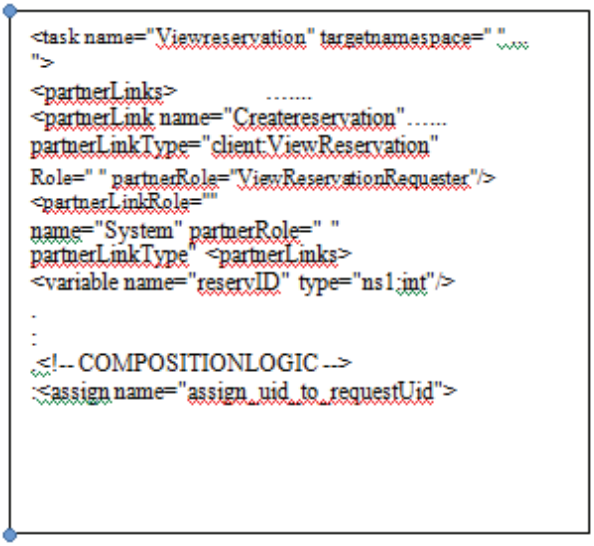

Figure 3. Example of BPEL

BPEL description includes task's namespace; business partner, variable, logic of composition and etc are shown in figure 3.

Figure 4 shows capture of mobile screen which displays the reservation service [10]. It displays functional requirements as well as nonfunctional requirements.

(a)

(b)

Figure 4(a and b) Capturing Mobile Screen

B. Embedded System Service Testing

Quality of test case depends on the completeness and optimization of the test case. Test case completeness is a method of test case measurement which indicates how many errors are detected with test case [16]. Test case optimization means how many test cases which are not expecting one is included during testing.

TABLE IV
RESULTS OF INTEROPERABILITY TESTING

Completeness	The number of methods which have Interoperability	The number of methods which include test case
	26	23
Test case optimization	Number of transitions before rule definition	Number of transitions after rule definition
	21	10

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

V. CONCLUSIONS

In this article the mobile service implementation and testing based on SOA to overcome embedded system restriction and to test service interoperability is presented. To improve the mobile efficiency, it is proposed that the service testing process use interoperability testing. The mobile application requirement analysis, service specification, optimize design are presented and test service interoperability which derived is from test case specification.

This article explains the implementation of embedded system service from business requirement to test case. It proposed a different type of mobile service testing process using test case specification. In this, service interoperability testing, results show high accuracy, completeness and optimization. Moreover, this approach of service interoperability test process can extend the application testing to develop cost efficient and optimized mobile services.

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