Testing Transactions in Service Oriented Architectures

Rubén Casado Tejedor, Javier Tuya

University of Oviedo
{rcasado, tuya}@uniovi.es

Abstract. This proposal studies the web transactions characteristics in Service Oriented Architectures (SOA) from a testing point of view. Our idea is to define adequacy criteria to test web transactions. This will be accomplished using risk analysis techniques in order to take into account the possible failures of the transactions. An adaptation of risk-based methodologies (like HAZOP or FMEA) will be applied to define adequacy criteria and the corresponding tests.

Keywords: web transaction, risk-based testing

1 Motivation

Web Services (WS) provide a new paradigm for developing Internet-based applications using standard technologies and protocols. WS provide a standard means of communication and collaboration among different distributed systems and applications running on a variety of platforms.

To describe interfaces, services, and protocols, new web programming languages are used. Most of the web programming languages also include the notion of web transaction, as a unit of work involving activities that may last long periods of time.

Specific solutions for WS transactions should be considered since the traditional transaction models based on ACID transaction are not suitable for WS typical application scenarios [1]. In order to deal with ACID-related issues, various extended transaction models have been adapted for WS. Extended transaction models mainly relax the strict atomicity and isolation policy of ACID properties such that intermediate results of active transactions are visible to other transactions. A web transaction is structured as *sagas* [2], a sequence of several smaller sub-transactions, each with an associated compensation. If one of the sub-transactions in the sequence aborts, the compensations associated with all committed subtransactions are executed in reverse order.

Several standard protocols have been published to coordinate the actions of distributed applications. The Business Transactions Protocol (BTP) [15] published on 2002 was the first cross-industry attempt to produce an XML standard for business-to-business transactions. The Web Services Composite Application Framework (WS-CAF) [16] for Transaction Coordination is a set of specifications published by Arjuna, Fujitsu, IONA, PLC, Oracle and Sun Microsystems on 2003. The Web Service

Coordination (WS-Coordination) [17] provides the protocol for distributing the coordination context of a transaction to its participants.

Given the prominence of this technology, test methods are required to ensure that robust, fault tolerant software services are deployed. Many software testing techniques have been proposed, including control flow testing [3], model based testing [4], passive testing [5], contract-based testing [6], model checking [7] and so on.

But these techniques focus on service composition, not in the transactions. Our proposed research is going to address this problem. We will provide specific techniques to test WS transactions to assess the correct behavior of transactions in a service composition.

2 Goals

The aims and objectives of the proposed research are summarized below:

- Study the specific characteristics of web transactions
- Study the existing standards to handle web transactions
- Study the problems of testing WS based on long-running transactions
- Developing specific adequacy criteria to test web transactions
- Definition and application of testing techniques based on the previous criteria
- To validate the results

3 Research methodology

In this section we present the state of our research and the tentative plan for future work.

3.1 The work done to date

Up to now we have studied the state of the art in two important fields: *transactions properties* and *web services transactions standards protocols*. Also we have studied some risk analysis techniques that could be used to discover the possible failures in a web transaction and produced a first classification of risks and a generic definition of tests to mitigate these risks.

3.1.1 Transactions properties and Web Services Transactions protocols

We have studied a number of the possible ACID variations for web transactions testing.

Younas et al [8] analyses the characteristics of Web-multidatabase transactions and proposes a relaxtion of ACID test. Lanotte et al [9] developed a model of *Communicating Hierarchical Timed Automata* suitable to describe long-running

transactions and the automaton-theoretic approach allows the verification of properties by model checking. Fischer [10] defines *set consistency*, a new notion of consistency for long-running transactions, and implemented an algorithm for verifying set consistency to propositional validity. Cacciari [11] explain the importance of controllability and observability in distributed testing. Zhang [12] presents an approach that preserves the *semi-atomicity* of flexible transactions, allowing local sites to autonomously maintain serializability and recoverability. Jin [13] et al suggests that web transactions are constructed through a series of compensable transactions, using the concept of compensation to ensure a relatively relaxed atomicity. Emmi [14] proposes a technique to translate programs with compensations to tree automata in order to verify compensating transactions supporting the illusion of atomicity.

Subtransactions, compensatory actions and relaxed atomicity are three of the most important concepts in long-running transactions. A coordinator agent is required to manage these new concepts.

We have studied the existing standards protocols: Business Transactions, Web Services Composite Application Framework for Transaction Coordination.
The most recent and widely accepted standards are Web Service Coordination, Web Service AtomicTransactions (WS-AT) [18] and Web Service BusinessActivity (WS-BA) [19]. WS-Coordination provides the protocol for distributing the coordination context of a transaction to its participants. A WS-AT is a short-lived transaction implementing the two-phase commit (2PC) protocol in terms of Web Services. The main purpose of WS-BA is to coordinate long-running, compensation-based activities that may consist of several atomic transactions. So our work focuses on these three standards.

3.1.2 Long-running transaction risk analysis

Risk analysis is a set of techniques used to investigate problems created by uncertainty and to assess their effects. Originally it was used in areas like nuclear, chemical and space industries. But nowadays it is used in software development where safety is very important too [20].

HAZOP [21] is a methodology for identifying and dealing with potential problems in industrial processes, particularly those which would create a hazardous situation or a severe impairment of the process. A quantitative analysis generally has the following stages: (1) Definition of the subsystems, (2) Identification of the hazards in each subsystem, (3) Estimation of the likelihood of a hazard becoming an accident, and (4) Discovery of the consequence of the hazard if it were to occur.

Several papers have suggested adaptations of HAZOP to the software environment [20][22]. We think that this technique could be used to analyze the possible failures in a web transaction. Our current work have already achieved some results. We have defined a set of *testing properties* (Composition, Sorting, Visibility, Consistency, Permanency, Recovery, and Control). For each property we have identified the risks and we have specified a set of tests in order to check all transactions aspects.

3.2 Future work

The main contribution of the research to Web Engineering is to create a conceptual framework to testing web transactions. This model will be organized hierarchically by levels. In the top level we define a set of properties based in the long-running transactions properties and the web services transactions protocols. In the next level, based on the generic transactions properties that we have proposed, we will apply risk analysis techniques for each property in order to identify potential failures and possible causes. The third level will state a set of tests to mitigate each identified risk. At this level we can identify potential problems in testing web transactions. In the last level we will specify how to use existing or new testing techniques to execute the proposed tests. The frame is illustrated in Figure 1.

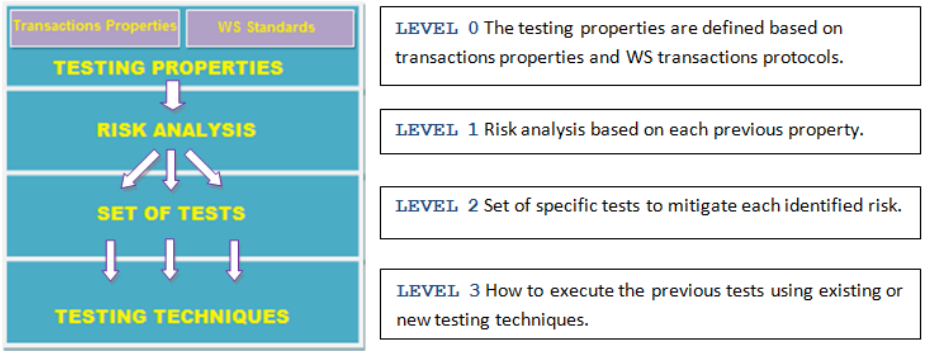

Figure 1. Conceptual frame to testing web transactions

The next work is to validate the obtained results in a real platform. We will develop some examples with injected faults and then we will apply the approach to analyze its feasibility and fault detection ability.

4 Acknowledgements

This work was partially funded by the Department of Science and Technology (Spain) and ERDF funds under the National Program for Research, Development and Innovation, project Test4SOA (TIN2007-67843-C06-01) and the RePRIS Software Testing Network (TIN2007-30391-E).

5 References

[1] Wenya Yang, ShaohuaTang, *A Solution for Web Services Transaction*, International Conference on Hybrid Information Technology, 2006

[2] H. Garcia–Molina and K. Salem, *Sagas*, in: Proc. SIGMOD'87 (ACM Press, 1987) 249–259.

[3] Li Li, Wu Chou, Weiping Guo, *Control Flow Analysis and Coverage Driven Testing for Web Services*, 2008 IEEE International Conference on Web Services
[4] X. Bai, W. Dong, W.T. Tsai, and Y. Chen, WSDLBased Automatic Test Case Generation for Web Services Testing, Proceeding of IEEE Int'l Workshop on Service-Oriented System Engineering (SOSE), 2005, pp. 207-212.
[5] Abdelghani Benharref, Rachida Dssouli, Mohamed Adel Serhani, Roch Glitho, *Efficient traces' collection mechanisms for passive testing of Web Services*, Information and Software Technology, Volume 51, Issue 2, February 2009, Pages 362-374
[6] Reiko Heckel, Marc Lohmann, *Towards Contract-based Testing of Web Services*, Electronic Notes in Theoretical Computer Science, Volume 116, 19 January 2005, Pages 145-156
[7] José García-Fanjul, Claudio de la Riva, Javier Tuya, *Generation of Conformance Test Suites for Compositions of Web Services Using Model Checking*, Testing: Academic & Industrial Conference - Practice and Research Techniques (TAIC-PART), Windsor, 2006
[8] Muhammed Younas, Bary Eagelstone, Rob Holton, *A review of Multidatabase Transactions on the Web: from ACID to SACRED*, BNCOD 2000: 140-152
[9] Ruggero Lanotte, Andrea Maggiolo–Schettini, Paolo Milazzo, Angelo Troina, *Design and Verification of Long–Running Transactions in a Timed Framework*, Science of Computer Programming Volume 73 , Issue 2-3 (October 2008)
[10] Jeffrey Fischer and Rupak Majumdar, *Ensuring Consistency in Long Running Transactions*, twenty-second IEEE/ACM international conference on Automated software engineering, 2007
[11] L. Cacciari, O. Rafiq, Controllability and observability in distributed testing, Information and Software Technology 41 (1999) 767–780
[12] A. Zhang, M. Nodine, B. Bhargava, O. Bukhres, *Ensuring relaxed atomicity for flexible transactions in multidatabase systems*, ACM SIGMOD Record Volume 23 , Issue 2 (June 1994)
[13] Jing Li, H. Zhu, J.He, *Specifyng and verifying web transactions*, International Federation for Information Processing 2008
[14] M. Emmi, . Majumdar, *Verifying Compensating Transactions*, Lecture Notes in Computer Science Volume 4349/2007 Springer Berlin / Heidelberg
[15] *OASIS Business Transaction Protocol*, http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=business-transaction
[16] *Web Services Composite Application Framework*, http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=ws-caf
[17] *Web Services Coordination*, http://docs.oasis-open.org/ws-tx/wstx-wscoor-1.1-spec-errata-os/wstx-wscoor-1.1-spec-errata-os.html
[18] *Web Services Atomic Transaction*, http://docs.oasis-open.org/ws-tx/wstx-wsat-1.1-spec/wstx-wsat-1.1-spec.html
[19] *Web Services Business Activity*, http://docs.oasis-open.org/ws-tx/wstx-wsba-1.1-spec-errata-os.pdf
[20] J. Bennett, G. Bohoris , E. Aspinwall, R. Hall, *Risk analysis techniques and their application to software development*, European Journal of Operational Research 95 (1996) 467-475
[21] T. Kletz, *Hazop and Hazun: Identifying and Assessing Process Industry Hiizards*, Institution of Chemical Engineers, third edition, 1992
[22] J. V. Earthy, *Hazard and operability studies as an approach to software safety assessment*, in I.E.1:. Computing and Control Division Colloquium on Hazard Analysis. Nov. 1992, Institution of Electrical Engineers, Digest No.: 1992/198.