MISQ: A Framework to Analyze and Optimize Web Service Composition in Business Service Networks

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EXECUTIVE SUMMARY

A novel UML-based analytical modeling methodology named MISQ is presented for optimizing Web service composition in Business Service Networks. MISQ enables functional and temporal analyses at a high-level design stage so that Web service composition can be optimized systematically. Furthermore, MISQ provides an automatic generation of Web service implementations for improving productivity and reliability.

Keywords: simulation; UML; Web service composition

INTRODUCTION

In Business Service Networks (BSNs), by combining multiple, heterogeneous services, one can establish new value-added business processes for further applications. In particular, Web services has emerged as a popular means to describe the services that each vendor provides. Web services (W3C, 2002) is a piece of XML-based software interface that can be invoked over the Internet; it can be viewed roughly as a next-generation successor of CORBA or RPC technique. In such a setting, one of the key issues is how to generate, discover, compose, and optimize Web services that are of interest.

In this paper, we especially focus on the problem of optimizing Web service composition and propose a novel methodology—MISQ—as a solution. That is, we use UML to design agent-based business processes and two formal modeling schemes—Stochastic Process Algebra (SPA) and Generalized Stochastic Petri Nets (GSPN) (Ribaudo,
1995)—to analyze initial business processes design and to obtain optimized parameters. Finally, we propose to use the Business Process Execution Language for Web Service (BPEL4WS) (Andrews et al., 2003) as implementation artifacts for expressing the optimized business processes.

**Example 1. Motivation**

Consider a scenario in a BSN where the optimization of composed Web services is a crucial issue.

Suppose Bill opens an Internet-based auto loan brokerage company (FirstBroker), where he locates a loan with a low interest rate for customers who pay a nominal fee as a return. FirstBroker uses Web services from three loan companies: StarLoan, UnitedLoan, and BestLoan. Once FirstBroker gets a customer’s inquiry, it sends bid requests to three loan companies, using their Web services, and forwards the lowest interest rate to the customer. Whenever FirstBroker sends loan rate requests to the loan companies, FirstBroker has to pay a fee to each. That is, FirstBroker is a business adapter, and the three loan Web services are software vendors in the BSN.

Furthermore, a customer pays a fee to FirstBroker only if he or she is satisfied with the proposed rate and decides to make a contract with FirstBroker. In summary, Bill’s profit model is the following:

\[
\text{Profit model} = (\text{# of accepted proposals by customers} \times \text{charge per customer}) - (\text{# of loan rate requests} \times \text{# of loan companies} \times \text{charge per loan rate request}).
\]

Suppose Bill agrees to pay $1 for each loan rate request to loan companies, while charging $10 to customers who eventually accept the proposed rate. The business is initially booming, attracting a large number of customers due to the fact that customers do not have to pay for initial inquiries and pay $10 only afterwards. However, FirstBroker eventually files a bankruptcy, despite many customers submitting inquiries.

*Figure 1. Use case of FirstBroker example*
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