11 High-Confidence Compositional Reliability Assessment of SOA-Based Systems Using Machine Learning Techniques

Venkata U. B. Challagulla, Farokh B. Bastani, and I-Ling Yen

Abstract Service-oriented architecture (SOA) techniques are being increasingly used for developing critical applications, especially network-centric systems. While the SOA paradigm provides flexibility and agility to better respond to changing business requirements, the task of assessing the reliability of SOA-based systems is quite challenging. Deriving high confidence reliability estimates for mission-critical systems can require huge costs and time. SOA-systems/applications are built by using either atomic or composite services as building blocks. These services are generally assumed to be realized with reuse and logical composition of components. One approach for assessing the reliability of SOA-based systems is to use AI reasoning techniques on dynamically collected failure data of each service and its components as one of the evidences together with results from random testing. Memory-Based Reasoning technique and Bayesian Belief Networks are verified as the reasoning tools best suited to guide the prediction analysis. A framework constructed from the above approach identifies the least tested and “high usage” input subdomains of the service(s) and performs necessary remedial actions depending on the predicted results.

11.1 Introduction

Service SOA-based methods are being used increasingly for developing complex dependable systems as evident from DoD’s recent projects, such as network-centric enterprise services (NCES), global information grid enterprise services (GES), and joint battle management command and control (JBMCC2) (Paul 2005a). Apart from the well-defined and high levels of abstraction provided by the service interfaces, the main advantage of service oriented archi-

---

1 Department of Computer Science, University of Texas at Dallas, Dallas, TX 75083-0688, USA, [uday, bastani, ilyen]@utdallas.edu

© Springer Science + Business Media, LLC 2009
tecture is the loose coupling between different services that are provided by the system, maximizing the system flexibility and easier reconfiguration with changes in business requirements (Gao et al. 2005). However, there exist challenges for assessing the reliability of SOA-based mission-critical software systems (Paul 2005b, Schneidewind 1998). Generally, these systems are large and complex and, hence, need more cost-effective methods of assessing their reliability.

In this chapter, we provide a framework for assessing the reliability of mission-critical SOA-based systems. The individual SOA services, that satisfy specific business requirements, are assumed to be built by logical composition of components provided by the underlying component layer. The components could be commercial off-the-shelf (COTS) / government-off-the-shelf (GOTS) software components. The business layer requests the services layer, which in turn invokes one (its own implementation component) or more components for realizing the desired functionality. In other words, each service is exposed as an interface to which a business layer client can bind and invoke its capabilities without knowledge of its underlying implementation. A service broker/registry lists the available services. Behind services are the implementation black boxes, i.e., components. The SOA infrastructure/framework provides the mechanism for reliable, standard, and managed communication between the applications business layer and service layer. A typical SOA-based system that consists of services, applications, and the intermediate connecting infrastructure (Arsanjani 2004) is shown in Fig. 11.1.

However, there are many issues surrounding the reliability estimation of SOA-based systems. These include the following:

- How to estimate the reliability of the individual components that constitute the service?
- How to estimate the reliability of a service, both from the client and service provider view-points, from the reliability of its constituent components?
- How to estimate the overall SOA-based system reliability when the system is orchestrated using several individual services?
- How to analyze the effects of usage profile changes on the service reliability and track sensitivity factors when replacing services/components with similar ones?