Chapter 5
Semantics for Service-Oriented Architectures

Michael Stollberg and Dieter Fensel

Abstract The concept of Service-Oriented Architectures (SOA) is the latest design paradigm for IT systems. The aim is to use Web services as the basic building blocks, which provide reusable functionalities that are invokable over the Internet. The initial Web service technology stack around WSDL, SOAP, and UDDI enables the technical provision and usage of Web services. However, the support for the detection of the suitable Web services for a specific client application is limited to manual inspection. To better support this for SOA applications with the larger numbers of available Web services that can be expected in real-world scenarios, the emerging concept of Semantic Web services (SWS) develops inference-based techniques for the automated discovery, composition, and execution of Web services. This chapter provides an overview on the SWS approach as well as the latest technology developments.

5.1 Introduction

The concept of Web services as been invented by a consortium of leading IT vendors in the late 1990s. Essentially, a Web service is a program that can be invoked over the Internet. It is accessible via an interface that specifies the physical address as well as the messages via which a client can consume the Web service. The actual consumption is realized by the exchange of XML data over the Web via SOAP. Remaining independent of the actual implementation, this technology facilitates computing
over the Web as well as seamless information exchange and reuse functionalities within and between organizations.

Because of this, Web services have been proclaimed as the core technology for Service-Oriented Architectures (SOA). In the future, IT systems shall be composed of Web services as the basic building blocks instead of proprietary solutions. The aim is to exploit the potential of the World Wide Web (WWW) as an infrastructure for computation, and also to reduce the development and maintenance costs for IT systems. The adaptation of Web services and the SOA paradigm within industry as well as by non-profit software developers has been facilitated by the early standardization of the necessary technologies. Commonly referred to as the initial Web service technology stack, these are (1) the Web Service Description Language (WSDL) for specifying the technical information, as well as the messages for invoking and consuming a Web service, (2) SOAP as a messaging technology for exchanging XML data over the Web, and (3) the Universal Description, Discovery and Integration Protocol (UDDI) which provides a registry technology for Web services.

This allows service providers to offer functionalities as Web services, and also supports the technical usage of Web services by clients. However, the descriptions remain on a syntactic level which limits the Web service usage to manual inspection: the developer of a client application needs to search for a suitable Web service within a UDDI repository, then inspect the WSDL description in order to determine how and in which order the necessary messages shall be exchanged, and finally integrate the Web service invocation into the application.

In order to overcome these deficiencies, the emerging concept of Semantic Web services (SWS) develops techniques for better supporting the detection and usage of Web services on the basis of semantic descriptions. The aim is to better support and eventually automate the Web service usage process, and to facilitate the dynamic detection and execution of the necessary Web services for solving a particular client request within SOA systems. For this, inference-based techniques for automated discovery as the detection of suitable candidates out of the available Web services, composition as the automated combination of several Web services, and the automated execution of Web services are developed. The SWS approach uses ontologies as the underlying data model, which are formally specified knowledge models propagated as the base technology for the Semantic Web—another prominent amendment of the existing Web.

This chapter provides an overview of the SWS approach as well as the latest technology developments for this. Firstly, Section 5.2 recalls the initial Web service technologies and the vision of Service-Oriented Architectures. Then, Section 5.3 introduces the concept and the most prominent frameworks for Semantic Web services, and Section 5.4 presents recent developments on SWS techniques for automating the detection, usability analysis, and execution of Web services. Finally, Section 5.5 summarizes the chapter and outlines perspectives for the future development and standardization of semantic SOA technologies.