Chapter 17
Mechanisms for Automatic Web Service Composition

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ABSTRACT

This chapter introduces the web services composition as a means of studying efficient integration of the existing web services to satisfy users’ requirements. It discusses the web services composition definition, combined with the current web services composition methods, and divides those methods into two categories: AI-based methods and Non-AI methods. Also, the authors present the features and the comparison of these two categories, to assist researchers in the understanding of web service composition in a variety of contexts.

INTRODUCTION

Web services are modular elements of application logic that offer functionality to other applications over the Internet. Wide deployment of web services has been made possible by the emergence of XML-based open standards and the ubiquity of internet connectivity. In essence, web services provide request-reply communication semantics similar to remote procedure calls (RPC).

For applications that have complex requirements, more sophisticated services can be composed by orchestrating execution of multiple basic web services. For instance, a web service for travel planning can be implemented by successively invoking web services for airline ticket purchasing, hotel room reservation, and car rental reservation. This composite travel planning web service could become a component of a larger corporate application that handles employee relocation, for instance.

Over a few years many organizations have exposed their products on the internet using web services. For a specific type of service there could be many providers available. For instance, mapping web services are available from Google, Yahoo,
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and Microsoft. Also, the range of service types has exploded, so that sophisticated distributed web applications can now be implemented. Because of the scale of available service options, the task of building a composite web service workflow manually can be difficult and time-consuming. Business process dynamics may also call for web service plans to adapt to changing conditions, such as product cost and availability. These factors have attracted researchers’ interest in designing mechanisms for **automated web service composition**. Automated web service composition is very relevant in mobile networking as well. Businesses have to support a growing mobile workforce, and web service provisioning must deal with the inherent variation in connection quality and availability. This issue is also valid for deployments in MANETs. The U.S. DoD Net-Enabled Command Capability (U.S. Department of Defense, 2008) program envisions a service-oriented architecture, with service users and providers executing on a variety of wired and wireless networks, including tactical MANETs.

In this chapter, we review recent developments in web service composition technologies. We review first methods for automatic web service composition that use Artificial Intelligence (AI) techniques, such as planning, theorem proving, expert systems, logic programming. AI techniques for knowledge representation and reasoning assist web service architecture design with specification of message and constraints semantics. XML languages developed for the Semantic Web, such as the Ontology Web Language (OWL) and the Resource Definition Language (RDF) (Klyne, 2004) are used by many of the surveyed techniques.

In the second part of the chapter we review web service composition methods that utilize more mainstream techniques for graph searching and optimization. Finally, a formal method for service composition is described. The chapter ends with an analysis of the advantages and disadvantages of each technique category.

**BACKGROUND**

In this section, we introduce some web service composition related terms and standards used in this chapter.

WSDL (Web Service Definition Language) is an XML-based language used for describing web services as a collection of endpoints that operate on messages that contain procedure or document-oriented information. When a client program connects to a web service, it can read the WSDL to determine what functions are available to be used. More information can be found in (Chinnici, 2007). WSDL is often used in conjunction with the Simple Object Access Protocol (SOAP).

SOAP is a protocol for exchanging XML-based messages over the internet. It defines an extensible messaging framework containing a message structure that is exchanged over different application-level protocols, such as HTTP or SMTP. SOAP is used in the context of web services to perform remote procedure calls and it has gained a considerable broader user base than CORBA or DCOM due to the ability of HTTP and HTTPS traffic to pass through firewalls. Additional information on SOAP can be found in (Gudgin, 2007).

UDDI (Universal Description, Discovery and Integration) (OASIS, 2008) is platform-independent XML-based registry that provides interfaces for publishing and searching services, defining thus how these services interact over the internet. UDDI is probed by SOAP messages and also provides access to WSDL documents describing the protocol bindings and message formats required to interact with the services listed in its directory.

OWL-S is an ontology built on top of Web Ontology Language (OWL) by the DARPA DAML program, for describing Semantic Web Services. It replaces the former DAML-S ontology. With OWL-S, users and software agents can automatically discover, invoke, compose, and monitor Web resources offering services, under