Chapter 10
Towards Patterns of Web Services Composition

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10.1 Introduction

The growth of the Internet has unleashed a wave of innovations that are reshaping the way organisations interact with their partners and customers. In particular, the concept of electronically-accessible service (also known as e-service or Web service) has gained a considerable momentum as a paradigm for supporting both Business-to-Consumer (B2C) interaction and Business-to-Business (B2B) collaboration.

In a nutshell, the term (Web) service as used in this chapter, denotes an abstraction of a set of computational and/or physical activities intended to fulfil a class of customer needs or business requirements. In other words, a service provides an interface to access functionalities offered by information systems, application programs, and business processes. Typical examples of services include the ability to book an airline ticket through an HTML-based interface, or provide access to a database of weather forecasts through a SOAP-based interface.

Following the recent explosion in Web-accessible services, established enterprises are continuously discovering new opportunities to form alliances with other enterprises, in order to share their costs, skills and resources by offering integrated services (also called composite services). An example of an integrated service, that could be seen as an entire system, is an accounting management system that uses payroll, tax preparation, and cash management services as components. The component services may be outsourced to business partners, and these business partners can in turn outsource part of the activities involved by the delivery of a service to other businesses or organisations.

The ability to efficiently and effectively share services on the Web is a critical step towards the development of the on-line economy. Virtually every organi-
sation needs to interact with manifold other organisations in order to request their services. Reciprocally, an organisation providing a service is often required to interact with a large and dynamic set of service requestors or clients.

Unfortunately, the technology to organise, abstract, search, compose, evolve, analyse, monitor, and access Web services has not entirely kept pace with the rapid growth of available opportunities. Indeed, the development of integrated services is still largely ad hoc, time-consuming and requiring a considerable effort of low-level programming. This approach is clearly tedious and hardly scalable because of the volatility and size of the Web. Worse, as service integration is done in an ad hoc manner, it is likely to rely on proprietary solutions, thereby rendering inter-service coordination a difficult task.

The lack of high level abstractions and functionalities for Web service integration has triggered a considerable amount of research and development effort, both in academia and industry. This has resulted in a number of products, standards, frameworks and prototypes addressing sometimes overlapping, sometimes complementary aspects of service integration. In particular, numerous XML-based variants for describing, advertising, retrieving and inter-connecting services have been defined, and some of these standards have been adopted, or are expected to be adopted by manifold commercial product such as catalogue management suites and business process managers. Although the emergence of these standards is undoubtedly a significant step towards facilitating service integration, the need to provide tools and methodologies supporting the rapid service integration of dynamic services still exists.

In this chapter we summarise some of the challenges and recent developments in the area of Web service integration, and we abstract some of them in the form of patterns. Specifically we present patterns for both bilateral service-based interactions, multilateral service composition, and execution of composite services. Due to the emerging nature of the topic addressed in this chapter, these patterns are still in an early stage of development, and could rather be called "proto-patterns".

The remainder of the chapter is organised as follows. In Section 10.2 we provide an overview of related fields such as application integration, workflow management and Web service development. Sections 10.3 and 10.4 describe patterns related to service request, provisioning, and outsourcing. Sections 10.5 and 10.6 introduce patterns related to the specification of composite services involving multiple partners, while Section 10.7 describes a pattern for executing composite services. Finally, Section 10.8 provides some concluding remarks.

### 10.2 Review of Enabling Technologies

Service composition is an active area of research and development in different fields including component-based frameworks, cross-enterprise workflows, Electronic Data Interchange, XML-based B2B frameworks, and agent-based frameworks. While these approaches provide solutions for different application domains, our discussion will concentrate on service composition requirements.