Web Services Coordination for Business Transactions

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INTRODUCTION

Many e-commerce companies such as Amazon.com, Yahoo.com, and eBay.com started to offer Web services to their partners and customers. Through such Web services, new value-added services could be provided and hence higher revenues would be generated. Essentially, the Web services technology is transforming the World Wide Web from a predominantly publishing platform to a programmable platform, which undoubtedly will make it easier to conduct business online, and enable automated business-to-business communications (Papazoglou, 2003). The Web services technology is particularly useful for Application Service Providers that offer various on-demand services and software-as-a-service (SAAS) to their customers (Chakrabarty, 2007). Such service-oriented computing is attractive to many businesses because they can save valuable resources and money by avoiding installing and maintaining sophisticated enterprise software on-site. Furthermore, most of business interactions are transactional, which require well-defined coordination support. To meet this requirement, a number of specifications have been proposed, and OASIS has recently rectified the Web Services Transactions specifications (Feingold & Jeyaraman, 2007; Freund & Little, 2007; Little & Wilkinson, 2007).

In this chapter, we provide an overview of the Web services technology, together with the set of standard specifications for Web services transactions. The core components of the Web services technology include eXtensible Markup Language (XML), HyperText Transfer Protocol (HTTP), Simple Object Access Protocol (SOAP), and Web Services Description Language (WSDL). Both SOAP and WSDL are based on XML. All these protocols and languages have the characteristic of strong extensibility, which lays a solid foundation for the success of the Web services technology. Due to the extensibility design, the protocols specified in the Web services transactions standards can be plugged into the Web services core seamlessly to provide the additional coordination needed for business transactions. Furthermore, we point out the need to protect the business transactions from the hardware failures and malicious faults, and for more robust coordination for Web services transactions.

BACKGROUND

In this section, we introduce the Web services concept and the basic building blocks of the Web services platform. There is no universal definition of the term Web services and its interpretation varies drastically. Web services can be loosely defined as any services offered over the World Wide Web. On the other hand, only the services enabled by the Web services technology are referred to as Web services by many researchers and practitioners. In this chapter, we use the latter interpretation. The Web services technology refers to the set of standards that enable automated machine-to-machine interactions over the Web. The corner stone of the Web services technology consists of eXtensible Markup Language (XML) (Bray, Paoli, Sperberg-McQueen, Maler, Yergeau & Cowan, 2006), HyperText Transfer Protocol (HTTP), Simple Object Access Protocol (SOAP) (Gudgin, Hadley, Mendelsohn, Moreau, Nielsen, Karmarkar et al., 2007), Web Services Description Language (WSDL) (Christensen, Curbera, Meredith & Weerawarana, 2001), and the Universal Description, Discovery and Integration (UDDI) service (Clement, Hately, Riegen & Rogers, 2004). From an architecture point of view, the Web services platform consists of Web services providers, Web services consumers, and UDDI registries that broker the providers and the consumers, as shown in Figure 1. If a Web services consumer wants to request a service, it can search for available service providers via UDDI. Based on the returned information, the consumer can invoke the service by sending the request directly to the service provider.

EXTENSIBLE MARKUP LANGUAGE

XML is designed to facilitate self-contained, structured data representation and transfer over the Internet. It allows users to define their own tags, which is why it is easily extensible. XML messages enable different applications to communicate with each other over the network using a variety of transport-level protocols such as HTTP and SMTP. To invoke a Web service, a user only needs to send an XML request message to the Web services provider. The provider will then send

Figure 1. The architecture of Web service
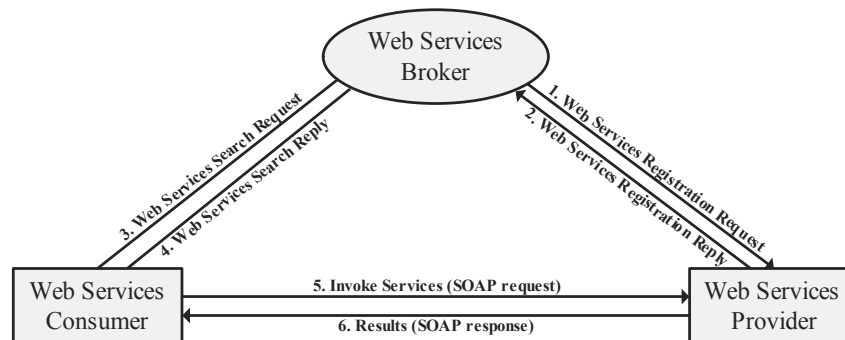
back an XML reply message containing the results the user wanted. Typically, the XML messages must conform to the SOAP standard.

Simple Object Access Protocol

SOAP, a communication protocol for message exchanges over the Internet, provides a standard modular packaging model, a data encoding method and a way to perform remote procedure calls (RPCs). SOAP is easy to use and it can be easily extended due to its use of XML as the messaging format. Like many public-domain application-level protocols, such as SMTP, a SOAP message contains a SOAP Envelop and a SOAP Body. A SOAP message often contains an optional SOAP Header element and a Fault element if an error is encountered by the sender of the SOAP message.

Web Service Description Language

WSDL provides a structured way to describe a Web service based on an abstract model. For each Web service, the corresponding WSDL document specifies the available operations, the messages involved with the operations, and a set of endpoints to reach the Web service. Due to the use of XML, WSDL is also extensible. In particular, it allows the binding of multiple different communication protocols and message formats.

Universal Discovery Description and Integration

A UDDI registry service acts like yellow pages for business providers and consumers. Business owners publish their Web services to the UDDI registry, and their partners and consumers can locate the Web services they needed and obtain detailed information regarding the services by searching the registry. There are three main components in UDDI,

often referred to as White Pages, Yellow Pages, and Green Pages. The White Pages provide the Web service provider's information, such as name, address, contact information and identifiers. The Yellow Pages describe industrial categories based on standard taxonomies. The Green Pages present technical information in detail regarding the Web services. The UDDI also support several ways to carry out the search, for example, one can search by service provider's location, or by specified service types.

Web Services Coordination of Business Transactions

Web services interactions are becoming more and more complex in structure and relationships. More complex means we need longer time to execute them, because of business latencies and user interactions. The Web Services Coordination specification (WS-Coordination) (Feingold & Jeyaraman, 2005) describes an extensible framework for plugging in protocols that coordinate the actions of distributed applications. Such coordination protocols can be used to support a variety of business applications, including those that require strict consistency and those that require agreement of a proper subset of the participants. The framework enables a Web service to create a context needed to propagate an activity to other Web services and to register for a particular coordination protocol.

There are two types of business transactions. One follows the traditional atomic transaction semantics, and the other is referred to as business activities, which implies that the atomicity property may be relaxed. The former is suitable for short transactions that require strong atomicity, such as a fund transfer transaction. The latter is more suitable long running transactions, such as those used in supply chain management. Based on WS-Coordination, two specifications, namely Web Service Atomic Transaction (WS-AtomicTransaction) (Little & Wilkinson, 2007) and Web Service Business Activity (WS-BusinessActivity) (Freund & Little, 2007), have been

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