Building Highly Dependable Wireless Web Services

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ABSTRACT

In this paper, the authors introduce Web services technology and its applications to mobile business transactions. This paper shows that the Web services technology is a powerful tool to build next-generation e-Commerce applications for wireless mobile devices following the service-oriented architecture. Such an approach would bring significant benefits to organizations involved with e-Commerce. The authors further discuss the importance of ensuring high dependability of Web services and provide a literature review of state-of-the-art techniques that are critical to the implementation of practical and dependable wireless Web services. Finally, research on the design, implementation, and performance evaluation of a fault tolerance framework for wireless Web services are described.

Keywords: Algorithms, Distributed Systems, E-Commerce Quality Issues, Middleware, Service Interruption, Web-Based Commerce, Wireless Technologies

INTRODUCTION

Electronic commerce or e-Commerce in short, refers to the selling and buying of products and services over electronic systems, which such as the Internet (Chaudhury & Kuilboer, 2001). E-Commerce has grown to a 100 Billion per year business and it is expected to continue growing with a staggering speed (Scheleur, King, & Kinyon, 2008). This article touches on two emerging issues related to e-Commerce: (1) e-Commerce over wireless mobile devices, and (2) the use of the Web services technology for e-Commerce systems. A Web service refers to a programmatic interface accessible by other applications via the World Wide Web (W3C, 2008). The Web services technology typically refers to the set of standards that enable Web services (more details will be provided in the next section).

We expect that many next generation e-Commerce systems will be built using the Web services technology and most of them will provide support for wireless mobile devices (by providing and enabling the consumption of wireless Web services). However, there exist substantial technical challenges in materializing this vision. In this article, we focus on one of the most important of challenges, i.e., how to ensure high dependability of wireless Web services provided by such systems. The reason why high dependability becomes a major concern for e-Commerce providers and users alike is primarily due to the high financial cost associated with unreliable services. Services are expected to be highly dependable 24 by

DOI: 10.4018/jeco.2010100101
7 and the unavailability of a service not only disrupts many end-users of the service, but the composite services built on top of the service as well. Extensive downtime would often mean massive loss of revenue, loss of employee productivity, and eventually the reputation of a business (Patternson, 2002).

This article is structured as follows. In the next section, we introduce the Web services technology and elaborate the benefits of using the Web services technology for conducting e-Commerce over mobile devices. We then layout the primary challenges for the Web services technology to support wireless mobile devices, and provide a literature review of the state-of-the-art solutions towards the objective. This is followed by the presentation of our research on dependable wireless Web services, including design, implementation and performance evaluation. Finally, we conclude the article and point out future research directions.

**Wireless Web Services for E-Commerce**

In this section, we first introduce the Web services technology, and then elaborate the benefits of using the Web services technology for conducting e-Commerce over wireless devices.

**The Web Services Concept**

The Web services technology refers to the set of standards that enable automated machine-to-machine interactions over the Web. The cornerstones of the Web services technology include eXtensible Markup Language (XML) (Bray et al., 2006), HyperText Transfer Protocol (HTTP), Simple Object Access Protocol (SOAP) (Gudgin et al., 2007), and Web Services Description Language (WSDL) (Christensen et al., 2001).

XML is designed to facilitate self-contained, structured data representation and transfer over the Internet. It is extensible because it allows users to define their own tags. The extensibility of XML makes it the essential building block for Web services. Here the term *extensibility* refers to the capability of introducing additional features and functionalities without disrupting existing systems.

HTTP is an application-level protocol following the client-server interaction model. HTTP is designed to share and access Web resources (i.e., hypertext objects). However, HTTP is a stateless protocol in that it does not keep track of the state across different HTTP requests. The design of HTTP not only removes unnecessary complexity, it ensures high degree of scalability as well.

As the name suggests, SOAP was originally designed to conduct remote procedure calls over the Web. It has evolved to become the main communication protocol to exchange XML documents. 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.

WSDL is an XML-based language used to describe Web services. 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.

To enable dynamic services publishing and discovery, a Universal Description, Discovery and Integration (UDDI) (Clement et al., 2004) service could be used. UDDI provides the standard way for Web services providers to describe their services, and for the consumers to search and discover available services. However, the experiments of offering global-scale public-domain UDDI registries were not successful, as evidenced by the shutdown of once well-known UDDI registries provided IBM, Microsoft and SAP (Krill, 2005). One reason for this failure is perhaps due to current business requirements, i.e., inter-enterprise transactions can rarely take place before the relevant legal documents are signed by the companies involved in the transactions. Nevertheless, UDDI has been gaining momentum to be used as a Web services registry within each enterprise. Thus, from an
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