

Interaction between Mobile Agents and Web Services

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INTRODUCTION

With the interconnection of computers in networks, particularly through the Internet, it becomes possible to connect applications on distant computers. An application works perfectly whether it is distant or local. Moreover, a distant application allows us to benefit from the following additional advantages:

- Data and processes can be stored on a remote server that has a bigger storage capacity than the local host.

Data can be shared between users using, for example, Remote Procedure Call (RPC), Remote Method Invocation (RMI), Java Message Service (JMS), and Enterprise JavaBeans (EJB) (Frénot, 2000):

- Distant application can be used at the same time by several users;
- Updating data and processes can be done only in one host;
- Flexibility on distribution of the load: An application can be executed on the available machine; and
- High availability: A faulty machine does not affect the others.

Many approaches have been proposed and developed for communication between distant hosts on a network such as Message Passing (MP), Remote Evaluation (REV), Remote Object Invocation (ROI), Mobile Agents (MA), Common Object Request Broker Architecture (CORBA), Web Services (WS), RPC, and RMI (Dejan, LaForge, & Chauhan, 1998). In this article, we will focus on two particular paradigms: The Web Services and the Mobile Agents.

WS defines a standard to invoke distant applications and to recover results across the Web. Its invocation is made in synchronous mode. MA has the faculty to move easily between a network's hosts to execute user requests. MA communication is made in asynchronous mode. The fusion of these two complementary technologies will solve many problems.

This article is composed of the following sections: In the first two sections, we introduce the concepts of WS and MA, their advantages and disadvantages. In the third section, we present different kinds of interaction between MA and WS. Finally, we study an example in the last section.

WEB SERVICES

Definition

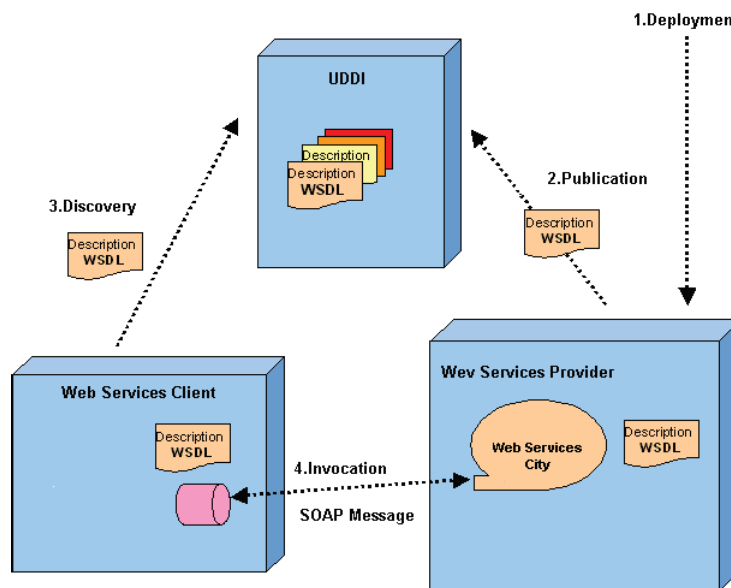
WS are a technology that allows interaction between applications distantly via the Internet, and thus independently of the platforms and the languages that they use. They lean on standard Internet protocols (XML, HTTP) to communicate. This communication is based on the principle of calls and answers, performed with messages in XML (Daum & Merten, 2003; Windley, 2003)

Web Services Components

WS are based on the following group of XML technologies which work together (Champion, Ferris, Newcomer, & Orchard, 2000) (see Figure 1):

- SOAP (Simple Object Access Protocol) is a protocol, standardized by W3C, which allows the invocation of remote methods by the exchange of XML messages (Box et al., 2000);

Figure 1. WS functioning



- WSDL (WS Description Language) is a norm derived from XML which represents the interface of the use of a WS. It provides specifications necessary for the use of a WS by explaining its methods, its parameters, and what it returns. WSDL is a services description language which represents the public interface of service and is accessible from a URL (Christensen, Curbera, Meredith, & Weerawarana, 1999); and
- UDDI (Universal Description, Discovery, and Integration) is a specification defining the way to publish and discover WS on a network. These descriptions of services are centralized on a server, private or public, that users can access. Such a server can be seen as a yellow pages directory (Kurt, 2001).
- **Publication:** The provider exposes his service by publishing its description to the (UDDI) directory;
- **Discovery:** In order to find the service description, the WS client searches in the UDDI directory. This step allows to find different available providers and to choose who best satisfies the client criteria; and
- **Invocation:** The client uses the service description to establish a connection with the provider and invoke the WS.

Web Services Advantages

WS offer many benefits over other distributed applications paradigms (Cavanaugh, 2006):

Web Services Functioning

The WS architecture is based on the Service-Oriented Architecture model (SOA) (Brown et al., 2003) which puts three actors in interaction: a client, a provider, and an intermediate directory. The interaction model (See Figure 1) is decomposed into four successive steps (Curbera, Dufler, Khalaf, Nagy, & Mukhi, 2002):

- **Deployment:** The service provider deploys a WS on a server and generates a description of

- Web services provide the interoperability between various software working on various platforms;
- Web services use standards and open protocols;
- Protocols and data formats are in text format, making it easier to understand the total functioning of exchanges; and
- Based on the HTTP protocol, Web services can work through firewalls without requiring changes in the rules of filtration.

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