

## Chapter 3.9

# Extending Apache Axis for Monitoring of Web Service Offerings

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### EXECUTIVE SUMMARY

The Web Service Offerings Infrastructure (WSOI) is a monitoring and management infrastructure for the Web Service Offerings Language (WSOL). It extends Apache Axis, an open-source tool for hosting Web services. We present technical details of several WSOI solutions for monitoring Web Services. To pass management information among management parties, we built WSOI serializer and WSOI deserializer modules converting data between formats of Axis' MessageContext

properties and SOAP headers. To perform different monitoring activities for different WSOL service offerings, we implemented Web Service Offering Descriptor (WSOD) as a complement to Axis' Web Service Deployment Descriptor (WSDD) component. To represent run-time values of WSOL-related management information, we developed WSOI management information model. All these solutions were verified with a prototype implementation of WSOI 2.0 and validated on case studies.

## INTRODUCTION AND MOTIVATION

Web Service Management (WSM) is the management of one or several XML (Extensible Markup Language) Web services within the same domain of responsibility (i.e., same business) (Tosic, Pagurek, Patel, Esfandiari & Ma, 2005). It consists of the monitoring of a Web service's operation and the control of the Web service to meet the guaranteed service and quality of service (QoS). Monitoring of a Web service includes measurement and calculation of relevant QoS metrics; evaluation of various conditions (requirements and guarantees); calculation of prices and monetary penalties; and accounting of executed operations, measured/calculated QoS metrics, evaluated constraints, and monetary amounts to be paid. The monitoring of a Web service can be performed by the provider, the consumer, and/or one or more management third parties or entities (e.g., Web services) independent of the provider and the consumer. Management third parties (Keller & Ludwig, 2003) can be used to perform monitoring and management actions that the provider and the consumer cannot execute. They also can be used when the consumer and the provider do not trust each other. We define the Web Service Composition Management (WSCM) as the management of which Web services are composed and how they interact (Tosic et al., 2005; Tosic, Ma, Pagurek & Esfandiari, 2004). Interaction among the composed Web services can be described explicitly and formally in various business and technical contracts. The monitoring of contract fulfillment combines the monitoring of the composed Web services (Tosic et al., 2004, 2005).

While management is a critical business activity, it can incur significant overhead. To provide management even for simple Web services, it is appropriate to study management solutions with relatively low run-time overhead. The most important of them is the concept of a service offering (Tosic et al., 2005; Tosic, Patel & Pagurek, 2003), which formally represents a class of service—a

discrete variation of the complete functionality and QoS provided by one Web service. When a provider Web service collaborates in parallel with a large number of consumers, it often has to provide different levels of QoS in order to accommodate different characteristics and needs of the consumers. Service offerings are one mechanism with which to achieve such differentiation of service and QoS. They can differ in measured QoS metrics, constraints to be evaluated, prices, involved management parties, and/or other management information.

Explicit and formal specification of service offerings, various types of constraint, and management statements for Web services can be achieved with the Web Service Offerings Language (WSOL) (Tosic et al., 2003, 2005). In order to demonstrate and further explore the use of WSOL for the management of Web services and their compositions, the Web Service Offerings Infrastructure (WSOI) (Tosic et al., 2004, 2005) was developed. WSOI enables the monitoring of Web services and dynamic (run-time) manipulation of classes of service described in WSOL. WSOI is an extension of Apache Axis (eXtensible Interaction System) (Axis Development Team, 2003), an open-source SOAP engine hosting Web services. Axis was chosen as the foundation for WSOI, because its modular, flexible, and extensible architecture enables implementing the support for monitoring of WSOL service offerings as a set of additional software components.

Previous WSOL and WSOI publications (Tosic et al., 2003, 2004, 2005) described WSOL, presented the overall architecture of WSOI (Tosic et al., 2004, 2005), and illustrated these with usage examples. This article describes technical details of several WSOI solutions for autonomic monitoring of Web services. Monitoring is the basis for other management activities. For example, without monitoring, accounting parties cannot charge consumers for Web service invocations, and management information used for control activities cannot be collected. This article builds

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