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A Service-Oriented Composition Framework with QoS Management

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ABSTRACT

Quality of Services (QoS) management in compositions of services requires careful consideration of QoS characteristics of the services and effective QoS management in their execution. This paper describes an approach to implementation of QoS management in compositions of Web services in the context of Computational Quality Attributes and Service Level Agreements. Building on prior research work of others in the use of Message Detail Records, this paper integrates the results from several research threads to propose a QoS Management Architecture to support dynamic processing of service- and flow-level quality attributes to support QoS requests and analyses in Web-service-oriented architectures. The study of QoS management in a Web service composition framework was motivated by the evolution of the composition framework for a toolkit for integration and experimentation of distributed system applications. A message tracking model is proposed for supporting QoS end-to-end management by applying the Computational Quality Attribute (CQA) concepts of Flow-Service-Quality engineering. Quality attributes are defined, computed and acted upon as dynamic characteristics of systems, with values constantly changing in operation. A CQA provision is illustrated, with a simple Web Services travel reservation example. The example is elaborated to illustrate QoS end-to-end management using the Simple Object Access Protocol (SOAP) message tracking model.

Keywords: *BPEL; message exchange patterns; QoS; SLA; SOAP; Web services*

INTRODUCTION

Management of quality in enterprise systems is challenging. Distributed systems and systems of systems require seamless integration of components and systems to run in heterogeneous environments. Such systems may have to support and manage data access to a wide range of users from anywhere, anytime. To meet QoS requirements of many concurrent providers and requestors, QoS management must provide adequate performance, admission control, prediction, resource management, monitoring and adaptation. Quality considerations, such as extensibility, flexibility, connectivity and

interoperability require that enterprise systems be easily accessible through published interfaces and easily enhanced to offer value-added services. In addition, quality identification, measurement, analysis and traceability have to be dealt with in a heterogeneous environment and a scalable fashion.

Current trends in information and communication technology are accelerating widespread use of Web services in supporting a Service-Oriented Architecture consisting of services, their compositions, interactions and management (Wang & Fung, 2004; Papazoglou & Georgakopoulos, 2003). A Web service is a software system designed to support interoperable application-to-application interactions over the Internet. Each service makes its functionality available through well-defined or standardized interfaces. Services can be independently developed and evolved over time. Each service is a self-describing, composable and open software component.

Building on previously published research work of others in the use of Message Detail Records (IBM, 2002), this paper integrates the research described in Linger, Pleszkoch, Walton and Hevner (2003); Hevner, Linger, Sobel and Walton (2002); Hevner, Linger, Pleszkoch and Walton (2003); Fung, Uczekaj, Wang and Moody (2004); and Fung et al. (2005) to describe an approach to implementation of QoS management in compositions of Web services in the context of CQA and Service Level Agreements. A QoS Management Architecture (Fung et al., 2004) is proposed to support dynamic processing of service- and flow-level quality attributes to support QoS requests and analyses in Web-service-oriented architectures. A message tracking model is described for supporting QoS end-to-end management by applying the CQA concepts of Flow-Service-Quality engineering (Hevner et al., 2002). Quality attributes are defined, computed and acted upon as dynamic characteristics of systems, with values constantly changing in operation. A CQA provision is illustrated with a simple Web Services travel reservation example (Fung et. al., 2002). The example is elaborated to illustrate QoS end-to-end management using the SOAP message tracking model.

The paper is organized as follows: Next, we discuss the evolution of the Network Centric Information Infrastructure (NCII) for large-scale distributed systems, a toolkit of prefabricated software components together with a composition framework that acts as a "breadboard" for application builders in an industrial setting to integrate and experiment with software components. The evolution of the NCII composition framework motivated the study of QoS management in a Web service composition framework. We provide a brief introduction to the concepts of Flow-Service-Quality engineering and propose the application of CQA (Linger et al., 2003; Hevner et al., 2002; Hevner et al., 2003) to QoS-enabled service-oriented architectures. Then, we illustrate a CQA provision with a simple Web Services travel reservation example. We give a sample architecture for CQA processing, elaborate on the use of Service Level Agreements to implement QoS, and introduce a conceptual model of SOAP Message Exchange Patterns, WSBPEL and SLA for illustrating QoS end-to-end management (Fung et al., 2005). Section 6 illustrates the SOAP message tracking model for supporting QoS end-to-end management with a travel reservation example that applies Message Detail Records in SOAP message headers. Finally, we conclude and discuss future research issues.

THE EVOLUTION OF COMPOSITION FRAMEWORK AND QOS MANAGEMENT IN A DISTRIBUTED SYSTEM TOOLKIT

The NCII for large-scale distributed systems is a toolkit of prefabricated software components together with a composition framework that acts as a "breadboard" for application builders to integrate and experiment with software components (Fung et al., 2004). A composition framework is the part of a running system that allows participants to "program" or

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