Chapter 68
Quality of Service Monitoring, Diagnosis, and Adaptation for Service Level Management

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ABSTRACT

A key requirement in Service Level Management (SLM) is managing the Quality of Services (QoS) demanded by clients and offered by providers. This managing process is complicated by the globalization and Internet scale of enterprise services and their compositions. This chapter presents two contributions to the QoS management task for SLM. First, instead of considering monitoring as an isolated service, it incorporates a monitoring service as an integral part of a comprehensive QoS management framework for SLM. Second, it includes a diagnosis service as an integral part of the QoS management framework. Using the data fed from monitoring service, diagnosis service detects system condition changes and reasons about the causes of detected degradation in networked enterprise system. With condition detection and situation understanding, the QoS management framework can then proactively activate adaptation mechanisms to maximize the system's ability to meet QoS contract requirements of concurrent clients. Using this framework, enterprise systems can provide real time automated QoS management to optimize system resources in meeting contract requirements. This approach is validated using QoS management services integrated in a publish/subscribe style of SOA. Benefits of QoS monitoring, diagnosis, and adaptation services for responsiveness SLM are demonstrated via experiments.

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INTRODUCTION

Traditionally, Service Level Management (SLM) relies on human analysts using monitoring tools (e.g., Microsoft SMS) and system management tools (e.g., HP OpenView). When enterprise services are interconnected as networked services in a Service Oriented Architecture (SOA) (Papazoglou & Georgakopoulos 2003), SLM becomes a complex process because of the dynamic, flexible, and compositional natures of SOA and the globalization of enterprise services. Globalization involves not only inter-enterprise collaboration and enterprise computing virtualization (e.g., grid computing), but also diverse physical locations of worldwide clients and computing systems. Global outsourcing adds additional demands for an integrated and comprehensive SLM framework. Instead of monitoring and reporting, this framework must establish service level agreements (SLA), monitor the execution of SLAs, and adapt autonomously whenever necessary to meet the constraints in SLAs. It will relieve human analysts from tedious repetitive work and let them focus on decision making.

A key requirement in SLM is managing the Quality of Services (QoS) demanded by clients and offered by providers in the SLAs. QoS management is critical for service-oriented enterprise architectures because services have different QoS characteristics and their interactions are dynamic and loosely coupled. In order to satisfy various QoS requirements from concurrent clients, QoS management in the networked enterprise systems needs to optimize system resources and activate computing mechanisms. These QoS requirements are expressed in terms of QoS characteristics such as performance, reliability, timeliness, and security. An integrated QoS management framework is desirable to provide comprehensive end-to-end QoS support in a consistent and coordinated fashion across all layers of enterprise systems, ranging from enterprise policies, applications, middleware platforms, and down to network layers. Under such an integrated QoS management framework, enterprise systems can bring policy management, SLA QoS contract management, monitoring and diagnosis, system management, resource management, and adaptations together for an autonomic SLM solution.

The publish/subscribe style of SOA has been widely adopted in the industrial and government enterprise systems. Examples include stock market applications using TIBCO publish/subscribe technology and the Joint Battlespace Infosphere concept well recognized in the US Air Force community (Combs, Hillman, Muccio & McKeel, 2005). In this chapter, we use the publish/subscribe style of SOAs to illustrate our QoS monitoring, diagnosis and adaptation approach. Specifically, different clients (publishers and subscribers) may have different QoS requirements in terms of performance, reliability, timeliness, and security. For instance, some publishers may have higher priority than others and may require their message deliveries to be guaranteed with correct ordering in faster response time. Similarly, some subscribers may be more critical than others and thus require shorter delays in receiving messages. Accordingly, the service provider, also called Information Broker or simply Broker in the following, must provide QoS guarantees to its publisher and subscriber clients. Clients and the Broker negotiate for mutually acceptable QoS contracts. The Broker must monitor not only the service levels agreed on in the contracts, but also the system health conditions of the server node, the network, and the client nodes. When contracts are violated or when contracts cannot continue to be honored due to system degradation, the Broker must also activate adaptation mechanisms to respond to these changes.

In this chapter, we present a policy based QoS management framework and its component services for SLM. This framework consists of QoS management services, including admission control, prognosis, resource management, monitoring, diagnosis, and adaptation. It uses policies to determine