Chapter 103
Rationale for Use of Cloud Computing:
A QoS-Based Framework for Service Provider Selection

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ABSTRACT

Cloud Computing is the most promising computing paradigm that provides flexible resource allocation on demand with the promise of realizing elastic, Internet-accessible, computing on a pay-as-you-go basis. With the growth and expansion of the Cloud services and participation of various services providers, the description of quality parameters and measurement units start to diversify and sometime contradict. Such ambiguity does not only result in the rise of various Quality of Service (QoS) interoperability problems but also in the distraction of the services consumers who find themselves unable to match quality requirements with the providers' offerings. Yet, employing the available QoS models that cover certain quality aspects while neglecting others drive consumers to perform their service selection based only on cost-benefit analysis and performance evaluation, without being able to perform subjective selection based on a comprehensive set of well-defined quality aspects. This chapter presents a novel QoS ontology that combines and defines all of the existing quality aspects in a unified way to efficiently overcome all existing diversities. Using such an ontology, a comprehensive broad QoS model combining all quality-related parameters of both service providers and consumers for different Cloud platforms is presented. The chapter also provides a mathematical model that formulates the Cloud Computing service provider selection optimization problem based on QoS guarantees. The validation of the provided model is addressed in the chapter through extensive simulation studies conducted on benchmark data of Content Delivery Network providers. The studies report the efficient matching of the model with the market-oriented different platform characteristics.

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1 INTRODUCTION

The promise of cloud computing is its potential to shift paradigms away from fixed IT assets to more flexible resource allocation on demand with the promise of realizing elastic, Internet-accessible, computing on a pay-as-you-go basis. Standing at different level of hardware and software stack levels - Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Services (SaaS), this form of service provides several benefits to consumers; no cost for purchasing, free of maintenance, accessibility through Internet, and high availability. Computing services are offered on-demand according to an auto-scaling paradigm following the pay-as-you-go financial model. Such flexible key tenets will lead Cloud Computing to become the next wave of technological revolution that will be able to provide IT-services required by business.

Although Cloud Computing is growing rapidly, its Quality of Service (QoS) still poses significant challenges, especially in the context of service provider selection and quality assurance. Various QoS models have been adopted by different service providers and consumers for describing QoS information. This diversity leads to the use of different QoS descriptions as well as different concepts, scales and measurements of, sometimes, the same QoS factor. Such ambiguity not only results in an increase of various QoS interoperability problems, but also in the confusion of consumers, who find themselves unable to match their quality requirements with provider' offerings. While Cloud service providers are increasingly offering novel services, it becomes a challenging task for Cloud consumers to select the appropriate service provider based on predefined QoS requirements.

Most of the current QoS models focus only on one quality factor such as transparency or security (Pauley, 2010), (Catteddu, 2010), and neglect others. Even those models that cover multiple QoS factors are tailored only for certain service platforms, such as SaaS, or certain applications domain, such as Customer-Relationship Management (CRM) applications (La & Kim, 2009) (Heart, Tsur, & Pliskin, 2010) (Armstrong & Djemame, 2009). Under such limited QoS models, the consumers often find themselves unable to perform independent subjective service selection based on a comprehensive set of well-defined quality aspects. Hence they perform it based on either cost-benefit analysis (Kondo, Javadi, Malecot, Cappello, & Anderson, May 2009), (Klems, Nimis, & Tai, 2009) or performance evaluation (Xiong & Perros, 2009), (Pathan, Broberg, & Buyya, 2009) measured only by response time and throughput. Meanwhile, existing selection approaches developed in the service computing community (i.e. grids and web services) cannot be directly migrated to the Cloud environment due to the difference in their service model structure. Yet optimal service provider selection based on QoS requirements for the purpose of maximizing the consumer's utility is still uncovered for Cloud Computing as it should be. By that, the necessity of developing a general framework, that gathers all of the QoS factors with a unified description, scale and measurement unit, becomes crucial. Such a framework should overcome QoS interoperability problems and all its consequent ones.

This chapter presents a novel QoS ontology that combines and defines all of the existing quality aspects in a unified way to efficiently overcome all existing diversities in expressing QoS aspects. Using such ontology, a comprehensive broad QoS model combining all quality related parameters of both service providers and consumers for different Cloud platforms – (IaaS, PaaS, SaaS). The model sustains the extension of QoS attributes according to specific situation, to support QoS-guaranteed Cloud service selection. The chapter also provides a mathematical model that formulates the Cloud Computing service provider selection optimization problem based on a multi-dimensional QoS approach, to satisfy the consumer quality requirements. The mathematical model assists decision makers in selecting the optimal Cloud service