A Novel QoS-Based Framework for Cloud Computing Service Provider Selection

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ABSTRACT

Cloud Computing is a promising computing paradigm that provides flexible, Internet-accessible resources allocation on demand on a pay-as-you-go basis. With the growth and expansion of Cloud services and participation of various services providers, the description of quality parameters and measurement units started to diverse and sometimes contradict. Such ambiguity does not only result in the raise of various QoS interoperability problems, but also in the distraction of the services consumers who find themselves unable to match their quality requirements with the providers’ offerings. Influenced by such diversity, the available QoS models are limited to either cost-benefit analysis or performance evaluation, without being able to cover a comprehensive set of well-defined quality aspects. In this paper, we provide a complete framework for such problem. We firstly propose a novel QoS ontology that combine and define all of the existing quality aspects in a unified way to efficiently overcome all existing diversity. Using such ontology, we propose a comprehensive broad QoS model combining all quality parameters of both service providers and consumers for different Cloud platforms. We then propose a mathematical model addressing the Cloud Computing service provider selection optimization problem based on QoS-guarantee. The proposed model reports an efficient matching with the market-oriented different platforms characteristics; validated through extensive simulation studies conducted on benchmark data of Content Delivery Network providers.

Keywords: Cloud Computing, Quality of Service, QoS Framework, QoS Ontology, Service Provider Selection

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1. INTRODUCTION

The Cloud Computing turn to be nowadays 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. Standing at different level of hardware and software stack levels (IaaS, PaaS, and SaaS), the Cloud Computing 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 lead the Cloud Computing to become the next wave of technological revolution that will be able to provide IT-services required by business.

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 diverse and sometime contradict. Such ambiguity does not only result in the raise of various QoS interoperability problems, but also in the distraction of the services consumers who find themselves unable to match their quality requirements with the providers’ offerings. As far as Cloud service providers increasingly offer novel services, it becomes a challenging task for the 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), neglecting others. Even those models that cover multiple QoS factors are tailored only for certain service platform, 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 found 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, 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 service computing community (i.e. grids and web services) cannot be directly migrated to the Cloud environment. 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 significantly crucial. Such framework is anticipated to overcome QoS interoperability problem and all its consequent ones.

In this paper, we design a novel QoS ontology that combine and define all of the existing quality aspects in a unified way to efficiently overcome all existing diversities in expressing QoS aspects. Using our ontology, we propose a comprehensive broad QoS model combining all quality related parameters of both service providers and consumers for different Cloud platforms - IaaS, PaaS and SaaS. The proposed model sustains the extension of QoS attributes according to specific situation, to support QoS-guaranteed Cloud service selection. We then develop a mathematical QoS-guaranteed model to address the Cloud Computing service provider selection problem based on a multi-dimensional QoS approach, to satisfy the consumer quality requirements. The proposed model assists decision makers in selecting the optimal Cloud service provider, incorporating a comprehensive set of well-defined quality aspects. The efficiency of the model is validated through extensive simulation studies conducted on benchmark data of Content Delivery Network providers (benchmarking the Cloud, 2001), representing a typical selection problem scenario.
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