別紙様式５(Attached Form 5)

学位論文要旨 Abstract of Thesis

所属専攻 Field: Computer Science and Electrical Engineering 専攻(Field)
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Title of Thesis

Techniques for Transparent Cloud Service Selection and Handling Performance Uncertainty in the Clouds
（トランスペアレントなクラウドサービス選択とクラウドの不確実な効率の操作に関する研究）

Abstract（within 1600 words）

The growing adoption of cloud services for hosting both legacy and new applications has brought forth a myriad of cloud service providers. A consequence of this growth is the challenge it poses on prospective cloud users in finding an optimal service provider in terms of matching their application requirements from a pool of similar offers. Hence, benchmarking Infrastructure as a Service (IaaS) cloud offerings in a fair and transparent manner has therefore become a necessity for cloud users rather than luxury. While other aspects of cloud service selection such as discovery and ranking have been given adequate attention, considerations for target application workload requirements and how to correlate benchmarking results remain a major concern.

To familiarize with developments in the research area, the first part of this thesis presents the outcome of a systematic mapping study of existing research contributions addressing various aspects of cloud service selection. Further on, we present the design of TCloud: a transparent framework for public cloud service comparison which constitutes four components namely; Cloud Monitoring and Testing Services, Benchmarking Management System, Cloud Comparator and User Feedback Management System. To initiate the development of the Benchmarking Management System of the TCloud framework, we developed a methodology and conducted experiments on the real public cloud environment by collating public cloud benchmarking data and correlating the observed performance metrics with cloud users' actual application workload requirements. We also demonstrated

how prospective cloud users could use the framework in understanding how well virtualized public cloud resources meet their application workload requirements. We also present the evaluation of the disk I/O sub system whilst considering different application requirements and workload characteristics. Next, we develop a transparent approach to performance analysis and comparison of IaaS providers with an improved methodology leveraging the TCloud framework and, considering nine public cloud instances grouped into three categories from three different cloud providers. In our approach using established benchmarks, we focused on obtaining deeper insights into the performance of the public cloud infrastructure as reflected by the CPU, memory and disk I/O subsystems. We also devised a static workload configuration for the SPECjvm2008 suite to significantly reduce the benchmarking time. In addition, we present performance cost analysis and comparisons via a devised Cloud Provider Value (CPV) metric. Furthermore, we demonstrate workload correlations to the adopted benchmarks with three real analytics applications from CloudSuite namely; Data Analytics, Graph Analytics and In-memory Analytics. Through the relative performance scores obtained, we analyzed the performance of the public cloud instances relative to a baseline VM on the premises, which provided better insight into the performance. Our empirical results show significant performance differences for comparable instances on the public cloud, underscoring the need for a thoughtful and transparent IaaS provider selection.

Observing the level of performance variability existing on public cloud instances, the second part of this thesis focused on developing a technique and model for handling this performance uncertainty. In particular, we proposed a novel Robust Deadline Constrained (RDC) workflow scheduling algorithm for handling the uncertainty in resource performance for executing deadline constrained workflow applications in IaaS clouds. We present a brief literature review and background to set the work in context. We detailed the challenges involved in scheduling in the IaaS clouds and presented a detailed analysis of the theoretical complexity of the proposed approach. We also presented the experimental evaluation conducted with detailed description on the experimental setup. The experimental results showed that RDC is robust and responsive to cloud performance variability while being scalable in terms of the number of tasks in the workflow. RDC was capable of generating better quality schedules and is successful in meeting deadline constraints under unpredictable conditions resulting from IaaS cloud resource performance variation, delay in VM provisioning and inaccurate task execution times. It achieves this with varying penalty cost depending on the size of the workflow. Being a static approach, it is more computationally efficient in comparison to other existing dynamic approaches.

The research methods used in this thesis include experiments on real public cloud instances to evaluate aspects of our transparent cloud service selection methodology while the other workflow scheduling aspect is evaluated via the CloudSim toolkit using workflows available in DAX format. The outcomes and insights from this thesis can be used by both cloud users and Software as a Service (SaaS) providers to enhance their cloud shift decision making process. Insights from the workflow scheduling aspect can be applicable in related domains such as Fog, Edge and Mobile Cloud Computing.