Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

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"Performance and Security Provisioning for Mobile Telecom Cloud"

Department of Computer Science

Thursday, August 20, 2015
1:00 P.M.
Engineering and Computer Science Building
Room 468

Supervisory Committee:
Dr. Kui Wu, Department of Computer Science, University of Victoria (Co-Supervisor)
Dr. Gholamali C Shoja, Department of Computer Science, UVic (Co-Supervisor)
Dr. Wu-Sheng Lu, Department of Electrical and Computer Engineering, UVic (Outside Member)

External Examiner:
Dr. Xue Liu, School of Computer Science, McGill University

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Dr. Harald Krebs, School of Music, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

Mobile Telecom Cloud (MTC) refers to cloud services provided by mobile telecommunication companies. Since mobile network operators support the last-mile Internet access to users, they have advantages over other cloud providers by providing users with better mobile connectivity and required quality of service (QoS). In addition, to save cost in cloud services, mobile network operators are in a stronger position to utilize their existing infrastructure, which are geographically distributed in nature. The dilemma in meeting higher QoS demands while saving cost poses a big challenge to MTC providers. We tackle this challenge by strategically placing users' data in distributed switching centres to minimize the total system cost and maximize users' satisfaction. We formulate and solve the optimization problems using linear programming (LP) based branch-and-bound and LP with rounding. For scalability, we propose a similarity-based clustering method to group users into classes. Simulation results show that with the help of our optimization algorithms, we can effectively reduce the system cost and enhance users' QoS. Furthermore, we discuss MTC brokerage where telecom companies play the role of a cloud brokerage. Compared to other third-party cloud providers (TPC) such as Amazon and Google, however, MTC providers usually have a much smaller scale of computing resources. We present an approach for MTC providers to take advantage of both MTC and TPC so that they can offer better and cheaper cloud services to their customers. The opportunity arises from the discounts that TPC normally offers to group buyers as well as the better QoS that MTC can support. Our solution is to allow MTC providers to act as a brokerage, called MTC brokerage, to broker TPC cloud resources and integrate the resources reserved from TPC with those of their own MTC. We address the technical challenges of optimally allocating users' cloud requests to MTC and TPC data centres to meet users' QoS requirement with minimum cost. We also study the price range that can be profitable to a MTC brokerage. We then investigate the resource reservation problem with dynamic request changes. We evaluate our solution using real Google traces collected over a 29-day period from a Google cluster. The results show that our solution results in cost savings for both MTC providers and their customers.

In the last part of this thesis, we address security provisioning in MTC. Mobile cloud allows users to offload computational intensive applications to a mobile phone's agent in the cloud, which could be implemented as a thin virtual machine (VM), also termed as phone clone, in the cloud. Due to shared hardware components (e.g. memory bus and CPU cache) among co-resident VMs, a VM is subject to covert channel attacks and may potentially leak information to other VMs located in the same physical host. Due to the large number of phone clones, it is not practical to guarantee absolute physical isolation of phone clones, and as such a phone clone may have to \dance with strangers" on the same host. We address two critical problems in such a computing platform: how to allocate phone clones to minimize the risk of information leakage and how to migrate phone clones whenever the risk becomes higher than a given threshold. We design SWAP: a security aware provisioning and migration scheme for phone clones. Our solution utilizes the spatial and temporal features of phone clones, and by considering the online social connection of mobile users, we greatly simplify the search space of the optimal solution. We evaluate our solution using Reality Mining and Nodobo dataset. Experimental results indicate that our algorithms are nearly optimal for phone clone allocation and are effective in maintaining low risk and minimizing the number of phone clone migrations.