Computer Networks 93 (2015) 405–407

Contents lists available at ScienceDirect

Computer Networks

journal homepage: www.elsevier.com/locate/comnet

Guest Editorial

Cloud networking and communications II

Cloud computing is having an important impact on communication networks, both fixed and mobile, stimulating intensive research and standardization of new network architectures, protocols and resource management mechanisms. In the literature, significant attention has been devoted to system aspects of cloud computing. More recently, however, the focus is shifting towards cloud networking and communications with evolutionary and revolutionary propositions.

The goal of this special issue is to offer stronger interworking and interoperability between system and network elements. With the proliferation of cloud offerings, new networking and communication challenges have also emerged. For instance, cata-centers are becoming containers of virtual provider networks, whose embedding can be optimized as a function of cost, customer demands, energy, dynamic scaling, Quality-of-Service (QoS) and Quality-of-Experience (QoE). Users' access to clouds can be subjected to provider-level filtering and shaping, functions implementable in novel network middle-boxes based on Cloud Service Level Agreements (CSLA).

Cloud computing has an increasing impact on mobile access networks as well. In particular, network offloading protocols and advanced service migration and caching techniques are being leveraged to offload cellular provider networks and improve user QoE. Efficient resource management in data center and Cloud networks is an open research challenge that needs to be addressed in order to provide bandwidth guarantees and performance isolation. This is particularly important with the increasing reliance on bandwidth-demanding Virtual Machine (VM) migrations for resource consolidation and energy management within data centers and across geographically distributed data centers. In general, cloud applications and their requirements are evolving so fast that new problems are faced by the telecommunication and Cloud providers everyday asking for novel networking and communication architectures, protocols and resource management mechanisms.

After the success of the first edition of the special issue, this **Cloud Networking and Communications II** attracted over 50 submissions out of which 10 papers were selected after extensive review and discussion. This special issue covers a palette of topics both timely and critical, addressed in carefully reviewed and selected papers, providing insights into the latest research outcomes and future research directions.

In "Measuring Network Throughput in the Cloud: The Case of Amazon EC2" [1], Persico et al. present a quantitative assessment of the networking performance of Amazon EC2 along with a comprehensive description of the adopted methodology. The performance evaluation study suggests that traffic policing is enforced by the provider such that a maximum allowed throughput is not exceeded. The maximum achievable throughput is then quantified and the cost at which and the conditions under which it can be reached are studied.

In "Server Placement with Shared Backups for Disaster-Resilient Clouds" [2], de Souza Couto et al. address the problem of optimally placing primary and backup servers in a geographically distributed data center supporting an Infrastructure as a Service (IaaS) cloud with a zero recovery point objective. The goal is to reduce the number of backup machines while insuring that backup machines do not fail at the same time as their primary counterparts. Results show that sharing the backup servers through virtualization can lead to up to 40% reduction in the number of required backup servers.

In "Elastic Virtual Machine Placement in Cloud Computing Network Environments" [3], Kavvadia et al. formulate the VM placement problem as an uncapacitated facility location (UFL) problem. They propose a distributed and elastic way to solve this NP hard problem that relies on local information for improved scalability and on VM replication and merging for cost effectiveness. The proposed VM replication and merging policy is discussed and evaluated.

In "Energy Aware Virtual Network Embedding with Dynamic Demands" [4], Zhang et al. take an energy-aware approach in addressing the virtual network embedding problem with dynamic virtual network demands. The authors start with modeling the dynamics of the virtual network demands as a combination of a Gaussian distribution

http://dx.doi.org/10.1016/j.comnet.2015.10.001

and a daily diurnal pattern, and then design two efficient heuristic-based algorithms that leverage the dynamics of the virtual network demands and minimize energy consumption while achieving high revenue. Through intensive simulations, it is shown that the proposed algorithms outperform state-of-the-art algorithms while nearly achieving the same revenue.

In "Energy-Aware Node and Link Reconfiguration for Virtualized Network Environment" [5], Ghazisaeedi and Huang study possible solutions to reduce the energy consumption in virtualized network environments during off-peak periods through the reconfiguration of the virtual nodes and links mapping. Different energy saving methods based on different possible mapping reconfigurations are investigated and an Integer Linear Program (ILP) is formulated for each as well as a heuristic-based algorithm to solve it. The proposed energy saving methods are evaluated over random virtualized network environment scenarios, and are shown to save notable amounts of energy in physical nodes and links, during the offpeak period.

In "Verification of Firewall Reconfiguration for Virtual Machines Migrations in the Cloud" [6], Jarraya et al. address the issue of security vulnerabilities introduced by virtual machine migration in firewall-secured environments and propose an automated approach to detecting potential misconfigurations in firewalls after the migration of VMs. A specification language is developed and used to establish the theoretical foundations of the approach and to reason about and verify network access control and state preservation.

In "Network service chaining with optimized network function embedding supporting service decompositions" [7], Sahhaf et al. study the problem of how to optimally decompose and embed network services and propose an ILP formulation to the problem. Two algorithms are proposed to map network service chains to the network infrastructure while allowing possible decompositions of network functions. The first algorithm solves the ILP optimally, while the second addresses the scalability issue of the first by relying on a heuristic that only considers a reasonable selection of possible network function decompositions. The experimental results indicate that considering network function decompositions at the time of the embedding significantly improves the embedding performance in terms of acceptance ratio while decreasing the mapping cost in the long run in both optimal and heuristic solutions.

In "Network Functions Virtualization in Real Cloud Deployments: Opportunities and Technical Challenges" [8], Bellavista et al. discuss the challenges and technical issues associated with the virtual data center concept, and in particular with the placement of virtual data centers where multiple virtual and physical resources and constraints are to be considered. A network-aware placement approach is designed and evaluated in production OpenStack deployments providing insights to open issues yet to be addressed towards the full-scale virtualization of network functions and services.

In "Scaling Persistent Connections for Cloud Services" [9], Lin et al. investigate a cost effective and scalable solution to the problem of maintaining persistent connectivity between cloud services and their growing number of clients. They present the design and implementation of *Connection Parking*, a novel push-based cloud service delivery mechanism for a large number of cloud-connected devices. The evaluation study shows that the proposed system significantly improves the scalability of cloud services with persistent connections under different operational scenarios.

In "Managing Mobile Cloud Computing Considering Objective and Subjective Perspectives" [10], Marotta et al. introduce a management model and architecture for managing mobile cloud computing components from objective and subjective perspectives. A proof of concept prototype of the proposed management system is presented and evaluated. Based on the evaluation results, the architecture and the benefits of combining and integrating objective and subjective perspectives are discussed.

We express our thanks to the authors who submitted papers and to the reviewers for their thoughtful comments. It has been a pleasure to put together an issue on such a timely topic. We are grateful to the editor in chief, Harry Rudin, for giving us this opportunity and for his support throughout the process.

References

[1] V. Persico, P. Marchetta, A. Botta, A. Pescapè, Measuring network throughput in the cloud: The case of Amazon EC2, Computer Networks 93 (2015) 408–422.
[2] R. de Souza Couto, S. Secci, M.E.M. Campista, L.H.M.K. Costa, Server placement with shared backups for disaster-resilient clouds, Computer Networks 93 (2015) 423–434.
[3] E. Kavvadia, S. Sagiadinos, K. Oikonomou, G. Tsioutsiouliklis, S. Aïssa, Elastic virtual machine placement in cloud computing network environments, Computer Networks 93 (2015) 435–447.
[4] Z. Zhang, S. Su, J. Zhang, K. Shuang, P. Xu, Energy aware virtual network embedding with dynamic demands, Computer Networks 93 (2015) 448–459.
[5] E. Ghazisaeedi, C. Huang, Energy-aware node and link reconfiguration for virtualized network environments, Computer Networks 93 (2015) 460–479.
[6] Y. Jarraya, A. Eghtesadi, S. Sadri, M. Debbabi, M. Pourzandi, Verification of firewall reconfiguration for virtual machines migrations in the cloud, Computer Networks 93 (2015) 480–491.
[7] S. Sahhaf, W. Tavernier, M. Rost, S. Schmid, D. Colle, M. Pickavet, P. Demeester, Network service chaining with optimized network function embedding supporting service decompositions, Computer Networks 93 (2015) 492–505.
[8] P. Bellavista, F. Callegati, W. Cerroni, C. Contoli, A. Corradi, L. Foschini, A. Pernafini, G. Santandrea, Network functions virtualizationin real cloud deploy-ments: Opportunities and technical challenges, Computer Networks 93 (2015) 506–517.
[9] W. Lin, P. Sharma, S. Chatterjee, D. Sharma, D. Lee, S. Iyer, A. Gupta, Scaling persistent connections for cloud services, Computer Networks 93 (2015) 518–530.
[10] M.A. Marotta, L.R. Faganello, M.A.K. Schimuneck, L.Z. Granville, J. Rochol, C.B. Both, Managing mobile cloud computing considering objective and subjective perspectives, Computer Networks 93 (2015) 531–542.

Raouf Boutaba received the M.Sc. and Ph.D. degrees in computer science from the University Pierre & Marie Curie, Paris, in 1990 and 1994, respectively. He is currently a professor of computer science at the University of Waterloo, Canada. His research interests include resource and service management in networks and distributed systems. He is the founding editor in chief of the IEEE Transactions on Network and Service Management (2007–2010) and on the editorial boards of other journals. He has received several best paper awards and other recognitions such as the Premiers Research Excellence Award, the IEEE Hal Sobol, the Fred W. Ellersick, the Joe LociCero, the Dan Stokesbury, the Salah Aidarous Awards, and the McNaughton Gold Medal. He is a fellow of the IEEE, the Engineering Institute of Canada, and the Canadian Academy of Engineering.

Nelson Fonseca obtained his Ph.D. degree from the University of Southern California in 1994. He is a Full Professor at the Institute of Computing, State University of Campinas, Brazil. He supervised 60+ graduate thesis and published 350+ refereed papers on different topics such and multimedia service, traffic management and resource allocation in clouds and virtualized networks. He received the ComSoc Joseph Lo Cicero Award for Exemplary Services to Publications, the Medal of the Chancelor of the University of Pisa, and the Elsevier Computer Network Journal Editor of Year 2001 award. He served as ComSoc Vice President Member Relations, Director of Latin America Region and Director of On-line Services. He is past EiC of the IEEE Communications Surveys and Tutorials and a Senior Editor for the IEEE Communications Magazine.

Dzmitry Kliazovich is a Research Fellow at the Faculty of Science, Technology, and Communication of the University of Luxembourg. He holds an award-winning Ph.D. in Information and Telecommunication Technologies from the University of Trento (Italy) and a large number of scientific awards, mainly from the IEEE Communications Society and European Research Consortium for Informatics and Mathematics (ERCIM). Kliazovich is the author of more than 100 research papers. He is the Associate Editor of the IEEE Communications Surveys and Tutorials and of the IEEE Transactions of Cloud Computing journals. He is Vice Chair of the IEEE ComSoc Technical Committee on Communications Systems Integration and Modeling. Kliazovich is a coordinator and principal investigator of the Energy-Efficient Cloud Computing and Communications initiative funded by the National Research Fund of Luxembourg.

Noura Limam received the M.Sc. and Ph.D. degrees in computer science from the University Pierre & Marie Curie, Paris VI, in 2002 and 2007, respectively. She is currently a research assistant professor of computer science at the University of Waterloo, Canada. Formerly, she was a research fellow at POSTECH, South Korea and researcher at Ucopia Communications Inc., France. She received the IEEE Communications Society Fred W. Ellersick Prize in 2008. Noura Limam is on the technical program committee and organization committee of several IEEE conferences. She recently co-chaired the technical program committee of IEEE CloudNet 2015. Her contributions are in the area of service management and service engineering. Her current research interests are in distributed sensing in large settings and network optimization.

Raouf Boutaba*
University of Waterloo, Canada

Nelson Fonseca
University of Campinas, Brazil

Dzmitry Kliazovich
University of Luxembourg, Luxembourg

Noura Limam
University of Waterloo, Canada

*Corresponding author.
E-mail addresses: rboutaba@uwaterloo.ca (R. Boutaba), nfonseca@ic.unicamp.br (N. Fonseca), Dzmitry.Kliazovich@uni.lu (D. Kliazovich), n2limam@uwaterloo.ca (N. Limam)