

Guest Editorial

Emerging Technologies in Software-Driven Communication

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COMPUTER networks fundamentally changed the way we communicate and interact with each other. In fact, they now form the backbone of our modern societies. While early networks were merely a mechanism for exchanging data between end-hosts, current computer and telecommunication networks are way more than that. Compared to the early days of the networking not only the hardware of networks has changed fundamentally, but with it also the software deployed to control and manage these networks. To reduce the significant management cost of large networks, automated management, including autonomic computing and communications evolved.

In addition, one fairly recent trend with strong impact on the network architecture was the emergence of cloud computing, with the promise of inherent scalability, availability, and better resource utilization. This led to a centralization of (virtual) network functions in data centers with clear cost benefits, but at the same time introducing new limitations. To address these limitations, some intelligence of the control plane is being shifted from the inner network nodes and data centers to the edge of the network, which is then referred to as edge or fog computing. At the same time, the network control logic moved from lower into higher layers, i.e., from hardware into software.

This special issue addresses these developments and the technical challenges they present, thereby putting a spotlight on the technology areas covered by three of ComSoc's Emerging Technology Initiatives (ETI),¹ namely issues in *Autonomic Communication*, *Software-Defined Networks (SDN)* and *Network Function Virtualization (NFV)*, as well as *Cloud Communications and Networking*.

We have received large number of interesting and well-written papers, and after thorough review and careful deliberations, we have accepted 20 papers as part of this special issue. Per topic area we have one tutorial paper that summarizes the state of the art and the major research challenges ahead.

In the **Autonomic Communication** track we accepted three papers. The track is introduced by a tutorial paper

on autonomic communication in SDNs to survey the state of the art in this area. The second paper proposes a novel mechanism for link load balancing and the deployment of low delay routes in SDNs. The third paper is about offloading traffic and allocating resources in heterogeneous and ultra-dense Software-defined Wireless Networks (SDWNs) via contracts established in a distributed manner. Thus, it covers autonomic communication as well as SDN aspects.

In the track on **SDN and NFV** we accepted in total eleven papers. A tutorial paper on NFV and SDN as two technological enablers for 5G networks introduces this track. It highlights various standards activities, technologies, testbeds and deployments around SDN/NFV that can be considered as the foundation of 5G networks. The remaining ten regular papers focus on real-life deployment challenges associated with SDN/NFV and propose potential solutions to ease their deployment. The papers cover aspects of high performance NFV as well as the dynamic slicing of virtualized networks, distributed service function chains, and optimization techniques to deal with resource and QoS constraints. They also introduce approaches for the joint optimization of the placement of service functions and flow distribution in networks, preferably SDNs, as well as scheduling congestion and loop-free network updates in timed SDNs. Furthermore, three papers in this topic area focus on specific applications of SDN and NFV like on a scalable SDN architecture for IXPs, on SDN overlays that interconnect datacenters, and on the dynamic content delivery via virtualized SDN-enabled NFV infrastructures. As operators begin to deploy SDN and NFV networks, the algorithms and results in the SDN and NFV papers of this special issue will be highly valuable.

Under the **Cloud Communication and Networking** track, eight papers are accepted with the main focus being on Mobile Edge Computing (MEC) and distributed cloud technologies including the Fog computing. This set of papers looks into the impact of MEC on various performance metrics including security, privacy, and energy efficiency. They also investigate the role of MEC in different application deliveries, such as IoT, Datacenters, and content delivery networks. The track is introduced by a tutorial papers that looks into the security and resilience of MEC and Fog. Further papers study data and location privacy within MEC and distributed cloud scenarios. Moreover, the aspects of SDN and network virtualization are addressed in three papers, which also demonstrate the link between these latter two tracks.

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¹<http://www.comsoc.org/committees/emerging-technologies-initiatives>

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Finally, we hope you find our selection of papers interesting and believe that this special issue will not be that last one on software-driven communication.



Mathias Fischer (M'07) received the Diploma degree in computer science and the Ph.D. degree from Technische Universitaet Ilmenau in 2008 and 2012, respectively. He held a post-doctoral position with the Center for Advanced Security Research Darmstadt, Technische Universitaet Darmstadt, from 2012 to 2014, and the International Computer Science Institute, UC Berkeley, from 2014 to 2015. He was an Assistant Professor with University Muenster from 2015 to 2016. He has been an Assistant Professor with University Hamburg since 2016. His

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Marcus Brunner (SM'07) received the Ph.D. degree from the Swiss Federal Institute of Technology (ETH Zurich) in 1999. He has been active in research, development, and standardization and has 20 years of experience in the programmability of networks and services, cloud technology for IT and network service providers (NfV), and the automation of network and IT, including autonomic communication. He is currently the head of standardization, eco-system development, and a Chief Researcher with the Strategy and Innovation Department,

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Toktam Mahmoodi (M'06–SM'16) received the B.Sc. degree in electrical engineering from the Sharif University of Technology, Iran, and the Ph.D. degree in telecommunications from King's College London, U.K. She was a Visiting Research Scientist with F5 Networks, a Post-Doctoral Research Associate with Imperial College London, a Mobile VCE Researcher, and a Telecom R&D Engineer. She is currently with the Academic Faculty of the Centre for Telecommunications Research, King's College London. She is also a member of the Tactile Internet

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²<http://www.comsoc.org/committees/standing/emerging-technologies>