Networking and the Cloud

THE NETWORK HAS ALWAYS HAD A CRITICAL ROLE IN COMPUTING, ESPECIALLY IN THE ERA OF THE INTERNET AND, AT PRESENT, IN THE AGE OF CLOUD COMPUTING, INTERNET OF THINGS (IOT), SMART MOBILITY, AND BIG DATA. The vast amount of data we generate every day—whether from sensors, tweets, billing transactions, or online orders—needs to move from one or more locations to one or more other locations. Here the network might transfer mission-critical data for an enterprise or small business along with grandma's birthday wishes or little Jasmine's soccer games feeds. Such data might traverse many hubs, moving in public Internet networks or in private dedicated networks. Although usually costlier, companies often opt for private networks because they provide better predictability and control than the public Internet. It's also easier to populate private networks with better end-to-end security controls and mechanisms to guarantee performance and service-level agreements (SLAs).

The network has possibly the highest impact on a cloud deployment's success because users need to access applications and data residing in the cloud from remote locations. For this reason, cloud computing requires a holistic approach to designing networks. A cloud network infrastructure must support the dynamic volatility of network traffic and its inherent characteristics, which includes not only performance, throughput, and latency, but also security, availability, and "other-ities." Network quality of service (QoS), SLA, and support don't end with "-ities," but they're of paramount importance as well since they directly reflect users' experiences using the cloud. For example, when users expect near-real-time delivery of audio and video streams, the end-to-end network design must facilitate such delivery; otherwise, users will move to a different provider with better QoS. The same applies to SLA and support.

Software-defined networking (SDN), which allows abstraction of higher-level network functions, has evolved as one approach to managing network design and operations. Specifically, SDN decouples the network's control plane (the intelligence) from the data plane (the pipe), letting administrators easily manage network functions. In other words, SDN removes the hardware limitations of the network infrastructure. SDN can also eliminate lock-in by allowing multiple software controllers to manage network services mapped to different network infrastructures. Open source software efforts to enable SDN have been evolving very quickly in the market. For example, OpenFlow has emerged as a leading communications protocol and Open Daylight as a leading open source framework to enable and support SDN. At the same time, other networking approaches are moving to adopt some of the same ideas that underlie these projects. Two other efforts that also intend to improve network agility and manageability and have some commonalities with SDN are network virtualization (NV) and network functions virtualization (NVF). NV attempts to create logical domains of existing network infrastructure. NVF virtualizes layer 4–7 functions such as load balancing and firewalls of the OSI Communication model. In this issue's "Cloud Tidbits," David Linthicum provides a much more detailed overview of SDN, its role when deployed in a cloud environment, and its advantages as well as some of its underlying challenges.

As expected, the columns and departments in this issue focus on the role of networks in cloud

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NEW EDITORIAL BOARD MEMBER

Welcome to Mianxiong Dong, the newest member of the *IEEE Cloud Computing* editorial board.

Mianxiong Dong is an associate professor in the Department of Information and Electronic Engineering at the Muroran Institute of Technology, Japan. Prior to joining Muroran-IT, he was a researcher at the National Institute of Information and Communications Technology, Japan. His research interests include wireless networks, cloud computing, and cyberphysical systems. Dong has BS, MS, and PhD degrees in computer science and engineering from the University of Aizu, Japan. He was a Japan Society for the Promotion of Science (JSPS) research fellow at the School of Computer Science and Engineering, the University of Aizu, Japan, and was a visiting scholar with the Broadband Communications Research Group at the University of Waterloo, Canada, supported by the JSPS Excellent Young Researcher Overseas Visit Program from April 2010 to August 2011. Dong was selected as a Foreigner Research Fellow (a total of three recipients from all over Japan) by the NEC C&C Foundation in 2011. His research results have appeared in international journals, conferences, and books, and he has received best paper awards at several major conferences. Dong serves as an editor for *IEEE Communications Surveys and Tutorials, IEEE Network, IEEE Wireless Communications Letters, IEEE Cloud Computing, IEEE Access*, and *Cyber-Physical Systems* (Taylor & Francis), as well as a guest editor for *ACM Transactions on Multimedia Computing, Communications and Applications, IEEE Transactions on Emerging Topics in Computing*, and *IEEE Transactions on Computational Social Systems*. He's currently serving as symposium chair of IEEE GLOBECOM in 2016 and 2017. Dong is currently a research scientist with the A3 Foresight Program (2011–2016) funded by JSPS, the National Natural Science Foundation of China, and the National Research Foundation of Korea.

deployments. In "Cloud Economics," Joe Weinman looks at the financials of networking in the cloud, which, for the most part, has been considered a cost. Weinman gives real-life comparable examples on how to view the cost of network infrastructure in a cloud deployment. In "Cloud and the Law," Aniello Castiglione, Francesco Palmieri, and Kim-Kwang Raymond Choo discuss enhanced network capabilities to support cloud infrastructure, with a focus on manufacturing and an eye on the law-related aspects. In "Blue Skies," Deepak Puthal, Surya Nepal, Rajiv Ranjan, and Jinjun Chen look at different types of network security threats in an IoT deployment with a focus on cloud and edge datacenters. Kevin Jackson, in his "Cloud and the Government" column, looks at how cloud networking is used to support government clouds. Finally, in "Standards Now," Alan Sill reviews the basic protocols and paradigms underlying SDN and discusses how they relate to networking standards.

I WANT TO MENTION A COUPLE OF ADMINISTRATIVE POINTS IN CLOSING. First, I'm pleased to announce that Professor Mianxiong Dong from the Muroran Institute of Technology, Japan, has joined the *IEEE Cloud Computing* editorial board. You can read his biography in the sidebar. The second point is that readers have enjoyed the various columns and department we're publishing. I always urge you, the reader, to give us feedback about the quality of these and previous columns by sending email to mazin@computer.org.

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