



Editorial:

Special issue on future network: software-defined networking

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Computer networks have to support an ever-increasing array of applications, ranging from cloud computing in datacenters to Internet access for users. In order to meet the various demands, a large number of network devices running different protocols are designed and deployed in networks. As a result, network management and the deployment of new protocols and applications are quite challenging. On one hand, network operators have to manage so many different network devices and manually configure these devices using different tools. On the other hand, vendors use different physical infrastructures as well as software interfaces to manufacture devices, which makes it difficult for researchers to implement new functions in devices. Therefore, network infrastructure and architecture design face great challenges.

Software-defined networking (SDN) has been proposed as a new way to facilitate network evolution. SDN decouples the data and control planes, and removes the control plane from network hardware. In SDN, all the devices are controlled by a centralized controller through open protocols, such as OpenFlow, BGP, and NETCONF. Then, control functions are implemented in the centralized controller to realize operational efficiency and reduce costs. Thus, it dramatically simplifies the network, and brings many potential benefits in terms of network management, network virtualization, trouble shooting, and other

new network function deployments. In fact, the advantages of SDN technology are attracting great attention from both academia and industry.

However, the current technologies of SDN have some limitations. In the perspective of architecture, the centralized controller needs to control all the resources of the network, and therefore the scalability of centralized control becomes an important problem in SDN. Additionally, compared to the distributed design that makes forwarding decisions locally, centralized control inevitably increases the delay of packet forwarding and thus affects the performance of applications. Therefore, using the distributed control plane and choosing the optimal placement of the controller are important for the performance of the network. In the perspective of network functions, SDN brings agile and programmable controllability, but leveraging this powerful controllability to design new network functions for cloud datacenters, wireless networks, or enterprise networks remains a challenge.

Motivated by the above considerations, we bring together researchers, developers, practitioners, and educators to identify and discuss the technical challenges and recent advances related to SDN. This special issue aims to attract the attention of both academia and industry in developing advanced and innovative SDN technologies. This special issue comprises eight best papers selected from the submissions. The topics in this special issue cover both theoretical analyses and practical systems.

To survey software-defined wireless networks (SDWNs) and their technologies, Feng *et al.* (2016) presented the architecture and the possible research directions of SDWN, and then investigated several important technical aspects of SDWN and analyzed how the SDN approach can be incorporated to enhance network performance with these aspects.

To improve the scalability and increase the performance of the control plane, Xiao *et al.* (2016) proposed spectral clustering based partition and placement algorithms. They partitioned large networks into small domains and thus reduced the control overheads and increased scalability. Simulation results showed the effectiveness of this algorithm for SDN domain partition and controller placement problems. A new multi-controller architecture based on distributed rule store (DRS) was presented to reduce the overhead of one controller (Wang *et al.*, 2016). The results showed that DRS can effectively maintain a consistent distributed rule store and, at the same time, achieve a shorter flow setup time and a higher processing throughput, compared with the traditional controller.

To improve performance and reduce network delays, LESSOR (Liu *et al.*, 2016) leverages multiple paths in datacenters, and computes optimal forwarding paths by using the centralized controller. Experimental results showed that LESSOR is scalable and that both the network scale and network load models have little impact on its performance. In the work by Xiong *et al.* (2016), to reduce the average traffic delay, an improved quantum genetic algorithm was used to choose the optimal service placement. Yang *et al.* (2016) presented a video conferencing system based on SDN-enabled SVC (scalable video coding) multicast to reduce the delay and achieve flexible management.

Failures in an ongoing session can cause packet losses and delay, which can significantly affect the quality of service (QoS). In the work by Renganathan Raja *et al.* (2016), a subtree-based technique was designed to detect failures and then recover from the failure for multicast applications, such as live video streaming and video conferencing. The method can detect link or node failures from a multicast tree and then determine which part of the multicast tree requires changes in the flow table to recover from the failure.

Virtual network embedding is a key problem in the SDN environment. However, most of the existing embedding algorithms cannot be directly applied to

SDN virtualization. Gong *et al.* (2016) presented a novel online virtual SDN embedding algorithm, called CO-vSDNE, to minimize the embedding cost as well as the controller-to-switch delay for each virtual SDN.

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References

- Feng, M.J., Mao, S.W., Jiang, T., 2016. Enhancing the performance of future wireless networks with software-defined networking. *Front. Inform. Technol. Electron. Eng.*, **17**(7):606-619.
<http://dx.doi.org/10.1631/FITEE.1500336>
- Gong, S.Q., Chen, J., Kang, Q.Y., *et al.*, 2016. An efficient and coordinated mapping algorithm in virtualized SDN networks. *Front. Inform. Technol. Electron. Eng.*, **17**(7): 701-716.
<http://dx.doi.org/10.1631/FITEE.1500387>
- Liu, B., Chen, M., Xu, B., *et al.*, 2016. An OpenFlow-based performance-oriented multipath forwarding scheme in datacenters. *Front. Inform. Technol. Electron. Eng.*, **17**(7): 647-660.
<http://dx.doi.org/10.1631/FITEE.1601059>
- Renganathan Raja, V., Lung, C.H., Pandey, A., *et al.*, 2016. A subtree-based approach to failure detection and protection for multicast in SDN. *Front. Inform. Technol. Electron. Eng.*, **17**(7):682-700.
<http://dx.doi.org/10.1631/FITEE.1601135>
- Wang, H.Z., Zhang, P., Xiong, L., *et al.*, 2016. A secure and high-performance multi-controller architecture for software-defined networking. *Front. Inform. Technol. Electron. Eng.*, **17**(7):634-646.
<http://dx.doi.org/10.1631/FITEE.1500321>
- Xiao, P., Li, Z.Y., Guo, S., *et al.*, 2016. A K self-adaptive SDN controller placement for wide area networks. *Front. Inform. Technol. Electron. Eng.*, **17**(7):620-633.
<http://dx.doi.org/10.1631/FITEE.1500350>
- Xiong, G., Hu, Y.X., Tian, L., *et al.*, 2016. A virtual service placement approach based on improved quantum genetic algorithm. *Front. Inform. Technol. Electron. Eng.*, **17**(7): 661-671.
<http://dx.doi.org/10.1631/FITEE.1500494>
- Yang, E.Z., Zhang, L.K., Yao, Z., *et al.*, 2016. A video conferencing system based on SDN-enabled SVC multicast. *Front. Inform. Technol. Electron. Eng.*, **17**(7): 672-681.
<http://dx.doi.org/10.1631/FITEE.1601087>



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