Cloud and Edge Computing

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Cloud and edge computing are currently undergoing a substantive transformation on several fronts, from applications to hardware, and from architectures to devices. This issue of the Cloud and Edge Computing Series solicited articles in the area of cloud and edge computing to address the main issues concerned with evolving processes and supporting pedagogies and applications in cloud computing, networking, and storage technologies. There have been advances on both the cloud and edge computing fronts that have affected this line of technology. Paradigms such as computing in virtualization-based architectures, issues on geographic constraints for deploying clouds, and the use of SDN/NFV in clouds, for example, were of special interest for this issue of the Series. Nevertheless, our attention was also focused on data center network (DCN) architectures, security, load balancing, and application data streaming supported by evidence from simulations, analysis, or experiments. Cloud and edge computing are also incorporated with the Internet of Things (IoT) ecosystem. IoT requiring multiple access edge computing systems is gaining momentum and considered to be deployed in smart cities, public safety, and e-health. The last but not least important factor we expected to see in articles was the standardization aspects of cloud and edge computing technology. We were especially interested in articles that could address communications standards in networking for clouds, fogs and edge computing.

This issue of the magazine presents three articles exploring cloud and edge computing in the context of the upcoming 5G cellular systems. 5G leverages significantly on cloud and edge computing technologies; indeed, 3GPP has standardized all the 5G core functions as to be cloud native and container based. This issue focuses on two fundamental 5G architectural enhancements:1) network slicing 2) edge computing and specifically multi-access edge computing (MEC) as defined by ETSI. Those two technologies are the most promising ones for mobile network operators to generate new revenue streams while reducing network management complexity.

The first article is entitled "From ATM to MPLS and QCI: The Evolution of Differentiated QoS Standards and Implications for 5G Network Slicing," by Emeka Obiodu and Nishanth Sastry. This article is an example of reviewing techniques whose goal is offering tailored connectivity to paying customers on a public network and refer to them as differentiated QoS (D-QoS) standards. The authors discuss while there is wide variation and dissimilarity in their underlying technical properties, the expectation and goal for all D-QoS standards is to provide guaranteed connection for which customers could be prepared to pay. The authors present analysis of transport layer technologies, signaling technologies, data packet markers, and end-to-end separation solutions. The authors additionally explore 5G network slicing and argue that despite its inherent technical differences with other D-QoS standards, the commercial performance of network slicing may end up resembling that of previous D-QoS standards.

The second article, "MEC Support for Network Slicing: Status and Limitations from a standardization Viewpoint" by Luca Cominardi *et al.*, presents an integrated view of the various network slicing concepts, as defined from the different standardization bodies, explaining how they slightly differ in focus and scope, but at the same time are complementary. It describes the role of the MEC components and how they can be integrated to simultaneously support the various network slicing concepts, as well as the use of either dedicated or shared network functions because of their impact on the MEC framework. The paper identifies the open gaps at the functional and management level, in the current ETSI MEC, ETSI NFV, and 3GPP standards description, to create a multi-domain system capable of verifying the network slice requirements across distinct domains. The authors then present two solutions on how to evolve the current MEC framework toward end-to-end multi-slice support in 5G deployments and the relative relevant reference points and procedures that should be extended.

The last article, "Multi-Access Edge Computing: A Comparative Analysis of 5G System Deployments and Service Consumption Locality Variants", provides a comprehensive view of MEC technology from both the logical and physical deployment perspectives. As the logical architecture defined in the standards does not aim to answer the deployment question (i.e. where is the "edge?"), the article starts by providing a technical analysis of MEC deployment options in 5G networks. The authors then present a first MEC performance case study focusing on different system deployments and service consumption localities while using different types of workloads. The study shows that in all cases, the RTT is highly impacted by the MEC application workload. Higher RTT is observed when a MEC application consumes remote MEC services, whereas low RTT gain is observed when moving from smart CO to RAN edge deployments, regardless of the considered workload.

Biographies

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