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EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: Future Networks: Architectures, Protocols, and Applications

Wireless communications and networking have been continually evolving to improve and be a part of our lifestyle. This uninterrupted development is due to many research projects and practices that are being carried out to improve the quality of services and applications supported by networking technologies. Initially, the plethora of computer networks research was designed to allow users to share the thoughts and facts using textual data through addressing devices. Meanwhile, we have witnessed that users play the role of both producers and consumers at the same time. These new emerging requirements gave birth to Cloud Computing (CC), Data Centric Networking (DCN), and other advancements in IEEE standards. Moreover, researchers also intended to redesign the networking architectures and protocols with the focus on content rather than the host. The resulting new architectures are Information Centric Networks (ICN) with various extensions like Content Centric Networks (CCN), Named Data Networks (NDN), Data-Oriented Network Architecture, etc.

Alternatively, significant efforts in cellular networks have also been made to improve the user experience, and as a result, today we can use LTE-Advanced and other emerging technologies. In this context, the upcoming 5G networking architectures tend to support the massive number of connected devices with diverse bandwidth requirements and minimum content retrieval latency. Furthermore, the deployment of supporting operational mechanisms such as network functions virtualization (NFV), cloud-based deployments, mobile edge computing (MEC), and new use cases are under consideration. Moreover, all these new technologies are being applied in other networking domains as well, including Vehicular Ad Hoc Network (VANETs), Smart Grid, Smart Cities, Internet of Things (IoT), Big Data, etc. Owing to the broad scope of this Special Section in IEEE Access, we received a substantial number of submissions, and after a rigorous review process, we accepted multiple articles in the following main categories: Future Information Centric Networking, IoT, cellular networks and communication technologies, cloud computing and big data, and vehicular and ad hoc networks.

Future ICN is a paradigm shift from the current IP based to the content-centric name based communication. Integral parts of ICN include in-network caching, inherent content security, and simplified communication architecture. The connected device is not concerned with the location and information of the content provider(s). Since there can be multiple providers for the same content, then it is convenient to access and forward the content if the temporary content replica information of the closer routers is available in the network, ***B. Li et al.*** [Advanced perceptive forwarding in content-centric networks]. The cache replication and eviction schemes, Conditional Leave a Copy Everywhere (CLCE) and Least Frequent Recently Used (LFRU), have been proposed by ***Muhammad Bilal and Shin-Gak Kang*** [A cache management scheme for efficient content eviction and replication in cache networks] to increase the content discovery and availability. In article by ***Deyun Gao et al.*** [Caching strategy based on hierarchical cluster for named data networking], the location and content popularity based caching policy also achieve better performance in the hierarchical topology network.

The DENA (Deep Exponential Networks based cache announcement and cache exergy based cache replacement Algorithms) has been proposed by ***Hengyang Zhang et al.*** [DENA: An intelligent content discovery system used in named data networking]. DENA is a dynamic and distributed algorithm that disseminates and discovers the cached contents' information using the shortest path with low Interest control overhead. Mobility support for all IP-based networks has been achieved using the NDN as an overlay architecture presented in the article by ***Z. Yan et al.*** [Distributed all-IP mobility management architecture supported by the NDN overlay]. The proposed solution uses the name based forwarding, and multipoint caching (anchor) points at the edge of the network are used to support mobility. Node's residual energy based interest forwarding scheme increases the lifetime of the NDN-enabled wireless ad-hoc network and presented in the article by ***R. A. Rehman et al.*** [OEFS: On-demand energy-based forwarding strategy for named data wireless ad hoc networks]. A secure multipath named-data dissemination for hierarchical NDN-enabled networks is proposed in the invited article by ***Lan Wang et al.*** [A secure link state routing protocol for NDN]. The traffic forwarding scheme for the software defined next generation Internetwork using the Internet Exchange Points (IXP) graph is presented in the work of ***A. Basit et al.*** [SDN orchestration for next generation internetworking: A multipath forwarding approach]. The work of

N. Morales and M. Bergstrom [Did the super bowl kill the Internet?] also analyzed that the streaming of a live event (e.g., Super Bowl 2016) may affect the performance of the Internet and requires new techniques to handle large bursts of traffic.

In addition to future networks, different solutions, and IoT based schemes have also been proposed in this Special Section. The ID-based signature revocation solution with cloud revocation server and collaborative live data analytics at the network edge and IoT cloud are proposed by ***Xiaoying Jia et al.*** [Efficient revocable ID-based signature with cloud revocation server] and ***Shree Krishna Sharma and Xianbin Wang*** [Live data analytics with collaborative edge and cloud processing in wireless IoT networks], respectively. The energy in IoT networks is also important, and there should be a joint framework that must keep track of the network's energy and act according to the sensor signals, channel condition, cross-traffic from other sources, etc., which is presented in the work of ***Andrea Zanella et al.*** [EC-CENTRIC: An energy- and context-centric perspective on IoT systems and protocol design]. In the same context, the IoT based smart home application is outlined by ***M. Khan et al.*** [Internet of things based energy aware smart home control system]. The software development process for reusability of IoT based resources is discussed by ***A. Abbas et al.*** [Binary pattern for nested cardinality constraints for software product line of IoT-based feature models]. Real-time electrocardiogram (ECG) filter for portable mobile devices are also proposed by ***J. Li et al.*** [Design of a real-time ecg filter for portable mobile medical systems]. Wireless sensor networks (e.g., underwater sensor networks) are the key enablers of the IoT. As all devices are battery operated, the battery conservation is one of the key challenges and are addressed in the articles by ***I. Azam et al.*** [Balanced load distribution with energy hole avoidance in underwater WSNs] and ***Naeem Jan et al.*** [A balanced energy-consuming and hole-alleviating algorithm for wireless sensor networks]. A game theoretic mobility management for energy efficient operation in heterogeneous networks is also proposed by ***K. Vasudeva et al.*** [Fuzzy-based game theoretic mobility management for energy efficient operation in HetNets]. The work of ***J. Zhu et al.*** [Multi-armed bandit channel access scheme with cognitive radio technology in wireless sensor networks for the Internet of things] exploits the cognitive radio in the WSN-based IoT to efficiently utilize the spectrum. Finally, review on the energy saving practices for the IoT is summarized by ***R. Arshad et al.*** [Green IoT: An investigation on energy saving practices for 2020 and beyond].

Future networking architectures along with IoT have to deal with the plethora of data, also called big data, that is either collected or stored in the cloud storage. Hence, there should be some solutions to deal with the issues related to big data, cloud storage, and computing. In mobile cloud computing environment, the compute-intensive tasks should be assigned in such a way to minimize the execution time and reduce energy cost by keeping the mobility under consideration as proposed by ***I. Yaqoob et al.*** [Heterogeneity-aware task allocation in mobile ad hoc cloud]. In the work by ***S. Vakilinia et al.*** [Energy efficient resource allocation in cloud computing environments], the power consumption at cloud provider is minimized by optimizing the scheduling and dynamically distributing the task processing load over the servers. Similarly, the power consumption minimized through efficient resource allocation, and using the coordinated scheduling schemes for the cloud radio access network (CRAN) in the article by ***Muhammad Awais et al.*** [Efficient joint user association and resource allocation for cloud radio access networks]. Security is one of the major challenges in cloud computing, and it requires the data protection and role based access control, which is discussed in the work by ***B. Lang et al.*** [Achieving flexible and self-contained data protection in cloud computing]. In addition, ***A. A. Alabdel et al.*** [Evolutionary game theoretic analysis of advanced persistent threats against cloud storage] proposed the advanced persistent threat/attack identification and their defense mechanisms that are also important for cloud storage systems. The cloud systems have to deal with big data produced by the large number of sensors and system. It requires efficient clustering and data fusion techniques for effective and accurate data processing and energy-aware routing, which are proposed by ***S. Din et al.*** [A cluster-based data fusion technique to analyze big data in wireless multi-sensor system].

Wireless network technologies, including cellular networks, have undergone rapid innovation and it is continuously growing the future market. Following are the very few solutions that have been proposed in this Special Section. The performance of the relay-enhanced full-duplex cellular network is affected by the residual self-interference, the uplink-downlink interference, as well as the relay-access-link interference. Hence the efficient power control mechanism is proposed by ***X. Huang et al.*** [Power control for full-duplex relay-enhanced cellular networks with QoS guarantees] to improve the QoS in these type of networks. Interference in the overlapped base stations deployment areas is also common, and it requires an optimized power-resource allocation to increase the user performance at the edge of the base station coverage, which is main idea of the work by ***Q. Song et al***. [An interference coordination-based distributed resource allocation scheme in heterogeneous cellular networks]. Cellular network coverage and performance can be increased by deploying the femtocell access points, called two-tier network. However, these femtocells also bring the co-tier and cross-tier interferences that is solved through cluster-based optimal sub-channel resource allocation by ***H. Zhang et al.*** in [Cluster-based resource allocation for spectrum-sharing femtocell networks]. For the two-tier heterogeneous networks, the article by ***A. Ijaz et al.*** [Coverage and rate analysis for downlink HetNets using modified reverse frequency allocation scheme] mitigates the interference problem through reverse frequency allocation (RFA) scheme and proves that the proposed solution pro-

vides an efficient resource allocation compared with the other state-of-the-art techniques. The fifth-generation (5G) cellular networks provide real-time device-to-device communication using the millimeter wave (mmWave) as a key technology. The work of ***X. Cui et al.*** [Real-time positioning based on millimeter wave device to device communications] investigates the real-time positioning using the dynamic threshold based on the artificial neural network over the 73-GHz mmWave. In the article by ***K. Xiong et al.*** [Evaluation framework for user experience in 5g systems: On systematic rateless-coded transmissions], the performance evaluation framework of systematic rateless-coded (SRCed) transmissions for user experience in future 5G systems is proposed. It is observed that application of the rotated and cyclic Q delayed (RCQD) modulation improves the performance of the receiver in case of fading channel conditions along with erasures if applied at the transmitter side. However, at the receiver side, the complexity increases significantly. ***A. R. Jafri et al.*** in [High-throughput and area-efficient rotated and cyclic Q delayed constellations demapper for future wireless standards] proposed a simplified damping technique to achieve better performance. In addition to that, an analytical model of the End-to-End (E2E) delay in OpenFlow based networks discussed by ***A. Iqbal et al*** [Analytical modeling of end-to-end delay in openflow based networks]. In last, the on-chip microfluidic integrated communication and cooling system has been discussed in the article by ***S. A. Wirdatmadja et al.*** [Microfluidic system protocols for integrated on-chip communications and cooling].

The next group of articles submitted to the Special Section proposes solutions for vehicular and ad hoc networks. A comprehensive layered architecture for the Internet of Vehicles (IoV) has been discussed by ***Omprakash Kaiwartya et al.*** in [Internet of vehicles: Motivation, layered architecture, network model, challenges, and future aspects]. As one of the IoV technologies, vehicular social networking has a significant role in the social lives. Vehicles in the vehicular social networks can act as mobile recommenders for marketing or some other applications, and the efficient recommender selection algorithms are proposed by ***Ting Li et al.*** [On selecting vehicles as recommenders for vehicular social networks]. To fulfill the QoS needs of the applications, a cross-layer paradigm for IoV ad hoc network is discussed in the work of ***S. ur Rehman et al.*** [Enhancing quality-of-service conditions using a cross-layer paradigm for ad-hoc vehicular communication]. The context aware retransmission of safety-application related information over the lossy network is necessary and proposed by ***H. Kang et al.*** [CANCORE: Context-aware network coded repetition for VANETs]. Other than vehicular, the mobile ad hoc networks (MANETs) with dynamic topology pose many challenges to provide sufficient quality of services. The article by ***M. Ahsen et al.*** [Propagation modeling in large-scale cooperative multi-hop ad hoc networks] discusses the propagation model for the large-scale cooperative multi-hop MANETs. The queue management algorithms under the distributed denial of service attack are summarized and simulated by ***W. Wei et al.*** [Research and simulation of queue management algorithms in ad hoc network under DDoS attack]. In addition to that, an on-demand hybrid routing algorithm for cognitive radio ad hoc network has been discussed by ***M. Zareei et al.*** [On-demand hybrid routing for cognitive radio ad-hoc network].

Other than the vehicular and ad hoc networks, a solution for the privacy preserving multi-qualitative-attribute winner determination problem has been proposed by ***W. Shi et al.*** [A verifiable sealed-bid multi-qualitative-attribute based auction scheme in the semi-honest model]. Finally, the detection of composite operations performed on the management model elements is discussed in the work of ***R. Zhang et al.*** [Detection of composite operation in model management].

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