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Editorial: Emerging Techniques and Applications for 5G Networks and Beyond

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Editorial:

It is predicted that 50 billion devices will be connected to the Internet by 2020, and the number of mobile-connected devices will exceed 11.5 billion by 2019. These growth numbers are tremendous and will further increase over next decades, which will certainly pose a huge traffic demand for ubiquitous communications. It has been projected that the total volume of data traffic will nearly triple between 2016 and 2021, of which about 75% will originate from non-PC devices and about 42% of all connections will be for M2M communication between over 10 billion smart objects. Driven by the rapid growth of mobile Internet, fifth generation (5G) wireless networks are expected to provide 1000-fold higher data throughput by the year 2030 compared to what we experience today. Predictions evidently indicate the skyrocketing demand on data traffic and applications for machine type communication such as self-driving vehicles, healthcare monitoring, smart cities and factories, and artificial intelligence-based personalized assistants along with traditional human-centric communications. Moreover, due to the fast development of the Internet of Things (IoT), beyond 5G wireless networks need to support massive connectivity for a very large number of devices such as sensors, actuators, computer devices, vehicles, and machines with very heterogeneous quality of service requirements. Current wireless radio access techniques are not capable of delivering these new applications and may pose a much higher security risk than the WiFi and 4G networks did. Innovative technologies are a must to add more capacity to mobile networks. In addition, in order to better support the Internet-of-Things (IoT) applications, many technical challenges need to be resolve in 5G and beyond including network architectures, network resource allocation schemes, and advanced signal processing techniques, etc. Recently, deep learning and AI techniques have been considered as promising approaches to unleash the full potential of beyond 5G networks.

This special issue will provide a forum for the latest research, innovations, and applications of emerging wireless communications and networks for 5G and beyond, which includes (but are not restricted to) the following topics: Advanced network architecture design for IoT towards 5G; New air interface design for 5G (New Radio (NR)); Energy-efficiency in 5G for IoT applications.

5G wireless heterogeneous networks: design and optimization; Mobility management of 5G networks for IoT applications; 5G wireless communications and networks for surveillance and management; 5G Cognitive networks and IoT; Ultra-reliable and low latency communication (URLLC); Data security, privacy and reliability for IoT towards 5G; Energy efficiency (harvesting and saving) wireless protocols and algorithms for 5G and IoT; Security and privacy concerns in 5G wireless communications; NOMA, full-duplex, massive MIMO; Green 5G multimedia wireless networks; Machine learning for resource allocation in wireless networks; Deep reinforcement learning for wireless communications; Network planning, optimization and learning theories for mmWave networks; Experimental results, prototypes, and testbeds of 5G wireless communications and networks.

This special issue includes nine high-quality papers. In the first paper entitled "Linearization of RF Power Amplifiers in Wideband Communication Systems by Adaptive Indirect Learning Using RPEM Algorithm," the authors propose an adaptive indirect learning architecture (ILA) by using a recursive prediction error minimization (RPEM) algorithm for linearizing radio frequency (RF) power amplifiers (PAs) in emerging wideband communication systems. Due to the time-varying forgetting factor, the predistorter coefficient estimates are consistent and accurate in steady state, which are capable of speeding up the convergence, reducing the

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normalized mean square error, as well as minimizing the total nonlinear distortion at the PA output.

In the second paper, entitled "A D2D-Based Solution for MTC Connectivity Problem in NOMA-Based Cellular IoT Networks: Dynamic User Grouping and Resource Allocation," a non-orthogonal multiple access (NOMA)-based cellular MTC model with successive interference cancellation (SIC) for both underlay and overlay spectrum access modes (SAMs) is proposed to increase the spectrum efficiency and the number of connected devices. In this way, a dynamic user grouping (UG) concept is introduced to reduce the complexity. The optimization problem of joint dynamic UG, power allocation, and RB assignment is formulated to maximize the total sum-rate of both CUs and MTC-Ds. Then, the quadratic fractional programming and heuristic method are proposed to for its solution. Evaluation results are provided to demonstrate the effectiveness of the proposed scheme in terms of total average sum-rate and network connectivity, while requiring less transmit power.

In the third paper, entitled "Renewable Energy Assisted Function Splitting in Cloud Radio Access Networks," to reduce the fronthaul bandwidth requirement and to relax the stringent end-to-end delay requirements, the authors introduce the edge-cloud layer in addition to the centralized cloud (CC) which splits the baseband unit (BBU) functions between the center cloud (CC) and edge clouds (ECs) combining with renewable energy sources in CC and ECs. Aiming at efficiency of the operational expenditure of this system, the authors formulate a mixed-integer linear programming (MILP) problem, and then develop a fast heuristic to obtain a sub-optimal solution which provides an exceptional solution for large radio access networks.

To cope with the increase in in video streaming traffic over the Internet, the authors of the fourth paper "QoE-aware Video Streaming over HTTP and Software Defined Networking" design a combined solution both from the client and network perspective to enhance users' experience while using HTTP Adaptive Streaming applications over SDN network. In particular, a novel architecture is proposed which incorporates bitrate adaptation and dynamic route allocation. Numerical results show that the proposed approach is superior to the existing methods and achieves smoother viewing experience than the traditional Internet.

To support a massive number of connections of high data rate services, the fifth paper "Social-aware Caching and Resource Sharing Maximized Video Delivery Capacity in 5G Ultra-dense Networks" proposes an efficient strategy based on social-aware caching and re-source sharing for video streaming services in 5G ultra-dense networks, taking into account the social relationship of each device-to-device user pair, the available storage of femtocell base stations and device-to-device users, the target signal to interference plus noise ratio of shared downlink resource users, and the popularity of videos. The proposed strategy not only relaxes the workload at backhaul links of the macro base stations (MBSs) and the femtocell base stations (FBSs), but also provides the macro users with high hit rate video services by requesting the videos alternately from MBSs and FBSs.

Motivated to realize the benefits of Software-Defined Networks (SDNs) while maintaining the network's topology and connectivity, the sixth paper entitled "Performance Analysis of Software Defined Network Concepts in Networked Embedded Systems" designs and implements a wireless-SDN which is suitable for a variety of networked embedded systems. The general behavior and key parameters are provided to investigate the network performance in typical operational scenarios. Also, the design is validated in a simulation setting and through experiments using commercial motes.

The seventh paper is on "5G and UAVs for Mission-Critical Communications: Swift Network Recovery for Search-and-Rescue Operations" in which Search-and-Rescue Operations (SAROs) is considered. In particular, the authors propose a new framework for SAROs after disaster strikes to find and locate survivors based on the assumption that most individuals have their own UEs and the victims may be still alive and need to be rescued. The proposed UE-based SARO addresses several critical concerns to find potential survivors, as quick as possible, by searching and locating their UEs which are treated as human based sensors on the ground.

The eight paper is "Enhancing Transmission on Hybrid Precoding Based Train-to-Train Communication." In this paper, the authors study the combination of millimeter wave (mmWave) and multiple input multiple output (MIMO) technologies to enhance the reliability and capacity of Train-to-Train (T2T) communication, in which a novel mmWave MIMO based transmission scheme is proposed. By adopting the hybrid precoding algorithm, the power consumption of the system is greatly reduced while satisfying the requirements of spectral efficiency and signal to noise ratio. Simulation results are provided to confirm the excellent performance of the proposed scheme.

In the last paper "Design and Analysis of Fractal Based Monopole Antenna Backed with Modified Jerusalem Cross Frequency Selective Surface for Wireless Personal Area Communications", the authors present a low-profile Single-layer Modified Jerusalem Cross Frequency Selective Surface (SMJC-FSS) inspired monopole antenna with a dimension of 75 mm × 75 mm × 31.2 mm. The proposed FSS achieves 50% size reduction and exhibits a fractional bandwidth of 14.69%. The measured results are consistent with the simulation ones, which confirm that the proposed FSS is well suited for wireless personal area communications in the ISM band at 2.45 GHz.

Van-Dinh Nguyen received the B.E. degree in electrical engineering from Ho Chi Minh City University of Technology, Ho Chi Minh City, Vietnam, in 2012 and the M.E. and Ph.D. degrees in electronic engineering from Soongsil University, Seoul, South Korea, in 2015 and 2018, respectively. He is currently a Research Associate with the SnT, University of Luxembourg. From 2012 to 2013, he spent 12 months with Vietnam Television as a principal engineer. He was PhD Visiting Scholar at Queen's University Belfast (U.K.) from June–July 2015 and August 2016. His current research interests include machine learning for wireless communications, UAV/drones communications, cyber-physical security, full-duplex radios and cognitive radio networks. Dr. Nguyen received several best conference paper awards, IEEE Transaction on Communications Exemplary Reviewer 2018 and IEEE GLOBECOM Student Travel Grant Award 2017. He has authored or co-authored in some 30 papers published in international journals and conference proceedings. He has served as a reviewer for many top-tier international journals on wireless communications, and has also been a Technical Programme Committee Member for several flag-ship international conferences in the related fields.

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