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Editorial: The Key Trends in B5G Technologies, Services and Applications

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Editorial:

The foundation for the development of society has been digitalized and data-driven technologies, services, and applications. Recently, 5G networks have been designed and launched to meet the diverse vertical sectors like networked industries, intelligent transport systems and smart cities. However, it is certain that the sustainable development of the society in the future requires more disruptive and stringent technologies, services and applications. As a key driver for the society of tomorrow, beyond 5G (B5G) networks, i.e., 6G networks, are expected to support an ever advanced services and applications with peak data rates up to 1 Tbps per user, make a routine life smoother and safer, and serve a far beyond any global business model seen so far, etc., in ubiquitous, reliable, and near-instant context.

In fact, there will have many challenges for 5G networks, towards 2030 for example, that will be progressed in B5G networks. These challenges include how to serve the users moving at 1000km/h, how to move the use of frequency range from 100GHz to 1THz, there have been many remote areas over the world lacking connectivity, how to provide a resilient and tolerant telecommunications networks in emergency situations like natural disasters of which hardly a week passes by without news and scenes destroying people's lives, how to fully connect the physical, cyber, and biological worlds, what are the pillars of B5G networks, etc. And thus, there is an urgent need for conducting state-of-the-art research on further solutions for B5G networks.

To overcome the aforementioned challenges and requirements of B5G networks, this special issue focuses on (but are not restricted to) the following topics: full-coverage broadband connectivity in B5G networks; autonomous systems and various interconnected B5G networks; sub-millisecond latency, high reliability and time-sensitive designs in B5G networks; vertical services and applications for digitized society of tomorrow; high accuracy localization and high-resolution sensing services in B5G networks; machine learning in B5G networks; trust, security and privacy in B5G networks; B5G technologies, services and applications for smart cities; edge intelligence for B5G networks; terahertz communications and networks; massive connectivity in communication systems; UAV-ground and UAV-to-UAV communications; 3D beamforming for cellular-connected UAVs; UAV-aided eMBB, MMTC, URLLC; UAV swarm in B5G networks; and massive MIMO/millimeter wave communications for cellular-connected UAVs.

The special issue includes five high-quality papers. In the first paper entitled "Priority-MECE: A Mobile Edge Cloud Ecosystem Based on Priority Tasks Offloading", the authors study a priority-mobile edge cloud ecosystem (priority-MECE). In such a priority-MECE, e.g., smart medical systems with different priority users in emergency, a priority offloading optimisation system is established to perform the urgent tasks. To work efficiently, the system is divided into a three layered cloud architecture including local cloud, edge cloud, and remote cloud. The optimisation problem is solved by dynamic programming for the best task offloading scheme. The system considers all the priority of user devices (sensed data, remote medical care, entertainment, etc.), bandwidth of edge nodes, and computing power limits to reduce the network delay and energy consumption. Simulation results are provided to demonstrate the benefits of the proposed system compared to other traditional designs.

The second paper is about "Secure Communication for RF Energy Harvesting NOMA Relaying Networks with Relay-User Selection Scheme and Optimization". In this paper, the authors consider the physical layer security (PLS) in a non-orthogonal multiple access (NOMA) relaying network with radio frequency energy harvesting (RF EH). In

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this network, there are one relay cluster (RC), two user clusters (UCs, i.e., high-priority cluster and low-priority cluster), one destination, and one passive eavesdropper. The users in the UCs harvest the RF energy from the selected relay in the RC to transmit the messages to the destination throughout the RC in the presence of the passive eavesdropper. The closed-form expressions of the secrecy outage probability are derived. In addition, the authors propose a relay and user selection scheme and find the best time switching ratio and power allocation ratio to enhance the PLS performance. The secrecy performance is analysed with respect to many system parameters to insightfully understand the behavior of the considered network. The analysis is validated by Monte-Carlo simulation. Finally, some interesting ideas are further discussed to provide the system designers with future research directions.

In the third paper, the authors study "Interference Suppression and Receiving Performance Improvement for Local Cooperation with Channel Estimation Error". This study considers the problem of interference suppression between different devices due to local spectrum sharing and cooperation. To solve this problem, current schemes require sufficiently accurate channel information, and thus they may not obtain the proper performance. To deal with this disadvantage, the authors further implement a low-complexity extra estimation to get more information of channel estimation error. Then, each device can separately execute a two-step process of interference suppression and receiving performance improvement with slight information interaction and overhead exchange between the devices. The numerical results and analysis are presented to demonstrate that the proposed scheme can achieve the proper performance in the local cooperative networks.

A performance assessment of OTFS modulation in high Doppler airborne communication networks is proposed in the fourth paper. It has been known that B5G/6G networks are expected to provide high-mobility wireless communication applications and services ranging from vehicle-to-vehicle, UAVs, to airborne platforms. In this context, the communications suffer from severe Doppler shifts. This paper considers a high Doppler airborne communication network where the mobile node speeds can exceed 1200 m/s. The mobile nodes, which form a mobile ad-hoc network, are equipped with antenna arrays to directly communicate with each other. Because orthogonal time frequency space (OTFS) can convert a time-varying fading channel into a time-independent channel in the two-dimensional delay-Doppler (DD) domain, the authors utilise the OTFS modulation to efficiently compensate for the high Doppler shifts. Comprehensive performance assessment is conducted by using bit error rate (BER) metric with respect to many physical system parameters to reveal the potential of OTFS modulation. The results show that the OTFS modulation over two-ray channels and the combination of multiple-input multiple-output systems with OTFS modulation can provide a reliable airborne communication network with low BER.

Finally, the last paper is about "A Cost-Effective 5-W GaN HEMT Power Amplifier for Sub-6-GHz 5G Wireless Communications". In this paper, the authors design a compact, low-cost and high-efficiency microwave power amplifier for 5G wireless communications. The design is a combination of harmonically tuned technique and appropriate structure of input and output matching networks to simplify ad miniaturise the power amplifier. The amplifier operates at 5.8 GHz band using a low-cost 5W GaN HEMT device from Qorvo. The input and output matching networks are designed to terminate correspondingly up to the 2^{nd} and 3^{rd} harmonics. The proposed power amplifier is evaluated by simulation and experiment on both small and large signals. For the small signal, the measured results are close to the electromagnetic simulated results. The best input and output return losses are -9.4 dB and -15.3 dB associated with 6 GHz and 6.1 GHz. The best power gain is 12.9 dB at 5.7 GHz and stable at the designed frequency of 5.8 GHz. For the large signal, the experimental results for the output power and power gain agree well with the simulated results. Furthermore, the efficiency, output power, and power gain at 5.72 GHz are 41.7 %, 37 dBm, and 10.5 dB, respectively.

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