Guest Editorial Special Section on Smart Rail Mobility: Communications, Signaling, and Emerging Technologies

RAIL transport networks are now reaching an important development stage worldwide. High-speed rail transports have achieved significant development in Europe and China and are becoming popular in many countries. On the other hand, metropolitan transport will have an increasing importance in the coming years to reduce pollution and congestion in cities.

Both metropolitan and high speed railways (HSR) require the use of advanced signaling and control systems to guarantee and optimize their operation. For these reasons it is necessary to use modern communication and signaling systems for the automated control of these railways. In addition, the railway infrastructures use many supplementary systems such as remote control, video surveillance, obstacle detection and operating aids that require the intensive use of information and communication technologies. In all cases the electrical and electronics equipment must have a high quality of service, reliability and availability to fulfill railway requirements. On the other hand, users of modern transport networks demand high-capacity broadband connections with quality equivalent to that of their private homes, and rail operators want to offer supplementary entertainment services to improve the experience of their users, so fifth-generation (5G) mobile communication systems will play an important role on the railway environment in the next years.

The purpose of this special issue is to provide the academic and industrial communities an excellent venue to present the vision, research, and dedicated efforts on the key emerging technologies for smart rail mobility. Seven high-quality contributions to this special issue have been selected in a strict peer review process supported by reputed international experts. They are divided into two categories.

The first part is composed of two papers, focusing on improving reliability of advanced signalling and train control systems. With the adoption of train-to-train communication, the next generation communication-based train control (CBTC) system can overcome most of the problems in existing system without sacrifice system performance. In order to evaluate the reliability of this system, L. Zhu *et al.* model the next generation CBTC data communication system reliability with deterministic and stochastic Petri nets (DSPNs). Then, H. Song *et al.* propose a universal procedure to assist the development and evaluation of the train-centric communication based system, which can help the researchers to analyze the current state, identify future goals, and refine the architectures and technologies for smart rail transportation.

The second category is composed of five papers, exploiting the emerging techniques, such as multiple-input multiple-output (MIMO), and massive MIMO, millimeter-wave (mmWave), to enable a seamless high-data-rate wireless connectivity for various bandwidth intensive applications. In order to achieve realistic performance assessment of future HSR communication systems, T. Zhou *et al.* characterize multi-link MIMO high-speed train (HST) based on field measurements in a long-term evolution (LTE) network along an HSR line. Moreover, in order to tackle the challenge that HST mobile communications suffer from severe attenuation and high Doppler spread in LTE-Advanced (LTE-A) scenarios, J. D. Oliva Sánchez and J. I. Alonso present a novel two-hop relay architecture by utilizing Mobile Relay Nodes (MRN) and mmWave bands at 60 GHz to forward the signal inside the train. Then, the last three papers cover efforts in realizing mmWave HST communications from propagation characterization, channel modeling, to system design. To begin with, D. He *et al.* analyze the influence of rural railway propagation environment and typical objects to the mmWave channel based on channel measurements at 28 GHz in a rural railway environment. Afterwards, Y. Liu *et al.* propose a novel three-dimensional (3D) space-time-frequency non-stationary mmWave massive MIMO theoretical model, as well as a corresponding simulation model, for 5G HST wireless channels based on WINNER II and Saleh-Valenzuela (SV) channel models. Then, J. Kim *et al.* present a comprehensive study on mmWave-based mobile hotspot network (MHN) system for HST communications, including system design, field trial, channel modeling based on measurement campaign, simulation and validation. The results show that it is feasible for mmWave-based systems to provide a broadband mobile wireless backhaul (MWB) with a peak data rate exceeding 5 Gbps at a speed of 500 km/h.

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for providing us the opportunity to organize this special issue. Finally, the guest editors wish you an enjoyable reading of the contributions to this special issue.

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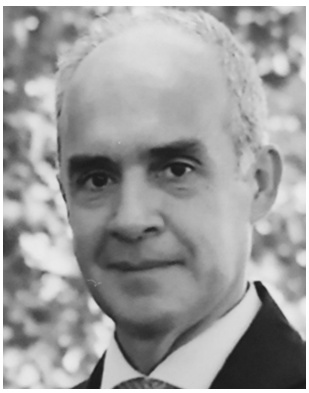

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