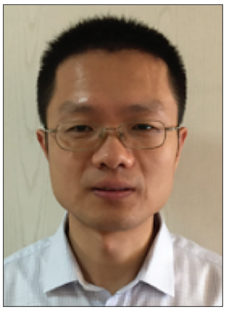
FUTURE RAILWAY COMMUNICATIONS

David W. Matolak

Marion Berbineau

David G. Michelson



Chen Chen

The growth of intelligent transportation systems (ITS) has recently accelerated as governments and regulators seek to use ITS to achieve important economic and policy goals. ITS must be efficient, environmentally friendly ("green"), and, of course, safe. The scope of ITS is broad, and all transportation modes will require communications, including future vehicular (automotive) systems and vehicle-to-vehicle/vehicle-to-infrastructure (V2V/V2I) communications, aeronautical communications, maritime communications, satellite communications, railway communications, and possibly others.

The growing use of railway communications for both passenger and freight transportation has yet to attract sufficient attention in the literature. With numerous high-speed rail systems being used and planned in China and Europe in particular, as well as the development of subways and tramway lines, reliable communications for both railway control/safety and passenger applications are of great current interest.

This Feature Topic on future railway communications should have broad appeal to this magazine's readership, as rail systems are used worldwide by millions of people daily. We have accepted eight papers for this Feature Topic, covering topics from channels and antennas to railway cellular and security.

"A Survey on Future Railway Radio Communications Services: Challenges and Opportunities" presents the main requirements and trends for the use of wireless systems in the high-speed rail, subway, and tramway contexts. The main operational services are described, and important key performance indicators (KPI) as well as safety requirements are given.

Of all the studies conducted in support of future railway communication systems, none are more fundamental than channel measurement. "Channel Sounding for High-Speed Railway Communication Systems" reviews the state of the art in radio channel sounding techniques for high-speed rail (HSR) and proposes a novel LTE-based HSR channel sounding scheme.

In the article "Future Railway Services Oriented Mobile Communications Network," the authors introduce the concept of the fifth generation (5G) for railways (5G-R), addressing 5G networks and key technical implementations in future railway development. Heterogeneous network architecture with Global System for Mobile Communications for Railway (GSM-R), Long Term Evolution for Railway (LTE-R), 5G-R, and integrated transportation are proposed.

In "WDM RoF-MMW and Linearly Located Distributed Antenna System for Future High-Speed Railway Communications," the authors propose a dual-hop architecture capable of providing high-speed communications for high-speed rail. Based on a fiber optic backhaul and millimeter-wave radio access network, the system uses conventional WLAN to provide service to users.

In "Providing Current and Future Cellular Services to High-Speed Trains," the authors provide an interesting comparison between using direct links from railway remote units to subscribers inside trains and using an intermediate relay unit located outside the train. Despite the high penetration losses incurred via propagation through train windows, the direct links provide a simpler and less expensive solution, albeit achieving lower system throughput. Other issues, both technical and operational, are also discussed, indicating directions for future work in this area.

In "Automatic Train Control over LTE: Design and Performance Evaluation," the authors propose a quality of service (QoS) management scheme for train control traffic based on methodologies used in conventional LTE and demonstrate how a QoS policy can be devised based on analysis of that traffic.

Reliable and secure transmission of train control data is of the utmost importance, as it allows safe operation of the train. In "Cybersecurity Analysis on Next Generation Train Control Systems," the authors present a detailed security analysis of the train operation control system under current and future scenarios. Based on their analysis, a more robust cryptographic mechanism, a new key distribution, and a key storage scheme are proposed for railway systems.

Wireless systems are used for sensor applications, too. In "Ultra-Wide-Bandwidth Systems for the Surveillance of Railway Crossing Areas," the authors raise the possibility of using UWB wireless systems to detect, localize, and discriminate vehicles or obstacles that might be entrapped in a level crossing area so that an appropriate alarm can be raised or appropriate action taken.

BIOGRAPHIES

DAVID W. MATOLAK (MATOLAK@cec.sc.edu) received his B.S. degree from Pennsylvania State University, his M.S. degree from the University of Massachusetts, and his Ph.D. degree from the University of Virginia, all in electrical engineering. He has more than 20 years' experience in communication system R&D and deployment, with AT&T Bell Labs, L3 Communication Systems, MITRE, and Lockheed Martin. He has over 100 publications, eight patents, and expertise in wireless channel characterization, spread spectrum, and ad hoc networking.

MARION BERBINEAU (marion.berbineau@ifsttar.fr) received an Engineer degree from Polytech Lille, France, and a Ph.D. degree from the University of Lille, both in electrical engineering, respectively. She is a research director at IFSTTAR and deputy director of the Components and Systems Department. She is an expert in the field of radio wave propagation, wireless systems for telecommunications, and localization for ITS, particularly for railways. She is active as an expert in GSM-R and future systems (e.g., LTE-R, 5G).

DAVID G. MICHELSON (davem@ece.ubc.ca) received his B.A.Sc., M.A.Sc., and Ph.D., all in electrical engineering, from the University of British Columbia. He now leads the Radio Science Lab at UBC and serves as co-director of the AURORA Connected Vehicle Test Bed. His research interests include antenna design and channel modeling for railway communications and intelligent transportation systems. He is a member of the Boards of Governors of both the IEEE Communications and Vehicular Technology Societies.

CHEN CHEN (chen.chen@samsung.com) received his Ph.D. degree in communication engineering from Xidian University, Xi'an, China, in 2005. Since 2005 he has been with Samsung Telecom R&D Center, Beijing, China. His research experience has been on mobile communication system R&D for FDD-LTE eNodeB and TD-LTE eNodeB; he is now in charge of the Department of Advanced Technology Research, including enhanced UL CoMP, FD-MIMO, FeICIC, and so on. His research interests also include intelligent transportation systems and vehicular ad hoc networks.