

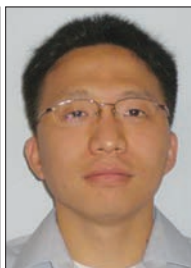
OPTICAL COMMUNICATIONS AND NETWORKS



Mohamed-Slim Alouini



Xiang Liu



Zuqing Zhu

In this first issue of the Optical Communications and Networks Series in 2021, we have selected four intriguing articles reporting on recent progress in optical communications and networking. They address (i) the optical wireless communication technologies for in-body and transdermal biomedical applications; (ii) the optical-domain multiple-input and multiple-output (MIMO) signal processing with the assistance from analog radio-over-fiber (RoF) for radio access networks (RANs); (iii) the role of digital twin in optical communications; and (iv) photoacoustic communication from air to underwater based on passive relays.

The first paper, “Optical Wireless Communications for In-Body and Transdermal Biomedical Applications” by A. Boulogeorgos *et al.*, reports on recent innovative designs that leverage the advances in optoelectronics and optogenetics and employ optical wireless communication (OWC) technologies to deliver more compact, reliable, and energy-efficient solutions for in-body and transdermal biomedical applications. The authors show that the solutions can also alleviate concerns related to RF radiation. In order to address the challenges from OWC-based biomedical applications, the authors discuss the new design principles, and explain how to adopt signal-transmission and neural-stimulation jointly, by taking into account the characteristics of patients.

The second paper, “Analog Radio over Fiber Aided Optical-Domain MIMO Signal Processing for High-Performance Low-Cost Radio Access Networks” by Y. Li *et al.*, presents a high-performance yet cost-efficient RoF-aided RAN concept and critically appraises the pros and cons of analog RoF (A-RoF) versus digitized RoF (D-RoF) designs. Then, the practical benefits of the centralized RAN (C-RAN) concept relying on A-RoF-aided MIMO signal processing are highlighted, where the MIMO signal is carried by fiber and processed optically in a central unit. The advantages of this new concept are highlighted in terms of the reduced number of components required at the Remote Radio Head, which ultimately reduces the capital expenses of ultra-dense networks. The authors conclude with a suite of future research ideas on optical processing aided beamforming by exploiting the different delays of the multi-mode fiber modes.

The third paper, “The Role of Digital Twin in Optical Communication: Fault Management, Hardware Configuration, and Transmission Simulation” by D. Wang *et al.*, presents a digital twin (DT)-enabled technical solution toward optical communications to promote its digital transformation and intelligent evolution. The authors design a DT framework particularly for optical communications and discuss its application for fault management, hardware configuration, and transmission simulation.

In view of the technical challenges faced in optical communications, DT has the potential to provide low-cost and lightweight solutions to ensure high-reliability operations and high-efficiency management of optical communication systems and networks.

Finally, the fourth paper, “Photoacoustic Communication from the Air to Underwater Based on Low-cost Passive Relays” by Z. Ji *et al.*, presents a photoacoustic communication scheme that is capable of not only minimizing the energy losses both in water and in an air-water interface, but also relieving the difficulty of target-seeking. Moreover, they introduce passive relays with high optical absorption coefficient to improve communication efficiency, and obtain six orders of magnitude reduction of laser energy (from 25 J to 27 μ J) in the photoacoustic communication system. Hence, the proposed scheme can potentially support practical communications from the air to underwater.

As the Editors of the Optical Communications and Networks Series, we hope that *IEEE Communication Magazine* readers will find these articles interesting and informative. We will continue to do our best to select similarly outstanding papers for our future issues. We would like to thank all the authors for submitting their important results to this series, the reviewers for their high-quality reviews that provide valuable feedback and comments to the authors, and the publication staff members and the Editor-in-Chief of the *IEEE Communications Magazine* for their support.

BIOGRAPHIES

MOHAMED-SLIM ALOUINI [F'09] (slim.alouini@kaust.edu.sa) received his Ph.D. degree in electrical engineering from the California Institute of Technology (Caltech), Pasadena, CA, USA in 1998. He served as a faculty member at the University of Minnesota, Minneapolis, and then at Texas A&M University at Qatar, Education City, Doha, before joining King Abdullah University of Science and Technology (KAUST), Thuwal, Makkah Province, Saudi Arabia, as a professor of electrical engineering in 2009. His current research interests include the modeling, design, and performance analysis of wireless communication systems.

XIANG LIU [F'17] (xiang.liu@futurewei.com) received his Ph.D. degree in applied physics from Cornell University, Ithaca, NY, USA in 2000. He is currently Vice President for Optical Transport and Access at Futurewei Technologies, focusing on next-generation optical transport and access technologies and industry development. He spent the early part of his career at Bell Laboratories in New Jersey, working on high-speed optical fiber transmission technologies. He is a Fellow of the IEEE and the OSA, and a Deputy Editor of *Optics Express*.

ZUQING ZHU [SM'12] (zqzhu@ieee.org) received his Ph.D. degree from the University of California, Davis, CA, USA in 2007. He is currently a full professor at the University of Science and Technology of China. Prior to that, he worked in the Service Provider Technology Group at Cisco Systems, San Jose, California. His research focuses on optical networks. He is a Senior Member of OSA, the Lead Series Editor of the Optical Communications and Networks Series in *IEEE Communications Magazine*, and an associate editor of *IEEE Transactions on Network and Service Management* and *Optics Express*.