ADVANCES IN OPTICAL COMMUNICATIONS TECHNOLOGIES


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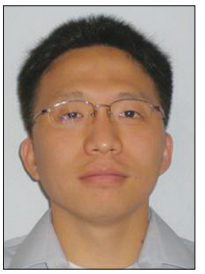
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In 2017, with advances in emerging fields such as silicon photonic integration and spatial-division multiplexing (SDM), optical communications and networking technologies demonstrated great success in supporting the ever increasing growth of data center networks. Meanwhile, the implementation of software-defined networking (SDN) is making optical communications networks (i.e., both fiber optic systems and optical wireless ones) more agile, programmable, and application-aware to provide short time to market and flexible service solutions. Moreover, we are also happy to witness attractive progress in optical camera communications, which can leverage the built-in cameras in smartphones to realize device-to-device communication. Finally, the development of optical communications and networking technologies always needs support from innovations in fundamental physics. The recent progress in orbital angular momentum (OAM) opens up interesting opportunities for increasing fiber capacity.

In this first Optical Communications Series (OCS) issue of 2018, we have selected six contributions that address the reconfigurable optical architecture for cloud data centers, ultra-dense wavelength switched networks, software-defined visible light communications, optical camera communications, and OAM of light.

In the first contribution, "NEPHELE: An End-to-End Scalable and Dynamically Reconfigurable Optical Architecture for Application-Aware SDN Cloud Data Centers," P. Bakopoulos *et al.* present a vertical approach to developing an optical data center network. They identify the main technological challenges hindering practical deployment of optical switching in the data center ecosystem and describe the end-to-end optical data center solution of the European project NEPHELE. A slotted data plane architecture is presented along with an optical routing scheme that allows dynamic operation. Control of the slotted data plane is enabled by bespoke resource allocation algorithms and synchronization methods, and network management is facilitated by an overarching SDN framework. Network scalability and techno-economics of the presented network solution are also elaborated.

In the second article, "Ultra-Dense Wavelength Switched Network: A Special EON Paradigm for Metro Optical Networks," G. Shen *et al.* present a special elastic optical network (EON) paradigm called ultra-dense wavelength switched network (UD-WSN) for metro optical networks. The architecture supports a fine spectrum granularity at the level of 5 GHz, which enables efficient spectrum utilization when provisioning metro low-speed service connections. From the techno-economic perspective, the authors use case studies to demonstrate the merits of the proposed architecture.

In the third contribution, "A Software-Defined Multi-Element VLC Architecture," S. Mushfique *et al.* present a unique example of a software-based visible light communication (VLC) system for solving the inherent problems of VLC such as alignment, line of sight (LOS), and seamless integration to legacy RF-based technologies. The presented framework for optimizing the multi-element bulb takes both signal quality and evenness of lighting into consideration. Since it specifically relies on a software-defined approach to handle the LOS discovery and alignment problems, the proposed system can serve as a flexible platform for future studies on VLC systems.

In the fourth contribution, "Undersampled-Based Modulation Schemes for Optical Camera Communications", P. Luo *et al.* first present an overview of the principles of modulation schemes used in optical camera communication (OCC) systems. Then they propose the undersampled-based modulation schemes, which offer a practical solution for establishing both short- and long-range as well as non-flickering OCC links using a low-frame-rate (e.g., 30 fps) camera as the receiver. The article covers all aspects of the OCC system, which uses the proposed modulation schemes, including the design, implementations, and evaluation as well as examples from real test scenarios.

In the fifth article, "Technical Issues on IEEE 802.15.7m Image Sensor Communication Standardization," T. Nguyen *et al.* present an overview of optical wireless communication (OWC) technologies using cameras. They discuss the recent advances of OWC technologies in the ongoing IEEE standardization Task Group on OWC technology, namely 802.15.7m. Specifically, they focus on the image sensor communication technologies that have significantly influenced the development of such OWC technologies.

In the sixth contribution, "Carrying Data on the Orbital Angular Momentum of Light," L. Rusch *et al.* present the spatial multiplexing in optical fiber using OAM. They first describe the strategy of using OAM to increase fiber capacity, while avoiding multiple-input multiple-output (MIMO) processing of modes, for applications in data centers and optical fronthaul. Then they describe several fiber types, and contrast properties of OAM and standard linearly polarized modes. Finally, they report experiments demonstrating compatibility with commercial single-mode transceivers (i.e., without MIMO modal processing).

BIOGRAPHIES

ZUQING ZHU [SM'12] (zqzhu@ieee.org) received his Ph.D. degree from the University of California, Davis, in 2007. He is currently a full professor at the University of Science and Technology of China. Prior to thast, he worked in the Service Provider Technology Group of Cisco Systems, San Jose, California. His research focuses on optical networks, and he received Best Paper Awards from IEEE ICC 2013, IEEE GLOBECOM 2013, IEEE ICNC 2014, and IEEE ICC 2015.

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