

Introduction to the Focus Issue on Next-Generation WDM-PON-Based Optical Access Networks

The demand for modernizing available applications to typical residential and business customers in addition to the new breed of services requires dramatically higher bandwidth network solutions offering media-rich applications such as high-definition television (HDTV), video-on-demand (VoD), voice-over-IP (VoIP), and high-speed Internet, as well as emerging applications such as multimedia conferencing, multiplayer online gaming, and online content generation. As a result, the future access networks will be faced with the challenge of transporting this increasing volume of data-centric traffic.

The optical access network requirements to meet these challenges will potentially require major contributions from the optical networking and photonics systems research communities. Currently, passive optical networks (PONs) based primarily on time division multiplexing (TDM) have evolved as an access solution to provide simplicity and low operational cost with provision of multiple tens of Mbps to each user. Recently, wavelength division multiplexed PONs (WDM-PONs) have been increasingly considered to deliver ultra-high-speed services in the critical first mile by enabling service providers to offer dedicated wavelengths straight to homes and businesses over the existing optical backbone. This approach is expected to simplify the implementation and development of scalable networks essential to demonstrate the ongoing service upgrade and next-generation rich multimedia content ranging from 100 Mbps to multiple Gbps per access subscriber. However, on the negative side, WDM-PONs are currently considerably costly to implement, operate, and maintain because the relevant technologies are not yet mature.

To address the recent research developments related to the topic of next-generation WDM-PON-based optical access networks, we have prepared this *Jour-*

nal of Optical Communications and Networking (JOCN) Focus Issue that consists of five selected invited contributions by leading researchers in the field. The particular groups of authors that have prepared the Focus Issue papers are well-recognized authorities in the area of WDM optical access networks, and the collection of their recent research activities and results is an excellent reference for scientists who would like to understand the issues and challenges associated with the design and operation of such networks as well as get the latest update on the relevant state-of-the-art technologies.

The paper “Key Technologies of WDM-PON for Future Converged Optical Broadband Access Networks” authored by Gee-Kung Chang, Arshad Chowdhury, Zhensheng Jia, Hung-Chang Chien, Ming-Fang Huang, Jianjun Yu, and Georgios Ellinas discusses the hurdles that need to be overcome before WDM-PON sees widespread commercial deployment and presents the key enabling technologies of WDM-PONs that ensure longer reach, higher data rate, and higher spectral efficiency. The authors also present their recent studies related to integrated schemes with radio-over-fiber- (ROF-) based optical-wireless access systems to serve both fixed and mobile users with a converged optical platform.

Martin Maier in his contribution entitled “WDM Passive Optical Networks and Beyond: the Road Ahead” discusses the respective advantages and limitations of point-to-point fiber to the home (FTTH), WDM-PONs, and multistage WDM-PONs, presents the evolutionary path from current TDM-PONs to next-generation WDM-PON architectures, and outlines future research directions. Furthermore, he introduces novel optical-coding-enhanced WDM-PONs that allow for enhanced real-time dynamic bandwidth allocation.

In the paper “Reach Extension Strategies for Passive Optical Networks” by Fabienne Saliou, Philippe Chanclou, Fabien Laurent, Naveena Genay, Jose A. Lazaro, Francesc Bonada, and Josep Prat, the authors present the main techniques that allow significant reach extension for PONs and outline the results they

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Ioannis Tomkos (e-mail: itom@ait.edu.gr) is with the Athens Information Technology Center, Athens, Greece.

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have obtained, demonstrating significantly enhanced optical power budgets for the migration to long-reach next-generation access networks.

The contribution entitled “Evolution Scenario Toward WDM-PON” by Filippo Ponzini, Fabio Cavaliere, Gianluca Berrettini, Marco Presi, Ernesto Ciaramella, Nicola Calabretta, and Antonella Bogoni presents different WDM-PON architectures compatible with pre-existing GPON infrastructures and the way to upgrade the network in a hitless way.

Finally, in their paper “Applications and Technical Issues of Wavelength-Division Multiplexing Passive Optical Networks With Colorless Optical Network Units,” Katsumi Iwatsuki and Jun-ichi Kani review their recent research activities on the applications and technical issues of WDM-PONs. They describe in detail a long-reach WDM-PON based on wavelength routing for metro/access integration as well as a short-reach WDM-PON for co-existence with current PON systems. They present the colorless optical network units (ONUs) that need to be developed in order to

serve both applications and outline their conclusions from the experimental studies they have performed on these technologies/architectures.

This Focus Issue was made possible by the dedicated efforts of a number of people. First, I would like to thank the authors of all the papers in this issue and the many reviewers who, despite their many other commitments, provided high-quality reviews of the manuscripts. I would also like to thank the OSA/IEEE publications staff for their general support and their prompt help. Finally, I would like to thank Keren Bergman, Editor-in-Chief, for her support and encouragement in putting together this issue.

All people involved in the preparation feel that this JOCN Focus Issue will be a highly referenced and valuable source of information about the present and the future of WDM-PONs, and we hope that the readers will appreciate it.

Ioannis Tomkos
Focus Issue Editor