Radio-over-optical-fiber networks: introduction to the feature issue

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Over the past few years, traffic patterns in access networks have intensified due to the broadband evolution from voice- and text-based services to video-based interactive and multimedia services, enabled by the continuing remarkable growth in the Internet. It is estimated that approximately 50% of the revenues of large telephone companies will be based on video services by 2010. In addition to the high-speed, symmetric, and guaranteed bandwidth demands for future video services, the next-generation access networks are driving the needs for the convergence of wired and wireless services. This scenario will require that voice, data, and video services can be delivered with the inclusion of mobility features, in order to serve both the fixed and mobile users in a unified networking platform. To provide integrated broadband services, these systems will need to offer data transmission capacities well beyond the present-day standards of wireless systems. Wireless LAN (IEEE802.11a/b/g) offering up to 54 Mbps and operating at carrier frequencies around 2.4 and 5 GHz, and 3G mobile networks (IMT2000/UMTS) offering up to 2 Mbps and operating around 2 GHz, are some of today’s main wireless standards. IEEE802.16 or WiMAX is another recent standard aiming to bridge the last mile through mobile and fixed wireless access to the end user at frequencies between 2 and 66 GHz. The need for increased capacity per unit area leads to higher operating frequencies (above 6 GHz) and smaller radio cells, especially in indoor applications where the high operating frequencies encounter tremendously high losses through the building walls. To reduce the system installation and maintenance costs of such systems, it is imperative to make the radio antenna units as simple as possible. This may be achieved by consolidating the radio carrier generation and data signal processing functions at a centralized head end, and from there distributing the modulated signals over fiber to the antennas, through radio-over-fiber technology. Moreover, this picocell approach enables the reduction of the radio radiation power from the antenna, thus contributing to an overall reduction of the system’s power consumption.

Hence, by making full use of the huge bandwidth and connectivity offered by fiber and the mobility feature presented via wireless links, the integration of wireless and optical networks can offer a solution for increasing the capacity and mobility, reducing power consumption, as well as decreasing the costs in the access network. Thus, future broadband access networks based on radio-over-fiber technologies came into play and have emerged as an affordable alternative solution in environments such as conference centers, airports, hotels, shopping malls, and ultimately homes and small offices. It is expected that the millimeter-wave (mm-wave) bands will be utilized to meet the requirement for higher signal bandwidth and to
overcome the frequency congestion in the future optical-wireless access networks. In this situation, it is necessary to minimize the cost of the base station (BS) and to shift the system complexity and expensive devices to the central office (CO) because the BS picocell has small coverage due to high atmospheric attenuation in the mm-wave band. At the CO, the optical mm-wave signals are generated and mixed using cost-efficient all-optical approaches. Optical networking technologies are leveraged to reach the longer transmission distance over a single-mode fiber (SMF) and to integrate with the WDM-PON between the BS and CO.

This special feature issue of the *Journal of Optical Networking* has attracted many submissions. Here we have selected 17 papers for publication. The accepted invited and regular contributions address the following research areas:

Enabling techniques including novel architectures and optical millimeter-wave generation for radio-over-fiber networks are addressed in the following seven papers:

- "Broadband radio-over-fiber-based wireless access with 10 Gbits/s data rates" by Ignacio González Insua *et al*.
- Invited paper "Application of an electroabsorption modulator in radio-over-fiber networks" by Chul Soo Park *et al*.
- "Optical millimeter wave generated by octupling the frequency of the local oscillator" by Jianxin Ma *et al*.
- "Demonstration and optimization of an optical impulse radio ultrawideband distribution system using a gain-switched laser transmitter" by Haymen Shams *et al*.
- Invited paper "Generation of optical millimeter-wave signals and vector formats using an integrated optical I/Q modulator" by Jyehong Chen *et al*.
- "Half-duplex 12-channel dense WDM 2.6-GHz-band radio-over-fiber system employing a 1.5 GHz bandwidth reflective semiconductor optical amplifier" by J. J. Vegas Olmos *et al*.
- Invited paper "Mitigation strategy for transmission impairments in millimeter-wave radio-over-fiber networks" by Christina Lim *et al*.

Optical wireless system integration techniques are addressed in the following two papers:

- "Low-cost optical line terminal for a WDM-PON compatible with radio-over-fiber systems" by Ze Dong *et al*.
- "Double-spread radio-over-fiber system for next-generation wireless technologies" by Arokiaswami Alphones

Network control and management and network protocol and admission control algorithms for radio-over-fiber networks are addressed in the following three papers:

- "Bandwidth and delay guaranteed polling with adaptive cycle time (BDGPACT): a scheme for providing bandwidth and delay guarantees in passive optical networks" by Tomaz Berisa *et al*.
- "Performance evaluation of IEEE 802.11e medium access control in fiber-fed networks" by Majlinda Mjeku *et al*.
- Invited paper "Indoor airport radio-over-fiber network traffic model and performance analysis using load-balancing techniques" by Ángela A. de Grado Vivero *et al*.

WiFi, WiMax, and WiMedia for optical wireless access networks are addressed in the following two papers:

- "SuperMAN: Optical-wireless integration of RPR and WiMAX" by Navid Ghazisaidi *et al*.
• "Interoperability of GPON and WiMAX for network capacity enhancement and resilience" by Milos Milosavljevic et al.

Finally, ultrawideband home networking via radio-over-fiber networks and emerging applications and solutions for IPTV and HDTV over optical wireless are addressed in the following three papers:

• Invited paper "Radio-over-fiber transport for the support of wireless broadband services" by Nathan J. Gomes et al.
• "Wireless high-definition services over optical fiber networks" by Zhensheng Jia et al.
• Invited paper "60 GHz radio-over-fiber technologies for broadband wireless services" by Andreas Stöhr et al.

Together, all these papers give a wide overview of the progress on certain key areas in the field of radio-over-fiber-optical network technologies, including the enabling technologies, architectures, and systems design. We thank the authors for their valuable contributions, and we trust that this special issue of the Journal of Optical Networking can provide a useful and in-depth archival reference for those interested in this area.