IEEE DL Prof. Patrick Yue Visits SSCS Santa Clara Valley Chapter

Distinguished Lecturer (DL) Prof. Patrick Yue gave talk, “Recent Developments in Transceiver SoC Design for Next Generation Optical Networks,” at the IEEE Solid-State Circuits Society (SSCS) Silicon Valley Chapter on 1 December 2017. He covered recent developments in transceiver system-on-chip (SoC) design for next-generation optical networks. The emerging 4.5/5G cellular network is projected to provide 500 Mb/s of mobile data rate to each user and, therefore, will require base stations to be equipped with 100-Gb/s backhaul connectivity. Optical fiber networks are widely employed in high-speed wireline communication, whereas a globally available unlicensed band at 60 GHz is well suited for wireless communication with an achievable data rate of 10–20 Gb/s.

The talk presented a 4-Gb/s fiber-to-mm-wave baseband-over-fiber (BoF) modulator SoC using 65-nm complementary-metal–oxide semiconductor (CMOS) with a fully integrated 850-nm wavelength optical receiver front end for short-range backhaul. Design considerations for an improved 10-Gb/s BoF I/Q modulator SoC with an integrated mm-wave power amplifier were also described. The seminar concluded by questions from the audience, and Yue shared his experiences from industry and academia in the United States and abroad.

Abstract
The emerging 4.5/5G cellular network is projected to provide 500 Mb/s of mobile data rate to each user and therefore will require base stations to be equipped with 100-Gb/s backhaul connectivity. Optical fiber networks are widely employed in high-speed wireline communications whereas globally available unlicensed band at 60 GHz is well suited for wireless communication with an achievable data rate of 10–20 Gb/s. Therefore, a hybrid fiber-mm-wave communication is being proposed as potentially a cost-effective and flexible solution to the next-generation cellular network deployment. A high-speed, point-to-point reciprocal wireless optical link is necessary to support this hybrid network in radio backhaul and fiber fronthaul. To address this need, two optical wireless signal transport schemes, RF-over-fiber (RoF) and baseband-over-fiber (BoF), have drawn significant interest and investigation in recent years.

However, hybrid fiber-mm-wave networks adopting an RoF configuration require the analog bandwidth of optical-electrical (O/E) and electrical-optical (E/O) interfaces to cover the mm-wave carrier frequency at 60 GHz, which is significantly higher than the targeted data speed of 10–20 Gb/s. The higher operating speed of RoF systems requires prohibitively expensive optical modulators and detectors, which are difficult to integrate with the 60-GHz mm-wave circuit even using the most advanced technologies available today. Compared to the RoF scheme, the BoF scheme requires lower bandwidth equivalent to the baseband data rate rather than the carrier frequency. Therefore, it significantly alleviates the bandwidth requirement for O/E and E/O interface and offers the advantages of low cost, high speed, and integration with advanced CMOS technology.

This talk presents a 4-Gb/s fiber-to-mm-wave BoF modulator SoC using 65-nm CMOS with a fully integrated 850-nm wavelength optical receiver front end for short-range backhaul. Design considerations for an improved 10-Gb/s BoF I/Q modulator SoC with integrated mm-wave power amplifier are also described.

—Patrick Yue

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