TAOS Newsletter – Issue 4, December 2015

The Future of Copper Access

Digital Subscriber Line (DSL) technology has enabled the large deployment of broadband access: over the past several decades, telecommunication operators have evolved from delivering plain old telephone service (POTS) over a copper loop plant to providing broadband access and high-definition video over hybrid fiber-copper networks.

Three revolutionary copper technologies in different stages of development will enable hybrid networks to continue to increase data-rates over orders of magnitude for many years to come. The first of the three, vectoring, is a mature technology with massive ongoing rollout that provides end user speeds above 100 Mb/s across distances of 500 m. The second, G.fast, is the first ultra-broadband technology offering 1 Gb/s speeds, across distances of around 100 m. It has recently gained approval in the standards bodies and is currently undergoing trials both in research labs and in the field by numerous telecom operators. Finally, Bell Labs' XG-FAST technology, now in a proof-of-concept phase, delivers 10 Gb/s across a 30 meter copper drop cable. XG-FAST paves the way for a homes-passed fiber network, leveraging high speed copper to the premises to increase their homes-connected.

For more details, we recommend:

[1] J. Maes and C.J. Nuzman, 'The Past, Present and Future of Copper Access', Bell Labs Technical Journal 20, pp 1-10, 2015.

5G C-RAN with Power-over-Fiber

Cloud Radio Access Networks (C-RANs) represent a promising solution to guarantee required quality of service (QoS) to future 5G network environments. With more than 10 Gbps capacity, and less than 1 ms latency, connectivity for numerous devices is expected to be provided, satisfying the high expectations in terms of quality of experience (QoE). In this section we highlight a recently proposed C-RAN solution based on passive optical networks (PONs) exploiting power over fiber (PoF) [2]. This solution is expected to be provided with low installation cost and without external power supply for remote radio head (RRH). The overall operation of the network is controlled by the Central Office where the PON Optical Line Terminals (OLTs) are located. In particular, the PON broadcasts the data from the Central Office to each RRH through a splitter from the OLT. The OLT uses PoF to send electric power to the RRHs. Each RRH has three parts: the Optical Network Unit (ONU) module, the antenna module and the battery module, which stores the received power from the OLT over the fiber (i.e., PoF) and provides the electric power for the ONU and antenna modules to function. In addition, each RRH has a sleep mode, which can reduce energy consumption by turning down specific modules. Considering reasonably good Quality of Experience, even 72 RRHs and 15 OLTs can be successfully deployed in a Central Office. The energy consumptions of RRHs is 0.7W in sleep mode and 1.5W in active states, with a transmission power of each OLT set to 20W (efficiency of optic-electric conversion 0.5). For more details please see:

[2] K. Miyanabe et al., "A Cloud Radio Access Network with Power ovr Fiber Toward 5G Networks: QoE-Guaranteed Design and Operation", IEEE Wireless Communications, August 2015

VCSEL-based Transmission

Current advanced datacentre solutions are mainly based on 25 Gb/s optical links implemented with 850nm vertical-cavity surface-emitting lasers (VCSELs) and multimode fiber. The next generation datacenters are expected to use optical links based on single-mode fiber with longer transmission distances that operate up to 50 Gb/s. Moreover, high-performance computing systems require the lowest possible latency. This can be achieved with non-return-to-zero (NRZ) modulation instead of 4-level pulse-amplitude modulation (PAM4) which generally requires forward error correction (FEC) and digital signal processing (DSP). Directly modulated C-band VCSELs have the potential to satisfy simultaneously both of these large system requirements. Additionally, NRZ modulation is likely to result in less power consumption than PAM4 and VCSELs may be less expensive than alternative technologies such as distributed feedback lasers (DFBs) and Silicon Photonics.

In [3], by relying on a novel VCSEL design based on Indium phosphide (InP) with a buried tunnel junction (BTJ), a transmission record of 56 Gb/s Back-to-back and 50 Gb/s over 2 km link has been successfully achieved using a directly NRZ-modulated 1530 nm VCSEL, without FEC or DSP.

For more details please see:

[3] D. Kuchta et al., "Error-free 56 Gb/s NRZ Modulation of a 1530 nm VCSEL Link", ECOC Conf., PDP.1.3, Sept. 2015

Next Generation Access

Today's standardized next-generation passive optical network (NG-PON2) employs 40 Gb/s time and wavelength division multiplexing TWDM-PON with four wavelengths, each supporting a downlink data rate of 10 Gb/s over power-split optical distribution network. As the demand for broadband services continues to rise, the upgrade from 10 Gb/s to 25 Gb/s or 40 Gb/s per wavelength is investigated intensively in cost-sensitive access networks, covering distances of around 20km.

In [4], the experimental demonstration of a real-time end-to-end 40-Gb/s PAM-4 system for next generation access applications is presented. The system relies on 10G class transmitters and on a pre-amplified receiver based on intensity modulation and direct detection. No optical domain chromatic dispersion compensation or chirp management is used. Experimental results showed up to 25-dB upstream link budget for 20 km over single mode fibers.

For more details please see:

[4] J. Wei et al., "First Demonstration of Real-Time End-to-End 40 Gb/s PAM-4 System using 10-G Transmitter for Next Generation Access Applications", ECOC Conf., PDP.4.4, Sept. 2015

Filippo Cugini
Editor

IEEE Communications Society
Technical Committee on Transmission, Access and Optical Systems (TAOS)
http://committees.comsoc.org/taos/

Contributors: Jochen Maes

Template and Other Contributions by: Walter Cerroni
TAOS officers:
Ahmed E. Kamal, Chair
Athanassios Manikas, Vice Chair
Fabrizio Granelli, Secretary