Sigma-Delta Modulated Radio over Fiber Transmission

Guy Torfs [1], Haolin Li [1], Laurens Breyne [1], J. Van Kerrebrouck, Chia-Yi Wu [1], Johan Bauwelinck [1], Piet Wambacq[2] and Piet Demeester [1]

[1] IDLab, Department of Information Technology, Ghent University – imec, B-9052 Gent, Belgium

[2] Imec, B-3001 Leuven, Belgium.

Abstract- The bandwidth demands in the up-coming 5G scenarios will require a dramatic increase in the number of antenna sites and tight coordination between different cells [1]. This requires centralization of baseband processing such that an efficient way to distribute radio signals to remote antenna units (RAU) is necessary. The industry standard reuses the existing infrastructure and transports the signals digitally using CPRI. As a result, still significant processing is required at the RAU: reception of the digital signal, processing, digital-to-analog conversion and up conversion. This introduces latency and increases the power consumption of the RAU. Alternatively, the optical carrier can also be modulated with the analog radio signal. This decreases the overhead in the RAU since only a linear receiver and amplifier are required. However, due to the non-linear behavior of most optical transmitters, especially low-cost devices, it is difficult to reach the required wireless signal quality [2]. Alternatively, we have proposed to oversample and quantize the analog signal to a single bit stream using a bandpass sigma delta modulator [2,3], which mitigates non-linear behavior of optical modulators by transmitting a 2-level signal. At the RAU, detection with a narrowband transimpedance amplifier (TIA) tuned [4] to the radio signal's carrier frequency can remove the out-of-band quantization noise, hence no further processing is required. In this talk, we present the real-time implementation of a 28GS/s bandpass sigma-delta modulator on FPGA, which is used to transmit 3.5 GHz, 256 QAM modulated signals over 200m of fiber using a multi-mode VCSEL. At the receive side, a resonant TIA is used to detect the signal with an error-vector-magnitude of -35dB. The 218.75 MBd symbol rate results in a wireless transmission of 1.75 Gb/s. Parallel streams can easily be generated synchronously with respect to each other enabling complex wireless scenarios such as distributed beamforming and distributed (Massive) MIMO.

REFERENCES

1. G. Torfs, et. al, "ATTO: Wireless Networking at Fiber Speed", *IEEE Journal of Lightwave Technology*, Vol. 36, 1468-1477, 2017.
2. L. Breyne, et. al, "Comparison between analog radio-over-fiber and sigma delta modulated radio-over-fiber," *IEEE Photonics Technology*, Vol. 29, 1808-1811, 2017.
3. J. Van Kerrebrouck, et. al, "Real-time all-digital radio-over-fiber LTE transmission," *Advances in Wireless and Optical Communications (RTUWO)*, Riga, Letvia, 2017.
4. L. Bogaert, et. al, "Resonant optical receiver design by series inductive peaking for sub-6 GHz RoF," *Microwave and Optical Technology Letters,* Vol. 59, 2279-2284, 2017.