Abstract

The exponential traffic increase demands faster, high capacity, and quality of service (QoS) guaranteed services. Cloud radio access network (C-RAN) has become an emerging enabling technology introduced into 5G networks, and proposed to support the upcoming next generation mobile technologies and provide high spectral efficiency and low energy consumption with a reduced capital expenditure and operational expenditure. Nevertheless, the current C-RAN imposes stringent requirements on the fronthaul link for seamless connectivity. Digital radio over fiber (D-RoF) based on common public radio interface (CPRI) is the most widely used means of distributing baseband samples in C-RAN fronthaul. However, the signal transmission of quantized IQ (In phase and quadrature) via CPRI requires very high aggregated bit rate on the optical link and flexibility limitation. Therefore, these make them impractical to be realized for massive MIMO, millimeter wave (mm-wave) and 5G applications.

Analogue radio over fiber (A-RoF) is currently being studied for mitigation of the huge bandwidth provisioning of D-RoF based on CPRI. It is a technique of aggregating massive amount of native radio waveforms through a more traditional analogue radio over fiber approach. In this Thesis, the numerical analysis, simulation and experimental demonstration of A-RoF on intensity modulated and direct detected (IM-DD) is studied based on a novel frequency division multiple access (FDMA) and time division multiple access (TDMA) digital signal processing (DSP) radio waveform aggregation techniques. These alternatives aims to transport in parallel many fourth generation long term evolution (4G LTE) or fifth generation new radio (5G NR) waveforms on the same fiber.

The transport of up to 96 20-MHz LTE waveforms is experimentally demonstrated over IM-DD optical link based on off-line DSP aggregation using FDMA and TDMA approaches. Furthermore, a simulative analysis of 5G NR uplink IM-DD optical channels with scalable bandwidth is performed, exploiting a numerical model implemented in MATLAB and considering both aggregation techniques FDMA and TDMA.

Finally, the bottom-line physical layer performance of two approaches is investigated. Particularly, which of the two gives the lowest error vector magnitude(EVM), better spectral efficiency (since bandwidth become the bottleneck in 4G and 5G systems) and less DSP

complexity for a given set of aggregated waveforms on the same opto-electronic transceiver.