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Project plan and time line for the 60 CP Master project

Machine-Learning-Aided Digital Resolution Enhancer for High-Speed Optical Transmission

The proliferating network services and applications (e.g., self-driving cars, video streaming, online gaming) require increasingly dynamic, high-capacity and autonomous optical transport networks. To ensure higher throughput, telecom infrastructure providers are forced to use more advanced optical signal formats. These formats are more spectrally efficient since they are designed to manipulate not only with signal intensity (as it was in conventional 10 Gbps on-off keying systems) but also with its phase, polarization and constellation properties. Thus, more complex higher-order modulation formats with geometrically and/or probability shaped (PS) constellation diagrams are introduced into the deployed network gradually. These features impose a considerable burden on the design of high-speed electronics and the required digital signal processing techniques. Consequently, coherent receivers in evolving optical networks are expected to quickly adapt their parameters (e.g., modulation format and bitrate), algorithms (e.g., carrier phase recovery (CPR), timing recovery and equalization) and settings (e.g., resolution of analog-to-digital and digital-to-analog converters (ADC/DAC)) to the changing network status.

The potential of machine learning (ML) in optical networking has recently been showcased in several applications, e.g., modulation format and bitrate identification, quality of transmission (QoT) prediction, and anomaly detection. Furthermore, ML-aided signal processing algorithms have capabilities to elevate the overall performance of the transmission system characterized by limited analog bandwidth, nonlinear noise presence and low DAC/ADC resolution. The latter is especially important as higher order modulation formats (beyond 64QAM) emerge in transponder and transceiver products where power consumption and cost are considerable factors for decision making about the suitable technology and components. To enable that low-end and low-cost optoelectronics can secure the required performance, digital pre-compensation techniques must be emplyed. Hence, this Master project focuses on ML-aided digital pre-compensation algorithm that increases the effective resolution of DAC/ADC devices. In other words, we are aiming at designing a ML framework that helps to overcome low effective number of bits (ENOB) and distortions (quantization noise) induced by its pre-compensation methods as well as to conduct measurements in our laboratory for experimental validation of the newly proposed scheme.

Time line

Block 1 (CW 36/2019 - 41/2019):
Laboratory introduction, getting familiar with the theoretical and technical background, performing first measurements and simulations
Thesis: Preparing the template, writing introduction and acknowledgements

Block 2 (CW 42/2019 - 51/2019):
Analysis and interpretation of the first data which will guide the next measurements, presentation of the progress on the half time meeting
Thesis: Writing theory and describing the applied methods, implementation of the first analysis

Block 3 (CW 1/2020 - 9/2020):
Performing further measurements to gather some final data, analysis and visualization of these measurements
Thesis: Writing results and drawing conclusions

Block 4 (CW 9/2019 - 18/2020):
Analysis and implementation of the final data
Thesis: Writing outlook and abstract, correction readings, final polish and hand-in