# ADVANCED DIGITAL SIGNAL PROCESSING IN HIGH-SPEED OPTICAL COMMUNICATIONS

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The continuous emergence of new bandwidth consuming services and applications, such as high-definition video and cloud computing, has been causing a steady traffic growth of approximately 30%-50% per year, thus putting a huge pressure into the Internet's enabling engine – optical core networks. In order to meet the bandwidth demands for the next decade, per-channel bit-rates above 100 Gb/s are required, reaching an aggregate multi-channel bandwidth of several Tb/s. These very ambitious requirements have triggered the rise of a new transmission/detection paradigm with the aim to optimize the bandwidth efficiency of long-haul optical fiber communications. Resembling the past evolution of radio-frequency-based communications (but with ~1000x higher bitrates and transmission distances), we are now witnessing the arrival of a digital revolution into fiber optic systems, powered by the adoption of multi-level signal modulation associated with coherent detection and very high-speed digital signal processing (DSP). In this new context, DSP has taken a prominent role, mostly at the receiver-side, simultaneously enabling and being potentiated by coherent detection. Indeed, taking profit of an almost lossless digitalization process, post-detection DSP enables to digitally equalize signal distortions caused by fiber propagation.

Under this topic, we have recently developed an efficient nonlinear compensator based on the Volterra series representation, a fast polarization demultiplexer and a polarization dependent losses compensator using the Stokes space formalism. As an illustrative example of the relevance of DSP post-processing, the constellation diagrams of a received and processed dually-polarized 16-quadrature amplitude modulation (DP-16QAM) signal are shown in Figure 1. Without post-detection DSP, the received signals are clearly meaningless, rendering the communication unfeasible. After DSP equalization and carrier recovery, the obtained constellations enable to successfully decode the transmitted information, guaranteeing an error free communication.

Envisioning real-time signal processing, we are currently working on the hardware implementation of the developed methods and algorithms.

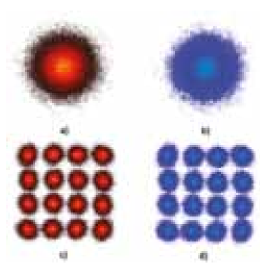

**FIGURE 1**
Constellation diagrams of a DP-16QAM signal before and after DSP. a), b) received signal constellations in the x/y polarization modes; c), d) signal constellations in the x/y polarization modes after DSP, including static linear and nonlinear equalization, dynamic linear equalization and carrier recovery.