Experimental Comparison of Probabilistic Shaping Methods for Unrepeated Fiber Transmission - DTU Orbit (30/10/2017)

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This paper studies the impact of probabilistic shaping on effective signal-to-noise ratios (SNRs) and achievable information rates (AIRs) in a back-to-back configuration and in unrepeated nonlinear fiber transmissions. For back-to-back, various shaped quadrature amplitude modulation (QAM) distributions are found to have the same implementation penalty as uniform input. By demonstrating in transmission experiments that shaped QAM input leads to lower effective SNR than uniform input at a fixed average launch power, we experimentally confirm that shaping enhances the fiber nonlinearities. However, shaping is ultimately found to increase the AIR, which is the most relevant figure of merit as it is directly related to spectral efficiency. In a detailed study of these shaping gains for the nonlinear fiber channel, four strategies for optimizing QAM input distributions are evaluated and experimentally compared in wavelength division multiplexing (WDM) systems. The first shaping scheme generates a Maxwell-Boltzmann (MB) distribution based on a linear additive white Gaussian noise channel. The second strategy uses the Blahut-Arimoto algorithm to optimize an unconstrained QAM distribution for a split-step Fourier method based channel model. In the third and fourth approach, MB-shaped QAM and unconstrained QAM are optimized via the enhanced Gaussian noise (EGN) model. Although the absolute shaping gains are found to be relatively small, the relative improvements by EGN-optimized unconstrained distributions over linear AWGN optimized MB distributions are up to 59%. This general behavior is observed in 9-channel and fully loaded WDM experiments.

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