Associative Professorship of Line Transmission Technology
TUM Department of Electrical and Computer Engineering
Technical University of Munich

Master's Thesis

Quasi-Linear Multiplexing in NFDM Systems with Purely Discrete Nonlinear Spectrum

As the achievable rates of modern transmission systems seem to saturate, while the bandwidth demand is steadily growing, it is necessary to consider alternative approaches for fiber optic data transmission. In recent years, many publications have explored possibilities to overcome the phenomenon, commonly known as 'capacity crunch', by using the nonlinear Fourier transform (NFT).

In a special case of nonlinear frequency division multiplexing (NFDM) only discrete eigenvalues of the Zakharov-Shabat-system are used for multiplexing data streams in the nonlinear Fourier domain. While, at first, this seems appealing, because the resulting signal pulses are N-soliton breathers and thus are not affected by chromatic dispersion in the same way as e.g. wave division multiplexing (WDM) signals, the time-bandwidth product of such pulses is rather high when compared to pulses used in WDM systems. This results in a low modulation efficiency for such discrete nonlinear spectrum NFDM systems.

One possible option to increase the spectral efficiency of the previously mentioned NFDM systems is to extend the modulated linear frequency range by linearly multiplexing such NFDM signals in a WDM fashion. Since the transformations used in NFDM systems are quite involved, it is not clear what the analog of this in nonlinear domain would be.

The task of the student would be to first get familiar with the necessary preliminaries regarding NFDM systems. Subsequently, the simulation of the system described above has to be implemented (certain parts of the system will be made available to the student by the supervisor) and evaluated in terms of some performance metrics.

While specific literature will be recommended to the student over the course of the thesis, some basic literature discussing the 'capacity peak' of WDM modulated optical fiber systems [1] and the basics of the nonlinear Fourier transform (NFT) [2-4], which is a central concept in NFDM systems, are given below. Note that, since NFDM is a very broad topic it is not necessary to fully understand every notion in [1-4]. Nonetheless, these publications give the reader a solid foundation for the further study of this topic.

[1] Essiambre, René-Jean, et al. "Capacity limits of optical fiber networks."

[2] Yousefi, Mansoor I., and Frank R. Kschischang. "Information transmission using the nonlinear Fourier transform, Part I: Mathematical tools."

[3] Yousefi, Mansoor I., and Frank R. Kschischang. "Information transmission using the nonlinear Fourier transform, Part II: Numerical methods."

[4] Yousefi, Mansoor I., and Frank R. Kschischang. "Information transmission using the nonlinear Fourier transform, Part III: Spectrum modulation."

Prerequisites

Having listened to the lecture 'Optical Communication Systems' by professor Hanik (or any comparable lecture on fiber optic systems) is highly beneficial.

Basic Matlab skills (and programming skills in general) are also beneficial.

Regarding the NFDM part of the thesis no prior knowledge is assumed.

Advisors

Benedikt Leible