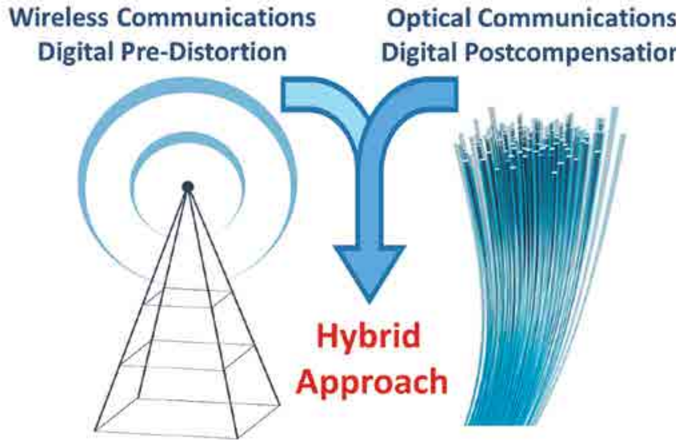
Volterra Analysis for Dynamic Optical Networks Compensation

The teams from Wireless Circuits and Optical Communications developed an efficient way to compensate signal degradation in fibre. It was found out that wireless digital predistortion techniques cannot deal with fibre linear dispersion, however if DPD were used in conjunction with digital backpropagation techniques, better compensation results could be obtained while reducing of computational cost.



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Indicators	
Funding	37k €
Journal Papers	1
Conference Papers	1
Two Main Publications	

J.P.F. Gonçalves, C. M. Martins, F. P. Guiomar, T.R. Cunha, J. C. Pedro, A. N. Pinto, P.M. Lavrador, Nonlinear compensation with DBP aided by memory polynomial, "Optics Express", Vol. 24, No. 26, pp. 30309 - 30316, December, 2016.

J.P.F. Gonçalves, P.M. Lavrador, F. P. Guiomar, A. N. Pinto, T.R. Cunha, J. C. Pedro, Nonlinear Behavioral Modeling Equalization Techniques for Optical Transmission Systems, "10th Conference on Telecommunications Conftele", Aveiro, Portugal, Vol. 1, pp. 1 - 3, September, 2015.

PROJECT WEBPAGE URL
https://www.it.pt/Projects/Index/2039

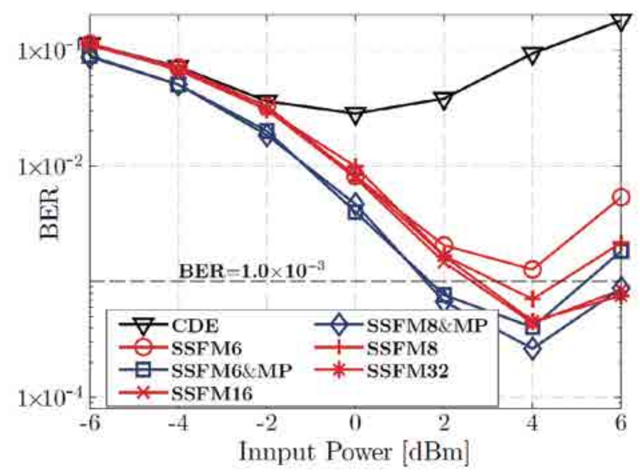

Fig. 1 BER improvement as a function of input power for DBP-SSFM (red curves) and DBP-SSFM aided with Memory Polynomial (blue curves) for a total link length of 800 Km.

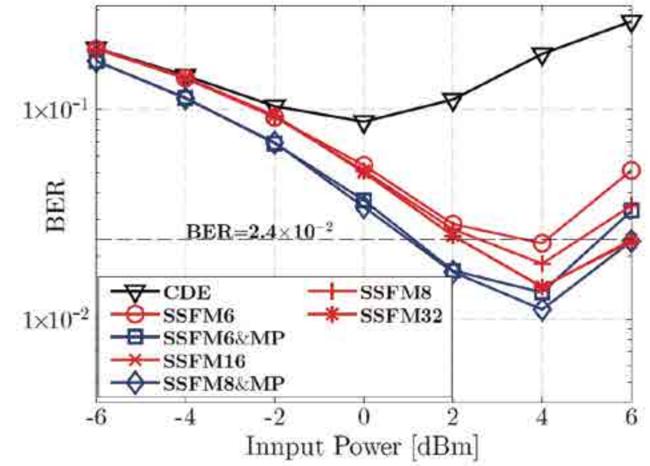

Fig. 2 BER improvement as a function of input power for DBP-SSFM (red curves) and DBP-SSFM aided with Memory Polynomial (blue curves) for a total link length of 1600 Km

GENERAL MOTIVATION AND OBJECTIVES

The first aim of this project was to create a bridge between two different working groups and knowledge areas: the Wireless Circuits and Systems and Optical Communications and Photonics.

In the wireless communications scenario, especially in mobile communications, there is a strong pressure to optimize the energy efficiency of the transmitters, in order to maximize their battery lifetime. However, the spectral cost and mask limitations impose linear transmission specifications to increase the communications rates and the spectral efficiency. The compromise between energy efficiency and linearity led, over the years, to the development of a wide variety of solutions to increase them both simultaneously. Among the solutions developed is the digital predistortion using black box modeling to represent the nonlinear power amplifier (PA) operation or directly to implement its inverse nonlinear response to achieve, this way, a precompensation of the transmitter impairments.

On the other hand, although optical communications are taking the first steps in this nonlinear system compensation new and challenging field, a significant amount of work has been recently developed in equalization and postcompensation of fiber optics impairments to improve the communications quality and to increase the communication distances.

CHALLENGE

The main challenges that were addressed in this project could be divided into two distinct categories: The first one was the definition of a modelling procedure for the communications channel that allowed its postcompensation. In this activity one should consider as a starting point the physical model provided by the Volterra Series Transfer Function, and study the inclusion of some black box terms that can improve its performance by introducing the possibility to be adapted according to slight variations in the system to be modelled. The second challenge of this project dealt with practical details associated with the implementation of such systems in real pre/postcompensation scenarios. The advantages and disadvantages of time versus frequency domain implementations of different algorithms were studied, and so the computational complexity and cost was assessed for each model considering the selected implementation.

In this project a behavioural approach, and linear optimization techniques were used in addition to a physics based model, to improve the approximation (and so, the postcompensation) capabilities of the physics based Volterra Series Transfer Function.

WORK DESCRIPTION AND ACHIEVEMENTS

By cascading a nonlinear MP model equalizer and DBP-SSFM, we have proposed a new approach for nonlinearity compensation in optical transmission systems. For the particular case of a single-channel transmission system (336 GB/S PM-64QAM), we have demonstrated that the combination DBP-SSFM&MP outperforms the conventional DBP-SSFM, enabling a significant reduction in the number of iterations to obtain a similar performance. The comparison of computational complexity between the two approaches reveals an extensive gain reduction – in terms of computational cost – for DBP-SSFM&MP with respect to DBP-SSFM, over 45%. The obtained results, presented in Fig. 1 and 2 for link lengths of 800Km and 1600Km respectively, indicate that the combination of MP with DBP is a promising approach to reduce the complexity associated with DBP-based techniques.