System-Aware Digital Signal Processing in Optical Communications

Manuel Neves[1], Abel Lorences-Riesgo[2], Paulo Monteiro[1], Fernando Guiomar[1]

1 – Department of Electronics, Telecommunications and Informatics & IT, University of Aveiro
2 –Optical Communication Technology Laboratory, Paris Research Center, Huawei Technologies France.

The average internet user does not often come across optical fibers, and thus naturally does not acknowledge their crucial role in our beloved internet. Optical fibers are indeed the backbone of internet systems, counting several millions kilometers laid around the globe. Making use of digital signal processing techniques, we can efficiently transmit information between any two arbitrary locations in the world.

Even though optical communications have initially taken a lot of knowledge and techniques from well-established radio-frequency communication theory, the restless demand for higher internet capacity, and subsequent interest in maximizing the communication rate per optical fiber cable, has brought to light some very own impairments specific to this domain. In this article, we report the invention of a carrier-phase recovery (CPR) algorithm tailored to the optical fiber channel [1]. This innovative algorithm has been initially developed within the scope of an MSc thesis, leading to the publication of an article in the prestigious IEEE Journal of Lightwave Technology and also a PCT patent application (pending approval). Instigated by the practical benefits of the proposed CPR method for high-capacity optical fiber systems, this work has also captured the attention of major industrial players, ultimately leading to a collaboration between Instituto de Telecomunicações (IT) and Huawei Technologies France. In this collaboration, a dedicated experimental campaign has been carried out, leading to a highly scored publication in the top European conference in the field [2,3].

This work, which has been developed within the Optical Communication Systems and Networking research group of IT, is part of a broader research line that encompasses multiple innovative contributions on different aspects of advanced digital signal processing, modulation and coding for Terabit-capacity modern optical communication systems, leading to an effective transfer of knowledge between the academic and industrial realities, being these achievements greatly supported by the Optical Radio Convergence Infrastructure for Communications and Power Delivering infrastructure (ORCIP).

FIGURE 1
Illustrative figure showcasing a communication-systems constellation before and after the correction of the laser phase noise impairment, through the usage of the developed technique..

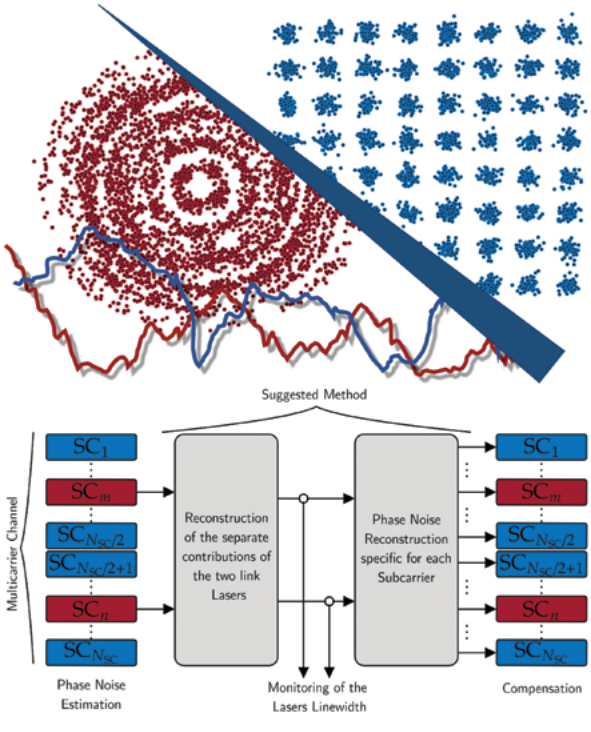

FIGURE 2
High-level diagram of the technique developed. SC stands for subcarrier, and NSC for the number of subcarriers of the considered system.

[1] M. S. Neves, P. P. Monteiro and F. P. Guiomar, "Enhanced Phase Estimation for Long-Haul Multi-Carrier Systems Using a Dual-Reference Subcarrier Approach," in Journal of Lightwave Technology, vol. 39, no. 9, pp. 2714-2724, 1 May1, 2021.
[2] C. S. Martins et al., "Maximizing the Performance of Digital Multi-Carrier Systems with Transmission-Aware Joint Carrier Phase Recovery," 2021 European Conference on Optical Communication (ECOC), 2021, Paper Tu4C2.6.
[3] M. S. Neves et al., "Leveraging Dispersion-Aware Phase Recovery for Long-Haul Digital Multi-Carrier Transmission: An Experimental Demonstration," in Journal of Lightwave Technology (Early Access).