IMPACT OF PERIODIC GAIN EQUALIZATION IN PRESENCE OF STIMULATED RAMAN SCATTERING

Chiara Lasagni*, Paolo Serena, Alberto Bononi

Department of Engineering and Architecture, University of Parma, Parma, Italy
**chiara.lasagni@unipr.it*

We investigate the impact of periodic equalization of inter-channel stimulated Raman scattering on the nonlinear interference variance by exploiting a modified Raman-aware EGN model.
Keywords: Stimulated Raman Scattering, GN model.

1. Introduction

Inter-channel stimulated Raman scattering (ISRS) is a wideband nonlinear effect for which higher frequencies are depleted while amplifying lower frequencies, yielding a tilted signal power profile. This nonlinear process was recently included in the Gaussian noise (GN) model [1] thus enabling the estimation of the nonlinear interference (NLI) variance in wideband optical communication systems.
In [2] we included the ISRS into the enhanced Gaussian noise (EGN) model accounting also for the modulation format dependency of the NLI.
The tilt on the signal profile can be equalized through a dynamic gain equalizer (DGE). However, this equalization process cannot cope with the distributed interaction between the nonlinear Kerr effects and the ISRS. Hence, at the receiver side, an ISRS-induced tilt remains.
The model proposed in [2] relies on the assumption that the signal power is frequency-flat at the beginning of each span, i.e., a DGE is placed after each span. Such an assumption is unrealistic in current optical communication systems and is addressed by parameters fitting in [1].
In this work, we modified the Raman-aware EGN model [2] to account for the NLI generation due to a signal power which has an accumulated ISRS-induced tilt because of a reduced number of DGE in the link. We exploited this model to investigate the impact of the signal power equalization period along the link length on the NLI variance in presence of ISRS.

2. DGE period impact

We considered polarization division multiplexing (PDM) signals modulated by 64 quadrature amplitude modulation (64QAM) with symbol rate 49 Gbaud. We focused on wavelength division multiplexing (WDM) transmissions with channel spacing 50 GHz over a 10×100 km single mode fiber (SMF) link with Raman gain slope $C_r = 0.028$ 1/(THz·W·km).
We investigated the impact of the DGE period in terms of number of spans for an increasing WDM bandwidth up to 10 THz. The channel power was fixed to 1 dBm. We measured the ISRS-induced tilt in dB on the NLI variance as the difference between the NLI affecting the two edge WDM channels.
In Fig.1 we reported the NLI tilt as a function of the WDM bandwidth for different link topologies, where a DGE is placed every 1,2,3 and 4 spans respectively, as well as at the receiver. The results show that the period of the DGE has a non-negligible impact on the NLI tilt, being more severe for wider bandwidths where the ISRS-induced power transfer increases. Contrary to the tilt on the signal power which, in a dB scale, accumulates linearly with the number of spans before equalization, the NLI tilt cannot be predicted through this simple scaling rule due to its distributed interaction with ISRS, as shown in the inset of Fig. 1 for the 7.5 THz bandwidth case. Hence, the link equalization period must be included in the model to correctly capture the ISRS effects on the NLI.
Due to space constraints, more results will be discussed during the presentation.

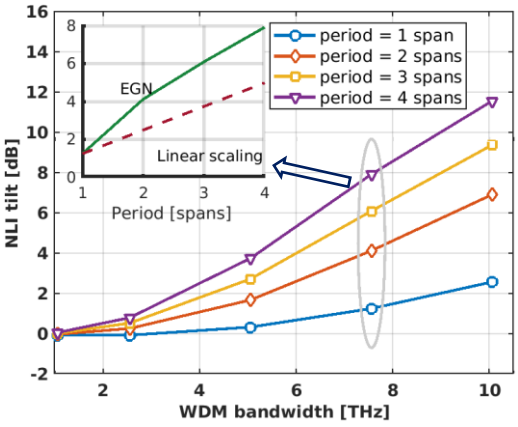

Fig. 1. NLI tilt vs total bandwidth for different link topologies (main section) and vs the DGE period for the 7.5 THz scenario (inset).

3. Conclusions

We extended a Raman-aware EGN model to include periodic dynamic gain equalizers for the compensation of the stimulated Raman scattering effects on the signal power. Our results show that the equalizer period has a non-negligible impact on the NLI variance.

References

1. Semrau D., Killey R.I., and Bayvel P., *J. Lighw. Technol.*, **37**, 1924 – 1936 (2019).
2. Lasagni C., Serena P., and Bononi A., *Proc. ECOC19*, Ireland, W.1.D2, (2019).