"Design of optical networks using elastic transponders”

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The advent of coherent detection improved by electronic post processing has paved the way to elastic optical transponders (EOT). One of the profitable utilizations of EOTs consists in possibly tuning their data rate with respect to the quality of the light path they bridge [1] and also to the ageing of the connection.

When an optical network is planned (either when building a new one, or for its upgrade, i.e. consisting of adding new services) optical line margins on the estimated optical signal-to-noise ratio (OSNR) are mandatory to insure the unobstructed service during the life of the network. However, when too large, line margins can significantly shorten the transmission reach of the WDM channels. Operators like France Telecom [2], and British Telecom [3] have shown interest in how to account for margins and the possibilities of using them to increase the total achieved distance and/or to increase the throughput of the link, that is, how to reduce the cost per bit.
We can distinguish three types of link margins: unallocated, design and system margins [2]. Unallocated margins are unwanted by-products of the system design and appear when the transponder’s reach exceeds the covered transmission distance and/or when the transponder’s capacity exceeds the service demand. One of the solutions for overcoming this limitation is by using EOTs which provide the flexibility to adjust baud rate, modulation format and/or channel spacing [4] and to translate these unallocated margins into better spectral efficiency leaving more spectral resources for future connections. Design margins are also seen as unwanted by-products of system design and are unlike the unallocated margins, unknown prior to field installations. They appear as a result of the uncertainties of physical parameters used as the input for quality of transmission (QoT) estimator and of its own uncertainties. The solution for overcoming this limitation lies in real time light path monitoring linked to control plane. System margins are on the other hand margins voluntarily added to ensure reliable service, resistant to various factors like equipment ageing, fast time varying penalties and impairments of non-linear effects of WDM transmission.

The goal of this talk is to assess the possible benefit for WDM network operators when dynamically fitting the modulation of their already deployed EOTs or of their new installed ones with respect to the ageing of their networks. This study assumes that the corresponding ageing margins can be tracked, either thanks to a fine modeling and/or by means of global QoT monitoring if the network is already deployed.

[1] A. Dupas *et al*., “Real-time demonstration of software-defined elastic interface for flexgrid networks,” Paper M3A.2, OFC'2015.
[2] J. L. Augé, “Can we use flexible transponders to reduce margins?” OFC/NFOEC, Paper OTu2A.1, 2013.
[3] A. Mitra *et al.*, “Effect of link margin and frequency granularity on the performance of a flexgrid optical network,” Opt. Express 22, 2014.
[4] Y. R. Zhou *et al*.,“1.4 Tb Real-time alien superchannel transport demonstration over 410 Km installed fiber link using software reconfigurable DP-16QAM/QPSK, Optical Fiber Communication Conference, Paper Th5A.9, San Francisco, CA, USA, 2014