Operating a Network Close to the "Zero Margin" Regime Thanks to Elastic Devices

Jelena Pesic* and Annalisa Morea
** Alcatel-Lucent Bell Labs France, 91620 Nozay, France*
Alcatel-Lucent Italia, 20871 Vimercate, Italy
e-mail: jelena.pesic@alcatel-lucent.com

ABSTRACT
Despite of recent progress in research on the subject of modernisation and automation of networks, most legacy optical networks still operate statically: when a connection has been set-up it is rarely reconfigured. Exception occurs in a case of a node/link failure: in that case reconfigurations concern only the traffic with a specific class of service (CoS) where a given resiliency has to be ensured. When network reconfigurations are needed, the newly set up connection has to be promptly operational, independently of the actual network state.

To ensure the fast set up of a connection, it is mandatory to have physical estimators defining the feasibility of a connection depending on the state of the network: the capacity and placement of neighbouring channels, the degradations of the network components due to aging, statistical penalties, etc... In order to guarantee the operational set up of a connection all the time, today various margins are introduced to ensure reliable network operation [1]. Firstly, system margins include transponder and fiber ageing as well as polarization dependent loss (PDL) and non-linear impairments (NLI); secondly, design margins are due to the uncertain knowledge of the physical characteristics of the system devices and predictor tool inaccuracies; and finally, unallocated margins as a by-product of network traffic demand heterogeneity in reach and capacity associated with a chosen data rate [2]. All these margins in total can attain 6 dB [3].

In the future, due to cloud computing, high data rate multimedia and the higher distribution of data centers, increasingly large data transfers are forecast placing new requirements and challenges on backbone networks relative to their dynamic nature. Because of this dynamic nature, it is possible to avoid some margins (system and unallocated margins, called operation margins in the following), by collecting information on the physical state of networks using real time optical performance monitoring. Thanks to coherent receivers, much information on the state of the network can be provided directly by the transponder, and no longer by special monitoring devices. Moreover, thanks to digital signal processing (DSP) enabled by advanced programmable digital-to-analog convertors (DAC), a transponder can dynamically adapt its capacity, adapting its modulation format/symbol rate/code correction as a function of the physical degradation on a given path.

In this paper, we show how such flexible transponders can be used to reduce operation margins at the beginning of life (BoL) of a network leading to lower network costs. During the network's life, adaptation to network degradations will be performed only when and where it is necessary. Finally, we estimate the total cost of a backbone network during its life cycle and we show the possible savings obtained by operating close to the "zero margin" regime when compared with the legacy network operation, where all margins are considered at the BoL.

Keywords: CapEx savings, optical margin, flexible transponders, adaptive modulation.

REFERENCES

[1] J.-L. Auge, "Can we use flexible transponders to reduce margins?" in *Proc. OFC 2013*, paper OTu2A.1.
[2] O. Rival, "Upgrading optical networks with elastic transponders," in *Proc. ECOC 2012*, paper P5.12.
[3] A. Morea, "Contribution à l'étude des réseaux optiques translucides : Évaluation de leur faisabilité technique et de leur intérêt économique," Ph.D. Thesis, Telecom Paris, France, 2006.