Unbundling the optical access with WDM-PONs

Diego Tuzi, Guido Maier
Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB)
Politecnico di Milano
Milan, Italy
diegotuzi@gmail.com, guido.maier@polimi.it

Abstract

Several different types of bandwidth-hungry applications and services, including multimedia-oriented applications as high-definition television, are rapidly being deployed in the access network. Hence, telecommunication operators are urged to upgrade their access networks to provide broader bandwidth to their subscribers [1]. This growing demand of bandwidth requires the deployment of a new optical access network: a challenging process under both technical and economic perspective. Independently of which operator will sustain most of the costs (still an open issue in many countries) the main question is how to ensure an effective cost sharing of the physical infrastructure by multiple operators. In the presence of an incumbent operator (which is the Italian case, for instance) such cost sharing is mandatory and regulated and is called Unbundling in the Local Loop (ULL). This paper proposes a technique to perform ULL when Passive Optical Networks (PONs) are deployed in the access.

This work is funded by the ROAD-NGN project [2], which investigates unbundling solutions for three different types of PONs, namely: WDM PONs, PONs based on electronic OFDM, PONs based on optical OFDM. We will focus on WDM PONs, only. The main feature of our proposal is to be fully standard-compliant as for the technology adopted by each operator. In particular, transmission technologies based upon last PON's standards XG-GPON [3] and NG-PON2 [4] are encompassed. Unbundling is achieved by assigning each operator different slices of the optical fiber spectrum. That implies giving up full compatibility with legacy PON standards, such as GPON, BPON, etc. Within ROAD-NGN this is not a big issue, being the project more oriented to greenfield rather than brownfield scenarios. ROAD-NGN will include in fact a case-study activity to design the new optical access network of the historical downtown L'Aquila, which still is to be rebuilt after the destructive earthquake of April 6th, 2009.

The unbundling proposals presented in this document, consists of three steps. In the first step, the optical spectrum of a PON, from 1200 to 1600 nm, is characterized, deriving a wavelength-dependent impairment-cost function. A cost proportional to the total impairment is calculated for each wavelength, taking into account (in terms of equivalent impairments) attenuation, chromatic dispersion and receiver sensitivity. By the second step, the total optical spectrum is partitioning in slots, referring to different standard partitions such as CDWM-grid [5] and different types of DWDM-grid [6]. In the third step slots are assigned to the operators involved in the ULL by solving an optimization problem.

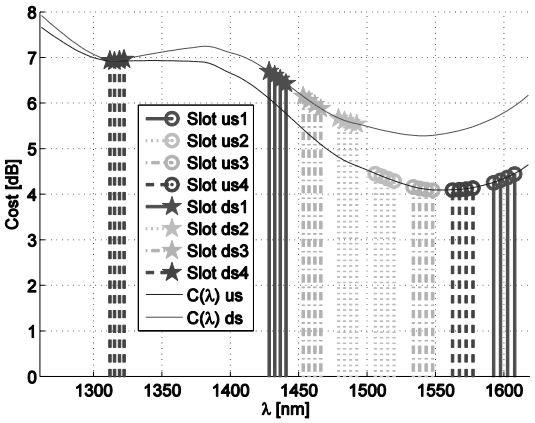

Fig. 1. PON-greenfield scenario in which four operators request two bundles of four wavelengths each, to satisfy the NG-PON2 requirements. Example of solution to the problem of optimum wavelength assignemt.

In the full paper, multiple formulations will be proposed, differing in the objective function to be optimized (e.g. minimization of total cost, maximization of fairness between operators, etc.). Several dimensioning results will then be presented and discussed. Fig. 1 shows a sample solution in a particular scenario: four wavelength channels per slot are assigned in unbundling to four operators in the up- and down-stream directions, minimizing the total (cost of) impairments.

References

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