

## Foreword

# Modeling and simulation in optical networks design

This special issue illustrates the emergence of a new technical field which merges various skills and cultures, cross-linking the optical network community, digital communications community and physical scientists concerned both by transmission networks and new devices and functions for telecommunication applications. This new topic is highly multidisciplinary by nature and is only now taking its first steps. This special issue illustrates this double trend.

The best proof of such an emergence is the success of the STREON workshop (Brest, France, October 2005) organized within the European network of Excellence ePhoton One. This symposium was the place for scientists (academic and industrial) to look over disciplinary fences and think across network layers and work-packages. It provided an opportunity for some simulation tool developers (freeware or commercial/private) to demonstrate new developments and models in their software, and to benefit in return from this first attempt at cross-fertilization. This special issue illustrates some of the topics tackled by this first initiative.

For more than ten years, suitable technologies and architectures for all-optical networks have been a topic of intense research dealing with issues such as: optical transmission at the physical layer, optically transparent network areas, protection and restoration schemes, multiple switching granularity (i.e. WDM and OTDM) and inter-networking between transport and control layers. The control plane is a particularly important element as it manages the state of the network and establishes flexible end-to-end connections. To maximize the breadth of the all-optical domains, the control plane must be capable of managing the constraints due to optical channels (supra- and sub-wavelength). These mainly include routing and resource-based constraints as well as optical transmission impairments.

While optical WDM transmission has been shown to be so efficient and cost-effective in long-haul links, that is today the unique technology in this application field, the situation is different in metro and access networks, where the unpredictable nature of traffic demands as well as more stringent economics and competing technologies have precluded wide-scale deployment of optics in these areas.

In this framework, the design of building blocks for optical networks (because field tests are too expensive and quite unpredictable due to the large number of parameters to be considered) has reached a stage at which smart software simulation has become a necessity, from the lower-level description (e.g. link budget) to higher-level network concepts such as Quality of Service. At the moment two types of simulation tool are considered: network-oriented simulation tools (NOST), for which the physical medium is abstracted to a simple parameter set, and photonics-oriented simulation tools (POST), focusing primarily on the physical layer, with reduced reference to logical topology, protocol or QoS, but evolutions are predicted in such an emerging field. POST can also be divided into two categories, some of them being focused on the components and devices, the others on the systems: the input parameters are not the same.

Another development level is related to the quality/price tradeoff for a particular application. One may consider freeware tools, developed by Universities or National Institutes (many NOSTs) or a commercial tool, providing a higher degree of technical and modeling assistance (most of the POSTs). A third category is the wide range of in-house software (confidential but potentially very powerful) that has been developed by companies to meet their own requirements. Finally, a very attractive characteristic shared by several simulation packages is that they can be particularly effective in education within the optical transmission and networking fields, as experienced by several academic teaching institutions.

About this special issue, several viewpoints and perspectives are given illustrating the richness and variety of approaches and potential application fields, as well as the clear benefits obtained from interaction between technical communities (physics, software etc.).

A first series of papers (belonging to the POST category) addresses the modelling of physical transmission aspects or/and fibre impairments such as the first paper by Xuefeng Tang and Zongyan Wu on "*WDM transmissions exploiting optical phase conjugation*", and the second by Pierluigi Poggiolini and Gabriella Bosco on the "*Impact of chromatic dispersion on DPSK and DQPSK direct-detection optical systems*".

A second category of papers concerns the design of WDM systems and networks with a third paper by Irène Joindot and Michel Joindot dealing with the "*Impact of cascaded filters based OADMs in an all optical backbone network*" and the fourth paper by Ioannis Tomkos, Anna Tzanakaki, Prasad Kulkarni, George Markidis and Carmen Mas Machuca, on the "*Benefits of the use of impairment constraint routing in optical networks*".

A third series addresses rather architectural aspects (belonging to the NOST category) with a fifth paper by Siamak Azoldolmolky, Anna Tzanakaki and Ioannis Tomkos on "*A simulation study of adaptive burst assembly algorithms in optical burst switched networks with self-similar traffic sources*" and a sixth by Jérémie Jauffrit, Bruno Fracasso, Michel Morvan and Daniel Betoule, on "*Performance evaluation of a WDM metropolitan network: a virtual prototyping approach.*" To conclude with a seventh paper by Guray Gurel, Onur Alparslan and Ezhan Karasan on "*NOBS: with*

*an ns2 based simulation tool for performance evaluation of TCP traffic in OBS networks.*"

Finally, a paper by Mustapha Razzak and Habib Hamam, entitled "A web-based user friendly simulator of optical fiber communication systems", describes a free optical transmission simulator running over Java Virtual Machine, and a last one entitled "Simulation of integrated optic devices based on BPM" by Lara Pellegrino, Teresa Vieira, Antonio Teixeira, Paulo André and Paulo Monteiro presents some simulations of integrated optic devices based on beam propagation methods for educational and research purposes.

Editors would like to thank Fabio Neri for accepting to give a short presentation of the ePhotonONE Network of Excellence in which most contributors to this issue are participants.

We hope that this very rich special issue will convince readers to contribute to this new emerging field which will greatly benefit from large multidisciplinary contributions. We also sincerely thank the experts who have accepted to review these papers over a very short lapse of time and therefore contribute to their high quality.

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