Computer Networks Journal
Special Issue on: *"Challenges and opportunities in advanced optical networking"*

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Guest Editorial

Optical communication systems and networks will continue to play a significant role in the development and deployment of emerging network infrastructures. These networks are expected to support the diverse requirements of a broad range of existing and future applications. To accommodate this wide spectrum of applications, network infrastructures are evolving rapidly in terms of technology and architecture towards a more flexible and intelligent optical layer based on Dense Wavelength Division Multiplexing (DWDM) that utilizes new optical switching architectures and technologies as well as advanced control and management protocols. Optical component technology is rapidly maturing, offering cost-effective solutions to a point where optical networks are currently being deployed in core backbone networks, and are gaining increased interest for deployment in metro and access environments. The widespread deployment of optical communication systems and networks introduces many challenges and opportunities, which this special issue aims to address.

This special issue is supported by the COST 291 action, TDON: "Towards Digital Optical Networks". The main goal of this special issue is to identify the key future optical networking technologies and solutions necessary to support a variety of existing and novel applications in a cost effective manner. Therefore, this special issue aims at providing a forum for researchers in academia and industry to present and discuss the challenges and possible solutions, potential new opportunities as well as emerging standards, for the development, deployment, and application of optical networks. In this context this special issue includes papers dealing with topics related to optical networking for traditional telecommunications applications such as network and node design, traffic modeling and routing, network management, control and signaling, etc. but also papers addressing optical network solutions suitable to support new applications and services such as storage networks, global grid computing, disaster recovery, etc.

This special issue includes two invited contributions from recognized experts in the field, as well as 15 peer-reviewed research papers accepted out of 45 papers submitted to the open call.

From the two invited papers, that authored by Dr. Haruhisa Ichikawa introduces a candidate possibility for a post-IP network called "appliance defined ubiquitous network (ADUN)", which supports niche ubiquitous network applications for affordable implementation. The paper discusses the direction for the functional enhancement of an optical network architecture using wavelengths dynamically for Grid computing so as to support the ADUN.

The other invited paper is a tutorial-like paper describing recent research activities and results in the area of photonic switching carried out within the Virtual Department on Switching (VDS) of the European e-Photon/ONe Network of Excellence. Contributions from outstanding European research groups in this field are collected to offer a platform for future research in optical switching. The paper addresses the main topics related to network scenarios, switch architectures and experiments, with an effort to investigate synergies and challenging opportunities for collaboration and integration of research expertise in the field.

With regards to the 15 regular papers, they cover a wide range of relevant areas including physical layer to control layer proposals, state-of-the-art to novel network architectures, theoretical performance evaluations and experimental results. The contributed papers are organized into 4 main groups and a short summary of each group and paper is provided below.

The first group of 5 papers focuses on different multi-layer problems in ASON/GMPLS optical networks. Yao and Ramamurthy propose in their paper "Rerouting schemes for dynamic traffic grooming in optical WDM networks" to employ a rerouting approach to effectively pack low-rate connections into high-rate light paths. Two rerouting algorithms are proposed and their performance evaluated through computer simulations. The paper entitled "Distributed approaches for impairment-aware routing and wavelength

assignment algorithms in GMPLS networks" by Pavani *et al.* present two different distributed algorithms for establishing light paths taking into account the impairments of the physical layer. A different multi-layer problem is considered in the paper entitled "A Bayesian decision theory approach for the techno-economic analysis of an all-optical router". López *et al.* develop a mathematical framework based on the Bayesian decision theory to decide on either optical or electronic switching a light path in a multi-layer capable router. The paper entitled "A multi-layer network model based on ITU-T G.805" by Dijkstra et al. proposes a model able to solve the path-finding problem in multi-layer networks based on ITU-T G.805 and GMPLS standards. The authors also present a simple formulation to verify the validity of a path establishment traversing multiple layers. The last paper of this group "Advance reservations for service-aware GMPLS-based optical networks" by Escalona *et al.* focuses on the problem of including service-aware connections in GMPLS optical networks. Novel algorithms are compared by computer simulations and experimental implementations validate their applicability.

The second group includes four papers which focus on the resilience problem in ASON/GMPLS optical networks. In the paper "Restoration in all-optical GMPLS networks with limited wavelength conversion", Ruepp *et al.* deal with the problem of restoration in a GMPLS network subject to limited wavelength conversion and show through extensive simulation results that an intelligent wavelength assignment scheme may significantly reduce the number of wavelength converters. In the paper "Intelligent shared-segment protection", Tornatore *et al.* develop a novel intelligent approach for shared segment protection exploiting the knowledge of connection holding time. The proposal presents a clear savings in terms of network resources compared to other solutions. In the paper "Introducing OMS Protection in GMPLS-based optical ring networks" Velasco et al. propose two solutions based on the GMPLS-LMP protocol for dedicated and shared link protection in ring-based optical networks. The validity of the proposals is experimentally evaluated through a proof-of-concept tested. The last paper of this group "DiffServ for differentiated reliability in meshed IP/WDM networks" by Awad et al. provides an exhaustive analysis comparing two different resilient models that offer protection at different layers, namely DiffServ to shield IP traffic and DiffProtect for protection in the optical layer.

Four papers dealing with OBS (Optical Burst-based Switching) technologies compose the third group. The first paper "CoCONet: a collision-free container-based core optical networks" by Mazloom *et al.* proposes a novel architecture named CoCONet consisting of a full mesh network with a central scheduler that handles signaling and scheduling. The data unit consists of containers. In the paper "Route optimization in optical burst switched networks considering the streamline effect", Chen *et al.* focus on improving the performance of OBS networks exploiting the streamline effect in the primary-and backup-path selection. In the paper "CORNet: an OBS metro ring network with QoS support and fairness control", Hui-Tang et al. propose the CORNet architecture. A MAC protocol with fairness control as well as QoS provisioning mechanisms are discussed and evaluated. The last paper "SIP-enabled OBS architectures and protocols for application-aware optical networks" by Zervas *et al.* presents three architecture models that integrate Session Initiation Protocol (SIP) with an OBS network. The authors also provide experimental results in a three-node test-bed to fully validate one of the proposed solutions.

Finally the last group of two papers treats physical layer issues. In the paper "Guideline for amplification of optical packets in WDM environment regarding impact of transient response of erbium-doped fiber amplifiers", Awaji et al. discuss the impairment amplification in WDM transmission and propose a mitigation approach based on a special case of erbium doped fiber that can supplement conventional electrical gain control. Two novel code designs and algorithms for differentiated QoS in OCDMA networks are proposed in the last paper of this special issue "Design of strictly variable-weight optical orthogonal codes for differentiated Quality of Service in optical CDMA networks" by Nasaruddin and Tsujioka.

In summary, this special issue has resulted in a synopsis of the challenges in the development and deployment of novel optical networking concepts and technologies, and the future opportunities emerging in this field.

We believe that the readers of the special issue will enjoy the papers and will appreciate their contribution and quality. At the same time readers should get a perspective on current hot research topics in optical networking and may be stimulated to pursue unsolved issues of significant importance, thus opening new horizons for research.

In closing, we would like to thank the authors for their high-quality contributions to this special issue, as well as all authors that submitted their papers for consideration. We are indebted to our referees for their

professional reviews, which greatly improved the quality of the selected papers. Special thanks go to Dr. Harry Rudin (Editor-in-Chief for the COMNET Special Issues) for his active involvement guidance and encouragement, and to Mrs. Mary Lynn van Dijk (COMNET Journal Manager) for her fruitful and never-ending help, without which this special issue would not be a reality.

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