# 2022 International Conference on Optical Network Design and Modeling (ONDM 2022)

**Warsaw, Poland**
**16 – 19 May 2022**

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# Monday, May 16 9:00 - 11:10

## Mo1: Opening and keynotes

Chair: Teresa Gomes (University of Coimbra & INESC COIMBRA, Portugal)

**9:00** *Opening...N/A*
Jarosław P. Turkiewicz (Warsaw University of Technology & Institute of Telecommunications, Poland)

**9:10** *Keynote: Coherent Technologies for the Edge...N/A*
Dave Welch (Infinera, USA)

**10:10** *Keynote: Towards Multi-Pbps Scale Backbone Optical Networking in Support of Future 6G Access Networks...N/A*
Ioannis Tomkos (University of Patras, Greece)

# Monday, May 16 11:10 - 11:30

## Coffee break

# Monday, May 16 11:30 - 13:00

## Mo2: Machine learning I

Chair: Jose Alberto Hernandez (Universidad Carlos III de Madrid, Spain)

**11:30** *Invited: Optical Networked Systems to Scale-Up and Speed-Up Training of Distributed Deep Learning Models: Architectures, Technologies, and Control...N/A*
Georgios Zervas (University College London, United Kingdom (Great Britain))

**12:00** *On Feature Selection in Short-Term Prediction of Backbone Optical Network Traffic...1*
Aleksandra Knapinska, Katarzyna Poltorak, Dominika Poreba, Jan Miszczyk, Mateusz Daniluk and Krzysztof Walkowiak (Wroclaw University of Science and Technology, Poland)

**12:20** *An ML Approach for Crosstalk-Aware Modulation Format Selection in SDM-EONs...7*
Shrinivas Petale (The George Washington University, USA); Suresh Subramaniam (George Washington University, USA)

**12:40** *If Not Here, There. Explaining Machine Learning Models for Fault Localization in Optical Networks...13*
Oleg Karandin (Politecnico di Milano, Italy); Omran Ayoub (Scuola Universitaria Professionale Della Svizzera Italiana, Switzerland); Francesco Musumeci (Politecnico di Milano, Italy); Yusuke Hirota (National Institute of Information and Communications Technology, Japan); Yoshinari Awaji (National

Institute of Information and Communications Technology (NICT), Japan); Massimo Tornatore (Politecnico di Milano & University of California, Davis, Italy)

# Monday, May 16 13:00 - 14:00

## Lunch break

# Monday, May 16 14:00 - 16:00

## Mo3: Workshop I

Physical layer technologies for decomposed and disaggregated data center, cloud and edge computing platforms
Chairs: Jose Manuel Delgado Mendinueta (National Institute of Information and Communications Technology, Japan), Juan Jose Vegas Olmos (NVIDIA, Denmark)

Networks for datacom and telecom have been decomposed into its key components and they are being disaggregated in order for services and applications to access them seamlessly. Hence, instead of building very heterogenous fabrics, current cloud and edge computing platforms are uniformly stack with clusters of underlying technologies (i.e. memory or processing). This decomposition process is possible thanks to high-capacity and low latency interconnect systems that effectively bridge space and distance, so abstract layers on such individual components can be virtualized.To support this decomposition, there is a body of work in the area of high-speed communications, optical switching, spatial division multiplexing (with embedded switching), frequency comb generators, and novel 2D and 3D co-integration platforms for denser physical layer functionalities integration.

Workshop program:

1. Maximizing capacity in data center interconnects and 6G converged PON and optical fronthaul, using NOMA-CAP, Jose Antonio Lazaro (UPC)
2. Towards a converged computing, networking, and optical solution at the edge, Filippo Cugini (CNIT)
3. Path towards Tbit/s short reach interconnects, Nikolay Ledentsov Jr. (VI-Systems)

# Monday, May 16 16:00 - 16:30

## Coffee break

# Monday, May 16 16:30 - 18:30

## Mo4: Planning I

Chair: Karcius Assis (Federal University of Bahia, Brazil)

**16:30** *Invited: Routed Optical Networking: An Alternative Architecture for IP+Optical Aggregation Networks...16*
Valerio Viscardi ( & Cisco, Italy); Dirk Schroetter (Cisco, USA); Moustafa Kattan (Cisco, United Arab Emirates)

**17:00** *Long-Term Cost-Effectiveness of Metro Networks Exploiting Point-To-Multipoint Transceivers...20*

Mohammad M. Hosseini (Aston University, United Kingdom (Great Britain)); Joao Pedro (Infinera Unipessoal Lda & Instituto de Telecomunicações, Portugal); Antonio Napoli (Infinera, UK); Nelson Costa (Infinera, Portugal); Jaroslaw Prilepsky (Aston University & Aston Institute of Photonic Tehcnologies, United Kingdom (Great Britain)); Sergei K. Turitsyn (Aston University & Photonics Research Group, United Kingdom (Great Britain))

**17:20** *Capacity and Energy Consumption Comparison in Translucent Versus Transparent Multi-Band Designs...26*

Rasoul Sadeghi and Bruno Correia (Politecnico di Torino, Italy); André Souza (Infinera, Portugal); Antonio Napoli (Infinera, Germany); Nelson Costa (Infinera, Portugal); Joao Pedro (Infinera Unipessoal Lda & Instituto de Telecomunicações, Portugal); Vittorio Curri (Politecnico di Torino, Italy)

**17:40** *A Filterless Design with Point-To-Multipoint Transceivers for Cost-Effective and Challenging Metro/Regional Aggregation Topologies...29*

Johan Bäck (Infinera Sweden, Germany); Antonio Napoli (Infinera, Germany); Emilio Riccardi (Telecom Italia Lab, Italy); Marco Quagliotti (Telecom Italia, Italy); Mario Porrega (Infinera, Italy); Joao Pedro (Infinera Unipessoal Lda & Instituto de Telecomunicações, Portugal); Tobias Eriksson (Infinera, Sweden); Fady Masoud (Infinera, Canada); Atul Mathur and Dave Welch (Infinera, USA)

# Tuesday, May 17

## Tuesday, May 17 9:00 - 11:40

## Tu1: Quantum and security

Chair: Konrad Banaszek (University of Warsaw, Poland)

**9:00** *Tutorial: Security Threats in Software Defined Networks...N/A*

Donna O'Shea (Cork Institute of Technology, Ireland)

**10:00** *Invited: Secure Communications in Quantum Networks...N/A*

Eleni Diamanti (UPMC, France)

**10:30** *Invited: Design and Applications of Quantum Secure Networks...N/A*

Emilio Hugues-Salas (University of Bristol, United Kingdom (Great Britain))

**11:00** *Eavesdropping G.652 vs. G.657 Fibres: A Performance Comparison...35*

Stefan Karlsson (Swedich Defence Material Administration, Sweden); Rui Lin (Chalmers University of Technology & Huazhong University of Science and Technology, Sweden); Lena Wosinska and Paolo Monti (Chalmers University of Technology, Sweden)

**11:20** *Quantum Bit Retransmission Using Universal Quantum Copying Machine...38*

Masab Iqbal (Universitat Politècnica de Catalunya, Spain); Luis Velasco (Universitat Politècnica de Catalunya (UPC), Spain); Marc Ruiz (Universitat Politècnica de Catalunya, Spain); Antonio Napoli

(Infinera, Germany); Joao Pedro (Infinera Unipessoal Lda & Instituto de Telecomunicações, Portugal); Nelson Costa (Infinera, Portugal)

# Tuesday, May 17 11:40 - 12:00

## Coffee break

# Tuesday, May 17 12:00 - 13:00

## Tu2: Keynote

Chair: Lena Wosinska (Chalmers University of Technology, Sweden)

**12:00** *Keynote: What Can Be Done to Make Optical Networks More Intelligent?...N/A*
Polina Bayvel (University College London, United Kingdom (Great Britain))

**12:40** *Invited: Towards a Traffic-Optimal Large-Scale Optical Network Topology Design...41*
Ruijie Luo, Robin Matzner, Georgios Zervas and Polina Bayvel (University College London, United Kingdom (Great Britain))

# Tuesday, May 17 13:00 - 14:00

## Lunch break

# Tuesday, May 17 14:00 - 16:00

## Tu3: Workshop II

Are we ready for the Quantum Era? The evolution of the QKD test-beds in the next decade
Chairs: Alberto Gatto (Politecnico di Milano, Italy), Michela Svaluto Svaluto Moreolo (Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), Spain)

In the last decades, the broad interest in photonics quantum technologies has led to several international scientific initiatives, dedicated to the development of new technologies to be employed in the next-generation optical networks. Among the different envisaged applications, quantum key distribution (QKD) has attracted the attention of the scientific community, owing to its potential of sharing information-theoretic secure (ITS) symmetric keys, thanks to the fundamental principles of quantum physics. Unlike digital bits, in fact, quantum states cannot be perfectly copied due to the Heisenberg uncertainty principle, leading to an unconditionally secure information exchange totally immune to any algorithmic cryptoanalysis. QKD is considered a quite mature technology, even though its employment in real networks is still not at hand and its commercialization needs some efforts to reach the operational standard required by mass-production devices.

In such a scenario, test beds and field-trials assume a strategic importance, since they permit to fill the gap between the ideal conditions of table-top experiments and the uncontrolled behavior of real-world environments. Moreover, the complete QKD protocol stack can be tested, leading to the development of intermediate and application layers ready for QKD integration in optical networks. The outcomes of test-beds are essential to reach a deeper knowledge of the quantum technology itself and of the requirements of the next-future commercially available devices, in order to guarantee the mandatory performance and to conceive fully-operative quantum networks.

The workshop aims to present the already deployed QKD test-bed infrastructures, focusing on their peculiarities in terms of involved technology and strategic vision for future implementation. Different architectures will be discussed in view of a widespread adoption of QKD in the already-deployed communication networks and to open a vibrant debate on new challenges and test-bed evolution for the next years.

Workshop program:
14:00 Welcome & Introduction (Alberto Gatto - Michela Svaluto Moreolo)
14:05 Hannes Hübel (AIT Austrian Institute of Technology, Austria) "Deployment of QKD use-cases in the OPENQKD project"
14:25 Diego Lopez (Telefonica, Spain) "MadQCI. The Multiverse Quantum Testbed"
14:45 Paul Wright (British Telecom, UK) "BT's UK QKD System Field Trials"
15:05 Paolo Martelli (Politecnico di Milano, Italy) "PoliQI initiative for a QKD infrastructure in the urban area of Milano"
15:25 Chigo Okonkwo (TuE, The Netherlands) "Building up a National Quantum Communications Infrastructure in the Netherlands"
15:45 Final Panel

# Tuesday, May 17 16:00 - 16:30

## Coffee break

# Tuesday, May 17 16:30 - 17:40

## Tu4: Network resilience

Chair: Joao Pedro (Infinera Unipessoal Lda & Instituto de Telecomunicações, Portugal)

**16:30** *Invited: Efficient Network Traffic Prediction After a Node Failure...44*
   Róża Goścień and Aleksandra Knapinska (Wroclaw University of Science and Technology, Poland)

**17:00** *Disaster-Resilient Network Upgrade...50*
   Ferenc Mogyorósi and Alija Pašić (Budapest University of Technology and Economics, Hungary)

**17:20** *Resources Optimization for a Resilient Time-Shared Optical Network...56*
   Karcius Assis (Federal University of Bahia, Brazil); Romerson Oliveira (University of Bristol & High Performance Networks Group, United Kingdom (Great Britain)); Ekin Arabul and Rui Wang (University of Bristol, United Kingdom (Great Britain)); Raul C. Almeida, Jr (Federal University of Pernambuco, Brazil); Reza Nejabati and Dimitra Simeonidou (University of Bristol, United Kingdom (Great Britain))

# Wednesday, May 18

# Wednesday, May 18 9:00 - 11:00

## We1: Planning II

Chair: Hiroshi Hasegawa (Nagoya University, Japan)

**9:00** *Invited: Towards Regeneration in Flexible Optical Network Planning...59*

Saquib Amjad (Technical University of Munich, Germany); Sai Kireet Patri (ADVA, Germany); Carmen Mas-Machuca (Technical University of Munich, Germany)

**9:30** *Impact of Physical Topology Features on Performance of Optical Backbone Networks...65*

Katsuaki Higashimori (NTT, Japan); Takeru Inoue (NTT Network Innovation Labs., Japan); Takafumi Tanaka (NTT, Japan); Fumikazu Inuzuka (NTT Corporation, Japan); Takuya Ohara (NTT, Japan)

**9:50** *Adaptive Multi-Path SnF Scheduling Method for Delay-Sensitive Transfers Across Inter-Datacenter Optical Networks...71*

Xiao Lin and Shuo Ji (Fuzhou University, China); Shengnan Yue (Shanghai Jiao Tong University, China); Jun Li (Soochow University, China); Weiqiang Sun (Shanghai Jiaotong University, China); Weisheng Hu (Shanghai Jiao Tong University, China)

**10:10** *Ultra-Fast Optical Network Throughput Prediction Using Graph Neural Networks...77*

Robin Matzner, Ruijie Luo, Georgios Zervas and Polina Bayvel (University College London, United Kingdom (Great Britain))

**10:30** *Adaptive Joint Optimization of IT Resources and Optical Spectrum Considering Operation Cost...80*

Takashi Miyamura (NTT, Japan); Akira Misawa (Chitose Institute of Science and Technology, Japan)

# Wednesday, May 18 11:00 - 11:30

## Coffee break

# Wednesday, May 18 11:30 - 13:00

## We2: Techno-economics in access network

Chair: Yvan Pointurier (Huawei, France)

**11:30** *Invited: Fixed/Wireless Heterogeneous Network Solutions for Future Industrial Services...N/A*

Thomas Pfeiffer (Nokia Bell Labs, Germany)

**12:00** *Techno-Economics of LiFi in IoT Applications...86*

Madeleine Kaufmann and Carmen Mas-Machuca (Technical University of Munich, Germany); Marcel Müller and Daniel Behnke (Weidmüller Group, Germany); Pieter J Stobbelaar (Signify, The Netherlands); Jean-Paul M. G. Linnartz (Eindhoven University of Technology, The Netherlands); Maximilian Riegel (Nokia Bell Labs, Germany); Dominic Schulz (Fraunhofer Heinrich Hertz Institute, Germany); Volker Jungnickel (Fraunhofer Heinrich Hertz Institute & Technische Universität Berlin, Germany)

**12:20** *Planning a Cost-Effective Delay-Constrained Passive Optical Network for 5G Fronthaul...92*

Abdulhalim Fayad, Manish Jha and Tibor Cinkler (Budapest University of Technology and Economics, Hungary); Jacek Rak (Gdansk University of Technology, Poland)

**12:40** *Cost Effective Hybrid FSO-Wireless Architecture for Broadband Access Network...98*

Priyanka Singh (IIIT Delhi, India); Akshita Gupta (Indraprastha Institute of Information Technology, India); Vivek A Bohara (Indraprastha Institute of Information Technology, Delhi (IIIT-Delhi), India); Anand Srivastava (Indraprastha Institute of Information Technology Delhi, India)

# Wednesday, May 18 13:00 - 14:00

## Lunch break

# Wednesday, May 18 14:00 - 15:30

## We3: Poster session

Chair: Markos Anastasopoulos (University of Bristol, United Kingdom (Great Britain))

*On the Effectiveness of Small Multicast Switches in Next-Generation Optical Transport Networks...N/A*

Joao Pedro (Infinera Unipessoal Lda & Instituto de Telecomunicações, Portugal); António Eira (Infinera Portugal, Portugal); Cátia Pinho (Infinera Corporation, Portugal)

*Quantum Limits on the Capacity of Multispan Links with Phase-Sensitive Amplification...N/A*

Karol Lukanowski, Marcin Jarzyna and Konrad Banaszek (University of Warsaw, Poland)

*A Reinforcement Learning-Based Dynamic Bandwidth Allocation for XGS-PON Networks...N/A*

Abdullah Quran and Sebastian Troia (Politecnico di Milano, Italy); Omran Ayoub (Scuola Universitaria Professionale Della Svizzera Italiana, Switzerland); Nicola Di Cicco (Politecnico di Milano, Italy); Massimo Tornatore (Politecnico di Milano & University of California, Davis, Italy)

*Impact of Modal Dispersion on the Performance of an SDM Optical Network...N/A*

Nicola Sambo (Scuola Superiore Sant'Anna, Italy); Chiara Lasagni (Università dell'Aquila, Italy); Paolo Serena (University of Parma, Italy); Piero Castoldi (Scuola Superiore Sant'Anna, Italy); Alberto Bononi (Università di Parma, Italy)

*Quantum Key Distribution Resource Sharing Schemes for Metropolitan Area Networks...N/A*

Juan Carlos Hernandez-Hernandez (University Carlos III de Madrid, Spain); David Larrabeiti and Maria Calderon (Universidad Carlos III de Madrid, Spain); Ignacio Soto (Universidad Politécnica de Madrid, Spain); Bruno Cimoli, Hui Lui and Idelfonso Tafur Monroy (Eindhoven University of Technology, The Netherlands)

*Outage Performance of Mixed RF-FSO Cooperative Satellite-Aerial-Terrestrial Networks...N/A*

Yuanyuan Ma and Tiejun Lv (Beijing University of Posts and Telecommunications, China); Han Liu (Beijing Institute of Technology, China)

# Wednesday, May 18 15:30 - 16:00

## Coffee break

# Wednesday, May 18 16:00 - 18:00

## We4: Disaggregation and automation

Chair: Cristina E.M. Rottondi (Politecnico di Torino, Italy)

**16:00** *Invited: Network Automation for Disaggregated Optical Transport Networks...N/A*
Achim Autenrieth (ADVA, Germany)

**16:30** *SDN Automation for Optical Networks Based on Open APIs and Streaming Telemetry...104*
Jelena Pesic (NOKIA Bell labs, France); Marina Curtol, Lahcen Abnaou and Abdelali El Imadi (Nokia, France); Stefano Morganti (Nokia, Italy)

**17:00** *Tutorial: Photonic Switching Technologies, Architectures, and Integrated-Systems for Future Disaggregated and Optically Reconfigurable Data Centers...110*
S. J. Ben Yoo (University of California, Davis, USA)

# Thursday, May 19

# Thursday, May 19 9:00 - 11:40

## Th1: Recent advances in deployable networks

Chair: Wojciech Kabacinski (Poznan University of Technology, Poland)

**9:00** *Invited: Optical Sensing in Urban Areas by Deployed Telecommunication Fiber Networks...116*
Pierpaolo Boffi (Politecnico di Milano, Italy); Maddalena Ferrario (Politecnico di Milano & Cohaerentia - start up of the Politecnico di Milano, Italy); Ilaria Di Luch (Politecnico di Milano, Italy); Giuseppe Rizzelli and Roberto Gaudino (Politecnico di Torino, Italy)

**9:30** *Invited: Optical Communications for Space Applications...N/A*
David Mackey (mBryonics, Ireland)

**10:00** *Invited: A SDN-Operated MEC Node for Network Cybersecurity Assurance...121*
Teodor Buchner (Warsaw University of Technology, Poland)

**10:30** *P4 Postcard Telemetry Collector in Packet-Optical Networks...124*
Faris Alhamed, Davide Scano and Piero Castoldi (Scuola Superiore Sant'Anna, Italy); Francesco Paolucci and Filippo Cugini (CNIT, Italy); Ilya Verschkov (Nvidia, Israel); Juan Jose Vegas Olmos (NVIDIA, Denmark)

**10:50** *A MEC and UPF Compatible OLT for Time-Critical Mobile Services...127*

Minqi Wang (Orange Labs, France); Gael Simon (Orange, France); Luiz Anet Neto (Imt-atlantique, France); Isabel Amigo and Loutfi Nuaymi (IMT Atlantique, France); Philippe Chanclou (Orange Labs, France)

**11:10** *Invited: Prioritizing Deployments Achieving Targeted Network Performance Across a Multilayer Pb/s Network...130*

Srivatsan Balasubramanian (Meta, Menlo Park, California, US); Bodhisattwa Gangopadhyay (Meta, United Kingdom (Great Britain)); Vinayak Dangui, Satyajeet Singh Ahuja, Varun Gupta, Grigory Pastukhov, Max Noormohammadpour, Alexander Nikolaidis and Ariyani Copley (Meta, Menlo Park, California, US); Xueqi He, Jiachuan Tian and Jiajia Chen (Meta, Menlo Park, California, USA); Arash Vakili, Chiun Lin Lim and Guanqing Yan (Meta, Menlo Park, California, US); Anand Gokul Mahalingam, Biao Lu and Debottym Mukherjee (Meta, Menlo Park, California, USA)

# Thursday, May 19 11:40 - 12:00

## Coffee break

# Thursday, May 19 12:00 - 13:00

## Th2: Workshop III

Fiber-Optic Telecom Network as a Sensor: Scientific Endeavour, Business Opportunity or just a Buzz Word?
Chair: Patryk Urban (InPhoTech & West Pomeranian University of Technology (ZUT), Poland)

The workshop will address the interleaving application areas of photonics in sensing and telecommunications. The speakers will present their views on the concept of using telecom infrastructure also for sensing purposes. The organizers aim at gathering representatives of telecom operator, telecom equipment vendor, sensing equipment vendor and academia to provide a complete perspective onto opportunities and challenges in this area.

Workshop program:
• "Optical Access Network Serving Sensor Applications", Philippe Chanclou, Fabienne Saliou, Gaël Simon, Orange (France)
• "Is Joint Optical Communication and Sensing a Table Stake?", Jim Zhou, ADVA (Germany)
• "Current challenges in the Fiber Bragg Grating-based sensing for telecom networks", Konrad Markowski, Fiber Team Photonic Solutions (Poland)

# Thursday, May 19 13:00 - 14:00

## Lunch break

# Thursday, May 19 14:00 - 16:00

## Th3: Machine learning II

Chair: Massimo Tornatore (Politecnico di Milano & University of California, Davis, Italy)

**14:00** *Invited: Machine-Learning-Aided Dynamic Reconfiguration in Optical DC/HPC Networks...136*
   Sandeep Kumar Singh (University of California, Davis, USA); CheYu Liu (University of California, San Diego, USA); S. J. Ben Yoo (University of California, Davis, USA); Roberto Proietti (University of California, Davis, USA & Politecnico di Torino, Italy)

**14:30** *Invited: Machine Learning Applied to Inverse Systems Design...142*
   Uiara Celine de Moura (Danmarks Tekniske Universitet (DTU), Denmark); Francesco Da Ros (Technical University of Denmark, Denmark); Darko Zibar (DTU Fotonik, depertment of Photonic Engineering, Technical University of Denmark, Denmark); Ann Margareth Brusin and Andrea Carena (Politecnico di Torino, Italy)

**15:00** *Invited: Federated Learning for Optical Network Automation: A Data Ownership Perspective...N/A*
   Behnam Shariati (Fraunhofer HHI, Germany)

**15:30** *Transfer Learning Aided QoT Computation in Network Operating with the 400ZR Standard...145*
   Fehmida Usmani (National University of Sciences and Technology, Pakistan); Ihtesham Khan and Muhammad Umar Masood (Politecnico di Torino, Italy); Arsalan Ahmad (National University of Sciences and Technology (NUST), Pakistan); Muhammad Shahzad (National University of Sciences & Technology, Pakistan); Vittorio Curri (Politecnico di Torino, Italy)

# Thursday, May 19 16:00 - 16:30

## Coffee break

# Thursday, May 19 16:30 - 17:30

## Th4: Re-architecting networks

   Chair: Jarosław P. Turkiewicz (Warsaw University of Technology & Institute of Telecommunications, Poland)

**16:30** *Tutorial: Re-Architecting Metro and Aggregation Networks with Coherent Interfaces for Beyond 5G...N/A*
   Paul Wright (BT plc, United Kingdom (Great Britain))

# Thursday, May 19 17:30 - 18:30

## Th5: Awards and closing ceremony

   Chair: Jarosław P. Turkiewicz (Warsaw University of Technology & Institute of Telecommunications, Poland)