
PALAIS DE L'ATLANTIQUE, BORDEAUX, FRANCE
ECOC 2021
BORDEAUX
13-16 SEPTEMBER
47th EUROPEAN CONFERENCE ON OPTICAL COMMUNICATION
PROGRAMME
Organized by
Systematic
Paris Region Deep Tech Ecosystem
www.ecoc2021.org

Programme

MONDAY 13 SEPTEMBER

	ROOM A	ROOM B	ROOM C1	ROOM C2	ROOM D	ROOM E	ROOM F	ROOM G
09:00	**Mo1A-WS** Recent progress and future challenge towards practical applications of SDM fibers - Part 1	**Mo1B-WS** How machine learning can revolutionize optical fiber communications? Part 1	**Mo1C1-WS** Co-Packaging: How many fibers is too many? Part 1	**Mo1C2-WS** Applications for IMDD and Coherent in Short Reach Systems. Part 1	**Mo1D-WS** Neuromorphic Computing - Is it going to shift signal processing to a new level? Part 1	**Mo1E-WS** Enabling 6G Networks - Part 1	**Mo1F-WS** Optical Network Evolution towards F5G and Beyond (organized by ETSI ISG-F5G)) - Part 1	**Mo1G-WS** Interoperable DSP-Based PON Systems - Fact or Fantasy? Part 1
10:30	Coffee Break in the exhibition - Hall 1							
11:00	**Mo2A-WS** Recent progress and future challenge towards practical applications of SDM fibers - Part 2	**Mo2B-WS** How machine learning can revolutionize optical fiber communications? Part 2	**Mo2C1-WS** Co-Packaging: How many fibers is too many? Part 2	**Mo2C2-WS** Applications for IMDD and Coherent in Short Reach Systems. Part 2	**Mo2D-WS** Neuromorphic Computing - Is it going to shift signal processing to a new level? Part 2	**Mo2E-WS** Enabling 6G Networks - Part 2	**Mo2F-WS** Optical Network Evolution towards F5G and Beyond (organized by ETSI ISG-F5G) - Part 2	**Mo2G-WS** Interoperable DSP-Based PON Systems - Fact or Fantasy? Part 2
12:30	Lunch Break							
13:30	**Mo3A-SE** WON - Part 1	**Mo3B-WS** Are 200+ GBaud Transmission Systems Feasible? The Path to Beyond 1 Terabit/s Optical Channels. Part 1	**Mo3C1-SE** MOPA - Part 1	**Mo3C2-WS** Post Moore Data Center Networks for 800GbE/1.6TbE. Part 1	**Mo3D-WS** Optical communications beyond 2020: Are we ready for the quantum age? Part 1		**Mo3F-SE** FTTR - Part 1	
15:00	Coffee Break in the exhibition - Hall 1							
15:30	**Mo4A-SE** WON - Part 2	**Mo4B-WS** Are 200+ GBaud Transmission Systems Feasible? The Path to Beyond 1 Terabit/s Optical Channels. Part 2	**Mo4C1-SE** MOPA - Part 2	**Mo4C2-WS** Post Moore Data Center Networks for 800GbE/1.6TbE. Part 2	**Mo4D-WS** Optical communications beyond 2020: Are we ready for the quantum age? Part 2		**Mo4F-SE** FTTR - Part 2	
17:00	Break							
17:15						Opening and Plenary Session		

- SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers
- SC2 - Optoelectronic devices and technologies
- SC3 - Integrated and co-integrated circuits
- SC4 - Techniques for digitally enhancing optical communication
- SC5 - Optical Transmission systems
- SC6 - Theory of Optical Communications and Quantum Communications
- SC7 - Photonics for RF and Free Space Optics applications
- SC8 - Core and metro networks
- SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks
- SC10 - Architecture, Control and Management of optical networks
- SC DEMO - all ECOC Topics

TUESDAY 14 SEPTEMBER

	ROOM A	ROOM B	ROOM C1	ROOM C2	ROOM D	ROOM E	ROOM F	ROOM
09:00	**Tu1A** Multicore fibers and amplifiers	**Tu1B** Free space optical communication	**Tu1C1** Network performance monitoring	**Tu1C2** Machine Learning I	**Tu1D** Nonlinear fiber channel modelling	**Tu1E** Control plane and orchestration	**Tu1F** Short Reach Communications and New Approaches for Access Systems	**Tu1G** Advanced component design
10:30	Coffee Break in the exhibition - Hall 1							
11:00	**Tu2A** Fiber lasers and amplifiers	**Tu2B** Space optical links	**Tu2C1** Monitoring and new functions in optical networks	**Tu2C2** Machine Learning II	**Tu2D** Fiber nonlinearity mitigation and space-division multiplexing	**Tu2E** Network and system design	**Tu2F -Demo** Demo Session 1	**Tu2G** Reconfigurable Si photonics circuits
12:30	Lunch Break							
14:00	**Tu3A** Modelling and characterization of SDM fibers	**Tu3B-SE** Labautomation Hackaton - Part 1	**Tu3C1** High capacity transmission in metro and core networks	**Tu3C2** Coherent Transceivers	**Tu3D** Directly modulated lasers	**Tu3E** Low latency and synchronization	**Tu3F-Demo** Demo Session 2	**Tu3G** Photonic Computing
15:30	Coffee Break							
16:15	**Tu4A** OAM and New guiding mechanisms	**Tu4B-SE** Labautomation hackathon 2	**Tu4C1** Amplifier technologies for transmission system	**Tu4C2** Coherent DSP	**Tu4D** Modulators and transmitters	**Tu4E** Optical networks for wireless	**Tu4F** SDN in Optical Access Networks	**Tu4G** Optical Neural networks

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Programme

WEDNESDAY 15 SEPTEMBER

	ROOM A	ROOM B	ROOM C1	ROOM C2	ROOM D	ROOM E	ROOM F	ROOM
09:00	**We1A** Advances in optical cables, devices and their use	**We1B** Novel subsystems and devices for analog photonics	**We1C1** High speed IM/DD transmission	**We1C2** Spatial Division Multiplexing	**We1D** VCSELs	**We1E** Network resilience	**We1F** Data Center Networks and Applications	**We1G** Optical circuits for Frequency conversion
10:30	Coffee Break in the exhibition - Hall 1							
11:00	Exhibition - Hall 1							
12:30	Lunch Break							
14:00	**We3A** Hollow Core Fibers	**We3B** Short reach optical wireless communication	**We3C1** High capacity transmission	**We3C2** Direct Detection I	**We3D** InP devices	**We3E** Network security	**We3F** Future PONs	**We3G** Packaging
15:30	Coffee Break in the exhibition - Hall 1							
16:15	**We4A** Spatiotemporal effects in fibers	**We4B** Novel radio-over-fiber devices and systems	**We4C1** Space division multiplexing	**We4C2** Direct Detection II	**We4D** Passive photonic circuits	**We4E** Optical network monitoring and telemetry	**We4F** Future PONs : Beyond 50G	**We4G** Co-integration for transceivers

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THURSDAY 16 SEPTEMBER

	ROOM A	ROOM B	ROOM C1	ROOM C2	ROOM D	ROOM E	ROOM F	ROOM
09:00	**Th1A** Physical layer modelling for optical networks	**Th1B** Optical wireless communication devices and systems	**Th1C1** Neural Networks in estimating lighpaths for Optical Communications	**Th1C2** Coded Modulation	**Th1D** LIDARs	**Th1E** Network performance	**Th1F** Optical Access Networks for 5G	**Th1G** Capacity, coding, and shaping in fiber-optic communication
10:30	Coffee Break in the Agora - Palais de l'Atlantique							
11:00	**Th2A** Design and optimization of optical networks	**Th2B** Photonic assisted THz wireless communication	**Th2C1** Advanced transceiver technologies	**Th2C2** Machine learning for optical netwoks	**Th2D** Detectors	**Th2E** Data center networking	**Th2F** Towards 6G Optical Networks	**Th2G** Quantum communication and quantum-key distribution in optical fibers
12:30	Lunch Break							
14:00		**Th3B-PD3** Postdeadline Session 3	**Th3C-PD2** Postdeadline Session 2			**Th3E-PD1** Postdeadline Session 1		
15:30	Break							
15:45						**Th4E- Closing Session** Closing Session		

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Welcome Address

Jean-Pierre HAMAIDE and
Christian LERMINIAUX
ECOC 2021 General Co-Chairs

Since its creation, ECOC is the best venue in Europe for catching up with the leading-edge research in the field of optical communication and all related topics. If you have to know about the latest technological or scientific discoveries, ECOC is definitely the place to be!
We didn't compromise for this 47th edition of ECOC, which is back again to France, but this time in Bordeaux, a dynamic and rapidly expanding city, a thriving tech hub, but also a long-standing historical city connected to the world.

The outbreak of the global health crisis of 2020 triggered an intense wave of digital transformation and digital expansion, with light as propellant. This wave reinforces ECOC as a unique, vibrant place for global opportunities, a place for knowledge sharing, stimulating creativity, steering innovation and building collaborations. In the conference as well as in the associated exhibition, companies and institutions from all over the world will share the latest news and scientific breakthroughs from materials and devices, to systems and networks. Expect to meet analysts, media, government bodies, vendors and users - as well as peers, colleagues or customers.

During the ECOC'21 conference, the latest progress in optical communication technologies will be reported during 4 days of scientific and technical content, including a large opening with 11 workshops followed by a plenary session, and over 50 technical sessions including 39 invited papers. The conference will include 4 special events, post-deadline papers, demo sessions, 13 tutorials, and will be the networking destination for the optical communications academy and industry community.

Organizing ECOC at the end of the summer this year, in Bordeaux, was a real challenge. And making the decision, a real bet…

We had to keep confidence and it was not always obvious. We made it! Thanks to all the organizing team but also to all of you. And if it was important for the organizers to bring the participants together in Bordeaux, we do not have to forget the colleagues who could not physically join the conference. This year, for the first time, ECOC allows you to attend in person or online simultaneously, doubling the organizational effort.
We recognize that participants made a real effort to register. In doing so, you all demonstrated your total commitment to maintaining and strengthening our optical community. That is why we are so grateful to each and every one of you.

We look forward to extending a warm welcome to you in Bordeaux and virtually for this 47th edition!

Future conferences

ECOC 2022
From September 18th to 22nd,
in Basel, Switzerland

ECOC 2023
UK

ECOC 2024
Germany

ECOC 2025
Scandinavia

ECOC 2021

Conference General co-chairs

Jean-Pierre HAMAIDE
III-V Lab, France

Christian LERMINIAUX
Chimie ParisTech-PSL

Technical Programme committee co-chairs

Philippe CHANCLOU
Orange Labs

Pierre SILLARD
Prysmian Group

Organizing Committee

Jean-Pierre HAMAIDE
Chairman & Managing Director
III-V Lab

Christian LERMINIAUX
Directeur
Chimie ParisTech-PSL

Sébastien BIGO
Activity Leader
Nokia Bell Labs

Pierre SILLARD
New Fiber products R&D Manager
Prysmian Group

Philippe CHANCLOU
Team Manager
Orange Labs

Florence BLEUZEN
Director Administration & Finance
Systematic Paris-Region

Marla DA SILVA
ECOC'21 coordinator
Systematic Paris-Region

Béatrice VALDAYRON
PCO
C2B Congress

Caroline ZAGO
PCO
C2B Congress

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Sant'Anna School of Advanced Studies-CNIT, Italy

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University of Technology, Sweden

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Universitat Politécnica de Valencia, Spain

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ADVA AG Optical Networking, Germany

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With the support of C2b Congress

Opening & Technical Sessions Monday 13 September - Room E

17:15 - Opening by Co General Chairs & Technical Co Chairs

17:30 - Key Industry Inflection Points driving Optical Communications
Tod SIZER, EVP Optical Research, Nokia Bell Labs.

18:00 - Laser Mega Joule-PETAL facility: quick overview
Jean LAJZEROWICZ, CEA/CESTA, France

18:30 - 6th Intergovernmental Panel on Climate Change - IPCC report: a reality check and a wake-up call
Christophe CASSOU, Cerfacs-CECI (Couplage Environnement Climat Incertitude) - France

Tod Sizer

Biography:

Dr. Theodore(Tod) Sizer is Executive Vice President of Optical Systems and Device Research in Nokia Bell Labs, leading teams innovating in all aspects of optical systems and devices for core, submarine, and data center communications. Prior to his current role, Tod lead Wireless Research in Nokia Bell Labs for eight years driving the vision and research of 5G. Tod graduated from Amherst College, and received his Masters and Doctorate in Optics from the Institute of Optics at the University of Rochester. In 2012 he received the Popular Science Breakthrough Innovation award for the lightRadio invention. Tod is a Fellow of Bell Labs, WWRF, and IEEE. He is the author of 54 US patents and a member of the IEEE and OSA.

TITLE: KEY INDUSTRY INFLECTION POINTS DRIVING OPTICAL COMMUNICATIONS

Christophe Cassou

Biography:

Christophe Cassou is a climate scientist at CNRS (Centre National de Recherche Scientifique) in France. His expertise is on past climate variability observed since preindustrial time and on future projected changes in response to human activities. From 2014 to 2018, he co-chaired the «decadal climate variability and predictabiliy» international research panel under the World Climate Research Program and lead several research initiatives at national levels aiming at improving climate prediction from monthly to decadal timescale. Since 2018, he is a lead author of the 6th IPCC (International Panel for Climate Change) report whose publication is running over 2021-2022. He is the author of 81 scientific publications and of two books about climate science for general public. He co-founded the «Train du Climat» in 2015, the largest scientific mediation operation on climate literacy, outside Paris in the wake of COP21, and he was in 2017 the co-recipient of the «Outreach & Communication» Prize awarded by the «European Meteorological Society» for this initiative.

TITLE: LASER MEGA JOULE-PETAL FACILITY: QUICK OVERVIEW

Abstract:
Climate change is now, everywhere, getting worse. The 6th IPCC report on the physical science basis, which has been just released in early August, is clear: it is a established fact that human activities are causing climate changes. It is unequivocal that the observed warming over the last decade (2010-2019) is entirely driven by anthropogenic forcing and the scale of recent changes across the climate system as a whole together with the present state of many aspects of the climate system are unprecedented over many centuries to many thousands of years. Human-induced climate change is already affecting every region on Earth in multiple ways, strengthening the frequency and intensity of extreme events such as heatwaves, heavy precipitation events, droughts, and fire weather.
The changes we experience will increase with further warming. Global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide and other greenhouse gas emissions occur immediately, rapidely and at large-scale including all the socio-economical sectors. Every fraction of degrees matters and every tonne of CO2 emissions adds to global warming.
Net zero CO2 emissions, along with strong reductions in other greenhouse gas emissions, is a geophysical constraint to stabilize human-induced global warming. Reductions of methane emissions would also limit the warming effect resulting from declining aerosol pollution and would improve air quality. The good news based on improved understanding of the CO2 cycle are that reduced global greenhouse gas emissions lead within years to discernible effects on greenhouse gas and aerosol concentrations, and air quality. The geophysical inertia of the climate system is lower compared to earlier estimates; this is why the climate we experience in the future at long-term, but also at near-term, typically before 2040, depends on your, our decisions now. We choose now the level of future risk of tomorrow.

Opening and Plenary Session Monday 13 September - Room E

FTTR - PART 1

17:15 - 19:00

M05E

17:15 - 17:22 ECOC 2021 General Chairs **Jean Pierre Hamaide & Christian Lerminiaux**

17:22 - 17:30 ECOC 2021 Technical Programme **Chairs Pierre Sillard & Philippe Chanclou**

17:30 - 18:00 Keynote 1 **- Theodore Sizer**

18:00 - 18:30 Keynote 2 - **Jean Lajzerowicz**

18:30 - 19:00 Keynote 3 - **Christophe Cassou**

ORGANIZERS:

Jean-Pierre Hamaide
III-V lab - France

Christian Lerminiaux
Chimie ParisTech-PSL - France

Philippe Chanclou
Orange Labs - France

Pierre Sillard
Prysmian Group - France

SPEAKERS:

Jean Lajzerowicz
CEA/CESTA - France
LMJ-PETAL facility: quick overview

Theodore Sizer
EVP Optical Research, Nokia Bell Labs - USA
Key Industry Inflection Points driving Optical Communications

Christophe Cassou
Cerfacs-CECI (Couplage Environnement Climat Incertitude) - France
6th IPCC report: a reality check and a wake-up call

Invited Papers

Invited Papers Tuesday 14 September

ROOM A

OAM AND NEW GUIDING MECHANISMS

16:20 - 16:45

Chair: Luca Palmieri University of Padova - Italy
SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers

Tu4A.1
Ring-Core Fibers Supporting Propagation of OAM Modes

Ring core fibers are particularly well-suited for spatial division multiplexing, by permitting good separation of mode effective indices. In the case of orbital angular momentum modes, the weakly guiding mode can be violated to greatly increase the number of supported modes.

Leslie Rusch* | *Presenter
COPL, Universite Laval - Canada
ECE Dept., Université Laval - Canada

Sophie LaRochelle
COPL, Universite Laval - Canada
ECE Dept., Université Laval - Canada
Mai Banawan
COPL, Universite Laval - Canada
ECE Dept., Université Laval - Canada

ROOM B

FREE SPACE OPTICAL COMMUNICATION

09:00 - 09:30

Chair: Michel Sotom Thales Alenia Space - France
SC7 - Photonics for RF and Free Space Optics applications

Tu1B.1 INVITED PAPER
HYDRON: the ESA initiative towards optical networking in space

The HydRON Project aims at developing innovative optical communication technologies / equipment, including flight opportunities for in-orbit verification, to validate the “Fibre in the Sky” concept integrated into terrestrial networks at Terabit capacity. This paper will present current status of the technical and programmatic aspects.

Josep Perdigues* | *Presenter
European Space Agency - The Netherlands

Harald Hauschildt
European Space Agency - The Netherlands
Wael El-Dali
European Space Agency - The Netherlands
Silvia Mezzasoma
European Space Agency - The Netherlands
Monica Politano
European Space Agency - The Netherlands
Zoran Sodnik
European Space Agency - The Netherlands
Christopher Vasko
European Space Agency - The Netherlands

ROOM C1

NETWORK PERFORMANCE MONITORING

09:15 - 09:45

Chair: Bernhard Schrenk AIT Austrian Institute of Technology - Austria
SC8 - Core and metro networks

Tu1C1.2
DSP Enabled, Amplitude Modulation Pilot Tone Based Optical Performance Monitoring in Coherent Systems

We review the progresses of amplitude modulation pilot tone generation and detection techniques and its applications in optical performance monitoring, such as signal spectrum, optical filtering, and fiber nonlinearity.

Zhiping Jiang* | *Presenter
Huawei Technologies - Canada
Xuefeng Tang
Huawei Technologies - Canada
Simin Wang
Huawei Technologies Co. Ltd. - China
Ge Gao
Huawei Technologies France - France
Dajiang Jin
Huawei Technologies Co. Ltd. - China
Jianfeng Wang
Huawei Technologies Co. Ltd. - China
Minggang Si
Huawei Technologies Co. Ltd. - China

AMPLIFIER TECHNOLOGIES FOR TRANSMISSION SYSTEM

16:15 - 16:45

Chair: Gabriel Charlet Huawei Technologies - France
SC5 - Optical Transmission systems

Tu4C1.1
Enhanced coherent communications with Brillouin amplifiers

Application of Brillouin amplification for enabling higher performance coherent communications with higher-order QAM signals is presented. Capabilities and limits for using the uniquely narrow gain bandwidth to suppress out-of-band spectral line noise for carrier recovery at the receiver from lower power pilot tones are described.

Mark Pelusi* | *Presenter
National Institute of Advanced Industrial Science and Technology (AIST) - Japan
Takashi Inoue
National Institute of Advanced Industrial Science and Technology (AIST) - Japan
Shu Namiki
National Institute of Advanced Industrial Science and Technology (AIST) - Japan

ROOM C2

COHERENT TRANSCEIVERS

14:00 - 14:30

Chair: Sebastian Randel Karlsruhe Institute of Technology (KIT), Institute of Photonics - Germany and Quantum Electronics (IPQ)
SC4 - Techniques for digitally enhancing optical communication

Tu3C2.1
Characterization, Modelling and Measurement of Device Imperfections in Advanced Coherent Transceivers

Device imperfections turn to be the dominant impairment for high speed, high order modulation transceivers. For both linear and nonlinear imperfections, the characterization, modelling, and measurement method are reviewed. There are various methods for linear imperfections, whereas the nonlinear imperfections need more research.

Zhenning Tao* | *Presenter
Fujitsu Ltd. - China

Yangyang Fan
Fujitsu Ltd. - China
Tong Ye
Fujitsu Ltd. - China
Xiaofei Su
Fujitsu Ltd. - China
Hisao Nakashima
Fujitsu Ltd. - Japan
Takeshi Hoshida
Fujitsu Ltd. - Japan

Tuesday 14 September

ROOM G

ADVANCED COMPONENT DESIGN

09:00 - 09:30

Chair: Lars Zimmermann IHP GmbH - Leibniz-Insitut für innovative Mikroelektronik - Germany
SC3 - Integrated and co-integrated circuits

Tu1G.1
Topological nanophotonics for integrated devices

We will show our recent works of topological nanophotonics in silicon-on-insulator platform, including topological routing in valley photonic crystals and on-chip filtering based on topological corner states. These results are promising for the development of topologically-protected integrated devices at telecommunication wavelength.

Jian-Wen Dong* | *Presenter
Sun Yat-sen University - China

Xin-Tao He
Sun Yat-sen University - China
Xiao-Dong Chen
Sun Yat-sen University - China
Meng-Yu Li
Sun Yat-sen University - China

09:30 - 10:00

Tu1G.3
Dimensionality reduction for the on-chip integration of advanced photonic devices and functionalities

Design of modern photonic devices requires to handle a large number of parameters and figures of merit. By scaling down the complexity of the problem, machine learning dimensionality reduction enables the discovery of better performing devices, higher integration scale, and efficient evaluation of fabrication tolerances.

Daniele Melati* | *Presenter
Centre de Nanosciences et de Nanotechnologies, Université Paris-Saclay, CNRS - France

Mohsen Kamandar Dezfouli
National Research Council - Canada
Yuri Grinberg
National Research Council - Canada
Muhammad Al-Digeil
National Research Council - Canada
Dan-Xia Xu
National Research Council - Canada
Jens H. Schmid
National Research Council - Canada
Pavel Cheben
National Research Council - Canada
Abi Waqas
Department of Telecommunication, Mehran University of Engineering and Technology - Pakistan
Paolo Manfredi
Politecnico di Torino - Italy
Jianhao Zhang
Centre de Nanosciences et de Nanotechnologies, Université Paris-Saclay, CNRS - France
Laurent Vivien
Centre de Nanosciences et de Nanotechnologies, Université Paris-Saclay, CNRS - France
Carlos Alonso-Ramos
Centre de Nanosciences et de Nanotechnologies, Université Paris-Saclay, CNRS - France

ROOM D

NONLINEAR FIBER CHANNEL MODELLING

09:00 - 09:30

Chair: Helmut Grießer ADVA Optical Networking SE - Germany
SC6 - Theory of Optical Communications and Quantum Communications

Tu1D.1 INVITED PAPER
Modeling the Delayed Nonlinear Fiber Response in Ultra-Wideband Transmission Systems

For transmission beyond the C-band, the nonlinear fiber response cannot be considered instantaneous and its delayed contribution, the Raman response, needs to be included. Numerical and analytical modeling approaches are discussed and the impact of the complex-valued Raman spectrum on the nonlinear interference is shown.

Daniel Semrau* | *Presenter
Infinera Corp. - USA

FIBER NONLINEARITY MITIGATION AND SPACE-DIVISION MULTIPLEXING

11:00 - 11:30

Chair: Cristian Antonelli University of L'Aquila - Italy
SC6 - Theory of Optical Communications and Quantum Communications

Tu2D.1
Tailored shaping, improved detection, simpler backpropagation: the road to nonlinearity mitigation

Several strategies for nonlinearity mitigation based on signal processing at the transmitter and/or receiver side are analyzed and their effectiveness is discussed. Improved capacity lower bounds based on their combination are presented.

Marco Secondini* | *Presenter
PNTLab, CNIT - Italy

Scuola Superiore Sant'Anna, TeCIP Institute - Italy
Stella Civelli
PNTLab, CNIT - Italy
Scuola Superiore Sant'Anna, TeCIP Institute - Italy
Enrico Forestieri
PNTLab, CNIT - Italy
Scuola Superiore Sant'Anna, TeCIP Institute - Italy

DIRECTLY MODULATED LASERS

14:00 - 14:30

Chair: Romain Brenot Huawei - France
SC2 - Optoelectronic devices and technologies

Tu3D.1
112-Gb/s PAM-4 Uncooled Directly Modulated BH Lasers

Uncooled 112-Gb/s and 106-Gb/s PAM-4 directly modulated BH lasers are reviewed. High frequency properties of submicron ridge localized buried heterostructure lasers achieve 112-Gb/s PAM-4 modulation from 25ºC to 85ºC. Moreover, low BER values below KP4 FEC threshold are demonstrated with uncooled 106-Gb/s PAM-4 direct modulation.

Kouji Nakahara* | *Presenter
Lumentum - Japan

Kazuki Suga
Lumentum - Japan
Kaoru Okamoto
Lumentum - Japan
Shigenori Hayakawa
Lumentum - Japan
Masatoshi Arasawa
Lumentum - Japan
Tetsuya Nishida
Lumentum - Japan
Ryu Washino
Lumentum - Japan
Takeshi Kitatani
Lumentum - Japan
Masatoshi Mitaki
Lumentum - Japan
Hironori Sakamoto
Lumentum - Japan
Yasushi Sakuma
Lumentum - Japan
Shigehisa Tanaka
Lumentum - Japan

ROOM E

OPTICAL NETWORKS FOR WIRELESS

16:45 - 17:15

Chair: Reza Nejabati Tu4E
SC10 - Architecture, Control and Management of optical networks

Tu4E.3
Optical Networking in Smart City and Wireless Future Networks Platforms

Innovation in optical networks is essential to delivering advanced performance for future smart city and wireless networks. Incorporating optical systems research in real-world platforms presents a number of challenges, which we are addressed through recent advances in the use of software defined networking and emulation.

Dan Kilper* | *Presenter
CONNECT Centre, Trinity College Dublin - Ireland

Jiakai Yu
University of Arizona - USA
Steven Santaniello
University of Arizona - USA

ROOM G

OPTICAL NEURAL NETWORKS

17:00 - 17:30

Chair: Ueli Koch ETH Zurich - Switzerland
SC3 - Integrated and co-integrated circuits

Tu4G.4
Compute with Light: Architectures, Technologies and Training Models for Neuromorphic Photonic Circuits

We discuss recent advances in the field of neuromorphic photonics, presenting our recent work and perspective towards optimizing the architecture, the enabling technology and the Deep Learning training models through a hardware/software co-design and co-development framework.

Apostolos Tsakyridis* | *Presenter
Aristotle University of Thessaloniki - Greece

Nikos Pleros
Aristotle University of Thessaloniki - Greece
Miltiadis Moralis-Pegios
Aristotle University of Thessaloniki - Greece
Angelina Totovic
Aristotle University of Thessaloniki - Greece
George Dabos
Aristotle University of Thessaloniki - Greece
George Giamougiannis
Aristotle University of Thessaloniki - Greece
George Mourgias-Alexandris
Aristotle University of Thessaloniki - Greece
Nikolaos Passalis Passalis
Aristotle University of Thessaloniki - Greece
Manos Kirtas
Aristotle University of Thessaloniki - Greece
Anastasios Tefas
Aristotle University of Thessaloniki - Greece

ROOM A

ADVANCES IN OPTICAL CABLES, DEVICES AND THEIR USE

09:00 - 09:30

Chair: Marc Wuilpart University of Mons - Belgium
SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers

We1A.1
Seismic sensing in submarine fiber cables

Optical fibers are ubiquitously deployed in terrestrial and submarine networks, making them attractive for sensing activities. We review optical technologies used for seismic sensing and show results of polarization sensing experiments performed over Google's submarine cable Curie, connecting US to Chile.

Mattia Cantono* | *Presenter | *Google - USA*
Antonio Mecozzi | *Department of Physical and Chemical Sciences, University of L'Aquila, Italy - Italy*
Valey Kamalov | *Google - USA*
Shuang Yin | *Google - USA*
Jorge Castellanos | *Seismological Laboratory, California Institute of Technology, Pasadena, USA - USA*
Rafael Muller | *Google - USA*
Zhongwen Zhan | *Seismological Laboratory, California Institute of Technology, Pasadena, USA - USA*

HOLLOW CORE FIBERS

15:00 - 15:30

Chair: Francesco Poletti University of Southampton - UK
SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers

We3A.5
Waveguide and Gas: the Advent of a New Tool for Photonics

The realisation of hollow-core fibres and nano-waveguides offers a unique opportunity to optimise the interactions between light and a gaseous medium. Stimulated Brillouin scattering is exploited to achieve unprecedented levels of amplification and to realise efficient all-optical processing.

Luc Thevenaz* | *Presenter
Ecole Polytechnique Fédérale de Lausanne - Switzerland
Fan Yang | *Ecole Polytechnique Fédérale de Lausanne - Switzerland*
Flavien Gyger | *Ecole Polytechnique Fédérale de Lausanne - Switzerland*

SPATIOTEMPORAL EFFECTS IN FIBERS

16:15 - 16:45

Chair: Camille-Sophie Brès EPFL - Switzerland
SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers

We4A.1
Waveform Generation in Space, Frequency, Time and Polarization

This paper shows three devices to perform 4D waveform generation: a time-reverser device combining a wavelength selective switch and a mode multiplexer, a spectral mode equalizer that comprising a wavelength blocker and a mode-multiplexer, and a beamformer comprising an array of modulators and a mode-multiplexer.

Nicolas Fontaine* | *Presenter
Nokia Bell Labs - USA

Mikael Mazur
Nokia Bell Labs - USA
Haoshuo Chen
Nokia Bell Labs - USA
Roland Ryf
Nokia Bell Labs - USA
David Neilson
Nokia Bell Labs - USA
Mickael Mounaix
University of Queensland - Australia
Joel Carpenter
University of Queensland - Australia

Wednesday 15 September

ROOM B

NOVEL RADIO-OVER-FIBER DEVICES AND SYSTEMS

16:15 - 16:45

Chair: Leif Katsuo Oxenløwe Technical University of Denmark - Denmark
SC7 - Photonics for RF and Free Space Optics applications

We4B.1
Power-over-Fiber for Radio-over-Fiber Links

This paper introduces simultaneous data and power transmission by power-over-fiber using a single optical fiber for driving a remote antenna unit in radio-over-fiber-based mobile communication networks. This paper also discusses the future prospects of power-over-fiber.

Motoharu Matsuura* | *Presenter
University of Electro-Communications - Japan

ROOM C1

HIGH SPEED IM/DD TRANSMISSION

09:00 - 09:30

Chair: Norbert Hanik TU Munich - Germany
SC5 - Optical Transmission systems

We1C1.1
High-speed IM/DD transmission with analog (de-)multiplexers

In this paper we give an overview on the status of devices for analog multiplexing and demultiplexing and experimental results in general and on the results achieved within the ECSEL Taranto project.

Karsten Schuh* | *Presenter
Nokia - Germany

Qian Hu
Nokia - Germany
Roman Dischler
Nokia - Germany
Vahid Aref
Nokia - Germany
Fred Buchali
Nokia - Germany
Son Le
Nokia Bell Labs - USA
Michael Collisi
Chair of Electronics and Circuits, Saarland University, Saarbrücken - Germany
Michael Möller
Chair of Electronics and Circuits, Saarland University, Saarbrücken - Germany
Horst Hettrich
Micram Microelectronic GmbH, Bochum - Germany
Rolf Schmid
Micram Microelectronic GmbH, Bochum - Germany
Xuan-Quang Du
Institute of Electrical and Optical Communications Engineering, University of Stuttgart - Germany
Markus Grözing
Institute of Electrical and Optical Communications Engineering, University of Stuttgart - Germany
Manfred Berroth
Institute of Electrical and Optical Communications Engineering, University of Stuttgart - Germany

HIGH CAPACITY TRANSMISSION

14:00 - 14:30

Chair: Jochen Schröder Chalmers University of Technology - Sweden
SC5 - Optical Transmission systems

We3C1.1
High Symbol-Rate Signal Optimization for Long-Haul Transmission Systems over 1-Tbps/λ Net-Data Rate

We discuss the theoretical and practical aspects of high symbol-rate signal optimization techniques for realizing a >1-Tbps/λ long-haul transmission system. We also review the key technologies for transmitting the high symbol-rate signal such as modulation format design, bandwidth extension techniques, and equalization schemes.

Masanori Nakamura* | *Presenter
NTT Network Innovation Laboratories - Japan

Fukutaro Hamaoka
NTT Network Innovation Laboratories - Japan
Takayuki Kobayashi
NTT Network Innovation Laboratories - Japan
Hiroshi Yamazaki
NTT Device Technology Laboratories - Japan
NTT Network Innovation Laboratories - Japan
Munehiko Nagatani
NTT Device Technology Laboratories - Japan
NTT Network Innovation Laboratories - Japan
Yoshihiro Ogiso
NTT Device Innovation Center - Japan
Hitoshi Wakita
NTT Device Technology Laboratories - Japan
Yutaka Miyamoto
NTT Network Innovation Laboratories - Japan

SPACE DIVISION MULTIPLEXING

16:15 - 16:45

Chair: Norbert Hanik TU Munich - Germany
SC5 - Optical Transmission systems

We4C1.1
Ultra-wide band transmission in few-mode fibers

Space-division multiplexing (SDM) enables the transmission of independent data channels over different fiber modes of multi-mode fibers. In this talk, we review key characteristics of devices and fibers for SDM transmission and summarize recent SDM transmission demonstrations, including 1.01 peta-bit/s transmission in a 15-mode fiber.

Georg Rademacher* | *Presenter
NICT - Japan

Benjamin Puttnam
NICT - Japan
Ruben S Luis
NICT - Japan
Tobias Eriksson
Infinera - Sweden
Nicolas Fontaine
Nokia Bell Labs - USA
Mikael Mazur
Nokia Bell Labs - USA
Haoshuo Chen
Nokia Bell Labs - USA
Roland Ryf
Nokia Bell Labs - USA
David Neilson
Nokia Bell Labs - USA
Pierre Sillard
Prysmian Group - France
Frank Achten
Prysmian - The Netherlands
Yoshinari Awaji
NICT - Japan
Hideaki Furukawa
NICT - Japan

Wednesday 15 September

ROOM C2

SPATIAL DIVISION MULTIPLEXING

09:00 - 09:30

Chair: Sebastian Randel Karlsruhe Institute of Technology (KIT), Institute of Photonics - Germany and Quantum Electronics (IPQ)
SC4 - Techniques for digitally enhancing optical communication

We1C2.1
Fiber device estimation techniques for SDM transmission

Space Division Multiplexing presents new impairments such as mode-dependent loss and differential mode dispersion, challenging to measure conventional processes. We discuss the feasibility of spatially-diverse swept wavelength interferometry and digital holography techniques capable of measuring these characteristics, obtaining transfer matrices of devices.

Chigo Okonkwo* | *Presenter
Technology University of Eindhoven - The Netherlands

Menno van den Hout
Technology University of Eindhoven - The Netherlands
Sjoerd van der Heide
Technology University of Eindhoven - The Netherlands
John van Weerdenburg
Infinera Corp. - USA
Technology University of Eindhoven - The Netherlands

DIRECT DETECTIOIN I

14:00 - 14:30

Chair: Christopher Fludger Infinera GmbH - Germany
SC4 - Techniques for digitally enhancing optical communication

We3C2.1
Phase Retrieval Receivers Based on Alternative Projections for Coherent Optical Communications

We review recent progress on phase retrieval receivers (Rx) employing alternative projections for coherent optical communications. Procedures for enhancing the Rx performance and achieving fast convergence are discussed in details.

Haoshuo Chen* | *Presenter
Nokia Bell Labs - USA

Nicolas K. Fontaine
Nokia Bell Labs - USA
Hanzi Huang
Nokia Bell Labs - USA
Shanghai University - China
Rene-Jean Essiambre
Nokia Bell Labs - USA
Mikael Mazur
Nokia Bell Labs - USA
Roland Ryf
Nokia Bell Labs - USA
David T. Neilson
Nokia Bell Labs - USA

ROOM D

PASSIVE PHOTONIC CIRCUITS

16:15 - 16:45

Chair: Hélène Debrégeas Almae Techologies - France
SC2 - Optoelectronic devices and technologies

We4D.1
Hybrid Polymer Integration for Communications, Sensing and Quantum Technologies from the Visible to the Infrared

We present concepts for transferring PIC building blocks from classical implementations in the C band towards shorter wavelengths. Exemplary functionalities include hybrid tunable lasers for 785 nm and 1064 nm, on-chip free-space sections for non-linear optics, and dielectric thin-film filters with 68 dB suppression.

Moritz Kleinert* | *Presenter
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany

David de Felipe
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Hauke Conradi
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Martin Kresse
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Lennart Jehle
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Madeleine Weigel
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Tianwen Qian
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Klara Mihov
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Jakob Reck
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Crispin Zawadzki
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Norbert Keil
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Martin Schell
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Technical University Berlin - Germany

ROOM E

NETWORK SECURITY

14:45 - 15:15

Chair: Luis Velasco Universitat Politecnica de Catalunya - UPC (Spain)
SC10 - Architecture, Control and Management of optical networks

We3E.4
Optical Network Architecture Supporting Dynamic and End-to-End Quantum Secure Networking

This paper proposes an optical network architecture including physical layer and control plane supporting dynamic networking and co-existence of quantum and classical channels over the same fibre infrastructure. It will discuss technological challenges for realising the proposed architecture and potential solutions for addressing them.

Reza Nejabati* | *Presenter
University of Bristol - UK

Rui Wang
University of Bristol - UK
George Kanellos
University of Bristol - UK
Dimitra Simeonidou
University of Bristol - UK

OPTICAL NETWORK MONITORING AND TELEMETRY

16:15 - 16:45

Chair: Claude Le Bouëtté EKINOPS - France
SC10 - Architecture, Control and Management of optical networks

We4E.1
Role of monitoring and analytics in next generation optical networks

We study the requirements that Control, Orchestration, and Management (COM) systems for optical networks should fulfil, present a minimal set of components they should implement, and propose our research point of view regarding the future needs for COM systems for optical networks.

Lluis Gifre Renom* | *Presenter
Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain
Nokia Bell Labs - France

Fabien Boitier
Nokia Bell Labs - France

Invited Papers Thursday 16 September

ROOM F

DATA CENTER NETWORKS AND APPLICATIONS

09:00 - 09:30

Chair: Stephan Pachnicke
SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

We1F.1
Improving Data Center Network Locality with Co-packaged Optics

Co-packaged optics can enable switches with unprecedented speeds of 51.2 Tb/s and beyond. This translates to networks with 4x higher bisection bandwidth, >40% fewer switches, and substantially improved network locality, i.e., large-scale applications can be placed under up to 50% fewer 1st-level switches.

Pavlos Maniotis* | *Presenter
IBM T. J. Watson Research Center - USA

Laurent Schares
IBM T. J. Watson Research Center - USA
Daniel Kuchta
IBM T. J. Watson Research Center - USA
Bengi Karacali
IBM T. J. Watson Research Center - USA

FUTURE PONS

14:00 - 14:30

Chair: Fabio Bottoni Cisco - Italy
SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

We3F.1
The Progress of Higher Speed Passive Optical Network Standardisation in ITU-T

The ITU-T initiated a Higher-Speed PON (HSP) project to meet the need to upgrade PON systems beyond the 10Gbps line-rates of today. Line-rates up to 50Gbps are addressed by HSP and the first system to be consented at the ITU-T is 50G-PON.

Derek Nesset* | *Presenter
Huawei Technologies - Germany

ROOM G

CO-INTEGRATION FOR TRANSCEIVERS

17:15 - 17:45

Chair: Daniel Kuchta IBM -USA
SC3 - Integrated and co-integrated circuits

We4G.5
Silicon photonics integrated circuits for nonlinear Fourier transform based transmission

We demonstrate a silicon photonics transmitter capable of modulating and optically merging solitons with reduced electronic constraints. Transmission over 3800 km and 5400 km has been experimentally shown for 2 Vpp and 4 Vpp drive voltages, respectively, without significant penalties between 2-channel and 4-channel configurations.

Jeremy Witzens* | *Presenter
RWTH Aachen University - Germany

Alvaro Moscoso-Mártir
RWTH Aachen University - Germany
Jonas Koch
Kiel University - Germany
Juliana Mueller
RWTH Aachen University - Germany
Alireza Tabatabaei Mashayekh
RWTH Aachen University - Germany
Arka Dipta Das
RWTH Aachen University - Germany
Florian Merget
RWTH Aachen University - Germany
Stephan Pachnicke
Kiel University - Germany

ROOM A

DESIGN AND OPTIMIZATION OF OPTICAL NETWORKS

12:00 - 12:30

Chair: Patricia Layec Nokia Bell Labs - France
SC8 - Core and metro networks

Th2A.5
Automation journey in core and metro networks: an operator view

We expose how moving from mono-vendor to multi-vendor optical transport networks raises challenges that can be solved leveraging on open source, open initiatives and standardization, and accelerate the deployment of automation solutions in current and future optical transport networks.

Esther Le Rouzic* | *Presenter
Orange Innovation Network - France

Olivier Augizeau
Orange Innovation Network - France
Olivier Renais
Orange Innovation Network - France
Julien Meuric
Orange Innovation Network - France
Thierry Marcot
Orange Innovation Network - France
Christophe Betoule
Orange Innovation Network - France
Gilles Thouenon
Orange Innovation Network - France
Ahmed Triki
Orange Innovation Network - France
Maxime Laye
Orange Innovation Network - France
Nicolas Pelloquin
Orange Innovation Network - France
Yannick Lagadec
Orange Innovation Network - France
Emmanuelle Delfour
Orange Innovation Network - France

ROOM B

OPTICAL WIRELESS COMMUNICATION DEVICES AND SYSTEMS

09:00 - 09:30

Chair: Liam Barry Dublin City University - Ireland
SC7 - Photonics for RF and Free Space Optics applications

Th1B.1
400G+ Wireless Transmission via Free-Space Optics

High-capacity wireless transmission is a key requirement for next-generation communication systems. In this paper, we review some of the most recent achievements on the convergence between coherent fiber communications and free-space optics systems, enabling data rates in the range of 400 Gbps to 1Tbps.

Fernando P. Guiomar* | *Presenter
Instituto de Telecomunicações, Universidade de Aveiro - Portugal

Marco A. Fernandes
Instituto de Telecomunicações, Universidade de Aveiro - Portugal
José Leonardo Nascimento
Instituto de Telecomunicações, Universidade de Aveiro - Portugal
Paulo P. Monteiro
Instituto de Telecomunicações, Universidade de Aveiro - Portugal

Thursday 16 September

PHOTONIC ASSISTED THZ WIRELESS COMMUNICATION

11:00 - 11:30

Chair: Leif Katsuo Oxenløwe Technical University of Denmark - Denmark
SC7 - Photonics for RF and Free Space Optics applications

Th2B.1
Free-Space Transmissions in the Upper- and Lower-THz Bands Assisted with Photonics

We report our recent studies in photonics-assisted free-space transmissions in both the lower- (0.3-0.5 THz) and upper- (~64.5 THz) terahertz bands. We adopt the hybrid electro-optical approach for the lower-THz signal transmission, whereas a directly modulated quantum cascade laser is used for the upper-THz band.

Xiaodan Pang | Presenter
KTH Royal Institute of Technology - Sweden
RISE Research Institutes of Sweden - Sweden

Oskars Ozolins
KTH Royal Institute of Technology - Sweden
Riga Technical University - Latvia
RISE Research Institutes of Sweden - Sweden
Shi Jia
Technical University of Denmark - Denmark
Lu Zhang
Zhejiang University - China
Richard Schatz
KTH Royal Institute of Technology - Sweden
Aleksejs Udalcovs
RISE Research Institutes of Sweden - Sweden
Vjaceslav Bobrovs
Riga Technical University - Latvia
Hao Hu
Technical University of Denmark - Denmark
Toshio Morioka
Technical University of Denmark - Denmark
Yan-Ting Sun
KTH Royal Institute of Technology - Sweden
Jiajia Chen
Chalmers University of Technology - Sweden
Sebastian Lourdudoss
KTH Royal Institute of Technology - Sweden
Leif Katsuo Oxenløwe
Technical University of Denmark - Denmark
Sergei Popov
KTH Royal Institute of Technology - Sweden
Xianbin Yu
Zhejiang University - China

ROOM C2

CODED MODULATION

09:00 - 09:30

Chair: Yves Jaouen Telecom Paris - France
SC4 - Techniques for digitally enhancing optical communication

Th1C2.1
Application Aware Forward Error Correction Design

Application aware forward error correction (FEC) design considers system aspects like affordable complexity, power-dissipation, latency limitations, component bandwidths, and rates to be supported as key constraints for optimizing system performance. We study performance enhancement of high-speed Ethernet links as an example.

Andreas Bisplinghoff | Presenter
Cisco Optical GmbH - Germany

Stefan Langenbach
Cisco Optical GmbH - Germany
Theodor Kupfer
Cisco Optical GmbH - Germany

ROOM D

LIDARS

09:00 - 09:30

Chair: Jean Teissier II-VI Laser Enterprise - Switzerland
SC2 - Optoelectronic devices and technologies

Th1D.1
III/V-on-bulk-Si platform: born for DRAM, transplanted to LiDAR

We overview the III/V-on-bulk-Si platform with its key process, device library, feasibility, and outlook for its applications along with comparison to III/V-on-SOI. Our trial on integrating photonics into 65-nm DRAM, laser development on the bulk-Si platform, and circuit and system developments for LiDAR are presented.

Dongjae Shin | Presenter
Samsung Advanced Institute of Technology - South Korea

Hyunil Byun
Samsung Advanced Institute of Technology - South Korea
Dongshik Shim
Samsung Advanced Institute of Technology - South Korea
Jungho Cha
Samsung Electronics - South Korea
Yonghwack Shin
Samsung Electronics - South Korea
Changgyun Shin
Samsung Advanced Institute of Technology - South Korea
Changbum Lee
Samsung Advanced Institute of Technology - South Korea
Eunkyung Lee
Samsung Advanced Institute of Technology - South Korea
Bongyong Jang
Samsung Advanced Institute of Technology - South Korea
Jisan Lee
Samsung Advanced Institute of Technology - South Korea
Inoh Hwang
Samsung Advanced Institute of Technology - South Korea
Kyunghyun Son
Samsung Advanced Institute of Technology - South Korea
Hyuck Choo
Samsung Advanced Institute of Technology - South Korea
Kyoungho Ha
Samsung Advanced Institute of Technology - South Korea

DETECTORS

11:00 - 11:30

Chair: Jean Teissier II-VI Laser Enterprise - Switzerland
SC2 - Optoelectronic devices and technologies

Th2D.1
Very High-Speed Waveguide Integrated Germanium Photo Detectors

We present a photodiode in which germanium is laterally sandwiched in between complementary in-situ doped silicon layers. We demonstrate optoelectrical 3-dB bandwidth >110 GHz with responsivities of 0.6 A/W at 1550 nm, and show, for the first time, results at 1310 nm wavelength.

Lars Zimmermann | Presenter
IHP – Leibniz-Institut für innovative Mikroelektronik - Germany
Technische Universität Berlin, Institut für HF- und HL-Systemtechnologien - Germany

Stefan Lischke
IHP – Leibniz-Institut für innovative Mikroelektronik - Germany
Anna Peczek
IHP Solutions GmbH - Germany
Daniel Steckler
IHP – Leibniz-Institut für innovative Mikroelektronik - Germany
Falk Korndörfer
IHP – Leibniz-Institut für innovative Mikroelektronik - Germany
Jesse Morgan
Department of Electrical and Computer Engineering, University of Virginia - USA
Andreas Beling
Department of Electrical and Computer Engineering, University of Virginia - USA

Thursday 16 September

ROOM E

NETWORK PERFORMANCE

10:00 - 10:30

Chair: Sébastien Bigo Nokia Bell-Labs - France
SC10 - Architecture, Control and Management of optical networks

Th1E.5
Disaggregation and cloudification of metropolitan area networks: impact on architecture, cost and power consumption

The article deals with the ongoing change in the architecture of metropolitan area networks, hard-pressed on one side by the deployment of 5G and new wireline systems and on the other side by the emerging of HW/SW disaggregation and cloudification paradigms.

Marco Quagliotti* | *Presenter
TIM Telecom Italia - Italy

Laura Serra
TIM Telecom Italia - Italy
Annachiara Pagano
TIM Telecom Italia - Italy

ROOM F

OPTICAL ACCESS NETWORKS FOR 5G

09:00 - 09:30

Chair: Fabienne Saliou
SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

Th1F.1
Human Centric Networking: From device centric 5G networks to full cyber-physical convergence in 6G

This paper outlines a novel vision of human-centric networking with the potential to drive a breakthrough in the way of designing and delivering future networks and services. New concepts of

“Collective-Intelligence” and sociotechnical design are introduced as key pillars driving future network architectures.

Dimitra Simeonidou* | *Presenter
Smart Internet Lab, University of Bristol - UK

Reza Nejabati
Smart Internet Lab, University of Bristol - UK

TOWARDS 6G OPTICAL NETWORKS

11:00 - 11:30

Chair: Paulo P. Monteiro University of Aveiro - Portugal
SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

Th2F.1
Optical Access Network for Future Super-Broadband Services and 6G Mobile Networks

This paper first reviews the history and the current state of the optical access network. It then discusses how the optical access network will change given overall network evolution to realize super-broadband services as well as to support 6G mobile networks.

Jun-ichi Kani* | *Presenter
NTT Corporation - Japan

Tomoaki Yoshida
NTT Corporation - Japan
Kazutaka Hara
NTT Corporation - Japan
Shin Kaneko
NTT Corporation - Japan

ROOM G

QUANTUM COMMUNICATION AND QUANTUM-KEY DISTRIBUTION IN OPTICAL FIBERS

11:00 - 11:30

Chair: Helmut Grießer ADVA Optical Networking SE - Germany
SC6 - Theory of Optical Communications and Quantum Communications

Th2G.1
Quantum-communication using multicore fibers

Quantum communication represents a key enabler for many applications from secure communications to advanced quantum simulations on the cloud. We here report our recent results on the generation, transmission and detection of high-dimensional quantum states exploiting multicore fibers.

Davide Bacco* | *Presenter
Technical University of Denmark - Denmark

Daniele Cozzolino
Technical University of Denmark - Denmark
Nicola Biagi
National Institute of Optics (INO-CNR) - Italy
Alessandro Zavatta
National Institute of Optics (INO-CNR) - Italy
Leif Katsuo Oxenløwe
Technical University of Denmark - Denmark

Special events

Special events Monday 13 September

ROOM A

WON - PART 1

13:30 - 15:00

Mo3A-SE
Wideband Optical Networks (WON)

This Special Event will focus on research in Wideband Optical Networks, particularly as pursued within the framework on the Horizon 2020 European Training Networks "Wideband Optical Networks" (Grant Agreement 814276), which supports 14 Early Stage Researchers (ESRs) hosted by Aston University, Infinera, Danmarks Tekniske Universitet, Technische Universiteit of Eindhoven, Universiteit Gent, Fraunhofer HHI, Politecnico di Torino, and VPIphotonics, supported by partners from Keysight, Finisar, Technische Universitaet Berlin, Universidade de Lisboa, and Orange.

Wideband Optical Networking has emerged as a topic of great global interest in recent years addressing near to mid-term requirements. Systems based on Wideband Technology are attractive to end-users because they leverage the massive investment in the single mode optical fibre plant already deployed in millions of km worldwide, by potentially making use of the whole low-loss transmission window, from ~1250nm to ~1650nm. This approach provides a cost-effective and green solution to increasing capacity, when compared to solutions requiring the deployment of new fibre cables. Many research challenges remain, however, such as the availability of highly integrated wideband optical components and sub-systems, bandwidth allocation, spectral power management, and the impact of the Raman effect in such high bandwidth systems.

The Special Event will begin with an introduction to the ITN WON project, its context and highlights from its work packages, followed by a series of short "lightning presentations" from the ESRs focussing on their specific subjects of interest, and conclude with an extended external presentation on the current state-of-the-art in Wideband Optical Networks research from Dr Ben Puttnam of NICT, Japan.

ORGANIZERS:

Wladek Forysiak
Aston University - UK

Antonio Napoli
Infinera - Germany

SPEAKERS:

Wladek Forysiak
Aston University - UK
Introduction to ETN «Wideband Optical Networks»

Vittorio Curri
Politecnico di Torino - Italy
Overview of WP1 - Network management: planning and control, and WP2 - Digital signal processing and system modelling

Johannes K. Fischer
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Overview of WP3 - In-line components design, and WP4 - Transceiver components design

Elliot London
Politecnico di Torino - Italy
Nonlinear interference generation in wideband and disaggregated optical networks

Bruno Correia
Politecnico di Torino - Italy
Impact on quality of transmission of launch power choice for wide-band scenarios

Rasoul Sadeghi
Politecnico di Torino - Italy
Comparison of Transparent C+L Band Network versus C-band Translucent Upgrade

Aleksandr Donodin
Aston University - UK
Bismuth-doped fibre amplifier as a promising solution for multi-band transmission networks

Pratim Hazarika
Aston University - UK
Multistage Raman amplifier for ultra-wideband signal amplification

Rafael Kraemer
Technology University of Eindhoven - The Netherlands
Multi-band wavelength selective switching in metro networks

Yu Wang
Technology University of Eindhoven - The Netherlands
Ultra-wide band (O to L) integrated polymer TIR thermo-optic switch matrix

Emadreza Soltanian
Ghent University - IMEC - Belgium
Micro-transfer-printing integration of III-V-on-Si to realize SOAs and tuneable lasers

Thyago Monteiro Sá Pinto
Technical University of Denmark - Denmark
Optical Frequency Combs Optimization using Evolutionary Algorithms

Yaonian Cui
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Broadband InP based Mach-Zehnder Modulator

Matheus Sena
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Enabling cognitive transceivers for multiband operation

Gabriele Di Rosa
VPIphotonics - Germany
Wavelength-Dependency of Standard C-Band Transceivers Performance in Multiband Systems

Andre Souza
Infinera - Portugal
Going beyond C+L-band Transmission: Accurate and Scalable Quality of Transmission Estimation and its applications

Benjamin Puttnam
National Institute of Information and Communications Technology - Japan
Extending transmission window and data-rates in SMF and low spatial-channel count SDM fibers

Special events Monday 13 September

ROOM A

WON - PART 2

15:30 - 17:00

Mo4A-SE
Wideband Optical Networks (WON)

This Special Event will focus on research in Wideband Optical Networks, particularly as pursued within the framework on the Horizon 2020 European Training Networks "Wideband Optical Networks" (Grant Agreement 814276), which supports 14 Early Stage Researchers (ESRs) hosted by Aston University, Infinera, Danmarks Tekniske Universitet, Technische Universiteit of Eindhoven, Universiteit Gent, Fraunhofer HHI, Politecnico di Torino, and VPIphotonics, supported by partners from Keysight, Finisar, Technische Universitaet Berlin, Universidade de Lisboa, and Orange.

Wideband Optical Networking has emerged as a topic of great global interest in recent years addressing near to mid-term requirements. Systems based on Wideband Technology are attractive to end-users because they leverage the massive investment in the single mode optical fibre plant already deployed in millions of km worldwide, by potentially making use of the whole low-loss transmission window, from ~1250nm to ~1650nm. This approach provides a cost-effective and green solution to increasing capacity, when compared to solutions requiring the deployment of new fibre cables. Many research challenges remain, however, such as the availability of highly integrated wideband optical components and sub-systems, bandwidth allocation, spectral power management, and the impact of the Raman effect in such high bandwidth systems.

The Special Event will begin with an introduction to the ITN WON project, its context and highlights from its work packages, followed by a series of short "lightning presentations" from the ESRs focussing on their specific subjects of interest, and conclude with an extended external presentation on the current state-of-the-art in Wideband Optical Networks research from Dr Ben Puttnam of NICT, Japan.

ORGANIZERS:

Wladek Forysiak
Aston University - UK

Antonio Napoli
Infinera - Germany

SPEAKERS:

Wladek Forysiak
Aston University - UK
Introduction to ETN «Wideband Optical Networks»

Vittorio Curri
Politecnico di Torino - Italy
Overview of WP1 - Network management: planning and control, and WP2 - Digital signal processing and system modelling

Johannes K. Fischer
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Overview of WP3 - In-line components design, and WP4 - Transceiver components design

Elliot London
Politecnico di Torino - Italy
Nonlinear interference generation in wideband and disaggregated optical networks

Bruno Correia
Politecnico di Torino - Italy
Impact on quality of transmission of launch power choice for wide-band scenarios

Rasoul Sadeghi
Politecnico di Torino - Italy
Comparison of Transparent C+L Band Network versus C-band Translucent Upgrade

Aleksandr Donodin
Aston University - UK
Bismuth-doped fibre amplifier as a promising solution for multi-band transmission networks

Pratim Hazarika
Aston University - UK
Multistage Raman amplifier for ultra-wideband signal amplification

Rafael Kraemer
Technology University of Eindhoven - The Netherlands
Multi-band wavelength selective switching in metro networks

Yu Wang
Technology University of Eindhoven - The Netherlands
Ultra-wide band (O to L) integrated polymer TIR thermo-optic switch matrix

Emadreza Soltanian
Ghent University - IMEC - Belgium
Micro-transfer-printing integration of III-V-on-Si to realize SOAs and tuneable lasers

Thyago Monteiro Sá Pinto
Technical University of Denmark - Denmark
Optical Frequency Combs Optimization using Evolutionary Algorithms

Yaonian Cui
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Broadband InP based Mach-Zehnder Modulator

Matheus Sena
Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany
Enabling cognitive transceivers for multiband operation

Gabriele Di Rosa
VPIphotonics - Germany
Wavelength-Dependency of Standard C-Band Transceivers Performance in Multiband Systems

Andre Souza
Infinera - Portugal
Going beyond C+L-band Transmission: Accurate and Scalable Quality of Transmission Estimation and its applications

Benjamin Puttnam
National Institute of Information and Communications Technology - Japan
Extending transmission window and data-rates in SMF and low spatial-channel count SDM fibers

Special events Monday 13 September

ROOM C1

MOPA - PART 1

13:30 - 15:00

Mo3C1-SE
Mobile Optical Pluggable Alliance (MOPA) - what is around the corner

MOPA is a multi-lateral industry-driven initiative, created to provide a common industry view of the relevant optical solutions for 5G mobile transport, to facilitate network evolution for mobile operators and mobile transport network equipment manufacturers. The initiative was launched at OFC 2021 (June 8, 2021) with the publication of a technical paper which was authored by 23 technical experts from two RAN vendors (Ericsson, Nokia) and three optical pluggable vendors (II-VI, Lumentum and Sumitomo), describing all relevant high-level requirements for optical solutions for 5G mobile transport. Each of the solutions or Blueprints captures the different network solutions relevant components including the optical pluggable for passive and active network deployments, and for each use case the high-level optical requirements are documented.

The focus of the paper is on current mainstream solutions, implemented with the best technologies, but there are new problems that need new solutions and technologies. Examples are:

environmental operating aspects including high temperature operating condition (above 100°C); cost efficient high-capacity transceivers for both coherent and direct detection; pluggable optical amplifiers and dispersion compensators; higher speed and lower latency TDM-PON technologies; and DWDM wavelength multiplexed links over a power splitter ODN (WS-WDM-PON) architectures. These technological developments will allow cost-efficiently evolution of mobile transport networks and to support higher capacities and longer distances. To improve the eco-system understanding in terms of cost efficiency and time to market versus product requirements and complexity, special is dedicated to moving technologies from research and proof of concepts to technology market readiness in a timely manner.

On one hand, the RAN system vendors concerned about the requirements of the next generation mobile networks want to ensure that the optical transport network and associated pluggables are future proof as such: the right set of variants to improve time to market and fewer variants at higher volumes to reduce cost. Meanwhile, pluggable vendors are eager to get clearer and more coherent guidance on the market needs in order to increase foresight of volume and timing, lower product development uncertainty and have a stable and sustainable global technology supply chain. Finally, mobile network operators could benefit from having a better understanding of the evolution of the optical transport technology for radio access, as well as a more coherent and consolidated message from the industry offering a better foresight for choosing and protecting network technology investment, and reduced risk for interworking issues.

ORGANIZERS:

Fabio Cavaliere
Ericsson - Italy

Ronald Heron
Nokia - Canada

SPEAKERS:

Fabienne Saliou
Orange Labs - France
Which optics flavors are the best for our mobile X-haul networks ?

Lieven Levrau
Nokia - Germany
Mobile optical pluggable - a strategy for optimisation

Antonio Tartaglia
Ericsson - Italy
Mind the telecom/datacom gap: emerging technologies for future mobile optical blueprints

ROOM C1

MOPA - PART 2

15:30 - 17:00

Mo4C1-SE
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ORGANIZERS:

Fabio Cavaliere
Ericsson - Italy

Ronald Heron
Nokia - Canada

SPEAKERS:

Kenneth Jackson
Sumitomo Electric - USA
MOPA Optical Interfaces - Technologies and Standards

Justin Abbott
Lumentum - Canada
MOPA Optical Interfaces - Technologies and Standards ?

Ken Cockerham
II-V Incorporated - USA
MOPA Optical Interfaces - Technologies and Standards

Special events Monday 13 September

ROOM F

FTTR - PART 1

13:30 - 15:00

Mo3F-SE
Bringing fiber to last meter: Fiber to the Room - Session 1: Operators

Now that fiber has made strong inroads into the access portion of the network, the industry can begin to think about ways to extend fiber all the way to the end user. This exciting new area of research has been called Fiber to the Room (FTTR) and encompasses any kind of home optical network.

In the domain of home networking, wireless Ethernet has become ubiquitous. And yet, there are scenarios and applications where it does not really solve all the problems. Some homes and businesses are arranged such that good coverage in all rooms is not possible. Some applications cannot tolerate the unreliability and uncontrollability of wireless networking. In these cases, FTTR can serve as a complementary solution that fills in the gaps and satisfies the unmet requirements.

FTTR raises many diverse questions. What kind of fiber will be used, and how will it be installed? What kind of optoelectronics are most optimal for this short reach application? Which network topologies will be supported? Will passive optical networking technology be the basis for FTTR, or will it be based on some other system? How will the in-home network interwork with the access network, and who will manage it? What are the commercial and regulatory aspects of fiber installed inside of the customer premises? What are the practical issues that may impact the deployment and operation of these systems? This event will bring together a diverse set of speakers from multiple sectors of the industry to discuss these issues and more.

ORGANIZERS:

Frank Effenberger
Futurewei Technologies - USA

Luca Pesando
Telecom Italia - Italy

SPEAKERS:

Manoj Jaitly
Verizon - USA
Fiber inside the premises in the VZ network

Yan Shao
China Unicom Research - China
CU smart home network challenge and solution

Zhonghai You
CN Land & Dev - China
The Future home based on FTTR

Philippe Chanclou
Orange Labs - France
Fiber inside the customer premises

Special events Monday 13 September

ROOM F

FTTR - PART 2

15:30 - 17:00

Mo4F-SE
Bringing fiber to last meter: Fiber to the Room - Session 2: Technology

Now that fiber has made strong inroads into the access portion of the network, the industry can begin to think about ways to extend fiber all the way to the end user. This exciting new area of research has been called Fiber to the Room (FTTR) and encompasses any kind of home optical network.

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ORGANIZERS:

Frank Effenberger
Futurewei Technologies - USA

Luca Pesando
Telecom Italia - Italy

SPEAKERS:

Tony Zeng
Home Networks,Huawei - China
Thoughts of Fibre-to-The-Room architecture and technologies

Martin Warne
OFS - USA
Optical Cabling Solutions to Enable FTTR

Gangxiang Shen
Soochow University - China
Research prospects of F5G-oriented PON and WiFi convergence technology

Wei Hong
South Eastern University - China
A Perfect Solution for Indoor High Throughput Short-range Wireless Access: mmWave WLAN + FTTR

Special events Monday 13 September

ROOM E

FTTR - PART 1

17:15 - 19:00

Mo5E
Opening and Plenary Session

17:15 - 17:22 ECOC 2021 General Chairs Jean Pierre Hamaide & Christian Lerminiaux
17:22 - 17:30 ECOC 2021 Technical Programme Chairs Pierre Sillard & Philippe Chanclou
17:30 - 18:00 Keynote 1 - Jean Lajzerowicz
18:00 - 18:30 keynote 2 - Theodore Sizer
18:30 - 19:00 Keynote 3 - Christophe Cassou

ORGANIZERS:

Jean-Pierre Hamaide
III-V lab - France

Christian Lerminiaux
Chimie ParisTech-PSL - France

Philippe CHANCLOU
Orange Labs - France

Pierre Sillard
Prysmian Group - France

SPEAKERS:

Jean Lajzerowicz
CEA/CESTA - France
LMJ-PETAL facility: quick overview

Theodore Sizer
EVP Optical Research, Nokia Bell Labs - USA
Key Industry Inflection Points driving Optical Communications

Christophe Cassou
Cerfacs-CECI (Couplage Environnement Climat Incertitude) - France
6th IPCC report: a reality check and a wake-up call

Special events Tuesday 14 September

ROOM B

LABAUTOMATION HACKATON - PART 1

14:00 - 15:30

Tu3B-SE
Labautomation Hackathon

Lab work is most efficient when data can be acquired in an automated way, especially when taking measurements over long durations. Automated acquisition avoids introducing human error and allows researchers to concentrate on the fun part of experimental work. Open source software in easy-to-learn languages such as Python provides just as much, or more features/interoperability for lab automation than alternative commercial software.

The hackathon will run as multiple parallel interactive demo sessions with for plenty of time for Q&A with the presenters to ask about their tips and tricks. Demos include researchers with 10+ years in labautomation presentikng how they use Python to automate their experiments, speed up their simulations, and display their measurements in graphical user interfaces. Attendees will learn from companies that work in photonics and how they take advantage of Python to create easy interfaces to their software and hardware. Students will be able to show how they are developing new tools to complete their PhD.

There is plenty of opportunity to just network, talk with others about their challenges and solutions or just hang out with other photonics researchers. Food and drinks will be provided.

ORGANIZERS:

Jochen Schröder
Chalmers University of Technology - Sweden

Nicolas Fontaine
Nokia Bell Labs - USA

Roland Ryf
Nokia Bell Labs - USA

Binbin Guan
Microsoft - USA

Mikael Mazur
Nokia Bell Labs - USA

Marco Eppenberger
ETH Zürich - Switzerland

Special events Tuesday 14 September

ROOM B

LABAUTOMATION HACKATHON 2

16:15 - 17:45

Tu4B-SE
Labautomation Hackathon

Lab work is most efficient when data can be acquired in an automated way, especially when taking measurements over long durations. Automated acquisition avoids introducing human error and allows researchers to concentrate on the fun part of experimental work. Open source software in easy-to-learn languages such as Python provides just as much, or more features/interoperability for lab automation than alternative commercial software.

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Roland Ryf
Nokia Bell Labs - USA

Binbin Guan
Microsoft - USA

Mikael Mazur
Nokia Bell Labs - USA

Marco Eppenberger
ETH Zürich - Switzerland

Workshops

Workshops

Monday 13 September
09:00 - 10:30

ROOM A

RECENT PROGRESS AND FUTURE CHALLENGE TOWARDS PRACTICAL APPLICATIONS OF SDM FIBERS - PART 1

SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers

ORGANIZERS:

Itsuro Morita
KDDI Research Inc. – Japan

Lars Grüner-Nielsen
Technical University of Denmark - Denmark

Benyuan Zhu
OFS Laboratories - USA

Mo1A-WS
Recent progress and future challenge towards practical applications of SDM fibers

Space division multiplexing (SDM) using multi-core fibers and few-mode fibers is a potential technology for future optical transmission systems and has been intensively studied over the last decade. With SDM technologies, high-capacity transmission over 10 Pbit/s has successively demonstrated in the laboratory recently. However, there still remains a number of unsolved problems for the actual deployment of SDM technologies. This workshop will review and discuss the recent progress and future challenge of SDM technologies towards their commercialization.

The focus of this workshop is to investigate the practical elements associated with SDM technologies, including the following:

- Current status and future perspective of standardization
- Expected application areas
- Field evaluation on the deployed fibers
- Cost-effective fiber fabrication and measurement methods
- Compatibility with conventional fibers
- Suppression of SDM inherent properties, such as the crosstalk, dispersion and loss between SDM passes
- Connection and amplification technologies

SPEAKERS:

Valey Kamalov
Google - USA
Perspective and requirement for multicore fiber cables for submarine systems

John Downie
Corning - USA
Maximum capacity in submarine systems: evaluation of different SDM options

Alan McCurdy
OFS - USA
Standardization of multi core fibers

Cristian Antonelli
University of L'Aquila - Italy
Field test of deployed SDM fibers

Tetsuya Hayashi
Sumitomo Electric Industries, Ltd - Japan
Recent status of standard-diameter multi-core fibers

Kazunori Mukasa
Furukawa Electric Co., Ltd. - Japan
The way to reduce the cost per core of multi-core fibers taking fiber manufacturing and connections into account

Yongmin Jung
University of Southampton - UK
Multicore EDFA, status and challenges for practical application

Workshops

Monday 13 September
09:00 - 10:30

ROOM B

HOW MACHINE LEARNING CAN REVOLUTIONIZE OPTICAL FIBER COMMUNICATIONS? PART 1

SC4 - Techniques for digitally enhancing optical communication

ORGANIZERS:

Ezra Ip | *NEC Laboratories America - USA*
Faisal Khan | *Tsinghua University - China*
Christian Häger | *Chalmers University of Technology - Sweden*

Mo1B-WS
How machine learning can revolutionize optical fiber communications?

Recently, there has been a global trend towards using machine learning to improve everyday life. Machine learning models are well suited to problems with no clear analytical solutions, such as image recognition, natural language processing, medical diagnostics, game playing, etc. In telecommunications, there are many problems where analytical solutions are either not obvious, or are computationally difficult to solve. There has been a trend towards using machine learning across all aspects of optical fiber communications from device modeling to transponder impairment compensation to fiber nonlinearity compensation to link modeling to network planning and optimization.

This workshop will be in three parts: part one will focus on how ML can guide the design of optical components and predict their performance; part two will focus on algorithms for link compensation; and part three will focus on the network layer, covering link performance prediction, network optimization & management, and offer a carrier's perspective on how ML can assist the provisioning of services.

In each part, speakers will give 6-minute presentations on a topic targeted by the workshop, followed by 4-minute interactive panel discussion at the end. After all three parts are concluded, there will be an additional 30 minutes for interactive panel discussion with all of the speakers."

Part I: Optical components
1. Darko Zibar: Machine learning for the inverse design of optical amplifiers
2. Maxim Kushnerov: Deep learning applications in coherent optical modems
3. Keisuke Kojima: Machine learning for design and optimization of photonic devices
4. Dan Kilper: Machine learning based optical amplifier gain estimation

Part II: Link compensation
5. Elias Giacoumidis: Unsupervised machine learning for modern transmission systems
6. Berthold Bitachon: Replacing digital backpropagation with neural network
7. Vladislav Neskorniuk: Machine learning methods for nonlinearity mitigation in the physical layer of fiber-optic communication links
8. Shinsuke Fujisawa: Expectations and perspectives from industry on photonic platform for AI-processing in telecommunications

Part III: Network layer applications:
9. Boris Karanov: End-to-end link optimization using deep learning
10. Faisal Nadeem Khan: Comparison of ML and analytical models for lightpaths QoT estimation
11. Marija Furdek: Applications of ML for network security management
12. Luis Velasco: Applications of ML for network control
13. Massimo Tornatore: Routing and spectral assignment using ML-based QoT models
14. Glenn Wellbrock: Carrier's perspective on how ML can assist terrestrial networks
15. Ahmed Triki: Carrier's perspective on how ML can revolutionize terrestrial optical communication networks

SPEAKERS:

Darko Zibar | *DTU - Denmark*
Machine learning for the inverse design of optical amplifiers

Maxim Kuschnerov | *Huawei Munich - Germany*
Deep learning applications in coherent optical modems

Keisuke Kojima | *Mitsubishi - USA*
Machine learning for design and optimization of photonic devices

Dan Kilper | *Trinity College - Ireland*
Machine learning based optical amplifier gain estimation

Elias Giacoumidis | *Dublin City University - Ireland*
Unsupervised machine learning for modern transmission systems

Bertold Ian Bitachon | *ETH Zurich - Switzerland*
Replacing digital backpropagation with neural network

Vladislav NeskorniUK
Aston University - UK
Machine learning methods for nonlinearity mitigation in the physical layer of fiber-optic communication links

Shinsuke Fujisawa | *NEC Corp. - Japan*
Expectations and perspectives from industry on photonic platform for AI-processing in telecommunications

Boris Karanov | *Technology University of Eindhoven - The Netherlands*
End-to-end link optimization using deep learning

Faisal Khan | *Tsinghua University - China*
Comparison of machine learning and analytical models for lightpath QoT estimation

Marija Furdek | *Chalmers University of Technology - Sweden*
Applications of machine learning for network security management

Luis Velasco | *Universitat Politècnica de Catalonia - Spain*
Applications of machine learning for network control

Massimo Tornatore | *Politecnico di Milano - Italy*
Routing and spectral assignment using machine learning based QoT models

Glenn Wellbrock | *Verizon - USA*
Carrier's perspective on how machine learning can assist terrestrial networks

Ahmed Triki | *Orange Labs - France*
Carrier's perspective on how machine learning can revolutionize terrestrial optical communication networks

Workshops

Monday 13 September
09:00 - 10:30

ROOM C1

CO-PACKAGING: HOW MANY FIBERS IS TOO MANY? PART 1

SC3 - Integrated and co-integrated circuits

ORGANIZERS:

Daniel Kuchta
IBM Research - USA

Mo1C1-WS
Co-Packaging: How many fibers is too many?

Co-packaging of optical transceivers with their data source (Switch or CPU/GPU) on the same first level package is viewed by many to be the strategic solution to the simultaneous problems of high bandwidth escape and power dissipation of large ICs. In this arena, there are proposals for individual optical modules with fiber counts on the order of 40 and full configurations of these optical modules approaching or exceeding 1000 fibers. The industry has not demonstrated prior commercial success with high-fiber-count transceivers. In fact the track record has been rather dismal. At the start of this century, three companies were producing transceivers with 36, 48, and 72 fibers respectively. All three are no longer in existence. In this past decade, another company appeared with a 336 fiber transceiver. It, too, is gone. Were these companies ahead of their time or are there fundamental problems with high-fiber-count devices?

This workshop will discuss progress towards high-fiber-count co-packaged optical transceivers with a focus on fiber related issues. One of the issues is related to scaling. If the solution today incorporates 40 fibers, how many will be used in the next generation? Will optical transceivers use 80 or 160 fibers and if so, how will this be accomplished? Does this require a smaller diameter fiber? When, if ever, does it make sense to use multicore fibers? Smaller diameter fibers enable a finer pitch. Are there limits to the pitch of V-grooves in Si or the pitch of arrays of microlenses? Scaling is also possible using higher data rates and more wavelengths. Is there a limit to the number of wavelengths that can be added? Large numbers of wavelengths per fiber are suitable for “fat” point to point links but not for links that need breakouts like 1:4, for example.

During ECOC2020 workshops, one large data center operator stated that mishandling of fiber cables and pluggable optics was their primary field reliability issue. How will this be avoided with high-fiber-count co-packaged modules? Are the OSATs (Outsourced Semiconductor Assembly and Test) ready to handle a large number of fibers? Are they able to handle pigtailed optics and assemble into delicate LGAs or to attach multiple connectors to an assembly? What are the issues with protecting the fibers within air cooled systems that provide hurricane force winds? Is water cooling the solution or just a different problem? And there is the mundane but important topic of slack management.

SPEAKERS:

Alexander Janta-Polczynski
IBM Bromont - Canada
Bandwidth Density with Photonic Co-packaging

Karl Muth
Broadcom - USA
There can not be enough fiber!

Tiger Ninomiya
Senko - Japan
How to deal with “too many fibers”

Hong Nguyen
Sumitomo Electric Industries, Ltd - Japan
Fiber Connectivity and Management in Co-Packaging

Henning Lysdal
NVIDIA - Denmark
CPO! This too is all about alignment

Mike Tan
HPE - USA
A CWDM Co-packaged optical module for short reach Data Center links

Jeff Hutchinson
OIF - USA
Co-packaging: Challenges of Implementing Multi-Terabyte Fiber Connectivity

Brian Kirk
Amphenol - USA
Copper and Optical Hybrid Co-packaging

Dominic Goodwill
Huawei - Canada
The limits of fiber attach to silicon photonics

Workshops

Monday 13 September
09:00 - 10:30

ROOM C2

APPLICATIONS FOR IMDD AND COHERENT IN SHORT REACH SYSTEMS. PART 1

SC4 - Techniques for digitally enhancing optical communication

ORGANIZERS:

Christopher Fludger
Infinera - Germany
Jochen Maes
Nokia Bell Labs - Belgium
Xi Chen
Nokia Bell Labs - USA

Mo1C2-WS
Applications for IMDD and Coherent in Short Reach Systems

This workshop will reveal decision factors for intensity modulation and direct detection (IM-DD) and coherent transmission in short-reach systems (e.g. intra-data center connections, passive optical networks (PON), and all other applications that cover transmission distances up to 20 km) where IMDD are incumbent and coherent is a contender. We will discuss, in the foreseeable future, what are the right applications for IMDD systems and coherent systems, as well as whether there will be a role for self-coherent solutions such as Kramers-Krönig (KK) receivers, Stokes receivers, and phase retrieval techniques.

In this workshop, we aim to discuss and answer the following questions

- What are the unique advantages of coherent systems? Is coherent inevitable?
- Since IM-DD and self-coherent systems allow uncooled lasers, will this be a key benefit that prevents coherent to take over for short-distance applications?
- For applications where the optical loss over the communication channel is high, do the required laser and amplifier power make coherent a bad choice?
- How much digital signal processing (DSP) is too much for short-reach systems?
- Will anyone make the effort to develop something other than IMDD or Coherent (e.g. Stokes receivers, KK receivers, etc.)?
- Is electrical bandwidth efficiency important? Are operators happy with increasing the number of fibers / parallel optics at lower data rates?
- We hear a lot about coherent PON at conferences recently. Is coherent PON becoming a reality?
- What is the network operators' view?
- Does the cost breakdown of an optical transceiver module show an advantage for IMDD vs Coherent vs Stokes receivers?

SPEAKERS:

Chris Cole
II-V Incorporated - USA
Coherent is a hammer trying to contort the datacenter into a nail

Tom Wettlin
Kiel University - Germany
Direct-detection is the right choice ?

Fernando P. Guiomar
University of Aveiro - Portugal
Coherent transceivers have so many advantages, they cannot be ignored

Johan Bäck
Infinera GmbH - Germany
Coherent selection will be a requirement for future short-reach system

David Plant
McGill University - Canada
High performance silicon photonic modulators for data center interconnects

Philippe Chanclou
Orange Labs - France
Do we have Optical Line Terminal shelf for next generation access demands ?

Workshops

Monday 13 September
09:00 - 10:30

ROOM D

NEUROMORPHIC COMPUTING - IS IT GOING TO SHIFT SIGNAL PROCESSING TO A NEW LEVEL? PART 1

SC5 - Optical Transmission systems

ORGANIZERS:

Stephan Pachnicke
Kiel University - Germany

Peter Bienstman
Ghent University - IMEC - Belgium

Mo1D-WS
Neuromorphic Computing – Is it going to shift signal processing to a new level?

Conventional signal processing in the electrical domain based on binary computing faces various technological and economical limitations. The further scaling of transistors to smaller feature sizes may end soon at about 3nm due to physical, technological and economic constraints. At the same time the exponential growth of physical layer interfaces' bit rates is expected to continue in the foreseeable future leading to an exponential growth of the power dissipation of processors, if no disruptive technology shift is taken.

In the recent past artificial intelligence concepts are being tested for various problems in the optical transmission system environment. It has been shown that problems such as failure prediction, optical performance monitoring and nonlinearity compensation just to name a few can profit from machine learning approaches. Nevertheless, these concepts mostly rely on numerical implementations, which are still being executed in classical (electrical) signal processing hardware.

To be scalable to much higher signal processing speeds (or bandwidths) and significantly lower energy consumption per bit radically new paths have to be followed. In that respect also concepts borrowed (or adapted) from the nature and implemented in the optical or electrical domain are appealing. Potential realizations of neural networks in the optical domain are for example reservoir computing concepts. Also other concepts such as photonic neuron architectures have been investigated in the past and offer radically new ways of information processing. Furthermore, bio inspired neural networks in the electrical domain may offer significant advantages such as much lower power consumption than today's electrical signal processing circuits.

This workshop shall investigate information processing based on neuromorphic circuits in the optical and electrical domain. It shall shed light on how and when such approaches may be ready for implementation into optical transmission systems and what advantages they may offer. Furthermore, current limits and technological hurdles shall be discussed.

SPEAKERS:

Ghazi Sarwat
IBM - Switzerland
Brain Inspired Data Processing Using Resistive Memories

Francesca Parmigiani
Microsoft - UK
Optical Computing for the Cloud: Challenges and Opportunities

Laurent Daudet
LightOn - France
Scaling up AI with Photonics Computing

Piotr Cegielski
AMO GmbH - Germany
Silicon photonics for optical neuromorphic computing

Bofang Zheng
Huawei - China
More than Moore for next generation signal processing for fiber optical communication

Workshops

Monday 13 September
09:00 - 10:30

ROOM E

ENABLING 6G NETWORKS - PART 1

SC10 - Architecture, Control and Management of optical networks

ORGANIZERS:

Dimitra Simeonidou
Smart Internet Lab, University of Bristol - UK
Reza Nejabati
University of Bristol - UK
Sergi Figuerola Fernandez
i2CAT - Spain
Luiz DaSilva
Virginia Tech - USA

Mo1E-WS
Enabling 6G Networks

As mobile networks are evolving from the 5th to the 6G generation, we need to address requirements for technological breakthroughs and challenges, along with commercial and societal drivers for such evolution.

It is expected that 6G networks will drive a full convergence of cyber and physical systems enabling a seamlessly connected, fully inclusive and equitable digital society.

New standards will support huge data rate (+1Tbps) and extremely low delay (0.1ms) and will also enable “hyper-connected” infrastructures of users and things, creating an “Internet of Senses”.

Moreover, Artificial Intelligence (AI) will play a major role within 6G, which on its own will consume massive computation and communication resources.

As such, the future 6G network complexity will be unprecedented, due to the ultra-high-performance requirements, widely diverse applications and hyper-scale. Examples will include very low latency for critical vehicle communication, the growing demand of high positioning accuracy for location- based services, and ultra-dense heterogeneous architectures.

Several emerging topics need to be considered within 6G and this workshop will focus on such topics, and potential solutions will be presented and debated. The list of topics includes, but not restricted to the following:

- New network architectures enabling 6G KPIs including speed, latency, location accuracy, densification, etc.
- Emerging 6G technological needs including multi-access convergence, optical networking, cloudification, disaggregation, convergence with non-terrestrial systems.
- End-to-end open cellular architectures: from Open RAN to transport and core.
- New security approaches for 6G including quantum.
- Artificial Intelligence (AI) for 6G communications.
- 6G Radio Technologies including Terahertz.
- Visible Light Communications for 6G.
- Novel signal processing techniques for 6G communications.
- Dynamic spectrum access/sharing at the 6G bands.
- Spectrum regulatory for 6G bands.
- Technology governance focusing on native open-source, big data, infrastructure and resource sharing.
- 6G-enabled Internet of Senses.
- Sociotechnical considerations and methodology.
- 6G Applications such as Internet of Skills, Holographic Society, Digital Twins, etc.

SPEAKERS:

David Soldani
UNSW/Sydney - Australia
6G Fundamentals

Howard Benn
Samsung - UK
6G the hyper-connected experience for all

Juan Pedro Fernández-Palacios
Telefonica - Spain
How to build a vendor agnostic Transport SDN architecture for 6G networks

Jörg-Peter Elbers
ADVA Optical Networking SE - Germany
6G networks: wireless only or impossible without more wires

Workshops

Monday 13 September
09:00 - 10:30

ROOM F

OPTICAL NETWORK EVOLUTION TOWARDS F5G AND BEYOND (ORGANIZED BY ETSI ISG-F5G)) - PART 1

SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

ORGANIZERS:

Philippe Chanclou
Orange Labs - France
Luca Pesando
Telecom Italia - Italy
Xiang Liu
Futurewei Technologies - USA

Mo1F-WS
Optical Network Evolution towards F5G and Beyond

Optical network is playing an increasingly important role in supporting broadband services to homes, offices, shopping centres, business buildings, factories, smart cities, and much more. Reaching deeper to final access points, optical fibre will realize its full potential to support a fully connected, intelligent world with high bandwidth, high reliability, low latency, and low energy consumption. With the fiber-to-everywhere vision, the European Telecommunications Standards Institute (ETSI) established at the beginning of 2020 an industry specification group (ISG) dedicated to the definition and specification of the 5th generation fixed network (F5G). Since then, the first release of 14 use cases of F5G have been published and based on those a complete analysis of the gaps in fibre networks standards and the requirements for their evolution to F5G are going to be published soon, as well as the general architecture. With the mobile network evolving beyond 5G and similar evolution for wireless local area network (WiFi and LiFi), it is timely to consider the evolution of optical networks beyond F5G, expanding the application scenarios of enhanced fixed broadband (eFBB), guaranteed reliable experience (GRE), and full-fibre connection (FFC).

This workshop aims to provide an up-to-date overview of the progresses made in F5G and encourage stimulating discussion on the future evolution beyond F5G. The topics of this workshop include:

- F5G network architecture
- F5G use cases with focus on service enablement
- Advances in end-to-end (E2E) optical network slicing
- The use of F5G to better support Industry 4.0 and industrial internet of things (IIOT)
- Energy-efficient broadband communication
- Real-time broadband communication
- Harmonized communication and sensing/positioning
- Enabling fibre optical technologies for ubiquitous F5G
- AI-assisted autonomous driving network technologies for F5G
- Evolution towards F6G: How optical network would look like in 2025 and 2030

SPEAKERS:

Luca Pesando
Telecom Italia - Italy
Progresses and Future Plans of ETSI ISG-F5G

Andreas Gladisch
Deutsche Telekom - Germany
Optical Network Evolution towards F5G and Beyond

Ming Jiang
China Telecom - China
Advances in Industrial PON

Behnam Shariati
HHI - Germany
Distributed Intelligence for Cloud-based Industrial Applications: A Vision Inspection Use Case

Workshops

Monday 13 September
09:00 - 10:30

ROOM G

INTEROPERABLE DSP-BASED PON SYSTEMS - FACT OR FANTASY? PART 1

SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

ORGANIZERS:

Fabienne Saliou
Orange Labs - France
Derek Nesset
Huawei Technologies - Germany
Luiz ANET NETO
IMT Atlantique - France

Mo1G-WS
Interoperable DSP-Based PON Systems – Fact or Fantasy?

The recently consented 50G-PON recommendation from the ITU will be the first to anticipate the use of DSP enabled receivers. DSP enabled equalization may be used to increase Rx sensitivity in the presence of component bandwidth limitations, transmitter chirp and fibre chromatic dispersion. In the future, advanced signal processing techniques could become even more prevalent in PON systems if coherent reception becomes necessary to continue supporting capacity growth.

A key requirement for fibre access systems is interoperability between the head-end (OLT) and subscriber equipment (ONU) coming from different vendors. This must remain the case even when any new signal processing technique may be used.

The objective of this workshop is to address the topic of DSP-enabled PON systems and the challenge of realising physical layer interoperability. Can such interoperability requirement be supported? How might it be achieved?

The workshop will address this topic from the perspectives of the main actors for optical access, namely: network operators, optical system/component vendors, IC vendors and test equipment vendors. Furthermore, academic researchers will provide their insights on the interoperability challenges for more futuristic PON systems.

SPEAKERS:

Fabrice Bourgart
Orange Labs - France
HSP standard recap and new considerations for network operators

Dezhi Zhang
China Telecom - China
Operator View on 50G-PON in China

Rainer Strobel
MaxLinear - Germany
ASIC/SoCs for 50G-PON ONUs - Implementation and performance considerations

Ivan Cano
Huawei Technologies - Germany
Adapting TDEC as a New Transmitter Metric for 50G-PON

Lilin Yi
Shanghai Jiao Tong University - China
Advanced equalization approaches for beyond 50G-PON

Workshops

Monday 13 September
11:00 - 12:30

ROOM A

RECENT PROGRESS AND FUTURE CHALLENGE TOWARDS PRACTICAL APPLICATIONS OF SDM FIBERS - PART 2

SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers

ORGANIZERS:

Itsuro Morita
KDDI Research Inc. - Japan

Lars Grüner-Nielsen
Technical University of Denmark - Denmark

Benyuan Zhu
OFS Laboratories - USA

Mo2A-WS`
Recent progress and future challenge towards practical applications of SDM fibers

Space division multiplexing (SDM) using multi-core fibers and few-mode fibers is a potential technology for future optical transmission systems and has been intensively studied over the last decade. With SDM technologies, high-capacity transmission over 10 Pbit/s has successively demonstrated in the laboratory recently. However, there still remains a number of unsolved problems for the actual deployment of SDM technologies. This workshop will review and discuss the recent progress and future challenge of SDM technologies towards their commercialization.

The focus of this workshop is to investigate the practical elements associated with SDM technologies, including the following:

- Current status and future perspective of standardization
- Expected application areas
- Field evaluation on the deployed fibers
- Cost-effective fiber fabrication and measurement methods
- Compatibility with conventional fibers
- Suppression of SDM inherent properties, such as the crosstalk, dispersion and loss between SDM passes
- Connection and amplification technologies

SPEAKERS:

Masaki Ozeki
Fujikura - Japan
Alignment and fusion splicing techniques for MCFs

Ryo Nagase
Chiba Institute of Technology - Japan
Optical Connectivities for SDM Fibers

Marianne Bigot
Prysmian Group - France
Optimization of few mode fibers for practical applications

Guillaume Labroille
CAILabs - France
Multi-plane light conversion based mode multiplexer for SDM application

Workshops

Monday 13 September
11:00 - 12:30

ROOM B

HOW MACHINE LEARNING CAN REVOLUTIONIZE OPTICAL FIBER COMMUNICATIONS? PART 2

SC4 - Techniques for digitally enhancing optical communication

ORGANIZERS:

Ezra Ip | *NEC Laboratories America - USA*
Faisal Khan | *Tsinghua University - China*
Christian Häger | *Chalmers University of Technology - Sweden*

Mo2B-WS
How machine learning can revolutionize optical fiber communications?

How machine learning can revolutionize optical fiber communications?

Recently, there has been a global trend towards using machine learning to improve everyday life. Machine learning models are well suited to problems with no clear analytical solutions, such as image recognition, natural language processing, medical diagnostics, game playing, etc. In telecommunications, there are many problems where analytical solutions are either not obvious, or are computationally difficult to solve. There has been a trend towards using machine learning across all aspects of optical fiber communications from device modeling to transponder impairment compensation to fiber nonlinearity compensation to link modeling to network planning and optimization.

This workshop will be in three parts: part one will focus on how ML can guide the design of optical components and predict their performance; part two will focus on algorithms for link compensation; and part three will focus on the network layer, covering link performance prediction, network optimization & management, and offer a carrier's perspective on how ML can assist the provisioning of services.

In each part, speakers will give 6-minute presentations on a topic targeted by the workshop, followed by 4-minute interactive panel discussion at the end. After all three parts are concluded, there will be an additional 30 minutes for interactive panel discussion with all of the speakers."

Part I: Optical components
1. Darko Zibar: Machine learning for the inverse design of optical amplifiers
2. Maxim Kushnerov: Deep learning applications in coherent optical modems
3. Keisuke Kojima: Machine learning for design and optimization of photonic devices
4. Dan Kilper: Machine learning based optical amplifier gain estimation

Part II: Link compensation
5. Elias Giacoumidis: Unsupervised machine learning for modern transmission systems
6. Berthold Bitachon: Replacing digital backpropagation with neural network
7. Vladislav Neskorniuk: Machine learning methods for nonlinearity mitigation in the physical layer of fiber-optic communication links
8. Shinsuke Fujisawa: Expectations and perspectives from industry on photonic platform for AI-processing in telecommunications

Part III: Network layer applications:
9. Boris Karanov: End-to-end link optimization using deep learning
10. Faisal Nadeem Khan: Comparison of ML and analytical models for lightpaths QoT estimation
11. Marija Furdek: Applications of ML for network security management
12. Luis Velasco: Applications of ML for network control
13. Massimo Tornatore: Routing and spectral assignment using ML-based QoT models
14. Glenn Wellbrock: Carrier's perspective on how ML can assist terrestrial networks
15. Ahmed Triki: Carrier's perspective on how ML can revolutionize terrestrial optical communication networks

SPEAKERS:

Darko Zibar | *DTU - Denmark*
Machine learning for the inverse design of optical amplifiers

Maxim Kuschnerov | *Huawei Munich - Germany*
Deep learning applications in coherent optical modems

Keisuke Kojima | *Mitsubishi - USA*
Machine learning for design and optimization of photonic devices

Dan Kilper | *Trinity College - Ireland*
Machine learning based optical amplifier gain estimation

Elias Giacoumidis | *Dublin City University - Ireland*
Unsupervised machine learning for modern transmission systems

Bertold Ian Bitachon | *ETH Zurich - Switzerland*
Replacing digital backpropagation with neural network

Vladislav NeskorniUK | *Aston University - UK*
Machine learning methods for nonlinearity mitigation in the physical layer of fiber-optic communication links

Shinsuke Fujisawa | *NEC Corp. - Japan*
Expectations and perspectives from industry on photonic platform for AI-processing in telecommunications

Boris Karanov | *Technology University of Eindhoven - The Netherlands*
End-to-end link optimization using deep learning

Faisal Khan | *Tsinghua University - China*
Comparison of machine learning and analytical models for lightpath QoT estimation

Marija Furdek | *Chalmers University of Technology - Sweden*
Applications of machine learning for network security management

Luis Velasco | *Universitat Politècnica de Catalonia - Spain*
Applications of machine learning for network control

Massimo Tornatore | *Politecnico di Milano - Italy*
Routing and spectral assignment using machine learning based QoT models

Glenn Wellbrock | *Verizon - USA*
Carrier's perspective on how machine learning can assist terrestrial networks

Ahmed Triki | *Orange Labs - France*
Carrier's perspective on how machine learning can revolutionize terrestrial optical communication networks

Workshops

Monday 13 September
11:00 - 12:30

ROOM C1

CO-PACKAGING: HOW MANY FIBERS IS TOO MANY? PART 2

SC3 - Integrated and co-integrated circuits

ORGANIZERS:

Daniel Kuchta
IBM Research - USA

Mo2C1-WS
Co-Packaging: How many fibers is too many?

Co-packaging of optical transceivers with their data source (Switch or CPU/GPU) on the same first level package is viewed by many to be the strategic solution to the simultaneous problems of high bandwidth escape and power dissipation of large ICs. In this arena, there are proposals for individual optical modules with fiber counts on the order of 40 and full configurations of these optical modules approaching or exceeding 1000 fibers. The industry has not demonstrated prior commercial success with high-fiber-count transceivers. In fact the track record has been rather dismal. At the start of this century, three companies were producing transceivers with 36, 48, and 72 fibers respectively. All three are no longer in existence. In this past decade, another company appeared with a 336 fiber transceiver. It, too, is gone. Were these companies ahead of their time or are there fundamental problems with high-fiber-count devices?

This workshop will discuss progress towards high-fiber-count co-packaged optical transceivers with a focus on fiber related issues. One of the issues is related to scaling. If the solution today incorporates 40 fibers, how many will be used in the next generation? Will optical transceivers use 80 or 160 fibers and if so, how will this be accomplished? Does this require a smaller diameter fiber? When, if ever, does it make sense to use multicore fibers? Smaller diameter fibers enable a finer pitch. Are there limits to the pitch of V-grooves in Si or the pitch of arrays of microlenses? Scaling is also possible using higher data rates and more wavelengths. Is there a limit to the number of wavelengths that can be added? Large numbers of wavelengths per fiber are suitable for “fat” point to point links but not for links that need breakouts like 1:4, for example.

During ECOC2020 workshops, one large data center operator stated that mishandling of fiber cables and pluggable optics was their primary field reliability issue. How will this be avoided with high-fiber-count co-packaged modules? Are the OSATs (Outsourced Semiconductor Assembly and Test) ready to handle a large number of fibers? Are they able to handle pigtailed optics and assemble into delicate LGAs or to attach multiple connectors to an assembly? What are the issues with protecting the fibers within air cooled systems that provide hurricane force winds? Is water cooling the solution or just a different problem? And there is the mundane but important topic of slack management.

SPEAKERS:

Alexander Janta-Polczynski
IBM Bromont - Canada
Bandwidth Density with Photonic Co-packaging

Karl Muth
Broadcom - USA
There can not be enough fiber!

Tiger Ninomiya
Senko - Japan
How to deal with “too many fibers”

Hong Nguyen
Sumitomo Electric Industries, Ltd - Japan
Fiber Connectivity and Management in Co-Packaging

Henning Lysdal
NVIDIA - Denmark
CPO! This too is all about alignment

Mike Tan
HPE - USA
A CWDM Co-packaged optical module for short reach Data Center links

Jeff Hutchinson
OIF - USA
Co-packaging: Challenges of Implementing Multi-Terabyte Fiber Connectivity

Brian Kirk
Amphenol - USA
Copper and Optical Hybrid Co-packaging

Dominic Goodwill
Huawei - Canada
The limits of fiber attach to silicon photonics

Workshops

Monday 13 September
11:00 - 12:30

ROOM C2

APPLICATIONS FOR IMDD AND COHERENT IN SHORT REACH SYSTEMS. PART 2

SC4 - Techniques for digitally enhancing optical communication

ORGANIZERS:

Christopher Fludger
Infinera - Germany

Jochen Maes
Nokia Bell Labs - Belgium

Xi Chen
Nokia Bell Labs - USA

Mo2C2-WS
Applications for IMDD and Coherent in Short Reach Systems

This workshop will reveal decision factors for intensity modulation and direct detection (IM-DD) and coherent transmission in short-reach systems (e.g. intra-data center connections, passive optical networks (PON), and all other applications that cover transmission distances up to 20 km) where IMDD are incumbent and coherent is a contender. We will discuss, in the foreseeable future, what are the right applications for IMDD systems and coherent systems, as well as whether there will be a role for self-coherent solutions such as Kramers-Krönig (KK) receivers, Stokes receivers, and phase retrieval techniques.

In this workshop, we aim to discuss and answer the following questions

- What are the unique advantages of coherent systems? Is coherent inevitable?
- Since IM-DD and self-coherent systems allow uncooled lasers, will this be a key benefit that prevents coherent to take over for short-distance applications?
- For applications where the optical loss over the communication channel is high, do the required laser and amplifier power make coherent a bad choice?
- How much digital signal processing (DSP) is too much for short-reach systems?
- Will anyone make the effort to develop something other than IMDD or Coherent (e.g. Stokes receivers, KK receivers, etc.)?
- Is electrical bandwidth efficiency important? Are operators happy with increasing the number of fibers / parallel optics at lower data rates?
- We hear a lot about coherent PON at conferences recently. Is coherent PON becoming a reality?
- What is the network operators' view?
- Does the cost breakdown of an optical transceiver module show an advantage for IMDD vs Coherent vs Stokes receivers?

SPEAKERS:

Vincent Houtsma
Nokia Bell Labs - USA
High speed PONs for this decade

Christoph Füllner
KIT - Germany
Kramers-Kronig reception - an attractive solution for future PONs?

Andrew Lord
British Telecommunications - UK
The evolution from bespoke point-point QKD to fully managed global quantum networks

Workshops

Monday 13 September
11:00 - 12:30

ROOM D

NEUROMORPHIC COMPUTING - IS IT GOING TO SHIFT SIGNAL PROCESSING TO A NEW LEVEL? PART 2

SC5 - Optical Transmission systems

ORGANIZERS:

Stephan Pachnicke
Kiel University - Germany

Peter Bienstman
Ghent University - IMEC - Belgium

Mo2D-WS
Neuromorphic Computing – Is it going to shift signal processing to a new level?

Conventional signal processing in the electrical domain based on binary computing faces various technological and economical limitations. The further scaling of transistors to smaller feature sizes may end soon at about 3nm due to physical, technological and economic constraints. At the same time the exponential growth of physical layer interfaces' bit rates is expected to continue in the foreseeable future leading to an exponential growth of the power dissipation of processors, if no disruptive technology shift is taken.

In the recent past artificial intelligence concepts are being tested for various problems in the optical transmission system environment. It has been shown that problems such as failure prediction, optical performance monitoring and nonlinearity compensation just to name a few can profit from machine learning approaches. Nevertheless, these concepts mostly rely on numerical implementations, which are still being executed in classical (electrical) signal processing hardware.

To be scalable to much higher signal processing speeds (or bandwidths) and significantly lower energy consumption per bit radically new paths have to be followed. In that respect also concepts borrowed (or adapted) from the nature and implemented in the optical or electrical domain are appealing. Potential realizations of neural networks in the optical domain are for example reservoir computing concepts. Also other concepts such as photonic neuron architectures have been investigated in the past and offer radically new ways of information processing. Furthermore, bio inspired neural networks in the electrical domain may offer significant advantages such as much lower power consumption than today's electrical signal processing circuits.

This workshop shall investigate information processing based on neuromorphic circuits in the optical and electrical domain. It shall shed light on how and when such approaches may be ready for implementation into optical transmission systems and what advantages they may offer. Furthermore, current limits and technological hurdles shall be discussed.

SPEAKERS:

Apostolos Argyris
UIB-IFISC - Spain
Fiber-based reservoir computing for processing PAM-4 encoded signals

Charis Mesaritakis
University of Athens - Greece
Neuromorphic schemes for next generation telecomunication and security applications

Kambiz Jamshidi
TU Dresden - Germany
Silicon ring resonators for reservoir computing-based transmission impairment compensation

Ripalta Stabile
Tu Eindhoven - The Netherlands
All-Optical Neural Networks through InP Photonic Integrated Cross-Connects

Francesco Da Ros
DTU - Denmark
Extending the transmission reach of IM/DD links through reservoir computing

Workshops

Monday 13 September
11:00 - 12:30

ROOM E

ENABLING 6G NETWORKS - PART 2

SC10 - Architecture, Control and Management of optical networks

ORGANIZERS:

Dimitra Simeonidou
Smart Internet Lab, University of Bristol - UK
Reza Nejabati
University of Bristol - UK
Sergi Figuerola Fernandez
i2CAT - Spain
Luiz DaSilva
Virginia Tech - USA

Mo2E-WS
Enabling 6G Networks

As mobile networks are evolving from the 5th to the 6G generation, we need to address requirements for technological breakthroughs and challenges, along with commercial and societal drivers for such evolution.

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- Emerging 6G technological needs including multi-access convergence, optical networking, cloudification, disaggregation, convergence with non-terrestrial systems.
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- Technology governance focusing on native open-source, big data, infrastructure and resource sharing.
- 6G-enabled Internet of Senses.
- Sociotechnical considerations and methodology.
- 6G Applications such as Internet of Skills, Holographic Society, Digital Twins, etc.

SPEAKERS:

Simon Fletcher
Real Wireless - UK
The techno-economic implications of making a seamless transition to 6G

Workshops

Monday 13 September
11:00 - 12:30

ROOM F

OPTICAL NETWORK EVOLUTION TOWARDS F5G AND BEYOND (ORGANIZED BY ETSI ISG-F5G) - PART 2

SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

ORGANIZERS:

Philippe Chanclou
Orange Labs - France
Luca Pesando
Telecom Italia - Italy
Xiang Liu
Futurewei Technologies - USA

Mo2F-WS
Optical Network Evolution towards F5G and Beyond

Optical network is playing an increasingly important role in supporting broadband services to homes, offices, shopping centres, business buildings, factories, smart cities, and much more. Reaching deeper to final access points, optical fibre will realize its full potential to support a fully connected, intelligent world with high bandwidth, high reliability, low latency, and low energy consumption. With the fiber-to-everywhere vision, the European Telecommunications Standards Institute (ETSI) established at the beginning of 2020 an industry specification group (ISG) dedicated to the definition and specification of the 5th generation fixed network (F5G). Since then, the first release of 14 use cases of F5G have been published and based on those a complete analysis of the gaps in fibre networks standards and the requirements for their evolution to F5G are going to be published soon, as well as the general architecture. With the mobile network evolving beyond 5G and similar evolution for wireless local area network (WiFi and LiFi), it is timely to consider the evolution of optical networks beyond F5G, expanding the application scenarios of enhanced fixed broadband (eFBB), guaranteed reliable experience (GRE), and full-fibre connection (FFC).

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- F5G use cases with focus on service enablement
- Advances in end-to-end (E2E) optical network slicing
- The use of F5G to better support Industry 4.0 and industrial internet of things (IIOT)
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- Real-time broadband communication
- Harmonized communication and sensing/positioning
- Enabling fibre optical technologies for ubiquitous F5G
- AI-assisted autonomous driving network technologies for F5G
- Evolution towards F6G: How optical network would look like in 2025 and 2030

SPEAKERS:

Philippe Chanclou
Orange Labs - France
Optical Access Networks for 5G and Beyond

Paulo P. Monteiro
University of Aveiro - Portugal
Towards Converged Optical and Wireless Fronthaul Solutions for 5G and Beyond Networks

Chathurika Ranaweera
Deakin University - Australia
Optical Network Design and Planning towards F5G and Beyond

Frank Effenberger
Futurewei Technologies - USA
50G-PON and Enhanced Features for Future Networks Beyond F5G

Yongli Zhao
Beijing University of Posts and Telecommunications - China
Deterministic Full-Fibre Service Network for F5G and Beyond

Workshops

Monday 13 September
11:00 - 12:30

ROOM G

INTEROPERABLE DSP-BASED PON SYSTEMS - FACT OR FANTASY? PART 2

SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

ORGANIZERS:

Fabienne Saliou
Orange Labs - France
Derek Nesset
Huawei Technologies - Germany
Luiz ANET NETO
IMT Atlantique - France

Mo2G-WS
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SPEAKERS:

Allard Van Der Horst
Semtech - UK
Future High Speed PON ICs

Roberto Gaudino
Politechnico di torino - Italy
50G-PON and beyond enabled by DSP

Seb J. Savory
Cambridge University - UK
DSP for Coherent PON

Dora van Veen
Nokia - USA
Equalization for Standardized 50G-PON and Beyond

Greg Lecheminant
Keysight - Germany
TDEC in PON as a Metric to Enable Physical Layer Interop

Workshops

Monday 13 September
13:30 - 15:00

ROOM B

ARE 200+ GBAUD TRANSMISSION SYSTEMS FEASIBLE? THE PATH TO BEYOND 1 TERABIT/S OPTICAL CHANNELS. PART 1

SC5 - Optical Transmission systems

ORGANIZERS:

Stefanos Dris
Huawei Technologies France - France

Paraskevas Bakopoulos
Nvidia - Greece

Chigo Okonkwo
Technology University of Eindhoven - The Netherlands

Mo3B-WS
Are 200+ GBaud Transmission Systems Feasible? The Path to Beyond 1 Terabit/s Optical Channels

Current commercial 400G and 800G optical transmission systems operate at symbol rates of just over 50 and 90 Gbaud in short and long-reach scenarios respectively. If historical trends were to continue, we'd expect a doubling of symbol rates roughly every 5 years, bringing 200+ Gbaud systems to the market in ~6-7 years. With Moore's Law soon to be given its last rites, the industry faces a seemingly insurmountable hurdle in the quest to make future ultra-high baudrate systems a commercial reality. The electronic DAC based on CMOS technology is a key ingredient of the modern transceiver, but is maxed out in terms of both bandwidth and performance. A recent lifeline has emerged in the form of bandwidth-expanding multiplexing schemes based on hybrid approaches (e.g. CMOS with SiGe BiCMOS or InP HBT). Researchers have achieved over 200 Gbaud in this way. Close integration with the photonics is also essential, as are modulators with sufficiently high electro-optic bandwidth and low energy/bit, and signal integrity-preserving assembly and packaging solutions.

But even if we can reach our technological El Dorado in time, should we? An apparent straightforward alternative would be to employ parallelization, combining several lower-rate transceivers to form a superchannel. Throwing more opto-electronic hardware at the problem may be costly and power-consuming, but it could also be the only option to achieve the required performance. Furthermore, development of components such as multi-wavelength laser sources would alleviate some of the cost burden.

The aim of this workshop is to stimulate a lively discussion among academic and industry experts on the competing solutions for future ultra-high capacity optical channels. What will be the technologies of choice, and what architectures will be employed? Under what circumstances does parallelization make more sense than employing a single-wavelength? Is a one-size-fits-all solution possible, or will we differentiate between (e.g.) intra-DC, DCI and metro/core networks? The workshop will showcase the most promising recent developments in ultra-high baudrate technologies, extrapolating to what can be expected in the near future. The impact on (and of) the DSP ASIC will also be examined, as will be the system and network-level perspective, including techno-economic considerations.

SPEAKERS:

Karthik Balasubramanian
Microsoft - India
100 GBaud and Beyond - Considerations for Next Generation Networks

Fukutaro Hamaoka
NTT Network Innovation Laboratories - Japan
DAC Multiplexing Schemes for Optical Transmitters

Johan Bauwelinck
Ghent University - imec - Belgium
CMOS & SiGe BiCMOS Electronics for High-Baudrate Signal Generation

Xinlun Cai
Sun Yat-sen University - China
Recent Developments and Future Outlook in Thin Film Lithium Niobate Modulators

Juerg Leuthold
ETH Zurich - Switzerland
High Speed Photonic/Plasmonic Components for Dense Integration with Electronics

John Bowers
University of California, Santa Barbara - USA
Frequency Comb Laser Sources Enabling Parallel, Energy-Efficient Links

Ted Letavic
GlobalFoundries - USA
Monolithic Silicon Photonics Foundry Technology Considerations for High Speed Low Power Interconnects

Workshops

Monday 13 September
13:30 - 15:00

ROOM C2

POST MOORE DATA CENTER NETWORKS FOR 800GBE/1.6TBE. PART 1

SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

ORGANIZERS:

Maxim Kuschnerov
Huawei Technologies - Germany
Fotini Karinou
Microsoft - UK
Qixiang Cheng
University of Cambridge - UK

Mo3C2-WS
Post Moore Data Center Networks for 800GbE/1.6TbE

The demand for cloud capacity for AI and HPC applications is scaling much faster than Moore's Law can support, which still offers a doubling of switching capacity every two years. The evolution towards 5G access will also lead to new use cases, which in turn will impact and change data center architectures and accelerate the evolution of the edge cloud. Beyond 400G interconnect technologies for data centers are undergoing standardization, although it's clear that optical interconnects scale up even slower than CMOS ASICs, which in turn will also face fundamental challenges due to the slowing down of Moore's Law. This workshop will focus on future cloud network technologies from subcomponent to architecture level to address the technological bottleneck of an incremental evolutionary development. We will analyze disruptive concepts for optics, electronics in the context of a long term cloud evolution and discuss new cloud application drivers for the Post Moore data center.

Following questions will be addressed in the workshop:

- Co-packaged optics (CPO) vs. near-package optics (NPO): what is the better path for the ecosystem beyond pluggable modules?
- Will we see specialized optics for AI, server disaggregation or HPC & what are the key technologies to enable low latency & low cost server disaggregation?
- Will the edge cloud be a driver for optical low power computing?
- What are the benefits of optical computing vs. analog electrical processing?
- Is 200G/lane optical the end for VCSELs? Will DML be possible for 2km?
- What will be the enabler for higher parallelization in the data center, e.g. for 1.6T (8x200G) and beyond - WDM or PSM?
- Will we see a fast upgrade cycle to 200G SerDes requiring advanced switch design paradigms or will 100G SerDes be the node of choice for a longer time?
- How will error correction evolve at 200G/lane in conjunction with 100G and 200G SerDes targeting low latency?
- Which advanced equalization options will have to become standardized for 200G/lane?
- At which point will we need disruption on DSP design going beyond Moore's Law?
- How will packaging evolve for CPO and NPO and can these two approaches be united?
- Will optical switching finally be able to disrupt data center networks given the rapid scale out of AI applications?

SPEAKERS:

Hitesh Ballani
Microsoft Research Ltd - USA
Cloud Networking for a Post-Moore's Law Era

Youxi Lin
Huawei Technologies Co. Ltd. - China
Technologies for 200G/lane oDSP

Mark Wade
Ayar Labs - USA
1.6Tb/s co-packaged optics

Peter Ossieur
Ghent University - IMEC - Belgium
VCSELS vs SiPh for disaggregated scalable architectures

Peter O'Brien
Tyndall National Institute - Ireland
Packaging trends and challenges for future computing

Workshops

Monday 13 September
13:30 - 15:00

ROOM D

OPTICAL COMMUNICATIONS BEYOND 2020: ARE WE READY FOR THE QUANTUM AGE? PART 1

SC6 - Theory of Optical Communications and Quantum Communications

ORGANIZERS:

Hannes Hübel
AIT Austrian Institute of Technology - Austria
Reza Nejabati
University of Bristol - UK
Helmut Grießer
ADVA Optical Networking SE - Germany

Mo3D-WS
Optical communications beyond 2020: Are we ready for the quantum age?

The quantum communication industry is at the verge of a major roll-out of quantum-based technologies across the globe. In Europe, the deployment is heavily driven be the EuroQCI initiative, aiming to establish a Quantum Internet by the end of the decade and unleashing new concepts such as distributed quantum computing. On a shorter timescale, EuroQCI will deploy a QKD secured communication infrastructure around the Europe. Such a significant addition to classical communication networks requires a concerted effort on many levels. The aim of this workshop is therefore to bring together players from component manufacturing, system integration, network operators, and end-users to discuss the latest developments in this fast-moving field, with expert contributions on the following:

- Integration of point-to-point QKD links to large networks
- Dynamic control of QKD networks
- QKD system design
- QKD device implementation based on photonic integrated circuits
- Novel QKD protocols for long-distance transmission
- Industrial scale manufacturing of QKD systems
- Examination of practical deployment issues
- Standardization efforts

SPEAKERS:

Norbert Lütkenhaus
University of Waterloo - Canada
QKD networks and applications

Andrew Lord
British Telecommunications - UK
The evolution from bespoke point-point QKD to fully managed global quantum networks

George Kanellos
University of Bristol - UK
Fully programmable dynamic quantum networks

Antonio Pastor
Telefonica I+D - Spain
The case for data-driven operations in the MadQCI

Imran Khan
KEEQuant - Germany
Enabling a large scale deployment of QKD

André Richter
VPIphotonics - Germany
Modelling Weak-Coherent CV/DV QKD Systems using a Classical Simulation Framework

Workshops

Monday 13 September
15:30 - 17:00

ROOM B

ARE 200+ GBAUD TRANSMISSION SYSTEMS FEASIBLE? THE PATH TO BEYOND 1 TERABIT/S OPTICAL CHANNELS. PART 2

SC5 - Optical Transmission systems

ORGANIZERS:

Stefanos Dris
Huawei Technologies France - France
Paraskevas Bakopoulos
Nvidia - Greece
Chigo Okonkwo
Technology University of Eindhoven - The Netherlands

Mo4B-WS
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SPEAKERS:

Andrew Lord
Bristish Telecommunications - UK
The evolution from bespoke point-point QKD to fully managed global quantum networks

Mike Peng Li
Intel Corporation - USA
224 Gbps: The Next Generation SERDES, I/O, and Enabling Technologies

Huijian Zhang
HiSilicon Optoelectronics Co. Ltd - China
Transceiver Technology Evolution & Impairments at Ultra-High Bandwidths

Robert Maher
Infinera - USA
DSP Architecture Considerations: Single- Vs Multi- Implementations

Jeremie Renaudier
Nokia Bell Labs - France
Ultra-high Baudrate vs Parallelization for Future Coherent Optical Links

Vladimir Stojanovic
University of California, Berkeley - USA
Low Energy, High Bandwidth Density Electronic-Photonic Architectures for Multi-Tb/s Interconnects

Stephan Pachnicke
Kiel University - Germany
Challenges and Solutions for Beyond Terabit/second Intra-Datacenter Interconnects

Workshops

Monday 13 September
15:30 - 17:00

ROOM C2

POST MOORE DATA CENTER NETWORKS FOR 800GBE/1.6TBE. PART 2

SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

ORGANIZERS:

Maxim Kuschnerov
Huawei Technologies - Germany
Fotini Karinou
Microsoft - UK
Qixiang Cheng
University of Cambridge - UK

Mo4C2-W
Post Moore Data Center Networks for 800GbE/1.6TbE

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- How will packaging evolve for CPO and NPO and can these two approaches be united?
- Will optical switching finally be able to disrupt data center networks given the rapid scale out of AI applications?

SPEAKERS:

Mark Filer
OIF - USA
OIF's progress and vision on coherent 800G for data center modules

Keren Bergman
Columbia University - USA
Disaggregation in data centers

Frank Kschischang
University of Toronto - Canada
Advanced FEC for disaggregated data centers: latency vs. performance

Nicola Calabretta
Technology University of Eindhoven - The Netherlands
Optical switches for data center networks

Jose Capmany
iPronics - Spain
Optical computing & configurable optics

Workshops

Monday 13 September
15:30 - 17:00

ROOM D

OPTICAL COMMUNICATIONS BEYOND 2020: ARE WE READY FOR THE QUANTUM AGE? PART 2

SC6 - Theory of Optical Communications and Quantum Communications

ORGANIZERS:

Hannes Hübel
AIT Austrian Institute of Technology - Austria
Reza Nejabati
University of Bristol - UK
Helmut Grießer
ADVA Optical Network - Germany

Mo4D-WS
Optical communications beyond 2020: Are we ready for the quantum age?

The quantum communication industry is at the verge of a major roll-out of quantum-based technologies across the globe. In Europe, the deployment is heavily driven be the EuroQCI initiative, aiming to establish a Quantum Internet by the end of the decade and unleashing new concepts such as distributed quantum computing. On a shorter timescale, EuroQCI will deploy a QKD secured communication infrastructure around the Europe. Such a significant addition to classical communication networks requires a concerted effort on many levels. The aim of this workshop is therefore to bring together players from component manufacturing, system integration, network operators, and end-users to discuss the latest developments in this fast-moving field, with expert contributions on the following:

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- Industrial scale manufacturing of QKD systems
- Examination of practical deployment issues
- Standardization efforts

SPEAKERS:

Chris Erven
KETS QuantumSecurity - UK
Chip-based Quantum Cryptography - the key commercial and integration enabler for quantum-safe communications

Moritz Kleinert
Fraunhofer Heinrich Hertz Institute HHI - Germany
Hybrid Photonic Integration for Quantum Communications - From optical benches to integrated circuits

Florian Fröwis
IDQuantique - Switzerland
From Lab to Fab: Industrialized QKD Platform for Real-World Networks and Applications

Jörg-Peter Elbers
ADVA Optical Networking - Germany
6G networks: wireless only or impossible without more wires

Robert Woodward
Toshiba Europe - UK
QKD Network Integration & Practical Use Cases

Momtchil Peev
Huawei Technologies Duesseldorf - Germany
The world-wide effort for initial standardization and certification of the technology

Tutorials

Tutorials

Tuesday 14 September
09:00 - 10:00 - Room A

Chair: Tommy Geisler OFS Fitel Denmark ApS - Denmark
SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers

MULTICORE FIBERS AND AMPLIFIERS

Tu1A.1
Multicore Erbium Doped Fibre Amplification Techniques

Shigehiro Takasaka
Furukawa Electric Co., Ltd. - Japan

Abstract:

This tutorial will cover cladding-pumped multicore erbium doped fibre amplification (MC-EDFA) techniques. We review MC-EDFs, configuration, components, and amplification characteristics of the amplifiers, respectively. Power consumption of the amplifiers is discussed from the point of the view of MC-EDF's parameters and cladding-pump recycling technique.

Biography:

He received B.S., M.S. and the Ph.D. degrees in Physics from Hokkaido University, Sapporo, Japan, in 1994, 1996, and 1999, respectively.

He was a postdoctoral fellow of The University of Tokyo from 1999 to 2002. He joined Furukawa Electric Co., Ltd., Tokyo, Japan in 2002. He has been engaged in research and development of optical fiber applications such as nonlinear optical signal processing and fiber amplifiers. He has joined researching multicore amplification in 2013.

He was a manager of Sakigake project on PRESTO, JST, Kawaguchi, Japan from 2004 to 2008. He is a senior researcher of optical fiber application section of Telecommunication and Energy laboratories, Furukawa Electric Co., Ltd.

Tuesday 14 September
09:00 - 10:00 - Room E

Chair: Sébastien Bigo Nokia Bell-Labs - France
SC10 - Architecture, Control and Management of optical networks

CONTROL PLANE AND ORCHESTRATION

Tu1E.1
Advances in SDN control for Beyond 100G disaggregated optical networks

Ramon Casellas
CTTC/CERCA - Spain

Biography:

Ramon Casellas (Barcelona, 1975) graduated in Telecommunications Engineering in 1999 both from Technical University of Catalonia (UPC, Barcelona) and from the Ecole Nationale Supérieure des Télécommunications (now Telecom Paristech). He completed a PhD degree in Telecommunications in 2002, from the Ecole Nationale Supérieure des Télécommunications (ENST, Paris) funded by a CTI project with France Telecom Research and Development. He has worked as an undergraduate researcher at France Telecom Research and Development – FT R&D formerly known as Centre Nationale d'Etudes des Télécommunications (Issy les Molineaux, France) and British Telecom Labs (Ipswich, UK).

In 2002, he joined the Networks and Computer Science Department at the ENST as an Associate Professor and, in March 2006, he joined the CTTC Optical Networking Area, where he currently holds a Senior Researcher position. His research interest areas include GMPLS/PCE architecture, Software Defined Networking (SDN), Network Function Virtualization (NFV), Traffic Engineering and Distributed control schemes, with applications to Optical and Disaggregated Transport Networks.

He has been involved in program committees of major conferences such as ECOC, OFC or ONDM, and he is a regular reviewer for IEEE/OSA Journal of Lightwave Technology, Journal of Optical Communications and Networking (JOCN), IEEE Communications Magazine (CommMag) or IEEE Networks.

He has co-authored 5 book chapters, over 200 international and peer-reviewed journal and conference papers, 6 IETF Request For Comments (RFCs). He is a contributor of the Open Networking Foundation (ONF); member of the Open Disaggregated Transport Networks (ODTN) project and of the Telecom infra Project (TIP) OOPT group.

Tuesday 14 September
11:00 - 12:00 - Room B

Chair: Mathilde Gay
SC7- Photonics for RF and Free Space Optics applications

SPACE OPTICAL LINKS

Tu2B.1
Space optical links, a review of next challenges

Géraldine Artaud
CNES (Centre National d'Etudes Spatiales) - France

Biography:

Geraldine Artaud has been working 2 years as data handling engineer at ESA ESTEC, then 8 years in CNES as signal processing engineer in the fields of Radionavigation and space data transmissions in RF, for telecommunications and earth observation data repatriation. Since 2013 she is involved at CNES in the study of optical links for space applications. Working on all aspects of the system (on-board terminals, atmospheric propagation, and optical ground stations), she is also the French representative at the Consultative Committee for Space Data Systems (CCSDS), commissioned to define future optical communication standards for space.

Tuesday 14 September
14:00 - 15:00 - Room G

Chair: Daniel Kuchta IBM -USA
SC3 - Integrated and co-integrated circuits

PHOTONIC COMPUTING

Tu3G.1
Neuromorphic silicon photonics: principles, implementations, applications

Alexander Tait
National Institute of Standards and Technology - USA

Abstract:

Silicon photonic manufacturing has enabled scalable photonic systems. Neural network models have proliferated throughout machine learning applications. Neuromorphic photonics is the pursuit of a bridge between physics and application. This tutorial addresses fundamentals and current status: what makes a device neuromorphic; what applications are promising?

Biography:

Alex Tait is an electrical engineer in the Quantum Nanophotonics and Faint Photonics Group at the National Institute of Standards and Technology, Boulder, CO, USA, where he was previously an NRC postdoctoral fellow. He received his PhD in the Lightwave Communications Research Laboratory, Department of Electrical Engineering, Princeton University, Princeton, NJ, USA under the direction of Paul Prucnal. His research interests include silicon photonics, neuromorphic engineering, and superconducting optoelectronics. Dr. Tait is a recipient of the National Science Foundation (NSF) Graduate Research Fellowship (GRFP) and is a member of the IEEE Photonics Society and the Optical Society of America (OSA). He is the recipient of the Award for Excellence from the Princeton School of Engineering and Applied Science, the Best Student Paper Award from the 2016 IEEE Summer Topicals Meeting Series, and the Class of 1883 Writing Prize from the Princeton Department of English. He has authored 14 refereed journal papers and a book chapter, presented at 15 technical conferences, (co)filed 8 provisional patents, and contributed to the textbook Neuromorphic Photonics.

Tutorials

Tuesday 14 September
16:15 - 17:15 - Room C2

Chair: Sander Wahls Delft University of Technology - The Netherlands
SC4 - Techniques for digitally enhancing optical communication

COHERENT DSP

Tu4C2.1
Real-time Digital Signal Processing for Coherent Optical Communications

Mehdi Torbatian
Infinera - Canada

Abstract:

Today's long haul optical transmission networks employ coherent detection and DSP in the physical layer. This tutorial reviews DSP techniques in processing coherently detected signals and highlights the challenges in real-time implementation.

Biography:

Received his PhD from University of Waterloo in Wireless Communications, Information theory and Coding in 2011. He has worked in optical communication field for coherent modems since 2014. He joined Infinera Canada in 2016 where he is currently working on DSP design for high performance coherent modems.

Tuesday 14 September
16:15 - 17:15 - Room F

Chair: Fabienne Saliou
SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

SDN IN OPTICAL ACCESS NETWORKS

Tu4F.1
Fixed access networks evolutions towards software defined access network and disaggregated hardware: an operator perspective

Gaël Simon
Orange Labs - France

Abstract:

This tutorial will review the (r-)evolutions of fixed access networks (for FTTH, but also enterprise or mobile applications) in the context of SDN and NFV technologies. It includes new hardware, software, standards, architectures, protocols, interfaces ... We will also try to foresee the coming steps.

Biography:

Dr. Gaël Simon (male) received the engineering degree in Physics and Photonics from the Ecole Nationale Superieure des Sciences Appliquées et de Technologie, Rennes 1 University, Rennes, France, in 2013.

He was awarded with his Ph.D degree in electronics and communications from Telecom Paris Tech, Paris, France, in 2016.

His Ph.D. was cohosted by Orange Labs where he studied dense wavelength division multiplexing introduction in optical access networks.

He is currently working as a research engineer at Orange Labs, France, where he mainly studies optical access network evolutions, including physical layer innovations, but also the impacts of virtualization and software defined control and automation of fixed networks for future mobile networks.

Wednesday 15 September
09:00 - 10:00 - Room D

Chair: Romain Brenot Huawei - France
SC2 - Optoelectronic devices and technologies

VCSELS

We1D.1
Recent progress of VCSEL Photonics and their applications

Fumio Koyama
Tokyo Institute of Technology - Japan

Abstract:

The 40 years' research and developments opened up various applications of VCSELs, including 3D sensing and optical interconnects in datacenter networks. In this tutorial, the advances on VCSEL photonics will be reviewed, including the state-of-the-art performances of high-speed VCSELs and high-power VCSELs, and their applications.

Biography:

Fumio Koyama is a professor, Institute of Innovative Research, Tokyo Institute of Technology. He served as the dean, Institute of Innovative Research between 2018-2020. His research interest includes VCSEL photonics, photonic integrated devices, 3D optical sensing and LiDAR. He has authored or co-authored more than 1,000 journal and conference papers, including more than 100 invited talks.

For more than 35 years, Fumio Koyama has been one of leading researchers whose work contributed to VCSEL photonics and single-mode lasers for broadband optical communications. He received various awards, including the IEEE Student Paper Award in 1985, the IEE Electronics Letters Premium in 1985 and in 1988, Marubun Scientific Award in 1998, the Ichimura Award in 2004, the IEICE Electronics Society Award in 2006, the MEXT Prize for Science and Technology in 2007, IEEE/LEOS William Streifer Scientific Achievement Award in 2008, the 2012 Izuo Hayashi Award, the Ichimura Prize for Excellent Achievement in 2016, the 32nd Kenjiro Sakurai Memorial Award from OITDA in 2017, Okawa Award in 2018 and Nick Holonyak, Jr. Award from OSA in 2019 and IEICE Achievement Award in 2019. He is Fellow of IEEE, OSA, IEICE and the Japan Society of Applied Physics.

He was deputy editor for IEEE/OSA Journal of Lightwave Technology (2011-2016) and topical editor for OSA Optics Letters (2009-2013), and was the Guest Editor of IEEE JSTQE (2002 and 2007). He also has served as various committee members, including General Chair (2010) and Program Chair (2008) of IEEE International Semiconductor Laser Conferences.

Wednesday 15 September
09:00 - 10:00 - Room E

Chair: Nicola Calabretta Eindhoven University of Technology - The Netherlands
SC10 - Architecture, Control and Management of optical networks

NETWORK RESILIENCE

We1E.1
The challenges of end-to-end network resilience

Massimo Tornatore
Politecnico di Milano - Italy

Abstract:

Ultra-reliable network services envision end-to-end availability of 6-nines or more, across diverse technological domains (wireless, optical, cloud). Current network architectures fall short of this objective. This tutorial addresses how several technical innovations can help designing ultra-reliable optical metro networks fulfilling the targeted end-to-end network resilience.

Biography:

Massimo Tornatore is currently an Associate Professor with the Department of Electronics, Information, and Bioengineering, Politecnico di Milano. He also holds an appointment as Adjunct Professor at University of California, Davis, USA and as visiting professor at University of Waterloo, Canada. His research interests include performance evaluation, optimization and design of communication networks (with an emphasis on the application of optical networking technologies), network virtualization, network reliability and machine learning application for network management. In these areas, he co-authored more than 400 peer-reviewed conference and journal papers (with 19 best paper awards), 2 books and 1 patent. He is a member of the Editorial Board of IEEE Communication Surveys and Tutorials, IEEE Communication Letters, IEEE Transactions on Network and Service Management, and Elsevier Optical Switching and Networking. He is active member of the technical program committee of various networking conferences such as INFOCOM, OFC, ICC, and GLOBECOM. He acted as technical program chair of ONDM 2016 and DRCN 2017 and DRCN 2019 conferences. He participated in several EU R&D projects (among others FP7 COMBO, H2020 MetroHaul, and Cost Action RECODIS) as well as in several projects in USA, Canada and Italy.

Tutorials

Wednesday 15 September
14:00 - 15:00 - Room A

Chair: Francesco Poletti University of Southampton - UK
SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers

HOLLOW CORE FIBERS

We3A.1
Hollow core optical fibers: past developments and future opportunities

Walter Belardi
CNRS, University of Lille - France

Biography:

Dr Walter Belardi holds an excellence research chair in photonics at the University of Lille, France, and is the project coordinator of the European project GADEIRE.

Since his PhD studies at the Optoelectronics Research Centre, University of Southampton, he has cumulated over 20 years' experience in the field of fiber optics, including research activities both in the industrial and academic sector. He has contributed to over hundred scientific publications and patents on the design, fabrication and applications of specialty optical fibers.

He has one of the main pioneers in the field of hollow core antiresonant fibers, particularly with the very first theoretical proposal of a nested antiresonant fiber in 2014 and his first fabrication attempts. In parallel to the very strong implications of this design for telecommunications, Dr Belardi has given major contributions to the development of simplified hollow core optical fibers for practical use in the mid-infrared spectral range.

His dissemination efforts involve his invitation to several international conferences, seminars and short courses. Dr Belardi has also been editor of a collection of updated contributions and reviews within the field of hollow core optical fibers, as well as chair of a workshop celebrating the 25 years of microstructured optical fibers.

Wednesday 15 September
16:15 - 17:15 - Room C2

Chair: Yves Jaouen Telecom Paris - France
SC4 - Techniques for digitally enhancing optical communication

DIRECT DETECTION I

We4C2.1
Phase retrieval for optical communication

Yuki Yoshida
National Institute of Information and Communications Technology - Japan

Abstract:

Low-complexity computational coherent receivers based on direct detection(s) are a key to migrating coherent optics from backbone networks to edge, access, and even in-building networks. This tutorial gives an overview of recent advances and remaining challenges for carrier-less full-field detection via phase retrieval.

Biography:

Yuki Yoshida received his Ph.D. degree in informatics from Kyoto University, Kyoto, Japan, in 2009. From 2009 to 2016, he was an Assistant Professor at Osaka University, Osaka, Japan. Since 2016, he has been a Senior Researcher with the National Institute of Information and Communications Technology, Japan. He is also a Visiting Associate Professor in Osaka University, Japan. His research interests include digital signal processing for high-speed optical/wireless communications, optical/wireless access, and optical-wireless convergence. He has published over 200 papers in scientific journals and conferences.

Thursday 16 September
09:00 - 10:00 - Room A

Chair: Patricia Layec Nokia Bell Labs - France
SC8 - Core and metro networks

PHYSICAL LAYER MODELLING FOR OPTICAL NETWORKS
THURSDAY 16 SEPTEMBER

Th1A.1
GNPy Model for Design of Open and Disaggregated Optical Networks

Vittorio Curri
Politecnico di Torino - Italy

Abstract:

We describe the modeling approach of GNPy for software abstraction of WDM optical transport in disaggregated networks, also referring to extensive experimental validations. Then, we present the use of GNPy in network design and planning, and in computation of lightpath quality of transmission.

Biography:

Vittorio Curri is a Faculty at the Department of Electronics and Telecommunications of Politecnico di Torino (PoliTo), Italy since 2004, currently in the role of Associate Professor. Since late 1990's, his major research interests are in fiber transmission modeling, including nonlinearities, stochastic PMD, Raman amplification and Raman crosstalk, for WDM optical transport. Research activities on physical effects has been summarized in simulation and models of optical transmission to target the prediction of quality of transmission for transmitter and receiver optimization, and to define design and control strategies for optical transmission systems. Since 2015, Prof. Curri is investigating on the abstraction of physical layer for open optical network planning, control and management, also including machine learning techniques, leading the physical layer aware networking research activities at PoliTo. He has been an early promoter of multiband optical transmission as a solution for seamless increase of networking capacity and is currently investigating on this topic within the EU-funded ETN project WON. He also investigates on multiservice exploitation of optical infrastructure for T/F distribution within the EU-funded EMPIR project TIFOON. Since 2017, Prof. Curri operates in the industrial consortium for open networking named Telecom Infraproject where he leads the scientific activities of the GNPy project for the softwarization of the physical layer in open and disaggregated optical networks. Prof. Curri is a regular speaker at the major conferences of the field and is author of 300+ scientific publications. He is senior member of the IEEE and member of the OSA.

We describe the modeling approach of GNPy for software abstraction of WDM optical transport in disaggregated networks, also referring to extensive experimental validations. Then, we present the use of GNPy in network design and planning, and in computation of lightpath quality of transmission.

Thursday 16 September
09:00 - 10:30 - Room C1

Chair: Jochen Schröder Chalmers University of Technology - Sweden
SC5 - Optical Transmission systems

NEURAL NETWORKS IN ESTIMATING LIGHPATHS FOR OPTICAL COMMUNICATIONS

Th1C1.1
Neural Networks for Estimating Lightpath QoT in Optical Communications

Christine Tremblay
École de technologie supérieure - Canada

Abstract:

Machine learning is called to the rescue to address the challenges of managing the physical layer of increasingly heterogeneous and complex optical networks. In this tutorial, we illustrate how neural networks can be used for estimating and forecasting the quality of transmission (QoT) of lightpaths.

Biography:

Christine Tremblay is the Founding Researcher and Head of the Network Technology Lab at the École de technologie supérieure (ÉTS) in Montreal, Canada. She received her PhD degree in Engineering Physics (Optoelectronics) from Polytechnique Montreal in 1992. Before joining academia in 2004, she held senior R&D and technology management positions in the private sector. She was a Research Scientist with the National Optics Institute (INO) where she conducted research on integrated optical devices for communication and sensing applications. As Engineering Manager at EXFO and Director of Engineering at Roctest, she led the development of fiber-optic test instrumentation for the telecommunication and the geotechnical markets. She also served as Product Manager for high-capacity DWDM systems at Nortel.

Her team pioneered the research on filterless optical networking, a disruptive network architecture alternative demonstrated and deployed on national and regional networks. Her current research interests include machine learning for optical networking and network performance monitoring, as well as advanced access networks for 5G applications. She has been the co-instructor for SC314 and SC210 hands-on courses of the Optical Society of America (OSA) on optical fiber and polarization measurements at the Optical Fiber Communication (OFC) Conference. Senior member of IEEE and member of OSA since 1991, she is a member of Quebec FRQNT Strategic Clusters STARaCom and COPL. Since 2020, serves as Program Chair for the Photonics Networks and Devices OSA Topical Meeting, as well as Program Committee Member for the OFC Subcommittee N3: Architecture and software-defined control for metro and core networks.

Technical Sessions

Technical Sessions Tuesday 14 September

ROOM A

MULTICORE FIBERS AND AMPLIFIERS

10:00 - 10:15

Chair: Tommy Geisler OFS Fitel Denmark ApS - Denmark
SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers

Tu1A.5
Reduction of Power Consumption of Full C-band WDM Amplification by WDM Sub-banding and SDM Conversion using a High Core Count Multi-Core Amplifier

We propose a method for power reduction of amplification by sub-banding wideband WDM signals and using SDM conversion on the sub-bands. We demonstrated 6.6% of power reduction using a 19C-EDFA amplifying 4.8THz of signal bandwidth on the C band.

Keiichi Matsumoto **| *Presenter*** | *NEC Corp. - Japan*
Kohei Hosokawa | *NEC Corp. - Japan*
Emmanuel Le Taillandier de Gabory | *NEC Corp. - Japan*

10:15 - 10:30

Tu1A.6
Experimental Evaluation of the Crosstalk Impulse Response of a Temperature Controlled Homogeneous Multi-Core Fiber

We evaluate the temperature dependence of the impulse response of a multi-core fiber. We show a delay dependence of 40ps/km/degree C and negligible variation of the duration of the impulse response with temperature.

Ruben S Luis **| *Presenter*** | *National Institute of Information and Communications Technology - Japan*
Benjamin Puttnam | *National Institute of Information and Communications Technology - Japan*
Georg Rademacher | *National Institute of Information and Communications Technology - Japan*
Yoshinari Awaji | *National Institute of Information and Communications Technology - Japan*
Hideaki Furukawa | *National Institute of Information and Communications Technology - Japan*

ROOM B

FREE SPACE OPTICAL COMMUNICATION

09:30 - 09:45

Chair: Michel Sotom Thales Alenia Space - France
SC7 - Photonics for RF and Free Space Optics applications

Tu1B.3
Enhanced Model of Turbulence for the Design of Optical Satellite Systems

We develop a model which accurately predicts the spatio-temporal variation of atmospheric turbulence effects across the optical beam of a free space optical link. We show that, in some conditions, the optical launched power can be reduced by 2 dB, particularly at low windspeed.

Tituan ALLAIN **| *Presenter*** | *Institut d'Optique Graduate School, Paris-Saclay University - France*
Nokia Bell Labs - France
Rajiv Boddeda | *Nokia Bell Labs - France*
Sylvain Almonacil | *Nokia Bell Labs - France*
Daniel Romero Arrieta | *Nokia Bell Labs - France*
Paris-Saclay University - France
Sébastien Bigo | *Nokia Bell Labs - France*

9:45 - 10:00

Tu1B.4 HIGHLY SCORED
Experimental Study of the Impact of Molecular Absorption on Coherent Free Space Optical Links

We study the impact of molecular absorption on free space coherent communication signals with an optical set up incorporating a gas cell. We show that worst-case absorption at 1.5-1.6 ????m can be mitigated with constant modulus equalization and <1 dB additional signal launched power.

Marco A. Fernandes **| *Presenter***
Instituto de Telecomunicações, Universidade de Aveiro - Portugal, Universidade de Aveiro - Portugal
Paulo P. Monteiro | *Instituto de Telecomunicações, Universidade de Aveiro - Portugal*
Universidade de Aveiro - Portugal
Fernando P. Guiomar | *Instituto de Telecomunicações, Universidade de Aveiro - Portugal*
Universidade de Aveiro - Portugal

10:00 - 10:15

Tu1B.5
400G MIMO-FSO Transmission with Enhanced Reliability Enabled by Joint LDPC Coding

We experimentally demonstrate error-free MIMO-FSO transmission of 2×200 Gbps, with joint LDPC coding between the signals, leading to an increase in tolerated channel power loss of 2 dB. Moreover, we show enhanced communication reliability in Gamma-Gamma MIMO-FSO systems.

Marco A. Fernandes **| *Presenter*** | *Instituto de Telecomunicações, Universidade de Aveiro - Portugal*
Universidade de Aveiro - Portugal
Paulo P. Monteiro | *Instituto de Telecomunicações, Universidade de Aveiro - Portugal*
Universidade de Aveiro - Portugal
Fernando P. Guiomar | *Instituto de Telecomunicações, Universidade de Aveiro - Portugal*
Universidade de Aveiro - Portugal

10:15 - 10:30

Tu1B.6
Up to 6 Gbps Mid-Infrared Free-Space Transmission with a Directly Modulated Quantum Cascade Laser

We report on an experimental demonstration of a mid-infrared free-space communication link enabled by a directly modulated quantum cascade laser operating at room temperature. A record high transmission rate up to 6 Gbps over 50-cm link distance is demonstrated at 4.65 μm wavelength.

Xiaodan Pang **| *Presenter*** | *KTH Royal Institute of Technology - Sweden, RISE Research Institutes of Sweden - Sweden*
Richard Schatz | *KTH Royal Institute of Technology - Sweden*
Mahdieh Joharifar | *KTH Royal Institute of Technology - Sweden*
Aleksejs Udalcovs | *RISE Research Institutes of Sweden - Sweden*
Vjaceslav Bobrovs | *Riga Technical University - Latvia*
Lu Zhang | *Zhejiang University - China*
Xianbin Yu | *Zhejiang University - China*
Yan-Ting Sun | *KTH Royal Institute of Technology - Sweden*
Sergei Popov | *KTH Royal Institute of Technology - Sweden*
Sebastian Lourdudoss | *KTH Royal Institute of Technology - Sweden*
Oskars Ozolins | *KTH Royal Institute of Technology - Sweden, Riga Technical University - Latvia*
RISE Research Institutes of Sweden - Sweden

ROOM C1

NETWORK PERFORMANCE MONITORING

09:00 - 09:15

Chair: Bernhard Schrenk AIT Austrian Institute of Technology - Austria
SC8 - Core and metro networks

Tu1C1.1
Kerr Nonlinearity Dominance Diagnostic for Polarization-Dependent Loss Impaired Optical Transmissions

We present a method to classify optical transmission systems as linear or nonlinear based solely on signal-to-noise ratio statistics in presence of PDL-induced time-varying-performance. It obtains excellent accuracy (>95%), and it is proven accurate and robust under all the investigated conditions.

Matteo Lonardi **| *Presenter*** | *Nokia Bell Labs - France*
Paolo Serena | *University of Parma - Italy*
Petros Ramantanis | *Nokia Bell Labs - France*
Nicola Rossi | *Alcatel Submarine Networks, Nozay - France*
Simone Musetti | *Nokia - Italy*

09:45 - 10:00

Tu1C1.4
Fast Optical Performance Monitoring for Diagnosing Transient Behavior during Channel Add/Drop

Fast (millisecond scale), receiver DSP-based optical performance monitoring of key parameters, such as OSNR, fiber nonlinearity, BER, and power, is demonstrated and used in diagnosing the transient behavior during channel add/drop.

Zhiping Jiang **| *Presenter*** | *Huawei Technologies - Canada*

Tuesday 14 September

10:00 - 10:15

Tu1C1.5
Estimating Network Components Polarization-Dependent Loss Using Performance Statistical Measurements

We propose a novel approach to estimate reconfigurable optical add-drop multiplexers (ROADM) polarization-dependent loss (PDL) using the signal-to-noise ratio distribution induced by PDL. We show an uncertainty cut between 40% and 80% compared to datasheet in several configurations.

Joana Girard-Jollet **| *Presenter*** | *Alcatel Submarine Networks, Nozay - France, Télécom Paris, Institut Polytechnique de Paris - France*
Matteo Lonardi | *Nokia Bell Labs - France*
Petros Ramantanis | *Nokia Bell Labs - France*
Paolo Serena | *University of Parma, Department of Engineering and Architecture - Italy*
Chiara Lasagni | *University of Parma, Department of Engineering and Architecture - Italy*
Patricia Layec | *Nokia Bell Labs - France*
Jean-Christophe Antona | *Alcatel Submarine Networks, Nozay - France*

ROOM C2

MACHINE LEARNING I

09:00 - 10:30

Chair: Darko Zibar DTU Fotonik - Denmark
SC4 - Techniques for digitally enhancing optical communication

Tu1C2.1
End-to-end Learning of a Constellation Shape Robust to Variations in SNR and Laser Linewidth

We propose an autoencoder-based geometric shaping that learns a constellation robust to SNR and laser linewidth estimation errors. This constellation maintains shaping gain in mutual information (up to 0.3 bits/symbol) with respect to QAM over various SNR and laser linewidth values.

Ognjen Jovanovic **| *Presenter***
Technical University of Denmark - Denmark
Francesco Da Ros | *Technical University of Denmark - Denmark*
Metodi P. Yankov | *Technical University of Denmark - Denmark*
Darko Zibar | *Technical University of Denmark - Denmark*

09:30 - 09:45

Tu1C2.3
End-to-End Deep Learning of Long-Haul Coherent Optical Fiber Communications via Regular Perturbation Model

We present a novel end-to-end autoencoder-based learning for coherent optical communications using a «parallelizable" perturbative channel model. We jointly optimized constellation shaping and nonlinear pre-emphasis achieving mutual information gain of 0.18 bits/sym./pol. simulating 64GBd dual-polarization single-channel transmission over 30x80 km G.652 SMF link with EDFAs.

Vladislav NeskorniUK **| *Presenter*** | *Aston Institute of Photonic Technology - UK, Nokia, 70435 Stuttgart - Germany*
Andrea Carnio | *Nokia, Vimercate 20871 - Italy*
Vinod Bajaj | *Delft Center for Systems and Control, Delft University of Technology, 2628 CD Delft - The Netherlands, Nokia, 70435 Stuttgart - Germany*
Domenico Marsella | *Nokia, Vimercate 20871 - Italy*
Sergei K. Turitsyn | *Aston Institute of Photonic Technology - UK*
Jaroslaw E. Prilepsky | *Aston Institute of Photonic Technology - UK*
Vahid Aref | *Nokia, 70435 Stuttgart - Germany*

09:45 - 10:00

Tu1C2.4
Over-the-fiber Digital Predistortion Using Reinforcement Learning

We demonstrate, for the first time, experimental over-the-fiber training of transmitter neural networks (NNs) using reinforcement learning. Optical back-to-back training of a novel NN-based digital predistorter outperforms arcsine-based predistortion with up to 60% bit-error-rate reduction.

Jinxiang Song **| *Presenter*** | *Chalmers University of Technology - Sweden*
Zonglong He | *Chalmers University of Technology - Sweden*
Christian Häger | *Chalmers University of Technology - Sweden*
Magnus Karlsson | *Chalmers University of Technology - Sweden*
Alexandre Graell I Amat | *Chalmers University of Technology - Sweden*
Henk Wymeersch | *Chalmers University of Technology - Sweden*
Jochen Schröder | *Chalmers University of Technology - Sweden*

ROOM D

NONLINEAR FIBER CHANNEL MODELLING

09:30 - 09:45

Chair: Helmut Grießer ADVA Optical Networking SE - Germany
SC6 - Theory of Optical Communications and Quantum Communications

Tu1D.3
Power Allocation Optimization in the Presence of Stimulated Raman Scatterin

We leverage the simplicity of closed-form expressions of the nonlinear interference variance in the presence of stimulated Raman scattering (SRS) for fast pre-emphasis optimization in wideband wavelength division multiplexing (WDM) terrestrial systems with sparse dynamic gain equalizers.

Chiara Lasagni **| *Presenter*** | *University of Parma - Italy*
Paolo Serena | *University of Parma - Italy*
Alberto Bononi | *University of Parma - Italy*
Jean-Christophe Antona | *Alcatel Submarine Networks, Nozay - France*

09:45 - 10:00

Tu1D.4
Machine Learning for Power Profiles Prediction in Presence of Inter-channel Stimulated Raman Scattering

Two artificial neural network (ANN) models are presented to predict power profiles over C+L–band in presence of inter-channel stimulated Raman scattering (ISRS) and to support non-linear interference (NLI) modeling. High prediction accuracy is obtained with maximum errors ≤ 0.1 dB over thousands different partial loads.

Ann Margareth Rosa Brusin **| *Presenter*** | *Politecnico di Torino - Italy*
Mahdi Ranjbar Zefreh | *Politecnico di Torino - Italy*
Pierluigi Poggiolini | *Politecnico di Torino - Italy*
Stefano Piciaccia | *Cisco Photonics - Italy*
Fabrizio Forghieri | *Cisco Photonics - Italy*
Andrea Carena | *Politecnico di Torino - Italy*

10:00 - 10:15

Tu1D.5
Real Time Closed-Form Model for Nonlinearity Assessment of Fibre Optic Links with Lumped Loss

We upgraded the recently proposed closed-form model (CFM) for non-linear interference (NLI) estimation to account for lumped losses. Statistical validation analyses show a high level of accuracy with maximum errors below 1.1 dB in NLI which leads to GSNR estimation errors below 0.35 dB.

Mahdi Ranjbar Zefreh* | *Presenter | *Politecnico di Torino - Italy*
Andrea Carena | *Politecnico di Torino - Italy*
Ann Margareth Rosa Brusin | *Politecnico di Torino - Italy*
Fabrizio Forghieri | *Cisco Photonics - Italy*
Stefano Piciaccia | *Cisco Photonics - Italy*
Pierluigi Poggiolini | *Politecnico di Torino - Italy*

10:15 - 10:30

Tu1D.6
Exponentially-Weighted Energy Dispersion Index for the Nonlinear Interference Analysis of Finite-Blocklength Shaping

A metric called exponentially-weighted energy dispersion index (EEDI) is proposed to explain the blocklength-dependent effective signal-to-noise ratio (SNR) in probabilistically shaped fiber-optic systems. EEDI is better than energy dispersion index (EDI) at capturing the dependency of the effective SNR on the blocklength for long-distance transmission.

Kaiquan Wu* | *Presenter | *Technology University of Eindhoven - The Netherlands*
Gabriele Liga | *Technology University of Eindhoven - The Netherlands*
Yunus Can Gültekin | *Technology University of Eindhoven - The Netherlands*
Alex Alvarado | *Technology University of Eindhoven - The Netherlands*

ROOM E

CONTROL PLANE AND ORCHESTRATION

10:00 - 10:15

Chair: Sébastien Bigo Nokia Bell-Labs - France
SC10 - Architecture, Control and Management of optical networks

Tu1E.5
First Demonstration of Dynamic Deployment of SDN-enabled WDM Virtual Network Topologies (VNTs) over SDM networks

We present the dynamic deployment of logical WDM VNTs by deploying virtual links between ROADM/OXC nodes using spatial channels provided by SDM networks. We propose a cloud-native WDM over SDM (WDMoSDM) SDN rchestrator that is responsible for the lifecycle management of the SDN-enabled WDM VNTs.

Carlos Manso* | *Presenter | *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain*
Raul Muñoz* | *Presenter | *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain*
Filippos Balasis | *KDDI Research Inc. - Japan Ricardo Martínez* | *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain*
Ramon Casellas | *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain*
Ricard Vilalta | *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain*
Ricardo Martínez | *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain*
Cen Wang | *KDDI Research Inc. - Japan*
Noboru Yoshikane | *KDDI Research Inc. - Japan*
Takehiro Tsuritani | *KDDI Research Inc. - Japan*
Itsuro Morita | *KDDI Research Inc. - Japan*

10:15 - 10:30

Tu1E.6
Implementing a Machine Learning Function Orchestration

Deployment of Machine Learning (ML) applications require from an Orchestrator to create ML functions that are connected as ML pipelines. Orchestrator implementation and demonstration for the deployment and reconfiguration of a ML pipeline related to a lightpath is shown.

Axel Wassington* | *Presenter | *Universitat Politecnica de Catalunya - Spain*
Luis Velasco | *Universitat Politecnica de Catalunya - Spain*
Lluis Gifre Renom | *Nokia Bell Labs - France*
Marc Ruiz | *Universitat Politecnica de Catalunya - Spain*

ROOM F

SHORT REACH COMMUNICATIONS AND NEW APPROACHES FOR ACCESS SYSTEMS

09:00 - 09:15

Chair: Stephan Pachnicke
SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

Tu1F.1
Faster-Than-Nyquist Subcarrier Modulation Utilizing Digital Brick-Wall Filter-Based THP for Band-Limited DML-DD Systems

With digital brick-wall filter-based coefficients estimation and Tomlinson-Harashima precoding, we experimentally demonstrate faster-than-Nyquist subcarrier modulation using a 20GHz O-band DML. At the 20% SD-FEC threshold, up to 105%, 45.5%, and 18.2% FTN rates are achieved for QPSK, 16-QAM and 32-QAM formats, respectively.

Yixiao Zhu* | *Presenter | *Shanghai Jiao Tong University - China*
Qi Wu | *Shanghai Jiao Tong University - China*
Longjie Yin | *Shanghai Jiao Tong University - China*
Weisheng Hu | *Shanghai Jiao Tong University - China*

09:15 - 09:30

Tu1F.2
Experimental Assessments of a Flexible Optical Switch and Control System with Dynamic Bandwidth Allocation

A flexible optical switch and control system with dynamic bandwidth allocation is experimentally assessed to enable reconfigurable DCNs. Experiments validate the flexible system achieves 3.15 μs end-to-end latency (improving 48.61%) and decreases one order magnitude of packet loss, compared with the scheme with fixed connections.

Xuwei Xue* | *Presenter | *Technology University of Eindhoven - The Netherlands*
Kristif Prifti | *Technology University of Eindhoven The Netherlands*
Bitao Pan | *Technology University of Eindhoven The Netherlands*
Sai Chen | *Alibaba Cloud, Alibaba Group - China*
Xiaotao Guo | *Technology University of Eindhoven - The Netherlands*
Fulong Yan | *Alibaba Cloud, Alibaba Group - China*
Shaojuan Zhang | *Technology University of Eindhoven - The Netherlands*
Chongjin Xie | *Alibaba Cloud, Alibaba Group - USA*
Nicola Calabretta | *Technology University of Eindhoven - The Netherlands*

Tuesday 14 September

09:30 - 09:45

Tu1F.3
Novel EA-DFB Mode-Switching Transmitter Supporting Continuous Phase Frequency Shift Keying and Intensity Modulation for All-Photonics Network

A novel transmitter that offers both short-reach IM-DD transmission and higher optical budget coherent transmission is proposed for cost-effective user terminals. 25 Gb/s signal detection experiments confirm enhanced optical budget of 13 dB with high sensitivity of -37.7 dBm by modulation format switching.

Ryo Koma* | *Presenter | *NTT Corporation - Japan*
Kazutaka Hara | *NTT Corporation - Japan*
Takuya Kanai | *NTT Corporation - Japan*
Jun-ichi Kani | *NTT Corporation - Japan*
Tomoaki Yoshida | *NTT Corporation - Japan*

09:45 - 10:00

Tu1F.4
Environmental Interference Mitigation and Anti-LED Blocked using ANN with Memory Module in 3D Indoor VLP Systems

A novel deviation-correction algorithm named memory-artificial neural network is proposed in the ANN-based 3D indoor visible light positioning systems for environmental interference mitigation and anti-LED blocked. The average positioning error of 1.04cm and 2.89cm is experimentally achieved under environmental interference and LED-blocked, respectively.

Zicai Cao* | *Presenter | *School of Optical and Electronic Information, Huazhong University of Science and Technology, Wuhan, - China*
Mengfan Cheng | *School of Optical and Electronic Information, Huazhong University of Science and Technology, Wuhan, - China*
Qi Yang | *School of Optical and Electronic Information, Huazhong University of Science and Technology, Wuhan, - China*
Deming Liu | *School of Optical and Electronic Information, Huazhong University of Science and Technology, Wuhan, - China*
Lei Deng | *School of Optical and Electronic Information, Huazhong University of Science and Technology, Wuhan, - China*

10:00 - 10:15

Tu1F.5
50Gb/s Optical Wireless Data Center Network Architecture Using SOA-based Wavelength Selector and AWGR

We experimentally demonstrate a fast optical wireless datacenter network architecture using nanoseconds SOA-based wavelength selector and Arrayed Waveguide-Grating Router for optical switching. 4x4 prototype experiments show error-free 50Gb/s OOK per link with power penalty <2dB.

Shaojuan Zhang* | *Presenter | *Technology University of Eindhoven - The Netherlands*
Xuwei Xue | *Technology University of Eindhoven - The Netherlands*
Bitao Pan | *Technology University of Eindhoven - The Netherlands*
Xiaotao Guo | *Technology University of Eindhoven - The Netherlands*
Eduward Tangdiongga | *Technology University of Eindhoven - The Netherlands*
Nicola Calabretta | *Technology University of Eindhoven - The Netherlands*

10:15 - 10:30

Tu1F.6
Optical Beat Interference in Burst Mode Upstream Links of the Higher Speed-PON: Situation, Penalties and Solution

We perform a 25Gb/s NRZ-OOK burst mode transmission. A beating between two optical sources is detected on a DC-30GHz photodiode and a penalty due to OBI on the BER as high as 2.8dB is experimentally observed. Solutions to reduce the impact of OBI are proposed.

Jérémy Potet* | *Presenter | *Institut Foton - France, Orange Labs - France*
Gaël Simon | *Orange Labs - France*
Fabienne Saliou | *Orange Labs - France*
Mathilde Gay | *Institut Foton - France*
Laurent Bramerie | *Institut Foton - France*
Philippe Chanclou | *Orange Labs - France*
Monique Thual | *Institut Foton - France*

ROOM G

ADVANCED COMPONENT DESIGN

10:00 - 10:15

Chair: Lars Zimmermann IHP GmbH - Leibniz-Insitut für innovative Mikroelektronik - Germany
SC3 - Integrated and co-integrated circuits

Tu1G.5
Robust Topology Optimization for Foundry-Photonics Inverse Design: Examining Compact and Arbitrary Power Splitters

We present a novel framework for robust inverse-design of semiconductor-foundry devices tolerant to standard fabrication variability. We designed and tested compact 50/50, 90/10, and 99/1 power splitters sampled across multiple wafers on a commercial silicon photonic process, demonstrating <±2% deviation over 100 nm of bandwidth.

Alec Hammond* | *Presenter | *Georgia Institute of Technology - USA*
Joel Slaby | *Georgia Institute of Technology - USA*
Gareeyasee Saha | *Georgia Institute of Technology - USA*
Stephen Ralph | *Georgia Institute of Technology - USA*

ROOM A

FIBER LASERS AND AMPLIFIERS

11:00 - 11:15

Chair: Marianne Bigot Prysmian Group - France
SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers

Tu2A.1
64-fs L-band Pulse Generation by an All-Fibre Er-Doped Laser

We demonstrate a L-band all-fibre erbium-doped laser mode-locked by nonlinear polarisation rotation. The use of a single gain segment with appropriate length and dispersion and a L-band optimised Brewster fibre grating as an in-fibre polariser enables the generation of 64-fs pulses at 1.59 µm.

Sonia Boscolo* | *Presenter | *Aston Institute of Photonic Technology - UK*
Zinan Huang | *Key Laboratory of Specialty Fiber Optics and Optical Access Network, Shanghai University - China*
Qianqian Huang | *Key Laboratory of Specialty Fiber Optics and Optical Access Network, Shanghai University - China*
Zhikun Xing | *National Engineering Laboratory for Next Generation Internet Access System, Huazhong University of S - China*
Zhijun Yan | *National Engineering Laboratory for Next Generation Internet Access System, Huazhong University of S - China*
Tao Chen | *Key Laboratory of Space Active Opto-Electronics Technology, Shanghai Institute of Technical Physics - China*
Yunqi Liu | *Key Laboratory of Specialty Fiber Optics and Optical Access Network, Shanghai University - China*
Chengbo Mou | *Key Laboratory of Specialty Fiber Optics and Optical Access Network, Shanghai University - China*

11:15 - 11:30

Tu2A.2
Performance Benefits of 1860 nm vs. 1940 nm Pumping of Holmium-doped Fibres with Significant Ion Pairing

We report a first investigation of the performance of single clad Ho-doped fibres as a function of both ion pairing and pump wavelength. Our report shows that 1860 nm yields a significant performance advantage over 1940 nm pumping for representative Ho-doped fibres with a wide range of ion pairing. We find that our simulations when compared with experiment yield an accurate value for the degree of ion pairing. Our simulations are confirmed by experimental data.

Robert Tench* | *Presenter | *Cybel LLC - USA*
Wiktor Walasik | *Cybel LLC - USA*
Alexandre Amavigan | *Cybel LLC - USA*
Jean-Marc Delavaux | *Cybel LLC - USA*

11:30 - 11:45

Tu2A.3
Investigation of Hybrid S-band Amplifier Performance with 8-channel × 10 Gbaud 16-QAM signals

We experimentally demonstrate a hybrid S-band amplifier, consisting of two parametric-amplifier-based wavelength converters and an L-band EDFA in the middle, and evaluate its performance with 8 WDM channels carrying 10 Gbaud 16-QAM data.

Michael Vasilyev* | *Presenter | *Department of Electrical Engineering, University of Texas at Arlington, Arlington, TX - USA*
Cheng Guo | *Department of Electrical Engineering, University of Texas at Arlington, Arlington, TX - USA*
Afshin Shamsshooli | *Department of Electrical Engineering, University of Texas at Arlington, Arlington, TX - USA*
Youichi Akasaka | *Advanced Technology Labs, Fujitsu Network Communications, Richardson, TX - USA*
Paparao Palacharla | *Advanced Technology Labs, Fujitsu Network Communications, Richardson, TX - USA*

11:45 - 12:00

Tu2A.4
Polarization- insensitive fibre optic parametric amplifier with gain bandwidth of 35 nm in L-band

We experimentally demonstrate a polarisation-insensitive fibre optic parametric amplifier (PI FOPA) with the record wide gain bandwidth of 35 nm. We employ the PI-FOPA to amplify the full C- band equivalent 42x100GHz-spaced channels with net gain >10 dB and polarisation-dependent gain <0.5 dB in the wavelength range between 1580 nm and 1615 nm.

Chandra B. Gaur* | *Presenter | *Aston Institute of Photonic Technology - UK*
Vladimir Gordienko | *Aston Institute of Photonics Technology - UK*
Abdhullah Ali | *Aston Institute of Photonics Technology - UK*
Pratim Hazarika | *Aston Institute of Photonic Technology - UK*
Andrew Ellis | *Aston Institute of Photonic Technology - UK*
Nick J Doran | *Aston Institute of Photonics Technology - UK*

12:00 - 12:15

Tu2A.5
SNR-Improvement of Four-Wave-Mixing Wavelength Converters using Raman Amplification

Based on a detailed experimental data-quality analysis of a FWM wavelength converter based on highly nonlinear fibres, we find significant improvement potentials, and demonstrate >1-dB SNR improvement of a converted 16-QAM, 32-Gbaud data signal by adding Raman amplification to the FWM process.

Frederik Klejs* | *Presenter | *DTU - Denmark*
Lukasz Krzczanowicz | *DTU - Denmark*
Deming Kong | *DTU - Denmark*
Michael Galili | *DTU - Denmark*
Yabin Ye | *Huawei Technologies - Germany*
Leif Katsuo Oxenløwe | *DTU - Denmark*

12:15 - 12:30

Tu2A.6
First Experimental Mach-Zehnder FOPA for Polarization- and Wavelength-Division-Multiplexed Signals

We demonstrate and characterize a polarization insensitive fiber optical parametric amplifier based on a Mach-Zehnder configuration using a commercial 100G PDM-QPSK transponder. A net gain >10 dB is obtained for 17 channels in C-band, 100 GHz spaced.

Florent Bessin* | *Presenter | *Aston Institute of Photonic Technology - UK*
Vladimir Gordienko | *Aston Institute of Photonic Technology - UK*
Filipe Marques Ferreira | *Optical Networks Group, Department of Electronic and Electrical Engineering, UCL - UK*
Nick J Doran | *Aston Institute of Photonic Technology - UK*

ROOM C1

MONITORING AND NEW FUNCTIONS IN OPTICAL NETWORKS

11:00 - 12:30

Chair: Bernhard Schrenk AIT Austrian Institute of Technology - Austria
SC8 - Core and metro networks

Tu2C1.1 EXTENDED
Uncertainty Aware Real-Time Performance Monitoring for Elastic Optical Networks

We propose a quality of transmission metric which unifies different performance-related metrics into one. Our metric presents advantages such as the reduction of stored and transmitted data, low controlled uncertainty and high monitoring speed, while it is compatible with an extended range of performance regimes.

Petros Ramantanis* | *Presenter | *Nokia Bell Labs - France*
Camille Delezoide | *Nokia Bell Labs - France*
Patricia Layec | *Nokia Bell Labs - France*
Sébastien Bigo | *Nokia Bell Labs - France*

11:30 - 11:45

Tu2C1.3
Distributed Vibration Sensing of Seismic Event by Optical Frequency Domain Reflectometry

We measured a seismic event with OFDR. OFDR together with the unique feature of adjusting the measurement performance was used to analyse the event from different perspectives, and it could also be useful for revealing the features of infrequent seismic events.

Tatsuya Okamoto* | *Presenter | *NTT Access Network Service Systems Laboratories - Japan*
Daisuke Iida | *NTT Access Network Service Systems Laboratories - Japan*
Yusuke Koshikiya | *NTT Access Network Service Systems Laboratories - Japan*
Nazuki Honda | *NTT Access Network Service Systems Laboratories - Japan*

Tuesday 14 September

ROOM C2

MACHINE LEARNING II

11:00 - 11:15

Chair: Sander Wahls Delft University of Technology - The Netherlands
SC4 - Techniques for digitally enhancing optical communication

Tu2C2.1 EXTENDED
Neural Networks For Nonlinear Fourier Spectrum Computation

We demonstrate that neural networks can outperform conventional numerical nonlinear Fourier transform algorithms for processing the noise-corrupted optical signal. Applying the Bayesian hyper-parameters optimisation, we design the architecture of neural networks capable to compute nonlinear signal spectrum at low SNR more accurately than conventional algorithms.

Egor Sedov **| *Presenter*** | *Aston Institute of Photonic Technology - UK, Novosibirsk State University The Russian Federation*
Pedro Jorge Freire de Carvalho Souza | *Aston Institute of Photonic Technology - UK*
Igor Chekhovskoy | *Novosibirsk State University The Russian Federation*
Sergei K. Turitsyn | *Aston Institute of Photonic Technology - UK, Novosibirsk State University The Russian Federation*
Jaroslaw E. Prilepsky | *Aston Institute of Photonic Technology - UK*

11:15 - 11:30

Tu2C2.2
Gated Recurrent Unit based Autoencoder for Optical Link Fault Diagnosis in Passive Optical Networks

We propose a deep learning approach based on an autoencoder for identifying and localizing fiber faults in passive optical networks. The experimental results show that the proposed method detects faults with 97% accuracy, pinpoints them with an RMSE of 0.18 m and outperforms conventional techniques.

Khouloud Abdelli **| *Presenter*** | *ADVA Optical Networking SE - Germany*
Florian Azendorf | *ADVA Optical Networking SE - Germany*
Helmut Grießer | *ADVA Optical Networking SE - Germany*
Carsten Tropschug | *ADVA Optical Networking SE - Germany*
Stephan Pachnicke | *Kiel University - Germany*

11:30 - 11:45

Tu2C2.3
Symbol-Based Supervised Learning Predistortion for Compensating Transmitter Nonlinearity

We experimentally demonstrate a symbol-based nonlinear digital pre-distortion (DPD) technique utilizing supervised learning, which is robust against a change of modulation format. Back-to-back

transmission of 30 Gbaud 32, 64, and 256QAM confirms that our scheme significantly outperforms the baseline of arcsine-based pre-distortion.

Zonglong He **| *Presenter*** | *Chalmers University of Technology - Sweden*
Jinxiang Song | *Chalmers University of Technology - Sweden*
Christian Häger | *Chalmers University of Technology - Sweden*
Kovendhan Vijayan | *Chalmers University of Technology - Sweden*
Peter Andrekson | *Chalmers University of Technology - Sweden*
Magnus Karlsson | *Chalmers University of Technology - Sweden*
Alexandre Graell I Amat | *Chalmers University of Technology - Sweden*
Henk Wymeersch | *Chalmers University of Technology - Sweden*
Jochen Schröder | *Chalmers University of Technology - Sweden*

11:45 - 12:00

Tu2C2.4
Zero-Multiplier Sparse DNN Equalization for Fiber-Optic QAM Systems with Probabilistic Amplitude Shaping

We propose a multiplier-less deep neural network (DNN) to mitigate fiber-nonlinear distortion of shaped constellations. Our DNN achieves an excellent performance-complexity trade-off with progressive lottery ticket hypothesis (LHT) weight pruning and additive powers-of-two (APoT) quantization.

Toshiaki Koike-Akino **| *Presenter*** | *MERL - USA*
Ye Wang | *MERL - USA*
Keisuke Kojima | *MERL - USA*
Kieran Parsons | *MERL - USA*
Tsuyoshi Yoshida | *Mitsubishi Electric Corporation - Japan*

12:00 - 12:15

Tu2C2.5
Fiber Link Anomaly Detection and Estimation Based on Signal Nonlinearity

A fiber link anomaly detection and estimation approach is proposed. Using signal nonlinear distortion, signal power profile anomaly and passband narrowing anomaly can be recognized with high quantitative and position accuracy. Such approach does not require additional equipment and can support online working.

Gleb Sidelnikov **| *Presenter*** **|** *Huawei Moscow Research Center - The Russian Federation*
Konstantin Pestov | *Huawei Moscow Research Center - The Russian Federation*
Ji Luo | *Huawei Moscow Research Center - The Russian Federation*
Bofang Zheng | *Huawei Technologies Co. Ltd. - China*

ROOM D

FIBER NONLINEARITY MITIGATION AND SPACE-DIVISION MULTIPLEXING

11:30 - 12:00

Chair: Cristian Antonelli University of L'Aquila - Italy
SC6 - Theory of Optical Communications and Quantum Communications

Tu2D.3 EXTENDED
A Model of the Nonlinear Interference in Space-Division Multiplexed Systems with Arbitrary Modal Dispersion

We show how to include modal dispersion in the Gaussian noise model extended to space-division multiplexed systems with strongly-coupled modes. The proposed model enables fast and accurate design of SDM links. Here we use it to reveal a considerable dependence of cross-nonlinearities on modal dispersion.

Paolo Serena **| *Presenter*** | *University of Parma - Italy*
Chiara Lasagni | *University of Parma - Italy*
Alberto Bonon | *University of Parma - Italy*
Cristian Antonell | *University of L'Aquila - Italy*
Antonio Mecozzi | *University of L'Aquila - Italy*

12:00 - 12:15

Tu2D.5
Mode Vector Modulation

We propose a new energy-efficient, short-haul, multidimensional modulation using spatial degrees of freedom in SDM fibers to create well-separated points in the generalized Stokes space. We study the transceiver architecture, geometric constellation shaping, bit-to-symbol mapping, and the performance of the optically-preamplified direct-detection receiver.

Ioannis Roudas **| *Presenter*** | *Montana State University - USA*
Jaroslaw Kwapisz | *Montana State University - USA*
Eric Fink | *Montana State University - USA*

ROOM E

NETWORK AND SYSTEM DESIGN

11:00 - 11:15

Chair: Sébastien Bigo Nokia Bell-Labs - France
SC10 - Architecture, Control and Management of optical networks

Tu2E.1
Multiband Seamless Network Upgrade by Exploiting the E-band

We investigate the exploitation of the E-band in multi-band optical networks. A guard band of 14 THz is selected to isolate E- from C- and L-bands minimizing stimulated Raman scattering on already operating channels. Network simulations show double of supported traffic over the same infrastructure.

Nicola Sambo* | *Presenter | *Scuola Superiore Sant'Anna, TeCIP Institute - Italy*
João Pedro | *Infinera - Portugal*
Antonio Napoli | *Infinera - Germany*
Vittorio Curri | *Politecnico di Torino - Italy*
Alessio Ferrari | *Politecnico di Torino - Italy*
Leily Sehaar Kiani | *Lawrence Livermore National Laboratory - USA*
Piero Castoldi | *Scuola Superiore Sant'Anna, TeCIP Institute - Italy*

11:15 - 11:30

Tu2E.2
Optimized Translucent S-band Transmission in Multi-Band Optical Networks

For multi-band optical networks that encompass the C-, L-, and S-bands, the latter provides the poorest Quality of Transmission (QoT). We have evaluated optimization of the S-band in a multi-band optical network scenario, demonstrating the possibility of increasing overall network capacity in a cost-effective manner.

Rasoul Sadeghi* | *Presenter | *Politecnico di Torino - Italy*
Nelson Costa | *Infinera - Portugal*
João Pedro | *Infinera - Portugal*
Antonio Napoli | *Infinera - UK*
Vittorio Curri | *Politecnico di Torino - Italy*
Emanuele Virgillito | *Politecnico di Torino - Italy*
Bruno Correia | *Politecnico di Torino - Italy*
Elliot London | *Politecnico di Torino - Italy*

11:30 - 11:45

Tu2E.3
Quantifying Resource Savings from Low-Margin Design in Optical Networks with Probabilistic Constellation Shaping

We estimate resource savings from low-margin optical-network design considering (i) different transmission modes (including PCS), (ii) full vs. actual load for interference modelling and (iii) greedy heuristic vs. evolutionary metaheuristic for routing. Numerical results, mimicking multi-year-traffic evolution, allow to quantify extent of these savings.

Oleg Karandin* | *Presenter | *Politecnico di Milano - Italy*
Alessio Ferrari | *Huawei Technologies, Paris Research Center - France*
Yvan Pointurier | *Huawei Technologies, Paris Research Center - France*
Francesco Musumeci | *Politecnico di Milano - Italy*
Omran Ayoub | *Politecnico di Milano - Italy*
Massimo Tornatore | *Politecnico di Milano - Italy*

11:45 - 12:00

Tu2E.4
Evaluation of the Link Budget Increase using Error-Tolerant TCPs for Optical Communication in Nonlinear Regime on 200G PM-16QAM Real-time Signal Demodulation

We evaluated TCP/IP data transfer throughput using real-time 200G PM-16QAM signal over 75km SMF in the nonlinear regime. We show the validity of TCP/IP with an additional 0.2 dB increase in link budget in the nonlinear regime compared to 0.3 dB in the linear regime.

Yohei Hasegawa* | *Presenter | *NEC Corp. - Japan*
Hidemi Noguchi | *NEC Corp. - Japan*
Masaki Sato | *NEC Corp. - Japan*
Kohei Hosokawa | *NEC Corp. - Japan*
Morihiko Ota | *NEC Corp. - Japan*

12:00 - 12:15

Tu2E.5
Network-Wide SNR-based Channel Power Optimization

We propose a per-channel power allocation to maximize worst service's SNR network-wide. The technique, rooted in the Gaussian noise model but accounting for all transmission effects, is validated on a testbed with commercial, real-time equipment; a gain of 0.5 dB margin improvement is experimentally demonstrated.

Venkata Virajit Garbhapu* | *Presenter | *Huawei Technologies France - France, Telecom Paris - France*
Gabriel Charlet | *Huawei Technologies France - France*
Dylan Le Gac | *Huawei Technologies France - France*
Ivan Fernandez De Jauregui Ruiz | *Huawei Technologies France - France*
Alessio Ferrari | *Huawei Technologies France - France*
Yvan Pointurier | *Huawei Technologies France - France*

12:15 - 12:30

Tu2E.6
Lightweight Optical Constellation Modeling by Concatenating Artificial Neural Networks

A lightweight optical constellations modeling method based on concatenating ANNs is proposed. Statistical validation of the reproduced constellations is shown. The method accelerates data generation and facilitates detecting (un)intentioned misconfigurations, among others.

Diogo Gonçalo Sequeira* | *Presenter | *Universitat Politecnica de Catalunya - Spain*
Nelson Costa | *Infinera - Portugal*
João Pedro | *Infinera - Portugal*
Antonio Napoli | *Infinera - Germany*
Luis Velasco | *Universitat Politecnica de Catalunya - Spain*
Marc Ruiz | *Universitat Politecnica de Catalunya - Spain*

ROOM G

RECONFIGURABLE SI PHOTONICS CIRCUITS

11:00 - 12:30

Chair: Ueli Koch ETH Zurich - Switzerland
SC3 - Integrated and co-integrated circuits

Tu2G.1 EXTENDED
Multimode Free Space Optical link enabled by SiP integrated meshes

A silicon photonic mesh of tuneable Mach-Zehnder Interferometers (MZIs) is employed to receive two spatially-overlapped Hermite-Gaussian beams modulated at 10 Gbit/s, sharing the same wavelength and state of polarization. The mesh automatically self-configures, separating and sorting the two beams out without any excess loss.

Maziyar Milanizadeh* | *Presenter | *Politecnico di Milano - Italy*
SeyedMohammad SeyedinNavadeh | *Politecnico di Milano - Italy*
Giorgia Benci | *Politecnico di Milano - Italy*
Christian De Vita | *Politecnico di Milano - Italy*
Charalambos Klitis | *School of Engineering University of Glasgow - UK*
Marc Sorel | *School of Engineering University of Glasgow - UK*
Francesco Zanetto | *Politecnico di Milano - Italy*
Giorgio Ferrari | *Politecnico di Milano - Italy*
David A. B. Miller | *Ginzton Laboratory, Stanford University - USA*
Andrea Melloni | *Politecnico di Milano - Italy*
Francesco Morichetti | *Politecnico di Milano - Italy*

11:45 - 12:00

Tu2G.4
First Demonstration of Monolithic Silicon Photonic Integrated Circuit 32x32 Thin-CLOS AWGR for All-to-All Interconnections

We designed, fabricated, and demonstrated the first monolithic silicon photonic Thin-CLOS AWGR. The fabricated Thin-CLOS has 32 ports and four 16-port silicon nitride AWGRs integrated by compact multilayer waveguide routing. Experimental results show 4 dB insertion loss and -20 dB crosstalk.

Mingye Fu* | *Presenter | *University of California, Davis - USA*
Guangyao Liu | *University of California, Davis - USA*
Roberto Proietti | *University of California, Davis - USA*
Yichi Zhang | *University of California, Davis - USA*
S.J. Ben Yoo | *University of California, Davis - USA*

12:00 - 12:15

Tu2G.5
Polarization Transparent Add-Drop Multiplexer with Hitless Tuneability

An original microring-based filter exploiting non-rational Vernier scheme and controllable ring losses with FSR-free frequency response and wide range hitless tuneability is reported. Effectiveness of the device as Add/Drop multiplexer is demonstrated through BER assessments on 200 Gbit/s 16-QAM DP signals.

Matteo Petrini **| *Presenter*** | *Politecnico di Milano - Italy*
Maziyar Milanizadeh | *Politecnico di Milano - Italy*
Francesco Zanetto | *Politecnico di Milano - Italy*
Giorgio Ferrari | *Politecnico di Milano - Italy*
Francesco Morichetti | *Politecnico di Milano - Italy*
Andrea Melloni | *Politecnico di Milano - Italy*

12:15 - 12:30

Tu2G.3
Temperature-Tolerant Crosstalk-Free WDM Demultiplexing Using Controller-Integrated Cascaded AMZ Triplet (CAT) on Si Nano-Waveguide PIC Platform

We demonstrate 4-ch 400-GHz-spaced WDM demultiplexing with CAT integrated with a CMOS controller IC for the first time. Error-free operation with a 25 Gb/s NRZ signal is obtained even under a rapid temperature change.

Tomoyuki Akiyama **| *Presenter*** | *Fujitsu Ltd. - Japan, PETRA - Japan*
Motoyuki Nishizawa | *PETRA - Japan*
Akio Sugama | *Fujitsu Ltd. - Japan, PETRA - Japan*
Yasuhiro Nakasha | *Fujitsu Ltd. - Japan, PETRA - Japan*
Shinsuke Tanaka | *Fujitsu Ltd. - Japan*
Yu Tanaka | *Fujitsu Ltd. - Japan, PETRA - Japan*
Takeshi Hoshida | *Fujitsu Ltd. - Japan*

ROOM A

MODELLING AND CHARACTERIZATION OF SDM FIBERS

14:00 - 14:30

Chair: Luca Palmieri University of Padova - Italy
SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers

Tu3A.1 EXTENDED
Light Scattering Mechanisms in Few-Mode Fibers

The contributions of Rayleigh and small angle light scattering (SALS) mechanisms to attenuation for three different 6-LP-mode fibers are quantified and their impact on Differential Mode Attenuation (DMA) are analyzed. We show that a trapezoidal-index profile offers the best trade-off to reach low attenuation, low DMA and large effective-index differences between modes.

Maroun Bsaibes **| *Presenter*** | *Univ. Lille, CNRS, UMR 8523 - PhLAM - Physique des Lasers, Atomes et Molécules, F-59000 Lille - France*
Yves Quiquempoi | *Univ. Lille, CNRS, UMR 8523 - PhLAM - Physique des Lasers, Atomes et Molécules, F-59000 Lille - France*
Stephane Plus | *Univ. Lille, CNRS, UMR 8523 - PhLAM - Physique des Lasers, Atomes et Molécules, F-59000 Lille - France*
Adrien Masselot | *Univ. Lille, CNRS, UMR 8523 - PhLAM - Physique des Lasers, Atomes et Molécules, F-59000 Lille - France*
Guillaume Labroille | *Cailabs, 38 Boulevard Albert 1er, 35200 Rennes - France*
Marianne Bigot | *Prysmian Group - France*
Jean-Baptiste Trinel | *Prysmian Group - France*
Laurent Bigot | *Univ. Lille, CNRS, UMR 8523 - PhLAM - Physique des Lasers, Atomes et Molécules, F-59000 Lille - France*

14:30 - 14:45

Tu3A.3
Impulse Response Measurement of a Few-Mode Fiber Using Superconducting Nanowire Single-Photon Detectors

We use time-of-flight measurements of single photons to estimate the impulse response of a 96,km long few-mode fiber and obtain unparalleled sensitivity of -100dBm with a 40dB dynamic range using the high timing accuracy of superconducting nanowire single-photon detectors.

Mikael Mazur **| *Presenter*** | *Nokia Bell Labs - USA*
Nicolas Fontaine | *Nokia Bell Labs - USA*
Roland Ryf | *Nokia Bell Labs - USA*
Haoshuo Chen | *Nokia Bell Labs - USA*
Andrea Blanco-Redondo | *Nokia Bell Labs - USA*

14:45 - 15:00

Tu3A.4
Comparison of Linear Mode Coupling Dynamics in Single Mode and Multi Mode Fibers

We investigate the mode coupling dynamics in different fiber types for mechanical movement. It is shown that the power fluctuations in graded index fibers are significantly smaller and slower than in step index fibers. The mode dependent dynamics are dominant over the polarization dependent ones.

Christian Spenner **| *Presenter*** | *TU Dortmund - Germany*
Klaus Petermann | *TU Berlin - Germany*
Peter Krummrich | *TU Dortmund - Germany*

15:00 - 15:15

Tu3A.5
Characterisation of a Coupled-Core Fiber Using Dual-Comb Swept-Wavelength Interferometry

We present a measurement of the transfer matrix of a coupled three-core fiber using a novel combination of swept-wavelength interferometry and dual-comb spectroscopy capable of measuring 1 THz bandwidth with a frequency resolution of 50 kHz with only a 25 GHz laser sweep.

Ekaterina Deriushkina **| *Presenter*** | *Chalmers University of Technology - Sweden*
Israel Rebolledo Salgado | *Chalmers University of Technology - Sweden, Measurement Science and Technology, RISE Sweden - Sweden*
Mikael Mazur | *Nokia Bell Labs - USA*
Victor Torres-Company | *Chalmers University of Technology - Sweden*
Peter Andrekson | *Chalmers University of Technology - Sweden*
Simon Gross | *MQ Photonics Research Centre, Department of Physics and Astronomy, Macquarie University - Australia*
Michael J. Withford | *MQ Photonics Research Centre, Department of Physics and Astronomy, Macquarie University - Australia*
Tetsuya Hayashi | *Sumitomo Electric Industries, Ltd - Japan*
Takuji Nagashima | *Sumitomo Electric Industries, Ltd - Japan*
Jochen Schröder | *Chalmers University of Technology - Sweden*
Magnus Karlsson | *Chalmers University of Technology - Sweden*

ROOM C1

HIGH CAPACITY TRANSMISSION IN METRO AND CORE NETWORKS

15:15 - 15:30

Tu3A.6
Transfer Matrix Characterization and Mode-Dependent Loss Optimization of Packaged 7-Core Coupled-Core EDFA

We present the full transfer matrix characterization of a packaged 7-core coupled-core amplifier using all multi-core components. Pump current optimization is used to achieve a small mode-dependent loss of about 3dB, observed over a gain range of 17 to 25dB.

Mikael Mazur **|** ***Presenter*** | *Nokia Bell Labs - USA*
Nicolas Fontaine | *Nokia Bell Labs - USA*
Roland Ryf | *Nokia Bell Labs - USA*
Haoshuo Chen | *Nokia Bell Labs - USA*
Lauren Dallachiesa | *Nokia Bell Labs - USA*
Takafumi Ohtsuka | *Sumitomo Electric Industries, Ltd - Japan*
Hirotaka Sakuma | *Sumitomo Electric Industries, Ltd - Japan*
Tetsuya Hayashi | *Sumitomo Electric Industries, Ltd - Japan*
Takemi Hasegawa | *Sumitomo Electric Industries, Ltd - Japan*
Hidehisa Tazawa | *Sumitomo Electric Industries, Ltd - Japan*
David Neilson | *Nokia Bell Labs - USA*

14:00 - 14:30

Chair: Bernhard Schrenk AIT Austrian Institute of Technology - Austria
SC8 – Core and metro networks

Tu3C1.1 EXTENDED
Quasi-Continuous Symbol Rate Tunability for Maximum Capacity in Links Constrained by ROADM Filtering

Using real-time transceivers with symbol rates up to 72 GBd, we investigate the impact of ROADM filtering on optimum symbol rate and fractional m-QAM modulation required to maximize channel capacity. Granularity below 5 GBd is shown to yield maximum margin for a given link passband.

Steven Searcy **|** ***Presenter*** | *ADVA - USA*
Thomas Richter | *ADVA - USA*
Sergey Burtsev | *ADVA - USA*
Sorin Tibuleac | *ADVA - USA*

14:30 - 14:45

Tu3C1.3 HIGHLY SCORED
400 Gb/s CWDM-4 PAM-4 Uncooled (22°C to 70°C) Directly Modulation Transmission over 20 km

We demonstrate the first 400 Gb/s CWDM-4 PAM-4 transmission over a record distance of 20 km using commercial uncooled (22°C to 70°C) directly modulated lasers with tailored chirp characteristics for reach extension.

Son Le **|** ***Presenter*** | *Nokia Bell Labs - USA*
Yasuhiro Matsui | *II-VI Incorporated - USA*
Tsurugi Sudo | *II-VI Incorporated - USA*
Ashish Verma | *II-VI Incorporated - USA*

14:45 - 15:00

Tu3C1.4
High Capacity 400Gb/s Real-time Transmissions over AllWave ULL Fibres by 400ZR/ZR+ Pluggable Modules

We investigate the capability of 400ZR/ZR+ DWDM transmissions over G.652 fibres for DCI, metro/regional network. Real-time transmissions of 400Gb/s signals over 151km and 1010km fibre with capacity of >24Tb/s using 400ZR/ZR+ pluggable modules are demonstrated, respectively.

Benyuan Zhu **|** ***Presenter*** **|** *OFS - USA*
Robert Lingle | *OFS - USA*
David DiGiovanni | *OFS - USA*

15:00 - 15:15

Tu3C1.5
400GBASE-LR4 Transmission Over Field-Deployed Fibre Link Supported by Bismuth-Doped Fibre Amplifier

We demonstrated a transmission of 4x53 GBd PAM4 signals using a bismuth-doped fibre amplifier for the first time. Transmission reach was successfully expanded by amplifying 4 CWDM signals from 1271 to 1331 nm.

Yuta Wakayama **|** ***Presenter*** | *KDDI Research Inc. - Japan*
Vitaly Mikhailov | *OFS Laboratories - USA*
Daniel Elson | *KDDI Research Inc. - Japan*
Rachata Maneekut | *KDDI Research Inc. - Japan*
Jiawei Luo | *OFS Laboratories - USA*
Cen Wang | *KDDI Research Inc. - Japan*
Filippos Balasis | *KDDI Research Inc. - Japan*
Noboru Yoshikane | *KDDI Research Inc. - Japan*
Daryl Inniss | *OFS Laboratories - USA*
Takehiro Tsuritani | *KDDI Research Inc. - Japan*

15:15 - 15:30

Tu3C1.6
MEMS mirror-based 1×4 Core Selective Switch for 12-core fiber with low insertion-loss

We demonstrate a novel MEMS mirror-based 1x4 core selective switch for 12-core multicore fiber. It achieves an insertion loss of less than 3.16 dB and negligible performance degradation on switching experiments.

Yuta Goto **|** ***Presenter*** **|** *National Institute of Information and Communications Technology - Japan*
Ruben S Luis | *National Institute of Information and Communications Technology - Japan*
Yusuke Hirota | *National Institute of Information and Communications Technology - Japan*
Satoshi Shinada | *National Institute of Information and Communications Technology - Japan*
Sayaka Nagayama | *OPTOQUEST CO., LTD. - Japan*
Asa Higashitani | *OPTOQUEST CO., LTD. - Japan*
Tetsuya Kobayashi | *OPTOQUEST CO., LTD. - Japan*
Ryohei Fukumoto | *Fujikura - Japan*
Hideaki Furukawa | *National Institute of Information and Communications Technology - Japan*

Tuesday 14 September

ROOM C2

COHERENT TRANSCEIVERS

14:30 - 14:45

Chair: Sebastian Randel Karlsruhe Institute of Technology (KIT), Institute of Photonics - Germany and Quantum Electronics (IPQ)
SC4 - Techniques for digitally enhancing optical communication

Tu3C2.3
Experimental Investigation of Nonlinear Fourier Transform Based Fibre Nonlinearity Characterisation

First experimental results on the characterisation of the nonlinear fibre coefficient using nonlinear Fourier transforms are reported for a 1000 km NZDSF fibre link. No special training signals were used. Instead, conventional pulse-shaped QPSK symbols were transmitted.

***Pascal de Koste* | *Presenter* |** *Delft University of Technology - The Netherlands*
Jonas Koch | *Kiel University - Germany*
Stephan Pachnicke | *Kiel University - Germany*
Sander Wahls | *Delft University of Technology - The Netherland*

14:45 - 15:00

Tu3C2.4
The Interaction Between Pilot Based Linear Equalizer and Device Nonlinearity in Optical Coherent Communication

The interaction between QPSK pilot based linear equalizer and device nonlinearity and the corresponding penalty are demonstrated experimentally. By setting proper amplitude probabilistic distribution, new pilot design mitigates it and improves Q more than 1dB.

Xiaofei Su* | *Presenter | *Fujitsu Ltd. - China*
Ke Zhang | *Fujitsu Ltd. - China*
Tong Ye | *Fujitsu Ltd. - China*
Zhenning Tao | *Fujitsu Ltd. - China*
Hisao Nakashima | *Fujitsu Ltd. - Japan*
Takeshi Hoshida | *Fujitsu Ltd. - Japan*

15:00 - 15:15

Tu3C2.5
Polarization Change Monitor Based on Geometrical Analysis in Stokes Space

We propose a novel polarization change monitor by analyzing geometrical relation of pilot symbols in Stokes space. The proposed monitor is experimentally verified and result shows that the polarization change in the range of quasi static to 3MHz can be captured.

Jingnan Li* | *Presenter | *Fujitsu Ltd. - China*
Yangyang Fan | *Fujitsu Ltd. - China*
Zhenning Tao | *Fujitsu Ltd. - China*
Hisao Nakashima | *Fujitsu Ltd. - Japan*
Takeshi Hoshida | *Fujitsu Ltd. - Japan*

15:15 - 15:30

Tu3C2.6
Overcoming WSS Filtering with Bandwidth-Variable Probabilistic Constellation Shaping

Employing probabilistic constellation shaping with jointly optimized entropy and symbol-rate, we demonstrate that the tolerance towards WSS filtering can be significantly enhanced. Compared with standard uniform modulation, OSNR gains in the range of 1–3 dB are experimentally demonstrated for 400G–600G systems, after 5–10 WSS passes.

Fernando P. Guiomar* | *Presenter | *Instituto de Telecomunicações, Universidade de Aveiro - Portugal*
Marco A. Fernandes | *Instituto de Telecomunicações, Universidade de Aveiro - Portugal, University of Aveiro - Portugal*
Adriano Messias | *Idea! Electronic Systems - Brazil*
Tomaz Vilela | *Idea! Electronic Systems - Brazil*
Daniel Formiga | *Idea! Electronic Systems - Brazil*
Jacklyn Reis | *Idea! Electronic Systems - Brazil*
Paulo P. Monteiro | *Instituto de Telecomunicações, Universidade de Aveiro - Portugal, University of Aveiro - Portugal*

ROOM D

DIRECTLY MODULATED LASERS

14:30 - 15:00

Chair: Romain Brenot Huawei - France
SC2 - Optoelectronic devices and technologies

Tu3D.3 EXTENDED
2-channel 112-Gbps NRZ Short-Reach Transmission Based on 60-GHz-Bandwidth Directly-Modulated Membrane Laser Array on Si

Directly-modulated membrane lasers on SiO2/Si with ~60-GHz bandwidths are fabricated using an optimized longitudinal design for photon-photon resonance. A fabricated two-channel array exhibits 2×112 Gbps NRZ modulation over 2-km transmissions, consuming <0.3 pJ/bit operating energy.

Nikolaos Panteleimon Diamantopoulos* | *Presenter | *NTT Access Network Service Systems Laboratories - Japan*
Takuro Fuji | *NTT Access Network Service Systems Laboratories - Japan*
Suguru Yamaoka | *NTT Access Network Service Systems Laboratories - Japan*
Hidetaka Nishi | *NTT Access Network Service Systems Laboratories - Japan*
Takaaki Kakitsuka | *NTT Access Network Service Systems Laboratories - Japan •Waseda University - Japan*
Tai Tsuchizawa | *NTT Access Network Service Systems Laboratories - Japan*
Matsuo Shinji | *NTT Access Network Service Systems Laboratories - Japan*
Koji Takeda | *NTT Access Network Service Systems Laboratories - Japan*
Toru Segawa | *NTT Access Network Service Systems Laboratories - Japan*

15:00 - 15:15

Tu3D.5
1060nm Single-mode Metal-aperture VCSEL Array with Transverse Resonance and Low Power Consumption below 50 fJ/bit

We present 1060nm intracavity metal-aperture VCSELs array toward high-speed and single-mode operation with record low power consumption. The intracavity metal-aperture causes the transverse resonance which provides the modulation bandwidth-enhancement. We demonstrated 60Gbps PAM4 and 40Gbps NRZ modulations with energy efficiency of 48ft/bit and 50fj/bit, respectively.

Hameeda Ibrahim* | *Presenter | *Minia university - Egypt, Tokyo Institute of Technology - Japan*
Ahmed Hassan | *Department of Physics, Faculty of Science, Al-Azhar University, Assuit, Egypt - Egypt, Tokyo Institute of Technology - Japan*
Xiaodong Gu | *Ambition Photonics Inc. - Japan •Tokyo Institute of Technology - Japan*
Satoshi Shinada | *National Institute of Information and Communications Technology - Japan*
Mostafa Farghal | *Minia university - Egypt*
Fumio Koyama | *Tokyo Institute of Technology - Japan*

15:15 - 15:30

Tu3D.6
Inductance Impact on Digital Encoding Performance of 850-nm Multimode VCSELs for 50-Gbps NRZ-OOK Data Link

The 50-Gbit/s NRZ-OOK encoding of 850-nm multi-mode VCSEL is achieved by optimizing the contact inductance with shortening transmission-line length from 80 to 25 μm for bandwidth enhancement.

Jui-Hung Weng* | *Presenter | *National Taiwan University - Taiwan*
Wei-Chi Lo | *National Taiwan University - Taiwan*
Chih-Chiang Shen | *Berxel Photonics Inc. - China*
Jiaxing Wang | *Pinnacle Photonics Inc. - USA*
Pengfei Qiao | *Pinnacle Photonics Inc. - USA*
Jipeng Qi | *Pinnacle Photonics Inc. - USA*
Chih-Hsien Cheng | *Research Center for Advanced Science and Technology, University of Tokyo - Japan*
Constance J. Chang-Hasnain | *Berxel Photonics Inc. - China, Pinnacle Photonics Inc. - USA*
Gong-Ru Lin | *National Taiwan University - Taiwan*

ROOM E

LOW LATENCY AND SYNCHRONIZATION

14:00 - 14:30

Chair: Nicola Calabretta Eindhoven University of Technology - The Netherlands
SC10 - Architecture, Control and Management of optical networks

Tu3E.1 EXTENDED
DDX Add-On Card: Transforming Any Optical Legacy Network into a Deterministic Infrastructure

We propose a novel slotted, scheduled, and synchronous add-on modular card to deliver data with truly deterministic performance over legacy optical networks. We achieve ultralow 50ns jitter and 25μs latency end-to-end for edge-cloud scenarios.

Nihel Benzaoui* | *Presenter | *Nokia Bell Labs - France*
Sébastien Bigo | *Nokia Bell Labs - France*
Guillaume Soudai | *Nokia Bell Labs - France*
Olivier Angot | *Nokia - France*
Philippe Robineau | *Nokia - France*

14:30 - 14:45

Tu3E.3
Demonstration of Latency Control Label-Based Bounded-Jitter Scheduling in a Bridged Network for Industrial Internet

We propose and experimentally demonstrate a latency control label (LCL)-based bounded-jitter scheduling for Industrial Internet applications in an asynchronous bridged network. The demonstration results show that our proposed scheme can achieve a deterministic packet delay variation regardless of the number of hops.

Jiahao Ma* | *Presenter | *Beijing University of Posts and Telecommunications - China*
Jiawei ZhangPresenter | *Beijing University of Posts and Telecommunications - China*
Jim Zou | *ADVA Optical Networking SE - Germany*
Hao Yu | *Aalto University - Finland*
Tarik Taleb | *Aalto University - Finland*
Yaojia Dong | *Beijing University of Posts and Telecommunications - China*
Yuefeng Ji | *Beijing University of Posts and Telecommunications - China*

14:45 - 15:00

Tu3E.4
Novel Precise Time Synchronization and Distribution for Multi-layer Optical Metro and Access Networks

We present and experimentally assess a novel time slotted optical metro access network with precise time distribution and nodes synchronization. Results confirm successful time-slotted metro network operation with 5ns time accuracy and <12ns in two-layer metro and 5G fronthaul network with a single time reference.

***Bitao Pan* | *Presente*r** | *Technology University of Eindhoven - The Netherlands*
Xuwei Xue | *Technology University of Eindhoven - The Netherlands*
Fulong Yan | *Technology University of Eindhoven - The Netherlands*
Xiaotao Guo | *Technology University of Eindhoven - The Netherlands*
Nicola Calabretta | *Technology University of Eindhoven - The Netherlands*

15:00 - 15:15

Tu3E.5
Per Packet Distributed Monitoring Plane with Nanoseconds Measurements Precision

We propose a per-packet distributed monitoring plane for time-sensitive optical networking. Over a packet switched network and using our FPGA-based prototype, we demonstrate latency measurements of 6.4ns precision per hop with an offset of only 1.22μs.

Guillaume Soudais* | *Presenter | *Nokia Bell Labs - France*
Sébastien Bigo | *Nokia Bell Labs - France*
Nihel Benzaoui | *Nokia Bell Labs - France*

ROOM G

PHOTONIC COMPUTING

15:00 - 15:15

Chair: Daniel Kuchta IBM - USA
SC3 - Integrated and co-integrated circuits

Tu3G.5
Analysis of the Hardware Imprecisions for Scalable and Compact Photonic Tensorized Neural Networks

We simulated tensor-train decomposed neural networks realized by Mach-Zehnder interferometer-based scalable photonic neuromorphic devices. The simulation results demonstrate that under practical hardware imprecisions, the TT-decomposed neural networks can achieve >90% test accuracy with 33.6× fewer MZIs than conventional photonic neural network implementations.

Mehmet berkay on* | *Presenter | *UC Davis - USA*
Yun-Jhu Lee | *UC Davis - USA*
Xian Xiao | *UC Davis - USA*
Roberto Proietti | *UC Davis - USA*
S.J. Ben Yoo | *UC Davis - USA*

15:15 - 15:30

Tu3G.6
Broadband Balanced Homodyne Detector for High-Rate (>10 Gb/s) Vacuum-Noise Quantum Random Number Generation

We demonstrate a die-level balanced homodyne detector with a high quantum-to-classical noise clearance of 19.1dB over 3GHz bandwidth. We evaluate this receiver as a high-quality entropy source for random number generation at >10Gb/s and prove the functional integration of a classical 10Gb/s duobinary communication channel.

Florian Honz* | *Presenter | *AIT Austrian Institute of Technology - Austria*
Dinka Milovančev | *AIT Austrian Institute of Technology - Austria*
Nemanja Vokić | *AIT Austrian Institute of Technology - Austria*
Christoph Pacher | *AIT Austrian Institute of Technology - Austria*
Bernhard Schrenk | *AIT Austrian Institute of Technology - Austria*

Tuesday 14 September

ROOM A

OAM AND NEW GUIDING MECHANISMS

16:45 - 17:00

Chair: Luca Palmieri University of Padova - Italy
SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers

Tu4A.3 HIGHLY SCORED
Record (60) Uncoupled Modes in A Step-Index Fiber due to A New Light Guidance Mechanism: Topological Confinement

We exploit a recently discovered, so-called, topological confinement effect, to achieve mode-mixing resistant (inter-mode purity > 15 dB) propagation of a record 60 modes over 90 meters of a simple step-index fiber.

Zelin Ma **|** ***Presenter*** | *Boston University - USA*
Poul Kristensen | *OFS-Fitel - Denmark*
Siddharth Ramachandran | *Boston University - USA*

17:00 - 17:15

Tu4A.4
Experimental Demonstration of Amplifying 14 Orbital Angular Momentum Modes in Ring-Core Erbium-Doped Fiber with High Modal Gain

We propose and experimentally demonstrate an orbital angular momentum (OAM) fiber amplifier supporting 14 OAM modes based on a fabricated ring-core erbium-doped fiber with a core pump configuration acquiring a high modal gain up to 30.32 dB at 1550 nm.

Xi Zhang **|** ***Presenter*** | *Huazhong University of Science and Technology - China*
Jun Liu | *Huazhong University of Science and Technology - China*
Cheng Du | *Fiberhome Telecommunication Technologies Co. Ltd - China*
Wei Li | *Fiberhome Telecommunication Technologies Co. Ltd - China*
Jian Wang | *Huazhong University of Science and Technology - China*

ROOM C1

AMPLIFIER TECHNOLOGIES FOR TRANSMISSION SYSTEM

16:45 - 17:00

Chair: Gabriel Charlet Huawei Technologies - France
SC5 - Optical Transmission systems

Tu4C1.3 HIGHLY SCORED
13.4-Tb/s WDM Transmission over 1,280 km Repeated only with PPLN-based Optical Parametric Inline Amplifier

Inline-amplified 2.1-THz WDM transmission with the longest transmission distance of 1,280 km using OPA-based repeater only is demonstrated. Two-stage PPLN-based OPA offers sufficient gain to compensate losses of standard 80-km fibre span and optical gain equalizer for 640-Gb/s PDM-PS36QAM signals with 100-GHz-spaced 21-ch WDM configuration.

Takayuki Kobayashi **|** ***Presenter*** | *NTT Access Network Service Systems Laboratories - Japan*
Shimpei Shimizu | *NTT Access Network Service Systems Laboratories - Japan*
Masanori Nakamura | *NTT Access Network Service Systems Laboratories - Japan*
Takushi Kazama | *NTT Access Network Service Systems Laboratories - Japan*
Takeshi Umeki | *NTT Access Network Service Systems Laboratories - Japan*
Ryoichi Kasahara | *NTT Access Network Service Systems Laboratories - Japan*
Fukutaro Hamaoka | *NTT Access Network Service Systems Laboratories - Japan*
Yutaka Miyamoto | *NTT Access Network Service Systems Laboratories - Japan*

17:00 - 17:15

Tu4C1.4
8-Tbps (20 × 400 Gbps) Unrepeated Transmission over 80 km with 2-THz PPLN-Based Phase-Sensitive Amplification Using Precise Chromatic Dispersion Pre-Compensation

We demonstrate an 80-km unrepeated transmission of a 20-ch. 96-Gbaud PS-64QAM WDM signal with 100-GHz spacing using a periodically poled LiNbO3-based phase-sensitive amplifier. We achieve widest-band simultaneous phase-sensitive amplification over 2 THz (4 THz including an idler band) by precise chromatic dispersion pre-compensation.

Shimpei Shimizu **|** ***Presenter*** | *NTT Corporation - Japan*
Takayuki Kobayashi | *NTT Corporation - Japan*
Masanori Nakamura | *NTT Corporation - Japan*
Takushi Kazama | *NTT Corporation - Japan*
Takeshi Umeki | *NTT Corporation - Japan*
Ryoichi Kasahara | *NTT Corporation - Japan*
Yutaka Miyamoto | *NTT Corporation - Japan*
Koji Enbutsu | *NTT Corporation - Japan*

17:15 - 17:30

Tu4C1.5
12-Core Erbium/Ytterbium-Doped Fiber Amplifier for 200G/400G Long-Haul, Metro-Regional, DCI Transmission Applications with ROADM

A 12-core Er/Yb-doped fiber amplifier with 21-dBm/core output power and 5.3-Watts multimode pump is used to address various transmission applications with ROADM. 1200-km with 200G DP-QPSK and 300-km with 400G DP-16QAM are achieved in serial configuration at 1550-nm. Parallel 12x100-km transport with 400-ZR+ transceiver is also implemented.

Erwan PINCEMIN | *Presenter* | *Orange Labs - France*
Jérémie Jauffrit | *Ekinops - France*
Pierre-Yves Disez | *Ekinops - France*
Yann Loussouarn | *Orange Labs - France*
Claude Le Bouëtté | *Ekinops - France*
Romain Kerampran | *Lumibird - France*
Sylvain Bordais | *Lumibird - France*
Gilles Melin | *iXBlue - France*
Thierry Taunay | *Photonics Bretagne - France*
Yves Jaouen | *Telecom Paris - France*
Michel Morvan | *IMT Atlantique - France*

Technical Sessions Tuesday 14 September

ROOM C2

COHERENT DSP

17:15 - 17:30

Chair: Sander Wahls Delft University of Technology - The Netherlands
SC4 - Techniques for digitally enhancing optical communication

Tu4C2.5 HIGHLY SCORED
2 Tb/s Single-ended Coherent Receiver

We demonstrate a single-ended coherent receiver with a record net data rate of 2 Tb/s in B2B, showing 3 dB OSNR advantage compared to the conventional coherent receiver at a LOSPR of 10 dB. Over 80 km, a net data rate of 1.872 Tb/s is achieved

Son Le* | *Presenter | *Nokia Bell Labs - USA*
Vahid Aref | *Nokia - Germany*
Xi Chen | *Nokia Bell Labs - USA*

17:30 - 17:45

Tu4C2.6
Maximizing the Performance of Digital Multi-Carrier Systems with Transmission-Aware Joint Carrier Phase Recovery

Theoretical gains of digital multi-carrier systems are hindered by the use of sub-optimal conventional phase recovery, especially after fiber transmission. We experimentally validate an advanced, dispersion-aware algorithm that addresses this issue, achieving SNR gains up to ~0.5dB with 800G 125Gbaud 16-carrier PCS-64QAM, transmitted over 1800km.

Celestino S. Martins* | *Presenter | *Huawei Technologies France - France*
Abel Lorences-Riesgo | *Huawei Technologies France - France*
Manuel Neves | *Instituto de Telecomunicações, Universidade de Aveiro - Portugal*
Sami Mumtaz | *Huawei Technologies France - France*
Yann Frignac | *Huawei Technologies France - France*
Trung Hien Nguyen | *Huawei Technologies France - France*
Paulo P. Monteiro | *Instituto de Telecomunicações, Universidade de Aveiro - Portugal*
Gabriel Charlet | *Huawei Technologies France - France*
Fernando P. Guiomar | *Instituto de Telecomunicações, Universidade de Aveiro - Portugal*
Stefanos Dris | *Huawei Technologies France - France*

ROOM D

MODULATORS AND TRANSMITTERS

16:15 - 17:45

Chair: Hélène Debrégeas Almae Techologies - France
SC2 - Optoelectronic devices and technologies

Tu4D.1
A 260 Gb/s/λ PDM Link with Silicon Photonic Dual-Polarization Transmitter and Polarization Demultiplexer

We demonstrate a silicon-photonic dual-polarization transmitter with an integrated on-chip laser, transmitting 260 Gb/s PAM-4 data on a single wavelength carrier, and a single-chip polarization demultiplexer, recovering the polarization multiplexed signals with a TDECQ of 3.0 dB for both polarizations.

Meer Sakib* | *Presenter | *Intel Corporation - USA*
Peicheng Liao | *Intel Corporation - USA*
Duanni Huang | *Intel Corporation - USA*
Ranjeet Kumar | *Intel Corporation - USA*
Xinru Wu | *Intel Corporation - USA*
Chaoxuan Ma | *Intel Corporation - USA*
Guan-Lin Su | *Intel Corporation - USA*
Haisheng Rong | *Intel Corporation - USA*

16:45 - 17:00

Tu4D.3
Silicon IQ Modulator for 120 Gbaud QAM

We experimentally demonstrate an all-silicon IQ modulator with a segmented design operating at 120 Gbaud 32QAM. We achieve BER below the 25% FEC-threshold for a line-rate of 600 Gb/s (net 480 Gb/s) on a single polarization.

Zibo Zheng* | *Presenter | *COPL, Universite Laval - Canada, State Key Lab of Information Photonics and Optical Communications, Beijing Univ. of Posts and Teleco - China*
Abdolkhalegh Mohammadi | *COPL, Universite Laval - Canada*
Omid Jafari | *COPL, Universite Laval - Canada*
Hassan Sepehrian | *COPL, Universite Laval - Canada*
Jiachuan Lin | *Huawei Technologies - Canada*
Xiaoguang Zhang | *State Key Lab of Information Photonics and Optical Communications, Beijing Univ. of Posts and Teleco - China*
Leslie Rusch | *Presenter* | *COPL, Universite Laval - Canada*
Wei Shi | *COPL, Universite Laval - Canada*

17:00 - 17:15

Tu4D.4
Ge Ring Modulator Based on Carrier-injection Phaser Shifter Operating at Two Micrometer Band

We demonstrated proof-of-concept Ge ring modulator by carrier injection on the Ge-on-insulator (GeOI) platform. Owing to the strong optical confinement in Ge rib waveguide, the optical modulation with 13 dB extinction ratio was obtained by optical phase shift induced by 1 mA current injection.

Ziqiang Zhao* | *Presenter | *Department of Electrical Engineering and Information Systems, The University of Tokyo - Japan*
Chong Pei Ho | *Department of Electrical Engineering and Information Systems, The University of Tokyo - Japan*
Qiang Li | *Department of Electrical Engineering and Information Systems, The University of Tokyo - Japan*
Kasidit Toprasertpong | *Department of Electrical Engineering and Information Systems, The University of Tokyo - Japan*
Shinichi Takagi | *Department of Electrical Engineering and Information Systems, The University of Tokyo - Japan*
Mitsuru Takenaka | *Department of Electrical Engineering and Information Systems, The University of Tokyo - Japan*

17:15 - 17:30

Tu4D.5
Novel Single-Sideband Modulator in Silicon on Insulator Technology with Widely Tunable Carrier-to-Sideband Ratio for Broadband RF Signals

A compact silicon photonics single-sideband modulator with continuously tunable carrier-to-sideband ratio and large spurious sideband rejection of 40 dB is demonstrated using a single phase modulator, sideband selection through photonic integrated filter, and carrier re-insertion. Operation with a 5 Gbps ASK-modulated 16.5 GHz carrier is reported

Claudio Porzi* | *Presenter | *Scuola Superiore Sant'Anna, TeCIP Institute - Italy*
Fabio Falconi | *Scuola Superiore Sant'Anna, TeCIP Institute - Italy*
Antonella Bogoni | *Scuola Superiore Sant'Anna, TeCIP Institute - Italy*
Marc Sorel | *School of Engineering, University of Glasgow - UK, Scuola Superiore Sant'Anna, TeCIP Institute - Italy*

17:30 - 17:45

Tu4D.6
Silicon Microring Modulator with Polarization Insensitivity

We propose a polarization-insensitive silicon IQ microring modulator. We show theoretically and experimentally that the symmetric circular paths from the polarization splitter-rotator achieve polarization independence. We demonstrate our modulator is effective for single sideband modulation.

Xun Guan* | *Presenter | *Center of Optics, Photonics and Laser, Laval University - Canada*
Wei Shi | *Center of Optics, Photonics and Laser, Laval University - Canada*
Leslie Rusch | *Center of Optics, Photonics and Laser, Laval University - Canada*
Mingyang Lyu | *Center of Optics, Photonics and Laser, Laval University - Canada*

Tuesday 14 September

ROOM E

OPTICAL NETWORKS FOR WIRELESS

16:15 - 16:30

Chair: Reza Nejabati
SC10 - Architecture, Control and Management of optical networks

Tu4E.1
Dynamic User Plane Function Allocation in 5G Networks enabled by Optical Network Nodes

This paper studies the optimal User Plane Function (UPF) selection problem in 5G environments. UPF functionality is performed through programmable optical network nodes. Dynamic selection of UPF processing minimizing the overall service delay is performed through a novel Evolutionary Game Theory model

Victoria-Maria Alevizaki* | *Presenter | *University of Athens - Greece*
Alexandros-Ioannis Manolopoulos | *University of Athens - Greece*
Markos Anastasopoulos | *University of Athens - Greece*
Anna Tzanakaki | *University of Athens - Greece*

16:30 - 16:45

Tu4E.2
Optical Networks in Support of Open-RAN in 5G Systems and Beyond

This paper proposes an optical transport network suitable for 5G and beyond systems that is operated through a hybrid off-line optimisation and an on-line Machine Learning scheme executed at the Non-real time and the Real Time Radio Intelligent Controller respectively

Anna Tzanakaki* | *Presenter | *National and Kapodistrian University of Athens - Greece*
Antonia Pelekanou | *National and Kapodistrian University of Athens - Greece*
Alexandros-Ioannis Manolopoulos | *National and Kapodistrian University of Athens - Greece*
Markos Anastasopoulos | *National and Kapodistrian University of Athens - Greece*
Dimitra Simeonidou | *University of Bristol - UK*

17:15 - 17:30

Tu4E.5
Assessment of a Latency-aware Routing and Spectrum Assignment Mechanism Based on Deep Reinforcement Learning

We present a solution based on deep reinforcement learning (DRL) that jointly addressesspectrum allocation and latency constraint in EONs. The results show that using a simple networkrepresentation, this strategy outperforms typical K-Shortest Path heuristic approach and previous DRL-based approaches.

Carlos Hernandez-Chulde* | *Presenter | *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain*
Ramon Casellas | *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain*
Ricardo Martinez | *Centre Tecnológic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain*
Ricard Vilalta | *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain*
Raul Muñoz | *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain*

ROOM F

SDN IN OPTICAL ACCESS NETWORKS

17:15 - 17:30

Chair: Fabienne Saliou
SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

Tu4F.5
SDN-oriented Disaggregated Optical Access Node for Converged 5G Mobile and Residential Services

We experimentally transport the 5G backhaul interface over an OVS-DPDK based OLT in a generic server. Our SDN solution provides the flexible residential and 5G-mobile converged PON for different scenarios such as 5G self-healing in optical access network by means of dynamic SLA coordination.

Minqi Wang* | *Presenter | *IMT Atlantique - France, Orange Labs - France*
Gaël Simon | *Orange Labs - France*
Luiz Anet Neto | *IMT Atlantique - France*
Ayoub Bella | *Orange Labs - France*
Isabel Amigo | *IMT Atlantique - France*
Loutfi Nuaymi | *IMT Atlantique - France*
Philippe Chanclou | *Orange Labs - France*

17:30 - 17:45

Tu4F.6
Demonstration of Real-time Coherent 10-Gb/s QPSK Reception Implemented on a Commodity Server

The first real-time softwarization of coherent 10-Gb/s QPSK receiver DSP is demonstrated on a GPU platform by pairing novel data transfer with DSP algorithm. This maximizes the flexibility and scalability of access segment.

Sangyuep Kim* | *Presenter | *NTT Access Network Service Systems Laboratories - Japan*
Takahiro Suzuki | *NTT Access Network Service Systems Laboratories - Japan*
Jun-ichi Kani | *NTT Access Network Service Systems Laboratories - Japan*
Tomoaki Yoshida | *NTT Access Network Service Systems Laboratories - Japan*

ROOM G

OPTICAL NEURAL NETWORKS

16:15 - 16:30

Chair: Ueli Koch ETH Zurich - Switzerland
SC3 - Integrated and co-integrated circuits

Tu4G.1
25GMAC/sec/axon photonic neural networks with 7GHz bandwidth optics through channel response-aware training

We present a channel response-aware Photonic Neural Network (PNN) and demonstrate experimentally its resilience in Inter-Symbol Interference (ISI) when implemented in an integrated neuron. The trained PNN model performs at 25GMAC/sec/axon using only 7GHz-bandwidth photonic axons with 97.37% accuracy in the MNIST dataset

George Mourgias-Alexandris* | *Presenter | *Aristotle University of Thessaloniki - Greece*
Apostolos Tsakyridis | *Aristotle University of Thessaloniki - Greece*
Nikolaos Passalis Passalis | *Aristotle University of Thessaloniki - Greece*
Manos Kirtas | *Aristotle University of Thessaloniki - Greece*
Anastasios Tefas | *Aristotle University of Thessaloniki - Greece*
Frederic Gardes | *Optoelectronics Research Centre, University of Southampton - UK*
Teerapat Rutirawut | *Optoelectronics Research Centre, University of Southampton - UK*
Nikos Pleros | *Aristotle University of Thessaloniki - Greece*
Miltiadis Moralis-Pegios | *Aristotle University of Thessaloniki - Greece*

16:30 - 16:45

Tu4G.2
Silicon-integrated coherent neurons with 32GMAC/sec/axon compute line-rates using EAM-based input and weighting cells

We experimentally demonstrate a coherent SiPho neuron that relies on EAM for both on-chip data generation and weighting. A record-high 32GMAC/s/axon compute rate and an accuracy of 95.91% is reported, when the neuron is deployed as a hidden layer of a MNIST classifier neural network.

George Giamougiannis* | *Presenter | *Aristotle University of Thessaloniki - Greece*
Apostolos Tsakyridis | *Aristotle University of Thessaloniki - Greece*
George Mourgias-Alexandris | *Aristotle University of Thessaloniki - Greece*
Miltiadis Moralis-Pegios | *Aristotle University of Thessaloniki - Greece*
Angelina Totovic | *Aristotle University of Thessaloniki - Greece*
George Dabos | *Aristotle University of Thessaloniki - Greece*
Nikolaos Passalis Passalis | *Aristotle University of Thessaloniki - Greece*
Manos Kirtas | *Aristotle University of Thessaloniki - Greece*
Nikolaos Bamiedakis | *Celestial AI - USA*
Anastasios Tefas | *Aristotle University of Thessaloniki - Greece*
David Lazovsky | *Celestial AI - USA*
Nikos Pleros | *Aristotle University of Thessaloniki - Greece*

16:45 - 17:00

Tu4G.3
Photonic Reservoir Computing based on Optical Filters in a Loop as a High Performance and Low-Power Consumption Equalizer for 100 Gbaud Direct Detection Systems

We propose and numerically simulate a passive neuromorphic processor performing equalization in C-band IM-DD links, that employs a spatial reservoir computing scheme based on recurrent optical filters. Followed by a feed forward equalizer, the system achieves sub HD-FEC performance up to 60km in 224 Gbps/λ.

Kostas Sozos* | *Presenter | *University of West Attica - Greece*
Adonis Bogris | *University of West Attica - Greece*
Peter Bienstman | *Ghent University - IMEC - Belgium*
Charis Mesaritakis | *University of the Aegean - Greece*

17:30 - 17:45

Tu4G.6
Experimental Demonstration of Nonlinear Fibre Distortion Compensation with Integrated Photonic Reservoir Computing

Optical reservoir computing is a machine learning technique in which a photonic chip can be trained on classification tasks of time signals. This paper presents experimental results where linear and nonlinear fibre distortions are mitigated to below the 0.2×1e−3 FEC limit using a photonic reservoir.

Stijn Sackesyn* | *Presenter | *Ghent University - imec - Belgium*
Chonghuai Ma | *Ghent University - imec - Belgium*
Joni Dambre | *Ghent University - imec - Belgium*
Peter Bienstman | *Ghent University - imec - Belgium*

Wednesday 15 September

ROOM A

ADVANCES IN OPTICAL CABLES, DEVICES AND THEIR USE

09:30 - 09:45

Chair: Marc Wuilpart University of Mons - Belgium
SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers

We1A.3
180µm-Coated Bend-Insensitive Fiber and Micro-Duct Cable

We report the design and fabrication of a 180µm-coated bend-insensitive fiber with standard 125µm cladding. This fiber shows excellent optical and mechanical properties and is fully compatible with legacy 245µm- and 200µm-coated fibers. A 288-fiber micro-duct cable with a record fiber density is also fabricated.

Pierre Sillard* | *Presenter | *Prysmian Group - France*
Adrian Amezcua | *Prysmian Group - France*
Hélène Maerten | *Prysmian Group - France*
Cyril Mentzler | *Prysmian Group - France*
Alain Pastouret | *Prysmian Group - France*

09:45 - 10:00

We1A.4
Variations in the Optical Characteristics of 200 µm and 250 µm Coated Multicore Fibres Owing to Cabling

The optical characteristics of cabled four-core multicore fibres (4CFs) with 200 µm and standard 250 µm coating diameters are compared, and are found to be identical. Effective bending diameter of 4CFs in a cable is estimated to be small, which leads to low crosstalk.

Yusuke Sasaki* | *Presenter | *Fujikura - Japan*
Ryohei Fukumoto | *Fujikura - Japan*
Katsuhiro Takenaga | *Fujikura - Japan*
Shogo Shimizu | *Fujikura - Japan*
Kazuhiko Aikawa | *Fujikura - Japan*

10:00 - 10:15

We1A.5
High Reliability Fan-in / Fan-out Device with Isolator for Multi-core fibre Based on Free Space Optics

We developed a fan-in / fan-out (FIFO) device with an isolator with high reliability. We clarify the manufacturing accuracy to obtain high reliability in actual manufacturing. We conducted high-power optical input test using this device as practical reliability indicators and obtained good results.

Taketoshi Takahata* | *Presenter | *OPTOQUEST CO., LTD. - Japan*
Asumi Kaya | *OPTOQUEST CO.,LTD. - Japan*
Yuta Ozawa | *OPTOQUEST CO.,LTD. - Japan*
Yousuke Minagawa | *OPTOQUEST CO.,LTD. - Japan*
Tetsuya Kobayashi | *OPTOQUEST CO., LTD. - Japan*

ROOM B

NOVEL SUBSYSTEMS AND DEVICES FOR ANALOG PHOTONICS

09:00 - 09:15

Chair: Liam Barry Dublin City University - Ireland
SC7 - Photonics for RF and Free Space Optics applications

We1B.1
Real-Time Gapless Analog Time Frequency Analysis for Bandwidths above 20 GHz with Nanosecond Resolution

We propose a scheme for real-time, joint time-frequency analysis of arbitrary continuous optical signals. Through phase-only linear operations, we demonstrate the recovery of ns-duration transient events, 22-GHz bandwidth operation, and sub-GHz resolution. Billions of Fourier transforms per second are computed without information loss.

Connor Rowe* | *Presenter | *Institut National de la Recherche Scientifique - Énergie, Matériaux et Télécommunications (INRS EMT) - Canada*
Benjamin Crockett | *Institut National de la Recherche Scientifique - Énergie, Matériaux et Télécommunications (INRS EMT) - Canada*
José Azaña | *Institut National de la Recherche Scientifique - Énergie, Matériaux et Télécommunications (INRS EMT) - Canada*

09:15 - 09:30

We1B.2 HIGHLY SCORED
Programmable Integrated Microwave Photonic Filter using a Modulation Transformer and a Double-Injection Ring Resonator

We experimentally demonstrate a new kind of integrated Si3N4 microwave photonic (MWP) signal processor that combines a programmable modulation transformer (MT) with a versatile double-injection ring resonator (DI-RR). With this circuit we show an array of MWP filtering functions unmatched by traditional MWP circuits.

Okky Daulay* | *Presenter | *University of Twente The Netherlands*
Gaojian Liu | *University of Twente - The Netherlands*
Roel Botter | *University of Twente - The Netherlands*
Marcel Hoekman | *LioniX International The Netherlands*
Edwin Klein | *LioniX International - The Netherlands*
Chris Roeloffzen | *LioniX International The Netherlands*
Jose Capmany | *Universitat Politècnica de València - Spain*
David Marpaung | *University of Twente The Netherlands*

09:30 - 09:45

We1B.3
Reconfigurable Low-Phase Noise Frequency Generation up to 92.5 GHz in a Monolithically Integrated Silicon Photonics Circuit

A silicon photonics chip is successfully employed for frequency multiplication of an 18.5-GHz clock up to 92.5GHz (×5) with low additional phase noise. The chip includes a 20-GHz phase modulator for comb generation and a thermally tunable distributed feedback resonator for reconfigurable spectral mode selection

Antonio Malacarne* | *Presenter | *CNIT - Italy*
Fabio Falconi | *Scuola Superiore Sant'Anna, TeCIP Institute - Italy*
Alessandra Bigongiari | *Ericsson Research - Italy*
Antonio D'Errico | *Ericsson Research - Italy*
Antonella Bogoni | *Scuola Superiore Sant'Anna, TeCIP Institute - Italy*
Claudio Porzi | *Scuola Superiore Sant'Anna, TeCIP Institute - Italy*

09:45 - 10:00

We1B.4
Mobile Terahertz 6G Communications Enabled by Integrated Photonic-Assisted Beam Steering Antennas

We present photonic-assisted on-chip multi-beam THz leaky wave antennas for short-range Terahertz 6G. Experimentally, multi-beam mobile communications at 0.3 THz with an overall capacity of 48 Gbps, maximum net user data rate up to 20.4 Gbps and beam steering with a speed of ~18°/s is demonstrated.

Jonas Tebart* | *Presenter | *University of Duisburg-Essen - Germany*
Peng Lu | *University of Duisburg-Essen - Germany*
Thomas Haddad | *University of Duisburg-Essen - Germany*
Shuya Iwamatsu | *University of Duisburg-Essen - Germany*
Jörg Lackmann | *University of Duisburg-Essen - Germany*
Jose Fernandez-Estevez | *University of Duisburg-Essen - Germany*
Andreas Stöhr | *University of Duisburg-Essen - Germany*

Technical Sessions Wednesday 15 September

ROOM C1

HIGH SPEED IM/DD TRANSMISSION

09:30 - 09:45

Chair: Norbert Hanik TU Munich - Germany
SC5 - Optical Transmission systems

We1C1.3
800-Gbps PAM-4 O-band Transmission through 2-km SMF using 4λ LAN-WDM TOSA with MLSE Based on Nonlinear Channel Estimation and Decision Feedback

We demonstrate 224-Gbps/λ 2-km transmission using 4-ch LAN-WDM TOSA with integrated SOAs and EADFB lasers. We achieve a BER below the HD-FEC limit for all channels in the 10-dB bandwidth of 34.8-GHz and chromatic dispersion of –4.2-ps/nm with advanced nonlinear MLSE based on decision feedback.

Hiroki Taniguchi* | *Presenter | *NTT Corporation - Japan*
Shuto Yamamoto | *NTT Corporation - Japan*
Yoshiaki Kisaka | *NTT Corporation - Japan*
Shigeru Kanazawa | *NTT Corporation - Japan*
Toshihide Yoshimatsu | *NTT Corporation - Japan*
Yozo Ishikawa | *Furukawa Electric Co., Ltd. - Japan*
Kazuyo Mizuno | *Furukawa Electric Co., Ltd. - Japan*

09:45 - 10:00

We1C1.4
402 Gb/s PAM-8 IM/DD O-Band EML Transmission

We demonstrate record 402 Gb/s PAM-8 gross bit rate IM/DD transmission employing a single DAC directly driving an O-band EML. Considering 15.31%-overhead SD-FEC, a net bit rate of 348.62 Gbit/s is achieved over 5km SSMF.

Md Sabbir-Bin Hossain* | *Presenter | *Chair of Communication, Kiel University - Germany, Huawei Technologies Duesseldorf - Germany*
Jinlong Wei | *Huawei Technologies Duesseldorf - Germany*
Fabio Pittalà | *Huawei Technologies Duesseldorf - Germany*
Nebojša Stojanović | *Huawei Technologies Duesseldorf - Germany*
Stefano Calabrò | *Huawei Technologies Duesseldorf - Germany*
Talha Rahman | *Huawei Technologies Duesseldorf - Germany*
Georg Böcherer | *Huawei Technologies Duesseldorf - Germany*
Tom Wettlin | *Chair of Communication, Kiel University - Germany*
Changsong Xie | *Huawei Technologies Duesseldorf - Germany*
Maxim Kuschnerov | *Huawei Technologies Duesseldorf - Germany*
Stephan Pachnicke | *Chair of Communication, Kiel University - Germany*

10:00 - 10:15

We1C1.5
Ultra-Broadband Electrical Signal Generation and IM/DD Transmission of QAM Signals at Symbol Rates Up to 90 GBd

We study ultra-broadband electrical signal generation based on balanced heterodyne reception of I/Q modulated optical signals. We successfully generate signals with up to100 GHz electrical bandwidth and show the viability of our concept by IM/DD transmission of up to 90 GBd QAM signals modulated onto an electrical subcarrier.

Christoph Füllner* | *Presenter | *Karlsruhe Institute of Technology - Germany*
Dengyang Fang | *Karlsruhe Institute of Technology - Germany*
Patrick Matalla | *Karlsruhe Institute of Technology - Germany*
Wolfgang Freude | *Karlsruhe Institute of Technology - Germany*
Christian Koos | *Karlsruhe Institute of Technology - Germany •Karlsruhe Institute of Technology - Germany*
Sebastian Randel | *Karlsruhe Institute of Technology - Germany*

ROOM C2

SPATIAL DIVISION MULTIPLEXING

09:30 - 09:45

Chair: Sebastian Randel Karlsruhe Institute of Technology (KIT), Institute of Photonics - Germany and Quantum Electronics (IPQ)
SC4 - Techniques for digitally enhancing optical communication

We1C2.3
Mode-multiplexed 16QAM transmission over 60-km coupled four-core fibres using real-time MIMO-DSP with high-accuracy frequency offset estimation

We demonstrated the first real-time mode-multiplexed 16QAM transmission. Two-stage frequency offset compensation with high frequency resolution followed by real-value 16x4 MIMO was implemented based on FPGA boards. The mode-division multiplexed WDM DP-16QAM signals were transmitted over a 60-km coupled four-core fibre.

Shohei Beppu* | *Presenter | *KDDI Research Inc. - Japan*
Masahiro Kikuta | *NEC Platforms, Ltd. - Japan*
Koji Igarashi | *Osaka University - Japan*
Hiroshi Mukai | *NEC Platforms, Ltd. - Japan*
Masahiro Shigihara | *NEC Platforms, Ltd. - Japan*
Yasuo Saito | *NEC Platforms, Ltd. - Japan*
Daiki Soma | *KDDI Research Inc. - Japan*
Hidenori Takahashi | *KDDI Research Inc. - Japan*
Noboru Yoshikane | *KDDI Research Inc. - Japan*
Takehiro Tsuritani | *KDDI Research Inc. - Japan*

Wednesday 15 September

09:45 - 10:00

We1C2.4
Digital Interference Mitigation in Space Division Multiplexing Self-Homodyne Coherent Detection

We propose a digital interference mitigation scheme to reduce the impact of mode coupling in space division multiplexing self-homodyne coherent detection and experimentally verify its effectiveness in 240-Gbps mode-multiplexed transmission over 3-mode multimode fiber.

Hanzi Huang* | *Presenter | *Shanghai University - China*
Yetian Huang | *Shanghai University – China*
Haoshuo Chen | *Nokia Bell Labs - USA*
Qianwu Zhang | *Shanghai University - China*
Jian Chen | *Shanghai University - China*
Nicolas Fontaine | *Nokia Bell Labs - USA*
Mikael Mazur | *Nokia Bell Labs - USA*
Junho Cho | *Nokia Bell Labs - USA*
Roland Ryf | *Nokia Bell Labs - USA*
Yingxiong Song | *Shanghai University - China*

ROOM D

VCSELS

10:00 - 10:15

Chair: Romain Brenot Huawei - France
SC2 - Optoelectronic devices and technologies

We1D.5
VCSEL to Single-Mode Fiber Coupling Module for C-band Optical Transmitter

In this paper, a VCSEL-based C-band transmitter coupled to single-mode fiber is demonstrated. Using an on-wafer processed lens, low coupling loss (2.5dB) and large alignment tolerance (±3.4μm -1dB drop) are realized, allowing for up to 6km 25Gbps error-free data transmission.

Yuchen Song* | *Presenter | *Technology University of Eindhoven - The Netherlands*
Chenhui Li | *Technology University of Eindhoven - The Netherlands*
Oded Raz | *Technology University of Eindhoven - The Netherlands*

10:15 - 10:30

We1D.6
8x 2Gb/s LED-Based Optical Link at 420nm for Chip-to-Chip Applications

Using an array of 8 high-speed GaN-based emitters on sapphire, together with a custom lateral p-i-n Si CMOS detector array and discrete electronics, we demonstrate an aggregate 16Gb/s in a rectangular multicore imaging fiber <0.2mm on a side

Bardia Pezeshki | *Presenter* | *AvicenaTech Corp. - USA*
Alex Tselikov | *AvicenaTech Corp. - USA*
Cameron Danesh | *AvicenaTech Corp. - USA*
Robert Kalman | *AvicenaTech Corp. - USA*

ROOM F

DATA CENTER NETWORKS AND APPLICATIONS

09:30 - 10:00

Chair: Stephan Pachnicke
SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

We1F.3 EXTENDED
Real-time 400 Gb/s CDWM-4 DMT Directly Modulated Transmission over 10 km

We demonstrate the first real-time 400 Gb/s CDWM-4 DMT transmission over 10 km using a 16 nm CMOS ASIC operating at 71 GS/s and commercial 25 GHz-class directly modulated lasers.

Son Le* | *Presenter | *Nokia Bell Labs - USA*
Tomislav Drenski | *Socionext Europe GmbH - UK*
Andrew Hills | *Socionext Europe GmbH - UK*
Yasuhiro Matsui | *II-VI Incorporated – USA*
Ashish Verma | *II-VI Incorporated - USA*
Tsurugi Sudo | *II-VI Incorporated - USA*

10:00 - 10:15

We1F.6
Experimental Comparison of Cap and Cup Probabilistically Shaped PAM for O-Band IM/DD Transmission System

For 200Gbit/s net rates, uniform PAM-4, 6 and 8 are experimentally compared against probabilistic shaped PAM-8 cap and cup variants. In back-to-back and 20km measurements, cap shaped 80GBd PAM-8 outperforms 72GBd PAM-8 and 83GBd PAM-6 by up to 5.17dB and 2.17dB in receiver sensitivity, respectively.

Md Sabbir-Bin Hossain* | *Presenter | *Chair of Communication, Kiel University - Germany, Huawei Technologies Duesseldorf - Germany*
Georg Böcherer | *Huawei Technologies Duesseldorf - Germany*
Talha Rahman | *Huawei Technologies Duesseldorf - Germany*
Nebojša Stojanović | *Huawei Technologies Duesseldorf - Germany*
Patrick Schulte | *Huawei Technologies Duesseldorf - Germany*
Stefano Calabrò | *Huawei Technologies Duesseldorf - Germany*
Jinlong Wei | *Huawei Technologies Duesseldorf - Germany*
Christian Bluemm | *Huawei Technologies Duesseldorf - Germany*
Tom Wettlin | *Chair of Communication, Kiel University - Germany*
Changsong Xie | *Huawei Technologies Duesseldorf - Germany*
Maxim Kuschnerov | *Huawei Technologies Duesseldorf - Germany*
Stephan Pachnicke | *Chair of Communication, Kiel University - Germany*

ROOM G

OPTICAL CIRCUITS FOR FREQUENCY CONVERSION

10:15 - 10:30

We1F.5
Error-Free Operation for Fully Connected Wavelength-Routing Interconnect among 8 FPGAs with 2.8-Tbit/s Total Bandwidth

We developed high bandwidth-density embedded optical modules (EOMs) for C-band dense wavelength-division-multiplexing (DWDM) interconnect. We constructed fully connected wavelength routing network among 8 FPGA nodes with 4 EOMs per node and confirmed error-free operation for total bandwidth of 2.8 Tbit/s

Takanori Shimizu* | *Presenter | *Photonics Eletronics Technology Research Association (PETRA) - Japan*
Shigeru Nakamura | *Photonics Eletronics Technology Research Association (PETRA) - Japan*
Hiroshi Yamaguchi | *Photonics Eletronics Technology Research Association (PETRA) - Japan*
Koichi Takemura | *Photonics Eletronics Technology Research Association (PETRA) - Japan*
Kenji Mizutani | *Photonics Eletronics Technology Research Association (PETRA) - Japan*
Tatsuya Usuki | *Photonics Eletronics Technology Research Association (PETRA) - Japan*
Yutaka Urino | *Photonics Eletronics Technology Research Association (PETRA) - Japan*

09:00 - 09:15

Chair: Ségolene Olivier CEA-LETI - France
SC3 - Integrated and co-integrated circuits

We1G.1
Efficient Ultra-Broadband C-to-O Band Converter Based on Multi-Mode Silicon-on-Insulator Waveguides

We present a novel all-optical wavelength converter based on inter-modal FWM in a p-i-n-diode-assisted SOI integrated waveguide that is capable of converting wavelengths from the entire C band to the O band. 32 Gbd QPSK converted signals were experimentally transmitted over 100 km.

Gregor Ronniger* | *Presenter | *IHP – Leibniz-Institut für innovative Mikroelektronik - Germany , Technische*
Isaac Sackey | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Tasnad Kernetzky | *Technical University of Munich - Germany*
Ulrike Höfler | *Technical University of Munich - Germany*
Christian Mai | *IHP – Leibniz-Institut für innovative Mikroelektronik - Germany*
Colja Schubert | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Norbert Hanik | *Technical University of Munich - Germany*
Lars Zimmermann | *IHP – Leibniz-Institut für innovative Mikroelektronik - Germany, Technische Universität Berlin - Germany*
Ronald Freund | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Universität Berlin - Germany
Klaus Petermann | *Technische Universität Berlin - Germany*

09:15 - 09:30

We1G.2
Numerical Optimization and CW Measurements of SOI Waveguides for Ultra-Broadband C-to-O-Band Conversion

We analyze silicon-on-insulator waveguides, suitable for ultra-broadband inter-modal four-wave-mixing-based all-optical wavelength conversion.

We show numerical evaluations of waveguide modes and dispersion, and optimize phase matching. We finally present measurements of linear insertion loss and mode coupling, dispersion and four-wave-mixing conversion efficiency.

Tasnad Kernetzky* | *Presenter | *Technical University of Munich - Germany*
Gregor Ronniger | *IHP – Leibniz-Institut für innovative Mikroelektronik - Germany, Technische Universität Berlin - Germany*
Ulrike Höfler | *Technical University of Munich - Germany*
Lars Zimmermann | *IHP – Leibniz-Institut für innovative Mikroelektronik - Germany, Technische Universität Berlin - Germany*
Norbert Hanik | *Technical University of Munich - Germany*

09:30 - 09:45

We1G.3
Polarization selective ultra-broadband wavelength conversion in silicon nitride waveguide

We report broadband continuous-wave frequency conversion from the O-band (1.33 µm) to the short-wave infrared (2.6 µm) in a 50 cm long low-loss Si3N4 waveguide, leveraging polarization selective far-detuned phase matching.

Arman Ayan* | *Presenter | *École Polytechnique Fédérale de Lausanne, Photonic Systems Laboratory (PHOSL) - Switzerland*
Florent Mazeas | *École Polytechnique Fédérale de Lausanne, Photonic Systems Laboratory (PHOSL) - Switzerland*
Junqiu Liu | *École Polytechnique Fédérale de Lausanne, Laboratory of Photonics and Quantum Measurements (LPQM) - Switzerland*
Tobias Kippenberg | *École Polytechnique Fédérale de Lausanne, Laboratory of Photonics and Quantum Measurements (LPQM) - Switzerland*
Camille-Sophie Brès | *École Polytechnique Fédérale de Lausanne, Photonic Systems Laboratory (PHOSL) - Switzerland*

09:45 - 10:00

We1G.4
Stable Laser Without a Magneto-optic Isolator

A reflection-cancellation circuit on a silicon-on-insulator platform is used to stabilize a quantum well-distributed feedback laser against real-time changing back-reflections. The demonstrated optical insertion loss is 2.5 dB for 15 dB of isolation/cancellation.

Hossam Shoman* | *Presenter | *Nokia - USA*
Nicolas Jaeger | *University of British Columbia - Canada*
Connor Mosquera | *Lumentum - Canada*
Hasitha Jayatilleka | *Intel Corporation - USA*
Minglei Ma | *Ciena - Canada*
Haisheng Rong | *Intel Corporation - USA*
Sudip Shekhar | *University of British Columbia - Canada*
Lukas Chrostowski | *University of British Columbia - Canada*

Wednesday 15 September

ROOM B

SHORT REACH OPTICAL WIRELESS COMMUNICATION

14:00 - 14:15

Chair:Mathilde Gay
SC7 - Photonics for RF and Free Space Optics applications

We3B.1
Experimental Demonstration of Cooperative NOMA in Visible Light Communications

We propose a cooperative NOMA VLC scheme and demonstrate in 1.84-Gbit/s experiments that the performance and coverage of cooperative OFDM-NOMA is better than conventional OFDM-NOMA, DFT-S-OFDM-NOMA and OCT-P-OFDM-NOMA regardless of the user's receiving angles when the far user has either poor performance or communication interruption.

Geyang Wang* | *Presenter | *South China University of Technology - China*
Shuhua Song | *South China University of Technology - China*
Lian-Kuan Chen | *The Chinese University of Hong Kong - Hong Kong*
Jian Zhao | *South China University of Technology - China*

14:15 - 14:30

We3B.2
High Bandwidth Semipolar (20-21) µ-LED Serving as Photo-Receiver for Visible Light Communication

We propose and demonstrate a semipolar (20-21) green micro-light-emitting-diode (µ-LED) acting as high-speed photo-receiver for visible-light-communication (VLC). 300-Mbit/s green optical signal detection at free-space transmission distance of 125 cm is demonstrated using on-off-keying (OOK) format, fulfilling pre-forward error correction (FEC) threshold.

YH Chang* | *Presenter | *National Chiao Tung University - Taiwan, National Yang Ming Chiao Tung University - Taiwan*
FJ Liou | *National Chiao Tung University - Taiwan, National Yang Ming Chiao Tung University - Taiwan*
WH Gunawan | *National Chiao Tung University - Taiwan, National Yang Ming Chiao Tung University - Taiwan*
Chi-Wai Chow | *National Chiao Tung University - Taiwan, National Yang Ming Chiao Tung University - Taiwan*
Y Liu | *Philips Electronics - Hong Kong*
HC Kuo | *National Chiao Tung University - Taiwan, National Yang Ming Chiao Tung University - Taiwan*
CH Yeh | *Feng Chia University – Taiwan*

14:30 - 14:45

We3B.3
Ultrafast Perovskite Color Conversion of Blue Laser Diode for White-Lighting Optical Wireless Link

The ultrathin perovskite paper enables the color-converted white-lighting of an 80-mW blue laser diode without severely compromising its encoding bandwidth to demonstrate a 9-Gbit/s 8-QAM-OFDM optical wireless data link over 0.3-m free-space after waveform pre-leveling.

Yi-Chien Wu* | *Presenter | *National Taiwan University - Taiwan*
Chih-Hsien Cheng | *Research Center for Advanced Science and Technology, University of Tokyo - Japan*
Hao-Chung Kuo | *National Yang Ming Chiao Tung University - Taiwan*
Jr-Hau He | *City University of Hong Kong, Kowloon - China*
Gong-Ru Lin | *National Taiwan University - Taiwan*

14:45 - 15:00

We3B.4
Bidirectional WDM-over-POF with Spatial Diversity DMT Gigabits per Second Transmission Using POF as Luminaires

A bidirectional spatial diversity link for indoor optical wireless communications applying wavelength division multiplexing over 1mm core size plastic optical fibre and 1m free space is experimentally demonstrated. Discrete multitone modulation on red and green wavelengths demonstrates almost symmetrical 2Gbps for down/uplink.

Carina Ribeiro Barbio Corrêa* | *Presenter | *Technology University of Eindhoven - The Netherlands*
Ketemaw Mekonnen | *Technology University of Eindhoven - The Netherlands*
Frans M. Huijskens | *Technology University of Eindhoven - The Netherlands*
Ton Koonen | *Technology University of Eindhoven - The Netherlands*
Eduward Tangdiongga | *Technology University of Eindhoven - The Netherlands*

15:00 - 15:15

We3B.5
Efficient Handover for Mobile Device in Beam-Steered Infrared Light Communication with Vision-based Localization

We propose and experimentally verify an extrapolation algorithm based on the polynomial regression to trigger efficiently handover in beam-steered infrared light communication systems. Error-free connection is demonstrated for a wireless device while moving. The proposed mechanism also reduces significantly the number of handover failures.

Ngoc Quan Pham* | *Presenter | *Technology University of Eindhoven - The Netherlands*
Ketemaw Mekonnen | *Technology University of Eindhoven - The Netherlands*
Ali Mefleh | *KPN - The Netherlands*
Ton Koonen | *Technology University of Eindhoven - The Netherlands*
Eduward Tangdiongga | *Technology University of Eindhoven - The Netherlands*

ROOM C1

HIGH CAPACITY TRANSMISSION

14:30 - 14:45

Chair: Jochen Schröder Chalmers University of Technology - Sweden
SC5 - Optical Transmission systems

We3C1.3
63.2Tb/s Real-time Transmission Through Discrete Extended C- and L-Band Amplification in a 440km SMF Link

We demonstrate a 63.2-Tb/s throughput in a 5-span 440-km SSMF link employing real-time 400G 16QAM transponders and fully discrete C- and L-band amplifiers with a total amplification bandwidth approaching 100nm

Dylan Le Gac | *Presenter* | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Djalal Bendimerad | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Iosif Demirtzioglou | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Ivan Fernandez De Jauregui Ruiz | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Abel Lorences-Riesgo | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Nayla El Dahdah | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Antonin Gallet | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Hajar Elfaiki | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Shuqi Yu | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Ge Gao | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Romain Brenot | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Yann Frignac | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Gabriel Charlet | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*

14:45 - 15:00

We3C1.4
25.6 Tbit/s (64x400Gb/s) Real-time Unrepeatered Transmission over 320 km SCUBA Fibres by 400ZR+ Pluggable Modules

We report a record real-time unrepeatered experiment with 64 single-carrier 400Gb/s channels transmission over 320.5km fibre, applying large-area ultra-low loss fibre with average attenuation of 0.146dB/km at 1550nm, high power booster, and backward-propagating 2nd-order Raman without ROPA.

Benyuan Zhu | ***Presenter*** | *OFS - USA*
Tommy Geisler | *OFS - Denmark*
Peter Borel | *OFS - Denmark*
Rasmus Vincentz Skougaard Jensen | *OFS - Denmark*
Matthias Stegmaier | *OFS - Denmark*
Bera Palsdottir | *OFS - Denmark*
Robert Lingle | *OFS - USA*
David DiGiovanni | *OFS - USA*

15:00 - 15:15

We3C1.5
Real-time Demonstration of 12-λ×800-Gb/s Single-carrier 90.5-GBd DP-64QAM-PCS Coherent Transmission over 1122-km Ultra-low-loss G.654.E Fiber

A record real-time error-free coherent transmission of 12-λ×800-Gb/s single-carrier 90.5-GBd DP-64QAM-PCS signals with a spectral efficiency of 8.0 bit/s/Hz over 1122-km ultra-low-loss large-effective-area G.654.E fiber is experimentally demonstrated for the first time.

Han Li | ***Presenter*** | *China Mobile Research Institute - China*
Xiuguo Cui | *Huawei Technologies Co. Ltd. - China*
Dawei Ge | *China Mobile Research Institute - China*
Dong Wang | *China Mobile Research Institute - China*
Ruichun Wang | *Yangtze Optical Fibre and Cable Joint Stock Limited Company - China*
Hongqiang Zou | *China Mobile Communications Corporation Group Co., Ltd. - China*
Zhuo Liu | *China Mobile Communications Corporation Group Co., Ltd. - China*
Dechao Zhang | *China Mobile Research Institute - China*
Minggang Si | *Huawei Technologies Co. Ltd. - China*
Jiang Sun | *China Mobile Research Institute - China*
Yunbo Li | *China Mobile Research Institute - China*
Lixin Gu | *Yangtze Optical Fibre and Cable Joint Stock Limited Company - China*
Zhiyu Xiao | *Huawei Technologies Co. Ltd. - China*
Jihong Zhu | *Yangtze Optical Fibre and Cable Joint Stock Limited Company - China*
Ning Wang | *China Mobile Research Institute – China*
Sheng Liu | *China Mobile Research Institute - China*

15:15 - 15:30

We3C1.6
Impact of Wavelength-Dependent I/Q Imbalances of Standard C-Band Transceivers in Rate-Adaptive Multiband Systems

We experimentally characterize wavelength-dependent I/Q imbalances when operating standard C-band IQ-modulator and coherent receiver in S-C-L-band systems. We evaluate their impact on the achievable entropy rate for probabilistically shaped PDM-256/64-QAM and show no penalty up to 150 nm bandwidth based on a single calibration.

Gabriele Di Rosa | ***Presenter*** | *VPIphotonics GmbH - Germany*
Robert Emmerich | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Matheus Sena | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Johannes K. Fischer | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Colja Schubert | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
André Richter | *VPIphotonics GmbH - Germany*

Wednesday 15 September

ROOM C2

DIRECT DETECTION II

14:30 - 14:45

Chair: Christopher Fludger Infinera GmbH - Germany
SC4 - Techniques for digitally enhancing optical communication

We3C2.3
50GBaud PAM-4 IM-DD Transmission with 24% Bandwidth Compression Based on Polybinary Spectral Shaping

We experimentally and numerically investigate the minimum electrical bandwidth for 50GBaud PAM4 detection with polybinary spectral shaping. With only 19GHz electrical brick-wall bandwidth, 100Gb/s PAM-4 transmission is demonstrated with 24% bandwidth compression at BTB and 1km SSMF scenarios.

Qi Wu* | *Presenter | *Shanghai Jiao Tong University - China*
Yixiao Zhu | *Shanghai Jiao Tong University - China*
Weisheng Hu | *Shanghai Jiao Tong University - China*
Longjie Yin | *Shanghai Jiao Tong University - China*

14:45 - 15:00

We3C2.4
Multi-Symbol Output Long Short-Term Memory Neural Network Equalizer For 200+ Gbps IM/DD System

We propose a single-lane 212Gbps IM/DD PAM-4 system with a novel Multi-Symbol Output LSTM equalizer that performs much better than FFE&VNE and single-symbol output LSTM, and reduces complexity by 49.85% at the same time, and achieves similar performance with Bi-directional LSTM with around 1/4 complexity.

Bohan Sang* | *Presenter | *Fudan University, Shanghai - China*
Jiao Zhang | *Fudan University, Shanghai - China*
Chen Wang | *Fudan University, Shanghai - China*
Miao Kong | *Fudan University, Shanghai - China*
Yuxuan Tan | *Fudan University, Shanghai - China*
Li Zhao | *Fudan University, Shanghai - China*
Wen Zhou | *Fudan University, Shanghai - China*
Dongdong Shang | *Huawei Technol. Corp. - China*
Yamin Zhu | *Huawei Technol. Corp. - China*
Hong Yi | *Huawei Technol. Corp. - China*
Jianjun Yu | *Fudan University, Shanghai - China*

15:00 - 15:15

We3C2.5
O-Band 10-km PAM Transmission Using Nonlinear-Spectrum-Shaping Encoder and Transition-Likelihood-Based Decoder with Symbol- and Likelihood-Domain Feedbacks

We show that a nonlinear-spectral-shaping scheme with transition-likelihood-based decoder including symbol- and likelihood-domain feedbacks enhances the tolerance to bandwidth limitation and achieves KP4-FEC threshold in 10-km O-band transmission of 93-Gbaud PAM4 with very severe bandwidth limitation in which the 20-dB bandwidth is 40 GHz.

Shuto Yamamoto* | *Presenter | *NTT Corporation - Japan*
Hiroki Taniguchi | *NTT Corporation - Japan*
Masanori Nakamura | *NTT Corporation - Japan*
Yoshiaki Kisaka | *NTT Corporation - Japan*

15:15 - 15:30

We3C2.6
Application of Generalized THP for Arbitrary PAM Level Design in Short-Reach IM/DD Signalling

We introduce the concept of generalized-THP with arbitrary PAM level design for modulator non-linearity compensation and geometrical shaping of IM/DD THP-PAM signals, and show its effectiveness to lower BER floor by half an order of magnitude in 40-GBaud PAM4 and 50-GBaud faster-than Nyquist PAM4 signalling.

Nobuhiko Kikuchi* | *Presenter | *Hitachi Ltd. - Japan*
Riu Hirai | *Hitachi Ltd. - Japan*

ROOM D

INP DEVICES

14:00 - 14:30

Chair: Hélène Debrégeas Almae Techologies - France
SC2 - Optoelectronic devices and technologies

We3D.1
Wavelength Tunable Directly Modulated Laser for TWDM Applications

A PIC transmitter for application in TWDM passive optical networks is demonstrated. The device generates four 100 GHz-spaced channels and features an integrated section for chirp control that enables error-free transmission of 10 Gb/s OOK data over 50 km of fiber.

Ankit Sharma* | *Presenter | *Photonics Systems and Sensing Lab, School of Electronics Engineering, Dublin City University - Ireland, Pilot Photonics, Invent Centre, Dublin City University, Dublin 9 - Ireland*
Aleksandra Kaszubowska-Anandarajah | *CONNECT Research Centre, Dunlop Oriel House, Trinity College Dublin - Ireland, Photonics Systems and Sensing Lab, School of Electronics Engineering, Dublin City University - Ireland*
Michael J. Wallace | *Pilot Photonics, Invent Centre, Dublin City University, Dublin 9 - Ireland*
Gaurav Jain | *Pilot Photonics, Invent Centre, Dublin City University, Dublin 9 - Ireland*
Frank Smyth | *Pilot Photonics, Invent Centre, Dublin City University, Dublin 9 - Ireland*
Jules Braddell | *Pilot Photonics, Invent Centre, Dublin City University, Dublin 9 - Ireland*
Prince Anandarajah | *CONNECT Research Centre, Dunlop Oriel House, Trinity College Dublin – Ireland, Photonics Systems and Sensing Lab, School of Electronics Engineering, Dublin City University – Ireland*

14:30 - 14:45

We3D.2
High-Density Coplanar Strip-Line Mach-Zehnder Modulators in a InP Generic Platform

A high-density, 27µm wide, Mach-Zehnder modulator with a new coplanar strip-line electrode enables velocity and impedance matching, increasing the 3dB electro-optical bandwidth of 27.3 GHz, 3.6 times of a more conventional coplanar waveguide design with similar length, waveguide parameters, and n-doped substrate.

Arezou Meighan* | *Presenter | *Technology University of Eindhoven - The Netherlands*
Mike Wale | *Technology University of Eindhoven - The Netherlands, University College London - UK*
Kevin Williams | *Technology University of Eindhoven - The Netherlands*

14:45 - 15:00

We3D.3
Novel Semiconductor Optical Amplifier with Large Gain and High Saturation Output Power

A novel semiconductor optical amplifier (SOA) design achieving large gain and high saturation output power without reaching excessive power consumption levels is presented. Small-signal gain above 35 dB and 22 dBm high saturation output power were measured at 1.3 A biased current.

Shuqi Yu* | *Presenter | *Huawei optical communication Technology Lab, Paris Research Center - France*
Antonin Gallet | *Huawei optical communication Technology Lab, Paris Research Center - France*
Nayla El Dahdah | *Huawei optical communication Technology Lab, Paris Research Center - France*
Hajar Elfaiki | *Huawei optical communication Technology Lab, Paris Research Center - France*
Romain Brenot | *Huawei optical communication Technology Lab, Paris Research Center - France*

ROOM E

NETWORK SECURITY

15:00 - 15:15

We3D.4
Flat Noise Figure Semiconductor Optical Amplifiers

We propose a new SOA design with a detuned material at the input in order to guarantee low noise figure (NF) over the whole gain spectrum. NF reduction of 1.5 dB is experimentally achieved, and NF remains below 6.5 dB over C and L bands

Shuqi Yu* | *Presenter | *Huawei Technologies - France*
Antonin Gallet | *Huawei Technologies - France*
Nayla El Dahdah | *Huawei Technologies - France*
Hajar Elfaiki | *Huawei Technologies - France*
Iosif Demirtzioglou | *Huawei Technologies - France*
Loig Godard | *Huawei Technologies - France*
Romain Brenot | *Huawei Technologies - France*

15:15 - 15:30

We3D.5
Wide Wavelength Polarization-insensitive Electro-absorption Modulator with Low-driving Voltage

We present a 25 Gb/s wide wavelength polarization-insensitive electro-absorption modulator (PIM) operating at a low-driving voltage. Over 8 dB dynamic extinction ratio was obtained in the wavelength range of 1540-1560 nm with polarization sensitivity around 1.1 dB, at the driving-voltage as low as 1.8 Vpp.

Guangcan Chen* | *Presenter | *Huawei Technologies Co. Ltd. - China*
Yuanbing Cheng | *Huawei Technologies Co. Ltd. - China*
Fanchao Zeng | *Huawei Technologies Co. Ltd. - China*
Xin Zhang | *Huawei Technologies Co. Ltd. - China*
Yanbo Li | *Huawei Technologies Co. Ltd. - China*

14:00 - 14:15

Chair: Luis Velasco Universitat Politecnica de Catalunya - UPC (Spain)
SC10 - Architecture, Control and Management of optical networks

We3E.1
Transformer-based Alarm Context-Vectorization Representation for Reliable Alarm Root Cause Identification in Optical Networks

A Transformer-based alarm context-vectorization representation technique is proposed for alarm root cause identification and correlation analysis. Three common root alarms are identified with an accuracy of 94.47%, and other correlated alarms are obtained with quantified correlation degrees.

Jinwei Jia* | *Presenter | *State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Post - China*
Danshi Wang | *State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Post - China*
Chunyu Zhang | *State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Post - China*
Hui Yang | *State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Post - China*
Luyao Guan | *State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Post - China*
Xue Chen | *State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Post - China*
Min Zhang | *State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Post – China*

14:15 - 14:30

We3E.2
Scalable Physical Layer Security Components for Microservice-Based Optical SDN Controllers

We propose and demonstrate a set of microservice-based security components able to perform physical layer security assessment and mitigation in optical networks. Results illustrate the scalability of the attack detection mechanism and the agility in mitigating attacks.

Carlos Natalino* | *Presenter | *Chalmers University of Technology - Sweden*
Carlos Manso | *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain*
Ricard Vilalta | *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain*
Paolo Monti | *Chalmers University of Technology - Sweden*
Raul Muñoz | *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA) - Spain*
Marija Furdek | *Chalmers University of Technology – Sweden*

14:30 - 14:45

We3E.3
Vertical Federated Learning for Privacy-Preserving ML Model Development in Partially Disaggregated Networks

We present a novel framework that enables vendors and operators, with partial access to operational and monitoring features of a service, to collaboratively develop a ML-assisted solution without revealing any business-critical raw data to each other. We validate our proposal for a QoT estimation use-case.

Behnam Shariati* | *Presenter | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Nazila Hashemi | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Pooyan Safari | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Johannes K. Fischer | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute – Germany*

Wednesday 15 September

ROOM F

FUTURE PONS

14:30 - 14:45

Chair: Fabio Bottoni Cisco - Italy
SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

We3F.3
Enhanced Electrical Duobinary Decoder with Low-BW Based Receivers for Short Reach Indoor Optical Links

We propose and experimentally validate a novel scheme combining both binary and electrical duobinary detection. At 50Gb/s, in a 1-bit memory channel, we obtain a Rx sensitivity of -25.7dBm with a 25G-class Rx and a low path penalty after 20km using a 1342nm EML Tx.

Giuseppe Caruso* | *Presenter | *Huawei Technologies Duesseldorf - Germany, Politecnico di Torino - Italy*
Ivan Cano | *Presenter* | *Huawei Technologies Duesseldorf - Germany*
Ricardo Rosales | *Huawei Technologies Duesseldorf - Germany*
Derek Nesset | *Huawei Technologies Duesseldorf - Germany*
Giuseppe Talli | *Huawei Technologies Duesseldorf - Germany*
Roberto Gaudino | *Politecnico di Torino – Italy*

14:45 - 15:00

We3F.4
Clustering G-PON Field Data to Improve Flexibility in Next Generation PON Systems

We study two scenarios for more flexibility in next generation PONs, with the help of the collected data from 4 million deployed ONUs. Clustering the ONUs over the ODNs shows that a clustering based on the OLT-ONU distance is the best solution for balanced clusters.

Gaël SIMON* | *Presenter | *Orange Labs - France*
Philippe Chanclou | *Orange Labs - France*
Fabienne Saliou | *Orange Labs - France*
Jérémy Potet | *Orange Labs - France, Université Rennes, CNRS, Institut Foton, UMR 6082 - France*
Minqi WANG | *IMT Atlantique - France, Orange Labs - France*

15:00 - 15:15

We3F.5 HIGHLY SCORED
Carrier Lab Trial of a Real Time 50G-PON Prototype

The design and performance of a first real-time 50G-PON prototype with 50Gbps downstream and 25Gbps upstream line rate is described. Results from trials in a network carrier lab show ~40Gbps downstream service capacity with ~80µs latency for a 10km fibre link.

Dezhi Zhang* | *Presenter | *China Telecom - China*
Dekun Liu | *Huawei Technologies Co. Ltd. - China*
Derek Nesset | *Huawei Technologies - Germany*
Xuming Wu | *Huawei Technologies Co. Ltd. - China*
Jiang Ming | *China Telecom - China*

15:15 - 15:30

We3F.6
DSP-free and Shared SOA for HS-PON Transmissions with up to 30dB Optical Budget and 15dB dynamic range

We experimentally demonstrate a real time 50Gbit/s downstream and 25Gbit/s upstream HSP transmissions reaching 29.7dB of optical budget (45km reach) without DSP and using only a single SOA placed in the OLT.

Fabienne Saliou* | *Presenter | *Orange Labs - France*
Jérémy Potet | *Orange Labs - France*
Florian Foch | *Orange Labs - France*
Laurent Bramerie | *Université Rennes, CNRS, Institut Foton, UMR 6082 - France*
Mathilde Gay | *Université Rennes, CNRS, Institut Foton, UMR 6082 - France*
Gaël SIMON | *Orange Labs - France*
Philippe Chanclou | *Orange Labs - France*

ROOM G

PACKAGING

14:00 - 14:15

Chair: Lars Zimmermann IHP GmbH - Leibniz-Insitut für innovative Mikroelektronik - Germany
SC3 - Integrated and co-integrated circuits

We3G.1
110GHz Through-Silicon Via's Integrated in Silicon Photonics Interposers for Next-Generation Optical Modules

We report Through-Si Via's (TSV) with RF bandwidth beyond 110GHz integrated in a Silicon Photonics interposer, targeting next-generation optical modules operating at 100Gbaud data rates. Showcasing low RF loss, high-quality data transmission is demonstrated at 112Gb/s NRZ data rate for test structures including two TSVs.

Kenichi Miyaguchi* | *Presenter | *Ghent University - IMEC - Belgium*
Yoojin Ban | *Ghent University - IMEC - Belgium*
Nicolas Pantano | *Ghent University - IMEC - Belgium*
Xiao Sun | *Ghent University - IMEC - Belgium*
Philippe Absil | *Ghent University - IMEC - Belgium*
Lieve Bogaerts | *Ghent University - IMEC - Belgium*
Peter Verheyen | *Ghent University - IMEC - Belgium*
Dimitrios Velenis | *Ghent University - IMEC - Belgium*
Marianna Pantouvaki | *Ghent University - IMEC - Belgium*
Joris Van Campenhout | *Ghent University - IMEC - Belgium*

14:15 - 14:30

We3G.2
Passive Aligned Glass Waveguide Connector for Co-Packaged Optics

Co-packaged optics require novel packaging concepts for high fiber counts and low-cost assembly. We design and fabricate a glass waveguide substrate with MPO interfaces that yield an average connector loss of 0.5 dB. Simulations are performed to assess the required spring force for physical contact.

Lars Brusberg* | *Presenter | *Corning Research and Development Corporation - USA*
Jason Grenier | *Corning Research and Development Corporation - USA*
Juergen Matthies | *Corning Optical Communications GmbH & Co KG - Germany*
Allen Miller | *Corning Optical Communications LLC - USA*
Chad Terwilliger | *Corning Research and Development Corporation - USA*
Jeffrey Clark | *Corning Research and Development Corporation - USA*
Beibei Zeng | *Corning Research and Development Corporation - USA*
Pierre Beneke | *Corning Optical Communications GmbH & Co KG - Germany*

14:30 - 14:45

We3G.3
Glass Molded Optical Interposers for Wafer Scale Datacom Component Packaging

We report on glass-molded micro-optical interposers for single mode fiber-to-PIC coupling fabricated at the wafer scale that result in less than 1 dB excess insertion losses. They allow a narrow package footprint and can be extended to support polarization management, isolation and wavelength multiplexing.

Jeremy Witzens* | *Presenter | *aiXscale Photonics - Germany, Chair of Integrated Photonics / RWTH Aachen - Germany*
Florian Merget | *aiXscale Photonics - Germany, Chair of Integrated Photonics / RWTH Aachen - Germany*
Manuel Ackermann | *Chair of Integrated Photonics / RWTH Aachen - Germany*
Bin Shen | *Chair of Integrated Photonics / RWTH Aachen - Germany*
Gordon Davis Saunders | *Aixemtec GmbH - Germany*
Sebastian Haag | *Aixemtec GmbH - Germany*
Michael Wolz | *GD Optical Competence GmbH - Germany*

ROOM A

SPATIOTEMPORAL EFFECTS IN FIBERS

16:45 - 17:00

Chair: Camille-Sophie Brès EPFL - Switzerland
SC1 - Novel Fibres, Fibre Devices and Fibre Amplifiers

We4A.3
Femtosecond soliton spatio-temporal properties in multimode GRIN fibers

Femtosecond multimode solitons composed by non-degenerate modes have unique properties: their pulsewidth and energy only depend on linear dispersive properties, and coupling conditions. They are unstable objects which evolve into stable singlemode pulses.

Mario Zitelli* | *Presenter | *Department of Information Engineering, Electronics and Telecommunications (DIET), Sapienza Universit - Italy*
Fabio Mangini | *Department of Information Engineering, University of Brescia - Italy*
Mario Ferraro | *Department of Information Engineering, Electronics and Telecommunications (DIET), Sapienza Universit - Italy*
Stefan Wabnitz | *Department of Information Engineering, Electronics and Telecommunications (DIET), Sapienza Universit - Italy*

17:00 - 17:15

We4A.4
Beam Forming over 4.5km 45 Mode Multi-Mode Fiber

We modulate the amplitude, phase and polarization of 45 parallel phase-stabilized inputs to a mode multiplexer, achieving full control over the optical field's space, time, polarization, and frequency at the output of a 4.5km graded index multimode-fiber.

Mikael Mazur* | *Presenter | *Nokia Bell Labs - USA*
Nicolas Fontaine | *Nokia Bell Labs - USA*
Lauren Dallachiesa | *Nokia Bell Labs - USA*
Haoshuo Chen | *Nokia Bell Labs - USA*
Steve Corteselli | *Nokia Bell Labs - USA*
Louis-Anne de Montmorillon | *Prysmian Group - France*
Pierre Sillard | *Prysmian Group - France*
Roland Ryf | *Nokia Bell Labs - France*
David Neilson | *Nokia Bell Labs – USA*

17:15 - 17:30

We4A.5
Self-Optimising Breather Ultrafast Fibre Laser

We demonstrate the self-optimisation of the breather regime in an ultrafast fibre laser through an evolutionary algorithm. Depending on the specified merit function, single breathers with controllable breathing ratio and period, and breather molecular complexes with a controllable number of constituents can be obtained.

Sonia Boscolo* | *Presenter | *Aston Institute of Photonic Technology - UK*
Xiuqi Wu | *State Key Laboratory of Precision Spectroscopy, East China Normal University - China*
Junsong Peng | *State Key Laboratory of Precision Spectroscopy, East China Normal University - China*
Yu Zhang | *State Key Laboratory of Precision Spectroscopy, East China Normal University - China*
Christophe Finot | *Laboratoire Interdisciplinaire Carnot de Bourgogne, Université de Bourgogne-Franche Comté - France*
Heping Zeng | *State Key Laboratory of Precision Spectroscopy, East China Normal University – China*

ROOM B

NOVEL RADIO-OVER-FIBER DEVICES AND SYSTEMS

16:45 - 17:15

Chair: Leif Katsuo Oxenløwe Technical University of Denmark - Denmark
SC7 - Photonics for RF and Free Space Optics applications

We4B.3 EXTENDED
Flexible Optical and Millimeter-Wave Analog-RoF Transmission with a Silicon-based Integrated Dual Laser Module

A hybrid integrated InP-Si3N4 dual tunable laser module is deployed as a highly flexible source for converged optical/mm-wave fronthaul. Experimental results shows the wavelength flexible delivery of 5G signals over analog radio-over-fiber, incorporating wireless transmission at 60 GHz, with received EVMs as low as 5%.

Devika Dass* | *Presenter | *Dublin City University - Ireland*
Amol Delmade | *Dublin City University - Ireland*
Liam Barry | *Dublin City University - Ireland*
Chris Roeloffzen | *LioniX International - The Netherlands*
Douwe Geuzebroek | *LioniX International - The Netherlands*
Colm Browning | *Dublin City University - Ireland*

17:15 - 17:30

We4B.5
Hybrid Analogue / Digitized Radio-over-Fibre Downlink Through Orthogonal Optical mm-Wave and 10 Gb/s Baseband Transport

We experimentally demonstrate the simultaneous radio-over-fibre transmission of an analogue 1-GHz OFDM signal on a mm-wave carrier frequency at 33 GHz and digitized 10 Gb/s data. Single-wavelength transport is supported through an intensity/phase modulation pair and a compact silicon micro-ring resonator, at <1dB penalties.

Aina Val Martí* | *Presenter | *AIT Austrian Institute of Technology - Austria*
Nemanja Vokić | *AIT Austrian Institute of Technology - Austria*
Markus Hofer | *AIT Austrian Institute of Technology - Austria*
Dinka Milovančev | *AIT Austrian Institute of Technology - Austria*
Thomas Zemen | *AIT Austrian Institute of Technology - Austria*
Bernhard Schrenk | *AIT Austrian Institute of Technology - Austria*

17:30 - 17:45

We4B.6
Demonstration of FPGA-based A-IFoF/mmWave transceiver integration in mobile infrastructure for beyond 5G transport

We demonstrate the successful operation of an FPGA-based A-IFoF/mmWave transceiver into an existing MNO infrastructure, delivering 4K video streaming and IP-calls over mobile core network. Physical layer connectivity was successfully established, with EVM measurements of <10% for QPSK waveforms propagated through different optical-wireless network segments.

Panagiotis Toumasis* | *Presenter | *School of Electrical & Computer Engineering, National Technical University of Athens - Greece*
Konstantina Kanta | *School of Electrical & Computer Engineering, National Technical University of Athens - Greece*
Konstantinos Tokas | *School of Electrical & Computer Engineering, National Technical University of Athens - Greece*
Ioannis Stratakos | *School of Electrical & Computer Engineering, National Technical University of Athens - Greece*
Elissaios Alexios Papatheofanous | *National and Kapodistrian University of Athens - Greece*
Giannis Giannoulis | *School of Electrical & Computer Engineering, National Technical University of Athens - Greece*
Ioanna Mesogiti | *COSMOTE Mobile Telecommunications S.A. - Greece*
Elina Theodoropoulou | *COSMOTE Mobile Telecommunications S.A. - Greece*
George Lyberopoulos | *COSMOTE Mobile Telecommunications S.A. - Greece*
George Lentaris | *School of Electrical & Computer Engineering, National Technical University of Athens - Greece*
Dimitris Apostolopoulos | *School of Electrical & Computer Engineering, National Technical University of Athens - Greece*
Dionisios Reisis | *School of Electrical & Computer Engineering, National Technical University of Athens - Greece*
Dimitris Soudris | *School of Electrical & Computer Engineering, National Technical University of Athens - Greece*
Hercules Avramopoulos | *School of Electrical & Computer Engineering, National Technical University of Athens - Greece*

ROOM C1

SPACE DIVISION MULTIPLEXING

16:45 - 17:00

Chair: Norbert Hanik TU Munich - Germany
SC5 - Optical Transmission systems

We4C1.3
Data Transmission using Orbital Angular Momentum Mode Multiplexing and Wavelength Division Multiplexing with a Silicon Photonic Integrated MUX Chip

We present a simultaneous WDM and orbital angular momentum (OAM) mode photonic chip multiplexer, and demonstrate data transmission of 8xWDM channels on 2xOAM modes, each carrying 10-Gbit/s OOK data through an 800-m ring-core OAM fiber. All 16 channels attain BERs below the 7% FEC limit.

Yaoxin Liu* | *Presenter | *Technical University of Denmark - Denmark*
Lars Rishøj | *Department of Photonics Engineering, Technical University of Denmark - Denmark*
Michael Galili | *Department of Photonics Engineering, Technical University of Denmark - Denmark*
Yunhong Ding | *Department of Photonics Engineering, Technical University of Denmark - Denmark*
Leif Katsuo Oxenløwe | *Department of Photonics Engineering, Technical University of Denmark - Denmark*
Toshio Morioka | *Department of Photonics Engineering, Technical University of Denmark – Denmark*

17:00 - 17:15

We4C1.4
Demonstration of Intra-Data Center Link Based on 1x4 Multicore Fiber (MCF) Edge-Coupled to Silicon Photonics

We demonstrate 100 Gb/s single-wavelength as well as four wavelength CWDM4 error-free performance of a 2 km data center link consisting of 1x4 MCF, MTP connectors and effective coupling into silicon nitride (SiN) waveguides on Cisco's standard photonic integrated circuit platform.

Doug Butler* | *Presenter | *Corning - USA*
Norbert Schlepple | *Cisco - USA*
Sergey Ten | *Corning - USA*
Cliff Sutton | *Corning - USA*
Kevin Bennett | *Corning - USA*
Matthew Tuggle | *Corning - The Russian Federation*
Marc Lorenzo | *Corning - USA*
Jeffrey Clark | *Corning - USA*
Pushkar Tandon | *Corning - USA*
Aramais Zakharian | *Corning - USA*
Anthony Artuso | *Corning - USA*
Vasanta Rao | *Cisco - USA*
Dingchuan Chen | *Cisco - USA*
Nikolai Kalnin | *Cisco - USA*
Ravi Tummidi | *Cisco - USA*
Nadine Tsai | *Cisco - USA*
Bob Bullock | *Cisco - USA*
Alberto Cervasio | *Cisco - USA*
Joyce Peternel | *Cisco - USA*
Matt Traverso | *Cisco – USA*

17:15 - 17:30

We4C1.5
Performance Evaluation of an Interband All-Optical Wavelength Converter for Cost-Effective High-Capacity Optical Networks

Harnessing the capabilities of all-optical wavelength conversion is a key enabler for cost-effective high-capacity optical systems. We design and experimentally characterize the performance of a space-division multiplexing based interband wavelength converter for C- to S-band transmission and reception using a commercially available C-band transceiver.

Isaac Sackey | *Presenter* | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Robert Elschner | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Robert Emmerich | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Carsten Schmidt-Langhorst | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Dirk-Daniel Groß | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Georg Rademacher | *NICT - Japan*
Yoshinari Awaji | *NICT - Japan*
Hideaki Furukawa | *NICT - Japan*
Takemi Hasegawa | *Sumitomo Electric Industries, Ltd - Japan*
Colja Schubert | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Ronald Freund | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*

Technical Sessions Wednesday 15 September

ROOM C2

DIRECT DETECTION I

17:15 - 17:30

Chair: Yves Jaouen Telecom Paris - France
SC4 - Techniques for digitally enhancing optical communication

We4C2.5
Comparison of Direct-Detection Approaches for High-Speed Datacenter Campus Networks

We experimentally compare virtual carrier based self-coherent detection with Kramers-Kronig reception and chromatic dispersion pre-compensation for 10km C-band transmission at gross bit rates between 120Gb/s and 300Gb/s. The latter scheme shows a better performance up to 230Gb/s although being more demanding for the DAC.

Tom Wettlin* | *Presenter | *Kiel University - Germany*
Stefano Calabrò | *Huawei Technologies - Germany*
Talha Rahman | *Huawei Technologies - Germany*
Md Sabbir-Bin Hossain | *Huawei Technologies - Germany, Kiel University - Germany*
Jinlong Wei | *Huawei Technologies - Germany*
Nebojša Stojanović | *Huawei Technologies - Germany*
Stephan Pachnicke | *Kiel University - Germany*

17:30 - 17:45

We4C2.6
Blind Adaptation of Partial Response Equalizers for 200Gb/s per Lane IM/DD Systems

We propose a novel non-data-aided adaptation algorithm for a partial-response feed-forward equalizer. Performance is evaluated based on 224Gb/s PAM4 signals captured after 0km and 20km O-band transmission suitable for hyper-scale datacenter intra-connections.

Talha Rahman* | *Presenter | *Huawei Technologies Duesseldorf - Germany*
Stefano Calabrò | *Huawei Technologies Duesseldorf - Germany*
Nebojša Stojanović | *Huawei Technologies Duesseldorf - Germany*
Md Sabbir-Bin Hossain | *CAU Kiel - Germany*
Jinlong Wei | *Huawei Technologies Duesseldorf - Germany*
Maxim Kuschnerov | *Huawei Technologies Duesseldorf - Germany*
Changsong Xie | *Huawei Technologies Duesseldorf - Germany*

ROOM D

PASSIVE PHOTONIC CIRCUITS

16:45 - 17:00

Chair: Yves Jaouen Telecom Paris - France
SC2 - Optoelectronic devices and technologies

We4D.3
Experimental Demonstration of Automatic Reconfiguration and Failure Recovery of Silicon Photonic Circuits

Automatic reconfiguration with failure recovery of photonic functions has not been experimentally demonstrated as far as we know, which is important for real-time operating programmable photonics. Here we experimentally demonstrate automatic reconfiguration and failure recovery for silicon photonic circuits by bacterial foraging algorithm.

Guangwei Cong* | *Presenter | *AIST - Japan*
Noritsugu Yamamoto | *AIST - Japan*
Yuriko Maegami | *AIST - Japan*
Morifumi Ohno | *AIST - Japan*
Koji Yamada | *AIST - Japan*

17:00 - 17:15

We4D.4
Mode-Evolution-based Symmetrical Polarization Splitter-Rotator on Monolithic InP Platform

Symmetrical polarization splitter-rotator is experimentally demonstrated on monolithic InP platform for the first time. By employing an optimized adiabatic taper and a mode-independent splitter, polarization extinction ratio of 16.3 dB with a polarization-dependent loss below 0.7 dB is obtained at 1550 nm wavelength.

Takuo Tanemura* | *Presenter | *The University of Tokyo - Japan*
Maiko Ito | *The University of Tokyo - Japan*
Taichiro Fukui | *The University of Tokyo - Japan*
Yoshiaki Nakano | *The University of Tokyo - Japan*

17:15 - 17:30

We4D.5
An Ultra-Compact CMOS Compatible MMI based 1310/1550 nm Wavelength (de) Multiplexer

We demonstrate a broadband 1310/1550 nm wavelength (de) multiplexer using a compact 41 μm long multimode interference (MMI) waveguide. Measurements exhibit an extinction ratio better than 13 dB (17 dB at center wavelengths) covering 1275-1355 nm and 1500-1600 nm wavelengths.

Zakriya Mohammed* | *Presenter | *New York University-Tandon School of Engineering - USA*
Bruna Paredes | *New York University-Abu Dhabi - The United Arab Emirates*
Juan Villegas | *New York University-Tandon School of Engineering - USA*
Mahmoud Rasras | *New York University-Abu Dhabi - The United Arab Emirates*

ROOM E

OPTICAL NETWORK MONITORING AND TELEMETRY

16:45 - 17:00

Chair: Claude Le Bouëtté EKINOPS - France
SC10 - Architecture, Control and Management of optical networks

We4E.3
OSNR prediction for optical links via learned noise figures

We predict the per-channel OSNR of optical links with up to 23 EDFAs via a machine learning model based on learned noise figures from experimental data. For a 20 span link, the error margin to cover 99% of cases is less than 0.35 dB.

Sarah Kamel* | *Presenter | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Hartmut Hafermann | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Dylan Le Gac | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Ludovic Dos Santos | *Huawei Noah's Ark Lab, Paris, France - France*
Balázs Kégl | *Huawei Noah's Ark Lab, Paris, France - France*
Yann Frignac | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Gabriel Charlet | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab – France*

Wednesday 15 September

17:00 - 17:15

We4E.4
Machine Learning Approach for Online Monitoring of Quality of Transmission Performance Indicators in Optical Fiber Networks.

We propose online monitoring of quality of transmission (QoT) in optical fiber networks aided by machine learning. Three regression models were comparatively fitted to estimate the current and long-term QoT indicators. Real data from on-line measurable, equipment-agnostic features was provided through realistic network experimental scenarios.

Ricardo PoUSA **|** ***Presenter*** | *Instituto de Telecomunicações, Universidade de Aveiro - Portugal*
José Pina **|** ***Presenter*** | *Infinera - Portugal*
Pedro Cruz **|** ***Presenter*** | *Infinera - Portugal*
Paulo André **|** ***Presenter*** | *Instituto de Telecomunicações, Instituto Superior Técnico - Portugal*
Petia Georgieva **|** ***Presenter*** | *Instituto de Telecomunicações, Universidade de Aveiro - Portugal*

17:15 - 17:30

We4E.5 HIGHLY SCORED
An Autoencoder-Based Solution for IQ Constellation Analysis.

A method for IQ constellation analysis based on Autoencoders is proposed. Exhaustive numerical results show accurate physical metric prediction and large data compression, while providing useful model explainability.

Marc Ruiz | *Presenter* | *Universitat Politecnica de Catalunya - Spain*
Javier Roman Morales | *Universitat Politecnica de Catalunya - Spain*
Diogo Gonçalo Sequeira | *Universitat Politecnica de Catalunya - Spain*
Luis Velasco | *Universitat Politecnica de Catalunya - Spain*

17:30 - 17:45

We4E.6
Optical Network Telemetry with Streaming Mechanisms using Transport API and Kafka

We present a streaming mechanism for optical networks based on the Kafka architecture and protocols, to efficiently distribute state and network updates following the upcoming ONF Transport API streaming implementation agreement. The proposed mechanism is validated and experimentally evaluated.

Ricard Vilalta **|** ***Presenter*** | *CTTC - Spain*
Ramon Casellas | *CTTC - Spain*
Ricardo Martinez | *CTTC - Spain*
Raul Muñoz | *CTTC - Spain*
Alfredo González-Muñiz | *Telefónica I+D, Global CTO Unit - Spain*
Juan Pedro Fernández-Palacios | *Telefónica I+D, Global CTO Unit - Spain*

ROOM F

FUTURE PONS : BEYOND 50G

16:15 - 16:45

Chair: Fabienne Saliou
SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

We4F.1 EXTENDED
200G Bi-Directional TDM-PON with 29-dB Power Budget

We demonstrate the first 200-Gb/s (100-GBaud PAM-4) TDM-PON using directly modulated lasers and direct detection. We achieve >29-dB link power budget by combining distributed Raman amplification over 21-km fiber and an SOA-based pre-amplifier.

Di Che **|** ***Presenter*** | Nokia Bell Labs - USA
Patrick Iannone | Nokia Bell Labs - USA
Greg Raybon | Nokia Bell Labs - USA
Yasuhiro Matsui | II-VI Incorporated - USA

16:45 - 17:15

We4F.3 EXTENDED
Operator Trial of 100 Gbit/s FLCS-PON Prototype with Probabilistic Shaping and Soft-Input FEC

We introduce probabilistic shaping and soft-input FEC to our 100-Gbit/s flexible PON concept, FLCS-PON, beside varying the modulation format and FEC code shortening/puncturing. These features improve granularity of bitrate adjustment for various channel conditions in downstream direction. We demonstrate our prototype in an operator trial.

Robert Borkowski **|** ***Presenter*** | *Nokia Bell Labs - Germany*
Yannick Lefevre | *Nokia Bell Labs - Belgium*
Michael Straub | *Nokia Bell Labs - Germany*
Željko Jelić | *Nokia Bell Labs - Belgium*
Amitkumar Mahadevan | *Nokia Bell Labs - USA*
Noriaki Kaneda | *Nokia Bell Labs - USA*
Yanni Ou | *Nokia Bell Labs - Germany*
Wouter Lanneer | *Nokia Bell Labs - Belgium*
Ralph Kaptur | *Vodafone - Germany*
Björn Czerwinski | *Vodafone - Germany*
Bruno Cornaglia | *Vodafone - Italy*
Dora van Veen | *Nokia Bell Labs - USA*
Vincent Houtsma | *Nokia Bell Labs - USA*
Werner Coomans | *Nokia Bell Labs - Belgium*
René Bonk | *Nokia Bell Labs - Germany*
Jochen Maes | *Nokia Bell Labs - Belgium*

ROOM G

CO-INTEGRATION FOR TRANSCEIVERS

17:15 - 17:30

We4F.5
100G PAM-4 PON with 34 dB Power Budget Using Joint Nonlinear Tomlinson-Harashima Precoding and Volterra Equalization

We experimentally demonstrate 100G PAM-4 passive optical network using DML-based intensity modulation and direct detection with 3-dB system bandwidth of 15 GHz in O-band. Combining nonlinear Tomlinson-Harashima precoding at the transmitter and 2nd-order Volterra at the receiver enables 34-dB power budget for PON downstream

Lei Xue* | *Presenter | *Chalmers University of Technology - Sweden, Shanghai Jiao Tong University - China*
Rui Lin | *Chalmers University of Technology – Sweden*
VanKerrebrouck Joris | *Ghent University - IMEC - Belgium*
Lilin Yi | *Shanghai Jiao Tong University - China*
Jiajia Chen | *Chalmers University of Technology - Sweden*
Xin (Scott) Yin | *Ghent University - IMEC – Belgium Ghent University - IMEC – Belgium*

17:30 - 17:45

We4F.6
Real Time 100 Gbit/s Single Wavelength PAM-4 Experiments for Future Access Networks over 20 km with 29 dB Optical Budget

Real Time 100 Gbit/s Single Wavelength PAM-4 Experiments for Future Access Networks over 20 km with 29 dB Optical Budget. We achieve 29 dB of optical budget and 20 km reach in a 50 Gbaud PAM-4 experiment at pre-FEC BER threshold of 10-2. A PDFA at OLT, a SOA-PIN at ONU are used in a real time experiment.

Jérémy Potet* | *Presenter | *Institut Foton – France, Orange Labs - France*
Mathilde Gay* | *Presenter | *Institut Foton - France*
Laurent Bramerie | *Institut Foton - France*
Hamza Hallak Elwan | *Institut Foton - France*
Fabienne Saliou | *Orange Labs – France*
Gaël SIMON | *Orange Labs - France*
Philippe Chanclou | *Orange Labs – France*

16:15 - 16:30

Chair: Daniel Kuchta IBM -USA
SC3 - Integrated and co-integrated circuits

We4G.1
High Optical Output Power and High-responsivity IC-TROSA for 800 Gbps applications

We developed an IC-TROSA type-2 for 800 Gbps applications. A 3-dB E/O and O/E bandwidth of over 55 GHz, the unmodulated optical output power of over 6.0 dBm per polarization, and the minimum receiver responsivity for signal of 60 mA/W at 1550 nm were obtained.

Munetaka Kurokawa* | *Presenter | *Sumitomo Electric Industries, Ltd - Japan*
Kenichi Nakayama | *Sumitomo Electric Industries, Ltd - Japan*
Masaru Takechi | *Sumitomo Electric Industries, Ltd - Japan*
Yasutaka Mizuno | *Sumitomo Electric Industries, Ltd - Japan*
Taichi Misawa | *Sumitomo Electric Industries, Ltd - Japan*
Eiichi Banno | *Sumitomo Electric Industries, Ltd - Japan*
Hiroshi Uemura | *Sumitomo Electric Industries, Ltd - Japan*
Yoshiyuki Sugimoto | *Sumitomo Electric Industries, Ltd - Japan*
Seiji Kumagai | *Sumitomo Electric Industries, Ltd – Japan*
Takuya Okimoto | *Sumitomo Electric Industries, Ltd - Japan*
Naoya Kono | *Sumitomo Electric Industries, Ltd - Japan*
Tsutomu Ishikawa | *Sumitomo Electric Industries, Ltd - Japan*
Hiroshi Hara | *Sumitomo Electric Industries, Ltd - Japan*
Takatoshi Kato | *Sumitomo Electric Industries, Ltd - Japan*
Keiji Tanaka | *Sumitomo Electric Industries, Ltd - Japan*
Mitsuru Ekawa | *Sumitomo Electric Industries, Ltd - Japan*
Katsumi Uesaka | *Sumitomo Electric Industries, Ltd - Japan*

16:30 - 16:45

We4G.2
50 GBaud QPSK 0.98 pJ/bit Receiver in 45 nm CMOS and 90 nm Silicon Photonics

Low-power O-band receivers are required for next-generation coherent intra-datacenter interconnects. In this paper, a 0.98 pJ/bit QPSK receiver using a 45 nm CMOS process and a 90 nm Silicon Photonics (SiP) process is demonstrated at up to 50 GBaud.

Hector Andrade* | *Presenter | *University of California, Santa Barbara - USA*
Yujie Xia | *University of California, Santa Barbara - USA*
Aaron Maharry | *University of California, Santa Barbara - USA*
Luis Valenzuela | *University of California, Santa Barbara - USA*
James Buckwalter | *University of California, Santa Barbara - USA*
Clint Schow | *University of California, Santa Barbara - USA*

16:45 - 17:15

We4G.3 EXTENDED
A 4×50 Gb/s All-Silicon Ring-based WDM Transceiver with CMOS IC.

We demonstrate a 4λ ring-based WDM transceiver, with all-silicon ring photodetectors, ring modulators and all necessary CMOS transceiver electronics. All four channels are verified at 50 Gb/s/λ with < 1e-12 BER.

Hao Li* | *Presenter | *Intel Corporation - USA*
Zhe Xuan | *Intel Corporation - USA*
Ranjeet Kumar | *Intel Corporation - USA*
Meer Sakib | *Intel Corporation - USA*
Jahnavi Sharma | *Intel Corporation - USA*
Chun-Ming Hsu | *Intel Corporation - USA*
Chaoxuan Ma | *Intel Corporation - USA*
Haisheng Rong | *Intel Corporation - USA*
Ganesh Balamurugan | *Intel Corporation - USA*
James Jaussi | *Intel Corporation - USA*

Technical Sessions Thursday 16 September

ROOM A

PHYSICAL LAYER MODELLING FOR OPTICAL NETWORKS

10:00 - 10:15

Chair: Patricia Layec Nokia Bell Labs - France
SC8 - Core and metro networks

Th1A.5
Extension of the Measurement-Based Gain Model for non-Flat WDM Inputs and various pump currents

We extend our measurement-based model to accurately predict the gain of an EDFA for arbitrary input spectrum to the case of arbitrary pump currents with low root-mean square error and no extra training data and then, we analyze its accuracy against numerical simulations and experiments.

Alexis Carbo Meseguer* | *Presenter | *Alcatel Submarine Networks, Nozay - France*
Vitória Maria C. Mathias |*Alcatel Submarine Networks, Nozay - France*
Jean-Christophe Antona |*Alcatel Submarine Networks, Nozay - France*
Alberto Bononi |*Università di Parma, Dip. Ingegneria e Architettura, Parma - Italy*
Stephen Grubb |*Facebook - USA*
Olivier Courtois |*Alcatel Submarine Networks, Nozay - France*
Vincent Letellier |*Alcatel Submarine Networks, Nozay - France*

ROOM B

OPTICAL WIRELESS COMMUNICATION DEVICES AND SYSTEMS

09:30 - 10:00

Chair: Liam Barry Dublin City University - Ireland
SC7 - Photonics for RF and Free Space Optics applications

Th1B.3 EXTENDED
Experimental Demonstration of a 100-Gbit/s 16-QAM Free-Space Optical Link Using a Structured Optical "Bottle Beam" to Circumvent Obstructions

We experimentally demonstrate a 100-Gbit/s 16-QAM free-space optical link using/tailoring an optical bottle beam to circumvent obstructions with different sizes and locations. Experimental results show ~10-dB less obstruction-induced power penalty compared to using a Gaussian beam for the obstruction with a diameter of ~4.5 mm.

Huibin Zhou* | *Presenter | *Univ. of Southern California – USA*
Nanzhe Hu | *Univ. of Southern California - USA*
Xinzhou Su | *Univ. of Southern California - USA*
Runzhou Zhang | *Univ. of Southern California - USA*
Haoqian Song | *Univ. of Southern California - USA*
Hao Song | *Univ. of Southern California - USA*
Kai Pang | *Univ. of Southern California - USA*
Kaiheng Zou | *Univ. of Southern California – USA*
Amir Minoofar | *Univ. of Southern California - USA*
Brittany Lynn | *Naval Information Warfare Center Pacific - USA*
Moshe Tur | *Tel Aviv University - Israel*
Alan Willner | *Univ. of Southern California - USA*

10:00 - 10:15

Th1B.5
Submillimeter Large High-speed Photodetector for High Optical Alignment Robustness Optical Wireless Communications

We present a submillimeter large high-speed photodetector for mitigating optical alignment issues and low-cost receiver design for free-space optical (FSO) communications. In a 10-m FSO communication demonstration, a high data rate of up to 20-Gbps could be successfully achieved with a 4-mm alignment tolerance.

Toshimasa Umezawa* | *Presenter | *NICT - Japan*
Shinya Nakajima | *NICT - Japan*
Atsushi Kanno | *NICT - Japan*
Naokatsu Yamamoto | *NICT - Japan*

10:15 - 10:30

Th1B.6
Optical Wireless GbE Receiver with Large Field-of-View

We expanded our concept of NxN matrix of photodiodes, scalable to large aperture and wide field-of-view while retaining high bandwidth. A simple GbE OWC receiver with 4x4 matrix and single TIA was realised and showed a FoV>10 deg. We demonstrated GbE real-time high-definition video streaming.

Ton Koonen* | *Presenter | *Technology University of Eindhoven - The Netherlands*
Ketemaw Mekonnen | *Technology University of Eindhoven - The Netherlands*
Frans M. Huijskens | *Technology University of Eindhoven - The Netherlands*
Ngoc Quan Pham | *Technology University of Eindhoven - The Netherlands*
Zizheng Cao | *Technology University of Eindhoven - The Netherlands*
Eduward Tangdiongga | *Technology University of Eindhoven - The Netherlands*

ROOM C2

CODED MODULATIO

09:30 - 09:45

Chair: Yves Jaouen Telecom Paris - France
SC4 - Techniques for digitally enhancing optical communication

Th1C2.3
Squeezing Out the Last Shaping Gain with Optimum Enumerative Sphere Shaping for Short Block Lengths

We propose a practical solution of enumerative sphere shaping to minimize the average symbol energy of the output sequences, which permits lower rate loss and a Gaussian-like distribution, squeezing out the last shaping gain at short block lengths.

Yizhao Chen* | *Presenter | *School of Cyber Science and Engineering, Huazhong University of Science and Technology, Wuhan - China*
Junda Chen | *Wuhan National Lab for Optoelectronics (WNLO) & National Engineering Laboratory for Next Generation - China*
Weihao Li | *Wuhan National Lab for Optoelectronics (WNLO) & National Engineering Laboratory for Next Generation - China*
Mingming Zhang | *Wuhan National Lab for Optoelectronics (WNLO) & National Engineering Laboratory for Next Generation - China*
Deming Liu | *School of Cyber Science and Engineering, Huazhong University of Science and Technology, Wuhan - China, Wuhan National Lab for Optoelectronics (WNLO) & National Engineering Laboratory for Next Generation - China*
Ming Tang | *Wuhan National Lab for Optoelectronics (WNLO) & National Engineering Laboratory for Next Generation – China*

09:45 - 10:00

Th1C2.4
Rate Loss Reduction through Look-up Table Design for Hierarchical Distribution Matcher in Probabilistic Amplitude Shaped systems

We proposed a new method for the rate loss reduction in the hierarchical distribution matching (Hi-DM) approach for the constellation shaping. This method makes Hi-DM comparable with the enumerative sphere shaping (ESS) approach, at short block length, in terms of rate loss.

Pantea Nadimi Goki **| *Presenter*** | *Scuola Superiore Sant'Anna, TeCIP Institute - Italy*
Luca Poti **| *Presenter*** | *CNIT Photonic Networks and Technologies National Laboratory - Italy*

10:00 - 10:15

Th1C2.5
Short Blocklength Distribution Matching by Linear Programming

A low-complexity distribution matching algorithm that aims to achieve high information rate for short block-length probabilistic shaping by linear programming is proposed. At AIR of 4 bits/symbol and SNR of 11.87 dB, the distribution matching block length is shortened by 256 times compared with CCDM.

Shuangyu Dong **| *Presenter*** | *The University of Melbourne - Australia*
Honglin Ji **| *Presenter*** | *The University of Melbourne - Australia*
Zhaopeng Xu **| *Presenter*** | *The University of Melbourne - Australia*
Jingge Zhu **| *Presenter*** | *The University of Melbourne - Australia*
William Shieh **| *Presenter*** | *The University of Melbourne - Australia*

10:15 - 10:30

Th1C2.6
Multi-dimensional Probabilistic Shaping for Optical Superchannels

We present a multi-dimensional probabilistic shaping algorithm for optical superchannels, complemented with machine-learning assisted soft demapping at the receiver. The proposed system outperforms traditional shaping methods by 0.3-1.05 dB for the same block-length, to enable a 300-km superchannel transmission achieving 800 Gbps data-rate per carrier.

Lutz Lampe **| *Presenter*** | *University of British Columbia - Canada*
Mrinmoy Jana | *University of British Columbia - Canada*
Jeebak Mitra | *Huawei Technologies - Canada*
Chuandong Li | *Huawei Technologies - Canada*

ROOM D

LIDARS

09:30 - 09:4

Chair: Jean Teissier II-VI Laser Enterprise - Switzerland
SC2 - Optoelectronic devices and technologies

Th1D.3
Compact 1D/2D VCSEL Beam Scanner with Enhanced Field of View and High Resolution

We realized 1D beam steering with field of view of >100° and resolution number of >1400 by using electrical-driven solid-state beam scanner with submodule size of 10mm×6mm×3mm. We also demonstrated 2D-beam steering with field of view of 35°× 15° by integration of beam scanners array.

Ruixiao Li **| *Presenter*** | *Tokyo Institute of Technology - Japan*
Fumio Koyama | *Tokyo Institute of Technology - Japan*
Satoshi Shinada | *National Institute of Information and Communications Technology - Japan*
Xiaodong Gu | *Ambition Photonics Inc. - Japan •Tokyo Institute of Technology - Japan*

09:45 - 10:00

Th1D.4
Photonic-Integrated and Highly-Scalable FMCW LiDAR Concept based on Tilted Grating Couplers

Most Photonic-Integrated FMCW LiDAR systems rely on beam steering with optical phasedarrays, which require complex control of the individual phase modulators in the array. We propose a fully-integrated LiDAR chip that relies on tilted grating couplers, and does not require any phase modulators.

Vahram Voskerchyan **| *Presenter*** | *University of Vigo - Spain*
Yu Tian | *University of Vigo - Spain*
Francisco Soares | *Soares Photonics - Portugal*
Francisco Diaz Otero | *University of Vigo – Spain*

10:00 - 10:15

Th1D.5
Ultimate Impulse Response and Relative Delay of a Pulsated VCSEL Array at 940 nm for Improving ToF Resolution

Very short ~270 ps pulses are generated by 1~2W VCSEL arrays with fast rise/fall times. Spatially resolved time delays are observed for the first time to be <125 ps promising for high time-of-flight depth resolution ~5 mm.

Cheng-Ting Huang **| *Presenter*** | *National Taiwan University - Taiwan*
Wei-Chi Lo | *National Taiwan University - Taiwan*
Chih-Chiang Shen | *Berxel Photonics Inc. - China*
Jiaxing Wang | *Pinnacle Photonics Inc. - USA*
Pengfei Qiao | *Pinnacle Photonics Inc. - USA*
Jipeng Qi | *Pinnacle Photonics Inc. - USA*
Chih-Hsien Cheng | *National Taiwan University - Taiwan, Research Center for Advanced Science and Technology, University of Tokyo - Japan*
Constance J. Chang-Hasnain | *Berxel Photonics Inc. - China, Pinnacle Photonics Inc. - USA*
Gong-Ru Lin | *National Taiwan University – Taiwan*

Thursday 16 September

ROOM E

NETWORK PERFORMANCE

09:00 - 09:15

Chair: Sébastien Bigo Nokia Bell-Labs - France
SC10 - Architecture, Control and Management of optical networks

Th1E.1 HIGHLY SCORED
A QoT Estimation Method using EGN-assisted Machine Learning for Network Planning Applications

An ML model based on precomputed per-channel SCI is proposed. Due to its superior accuracy over closed-form GN, an average SNR gain of 1.1dB in an end-to-end link optimization and a 40% reduction in required lightpaths to meet traffic requests in a network planning scenario are shown.

Jasper Müller* | *Presenter | *ADVA Optical Networking SE - Germany*
Sai Kireet Patri | *ADVA Optical Networking SE - Germany, Technical University of Munich - Germany*
Tobias Fehenberger | *ADVA Optical Networking SE - Germany*
Carmen Mas-Machuca | *Technical University of Munich - Germany*
Helmut Grießer | *ADVA Optical Networking SE - Germany*
Jörg-Peter Elbers | *ADVA Optical Networking SE - Germany*

09:15 - 09:30

Th1E.2
Laser Linewidth Tolerant EVM Estimation Approach for Intelligent Signal Quality Monitoring Relying on Feedforward Neural Networks

Robustness against the large linewidth semiconductor laser-induced impairments in coherent systems is experimentally demonstrated for a feedforward neural network-enabled EVM estimation scheme. A mean error of 0.4% is achieved for 28 Gbaud square and circular QAM signals and linewidths up to 12.3 MHz.

Yuchuan Fan* | *Presenter | *KTH Royal Institute of Technology - Sweden, RISE Research Institutes of Sweden - Sweden*
Xiaodan Pang | *KTH Royal Institute of Technology - Sweden, RISE Research Institutes of Sweden - Sweden*
Aleksejs Udalcovs | *RISE Research Institutes of Sweden - Sweden*
Carlos Natalino | *Chalmers University of Technology - Sweden*
Richard Schatz | *KTH Royal Institute of Technology - Sweden*
Marija Furdek | *Chalmers University of Technology - Sweden*
Sergei Popov | *KTH Royal Institute of Technology - Sweden*
Oskars Ozolins | *KTH Royal Institute of Technology - Sweden, RISE Research Institutes of Sweden – Sweden*

09:30 - 09:45

Th1E.3
Impact of Operational Mode Selection and Grooming Policies on Auxiliary Graph-Based Multi-layer Network Planning

We propose a multi-layer path planning method that simultaneously applies a operational mode selection policy and grooming policy in auxiliary graphs. We quantitatively evaluated the impact of these two policies on multi-layer network planning performance.

Takafumi Tanaka* | *Presenter | *NTT Access Network Service Systems Laboratories - Japan*
Masayuki Shimoda | *NTT Access Network Service Systems Laboratories - Japan*

09:45 - 10:00

Th1E.4
Mask RSA: End-To-End Reinforcement Learning-based Routing and Spectrum Assignment in Elastic Optical Networks

We propose Mask RSA, an end-to-end deep reinforcement learning-based routing and spectrum assignment for elastic optical networks. Mask RSA masks unassignable choices, and decides routing and spectrum assignment concurrently for higher performance. Mask RSA outperforms KSP-FF under various traffic loads in small and large networks.

Takafumi Tanaka* | *Presenter | *NTT Access Network Service Systems Laboratories - Japan*
Masayuki Shimoda | *NTT Access Network Service Systems Laboratories - Japan*

ROOM F

OPTICAL ACCESS NETWORKS FOR 5G

09:30 - 09:45

Chair: Fabienne Saliou
SC9 –Access, Indoor, Short Reach for Data centers and Mobile Networks

Th1F.3
Live Network Demonstration of Point-to-Multipoint Coherent Transmission for 5G Mobile Transport over Existing Fiber Plant

We report on the live-network demonstration of coherent point-to-multipoint technology for mobile fronthaul applications with total transmission capacity up to 100~Gbps per radio unit and 400~Gbps per hub. We show significant network simplification enabled by coherent technology and Nyquist subcarriers.

Antonio Napoli* | *Presenter | *Infinera - UK*
Johan Bäck | *Infinera - Sweden*
Paul Choiseul | *American Tower - USA*
Andres Madero | *Infinera - USA*
German Garcia | *Infinera - USA*
Athul Mathur | *Infinera - USA*
João Pedro | *Infinera - USA*
Tobias Eriksson | *Infinera - Sweden*
Warren Sande | *Infinera - USA*
Aaron Chase | *Infinera - USA*
Fady Masoud | *Infinera - Canada*
David Welch | *Infinera – USA*
Fernando Guiomar | *Infinera - USA*

09:45 - 10:00

Th1F.4
eCPRI Radio Access Network Fronthaul Physical Reach Increase by using Hollow Core Fibr

We report how hollow core fibres low latency can be used to increase the physical distance on an eCPRI based Radio Access Network (RAN) fronthaul link. We show an increase out to 43km on a commercial open RAN system.

Neil Parkin | ***Presenter*** | *BT - UK*
Paul Wright | *BT - UK*
Richard Mackenzie | *BT - UK*
Md Asif Iqbal | *BT - UK*
Michael Brown | *Mavenir - USA*
David Hall | *Mavenir - USA*
Arsalan Saljoghei | *Lumenisity, Ltd - UK*
Seyed Reza Sandoghchi | *Lumenisity, Ltd – UK*
Radan Slavik | *University of Southampton - UK*
Marcelo Alonso | *Lumenisity, Ltd - UK*
Ian Lang | *Lumenisity, Ltd - UK*
Mike Fake | *Lumenisity, Ltd – UK*

10:00 - 10:15

Th1F.5
Guidelines for a cost optimised 5G WDM-based Fronthaul network

We evaluate the total cost of ownership of key 5G Centralised Radio Access Network Fronthaul architectures to provide a methodology for operators to select the most cost optimized transport architectures.

Lieven Levrau | ***Presenter*** | *Nokia - France*
Derrick Remedios | *Nokia - Canada*

10:15 - 10:30

Th1F.6
Experimental Evaluation of 5G vRAN Function Implementation in an Accelerated Edge Cloud

Disaggregated next generation eNodeB (gNB) largely benefits from offloading selected virtualized Distributed Unit (vDU) functions into a field programmable gate array (FPGA). Results show that the FPGA-based IFFT and Cyclic-prefix addition processing time is faster than dual-core high-end CPU on longer OFDM symbol size with lower power consumption

Justine Cris Borromeo | ***Presenter*** | *Scuola Superiore Sant'Anna, TeCIP Institute - Italy*
Koteswararao Kondepu | *Indian Institute of Technology Dharwad - India*
Nicola Andriolli | *Institute of Electronics, Information Engineering and Telecommunications, National Research Council - Italy*
Luca Valcarenghi | *Scuola Superiore Sant'Anna, TeCIP Institute - Italy*

ROOM G

CAPACITY, CODING, AND SHAPING IN FIBER-OPTIC COMMUNICATION

09:00 - 09:15

Chair: Alex Alvarado Eindhoven University of Technology - The Netherlands
SC6 - Theory of Optical Communications and Quantum Communications

Th1G.1
A sequence selection bound for the capacity of the nonlinear fiber channel

A novel technique to optimize the input distribution and compute a lower bound for the capacity of the nonlinear optical fiber channel is proposed. The technique improves previous bounds obtained with the additive white Gaussian noise decoding metric.

Stella Civelli | ***Presenter*** | *PNTLab, CNIT – Italy, Scuola Superiore Sant'Anna, TeCIP Institute – Italy*
Enrico Forestieri | *PNTLab, CNIT - Italy •Scuola Superiore Sant'Anna, TeCIP Institute - Italy*
Alexey Lotsmanov | *Huawei Moscow Research Center - The Russian Federation*
Dmitry Razdoburdin | *Huawei Moscow Research Center - The Russian Federation, Sternberg Astronomical Institute, Moscow M.V. Lomonosov State University - The Russian Federation*
Marco Secondini | *PNTLab, CNIT - Italy, Scuola Superiore Sant'Anna, TeCIP Institute – Italy*

09:15 - 09:30

Th1G.2
Extending White Gaussian Noise Capacity Estimation Method with Probabilistic Constellation Shaping

White Gaussian noise is used as a test signal in order to estimate transmission capacity. Based on the received noise signal, we design a probabilistically shaped constellation by mapping the received noise to constellation points and show a good agreement with theoretical capacity.

Menno van den Hout | ***Presenter*** | *Technology University of Eindhoven - The Netherlands*
Sjoerd van der Heide | *Technology University of Eindhoven - The Netherlands*
Ali Mefleh | *KPN - The Netherlands*
Chigo Okonkwo | *Technology University of Eindhoven - The Netherlands*

09:30 - 09:45

Th1G.3
Low-complexity Channel Polarized Multilevel Coding for Modulation-format-independent forward error correction

We propose a modulation-format-independent binary coding scheme that applies multilevel coding to channel polarized signals with different capacities. The simulation results show that the proposed method can reduce complexity with slight net coding gain degradation by applying SD-FEC only to non-reliable bits compared to BICM

Takeshi Kakizaki | ***Presenter*** | *NTT Network Innovation Laboratories - Japan*
Masanori Nakamura | *NTT Network Innovation Laboratories - Japan*
Fukutaro Hamaoka | *NTT Network Innovation Laboratories - Japan*
Yoshiaki Kisaka | *NTT Network Innovation Laboratories - Japan*

09:45 - 10:00

Th1G.4
On Kurtosis-limited Enumerative Sphere Shaping for Reach Increase in Single-span Systems

The effect of decreasing the kurtosis of channel inputs is investigated for the first time with an algorithmic shaping implementation. No significant gains in decoding performance are observed for multi-span systems, while an increase in reach is obtained for single-span transmission.

Yunus Can Gültekin | ***Presenter*** | *Technology University of Eindhoven - The Netherlands*
Alex Alvarado | *Technology University of Eindhoven - The Netherlands*
Olga Vassilieva | *Fujitsu Network Communications, Inc. - USA*
Inwoong Kim | *Fujitsu Network Communications, Inc. - USA*
Paparao Palacharla | *Fujitsu Network Communications, Inc. - USA*
Chigo Okonkwo | *Technology University of Eindhoven - The Netherlands*
Frans M.J. Willems | *Technology University of Eindhoven - The Netherlands*

Thursday 16 September

ROOM A

DESIGN AND OPTIMIZATION OF OPTICAL NETWORKS

10:00 - 10:15

Th1G.5
Dual Coding Concatenation for Burst-Error Correction in Probabilistic Amplitude Shaping

We investigate a dual coding concatenation in probabilistic amplitude shaping to mitigate post-shaping burst errors.

The joint use of pre-/post-shaping BCH codes can significantly relax bit error rate (BER) threshold after soft-decision code resulting in signal-to-noise ratio (SNR) gain of 0.1 dB.

Pavel Skvortcov* | *Presenter | *Aston University - UK, Mitsubishi Electric Research Laboratories - USA*
Toshiaki Koike-Akino | *Mitsubishi Electric Research Laboratories - USA*
David S. Millar | *Infinera Corp. - USA, Mitsubishi Electric Research Laboratories – USA*
Keisuke Kojima | *Mitsubishi Electric Research Laboratories - USA*
Kieran Parsons | *Mitsubishi Electric Research Laboratories – USA*

10:15 - 10:30

Th1G.6
Pump-Constrained Capacity Maximization: to Flatten or not to Flatten?

We show by simulation that, for power-efficient achievable information rate maximization,properly-operated links with gain-flattening filters (GFF) are superior to links without GFFs.

Alberto Bononi* | *Presenter | *Università di Parma, Dip. Ingegneria e Architettura, Parma - Italy*
Jean-Christophe Antona | *Alcatel Submarine Networks, Nozay - France*
Paolo Serena | *Università di Parma, Dip. Ingegneria e Architettura, Parma - Italy*
Junho Cho | *Nokia Bell Labs – USA*

11:00 - 11:15

Chair: Patricia Layec Nokia Bell Labs - France
SC8 – Core and metro networks

Th2A.1
Hubbedness: a Metric to Describe Traffic Flows in Optical Networks and an Analysis of its Impact on Efficiency of Point-to-Multipoint Coherent Transceiver Architectures

We propose a new metric called hubbedness to describe traffic flow in modern optical networks. We compare theoretical savings of point-to-multipoint vs point-to-point transceivers and find significant savings for a wide variety of traffic patterns when optical transceivers of sufficiently high data rates are available.

Johan Bäck* | *Presenter | *Infinera - Sweden*
João Pedro | *Infinera - Portugal*
Tobias Schaich | *University of Cambridge - UK*
Antonio Napoli | *Infinera - UK*
Paul Wright | *BT - UK*
Aaron Chase | *Infinera - USA*
Fernando Guiomar | *Infinera - USA*
Andrew Lord | *BT - UK*

11:15 - 11:30

Th2A.2
Optimized Deployment of S-band and Raman Amplification to Cost-Effectively Upgrade Wideband Optical Networks

The combined use of S-band and Raman amplification to cost-effectively increase the capacity of C+L-band transmission system is assessed. We show that Raman amplification improves and flattens the optical performance in the three bands, potentially reducing the complexity of routing and wavelength assignment algorithms.

Andre Souza* | *Presenter | *INFINERA UNIPESSOAL LDA - Portugal, Instituto Superior Técnico - Portugal*
Nelson Costa | *INFINERA UNIPESSOAL LDA - Portugal*
João Pedro | *INFINERA UNIPESSOAL LDA - Portugal, Instituto de Telecomunicações, Instituto Superior Técnico - Portugal*
João Pires | *Instituto de Telecomunicações, Instituto Superior Técnico - Portugal*

11:30 - 11:45

Th2A.3
Connectivity Challenges in E, S, C and L Optical Multi-Band Systems

Connectivity in Multi-Band networks depends on the attainable optical performance for a number of system-level parameters like number of channels, modulation format and symbol rate. We present three connectivity schemes engaging E, S, C and L bands. Exploiting a rigorous OSNIR optimisation method we tabulate their optical reach and the corresponding performance trade-offs.

Alexandros Stavdas* | *Presenter | *OpenLightComm Ltd - UK*
Dimitris Uzunidis | *OpenLightComm Ltd - UK*
Chris Matrakidis | *OpenLightComm Ltd - UK*
Evangelos Kosmatos | *OpenLightComm Ltd - UK*
Periklis Petropoulos | *University of Southampton - UK*
Andrew Lord | *British Telecommunications – UK*

11:45 - 12:00

Th2A.4
A Pareto Optimality Based Multi-Objective Optimisation Approach to Assist Optical Network (Re-)Design Choices

This paper presents a Pareto optimality based multi-objective optimisation approach to optimise optical network parameters considering multiple performance metrics simultaneously. Resultant Pareto-optimal solutions provide a set of options for practitioners to assist network (re-) design choices considering multiple (conflicting) performance goals.

Sam Nallaperuma* | *Presenter | *University of Cambridge - UK*
Nikita A. Shevchenko* | *Presenter | *University of Cambridge - UK*
Seb J. Savory | *University of Cambridge - UK*

ROOM B

PHOTONIC ASSISTED THZ WIRELESS COMMUNICATION

11:30 - 11:45

Chair: Leif Katsuo Oxenløwe Technical University of Denmark - Denmark
SC7 - Photonics for RF and Free Space Optics applications

Th2B.3 HIGHLY SCORED
Experimental Demonstration of Free-Space sub-THz Communications Link Using Multiplexing of Beams Having Two Different LG Modal Indices

We experimentally demonstrate a free-space sub-THz communication link using multiplexing of beams carrying two different LG modal indices. Multiplexed LG2,0 and LG1,1 beams each carrying a 1-Gbaud QPSK data channel at 300 GHz carrier frequency are transmitted over 40 cm link distance.

Amir Minoofar* | *Presenter | *University of Southern California - USA*
Xinzhou Su | *University of Southern California - USA*
Huibin Zhou | *University of Southern California - USA*
Fatemeh Alishahi | *University of Southern California - USA*
Kai Pang | *University of Southern California - USA*
Kaiheng Zou | *University of Southern California - USA*
Runzhou Zhang | *University of Southern California - USA*
Schlomo Zach | *School of Electrical Engineering, Tel Aviv University - Israel*
Moshe Tur | *School of Electrical Engineering, Tel Aviv University - Israel*
Andreas Molisch | *University of Southern California - USA*
Hirofumi Sasaki | *NTT Network Innovation Laboratories, NTT Corporation - Japan*
Doohwan Lee | *NTT Network Innovation Laboratories, NTT Corporation - Japan*
Alan Willner | *University of Southern California - USA*

11:45 - 12:00

Th2B.4
Integrated Terahertz High-Speed Data Communication and High-Resolution Radar Sensing System Based-on Photonics

We propose and demonstrate a new architecture that integrates terahertz high-speed data communications and high-resolution radar sensing systems. Based on THz photonics for the first time, we realize THz communication data transmission at THz band, while achieving two target detections.

Yanyi Wang* | *Presenter | *Fudan University, Shanghai - China*
Feng Zhao | *Xi'an University of Posts and Telecommunications - China*
Kaihui Wang | *Fudan University, Shanghai - China*
Jiao Zhang | *Purple Mountain Laboratories, Nanjing, Jiangsu - China*
Mingzheng Lei | *Purple Mountain Laboratories, Nanjing, Jiangsu - China*
Min Zhu | *Purple Mountain Laboratories, Nanjing, Jiangsu - China*
Cuiwei Liu | *Fudan University, Shanghai - China*
Li Zhao | *Fudan University, Shanghai - China*
Junjie Ding | *Fudan University, Shanghai - China*
Wen Zhou | *Fudan University, Shanghai - China*
Jianjun Yu | *Fudan University, Shanghai - China*

ROOM C1

ADVANCED TRANSCEIVER TECHNOLOGIES

11:00 - 11:30

Chair: Gabriel Charlet Huawei Technologies - France
SC5 - Optical Transmission systems

Th2C1.1 EXTENDED
Single-Carrier Coherent 930G, 1.28T and 1.60T Field Trial

We report, single-carrier net bitrate transmissions of 930-Gb/s over 1105 km, 1.28-Tb/s over 452.4 km, and 1.60-Tb/s over 153.4-km links, which are part of the R&D field test network of the German operator Deutsche Telekom.

Fabio Pittalà* | *Presenter | *Huawei Technologies Duesseldorf – Germany*
Ralf-Peter Braun | *Deutsche Telekom - Germany*
Georg Böcherer | *Huawei Technologies Duesseldorf - Germany*
Patrick Schulte | *Huawei Technologies Duesseldorf - Germany*
Maximilian Schaedler | *Huawei Technologies Duesseldorf - Germany*
Stefano Bettelli | *Huawei Technologies Duesseldorf - Germany*
Stefano Calabrò | *Huawei Technologies Duesseldorf – Germany*
Maxim Kuschnerov | *Huawei Technologies Duesseldorf - Germany*
Changsong Xie | *Huawei Technologies Duesseldorf – Germany*
Andreas Gladisch | *Deutsche Telekom - Germany*
Fritz-Joachim Westphal | *Deutsche Telekom - Germany*
Chen Rongfu | *Huawei Technologies Duetschland GmbH - Germany*
Qibing Wang | *Huawei Technologies Co. Ltd. - China*
Bofang Zheng | *Huawei Technologies Co. Ltd. - China*

11:30 - 11:45

Th2C1.3
Experimental Demonstration of 8-Dimensional Voronoi Constellations with 65,536 and 16,777,216 Symbols

We experimentally demonstrate high-cardinality, low-complexity Voronoi constellations based on the E8 lattice over multiple time slots with OSNR and launch power gains of up to 1.7 and 2.4 dB for back-to-back and 80 km fiber transmission, respectively, compared to QAM formats.

Ali Mirani* | *Presenter |*Chalmers University of Technology - Sweden*
Kovendhan Vijayan | *Chalmers University of Technology - Sweden*
Zonglong He | *Chalmers University of Technology – Sweden*
Shen Li | *Chalmers University of Technology – Sweden*
Erik Agrell | *Chalmers University of Technology - Sweden*
Jochen Schröder | *Chalmers University of Technology - Sweden*
Peter Andrekson | *Chalmers University of Technology - Sweden*
Magnus Karlsson | *Chalmers University of Technology - Sweden*

11:45 - 12:00

Th2C1.4
645-Gbit/s/carrier PS-16QAM WDM Coherent Transmission over 6,800 km Using Modified LSTM Nonlinear Equalizer

We experimentally demonstrated a 645-Gbit/s/carrier WDM coherent transmission over 6,800-km based on 106-GBd PS-16QAM by utilizing modified PS-suitable LSTM-NLE. Our results show that 55% reach improvement is obtained by LSTM-NLE. We also compared performance and computational complexity of LSTM-NLE, Bi-LSTM-NLE and VNLE.

Miao Kong* | *Presenter | *Fudan University, Shanghai - China*
Bohan Sang | *Fudan University, Shanghai - China*
Chen Wang | *Fudan University, Shanghai - China*
Bo Liu | *Beijing University of Posts and Telecommunications - China*
Xiangjun Xin | *Beijing University of Posts and Telecommunications - China*
Wen Zhou | *Fudan University, Shanghai - China*
Bing Ye | *ZTE Corp. - China*
Jianjun Yu | *Fudan University, Shanghai – China*

12:00 - 12:15

Th2C1.5
PCS-16QAM vs QPSK: What is the best choice for Next-Generation Long-Haul 400G?

We experimentally compare PCS-16QAM and QPSK for 400G transmission at 128Gbaud. A realistic, full system implementation that accounts for penalties from the FEC, distribution matcher, transceiver impairments, fiber nonlinearity, and DSP, reveals that the theoretical 0.8dB gain of PCS-16QAM is reduced to only 0.1dB.

Abel Lorences-Riesgo* | *Presenter | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Djalal Bendimerad | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Khoa Le-Trung | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Ivan Fernandez De Jauregui Ruiz | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Yu Zhao | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Marti Sales-Llopis | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Sarah Kamel | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Kechao Huang | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Celestino S. Martins | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Dylan Le Gac | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Sami Mumtaz | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Stefanos Dris | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Yann Frignac | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab - France*
Gabriel Charlet | *Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab – France*

12:15 - 12:30

Th2C1.6
Experimental Analysis of Mismatched Soft-Demapping for Probabilistic Shaping in Short-Reach Nonlinear Transmission

The impact of dimensionality of soft-demappers is investigated for probabilistic shaping in systems with short-memory correlated nonlinearities.

Simple instantaneous nonlinearity compensation is proposed, significantly improving the performance of a low-complexity 1D demapper.

Pavel Skvortcov* | *Presenter | *Aston University - UK*
David S. Millar | *Infinera Corp. - USA, Mitsubishi Electric Research Laboratories - USA*
Ian Phillips | *Aston University - UK*
Wladek Forysiak | *Aston University - UK*
Toshiaki Koike-Akino | *Mitsubishi Electric Research Laboratories - USA*
Keisuke Kojima | *Mitsubishi Electric Research Laboratories - USA*
Kieran Parsons | *Mitsubishi Electric Research Laboratories – USA*

ROOM C2

MACHINE LEARNING FOR OPTICAL NETWOKS

11:00 - 11:15

Chair: Florian Frank Orange Labs - France
SC8 - Core and metro networks

Th2C2.1
Enhancing Closed-Form Based Physical Layer Performance Estimations in EONs Via Machine Learning Techniques

We show that the combination of machine learning methods and analytical expressions can enhance the OSNIR estimation of an optical link of up to 2 dB compared with the use of an analytical expression alone. For this purpose, we exploit seven machine learning algorithms and we examine their OSNIR improvement for 3,000 different operational cases.

Alexandros Stavdas* | *Presenter | *OpenLightComm Ltd - UK*
Dimitris Uzunidis | *OpenLightComm Ltd – UK, University of West Attica – Greece*
Panagiotis Kasnesis | *University of West Attica - Greece*
Charalampos Patrikakis | *University of West Attica - Greece*
Andrew Lord | *British Telecommunications – UK*

11:15 - 11:30

Th2C2.2
Secure Multi-Party Computation and Statistics Sharing for ML Model Training in Multi-domain Multi-vendor Networks

We propose a secure aggregation algorithm that allows proprietary-owned domains, hosting statistically different datasets, train and operate ML models in a Horizontally Federated Learning fashion. The obtained results show a compelling test accuracy of 98.60% for a QoT estimation use-case in multi-domain multi-vendor networks

Pooyan Safari* | *Presenter | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Behnam Shariati | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Geronimo Bergk | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute - Germany*
Johannes K. Fischer | *Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute – Germany*

11:30 - 11:45

Th2C2.3
Field Trial of Failure Localization in a Backbone Optical Network

We propose a robust and easy-to-deploy failure localization method trialed on a backbone network carrying live traffic to generate strategic network health insights, notably regarding Q-drops.

Camille Delezoide* | *Presenter | *Nokia Bell Labs – France*
Petros Ramantanis | *Nokia Bell Labs - France*
Lluis Gifre Renom | *Nokia Bell Labs - France*
Fabien Boitier | *Nokia Bell Labs - France*
Patricia Layec | *Nokia Bell Labs - France*

ROOM D

DETECTOR

11:30 - 11:45

Chair: Jean Teissier II-VI Laser Enterprise - Switzerlande
SC2 - Optoelectronic devices and technologies

Th2D.3
Ultra Compact High responsivity Photodiodes for >100 Gbaud Applications

We demonstrated ultra-compact waveguide UTC photodiode with bandwidth efficiency product of 37 GHz on 50Ω load and above 55 GHz on 25Ω load, which allows to reach a bandwidth above 110 GHz with 0.6 A/W responsivity.

Christophe caillaud* | *Presenter | *III-V lab, a joint lab between Nokia Bell Labs France, Thales research and technology and CEA Leti - France*
Herve Bertin | *Presenter* | *III-V lab, a joint lab between Nokia Bell Labs France, Thales research and technology and CEA Leti - France*
Antoine Bobin | *III-V lab, a joint lab between Nokia Bell Labs France, Thales research and technology and CEA Leti - France*
Risab Gnanamani | *III-V lab, a joint lab between Nokia Bell Labs France, Thales research and technology and CEA Leti - France, IMS laboratory, University of Bordeaux, CNRS UMR 5218 - France*
Nicolas Vaissiere | *III-V lab, a joint lab between Nokia Bell Labs France, Thales research and technology and CEA Leti - France*
Frederic Pommereau | *III-V lab, a joint lab between Nokia Bell Labs France, Thales research and technology and CEA Leti - France*
Jean Decobert | *III-V lab, a joint lab between Nokia Bell Labs France, Thales research and technology and CEA Leti - France*
Cristell Maneux | *IMS laboratory, University of Bordeaux, CNRS UMR 5218 – France*

11:45 - 12:00

Th2D.4
Ultra-Low Noise Balanced Receiver with >20 dB Quantum-to-Classical Noise Clearance at 1 GHz

We demonstrate a die-level balanced homodyne receiver for coherent optical access and continuous-variable quantum applications, featuring a 40dB CMRR up to 1GHz and a high quantum-to-classical noise ratio of 26.8dB at 12.3mW of LO power. 500Mb/s QPSK transmission was accomplished with a sensitivity of -55.8dBm.

Dinka Milovančev* | *Presenter | *AIT Austrian Institute of Technology - Austria*
Florian Honz | *Presenter* | *AIT Austrian Institute of Technology - Austria*
Nemanja Vokić | *AIT Austrian Institute of Technology - Austria*
Fabian Laudenbach | *AIT Austrian Institute of Technology - Austria*
Hannes Hübel | *AIT Austrian Institute of Technology - Austria*
Bernhard Schrenk | *AIT Austrian Institute of Technology – Austria*

ROOM E

DATA CENTER NETWORKING

11:00 - 11:15

Chair: Reza Nejabati
SC10 - Architecture, Control and Management of optical networks

Th2E.1 HIGHLY SCORED
Experimental assessment of traffic prediction assisted data center network reconfiguration method

We experimentally demonstrate a traffic prediction assisted network reconfiguration method (TPANR) for data center networks based on deep reinforcement learning (DRL). Traffic prediction model performs the lowest MSE of 2.64E-4. Exploiting one-step ahead traffic prediction and DRL-based automatic network reconfiguration, TPANR achieves 17.3% latency improvement.

Xiaotao Guo* | *Presenter | *Technology University of Eindhoven - The Netherlands*
Xuwei Xue | *Technology University of Eindhoven The Netherlands*
Fulong Yan | *Technology University of Eindhoven The Netherlands*
Bitao Pan | *Technology University of Eindhoven The Netherlands*
Georgios Exarchakos | *Technology University of Eindhoven - The Netherlands*
Nicola Calabretta | *Technology University of Eindhoven - The Netherlands*

Thursday 16 September

11:15 - 11:30

Th2E.2
Integration and Control of Heterogeneous Telecom and Data Center Optical Networks Aided by FBD and TAPI for Enhancing Large-scale Optical Path Services and Network Resiliency

A common approach to facilitate the integration/control of disaggregate/legacy optical networks is developed with the aid of a functional block-based disaggregation (FBD) model and TAPI. Integration/control of heterogeneous Telecom and Data Center optical network resources, models, and APIs are demonstrated with a disaster recovery scenario.

Sugang Xu* | *Presenter | *National Institute of Information and Communications Technology - Japan*
Kiyo Ishii | *National Institute of Advanced Industrial Science and Technology (AIST) - Japan*
Noboru Yoshikane | *KDDI Research Inc. - Japan*
Takehiro Tsuritani | *KDDI Research Inc. - Japan*
Yoshinari Awaji | *National Institute of Information and Communications Technology - Japan*
Shu Namiki | *National Institute of Advanced Industrial Science and Technology (AIST) – Japan*

11:30 - 11:45

Th2E.3
Experimental Demonstration of SDN-enabled Reconfigurable Disaggregated Data Center Infrastructure

A 4-node prototype of SDN-controlled disaggregated data-center network is experimentally demonstrated based on the nanoseconds optical switch, enabling flexible hardware resource provisioning and dynamic resource reallocation. Experimental results show that, based on monitoring statistics, real-time reconfiguration reduces the memory node access latency by 21%.

Xiaotao Guo* | *Presenter | *Technology University of Eindhoven - The Netherlands*
Fernando Agraz | *Universitat Politecnica de Catalunya - Spain*
Xuwei Xue | *Technology University of Eindhoven The Netherlands*
Bitao Pan | *Technology University of Eindhoven The Netherlands*
Albert Pagès | *Universitat Politècnica de Catalonia - Spain*
Shaojuan Zhang | *Technology University of Eindhoven - The Netherlands*
Georgios Exarchakos | *Technology University of Eindhoven - The Netherlands*
Salvatore Spadaro | *Universitat Politècnica de Catalonia - Spain*
Nicola Calabretta | *Technology University of Eindhoven - The Netherlands*

11:45 - 12:00

Th2E.4
Introducing Best-in-Class Service Level Agreement for Time-Sensitive Edge Computing

To provide edge computing with pre-negotiated, guaranteed time budget, we propose an original joint optimization of compute and network resource allocations. For 20% time-sensitive applications, we show that we could guarantee 200-times smaller service latencies while reducing DC utilization efficiency by no more than 30%.

Subhadeep Sahoo* | *Presenter | *University of California, Davis - USA*
Sébastien Bigo | *Nokia Bell Labs - France*
Nihel Benzaoui | *Nokia Bell Labs - France*

12:00 - 12:15

Th2E.5
Dynamic Buffer Status Based Conflict Free Scheduling for a Fast Optical Switching Network

We propose a dynamic buffer status matrix decomposition (BSMD) based conflict free scheduling for a fast optical switching network. The performance of BSMD outperforms both static and retransmission scheduling mechanisms, and BSMD achieves 10.1 μs latency and 98.8% throughput at load of 0.8.

Fulongw | *Alibaba Cloud, Alibaba Group - China*
Chongjin Xie | *Alibaba Cloud, Alibaba Group - USA*
Nicola Calabretta | *Technology University of Eindhoven - The Netherlands*

ROOM F

TOWARDS 6G OPTICAL NETWORKS

11:30 - 11:45

Chair: Paulo P. Monteiro University of Aveiro - Portugal
SC9 - Access, Indoor, Short Reach for Data centers and Mobile Networks

Th2F.3
A Converged Fixed-Wireless TDMA-based Infrastructure Exploiting QoS-Aware End-to-End Slicing
We report a converged fixed wireless testbed spanning Metro-Access, built with no dedicated or mobile technology. An overarching intelligent orchestrator is implemented to tailor, in real-time, the fixed-line end-to-end QoS-aware bandwidth slices to the wireless system, taking into account the status of the entire network.

Alexandros Stavdas* | *Presenter | *OpenLightComm Ltd - UK*
Chris Matrakidis* | *OpenLightComm Ltd - UK
Evangelos Kosmatos | *OpenLightComm Ltd - UK*
Paraskevas Kostopoulos | *University of Peloponnese – Greece*
Dimitris Uzunidis | *OpenLightComm Ltd - UK*
Sebastian Horlitz | *Nokia Bell Labs - Germany*
Thomas Pfeiffer | *Nokia Bell Labs - Germany*
Andrew Lord | *British Telecommunications – UK*

11:45 - 12:00

Th2F.4
Experimental Demonstration of Delta-sigma Modulation Supported 65536-QAM OFDM Transmission for Fronthaul/WiFi Applications

We demonstrate the digitization and transmission of 65536-QAM OFDM signals over 20-km fiber via 10-Gbaud PAM-4 IM-DD channel. SNR of 57.7dB is achieved for baseband signals with standard PAM-4 and the proposed SNR-improved delta-sigma digitization.

Linsheng Zhong* | *Presenter | *Huazhong University of Science and Technology - China*
Yang Zou* | *Huazhong University of Science and Technology - China
Shenmao Zhang | *Huazhong University of Science and Technology - China*
Xiaoxiao Dai | *Huazhong University of Science and Technology - China*
Jing Zhang | *University of Electronic Science and Technology of China - China*
Mengfan Cheng | *Huazhong University of Science and Technology - China*
Lei Deng | *Huazhong University of Science and Technology - China*
Qi Yang | *Huazhong University of Science and Technology - China*
Deming Liu | *Huazhong University of Science and Technology – China*

12:00 - 12:15

Th2F.5
A Centralized and Reconfigurable 4x2.5Gb/s Fiber-Wireless mmWave Fronthaul for Network Sharing Applications

A centralized, reconfigurable Fiber-Wireless fronthaul selectively allocating 4λ-WDM channels of 2.5 Gb/s 16-QAM IFoF to four 60 GHz Phased Array Antennas through an all-passive AWGR is experimentally presented for the first time towards multi-operator/ tenant 5G C-RAN architectures that interconnect any edge-unit interface to any cell-site.

Ronis Maximidis* | *Presenter | *Department of Informatics, Center for Interdisciplinary Research & Innovation, Aristotle University - Greece*
Christos Vagionas | *Department of Informatics, Center for Interdisciplinary Research & Innovation, Aristotle University - Greece*
Eugenio Ruggeri | *Department of Informatics, Center for Interdisciplinary Research & Innovation, Aristotle University - Greece*
George Kalfas | *Department of Informatics, Center for Interdisciplinary Research & Innovation, Aristotle University - Greece*
Yigal Leiba | *Siklu Communication Ltd., Petach Tikva, 49517 - Israel* | *Amalia Miliou* | *Department of Informatics, Center for Interdisciplinary Research & Innovation, Aristotle University – Greece*
Amalia Miliou | *Department of Informatics, Center for Interdisciplinary Research & Innovation, Aristotle University - Greece*
Nikos Pleros | *Department of Informatics, Center for Interdisciplinary Research & Innovation, Aristotle University – Greece*

12:15 - 12:30

Th2F.6
In-Line Protocol-Independent Control and Management Method in End-to-End Optical Connections via Photonic Gateway

We propose and experimentally demonstrate novel in-line control and management scheme for in-service end-to-end user connections with any signal protocol in the All-Photonics Network. AMCC signals based on subcarrier allocation yield remote control of user terminals without any optical/electrical conversion with link budget of 47.5-dB.

Takuya Kanai* | *Presenter | *NTT Access Network Service Systems Laboratories - Japan*
Shin Kaneko* | *NTT Access Network Service Systems Laboratories - Japan
Kazutaka Hara | *NTT Access Network Service Systems Laboratories - Japan*
Jun-ichi Kani | *NTT Access Network Service Systems Laboratories - Japan*
Tomoaki Yoshida | *NTT Access Network Service Systems Laboratories - Japan*

ROOM G

QUANTUM COMMUNICATION AND QUANTUM-KEY DISTRIBUTION IN OPTICAL FIBERS

11:30 - 11:45

Chair: Helmut Grießer ADVA Optical Networking SE - Germany
SC6 - Theory of Optical Communications and Quantum Communications

Th2G.3 HIGHLY SCORED
High-Rate Continuous Variable Quantum Key Distribution Based on Probabilistically Shaped 64 and 256-QAM

We designed a CV-QKD system with off-the-shelf components and established the feasibility of distributing 67.6 and 66.8 Mb/s secret key rates on average over a 9.5 km SMF link, using respectively probabilistically shaped 64 and 256 QAM, and relying on a novel analytical security proof.

Francois Roumestan* | *Presenter | *Nokia Bell Labs - France*
Amirhossein Ghazisaeidi | *Nokia Bell Labs - France*
Jeremie Renaudier | *Nokia Bell Labs - France*
Luis Trigo Vidarte | *Sorbonne Université, CNRS, LIP6 - France*
Eleni Diamanti | *Sorbonne Université, CNRS, LIP6 - France*
Philippe Grangier | *Université Paris-Saclay, IOGS, CNRS, Laboratoire Charles Fabry - France*

11:45 - 12:00

Th2G.4
1.6 Tbps Classical Channel Coexistence With DV-QKD OverHollow Core Nested Antiresonant Nodeless Fibre (HC-NANF)

We demonstrate for the first time the coexistence of a quantum-channel and 8×200 Gpbs 16-QAM optical channels with launching powers as high as -9dBm/channel in a 2 km HC-NANF. Comparative analysis with single-mode fibre reveals that the quantum-channel could not be sustained at such power-levels

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Reza Nejabati | *High performance networking group / University of Bristol - UK*
Dimitra Simeonidou | *High performance networking group / University of Bristol - UK*

Demos

Demos

DEMO SESSION 1

Tuesday 14 September
11:00 - 11:30

ROOM F

Tu2F-Demo.1
Demonstration of a Disaggregated ROADM Network with Automatic Channel Provisioning and Link Power Adjustment

We design and implement a disaggregated ROADM network by treating an optical multiplex section as a basic building block. Both automatic channel provisioning and end-to-end link power adjustment are demonstrated in such network.

Organizers:

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DEMO SESSION 1

Tuesday 14 September
11:30 - 12:00

ROOM F

Tu2F-Demo.3
Hierarchical Control of SONiC-based Packet-Optical Nodes encompassing Coherent Pluggable Modules

A hierarchical structure of SDN controllers is demonstrated to enable the configuration of hybrid packet-optical nodes. The proposed workflow leverages on extension of the T-API interfaces and ONOS controller to coordinate the configuration steps required by the packet and the optical controllers..

Organizers:

Davide Scano | Presenter
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Alessio Giorgetti | Presenter
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DEMO SESSION 1

Tuesday 14 September 12:00 - 12:30

ROOM F

Tu2F-Demo.5
Chatty ROADMs: Streaming Telemetry with Open Source Software and Open Hardware

An interactive demo presents live, real-time optical performance monitoring of the optical spectrum from an Open Optical Line System. Built with open source software, open hardware, and using standard YANG tooling, we achieve a sub-GHz resolution and a sub-second refresh rate over the C-band.

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Martin Šlapák
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Jaroslav Jedlinský
CESNET - The Czech Republic

Josef Vojtech
CESNET - The Czech Republic

DEMO SESSION 2

Tuesday 14 September 14:00 - 14:30

ROOM F

Tu3F-Demo.1 INVITED DEMO
Vertical Integration of Quantum Key Distribution – Virtual tour of the European OPENQKD networt

The OPENQKD project is the largest QKD deployment activity in Europe. The demonstration at ECOC 2021 will consist of a live virtual tour to operational QKD testbeds. Visitors can toggle between the OPENQKD testbeds and have key performance parameters displayed in real time.

Organizers:

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Vicente Martin
Universidad Politécnica de Madrid - Spain

DEMO SESSION 2

Tuesday 14 September 14:30 - 15:00

ROOM F

Tu3F-Demo.3 INVITED DEMO
Demonstration of Cloud-Based Streaming Telemetry Processing for Optical Network Monitoring

We present a demonstration of the processing of streaming telemetry data from an optical network and machine-learning based video analytics on a cloud-based stream-processing platform. Real-time processing enhances network security and reliability by combining information from diverse

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