PROGRAMME

ECOC2024 FRANKFURT

50th Anniversary

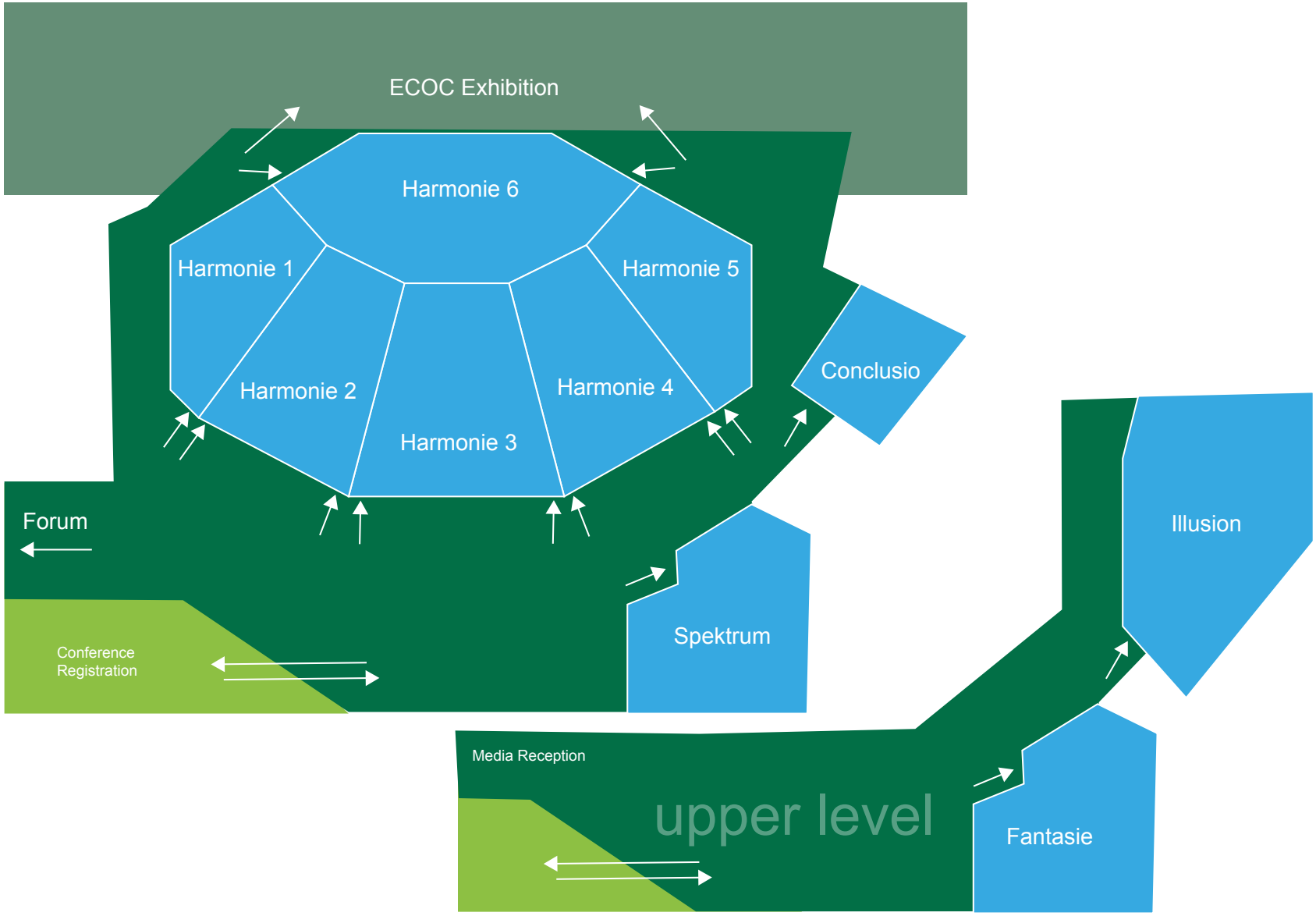
50th European Conference on Optical Communication

22.—26. September 2024
Congress Center Messe · Frankfurt, Germany

www.ecoc2024.org

VDE ITG

Conference Floorplan



Content

Programme Overview

Sunday 22.09.2024

	Harmonie 1	Harmonie 2	Harmonie 3	Harmonie 4	Harmonie 5	Harmonie 6	Spektrum
09:00	**WS1:** Has the Time Come for Quantum-Secure Optical Networks?	**WS2:** Massively Parallel Optical Transceivers and Interfaces – Where Are we on This Path?	**WS3:** What Is the Best Wavelength for Free-Space Optical (FSO) Communication?	**WS4:** When Could Multi-Band Systems Become More Cost-Effective Than Parallel C-Band Systems?	**WS5:** What Can Digital Twins Fueled With Generative AI Offer to Optical Networks?	**WS6:** 6G in Buildings: Head Against the Wall?	**WS7:** Overhyped or the Real Deal: Which Photonics Integration Platform Will Lead the Way?
10:30	Coffee Break (Conference Center)						
11:00	**WS1:** continued	**WS2:** continued	**WS3:** continued	**WS4:** continued	**WS5:** continued	**WS6:** continued	**WS7:** continued
12:30	Lunch Break (on your own)						
14:00	**WS8:** Is QKD Technology Ready to Become a Standard for Secure Communications?	**WS9:** Intra-Datacenter Connectivity: Bottlenecks & Trends for AI Clusters	**WS10:** Is There a Gold Standard Fiber Optic Sensing Technology to Monitor the Environment Around Us?	**WS11:** Beyond 50G-PON – Can We Still Use IMDD?	**WS12:** How Will AI Affect Future Transmission Systems?	**WS13:** Emerging From Under the Sea – Where Will SDM Land?	**WS14:** Mobile Optics for 6G and Open Cloud RAN: New Concepts or More of the Same?
15:30	Coffee Break (Conference Center)						
16:00	**WS8:** continued	**WS9:** continued	**WS10:** continued	**WS11:** continued	**WS12:** continued	**WS13:** continued	**WS14:** continued
17:30 20:00	Get-Together Reception (Conference Center)						

Monday 23.09.2024

	Harmonie 1	Harmonie 2	Harmonie 3	Harmonie 4	Harmonie 5	Harmonie 6	Spektrum	Illusion/Fantasie
09:00	Morning Coffee (Forum)							
09:30	ECOC 2024 Opening & Plenary Session (Forum)							
12:00	Lunch Break (on your own)							
14:00	**M2A:** Novel Short-Reach & Access Systems	**M2B:** Multiband Transmission I	**M2C:** Low-Power Consumption DSP	**M2D:** Optical Fibers: From Nanoparticles to Hollow Cores	**M2E:** Digital Twins	**M2F:** MWP Components	**M2G:** Integrated Passive Devices and Switches	Green ICT Symposium (Illusion)
15:30	Coffee Break (Exhibition)							
16:00 17:30	**M3A:** QKD Systems	**M3B:** Multiband Transmission II	**M3C:** Ultrafast Terrestrial FSO	**M3D:** Coherent PON – I	**M3E:** Longitudinal Power Profile Monitoring	**M3F:** Sensing and Microwave Photonics	**M3G:** Photonic Circuits for Integrated Neural Signal Processing	
17:45 19:15	Symposium 50 Years of ECOC (Illusion + Fantasie)							
19:30 23:00	50 Years of ECOC Celebration (Forum)							

	Harmonie 1	Harmonie 2	Harmonie 3	Harmonie 4	Harmonie 5	Harmonie 6	Spektrum	Illusion/Fantasie
	Tuesday 24. 09. 2024							
09:00	**Tu1A:** Doped Fiber Amplifiers Improved Designs, Multimode and Multicore	**Tu1B:** Advances in Network Control and Management	**Tu1C:** Novel Opportunities for Integrated Photonics & Trans-ceivers	**Tu1D:** Intra-Data Center Systems	**Tu1E:** LiFi for Indoor and Underwater Communications	**Tu1F:** THz Processing and Coding	**Tu1G:** Novel Modulators	10th International Symposium for Optical Interconnects in Data Centres (Illusion)
10:30	Coffee Break (Exhibition)							
11:00	Demo Session (Hall 5)	Exhibition Only Time						
12:30								
13:30	**Tu3A:** Photonic Devices for Quantum Communication	**Tu3B:** Space-Division Multiplexing I	**Tu3C:** Novel Optical and Digital Signal Processing Techniques	**Tu3D:** Coherent PON – II	**Tu3E:** Performance Monitoring Techniques	**Tu3F:** Wireless THz Comms	**Tu3G:** Heterogeneous Laser Integration	
15:00	Coffee Break (Exhibition)							
15:30	**Tu4A:** Few Mode Fibers and Characterization Techniques	**Tu4B:** High-Speed Transmission	**Tu4C:** FSO for Satellite Commu-nications	**Tu4D:** 6G and Network Convergence	**Tu4E:** Optical Network Resilience	**Tu4F:** Advanced Radio-Over-Fiber & Fronthaul Systems	**Tu4G:** Progress of Silicon Pho-tonic and Plasmonic Technology	
17:00								
17:15								Rump Session (Illus.)
18:45								
	Wednesday 25. 09. 2024							
09:00	**W1A:** QKD Security	**W1B:** Fiber Capacity and Transmission	**W1C:** Spatial Division Multiplexing	**W1D:** Challenges for Terrestrial FSO	**W1E:** Architecture from Submarine to Metro/Access Networks	**W1F:** Integrated Sensing and Comms	**W1G:** Integrated Devices for Future High-Capaciity Networks	
10:30	Coffee Break (Exhibition)							
11:00	**W2A:** Poster Session (Hall 6)							
12:30	Lunch Break (on your own)							Women in Photonics (Illusion)
14:00	**W3A:** Fibers for Nonlinearity and Amplification	**W3B:** Space-Division Multiplexing II and Modeling	**W3C:** Devices & Applications of Optical Frequency Tuning	**W3D:** Ultra-Highspeed PON	**W3E:** Network Automation	**W3F:** Integrated Sensing and Comms	**W3G:** Integrated Light Sources	Satellite Symposium (Fantasie)
15:30	Coffee Break (Exhibition)							
16:00	**W4A:** QKD Networks	**W4B:** Machine Learning in Optical Networks	**W4C:** Equalisation and Perfor-mance Monitoring for High Rate Transmissions	**W4D:** 50G PON	**W4E:** Network Programmability	**W4F:** Remote Sensing	**W4G:** Integrated Receivers	
17:30								
18:00						EPIF – 15th European Photonic Integration Forum	Photonics in Germany	Hack Your Research! (Illusion)
19:00	Conference Dinner (Palmengarten)							
20:00								
23:00								
	Thursday 26. 09. 2024							
09:00	**Th1A:** Advances in Hollow Core Fibers Beyond low Loss	**Th1B:** Hollow-Core Fiber and SOA	**Th1C:** Phase-Retrieval, Self-Coherent, and Direct-Detect	**Th1D:** Metro-Access, Fronthaul & 6G	**Th1E:** Network Architectures and Resource Allocation	**Th1F:** Remote Sensing	**Th1G:** Devices for High-Speed Transmission	Optical Networking Symposium (Fantasie)
10:30	Coffee Break (Conference Center)							
11:00	**Th2A:** QKD Field Trials	**Th2B:** Submarine and Long-Haul	**Th2C:** VCSEL Arrays & Optical Multiport Packaging	**Th2D:** Atmospheric Turbulence Mitigation for FSO	**Th2E:** Optical Node Architectures		**Th2G:** Resonator-Based Modulators	
12:30	Lunch Break (on your own)							
14:00	Post Deadline Sessions							
15:30								
15:45	Closing Session (Harmonie 5)							
16:30								

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Welcome to the 50th European Conference on Optical Communication – **ECOC 2024 in Frankfurt, Germany!**

ECOC is one of the world's two largest and Europe's most prestigious conference in the field of optical communications, bringing together scientists, engineers and business leaders from across the globe. It's more than just a conference – it's a unique platform to share knowledge, exchange groundbreaking ideas, spark innovations and foster collaborations that drive science and the future of our industry. Alongside the conference, the collocated exhibition is the largest of its kind in Europe, offering unparalleled opportunities to explore the latest products, connect with new customers and discover emerging trends.

This year's ECOC features an outstanding line-up of plenary speakers, who offer visionary insights into the evolving landscape of optical communication:

- **Andreas Bechtolsheim,** Co-Founder and Chief Architect of Arista Networks, *Can Interconnects Keep Up with AI?*
- **Thomas van Briel,** SVP Architecture and Strategy Deutsche Telekom Technik GmbH, *Evolution of IP and Optical Networks*
- **Roel Baets,** Emeritus Professor at Ghent University and former Group Leader at IMEC, *Towards Silicon Photonics 4.0*
- **Joyce Poon,** Head of Photonics Architecture at Lightmatter, *Future Computing with Integrated Photonics*

Over the past 50 years, optical technologies have revolutionized global communications, shaping the digital world we know today. As we look into the future, these technologies will be even more crucial in driving the next wave of digital transformation. Join us to explore the latest research, innovations and business opportunities in this vibrant field.

Selected highlights from the extensive technical programme at ECOC 2024 are:

- 8 in-depth tutorials, 52 invited presentations, 451 contributed papers as well post-deadline paper sessions featuring the latest breakthrough results.
- 14 workshops on hot topics in the community, covering optical as well as quantum communication in fibre and free-space, addressing the device, system and network level.
- Symposia on 50 years of ECOC, optical networking, optical satellite, green ICT and data-centre challenges.
- A demo session covering proof of concepts and early prototype developments that can be seen as a link between the scientific conference and the business-driven exhibition.
- A lively rump session debating the innovation potential of quantum technologies as well as sessions covering the topics *Hack your research!, Women in Photonics* and *Photonics in Germany.*

The exhibition, a central hub of networking for the community, has once again grown to welcome over 300 global exhibitors with many new products. You can find out about the latest market developments in the two theaters of the exhibition area.

Don't miss the chance to network and relax at our social events, including the welcome reception, the conference dinner and our special 50th anniversary celebration – a night filled with culinary delights reflecting the diverse countries that have contributed to ECOC's rich history.

We are delighted to host you here in Frankfurt and hope you enjoy both the technical sessions and the vibrant social atmosphere of ECOC 2024. Let's celebrate 50 years of ECOC and look forward to the next chapter in optical communication together!

General Chairs

Jörg-Peter Elbers
Adtran Networks SE

Ronald Freund
Fraunhofer HHI

Carmen Mas Machuca
University of the Bundeswehr Munich

Technical Program Chairs

Peter Krummrich
Technical University Dortmund

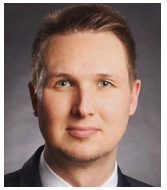
Sebastian Randel
Karlsruhe Institute of Technology

Local Organizing Committee

Damian Dudek
VDE ITG

Tina Franke
VDE

Alexandra Momberger
VDE



Nicolas Parisel
VDE

Hans-Joachim Grallert
Fraunhofer HHI

Technical Committees

SC1: Novel Fibres, Fibre Devices and Amplifiers

Chair: Camille-Sophie Brès, EPFL Switzerland, Switzerland

Xiaoyi Bao, University of Ottawa, Canada
Marianne Bigot, Prysmian, France
Tommy Geisler, OFS Fitel Denmark, Denmark
Patrice Mégret, University of Mons, Belgium
Kazunori Mukasa, Furukawa Electric Co., Ltd., Japan
Rogerio Nogueira, Instituto De Telecomunicacoes, Portugal
Lutz Rapp, Adtran Networks SE, Germany
Marco Santagiustina, Università di Padova, Italy
Lei Wei, Nanyang Technological University, Singapore
Nathalie Wheeler, ORC, UK

SC2: Discrete Photonic Devices and Technologies

Chair: Aleksandra Kaszubowska-Anandarajah, Trinity College Dublin, Ireland

Timo Aalto, VTT, Finland
Eric Bernier, Huawei, Canada
Woo-Young Choi, Yonsei University, Korea
Francisco Diaz-Otero, Universidad de Vigo, Spain
Selina Farwell, Lumentum, UK
Chaoran Huang, Chinese University of Hong Kong, Hong Kong
Yuriko Maegami, National Institute of Advanced Industrial Science and Technology (AIST), Japan
Dan Marom, Hebrew University, Israel
Despoina Petousi, Adtran Networks SE, Germany
Gunther Roelkens, Ghent University, Belgium
Jean Teissier, Coherent, Switzerland

SC3: Photonic Integrated Circuits, Assemblies and Packaging

Chair: Lars Zimmermann, IHP GmbH, Germany

Romain Brenot, Huawei, France
Claudio Porzi, Scuola Superiore Sant'Anna, Italy
Johan Bauwelinck, imec – Ghent University, Belgium
Francesco Da Ros, Technical University of Denmark, Denmark
Robert Halir, Universidad de Malaga, Spain
Folkert Horst, IBM, Switzerland
Daniel Kuchta, IBM Research, USA
Nobuhiko Nishiyama, Tokyo Institute of Technology, Japan
Marianna Pantouvaki, Microsoft, UK
Niels Quack, University of Sydney, Australia
Ripalta Stabile, EHCI – Eindhoven University, Netherlands
Keijiro Suzuki, National Institute of Advanced Industrial Science and Technology (AIST), Japan
Chin-Hui (Janet) Chen, Lumentum, USA

SC4: Signal Processing for Optical Communication and Computing

Chair: Bernhard Spinnler, Infinera Corporation, Germany

Xi (Vivien) Chen, Nokia Bell Labs, USA
Domenico Marsella, Nokia, Italy
Manabu Arikawa, NEC, Japan
Elie Awwad, IMT Paristech, France
Magnus Karlsson, Chalmers University of Technology, Sweden
Darli Mello, U. Estadual de Campinas, Brasil
Hae Young Rha, MIROandI, South Korea
Jianming Tang, Bangor University, UK
Sjoerd van der Heide, Effect Photonics, Netherlands
Fatih Yaman, NEC Labs, USA
Fan Zhang, Peking University, China

SC5: Optical Transmission Systems

Chair: René-Jean Essiambre, Nokia Bell-Labs, USA

Michael Galili, Technical University of Denmark, Denmark
Gernot Goeger, Huawei, Germany
Paul Harper, Aston University, UK
Tomoyuki Kato, Fujitsu, Japan
Chiara Lasagni, Parma Univeristy, Italy
Junjie Li, China Telecom Research Institute, China
Yan Li, BUPT (Beijing University of Posts & Telecom), China
Georg Rademacher, University of Stuttgart, Germany
Jeremie Renaudier, Nokia Bell Labs, France
Kouki Shibahara, NTT, Japan
David Millar, Infinera, USA
Fan Yu, Huawei, China

SC6: Architecture, Modelling and Performance of Optical Networks

Chair: Patricia Layec, Nokia Bell-Labs, France

Alejandra Beghelli, UCL, UK
Steinar Bjørnstad, Norwegian University of Science and Technology, Norway
Andrea Carena, Politecnico di Torino, Italy
Kiyo Ishii, National Institute of Advanced Industrial Science and Technology (AIST), Japan
Bernhard Schrenk, Austrian Institute of Technology, Austria
Alexandros Stavdas, OpenLightComm, UK
Takehiro Tsuritani, KDDI Research Inc., Japan
Carmen Vazquez, Universidad Carlos III, Spain
Tianjian Zuo, Huawei Technologies Co. Ltd, China
Michael Düser, DTAG, Germany

SC7: Access, Indoor and Short-Reach Systems for Data Centres and Mobile Networks

Chair: Stephan Pachnicke, Christian-Albrechts-University of Kiel, Germany

Gaël Simon, Orange Labs, France
Changyuan Yu, Hong Kong Polytechnic University, Hong Kong
Fabio Bottoni, Cisco Photonics, Italy
Christina Lim, University of Melbourne, Australia
Jochen Maes, Nokia Bell Labs, Belgium
Derek Nesset, Huawei, UK
Paola Parolari, Politecnico di Milano, Italy
Oded Raz, EHCI – Eindhoven Univ., Netherlands
Michela Svaluto Moreolo, Centre tecnologic de telecomunicacions de Catalunya, Spain
Lena Wosinska, Chalmers University of Technology, Sweden
Tomoaki Yoshida, NTT, Japan
Salvatore Spadaro, Universitat Politècnica de Catalunya BarcelonaTech, Spain

SC8: Sensing and Microwave Photonics

Chair: Guillermo Carpintero, Universidad Carlos III de Madrid, Spain

Ming-Fang Huang, NEC Labs, USA
Jasmin Smajic, ETH Zurich, Switzerland
Andreas Stöhr, University Duisburg-Essen, Germany
Colm Browning, mBryonics Ltd, Ireland
Miguel Drummond, Instituto de Telecomunicações Aveiro, Portugal
Jonas Hansryd, Ericsson, Sweden
Shota Ishimura, KDDI Research Inc., Japan
Oskars Ozolins, RISE, Sweden
Patryk Urban, West Pomeranian University of Technology in Szczecin, Poland
Chris Vagionas, Aristotle University of Thessaloniki, Greece

SC9: Free-Space Optics and Optical Wireless Technologies

Chair: Volker Jungnickel, Fraunhofer HHI, Germany

Martin Lavery, Univerisity of Glasgow, UK
Michel Sottom, Thales Alenia Space, France
Anjali Agarwal, CACI, USA
Liam Barry, Dublin City University, Ireland
Chi Wai Chow, National Chiao Tung University, Taiwan
Hwan Seok Chung, ETRI, Korea
Antonio D'Errico, Ericsson, Italy
Kasai Keisuke, Tohoku University, Japan
Eduward Tangdiongga, EHCI – Eindhoven University, Netherlands
Guy Torfs, imec – Ghent University, Belgium
Herwig Zech, Tesat-Spacecom, Germany

SC10: Control and Management of Optical Networks

Chair: Marija Furdek Prekratic, Chalmers University of Technology (CTH), Sweden

Jiajia Chen, Bytedance, USA
Nguyen-Cac (Karl) Tran, Genexis, Netherlands
Hideaki Furukawa, National Institute of Information and Communications Technology (NICT), Japan
Raul Muñoz, Centre technologic de telecommunicacions de catalunya, Spain
Yvan Pointurier, Huawei, France
Marco Quagliotti, Telecom Italia, Italy
Marco Ruffini, Trinity College Dublin, Ireland
Behnam Shariati, Fraunhofer HHI, Germany
Anna Tzanakaki, National and Kapodistrian University of Athens, Greece
Shuangyi Yan, Bristol University, UK

SC11: Quantum Communications and Quantum Computing

Chair: Vito Sorianello, CNIT, Italy

Takeshi Umeki, NTT, Japan
Amirhossein Ghazisaeidi, Nokia Bell Labs, France
Rachel Grange, ETH Zurich, Switzerland
Matthias Gunkel, Deutsche Telekom, Germany
Caterina Vigliar, Technical University of Denmark, Denmark
Catherine White, BT, UK

Technical Scope

SC1: Novel Fibres, Fibre Devices and Amplifiers

- Physics of light propagation in optical fibres
- Optical fibre design, fabrication and characterisation
- Specialty optical fibres for improved transmission performance
- Low-latency fibres and fibres for new wavelength ranges
- Microstructured fibres
- Fibre-based devices
- Fibre amplifiers and fibre lasers
- Multimode & multicore fibres and fibre amplifiers
- Highly nonlinear fibres and their applications
- Fibres for sensing applications
- Fibre installation, connectors, splicing, reliability

SC2: Discrete Photonic Devices and Technologies

- Novel material platforms and structured materials
- Design, fabrication and characterisation of novel devices for integration and functionality
- Detectors and sources, directly modulated lasers and VCSELs
- Hybrid III-V/Group IV materials and devices for silicon photonics
- Nanophotonics
- Optoelectronic devices
- Nonlinear waveguides
- Ultrafast devices and technologies
- Optical switching devices

SC3: Photonic Integrated Circuits, Assemblies and Packaging

- Large-scale photonic integrated circuits
- Packaging of devices, testing of performance and reliability
- Co-packaged optical and electronic ICs (2D, 2.5D and 3D)
- System-on-a-chip (SoC) and on-chip networks
- Advanced analogue and digital electronic/optical co-integrated circuits
- Reconfigurable photonic integrated circuits
- Photonic integrated circuits for neuromorphic applications and artificial intelligence
- Frequency combs and microresonators
- Optical processors, neuromorphic and reservoir computing

SC4: Signal Processing for Optical Communication and Computing

- Algorithms for DSP in optical transmission systems
- Modelling and design of DSP
- Experimental demonstration of DSP
- Design, implementation and implications of reduced complexity DSP algorithms
- Comparison of machine learning techniques with conventional DSP
- Real-time DSP implementations for optical communications
- Analogue electrical and optical signal processing
- Novel error correction coding
- Novel constellation shaping approaches
- Implementation complexity analysis of DSP algorithms and computational effort

SC5: Optical Transmission Systems

- Lab/field demonstrations of optical transmission links deploying novel fibres, devices, subsystems and multiplexing techniques
- Link system demonstrations using novel signal modulation techniques
- Transmission enhancements by analogue and nonlinear signal processing subsystems
- Multiplexing and demultiplexing subsystems for improved transmission
- Demonstration of spatially multiplexed transmission links
- Submarine links and cable deployment
- Novel transmission system modelling methods
- Capacity, reach, flexibility limits of optical transmission systems
- System level implications of physical impairments
- Impairment mitigation techniques
- Information theory for optical communications

SC6: Architecture, Modelling and Performance of Optical Networks

- Core, metro and transport optical network architectures
- Optical switching and routing architectures
- Submarine optical networks
- Satellite optical networks
- Optical network resilience and security
- Optical network deployments and field trials
- Inter data centre interconnection architectures
- Physical layer performance and technology integration in optical networks
- Multi-layer and multi-technology optical networks
- Planning and scaling of hybrid fibre/free space optical networks
- Performance monitoring techniques in optical networks

SC7: Access, Indoor and Short-Reach Systems for Data Centres and Mobile Networks

- Fibre-to-the-X and optical access networks
- Passive optical networks
- In-building optical networks
- Intra data centre interconnect networks
- Optical networks for high performance computing
- Backhaul, midhaul and fronthaul networks for mobile networks
- Highly parallel network and interconnect demonstrations
- Photonics for cloud and low latency services
- Optical switching and routing in short-reach networks

SC8: Sensing and Microwave Photonics

- Fibre-based optical sensing (e.g., DAS, OTDR)
- Free-space optical sensing (e.g., LiDAR, OCT)
- Joint communication and sensing
- Microwave photonics subsystems
- Millimetre-wave and THz photonics signal generation/detection
- Demonstration of optics-based THz wireless subsystems
- Demonstration of analogue radio-over-fibre systems for 5G/6G and beyond

SC9: Free-Space Optics and Optical Wireless Technologies

- Deep space optical communications
- Satellite photonic communication links
- Space-air-ground optical wireless systems
- Pointing, acquisition and tracking
- LiFi and VLC communication systems and networks
- Lab/field demonstration of free-space optical wireless transmission
- Underwater optical wireless communication
- Atmospheric turbulence characterization and modelling
- Field trials and experiments of optical wireless technologies
- Control and management of optical wireless technologies

SC10: Control and Management of Optical Networks

- Control, orchestration, and management of optical networks
- Multi-layer network control and management
- SDN/NFV enabled optical networking
- Protocols and signalling in optical network control and management
- Applications of artificial intelligence and machine learning in monitoring, control and management of optical networks
- Field trials and demonstrations with optical network hardware and software
- Protocols and software tools for network reliability, survivability, privacy, security and disaster recovery
- Open source testbeds, implementations and demonstrations

SC11: Quantum Communications and Quantum Computing

- Quantum optics and quantum communication
- Quantum nanophotonics
- Quantum interfaces
- Coherent state transfer between the optical and the microwave domain
- Quantum memories for photons
- Quantum network architectures, switching, routing and protocols
- Quantum light sources and detectors
- Theory of quantum communication systems
- Use case and demonstration of quantum communication systems
- Quantum cryptography lab/field demonstration
- Quantum computing interconnect
- Quantum repeaters
- Quantum Internet
- Co-existence of quantum and classical network
- Comparison of classical and quantum physical layer security

Social Events

In 2024 we are looking forward to celebrating 50 years of ECOC with you!
On the occasion of this special anniversary we have organized some great social events.

Get Together Reception

Congress Center Messe Frankfurt
Sunday, 22. September, 17:30

50 Years of ECOC Celebration

Forum Messe Frankfurt "Panorama"
Monday, 23. September, 19:30

Look forward to an entertaining and varied evening with tasty dishes reflecting the diversity of countries over the last 50 years of ECOC and a young band that will get you dancing with their live act. The Event will be a celebration not to be missed.

VIP Dinner

Klassikstadt Frankfurt
Tuesday, 24 September

For invited guests only!

Shuttle service

- Congress Center → Klassikstadt: 18:00 – 19:00
- Klassikstadt → Congress Center: 22:00 – 23:00

Conference Dinner

Palmengarten Frankfurt
Wednesday, 25. September

19:00 Reception
19:30 Dinner

Reservation required.

Travel Information

- Underground station tram and bus stop 'Bockenheimer Warte'.
- 15 – 20 minutes walk from the Congress Centre.

Gesellschaftshaus Palmengarten
Palmengartenstrasse 11
60325 Frankfurt/ Main

Workshops

WS1: Has the Time Come for Quantum-Secure Optical Networks?

Sunday, 22. September, 09:00–12:30, Harmonie 1

With the development of quantum computers and the luring threat of cryptanalytic attacks on today's cryptography by quantum computers, the development of alternative cryptography schemes is more pressing than ever. Quantum key distribution is one option to build quantum-safe networks. In this workshop, we address the question whether quantum key distribution is sufficiently matured and will become an adequate technology in future optical networks.

In particular, we address the following questions:

- Is there a market demand for quantum-secure communications?
- What is the time window for upgrading today's crypto infrastructure?
- Which QKD key volumes are expected?
- What operator investment is needed for a QKD network compared to alternative approaches?
- How much might a QKD key delivery cost for users?
- How could PQC complement quantum-based crypto?

Besides these questions directly related to QKD, in the second part of the workshop, we address alternatives to QKD (quantum-cryptography, post-quantum-cryptography, loss monitoring) and discuss whether those are viable and what their related pros and cons are for optical networks.

Organisers:

- Laurent Schmalen (Karlsruhe Institute of Technology)
- Matthias Gunkel (Deutsche Telekom)
- Hannes Hübel (Austrian Institute of Technology)

Session 1: Quantum-secure communications

Organizers' introduction

Quantum-secure communications – what is the market perspective?
Henning Soller (McKinsey)

On the industrial maturity of QKD
Helmut Grießer (Adva Network Security)

The role of Quantum Stream Cipher for quantum-safe networks
Fumio Futami (Tamagawa University)

Session 2: Alternative approaches

Loss-control protocol as quantum-secure alternative
NN

When is quantum-secure communication trustworthy?
Florian Fröwis (ID Quantique)

Panel: all speakers

At an interactive panel discussion, all speakers will be happy to delve deeper into their core messages with the audience, explore different options how to build quantum-safe networks and discuss the associated advantages and challenges for practical deployments.

WS2: Massively Parallel Optical Transceivers and Interfaces – Where Are we on This Path?

Sunday, 22. September, 09:00–12:30, Harmonie 2

With an annual increase of 40% – 60% in interface data rate, yet only a ~13% increase for single lambda transceivers, it is anticipated that future transceivers will utilize one or more types of spatial and/or wavelength parallelization. This workshop aims to have a reality check of where we are on this path.

The discussion includes:

- What level of parallelization do we need in the 5 to 10 years range?
- What needs to be developed (hardware, DSP, packaging, interface solutions) to achieve the desired level of parallelization?
- Innovative transceiver structures for massively parallel transceivers.

The discussions will be arranged into two parts addressing two (very different) applications:

- Ultra-short reach (intra-data center distances and shorter)
- Long distances (from inter-data centers to long-haul systems.

Organisers:

- Xi (Vivian) Chen (Nokia Bell Labs)
- Dan Kuchta (IBM Research)

Session 1

Chris Cole (Parallax Group)

Guilhem de Valicourt (Nubis Communications)

Vipul Bhatt (Coherent)

Thomas Lijeberg (Intel)

Darrell Childers (US Conec)

Anand Ramaswamy (Broadcom)

Panel Discussions

Session 2

Roland Ryf (Nokia Bell Labs)

Jizhao Zhang (National Institute of Standards and Technology (NIST), and University of Colorado)

Amir Youssefi (EDWATEC)

Bilal Riaz (Ciena)

Peter Evans (Infinera)

Mian Zhang (HyperLight)

Tetsuya Hayashi (Sumitomo Electric Industries)

Panel Discussions

WS3: What Is the Best Wavelength for Free-Space Optical (FSO) Communication?

Sunday, 22. September, 09:00–12:30, Harmonie 3

Mainstream free-space optical (FSO) communication systems converged on using the 1.55µm band offering data rates up to Tbit/s, e.g., between satellites. Besides, recent years have shown increasing research activities on atmospheric FSO using other wavelength bands reaching tens of Gbit/s in laboratory and outdoor trials over distances up to hundreds of meters. This workshop will examine the best wavelength for FSO communication systems. It will compare near-infrared (NIR, 0.78-1.4 µm), short-wavelength IR (SWIR, 1.4-2 µm), mid-wavelength IR (MIR, 3-5 µm), and long-wavelength IR (LWIR, 8-12 µm). Talks will demonstrate the significant potential for FSO using NIR, MIR, and LWIR, especially in terms of performance, range, and cost under adverse weather conditions (atmospheric scattering, turbulence). Based on the increasing technological maturity of components and sub-systems, speakers will assess the readiness of NIR, MIR, and LWIR for practical FSO applications in commercial deployments. The goal is to advance the use of FSO in future communication infrastructures, including ground-to-ground and ground-to-satellite links.

Key questions to be explored include:

- How do different wavelengths influence the performance and reliability of FSO systems?
- What are the latest developments of NIR, MIR, and LWIR components?
- How to keep availability high under challenging weather conditions?
- How to integrate NIR, MIR, and LWIR into existing and future networks?

Organisers:

- Oskars Ozolins (RISE)
- Herwig Zech (Tesat-Spacecom)
- Nicolas Perlot (Fraunhofer HHI)

Session 1: Shortwave Infrared vs Near Infrared

Organizer's introduction

Devin Brinkley (Project Taara)

Christoph Kottke (Fraunhofer HHI)

Mark Gregory (TESAT)

Henning Helmers (Fraunhofer ISE)

Panel

Session 2: Shortwave Infrared vs Mid Infrared and Longwave Infrared

Mustafa Cardakli (Project Kuiper, Amazon)

Christian Fuchs (DLR)

Alessandro D Acierno (Huawei)

Xiaodan Pang (KTH Royal Institute of Technology)

Panel

WS4: When Could Multi-Band Systems Become More Cost-Effective Than Parallel C-Band Systems?

Sunday, 22. September, 09:00–12:30, Harmonie 4

C-band systems have been widely deployed for over 25 years. Once fiber capacity is saturated on one link, the option of lighting another (possibly wider) C-band system is the one selected by many operators owning their fiber. "Fiber-renting" operators (typical case of OTT) have deployed C+L systems in the past 5 years to reduce network bandwidth cost, even if a C+L system equipment may currently be more expensive than 2 C-band systems. However, these C+L systems may also be saturated given the ceaseless traffic growth.

The questions that will be addressed during the workshop are the following:

- What capacity growth is expected over the next 10 years? x10, x5, x2?
- Will "fiber-owning" operators keep C-band systems and increase the number of fibers used? Given WSS have a (physically) limited number of ports, which no longer increases, what is the risk of saturating WSS ports?
- What are the main challenges for deploying C+L systems: physical effects (SRS), cost/supply of L-band assets (lasers, WSS, OA)?
- Is C+L mostly for long-haul networks? Or could that also be interesting for DCI or metro in some regions of the world?
- Will C+L systems become the new standard, even for "fiber-owning" operators?
- Will operators renting fiber (mostly OTT) continue to deploy standard C+L (4.8THz+4.8THz) systems, or evolve toward wider bandwidth C+L (6+6THz) systems?
- C+L deployment only started ~20 years after C-band deployment. Should we wait 15 more years to see S+C+L? or could S+C+L appear in the next 5 years?
- What could trigger the development of S+C+L systems (up to 18THz, so almost doubling bandwidth of current 4.8+4.8THz C+L systems)?
- Technologies providing OA for additional bands is progressing and O/E/S/C/L/U bands research experiments have been reported. While worse performance is observed for additional bands, what could drive the adoption of such systems? Could "renting fiber" operators see interest despite potential higher cost per bit?
- Could new generations of fibers (MCF, HCF) become a game changer?

Organisers:

- Gabriel Charlet (Huawei)
- Jeremie Renaudier (Nokia Bell Labs)
- Chongjin Xie (Alibaba Cloud)

Session 1: C+L vs. parallel-fiber C-band systems: Mostly for operators renting fibers or soon becoming the new "standard"?

Operators:

- Dong Wang (China Mobile)
- Véronique Guillot (Orange)

System/subsystems vendors:
- Robert Keys (Ciena)
- Zhang Dejiang (Huawei)
- Rodney Dellinger (Nokia)
- Simon Warren (Lumentum)

OTT:
- Mattia Cantono (Google)
- Chongjin Xie (Alibaba Cloud)

Panel discussion and poll

Session 2: Looking forward to S+C+L, E+S+C+L, O+E+S+C+L: When could they be deployed? How could they be cost effective?

Operators/OTT:
- Ben Puttnam (Microsoft, previously NICT)
- Fukutaro Hamaoka (NTT)

System vendors:
- Antonio Napoli (Infinera)

Academics:
- Pierluigi Poggiolini (Politecnico di Torino)
- Periklis Petropoulos (Southampton University)

Panel discussion and poll

WS5: What Can Digital Twins Fueled With Generative AI Offer to Optical Networks?

Sunday, 22. September, 09:00–12:30, Harmonie 5

Digital Twin (DT) of optical networks has recently received significant attention from our community as a tool that can use historical data, real-world monitoring data, and expert knowledge to provide a highly reliable simulation environment for modeling, optimization, and predicting the future behavior of the network. DTs may appear in different forms from the DT of a single sub-system, the DT of an entire system, or the DT of a complex meshed network. The advancements in the monitoring capabilities of coherent receivers, versatile telemetry collection protocols for optical line systems and terminals, as well as the fast pace for the realization of self-healing networks, justify the current trends toward the development of a full-fledged DT of optical networks.

Driven by the recent breakthroughs in the development of Large Language Models (LLM) and the success of Generative AI (GenAI) models such as ChatGPT, Bard, and Llama 2, one could see numerous use-cases where GenAI could be valuable for telecom networks, from facilitating device configuration scripts with no limitation on vendor-specific syntaxes, to generating large amount of synthetic, yet realistic, data samples of real-world network failures. This workshop is going to trigger a discussion around the current status of DT development for optical networks and offer a medium to exchange opinions on how GenAI could help DTs become more successful. For instance, will creating a foundational model of various network assets – fiber plants, transceivers, ROADMs, amplifiers, etc. – result in DTs that can model the real-world phenomenon closer to reality? Can foundation models relying on real-time monitoring data and operational DTs replace engineers to design and operate networks? What are the challenges ahead for curating a multi-purpose, clean dataset for creating such foundational models?

Organisers:
- Behnam Shariati (Fraunhofer HHI)
- Shoichiro Oda, (Fujitsu Limited)

Session 1

Hideki Nishizawa (NTT Network Innovation Laboratories)

Ioannis Tomkos (University of Patras)

Inwoong Kim (Fujitsu Network Communications)

Yvan Pointurier (Huawei)

Ricard Vilalta (Centre Tecnològic de Telecomunicacions de Catalunya)

Achim Autenrieth (Adtran)

Session 2

Pooyan Safari (Fraunhofer HHI)

Cen Wang (KDDI Research)

Takahito Tanimura (Hitachi)

Danshi Wang (Beijing University of Posts and Telecommunications)

Panel

WS6: 6G in Buildings: Head Against the Wall?

Sunday, 22. September, 09:00–12:30, Harmonie 6

The workshop addresses the increasingly important in-building network segment, where more than 80% of our data traffic is consumed and people get used to connecting wirelessly, at least on the last hop.

The growth of mobile data rates has been realized mostly by network densification. While 4G and its evolution to 5G requires optical fiber to every base station, 6G needs fibers to and inside every building. Fiber-to-the-room (FttR) will connect numerous wireless access points inside buildings, what has the potential to increase area capacity and reduce energy per bit by orders of magnitude compared to “illuminating” the building from outdoor base stations, i.e. common practice today.

5G campus networks are a high-end solution for big industry, but acceptance in small and medium enterprises is low, due to the cost of equipment, deployment and maintenance. As a low-end alternative, 6G may be complemented by optical access and in-building networks, such as 2.5/10/50G-PON, besides Ethernet, PLC and Coax, to connect every room and install new wireless technologies, e.g., Wi-Fi 8 together with mm-wave and LiFi. A mix of low-cost optical and wireless technologies has the potential to provide high reliability, low latency and low energy per bit inside buildings, and thus meet 6G requirements.

Panelists will discuss with the audience, e.g. how optical technologies support higher QoS inside buildings, how they can be scaled to higher volumes to enable lower cost, how to deploy fiber inside buildings, how to combine FttR

with Wi-Fi, mm-wave and LiFi, how to integrate in-building networks into 6G, what the main application areas are and what optical communication can do to improve the reliability and reduce latency of in-building networks in general.

Organisers:
- Volker Jungnickel (Fraunhofer HHI)
- Maxim Kuschnerov (Huawei)

Session 1

Fixed network technologies into and inside the building

Introduction
Volker Jungnickel (Fraunhofer HHI)

Optical Access Networks – Passive Optical Networks
Rene Bonk (Nokia)

Internet via (Low Earth Orbit) Satellites – Revolutionary, Complementary, or Unreasonably?
Joerg Deutschmann (FAU Erlangen-Nürnberg)

Intelligent FTTR: Technological Roadmap towards 2030 for 10G & Beyond
Xu Fan (Huawei)

Wireless technologies

In-Building Networks – Distributing the Multi-Gigabit Service inside the Home
Rainer Strobel (Maxlinear)

Wi-Fi—A subjective overview of yesterday, today, and tomorrow
Guido Hiertz (Ericsson)

Session 2

Wireless technologies – *continued*

mm-Wave for Access and Inbuilding Networks
Wilhelm Keusgen (TU Berlin)

Optical Wireless Communication (LiFi)
Christoph Kottke (Fraunhofer HHI)

Applications

Industrial and Medical Applications
Ernst-Joachim Steffens (EJS)

Panel (all speakers)

WS7: Overhyped or the Real Deal: Which Photonics Integration Platform Will Lead the Way?

Sunday, 22. September, 09:00–12:30, Spektrum

Photonic Integrated Circuits (PICs) have long been anticipated as a revolution for the optical components market. With the advent of AI, the potential for PICs to scale production volumes to unprecedented levels has never been more attainable. But is this the moment when the long-anticipated mass adoption of PICs becomes a reality?

The commercial success of PICs hinges on integrating diverse material platforms and innovative light source strategies. As the industry debates the merits of silicon photonics (SiP) versus indium phosphide (InP) technologies, a new frontier is emerging—one that leverages hybrid and heterogeneous integration to combine the strengths of these and other materials, such as Lithium Niobate and phase-change materials. Which platform, and which functionality, is really needed?

Organisers:
- Eric Bernier (HiSilicon OE)
- Martijn Heck (Eindhoven University of Technology)
- Lars Zimmermann (IHP Microelectronics)

Session 1: Requirement for photonics platforms

Introduction

Where should the optical industry be going?
Mark Lutkowitz (Fibre Reality)

Platforms requirements for 400Gbps and beyond
Gernot Fasching (Huawei)

More to be confirmed

Panel Discussion

Session 2: Platform and components availability

Introduction

GF's silicon photonics foundry platforms
Ken Giewont (Global Foundry)

Heterogenious Silicon Platform
Steven Alleston (OpenLight)

Advances in BTO modulator technology
Felix Eltes (Lumiphase)

More to be confirmed

Panel Discussion

WS8: Is QKD Technology Ready to Become a Standard for Secure Communications?

Sunday, 22. September, 14:00–17:30, Harmonie 1

Current security solutions face significant challenges as technology advances and cyber threats become more sophisticated. Quantum Key Distribution (QKD) promises a new paradigm of security, but is QKD technology ready to become a standard for secure communications?

Join us for an engaging workshop where we delve into the latest advancements in QKD technology, explore evolving certification processes, and identify gaps for future QKD deployment. This event offers a unique opportunity to engage with thought leaders, gain valuable insights, and network with peers at the forefront of secure communications, fostering meaningful connections and collaborations. Whether you're a cybersecurity professional, an optical communications expert, or simply someone deeply invested in the future of secure communications, this workshop will provide the knowledge and connections you need to stay ahead.

The organization of this workshop is supported by the SQuaD project and by QBN (www.qbn.world).

Agenda:

Industry Perspective

Leading QKD manufacturers will share insights on what makes their QKD solutions unique and ready for deployment.

QKD Certification

Key players in the certification process will provide updates on their progress and how they are advancing certification beyond the current standards.

QKD Readiness – Gap Analysis for Future QKD Deployment

A panel of experts will discuss the current state of QKD deployment, examining key challenges and exploring potential opportunities for the future. Attendees will have the opportunity to interact with the panelists, ask questions, and engage in meaningful discussions.

Organisers:
- Haissam Hanafi (Quantum Business Network)
- Linus Krieg (Physikalisch-Technische Bundesanstalt)
- Imran Khan (KEEQuant)

WS9: Intra-Datacenter Connectivity: Bottlenecks & Trends for AI Clusters

Sunday, 22. September, 14:00–17:30, Harmonie 2

This workshop focuses on advanced AI cluster scalability issues and solutions, covering a variety of important aspects such as scale-up and scale-out architectures and the supporting hardware, multi-chip package scaling, reliability and redundancy requirements, thermal and cooling challenges, as well as electrical and optical I/O solutions based on pluggable optics and near-package/co-packaged optics.

Organisers:
- Peter Winzer (Nubis Communications)
- Shu Namiki (AIST)
- Laurent Schares (IBM)

Session 1: AI cluster architecture challenges

Ashkan Seyedi (Nvidia)

Dylan Patel (SemiAnalysis)

Jean-Philippe Fricker (Cerebras)

Drew Alduino (Meta)

Andy Bechtoldsheim (Arista)

Peter Liu (Formerica)

Session 2: I/O solutions for AI clusters

Xiang He (Huawei)

Tony Chan Carusone (Alphawave)

Karl Muth (Broadcom)

Matt Traverso (Marvell)

Mizuki Shirao (Mitsubishi)

Vipul Bhatt (Coherent)

WS10: Is There a Gold Standard Fiber Optic Sensing Technology to Monitor the Environment Around Us?

Sunday, 22. September, 14:00–17:30, Harmonie 3

Fibre Optical Sensing (FOS) and monitoring have been developed to oversee, predict and survey critical field parameters from the environment around us, acquiring, processing, and interpreting vast amounts of rapid changing data. Optical networks today represent one of the most expensive and pervasive distribution infrastructures. Is it possible to employ them as a mean for extensive optical sensing and monitoring? Which FOS applications will drive the development of new business opportunities or will be able to meet societal needs?

Invited speakers will detail the main applications for residential, industry 4.0 and mobile markets, providing solutions for temperature and humidity metering, intrusion detection, seismology, energy saving, road traffic monitoring, fault prediction, fire prevention, and more. In particular, the current and future FOS solutions will be analysed with regard to business development around carrier networks, debating where it is worth to use sensing technologies based on scattering (Brillouin, Rayleigh, Raman) or state of polarization processing.

The following questions will be explored:

- What are the main applications that will drive fibre-optic sensing to productization?
- How well suited are the different sensing technologies for the applications and is there a universal technology that addresses all applications?
- How will Artificial Intelligence and machine learning techniques support those applications and how will such amount of data be handled?
- Are there new technologies on the horizon that will revolutionize the fibre-optic industry?

Organisers:
- Sander Jansen (Adtran)
- Paola Parolari (Politecnico di Milano)

Session 1

Introduction

Operator NN

Andreas Wuestefeld (Norsar)

Clemens Pohl (AP Sensing)

Roman Ermakov (Technical University of Denmark)

Session 2

Mikael Mazur (Nokia Bell Labs)

Maddalena Ferrario (Cohaerentia)

Harisha Parampalli (Luna)

Steinar Bjørnstad (Tampnet)

Panel

WS11: Beyond 50G-PON – Can We Still Use IMDD?

Sunday, 22. September, 14:00–17:30, Harmonie 4

With the completion of 50G-PON (Higher Speed PON) standardisation in the ITU-T, the announcement of 50G-PON products and operator deployment plans, the

ITU-T has initiated a study into the requirements and candidate technologies for the next generation of Very High Speed PON (VHSP) expected ~ 2030 timeframe.

In parallel, the development of 6G and the evolution of mobile towards smaller cells will position PON as a primary candidate technology for deep fibre connectivity. Any convergence of residential and wireless access services on the same PON architecture will bring new challenges due to requirements for very low and deterministic latency, higher reliability and high data rates for continuous learning, fuelled by edge-AI computing and by a future network of intelligent machines.

With the expectation from network operators of a very high service capacity (e.g. 200G) in combination with demands for longer reach and higher loss budgets, it seems like we could be at a technology inflection point for PON. Such requirements could be met by coherent technology, but questions remain concerning the economics in this highly cost sensitive network segment.

This workshop will review the different technologies in scope for VHSP and address the question as to whether IMDD is still a candidate technology for this beyond 50G generation of ITU-T PON or whether coherent technology is needed to meet the high capacity and loss budget expectations.

Network operators will be invited to give their view on the key requirements for VHSP and the potential applications. Experts from industry and academia will review the different technology options and potential challenges to meet the operator requirements.

A lively debate is expected as PON pushes the performance limits of conventional IMDD PON and challenges the costs of the alternatives. Such a debate will be very timely and a great chance to contribute research ideas that could impact the ITU-T standardisation effort.

Organisers:
- Derek Nesset (Huawei)
- Fabienne Saliou (Orange)
- Jochen Maes (Nokia)

Session 1

Operator requirements for Beyond 50G PON: an FSAN and ITU perspective
Denis Khotimsky (Verizon)

Access network evolution to VHSP – service drivers and technology options
Cláudio Rodrigues (Altice Labs)

IM-DD solutions for next-generation PONs
Vincent Houtsma (Nokia)

Recent advancements in high-speed optical components for IMDD operation
Asami Uchiyama (Mitsubishi Electric)

Embracing Coherent Optics for Next-Gen PON Potential
Zhensheng (Steve) Jia (Cablelabs)

Session 2

The expected advances in fixed access networks for mobile networks
Philippe Chanclou (Orange)

System Vendor Considerations on Coherent PON
Giuseppe Talli (Huawei)

Revolutionizing PON transceiver electronics: The Leap to 100G+ Baud Rates
Scott Yin (IMEC)

How Photonic Integrated Circuits may unlock the 50G+ -PON
Francisco Rodrigues (PICadvanced)

Coherent Optics Ready for Next-Generation PON: from 50G to 200G
Junwen Zhang (Fudan University)

WS12: How Will AI Affect Future Transmission Systems?

Sunday, 22. September, 14:00–17:30, Harmonie 5

The traffic demands of emerging AI systems appear to be imposing fundamentally new demands on optical networks. Many varied systems are being deployed while utilizing massive amounts of data; for training models, distributing model parameters, and inference. In this workshop, we will discuss how AI workloads will affect the design of optical transmission systems, and the components and subsystems that comprise them.

- How will AI affect traffic growth in the core, metro and edge?
- Will this lead to increased decoupling of rates required by Telecom and ICPs?
- What is the impact of AI on coherent transceivers?
- Will it drive coherent inside the datacenter?
- Do we need more options for coherent pluggable transceivers?
- How will regulations impact network designs?
- Will AI drive widespread adoption of hollow core fiber?

Organisers:
- David Millar (Infinera)
- Lidia Galdino (Corning)

Session 1

Introduction

Andrew Schmitt (Cignal AI)

Josef Berger (Marvell)

Stefanos Dris (Nvidia)

Carsten Behrens (Deutsche Telekom)

Panel

Session 2

Kei Karasawa (NTT)

Timo Pfau (Cisco)

Julia Larikova (Infinera)

Bodhisattwa Gangopadhyay (Meta)

Panel

WS13: Emerging From Under the Sea – Where Will SDM Land?

Sunday, 22. September, 14:00–17:30, Harmonie 6

Space division multiplexing (SDM) has established itself as one of the most promising technologies to cope with the ever-growing traffic demand in optical networks after more than a decade of fundamental research. Motivated by the higher achievable throughput, SDM recently entered the commercial level in subsea cables, as we experienced the deployment of the first submarine cable based on multi-core fiber technology.

This workshop will explore the benefits, advancements, and challenges of SDM technology and its potential for broader application in different segments of future optical networks. The panel will include a broad spectrum of academic researchers and leading industry technology providers and adopters. The workshop will cover fundamental SDM aspects and models as well as SDM subsystem developments and requirements, fiber developments and standardization efforts, and applications in both short-reach and long-haul optical systems.

Organisers:

- Georg Rademacher (University of Stuttgart)
- Ruben Luis (NICT)
- Gabriele Da Rosa (Adtran)

Session 1

Introduction

Mattia Cantono (Google)

Tetsuya Hayashi (Sumitomo Corporation)

Martin Böttcher (Heraeus Comvance)

Chiara Lasagni (Università degli studi di Parma)

Kazuhide Nakajima (NTT Corporation)

Session 2

Marco Lamponi (Nubis Communications)

Lutz Rapp (Adtran Networks SE)

Nicolas Fontaine (Nokia Bell Labs)

Panel

WS14: Mobile Optics for 6G and Open Cloud RAN: New Concepts or More of the Same?

Sunday, 22. September, 14:00–17:30, Spektrum

Optics plays an increasingly critical role in enabling all the vital mobile broadband applications and services of our modern society. The 5th generation mobile systems (5G) first wave of global roll-out has surpassed all previous generations and continues in 2nd and 3rd waves. Being forward-looking towards the 6th generation (6G) mobile systems, ITU-R has released a new Recommendation ITU-R M.2160 on the “IMT-2030 Framework”. The industry is actively investigating optical solutions to enable this very advanced 6G vision. At the same time, the mobile optics industry is developing new solutions for open cloud RAN.

Mobile optics is characterized by the specific requirements for mobile networks, including high temperature, tight sync, long life spans, and small formfactors. All this must be achieved at very low cost not to impair global mobile systems roll-outs.

The workshop will include relevant results from industry efforts and standardization bodies including MOPA, ITU-T, IEEE, IOWN, ORAN and SNIA SFF.

The focus of the 2024 workshop will be talks from operators, academia, module and systems vendors on the new developments for mobile optics, especially regarding (but not limited to) new operator requirements towards 6G and open cloud RAN. Specific topics will include new findings specific to mobile optical deployment cases regarding 100G/200G optics for re-timed and half/full linear modes in SFP formfactors, coherent vs IM-DD, optical solutions for cloud RAN and advances in solutions for very tight sync/latency. Each of the workshop’s three parts, Operators, Vendors and Academia, will be concluded by panel Q&As with the speakers allowing the workshop participants to be part of open discussions of the most interesting and relevant topics.

The organization of this workshop is supported by the Mobile Optical Pluggable Alliance (https://mopa-alliance.org).

Organisers:

- Stefan Dahlfort (Ericsson)
- Philippe Chanclou (Orange)
- Xiaodan Pang (KTH)

Session 1

Operators

Organizer: Philippe Chanclou (Orange)

Optical-Wireless Cooperative Control with eCTI toward Beyond 5G and 6G
Kenji Miyamoto (NTT)

Hongseok Shin (SK Telecom)

Philippe Chanclou (Orange)

Operator Q&A panel

Vendors

Organizer: Stefan Dahlfort (Ericsson)

100G optics for 6G
Kenneth Jackson (Sumitomo Electric)

Session 2

Vendors – *continued*

Optical solutions for open cloud RAN
Antonio Tartaglia (Ericsson)

Implementation considerations for tight sync; caveats and solution paths
Francois Fredricx (Nokia)

Academia

Organizer: Xiaodan Pang (KTH)

High symbol rate transmissions with SiP modulators
Armands Ostrovskis (Riga Technical University and Keysight Technologies)

SiP coherent modulators for energy-efficient metro/access networks
David Plant (McGill University)

Vendor and Academia Q&A panel

Special Symposium 50 Years of ECOC

Monday, 23. September, 17:45–19:15, Illusion & Fantasie

Since its inception in 1975 in London, UK, the European Conference on Optical Communication (ECOC) has grown into a remarkable success story, becoming one of the most prestigious events in the field of optical communication. Over the past five decades, ECOC has consistently provided a platform for researchers, industry professionals, and academics to share their groundbreaking work, foster collaborations, and drive the field forward.

As we gather to celebrate the 50th edition of ECOC in the vibrant city of Frankfurt am Main, Germany, we reflect on the incredible journey of innovation and progress that has defined this conference. This milestone is not just a testament to the enduring relevance of ECOC, but also to the relentless pursuit of excellence by the global optical communication community.

To commemorate this special occasion, we are hosting a symposium that will delve into the rich history and future prospects of optical communication. We are honored to have four distinguished speakers, each a luminary in their own right, who have made significant contributions to the field. These experts will share their insights and perspectives on the evolution of optical communication technologies and the pivotal role that ECOC has played in shaping this dynamic landscape.

Join us as we celebrate the past, present, and future of optical communication, and honor the achievements that have brought us to this momentous 50th edition of ECOC. Together, we will explore the innovations that have transformed our world and look ahead to the exciting advancements that lie on the horizon.

Organisers:

- Peter Krummrich (Technische Universität Dortmund)
- Sebastian Randel (Karlsruhe Institute of Technology)

Line-up of Speakers

Meint K. Smit

Professor emeritus of TU Eindhoven

Progress in InP-based Photonic Integration

Meint K. Smit started research in photonic integration in 1981. He invented the Arrayed Waveguide Grating (LEOS Technical Achievement 1997) and was closely involved in the introduction of MMI-couplers, key components in Photonic ICs. In 2000 he became the leader of the Photonic Integration group at the COBRA Research Institute of TU Eindhoven. He is the founder of the JePPIX platform, the Joint European Platform for Photonic Integration of Components and Circuits and he was strongly involved in the development of the InP-based photonic foundry system in Europe. Meint Smit is an IEEE Fellow. In 2012 he received an ERC Advanced Grant, in 2016 the Rank Prize for Optoelectronics and in 2021 the John Tyndall Award.

Robert W. Tkach

Former Director of Transmission Subsystems Research at Nokia Bell Labs

High Capacity Optical Transmission: A Look Back at the Future

Robert W. Tkach was Director of Transmission Subsystems Research at Nokia Bell Labs until his retirement in 2021. His research involved fiber nonlinearity and dispersion management, optical amplification, optical networking, and high-capacity DWDM transmission systems. Prior to rejoining Bell Laboratories in 2006, he was: CTO of Celion Networks, Division Manager at AT&T Labs – Research, and a Distinguished Member of Technical Staff at AT&T Bell Laboratories. He served as a member of the International Advisory Committee of the ECOC Executive Management Committee. He is a Fellow of the Optical Society of America, the IEEE, and AT&T. He is a member of the National Academy of Engineering and has received the Thomas Alva Edison Patent Award from the R&D Council of New Jersey the IEEE/OSA John Tyndall Award the Marconi Prize and Fellowship and the IEEE Alexander Graham Bell Medal.

Yutaka Miyamoto

NTT Fellow, NTT Network Innovation Laboratories

Progress of Digital Lightwave Communication Transforming Data-Centric Optical Transport Network

Yutaka Miyamoto received the B.E. and M.E. degrees in electrical engineering from Waseda University in 1986 and 1988, respectively, and received Dr. Eng. degree in electrical engineering from Tokyo University in 2016, Japan. He joined the NTT Transmission Systems Laboratories in 1988, where he engaged in research and development (R&D) on 10-Gbit/s first terrestrial optical transmission system (FA-10G) using EDFA inline repeaters. Since 1997, he had studied and directed the R&D of optical transport technologies based over 40-Gbit/s channel and beyond in NTT Network Innovation Labs. He had served as an ECOC TPC member of digital transmission subcommittee from 2011 to 2017. Since 2020, he has been NTT Fellow of NTT Network Innovation Laboratories, promoting the R&D for future scalable Optical Transport Network with Pbit/s-class capacity. He is a member of the IEEE, and a Fellow of IEICE.

David Payne

Professor of Photonics, Optoelectronics Research Centre, University of Southampton

50 Years of ECOC: Some memories from London to Frankfurt

David Payne is a Professor of Photonics and former Director of the Optoelectronics Research Centre (ORC), University of Southampton. He has published over 650 Conference and Journal papers and is co-inventor on over 40 patents. Over the last 58 years, he has made numerous key contributions in optical fibre communications and laser technology. His work in fibre fabrication in the 1970s resulted in most of the special fibres used today, including the revolutionary erbium-doped fibre amplifier (EDFA) and kilowatt-class fibre lasers for manufacturing and defence. Recognition of his work includes the 1998 Benjamin Franklin Medal for Engineering, the 2007 IEEE Photonics Award, the 1991 IEEE/LEOS Tyndall Award and he is Laureate of the 2008 Millennium Technology Prize. Most recently, with others he received the VinFutures Grand Prize. As an entrepreneur, he has helped found several companies in the local area. David was knighted in 2013 for services to Photonics Research and Applications.

Demo Session

Tuesday, 24. September, 11:00 – 12:30, Hall 5

Demo 1: SQSS: Smart Quantum-key Supply System for Practical End-to-end Quantum-secured Service

Kyu-Seok Shim, Chankyun Lee, Hyunkyo Lim, Wonhyuk Lee; Korea Institute of Science and Technology Information

We demonstrate smart quantum-key supply system which supports both post-quantum and legacy cryptography to forward quantum-key to quantum-secured service node. A cryptography method is adaptively selected based on the algorithm supportability of the service node.

Demo 2: Live Demonstration of Edge Cloud based Visual Inspection in Manufacturing on a Passive Optical Network Testbed

Massimiliano Sica[1,2], Behnam Shariati[1], Hagen Hösl[1], David Przewozny[1], Paul Chojecki[1], Johannes Karl Fischer[1], Ronald Freund[1,2]; [1]Fraunhofer Heinrich Hertz Institut (HHI), [2] TU Berlin

We demonstrate the value of PON as an enabler for the manufacturing sector. We showcase real-time telemetry insights of a visual inspection use-case, such as the evolution of energy and traffic throughout the process, their relationship and the importance of network slicing for QoS assurance.

Demo 3: Enabling Cloud AR/VR Gaming Services by an Open-Source and Standards-Based Network-as-a-Service Platform for Control and Management of Optical Networks

Hesam Rahimi[1], Lluis Gifre[2], Ricard Vilalta[2], Raul Muñoz[2], Henry Yu[1], Yanpeng Wang[1], Ruilin Cai[1], Yixiao Chen[1], Hao Li[1], Haoyu Feng[1], Christopher Janz[1]; [1]Huawei Technologies, [2] Centre Tecnològic de Telecomunicacions de Catalunya (CTTC-CERCA)

This demo presents a novel standards-based and open-source platform for control and management of optical networks. Using this platform, cutting-edge Fifth Generation Fixed Network (F5G) capabilities can be introduced to enterprises, users, and application developers. We evaluate the platform with a cloud-based VR gaming use-case.

Demo 4: Autonomous Link-Capacity Adjustment using TeraFlowSDN Controller in a Disaggregated Optical Network Testbed

Mihail Balanici[1], Behnam Shariati[1], Muhammad Rehan Raza[1], Pooyan Safari[1], Aydin Jafari[1], Vignesh Karunakaran[2], Achim Autenrieth[2], Johannes Karl Fischer[1], Ronald Freund[1]; [1]Fraunhofer Heinrich Hertz Institute HHI, [2] Adtran Networks SE

We demonstrate a closed-loop operation for the use-case of autonomous optical link-capacity adjustment in a partially-disaggregated testbed. Our proposal employs a state-of-the-art traffic forecaster for capacity provisioning and an instance of TeraFlowSDN Controller for (re)configuration of IP/Optical network elements, without interrupting the end-to-end service.

Demo 5: Demonstration of LLM-based AI-Agent for Optical Network Management and Automation

Chenyu Sun[1,2,3], Reda Ayassi[1], Xin Yang[1,4], Gabriel Charlet[1], Photios A. Stavrou[2], Yvan Pointurier[1]; [1]Huawei Paris Research Center, [2] EURECOM, [3] Sorbonne University, [4] Politecnico di Milano

We deployed an LLM-based AI-agent on a commercial product testbed for optical network management and automation. This demonstration showcases how the AI-agent interacts with controller APIs to implement service establishment, QoT estimation, and power optimization.

Demo 6: Dynamic Service Provisioning and Control Relying on Time-Varying Telemetry-Driven QoT Digital-Twin

Renato Ambrosone[1], Ramon Casellas[2], Alessio Giorgetti[3], Riccardo Schips[1], Stefano Straullu[4], Francesco Aquilino[4], Antonino Nespola[4], Roberto Morro[5], Vittorio Curri[1]; [1]Politecnico di Torino, [2] Tecnològic de Telecomunicacions de Catalunya (CTTC), [3] University of Pisa, [4] LINKS Foundation, [5] Telecom Italia

This demo showcases innovative optical network control to enhance performance and QoT predictability. By means of a modular, closed-loop SDN control plane, it demonstrates dynamic service provisioning and optimal path selection, using telemetry, digital twin technology, open amplifier control and time-varying QoT estimation.

Demo 7: Low latency Low-Jitter Bandwidth-Efficient PON for Industry applications

Sandip Das; Nokia Solutions and Networks

We demonstrate a TDM-PON based end-to-end system that achieves ultra-low latency and jitter with high throughput efficiency for time-sensitive applications. This is achieved using co-scheduling of TDM-PON with Ethernet Time Sensitive Network (TSN) elements to serve industrial applications requiring such end-to-end network performance.

Demo 8: Longitudinal Power Profile Monitoring telemetry enabling fault location-aware SDN controller

Alessandro Pacini[1], Fabien Boitier[2], Alix May[2], Vinod Bajaj[2], Andrea Sgambelluri[1], Alessio Giorgetti[3], Luca Valcarenghi[1], Patricia Layec[2]; [1]Scuola Superiore Sant'Anna, [2] Nokia Bell Labs, [3] University of Pisa

This demonstration showcases sharper optical network reconfigurations through a SDN controller, enhanced with longitudinal PPE monitoring to enable soft-failure location. We developed a standard-compliant implementation of an efficient telemetry using OpenConfig and gNMI while balancing the computational needs between the receiver and the SDN controller.

Symposia

Green ICT Symposium

Monday, 23. September, 14:00–17:30, Illusion

Green information and communication technology (ICT) is the key to achieve carbon neutrality and a low-carbon economy. Further innovations on component, (sub-)system and network level are needed to systematically tap into potential savings and to increase the energy efficiency of digital end devices, data centers, telecommunication networks and computing resources.

This symposium will feature impulse presentations and a panel discussion dedicated to discuss about innovative Green ICT solutions and their impact in the digitalization process of selected industries (ICT for Green).

Don't miss the opportunity to get familiar with the methodologies of lifecycle assessment as well as carbon footprint calculation methodologies. Discuss with the experts the role of Photonics in supporting the net-zero carbon emission target for Europe in 2050.

Organisers:

- Ronald Freund (Fraunhofer Heinrich Hertz Institute)
- Andreas Gladisch (Deutsche Telekom AG)

14:00 Session 1

What is the Twin Green and Digital Transition and How it can benefit People, Environment and Economy?
Thomas Ebert (Seconded National Expert, DG Connect, European Commission)

Energy Consumption and Carbon Footprint of the ICT Sector
Severin Beucker (Borderstep Institute for Innovation and Sustainability)

The Definition of Fixed Network Efficiency and How to calculate the avoided Emission using ICT Solutions: The Standard Evolutions
Paolo Gemma (ITU-T, Study Group 5, working party 2)

ICT for Green: Enabling Decarbonization in Manufacture and Logistics
Camilla Willeke (Detecon International)

Optimizing Energy Efficiency in Telecommunications Networks – the IOWN Approach
Lieven Levrau (Nokia)

16:00 Session 2

How Photonics enables the Reduction of Power Consumption in future Radio Access Networks?
Fabio Cavaliere (Ericsson)

How to provide more Bits at less Watts – the ETSI F5G Approach
Marcus Brunner (ETSI ISG F5G)

Energy Efficiency in Optical (Access) Networks – an updated Outlook
Luca Valcarenghi (Sant'Anna School of Advanced Studies)

Energy Efficiency in Passive Optical Networks – an Operator's Perspective
Philippe Chanclou (Orange)

17:00 Final Panel Discussion

10th International Symposium on Optical Interconnects in Data Centres

Tuesday, 24. September, 09:00–17:15, Illusion

As part of the 50th European Conference on Optical Communication (ECOC 2024) in Frankfurt, we invite you to attend the 10th International Symposium on Optical Interconnects in Data Centres on Tuesday, September 24, 2024.

Hyperscale data centres are undergoing a paradigm shift with the rapid proliferation of Artificial Intelligence, necessitating disruptive innovations in optical interconnects. Addressing the power consumption bottleneck is critical for AI infrastructure providers.

Energy efficiency is being addressed at various levels within the hyperscale hierarchy. Innovations include novel WDM architectures, immersion cooling, optical and neuromorphic computing, and ultra-low-power optical phase change materials including EO polymers. We will also hear about the latest advances in Co-Packaged Optics versus Linear Drive pluggable optics.

With the increasing adoption of Quantum Dot lasers in mainstream transceivers, reliability has become increasingly important.

Furthermore, quantum technologies are making their way into hyperscale environments through Quantum Computing as a Service and quantum cryptography to safeguard critical communications to and from data centres.

Photonic Integrated Circuits (PICs) are the critical enabling technology throughout and we will hear on the latest advances in PIC technologies.

Organisers:

- Tolga Tekin (Fraunhofer Institute for Reliability and Microintegration (IZM), Germany)
- Richard Pitwon (Resolute Photonics Ltd., Ireland)
- Nikos Pleros (Aristotle University of Thessaloniki, Greece)
- Dimitrios Apostolopoulos (National Technical University of Athens, Greece)
- Paraskevas Bakopoulos (NVIDIA, Greece)

09:00 Session 1: Optics for Hyperscale AI

Optical I/O for AI Systems
Benjamin G. Lee (NVIDIA Research)

SDN architecture and AI usecases for optical communication networks
Oscar Gonzalez De Dios (Telefonica Innovacion Digital SL)

PICs for coherent communication networks
Benjamin Wohlfeil (Adtran Networks SE)

Carbon footprint considerations with optical transceivers evolution
Fabienne Saliou (Orange S.A.)

Integrated optical I/O chiplets for bandwidth and performance scaling in AI infrastructure
Thomas Liljeberg (Intel Corporation)

Cambrian explosion in optical interconnects for AI Clusters
Vladimir Kozlov (LightCounting)

11:00 Session 2: Advances in PIC

An analogue optical computer for machine learning and optimisation workloads
James Clegg (Microsoft Research)

Photonic Fabric for High-Performance Interconnects
Nikos Bamiedakis (Celestial AI)

An Overview of PIC Technologies for Quantum Communications
Taofiq K. Paraïso (Toshiba Europe Limited)

Scaling to large silicon photonic circuits in the PHORMIC project
Wim Bogaerts (Ghent University – imec)

Speeding up AI networking with software-defined optical engines
Ana Gonzalez (Ipronics Programmable Photonics, SL)

Coherent Transceivers for AI-Drive Data Centers
Antonio Napoli (Infinera)

13:15 Session 3: Optical Circuits and Packages

Ultra-Compact VCSEL-Based Transceivers Employing High-Density Electrical Pluggable Interface for Co-Packaged Optics
Hideyuki Nasu (Furukawa Electric Co., Ltd.)

Micro lenses for optical interconnects molded in a new reflow resistant EXTEM(TM) TPI resin
Jos van Gisbergen (SABIC)

Silicon-organic hybrid electro-optic modulators for next generation optical interconnects
Adrien Mertens (SilOriX GmbH)

Glass Substrate Integration of low loss optical Waveguides for e/o Interposer and automated testing
Henning Schroder (Fraunhofer IZM)

Metallic Interconnects for Co-Packaged Photonic Integrated Circuits
Andrew Meek (Senko Advanced Components)

High density 3-dimensional polymer optical waveguide for co-packaged optics
Takaaki Ishigure (Keio University)

High Performance Materials for Co-Packaged Optics
Habib Hichri (Ajinomoto Fine-Techno)

15:30 Session 4: The Next Generation

Linear Optics for Computing and Microwave Photonics
Nikos Pleros (Aristotle University of Thessaloniki)

POLYNICES Project – Integration of Polymer-Based Electro-Optic PCB Motherboards with Si3N4 Chiplets, InP Components, and ICs for Cost-Effective Photonic Modules
Christos Tsokos (Institute of Communication & Computer Systems "ICCS")

OCTAPUS Project – Optical Circuit switched Time sensitive network architecture for high-speed Passive optical networks and next generation Ultra-dynamic & reconfigurable central office environments
Chris Vagionas (Aristotle University of Thessaloniki)

Broadband-tunable external cavity laser for intra-datacentre interconnects developed in DYNAMOS
Timo Aalto (VTT Technical Research Centre of Finland Ltd.)

ADOPTION Project – Advance co-packaged optics enabling high-efficiency cloud computing
Giuseppe Talli (Huawei Technologies Duesseldorf GmbH)

HAMR – integrating lasers and plasmonics for the ultimate high volume co-packaged optical assembly
Richard Pitwon (Seagate; Resolute Photonics Ltd.)

Satellite Symposium

Wednesday, 25. September, 14:00–17:30, Fantasie

Satellite communications are undergoing rapid changes: As GEO satellites and MEO constellations are now being complemented by innovative LEO constellations, the integration of terrestrial and non-terrestrial networks is paving the way for ubiquitous connectivity and enhanced resiliency. Optical link technologies are revolutionizing the field and enable multi-Tb/s network capacities. Commercial-of-the-shelf technologies offer opportunities to accelerate development timelines and leverage economies of scale.

This special symposium will feature two panel sessions dedicated to discussing the future directions of satellite communication and the pivotal role of optical intersatellite and ground-to-satellite links. Don't miss this opportunity to gain insights from industry leaders and experts shaping the future of global connectivity.

Organisers:

- Jörg-Peter Elbers (Adtran)
- Christian Fuchs (DLR)

14:00 Session 1: Satellite Communications – Where Are We Going?

State of the Art and Recent Trends in Satellite Communications
Andreas Knopp (University of the Bundeswehr Munich)

LEO Constellation Satellite Optical Communications
Mustafa Cardakli (Amazon Kuiper)

Rivada Outernet for Private Space Networks
Alessandro Le Pera (Rivada Space Networks)

Space Networks with Laser Communications: HydRON and Other Examples
Klaus Schönherr (Airbus Defense & Space)

Optical Direct-to-Earth Communications for Space and Earth Observation
Andrea Di Mira (ESA)

Panel discussion

16:00 Session 1: Optical Satellite Links – Challenges and Opportunities

Optical Satellite Communications for Non-Terrestrial Networks Towards Beyond 5G & 6G
Morio Toyoshima (NICT)

Availability of Optical Satellite-Gound Links and Diversity Techniques
Nicolas Perlot (Fraunhofer HHI)

Laser Communication Terminals for 10G, 100G and Beyond
Herwig Zech (Tesat-Spacecom)

Opportunities and Challenges in Ground-to-Space Links
Amita Shrestha (DLR)

Turbulence Mitigation for Ground-to-Space Optical Links
Sebastien Bigo (Nokia Bell Labs)

Panel discussion

Optical Networking Symposium

Thursday, 26. September, 09:00–12:30, Fantasie

The evolution towards 6G mobile access (terrestrial, mobile, satellite, …) will push of an evolution of the optical network infrastructure in wired segments to support many types of new diversified services. This evolution will also bring new challenges for high-capacity optical transport architectures and technologies both for the medium/long haul segment but also penetrating edge network segments closer to the to the mobile base stations and the computation/storage available in the cloud/edge continuum.

The optical network architecture, and its hardware and software components should match the increased resulting aggregated traffic, the slicing features, in terms of network capacity, latency (also supporting synchronization capabilities), packet loss, access to computing, density of connected devices, energy consumption, security, network availability and reliability, The optical network of the future must be able to cope with such capabilities, easing the interoperability among vendors and allowing operators to offer new services.

The WINE symposium aims to explore such future landscape of optical networking and its control plane evolution exploring a few technologies that can address these challenges and determine a scientific and industrial impact. WINE aims to gather experts, researchers, and practitioners to discuss directions of optical networking advancements.

Organisers:

- Piero Castoldi (Scuola Superiore Sant'Anna, Pisa, Italy)

09:00 Session 1

Introduction and overview of the WINE workshop

Safeguarding Connectivity in optical networks through quantum technologies
Masahiro Takeoka (Keyo University, Japan)
Cristoph Becher (Saarland University, Germany)

Bridging worlds: joint Networking and Sensing
Francesco Carpentieri (OpenFiber, Italy)
Pierpaolo Boffi (Politecnico di Milano, Italy)

Harnessing Data Processing Units: Introducing SmartNic in the optical networking arena
Juan Jose Vegas Olmos (NVIDIA/Mellanox Israel)

11:00 Session 2

Physical layer security: A novel approach for security in the optical domain
Marija Furdek (Chalmers University of Technology, Sweden)

Embedding intelligence: Machine Learning and Artificial Intelligence in Optical Networking
Nicola Sambo (Scuola Superiore Sant'Anna, Italy)
Antonio Eira (Infinera, Portugal)

Final panel discussion

Moderator: Piero Castoldi

Opening and Plenary Session

Monday, 23. September, 09:30–12:00, Forum

Andreas “Andy” Bechtolsheim

Co-Founder and Chief Architect of Arista Networks

Previously, Andy was a Co-Founder and Chief System Architect at Sun Microsystems, responsible for next generation server, storage, and network architectures.

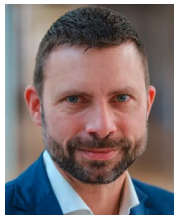
As a private venture investor, Andy has been involved in the funding of numerous companies including Google, VMware, Mellanox, and Brocade. He has served on the Board of Directors of over 25 companies, the majority of which went public or were acquired.

Andy earned a M.S. in Computer Engineering from Carnegie Mellon University in 1976 and was a doctoral student in Computer Engineering at Stanford University from 1977 to 1982.

He has been honored with a Fulbright scholarship, a Studienstiftung scholarship, the Stanford Entrepreneur Company of the year award, the Smithsonian Leadership Award for Innovation, and is a member of the National Academy of Engineering.

Can Interconnects Keep Up with AI?

The bandwidth requirements of AI clusters represent an unprecedented challenge for AI Fabric interconnects. I will discuss ways to improve the power, cost and reliability of optics, the boundaries between copper and optics, and opportunities for packaging innovation.



Thomas van Briel

SVP Architecture and Strategy Deutsche Telekom Technik GmbH

At the core of Thomas’ career is driving transformation of technology, business and organization, building on experience from a broad range of roles within telecommunications. He is holding master degrees in computer science and business administration. Thomas started his career in software development with Nortel and Swisscom, followed by an executive leadership of project and investment controlling. Since 2010, he holds executive

leadership roles in IT and NT strategy and architecture. He joined DT end of 2016 as a dual citizen to establish and lead today’s DT Technik architecture and strategy team.

He is currently responsible for network and service architecture Germany (fixed & mobile access, core & transport network, service platforms), OSS architecture as well as network automation (DT group level).

Evolution of IP and Optical Networks

Experience an informative insight into the past, present, and future of Optical Networks. I will highlight the strategic importance and technological advancements that have revolutionized Optical Transmission and will continue to drive it forward.

Roel Baets

Emeritus Professor at Ghent University and former Group Leader at IMEC

Roel received MSc degrees in Electrical Engineering both from UGent and from Stanford University. He received a PhD degree from UGent in 1984. From 1984 till 1989 he held a postdoctoral position at IMEC. Since 1989 he has been a professor in the Faculty of Engineering and Architecture of UGent where he founded the Photonics Research Group. He has also held part-time professor positions at Delft University of Technology and at Eindhoven University of Technology.

Roel Baets has made contributions to research on photonic integrated circuits (PICs), both in silicon photonics and in III-V semiconductors, including their heterogeneous integration. His early research focused mostly on components and technologies, such as widely tunable lasers for optical fiber communication systems, grating couplers for fiber-chip coupling, phased array beam steerers and light sources integrated with silicon photonics. Later his research gradually moved to the application level, especially with focus on medical and environmental sensing.

Roel Baets has chaired the Photonics Research Group at UGent-IMEC until October 2022. With 12 professors and 85 researchers this group is involved in numerous (inter)national research programs. Seven spin-off companies have resulted from the group’s research.

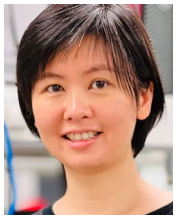
Roel Baets has led major research projects in silicon photonics in Europe. In 2006 he founded ePIXfab, the globally first Multi-Project-Wafer service for silicon photonics. Since then ePIXfab has evolved to become the European Silicon Photonics Alliance. He was also co-founder of a MSc pro-

gramme in Photonics, a joint master programme of UGent and VUB.

Roel Baets has been an ERC grantee of the European Research Council and a Methusalem grantee of the Flemish government. He is a Fellow of the IEEE, of the European Optical Society (EOS) and of Optica. He has been a recipient of the 2011 MOC award, of the 2018 PIC-International Lifetime Achievement Award, of the 2020 OSA-IEEE John Tyndall award and of the 2023 IEEE Photonics Award.

Towards Silicon Photonics 4.0

Silicon photonics is rapidly transitioning from a relatively uniform and monolithic technology used primarily for data centers to a diverse and heterogeneous technology family serving a much broader array of markets. Adopting an "Industry 4.0" approach will be crucial for the success of this transition.



Joyce Poon

Head of Photonics Architecture at Lightmatter

Joyce Poon's career has taken her across the globe, from the curiosity-driven explorations in academia to the dynamic world of industry. Dr. Poon is currently the Head of Photonics Architecture at Lightmatter. She is on leave from the University of Toronto, where she is a Professor of Electrical and Computer Engineering and has been on faculty since 2007. She is a guest scientist at the Max Planck Institute of Microstructure Physics, where she served as Director from 2018 until July 2024. She is also an Honorary Professor in the Faculty of Electrical Engineering and Computer Science at the Technical University of Berlin.

Dr. Poon and her team specialize in integrated photonics on silicon. They work closely with foundries on a wide range of topics in silicon photonics, including multi-layer silicon nitride integration, hybrid lasers, and integrated optics for the visible spectrum. Their research aims to advance integrated photonics for communications, computing, and brain interfaces.

Dr. Poon obtained the Ph.D. and M.S. in Electrical Engineering from the California Institute of Technology in 2007 and 2003 respectively, and the B.A.Sc. in Engineering Science (physics option) from the University of Toronto in 2002. Recognitions she has received include a Canada Research Chair (2012–2019), ECE Department Teaching Award (2017), OFC Top-Scored Paper (2017), MIT TR35 (2012), and the IBM Faculty Award (2010, 2011). She served as a Director-at-Large for Optica (formerly OSA) from 2021 to 2023. She is an Optica Fellow and a Fellow of the IEEE.

Future Computing with Integrated Photonics

The most significant opportunities and challenges in computing lie at the extreme ends of the size scale – in large datacenters and personal devices. I will discuss how advanced integrated photonics can transform computing across these different scales, from boosting the efficiency of large-scale AI systems to enabling new types of wearables and brain-computer interfaces.

Women in Photonics

Wednesday, 25. September, 12:30–14:00, Illusion

Empowerment Bridge: Taking Cognizance from Leading Ladies in Photonics and Optics

Join us for a special event that honors and celebrates professional women in the dynamic fields of optics and photonics. Discover the remarkable achievements and innovative ideas of female mentors and role models, and seize the chance to network with fellow participants and potential mentors.

Engage in a thought-provoking panel discussion featuring distinguished speakers from academia and industry. They will share their insights and visions on promoting fairness in the workplace, discuss the challenges they've overcome, and reveal invaluable lessons from their journeys. This event is your opportunity to be inspired and to foster mentorship opportunities that drive gender diversity within the photonics and optics industry.

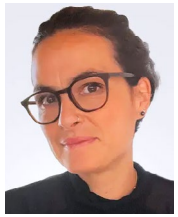
After the panel, enjoy a networking lunch designed to facilitate meaningful connections and the exchange of ideas. The lunch is sponsored by OPTICA.

Don't miss out on this inclusive and empowering experience. Register your interest when you sign up for ECOC online. This event is open to all registered attendees of ECOC.

Organisers:

- Anna Lena Schall-Giesecke (Fraunhofer IMS and University of Duisburg-Essen, Germany)
- Elena Noeke (1&1 Versatel Düsseldorf, Germany)
- Anjali Sharma (University of the Bundeswehr Munich, Germany)

Panel Members



Camille-Sophie Brès

Physicist and Professor at EPFL Switzerland

Camille-Sophie Brès is an associate professor at EPFL in the institute of Electrical Engineering. She received her bachelor degree with honors in electrical engineering from McGill University, Canada, in 2002. She obtained her PhD in electrical engineering from Princeton University in 2006. After a post-doctoral position at the University of California San Diego, she joined EPFL in 2011 as a tenure track professor and director of the Photonic Systems Laboratory. She and her team specialize on the design, simulation and demonstration of optical waveguides and devices for enhancing and controlling nonlinear processes aimed at light generation, signal processing, or sensing. She was awarded the early career Women in Photonics Award from the European Optical Society in 2016, as well as ERC starting (2012), Consolidator (2017) and Proof of Concept (2019) grants. She is active as part as technical program committees for various international conferences and is an OPTICA fellow.

Myriam Recha

Consulting Account Lead at Google

Myriam Recha is Consulting Account Lead at Google Cloud, helping customers in the telecommunications industry successfully adopt Google Cloud's products and services, enabling their IT and Network cloud transformation.

Prior to joining Google, Myriam held technology leadership and sales roles in Mavenir, Vodafone, Alcatel and Jazztel. Myriam has 25 years of international experience in the telecommunications industry, with expertise in network engineering, cloud, organizational transformation, and business development.

After a long career in technology organizations, with her last role at Vodafone as Director Local Design, leading the fixed access and TV engineering teams in Germany as well as the Vodafone Innovation Park, Myriam pivoted to sales roles at Mavenir and later Google, where she continues to operate in her sweet spot – the intersection between technology and business.

Myriam holds a degree in Telecommunications Engineering from Universitat Politècnica de Catalunya and currently lives in Düsseldorf, Germany.

Julie Eng

Coherent Corp.

Julie Sheridan Eng was named Chief Technology Officer (CTO) of Coherent in 2022. Prior to becoming CTO, Dr. Eng served as Senior Vice President and General Manager of Coherent/II-VI's Optoelectronic Devices and Modules Business Unit. Prior to joining II-VI through the II-VI acquisition of Finisar, Dr. Eng worked at Finisar, serving most recently as Executive Vice President and General Manager of Finisar's 3D Sensing Business Unit, and prior to that, as Executive Vice President of Datacom Engineering. Prior to joining Finisar, Dr. Eng was part of AT&T/Lucent/Agere, where she managed datacom transceivers.

Dr. Eng is a Past Chair of the IEEE Committee on Women in Engineering and presently serves on the Board of Directors of Optica (formerly the Optical Society of America). She holds a B.A. degree in Physics from Bryn Mawr College and a B.S. degree in Electrical Engineering from the California Institute of Technology (Caltech). She earned M.S. and Ph.D. degrees in Electrical Engineering from Stanford University. In 2022, she was elected Fellow of Optica for distinguished contributions to the advancement of optics and photonics.

Claudia Hoessbacher

CEO Polariton

Claudia's interest in light was stimulated during her B.Sc. in Electrical Engineering at KIT, Germany, and further nurtured by her Master's in Optics and Photonics. This fascination led her to delve into photonic integrated circuits (PICs), plasmonics, and electro-optics for her PhD at ETH Zurich. Her cutting-edge research earned her the ETH Pioneer Fellowship in 2019, enabling her to co-found Polariton, a company aimed at providing the world's fastest, smallest, and most energy-efficient PICs to address the future of connectivity.

Sponsor

OPTICA

Moderator

Michela Svaluto

Michela Svaluto Moreolo is Research Director and the Coordinator of the "Photonic and Quantum Communication Technologies" research line within the Packet Optical Networks and Services research unit at the Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), Spain. She is also a member of the CTTC Management Team, with the role of Director of Quality Programs. Her Institutional responsibilities include the Human Resources Strategy for Researchers (HRS4R) and the Gender Equality Plan. In her role of mentor, she supervised various PhD and MSc/BSc students, as well as PostDoc and visiting researchers. She has been actively involved in several R&D projects and she has co-authored over 200 scientific publications. She serves as Associate Editor for the Journal of Optical Communications and Networking. She has organized different scientific events and serves as TPC member of the most relevant international conferences in the field of optical communications and photonics (e.g., ECOC, OFC, SPIE Photonics West, OECC/PSC, Optica APC). Dr. Svaluto Moreolo is an IEEE Senior Member.

Tutorials

SC1: Novel Fibres, Fibre Devices and Amplifiers

Wilfried Blanc, Université Côte d'Azur, CNRS, Institut de physique de Nice

Nanoparticles in optical fiber, issue and opportunity of light scattering
M2D.1 – 23.09.2024, 14:00–15:00, Harmonie 4

Wilfried Blanc received the M.Sc. Degrees in Physics and the Ph.D. degree in Physics from University Claude Bernard, Lyon, France, in 1996 and 2000, respectively. He held a post-doctoral position at the University of Bordeaux (ICMCB laboratory), funded by Rhodia-Solvay. In 2002, he commenced with the Centre National de la Recherche Scientifique (CNRS) at the Laboratoire de Physique de la Matière Condensée (now Institut de Physique de Nice), where his main interests are the design, realization and characterization of nanoparticles-doped optical fibers which are made by using modified chemical vapor deposition (MCVD) technique.

SC2: Discrete Photonic Devices and Technologies

Juerg Leuthold, ETH Zurich

Plasmonic-based devices for ultra-fast communication
Th1G.3 – 26.09.2024, 09:30–10:30, Spektrum

Juerg Leuthold is the head of the department of Information Science and Elecrical Engineering (D-ITET) and he is the head of the Institute of Electromagnetic Fields (IEF) of ETH Zurich, Switzerland. His interest are in the field of Photonics, Plasmonics and Microwave with an emphasis on applications in communications and sensing. Before his time at ETH he was affiliated with the Karlsruhe Institute of Technology (KIT) in Germany, where he was the Head of the Institute of Photonics and Quantum Electronics (IPQ) and the Helmholtz Institute of Microtechnology (IMT) in the time from 2004 until 2013. From 1999 to 2004, he was affiliated with Bell Labs, Lucent Technologies, Holmdel, NJ, USA, where he performed device and system research with III/V semiconductors and silicon photonics for applications in high-speed telecommunications. Juerg Leuthold received the Ph.D. degree in physics from ETH Zurich in Switzerland for work in the field of integrated optics and all-optical communications in 1998.

Juerg Leuthold is a fellow of the Optica, a fellow of the IEEE, a member of the Swiss Academy of Engineering Sciences (SATW), and a member of the Heidelberg Academy of Sciences. He served the community as member of the Helmholtz Association Think Tank, as a member of the board of directors of the OSA (now Optica), as a general chair, program chair and member of many committees.

SC3: Photonic Integrated Circuits, Assemblies and Packaging

Alex Gaeta, Columbia University, New York, USA

Optical Frequency Combs from device to applications
W3C.1 – 25.09.2024, 14:00–15:00, Harmonie 3

Gaeta received his PhD in Optics from the University of Rochester. He joined Columbia University as the David M. Rickey Professor of Applied Physics and Materials Science in 2015. Prior to that, Gaeta was the Samuel B. Eckert Professor of Engineering at Cornell University and was Chair of the School of Applied and Engineering Physics from 2011 – 2014. He has published more than 300 journal articles in quantum and nonlinear photonics. He served as the founding Editor-in-Chief of the journal Optica from 2014–2020. Gaeta co-founded Xscape Photonics, Inc. and served as the CEO from 2021–2023. He is a Fellow of the Optica, APS, and IEEE, and a Thomson Reuters Highly Cited Researcher, and received the 2019 Charles H. Townes Prize and the 2023 Stephen D. Fantone Distinguished Service Award.

SC5: Optical Transmission Systems

Gerhard Kramer, Technical University of Munich (DGFI-TUM)

Information Theory of the Optical Channel
W1B.3 – 25.09.2024, 09:30–10:30, Harmonie 2

Gerhard Kramer is Senior Vice President for Research and Innovation at the Technical University of Munich (TUM). He received the B.Sc. and M.Sc. degrees in Electrical Engineering from the University of Manitoba in 1991 and 1992, and the Dr. sc. techn. degree from ETH Zurich in 1998. From 1998 to 2000, he was with Endora Tech AG in Basel, Switzerland; from 2000 to 2008, he was with the Math Center at Bell Labs in Murray Hill, NJ; and from 2009–2010 he was with the University of Southern California (USC), Los Angeles, CA. He joined TUM as Chair of Communications Engineering in 2010.

Kramer is an IEEE Fellow and served as the 2013 President of the IEEE Information Theory Society. He has received several recognitions for his research, including an Alexander von Humboldt Professorship, an IEEE Communications Society Stephen O. Rice Prize Paper Award, a Thomas Alva Edison Patent Award, and the Aaron D. Wyner Distinguished Service Award of the IEEE Information Theory Society. He is a member of the Bavarian Academy of Sciences and Humanities.

SC6: Architecture, Modelling and Performance of Optical Networks

Francesco Musumeci, Politecnico di Milano

Machine-Learning-Assisted Optical Network Failure Management: Challenges and Pitfalls
W4B.3 – 25.09.2024, 16:30–17:30, Harmonie 2

Francesco Musumeci is currently Associate Professor with the Department of Electronics, Information and Bioengineering of Politecnico di Milano, where he got the PhD in 2013.

His current research interests include Machine-Learning-assisted networking, design and optimization of optical networks, network disaster resilience, and converged space-ground network infrastructures. In these areas, he is author of more than 130 papers published in international journals and conference proceedings, 3 book chapters and 1 patent in the area of communication networks, and is co-winner of three best paper awards from IEEE-sponsored conferences.

Dr. Musumeci acted or is acting as general chair of IEEE ANTS 2023, and as technical program chair of DRCN 2021, IEEE ANTS 2022, IEEE ICC 2025. He uses to serve as a TPC member and/or reviewer for several IEEE/Optica-sponsored conferences as well as IEEE, Optica, Springer and Elsevier journals since 2010.

Francesco Musumeci is and has been involved in several EU R&D projects as well as national projects funded by the Italian Government. He is also IEEE Senior Member.

SC7: Access, Indoor and Short-Reach Systems for Data Centres and Mobile Networks

Seb Savory, University of Cambridge

Simplified Transceivers for Coherent-Lite Systems
Tu3D.3 – 24.09.2024, 14:00–15:00, Harmonie 4

Seb Savory is the Professor of Optical Fibre Communication at the University of Cambridge. His interest in optical fibre communication began in 1991, when he joined STL (subsequently Nortel) in Harlow. Having been sponsored by Nortel through his undergraduate and postgraduate studies at Cambridge he re-joined the Harlow Laboratories in 2000. In 2005, he joined the Optical Networks Group at UCL, progressing from Research Fellow to Professor. In 2016 he returned to Cambridge, being promoted to Professor in 2019.

SC8: Sensing and Microwave Photonics

Ezra Ip, NEC Laboratories America

Fiber sensing with and for optical networks
M3F.2 – 23.09.2024, 16:30–17:30, Harmonie 6

Ezra Ip received his B.E. (Hons) degree in electrical & electronics engineering from the University of Canterbury, Christchurch, New Zealand in 2002. He received his M.S. and Ph.D. degrees in electrical engineering in 2004 and 2008 from Stanford University, Stanford, CA, USA. His doctoral thesis was on coherent detection and digital signal processing for optical communications. Dr. Ip joined NEC Laboratories America in 2009 and is a senior researcher in the optical networking and sensing department. He has published more than 100 journal and conference papers in the areas of high-capacity optical transmission, digital signal processing techniques, space division multiplexing, and distributed fiber sensing.

SC10: Control and Management of Optical Networks

Piero Castoldi, Scuola Superiore Sant'Anna

Control of optical networks: a reality check and future perspectives
Tu1B.3 – 24.09.2024, 09:30–10:30, Harmonie 2

Piero Castoldi (IEEE Senior Member) is Full Professor in Telecommunications and Responsible for the "Networks and Services" area of the TeCIP Institute at Scuola Superiore Sant'Anna (Pisa, Italy). He is also Director of the Institute for Telecommunications, Informatics and Photonics (TeCIP) at Scuola Superiore Sant'Anna.

Piero Castoldi got his MSc degree from the University of Bologna and his Ph.D. degree in Information Technology from the University of Parma. In the academic year 1996/97 he was a post-doc at the Department of Electrical Engineering of Princeton University (USA) where he was also hosted as visiting Fellow in the summers 1999 and 2000. He has been involved with various responsibilities in several national and EU FP7, H2020 and HE projects and he has managed several corporate-sponsored projects with the italian Railway Infrastruture Company, Ericsson, Telecom Italia and other companies. He has served as project manager for several projects of the Italian National Consortium for Telecommunications (CNIT).

His teaching activity has been extensive including the coordination of two Erasmus Mundus Master programs. His most recent research interests lie in the areas of optical network architectures, network management and control, interconnection networks for Data Centers, networks for industrial applications, 5G/6g networking. He is author of more than 500 technical papers published in international journals and international conference proceedings and he has filed more than 20 patents.

Invited Speakers

SC1: Novel Fibres, Fibre Devices and Amplifiers

Yingying Wang, Jinan University / Linfiber. Tech., Canada
Hollow-Core Fibres: Design, Fabrication and Characterisation
M2D.2 – 23.09.2024, 15:00–15:30, Harmonie 4

Markus Schmidt, Leibniz Institute of Photonic Technology, Germany
Liquid-Core Fibers: a base for tunable nonlinear frequency conversion
W3A.3 – 25.09.2024, 14:30–15:00, Harmonie 1

Vitaly Mikhailov, OFS Laboratories, USA
O-band Bismuth Doped Fibre Amplifiers
W3A.4 – 25.09.2024, 15:00–15:30, Harmonie 1

Rodrigo Amezcua Correa, CREOL, University of Central Florida, USA
High energy transmission in hollow core fibers
Th1A.5 – 26.09.2024, 10:00–10:30, Harmonie 1

SC2: Discrete Photonic Devices and Technologies

Alexander White, Stanford, USA
Integrated passive nonlinear optical isolators
M2G.3 – 23.09.2024, 14:30–15:00, Spektrum

Felix Eltes, Lumiphase AG, Switzerland
BTO-enhanced Silicon Photonics for Next-Generation Transceivers
Tu1G.1 – 24.09.2024, 09:00–09:30, Spektrum

Mian Zhang, HyperLight Corp, USA
Thin-film Lithium Niobate Modulators
Tu1G.4 – 24.09.2024, 10:00–10:30, Spektrum

Jonathan Klamkin, University of California Santa Barbara, USA
Quantum Dot Lasers on Silicon by Heterogeneous Integration
Tu3G.1 – 24.09.2024, 13:30–14:00, Spektrum

Richard Taylor, Vector Photonics, United Kingdom
Illuminating Tomorrow: Photonic Crystal Surface Emitting Lasers (PCSELS) Advantages and Pitfalls
W3G.5 – 25.09.2024, 15:00–15:30, Spektrum

Alireza Geravand, Université Laval, Canada
Terabit All-Silicon Micrometer-Scale Coherent Modulator
Th2G.5 – 26.09.2024, 12:00–12:15, Spektrum

SC3: Photonic Integrated Circuits, Assemblies and Packaging

Fabio Cavaliere, Ericsson, Italy
Integrated Photonics for Radio Access: Where We Are
Tu1C.1 – 24.09.2024, 09:00–09:30, Harmonie 3

Kristinn Gylfason, KTH Royal Institute of Technology, Sweden
Opportunities for Mechanically Actuated Photonics
Tu1C.4 – 24.09.2024, 10:00–10:30, Harmonie 3

Hao Hu, Technical University of Denmark, Denmark
Integrated Optical Phased Array with a 180-Degree Field of View for Solid-State 2D Optical Beam Steering
Tu4G.1 – 24.09.2024, 15:30–16:00, Spektrum

Kazuhiro Ikeda, AIST, Japan
Large Switching Fabrics Enabled by Silicon Photonics
Tu4G.2 – 24.09.2024, 16:00–16:30, Spektrum

SC4: Signal Processing for Optical Communication and Computing

Chris Fludger, Infinera, Germany
Advances in Power-Optimized Coherent Transceivers for Metro-Edge and DCI Applications
M2C.5 – 23.09.2024, 15:00–15:30, Harmonie 3

DAT PHAM, National Institute of Information and Communications Technology (NICT), Japan
Photonics-Enabled Terahertz Signal Processing for Extreme Communications in 6G and Beyond
Tu1F.5 – 24.09.2024, 10:00–10:30, Harmonie 6

Jose Capmany, Universidad politécnica de Valencia, Spain
Perspectives in programmable photonics (focus on algorithms)
Tu3C.5 – 24.09.2024, 14:30–15:00, Harmonie 3

Ruby Stella Bravo Ospina, Nokia Bell Labs, France
DSP-based MDG Estimation in SDM Transmission
W1C.1 – 25.09.2024, 09:00–09:30, Harmonie 3

Mikael Mazur, Nokia Bell Labs, USA
SDM transmission using real-time Digital Signal Processing
W1C.4 – 25.09.2024, 10:00–10:30, Harmonie 3

SC5: Optical Transmission Systems

Daiki Soma, KDDI Research, Inc., Japan
Multiband DWDM Transmission Using a Deployed Fibre-Optic Cable
M2B.3 – 23.09.2024, 14:30–15:00, Harmonie 2

Daniel J. Elson, KDDI Research, Inc., Japan
An Ideal Pairing: Multicore Fibres and Coherent O-band DWDM Transmission Supported by BDFA
M3B.5 – 23.09.2024, 17:00–17:30, Harmonie 2

Ruben Soares Luis, National Institute of Information and Communications Technology (NICT), Japan
High Data-Rate Optical Transmission in Multi-Core/ Multi-Mode Fibers
Tu3B.1 – 24.09.2024, 13:30–14:00, Harmonie 2

Cristian Antonelli, L'Aquila University, Italy
Space-Division Multiplexed Transmission from the Lab to the Field
Tu3B.4 – 24.09.2024, 14:30–15:00, Harmonie 2

Menno van den Hout, Eindhoven University of Technology, Netherlands
Long-Distance Space-Division-Multiplexed Transmission Using High-Mode-Count Multi-Mode Fibers
W3B.3 – 25.09.2024, 14:30–15:00, Harmonie 2

Zhixue He, Peng Cheng Laboratory, China
Beyond 200 Terabit per Second S+C+L-band Transmission over Ultra-Wideband Anti-Resonant Hollow-Core Fibre
Th1B.5 – 26.09.2024, 10:00–10:30, Harmonie 2

SC6: Architecture, Modelling and Performance of Optical Networks

Matheus Ribeiro Sena, Deutsche Telekom AG, Germany
Link Tomography: A Tool for Monitoring Optical Network and Designing Digital Twins
M3E.5 – 23.09.2024, 17:00–17:30, Harmonie 5

Stefan Karlsson, Swedish Defense Material Administration, Sweden
Detection and Classification of Eavesdropping and Mechanical Vibrations in Fiber Optical Networks by Analyzing Polarization Signatures Over a Noisy Environment
Tu4E.5 – 24.09.2024, 16:30–17:00, Harmonie 5

Shin Kaneko, NTT Access Network Service Systems Laboratories, NTT Corporation, Japan
Recent Metro/Access Converged Network Technology
W1E.1 – 25.09.2024, 09:00–09:30, Harmonie 5

SHU NAMIKI, AIST, Japan
Optical Switching Challenges for the Post-Moore's Law Era
Th2E.3 – 26.09.2024, 11:30–12:00, Harmonie 5

SC7: Access, Indoor and Short-Reach Systems for Data Centres and Mobile Networks

Zhensheng Jia, China
Advances in the Latest Coherent PON Technology and Industry Specification Development
M3D.5 – 23.09.2024, 17:00–17:30, Harmonie 4

Rene Bonk, Nokia, Bell Labs, Germany
The road towards 100G and 200G-Passive Optical Networks
W3D.4 – 25.09.2024, 15:00–15:30, Harmonie 4

Devika Dass, CONNECT, School of Computer Science and Statistics, Trinity College Dublin, IE
Coexistence of Analogue Radio and Digital Coherent Transmission Over Access/Metro Networks fibre for Bandwidth-Efficient Fronthaul Beyond 5G
Th1D.1 – 26.09.2024, 09:00–09:30, Harmonie 4

Fabienne SALIOU, Orange S.A., France
Future Converged Fixed/Mobile Access Networks in the 6G Era (Invited)
Th1D.2 – 26.09.2024, 09:30–10:00, Harmonie 4

SC8: Sensing and Microwave Photonics

Cheng Wang, City University of Hong Kong, Hong Kong
Integrated lithium niobate microwave and millimeter-wave photonics
M2F.3 – 23.09.2024, 14:30–15:00, Harmonie 6

Chris Roeloffzen, LioniX International, Netherlands
Hybrid Integrated Microwave Photonics for Multi-Beam Antenna applications
M3F.1 – 23.09.2024, 16:00–16:30, Harmonie 6

Yijie Tao, The University of Melbourne, Australia
Optical Wireless Convergence in the B5G Era
Tu4F.5 – 24.09.2024, 16:30–17:00, Harmonie 6

Luca Rinaldi, CNIT- National Inter-University Consortium for Telecommunications, Italy
Microwave photonics radars
W1F.5 – 25.09.2024, 10:00–10:30, Harmonie 6

Jean Pierre von der Weid, Pontifical Catholic University of Rio de Janeiro, Brazil
Long Term Monitoring of Fibre-Optic Submarine Networks
W3F.3 – 25.09.2024, 14:30–15:00, Harmonie 6

Tiejun Xia, Verizon, USA
Leveraging Fiber Sensing Applications for Next-Generation Optical Transport Networks
W4F.5 – 25.09.2024, 17:00–17:30, Harmonie 6

SC9: Free-Space Optics and Optical Wireless Technologies

Devin Brinkley, Google X, USA
Optical Phased Arrays for Wireless Connectivity
M3C.1 – 23.09.2024, 16:00–16:30, Harmonie 3

Rajiv Boddeda, Nokia Bell Labs, France
Current State, Prospects, and Opportunities for Reaching Beyond 100 Gbps per Carrier Using Coherent Optics in Satellite Communications
Tu4C.3 – 24.09.2024, 16:00–16:30, Harmonie 3

Katherine Newell, Johns Hopkins Applied Physics Laboratory, USA
Free Space Optical Link Between Two Ships at Sea
W1D.5 – 25.09.2024, 10:00–10:30, Harmonie 4

Fernando Guiomar, Instituto de Telecomunicações, University of Aveiro, Portugal
Can DSP mitigate the effect of turbulence on FSO signals?
Th2D.1 – 26.09.2024, 11:00–11:30, Harmonie 4

SC10: Control and Management of Optical Networks

Ricard Vilalta, Centre Tecnològic de Telecomunicacions de Catalunya (CTTC-CERCA), Spain
Applying Digital Twins to Optical Networks with Cloud-native SDN Controllers and Generative AI
M2E.4 – 23.09.2024, 15:00–15:30, Harmonie 5

Takahiro Suzuki, NTT Access Network Service Systems Laboratories, Japan
Full-stack Softwarization in Optical Access Network
Tu4D.1 – 24.09.2024, 15:30–16:00, Harmonie 4

Jesse Simsarian, Nokia Bell Labs, USA
Scaling and Autonomous Operation of Future Transport Networks
W3E.5 – 25.09.2024, 15:00–15:30, Harmonie 5

Filippo Cugini, CNIT, Italy
Data Processing Unit (DPU) and P4 Programmability in Support of the Edge Continuum
W4E.1 – 25.09.2024, 16:00–16:30, Harmonie 5

Nina Skorin-Kapov, University Center of Defense, San Javier Air Force Base, Spain
Digital Subcarrier-based Point-to-Multipoint Trees in ROADM-based Networks
Th1E.1 – 26.09.2024, 09:00–09:30, Harmonie 5

SC11: Quantum Communications and Quantum Computing

Eleni Diamanti, Sorbonne Université – CNRS, France
Secure Communication with Quantum Continuous Variables
M3A.1 – 23.09.2024, 16:00–16:30, Harmonie 1

Klaus Jons, Paderborn University, Germany
Quantum Light Sources
Tu3A.1 – 24.09.2024, 13:30–14:00, Harmonie 1

Stefanie Barz, University of Stuttgart (D), Germany
Photonic Quantum Technologies: From Quantum Optics to Quantum Networks
W1A.1 – 25.09.2024, 09:00–09:30, Harmonie 1

Robert Chapman, ETH Zurich, Switzerland
Lithium niobate-on-insulator photonics – an emerging platform for quantum communication and computation
W4A.5 – 25.09.2024, 17:00–17:30, Harmonie 1

Felix Wissel, Deutsche Telekom Geschäftskunden GmbH, Germany
Pan-European QKD Deployments within the EuroQCI Initiative
Th2A.3 – 26.09.2024, 11:30–12:00, Harmonie 1

Agenda of Sessions — Sunday, 22. September

	Harmonie 1	Harmonie 2	Harmonie 3	Harmonie 4	Harmonie 5	Harmonie 6	Spektrum
09:00	**WS1:** Has the Time Come for Quantum-Secure Optical Networks?	**WS2:** Massively Parallel Optical Transceivers and Interfaces – Where Are we on This Path?	**WS3:** What Is the Best Wavelength for Free-Space Optical (FSO) Communication?	**WS4:** When Could Multi-Band Systems Become More Cost-Effective Than Parallel C-Band Systems?	**WS5:** What Can Digital Twins Fueled With Generative AI Offer to Optical Networks?	**WS6:** 6G in Buildings: Head Against the Wall?	**WS7:** Overhyped or the Real Deal: Which Photonics Integration Platform Will Lead the Way?
10:30	Coffee Break (Conference Center)						
11:00	**WS1:** continued	**WS2:** continued	**WS3:** continued	**WS4:** continued	**WS5:** continued	**WS6:** continued	**WS7:** continued
12:30	Lunch Break (on your own)						
14:00	**WS8:** Is QKD Technology Ready to Become a Standard for Secure Communications?	**WS9:** Intra-Datacenter Connectivity: Bottlenecks & Trends for AI Clusters	**WS10:** Is There a Gold Standard Fiber Optic Sensing Technology to Monitor the Environment Around Us?	**WS11:** Beyond 50G-PON – Can We Still Use IMDD?	**WS12:** How Will AI Affect Future Transmission Systems?	**WS13:** Emerging From Under the Sea – Where Will SDM Land?	**WS14:** Mobile Optics for 6G and Open Cloud RAN: New Concepts or More of the Same?
15:30	Coffee Break (Conference Center)						
16:00	**WS8:** continued	**WS9:** continued	**WS10:** continued	**WS11:** continued	**WS12:** continued	**WS13:** continued	**WS14:** continued
17:30 20:00	Get-Together Reception (Conference Center)						

Agenda of Sessions — Monday, 23. September

	Harmonie 1	Harmonie 2	Harmonie 3	Harmonie 4	Harmonie 5	Harmonie 6	Spektrum	Illusion/Fantasie
09:00	Morning Coffee (Forum)							
09:30	ECOC 2024 Opening & Plenary Session (Forum)							
12:00	Lunch Break (on your own)							
14:00	**M2A:** Novel Short-Reach & Access Systems	**M2B:** Multiband Transmission I	**M2C:** Low-Power Consumption DSP	**M2D:** Optical Fibers: From Nanoparticles to Hollow Cores	**M2E:** Digital Twins	**M2F:** MWP Components	**M2G:** Integrated Passive Devices and Switches	Green ICT Symposium (Illusion)
15:30	Coffee Break (Exhibition)							
16:00 17:30	**M3A:** QKD Systems	**M3B:** Multiband Transmission II	**M3C:** Ultrafast Terrestrial FSO	**M3D:** Coherent PON – I	**M3E:** Longitudinal Power Profile Monitoring	**M3F:** Sensing and Microwave Photonics	**M3G:** Photonic Circuits for Integrated Neural Signal Processing	
17:45 19:15	Symposium 50 Years of ECOC (Illusion + Fantasie)							
19:30 23:00	50 Years of ECOC Celebration (Forum)							

Agenda of Sessions — Tuesday, 24. September

	Harmonie 1	Harmonie 2	Harmonie 3	Harmonie 4	Harmonie 5	Harmonie 6	Spektrum	Illusion/Fantasie
09:00	**Tu1A:** Doped Fiber Amplifiers Improved Designs, Multimode and Multicore	**Tu1B:** Advances in Network Control and Management	**Tu1C:** Novel Opportunities for Integrated Photonics & Transceivers	**Tu1D:** Intra-Data Center Systems	**Tu1E:** LiFi for Indoor and Underwater Communications	**Tu1F:** THz Processing and Coding	**Tu1G:** Novel Modulators	10th International Symposium for Optical Interconnects in Data Centres (Illusion)
10:30	Coffee Break (Exhibition)							
11:00	Demo Session (Hall 5)	Exhibition Only Time						
12:30								
13:30	**Tu3A:** Photonic Devices for Quantum Communication	**Tu3B:** Space-Division Multiplexing I	**Tu3C:** Novel Optical and Digital Signal Processing Techniques	**Tu3D:** Coherent PON – II	**Tu3E:** Performance Monitoring Techniques	**Tu3F:** Wireless THz Comms	**Tu3G:** Heterogeneous Laser Integration	
15:00	Coffee Break (Exhibition)							
15:30 17:00	**Tu4A:** Few Mode Fibers and Characterization Techniques	**Tu4B:** High-Speed Transmission	**Tu4C:** FSO for Satellite Communications	**Tu4D:** 6G and Network Convergence	**Tu4E:** Optical Network Resilience	**Tu4F:** Advanced Radio-Over-Fiber & Fronthaul Systems	**Tu4G:** Progress of Silicon Photonic and Plasmonic Technology	
17:15 18:45								Rump Session (Illus.)

Agenda of Sessions — Wednesday, 25. September

	Harmonie 1	Harmonie 2	Harmonie 3	Harmonie 4	Harmonie 5	Harmonie 6	Spektrum	Illusion/Fantasie
09:00	**W1A:** QKD Security	**W1B:** Fiber Capacity and Transmission	**W1C:** Spatial Division Multiplexing	**W1D:** Challenges for Terrestrial FSO	**W1E:** Architecture From Submarine to Metro/ Access Networks	**W1F:** Integrated Sensing and Comms	**W1G:** Integrated Devices for Future High-Capaciity Networks	
10:30	Coffee Break (Exhibition)							
11:00	**W2A:** Poster Session (Hall 6)							
12:30	Lunch Break (on your own)							Women in Photonics (Illusion)
14:00	**W3A:** Fibers for Nonlinearity and Amplification	**W3B:** Space-Division Multiplexing II and Modeling	**W3C:** Devices & Applications of Optical Frequency Tuning	**W3D:** Ultra-Highspeed PON	**W3E:** Network Automation	**W3F:** Integrated Sensing and Comms	**W3G:** Integrated Light Sources	Satellite Symposium (Fantasie)
15:30	Coffee Break (Exhibition)							
16:00	**W4A:** QKD Networks	**W4B:** Machine Learning in Optical Networks	**W4C:** Equalisation and Performance Monitoring for High Rate Transmissions	**W4D:** 50G PON	**W4E:** Network Programmability	**W4F:** Remote Sensing	**W4G:** Integrated Receivers	
17:30								
18:00						EPIF – 15th European Photonic Integration Forum	Photonics in Germany	Hack Your Research! (Illusion)
19.00	Conference Dinner (Palmengarten)							
20:00 23:00								

Agenda of Sessions — Thursday, 26. September

	Harmonie 1	Harmonie 2	Harmonie 3	Harmonie 4	Harmonie 5	Harmonie 6	Spektrum	Illusion/Fantasie
09:00	**Th1A:** Advances in Hollow Core Fibers Beyond low Loss	**Th1B:** Hollow-Core Fiber and SOA	**Th1C:** Phase-Retrieval, Self-Coherent, and Direct-Detect	**Th1D:** Metro-Access, Fronthaul & 6G	**Th1E:** Network Architectures and Resource Allocation	**Th1F:** Remote Sensing	**Th1G:** Devices for High-Speed Transmission	Optical Networking Symposium (Fantasie)
10:30	Coffee Break (Conference Center)							
11:00	**Th2A:** QKD Field Trials	**Th2B:** Submarine and Long-Haul	**Th2C:** VCSEL Arrays & Optical Multiport Packaging	**Th2D:** Atmospheric Turbulence Mitigation for FSO	**Th2E:** Optical Node Architectures		**Th2G:** Resonator-Based Modulators	
12:30	Lunch Break (on your own)							
14:00 15:30	Post Deadline Sessions							
15:45 16:30	Closing Session (Harmonie 5)							

Technical Programme

Harmonie 1

09:00–12:30
WS1 • Has the Time Come for Quantum-Secure Optical Networks?
Organisers: Laurent Schmalen (Karlsruhe Institute of Technology); Matthias Gunkel (Deutsche Telekom); Hannes Hübel (Austrian Institute of Technology)

See page 13 of this programme for more information about this workshop.

10:30–11:00 Coffee Break, Conference Center

WS1 • Has the Time Come for Quantum-Secure Optical Networks? — *Continued*

See page 13 of this programme for more information about this workshop.

12:30–14:00 Lunch Break (on your own)

Harmonie 2

09:00–12:30
WS2 • Massively Parallel Optical Transceivers and Interfaces – Where Are we on This Path?
Organisers: Xi (Vivian) Chen (Nokia Bell Labs); Dan Kuchta (IBM Research)

See page 13 of this programme for more information about this workshop.

WS2 • Massively Parallel Optical Transceivers and Interfaces – Where Are we on This Path? — *Continued*

See page 13 of this programme for more information about this workshop.

Harmonie 3

09:00–12:30
WS3 • What Is the Best Wavelength for Free-Space Optical (FSO) Communication?
Organisers: Oskars Ozolins (RISE); Herwig Zech (Tesat-Spacecom); Nicolas Perlot (Fraunhofer HHI)

See page 14 of this programme for more information about this workshop.

WS3 • What Is the Best Wavelength for Free-Space Optical (FSO) Communication? — *Continued*

See page 14 of this programme for more information about this workshop.

Harmonie 4

09:00–12:30
WS4 • When Could Multi-Band Systems Become More Cost-Effective Than Parallel C-Band Systems?
Organisers: Gabriel Charlet (Huawei); Jeremie Renaudier (Nokia Bell Labs); Chongjin Xie (Alibaba Cloud)

See page 14 of this programme for more information about this workshop.

WS4 • When Could Multi-Band Systems Become More Cost-Effective Than Parallel C-Band Systems? — *Continued*

See page 14 of this programme for more information about this workshop.

Harmonie 5

09:00–12:30
WS5 • What Can Digital Twins Fueled With Generative AI Offer to Optical Networks?
Organisers: Behnam Shariati (Fraunhofer HHI); Shoichiro Oda, (Fujitsu Limited)

See page 15 of this programme for more information about this workshop.

Harmonie 6

09:00–12:30
WS6 • 6G in Buildings: Head Against the Wall?
Organisers: Volker Jungnickel (Fraunhofer HHI); Maxim Kuschnerov (Huawei)

See page 15 of this programme for more information about this workshop.

Spektrum

09:00–12:30
WS7 • Overhyped or the Real Deal: Which Photonics Integration Platform Will Lead the Way?
Organisers: Eric Bernier (HiSilicon OE); Martijn Heck (Eindhoven University of Technology); Lars Zimmermann (IHP Microelectronics)

See page 16 of this programme for more information about this workshop.

10:30–11:00 Coffee Break, Conference Center

WS5 • What Can Digital Twins Fueled With Generative AI Offer to Optical Networks? — *Continued*

See page 15 of this programme for more information about this workshop.

WS6 • 6G in Buildings: Head Against the Wall? — *Continued*

See page 15 of this programme for more information about this workshop.

WS7 • Overhyped or the Real Deal: Which Photonics Integration Platform Will Lead the Way? — *Continued*

See page 16 of this programme for more information about this workshop.

12:30–14:00 Lunch Break (on your own)

Harmonie 1

14:00–17:30
WS8 • Is QKD Technology Ready to Become a Standard for Secure Communications?
Organisers: Haissam Hanafi (Quantum Business Network); Linus Krieg (Physikalisch-Technische Bundesanstalt); Imran Khan (KEEQuant)

See page 16 of this programme for more information about this workshop.

Harmonie 2

14:00–17:30
WS9 • Intra-Datacenter Connectivity: Bottlenecks & Trends for AI Clusters
Organisers: Peter Winzer (Nubis Communications); Shu Namiki (AIST); Laurent Schares (IBM)

See page 17 of this programme for more information about this workshop.

Harmonie 3

14:00–17:30
WS10 • Is There a Gold Standard Fiber Optic Sensing Technology to Monitor the Environment Around Us?
Organisers: Sander Jansen (Adtran); Paola Parolari (Politecnico di Milano)

See page 17 of this programme for more information about this workshop.

Harmonie 4

14:00–17:30
WS11 • Beyond 50G-PON – Can We Still Use IMDD?
Organisers: Derek Nesset (Huawei); Fabienne Saliou (Orange); Jochen Maes (Nokia)

See page 17 of this programme for more information about this workshop.

15:30–16:00 Coffee Break, Conference Center

WS8 • Is QKD Technology Ready to Become a Standard for Secure Communications? — *Continued*

See page 16 of this programme for more information about this workshop.

WS9 • Intra-Datacenter Connectivity: Bottlenecks & Trends for AI Clusters — *Continued*

See page 17 of this programme for more information about this workshop.

WS10 • Is There a Gold Standard Fiber Optic Sensing Technology to Monitor the Environment Around Us? — *Continued*

See page 17 of this programme for more information about this workshop.

WS11 • Beyond 50G-PON – Can We Still Use IMDD? — *Continued*

See page 17 of this programme for more information about this workshop.

17:30–20:00 Get-Together Reception, Conference Center

Harmonie 5

14:00–17:30
WS12 • How Will AI Affect Future Transmission Systems?
Organisers: David Millar (Infinera); Lidia Galdino (Corning)

See page 18 of this programme for more information about this workshop.

Harmonie 6

14:00–17:30
WS13 • Emerging From Under the Sea – Where Will SDM Land?
Organisers: Georg Rademacher (University of Stuttgart); Ruben Luis (NICT); Gabriele Da Rosa (Adtran)

See page 19 of this programme for more information about this workshop.

Spektrum

14:00–17:30
WS14 • Mobile Optics for 6G and Open Cloud RAN: New Concepts or More of the Same?
Organisers: Stefan Dahlfort (Ericsson); Philippe Chanclou (Orange); Xiaodan Pang (KTH)

See page 19 of this programme for more information about this workshop.

15:30–16:00 Coffee Break, Conference Center

WS12 • How Will AI Affect Future Transmission Systems? — *Continued*

See page 18 of this programme for more information about this workshop.

WS13 • Emerging From Under the Sea – Where Will SDM Land? — *Continued*

See page 19 of this programme for more information about this workshop.

WS14 • Mobile Optics for 6G and Open Cloud RAN: New Concepts or More of the Same? — *Continued*

See page 19 of this programme for more information about this workshop.

17:30–20:00 Get-Together Reception, Conference Center

Harmonie 1	Harmonie 2	Harmonie 3	Harmonie 4

09:00–09:30 Morning Coffee, Forum

09:30–12:00 ECOC 2024 Opening & Plenary Session, Forum

12:00–14:00 Lunch Break (on your own)

14:00–15:30
M2A • Novel Short-Reach & Access Systems
Presider: Oded Raz; Eindhoven University of Technology

M2A.1 • 14:00
Real-time 50G PON in service ODN monitoring based on receiver side DSP, *Vincent Houtsma; Robert Borkowski; Kovendhan Vijayan; Doutje van Veen; Nokia, Bell Labs.*

Real-time in operation ODN monitoring for a 50G PON system was performed relying solely on extract-ing information from the PON transceivers without the need for any additional optical hardware. Different fault scenarios and use cases were explored.

M2A.2 • 14:15
Longitudinal Power Monitoring for Simplified Coherent PONs, *Chenxi Tan; Istvan Bence Kovacs; Seb Savory; University of Cambridge.*

We demonstrate longitudinal power monitoring with piecewise linear fitting for a PON using a simplified coherent receiver employing Alamouti coding. Simulation results and experimental validation gives a lumped loss / splitter

14:00–15:30
M2B • Multiband Transmission I
Presider: Tomoyuki Kato; Fujitsu Ltd.

M2B.1 • 14:00
Record 202.3 Tb/s Transmission over Field-Deployed Fibre using 15.6 THz S+C+L-Bands, *Jiaqian Yang[1]; Eric Sillekens[1]; Benjamin Puttnam[2]; Ronit Sohanpal[1]; Mindaugas Jarmolovičius[1]; Romulo Aparecido[1]; Henrique Buglia[1]; Ruben Luis[2]; Ralf Stolte[3]; Polina Bayvel[1]; Robert Killey[1]; [1]Optical Networks Group, UCL (University College London), London; [2]National Institute of Information and Communications Technology, Tokyo; [3]Coherent / Finisar, New South Wales.*

Ultra-wideband, field-deployed metropolitan fibre transmission is experimentally demonstrated, measuring a record 202.3 Tb/s GMI and 189.5 Tb/s after decoding with 20.9 dBm launch power and lumped amplification only. An experimentally-optimised 5 dB pre-tilt over the 15.6 THz optical bandwidth was applied to overcome ISRS.

M2B.2 • 14:15
339.1 Tb/s OESCLU-band transmission over 100 km SMF, *Ben Puttnam[1]; Ruben Luis[1]; Ian Phillips[2]; Mingming Tan[2]; Alex Donodin[2]; Dini Pratiwi[2]; Lauren Dallachiesa[3]; Yetian Huang[3]; Mikael Mazur[3]; Nicolas Fontaine[3]; Haoshuo Chen[3]; Dicky Chung[4]; Victor Ho[4]; Daniele Orsuti[5]; Divya Ann Shaji[6]; Budsara Boriboon[1]; Georg Rademacher[7]; Luca Pallmieri[5]; Ray Man[4]; Roland Ryf[3]; David Neilson[3]; Wladek*

14:00–15:30
M2C • Low-Power Consumption DSP
Presider: Xi (Vivian) Chen; Nokia Bell Labs

M2C.1 • 14:00
Low-complexity Half-iterative Decoder with Channel-polarized Multilevel Coding for Power Consumption Constrained Data Center Network Application, *Takeshi Kakizaki[1]; Masanori Nakamura; Fukutaro Hamaoka; Shuto Yamamoto; Etsushi Yamazaki; [1]NTT Corporation.*

A low-complexity iterative decoding scheme for channel-polarized multilevel coding is proposed, halving the number of soft-decision decoders based on factor graph representation. The proposed scheme improves >0.25-dB net coding gain compared to the conventional 20$\%$-overhead concatenated BCH/KP4 codes for the same number of soft-decision decoders.

M2C.2 • 14:15
FPGA-based Low-complexity Digital Signal Processing for Multiple Symbol Rates and Modulation Formats, *Jingwei Song; Yan Li; Kejia Xu; Zhisheng Yang; Jifang Qiu; Xiaobin Hong; Hongxiang Guo; Jian Wu; Beijing University of Posts and Telecommunications.*

We proposed a clock recovery algorithm for multiple symbol rates and a phase-domain carrier recovery for

14:00–15:30
M2D • Optical Fibers: From Nanoparticles to Hollow Cores
Presider: Rogério Nogueira; Instituto de Telecomunicações – PT

M2D.1 • 14:00 **Tutorial**
Nanoparticles in optical fiber, issue and opportunity of light scattering, *Wilfried Blanc; Université Côte d'Azur, CNRS, Institut de physique de Nice, France.*

This Tutorial aims to introduce optical fibers containing nanoparticles in their cores. Particle-induced light scattering, an issue up to now, has for the last few years, on the contrary, been an opportunity to develop new applications for fiber sensors and fiber lasers.

Harmonie 5	Harmonie 6	Spektrum	Illusion

09:00–09:30 Morning Coffee, Forum

09:30–12:00 ECOC 2024 Opening & Plenary Session, Forum

12:00–14:00 Lunch Break (on your own)

14:00–15:30
M2E • Digital Twins
Presider: Marco Ruffini; Trinity College Dublin

M2E.1 • 14:00 Upgraded Invited

Digital Twin Enabled Automatic Power Adjustment with Multi-Step Lookahead Prediction, *Chenyu Sun[1]; Xin Yang[2]; Gabriel Charlet[3]; Photios A. Stavrou[4]; Yvan Pointurier[3]; [1]EURECOM / Huawei Technologies France S.A.S.U.; [2]Politecnico di Milano / Huawei Technologies France S.A.S.U.; [3]Huawei Technologies France S.A.S.U.; [4]EURECOM.*

We speed up network automatic power re-optimization by 2x with an algorithm leveraging prediction of SNR variations of all services when power adjustments are made, in a meshed optical network testbed based on commercial products.

14:00–15:30
M2F • MWP Components
Presider: Andreas Stöhr

M2F.1 • 14:00

Sub-THz D-Band wireless transmission using an ultrafast graphene photodetector, *Alberto Montanaro[1]; Alex Boschi[2]; Guillaume Ducournau[3]; Vaidotas Miseikis[4]; Stefano Soresi[5]; Sara Pascale[5]; Mario Giovanni Frecassetti[6]; Paola Galli[7]; Henri Happi[8]; Sergio Pezzini[9]; Camilla Coletti[2]; Marco Romagnoli[1]; Vito Sorianello[1]; [1]PNTLAB – CNIT; [2]Center for Nanotechnology Innovation @NEST, IIT; [3]CNRS, Centrale Lille, Université Polytechnique Hauts de France; [4]Graphene Labs, Istituto Italiano di Tecnologia; [5]Inphotec, CamGraPhIC srl; [6]NOKIA X-Haul BU; [7]Nokia Solutions and Networks Italia; [8]IEMN, Université de Lille; [9]NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore.*

We demonstrate a photonic-aided D-band up-conversion based on an ultrafast photonic integrated graphene photodetector with bandwidth exceeding 180 GHz. We show a D-Band transmission at 140 GHz carrier frequency, performing 10 Gb/s QPSK and 4 Gb/s 16-QAM signals transmission.

M2F.2 • 14:15

300-GHz band 125-Gbit/s wireless communication enabled by photomixer on SiC substrate, *Ryo Doi[1]; Yoshiki Kamiura[1]; Chengyuan Qian[1]; Yuma Kawamoto[2]; Weijie Gao[2]; Ming Che[1]; Yuya Mikami[1]; Tadao Nagatsuma[2]; Tadao Ishibashi[3]; Kazutoshi Kato[1]; [1]Graduate School of Information Science and Electrical Engineering, Kyushu University; [2]Osaka University; [3]wavepackets LLC.*

14:00–15:30
M2G • Integrated Passive Devices and Switches
Presider: Timo Aalto; VTT Technical Research Centre of Finland Ltd.

M2G.1 • 14:00

Strictly Non-blocking 8×8 Electro-optic Silicon Mach-Zehnder Switch with, *Peng Bao[1]; Chunhui Yao[1]; Minjia Chen[1]; Zhitian Shi[1]; Giuseppe Talli[2]; Maxim Kuschnerov[2]; Richard Penty[1]; Qixiang Cheng[1]; [1]University of Cambridge; [2]Huawei Technologie Dusseldorf GmbH.*

We report for the first time a strictly non-blocking 8×8 electro-optic silicon photonic switch that counter-balances free-carrier-absorption loss in the Mach-Zehnder interferometer cells by harnessing self-heating effect. Experimentally, we demonstrate a record-low crosstalk ratio of −40 dB and on-chip loss of as low as

M2G.2 • 14:15

Lattice-type Reconfigurable Spectral Filter for S/C/L Multiband WDM Signal Equalization, *Yoshie Morimoto[1]; Kenya Suzuki[1]; Keita Yamaguchi[1]; Fukutaro Hamaoka[2]; Masanori Nakamura[2]; Takayuki Kobayashi[2]; Yutaka Miyamoto[2]; Osamu Moriwaki[1]; [1]NTT Device Innovation Center, NTT Corporation; [2]NTT Network Innovation Laboratories, NTT Corporation.*

14:00–17:30
Green ICT Symposium
Organisers: Ronald Freund (Fraunhofer Heinrich Hertz Institute); Andreas Gladisch (Deutsche Telekom AG)

Green information and communication technology (ICT) is the key to achieve carbon neutrality and a low-carbon economy. Further innovations on component, (sub-)system and network level are needed to systematically tap into potential savings and to increase the energy efficiency of digital end devices, data centers, telecommunication networks and computing resources.

This symposium will feature impulse presentations and a panel discussion dedicated to discuss about innovative Green ICT solutions and their impact in the digitalization process of selected industries (ICT for Green).

Don't miss the opportunity to get familiar with the methodologies of lifecycle assessment as well as carbon footprint calculation methodologies. Discuss with the experts the role of Photonics in supporting the net-zero carbon emission target for Europe in 2050.

See page 23 of this programme for a list of speakers and topics for this symposium.

Harmonie 1

M2A • Novel Short-Reach & Access Systems — *Continued*

localisation of 0.16 km and 0.28 km respectively and an accuracy of 0.04 dB.

M2A.3 • 14:30

The Role of Power-division Non-orthogonal Multiplexing Access (NOMA) for Enhancing Density and Fairness of Different Coherent Optical Metro-access Networks, *Zixian Wei; Jinsong Zhang; Weijia Li; Charles St-Arnault; Santiago Bernal; Mostafa Khalil; Ramón Gutiérrez-Castrejón; Lawrence R. Chen; David V. Plant; McGill University.*

We investigate NOMA-based optical transmission over different network configurations, including tree-like coherent PON and star-like WDN interconnects. Flexible sum 400-Gbps rates for two users at different locations are achieved below the HD-FEC threshold, demonstrating the role of power-domain NOMA in further increasing network density.

M1A.4 • 14:45

Coexistence of OOK Transceivers in Point-to-Multipoint Access Systems Based on Coherent Subcarrier Multiplexing, *Ryosuke Matsumoto[1]; Takashi Inoue; Shu Namiki; [1]National Institute of Advanced Industrial Science and Technology (AIST).*

We propose a subcarrier-multiplexed access system enabled by a digital coherent OLT supporting QAM and legacy OOK signals. Combined with developed design criteria and optimised DSP algorithms such as pre/post dispersion compensation, we achieve a power budget better than 31 dB after 50-km SMF transmission.

Harmonie 2

M2B • Multiband Transmission I — *Continued*

Forysiak[2]; Hideaki Furukawa[1]; Cristian Antonelli[8]; [1]NICT Japan; [2]Aston University, Aston Institute of Photonics Technologies; [3]Nokia Bell labs USA; [4]Amonics PLC; [5]University of Padova; [6]University of L'Aquila; [7]University of Stuttgart; [8]L'Aquila University.

We investigate wideband signal transmission over 100 km single-mode fiber (SMF) links with transmission of a 36 THz aggregate bandwidth covering OESCLU-bands using 6 doped-fiber amplifier variants with lumped and distributed Raman-amplification for a GMI-estimated data-rate of 339.1 Tb/s and decoded data-rate of 322.8 Tb/s

M2B.3 • 14:30 Invited

Multiband DWDM Transmission Using a Deployed Fibre-Optic Cable, *Daiki Soma[1]; Tomoyuki Kato[2]; Shohei Beppu[1]; Daniel J. Elson[1]; Hidenobu Muranaka[2]; Hiroyuki Irie[2]; Shun Okada[2]; Yu Tanaka[2]; Yuta Wakayama[1]; Noboru Yoshikane[1]; Takeshi Hoshida[2]; Takehiro Tsuritani[1]; [1]KDDI Research, Inc.; [2]Fujitsu Limited.*

Increasing capacity per fibre requires extending the optical signal bandwidth in the wavelength and spatial axes. This paper presents O+S+C+L+U band 45 km single-mode fibre transmission and C+L band 2,160 km uncoupled four-core fibre transmission using deployed fibre-optic cables for multiband DWDM transmission.

Harmonie 3

M2C • Low-Power Consumption DSP — *Continued*

multiple modulation formats. We demonstrated a FPGA-based real-time coherent receiver that supports BPSK, QPSK and 16QAM with different symbol rates, achieving a line bit rate from 2.5 Gbps to 100 Gbps.

M2C.3 • 14:30

Error-Pattern-Dependent Lite Equalizer for intra-Data Center Interconnects, *Jiahao Zhou[1]; Jing Zhang[1]; Xue Zhao[1]; Chenye Wang[1]; Shaohua Hu[1]; Zhaopeng Xu[2]; Bo Xu[1]; Kun Qiu[1]; [1]University of Electronic Science and Technology of China (UESTC); [2]Peng Cheng Laboratory, Shenzhen, China.*

We propose an error-pattern-dependent lite equalizer to whiten the noise enhancement after FFE in a 224-Gb/s PAM-4 system. The EPD-LE achieves a pre-FEC BER of 2.6×10–4 with the maximum burst errors length of four compared to 11 in DFE, providing exceeding one-order-of-magnitude post-FEC performance gain.

M2C.4 • 14:45

FPGA Implementation of Complex Value-based Clustering Filter for Chromatic Dispersion Compensation in Coherent Metro Links with Ultra-low Power Consumption, *Geraldo Gomes; Pedro Freire[1]; Jaroslaw E. Prilepsky[1]; Sergei K. Turitsyn[1]; [1]Aston University.*

This paper introduces a new machine learning-assisted chromatic dispersion compensation filter, demonstrating its superior power efficiency compared to conventional FFT-based filters for metro link distances. Validations on FPGA confirmed an energy efficiency gain of up to 63.5% compared to the standard frequency-domain chromatic dispersion equalizer.

Harmonie 4

M2D • Optical Fibers: From Nanoparticles to Hollow Cores — *Continued*

Harmonie 5

M2E • Digital Twins — *Continued*

M2E.2 • 14:30

Building Digital Twin for Field-Deployed Mesh Optical Networks: A Practically Executable Four-Step Approach, *Yao Zhang[1]; Yuchen Song[1]; Yan Shi[2]; Yu Tang[2]; Shikui Shen[2]; Jin Li[1]; Min Zhang[1]; Danshi Wang[1]; [1]Beijing University of Posts and Telecommunications; [2]China Unicom Research Institute.*

We proposed a four-step approach for building digital twin (DT) of field-deployed mesh optical networks with services under the real-time transmission. By utilizing parameter refinement, we achieved accurate DT and verified it in a real protection switching scenario, with maximum errors of SNR within 0.34 dB.

M2E.3 • 14:45

Heuristic Optimization of Amplifier Reconfiguration Process for Autonomous Driving Optical Networks, *Qizhi Qiu; Xiaomin Liu; Yihao Zhang; Lilin Yi; Weisheng Hu; Qunbi Zhuge; Shanghai Jiao Tong University.*

We propose a heuristic-based optimization scheme for reliable optical amplifier reconfiguration process in ADON. In the experiment on a commercial testbed, the scheme prevents a 1.0-dB Q-factor degradation and outperforms 98.5% random solutions.

Harmonie 6

M2F • MWP Components — *Continued*

We develop a novel high-power compact 300 GHz photomixer module consisting of a uni-traveling carrier photodiode based on SiC substrate. The module exhibits an output power of up to 4 mW, which enables a wireless communication with a data rate of 125 Gbit/s.

M2F.3 • 14:30 Invited

Integrated lithium niobate microwave and millimeter-wave photonics, *Cheng Wang; City University of Hong Kong.*

I will discuss our recent efforts on integrated lithium niobate photonics towards microwave and millimeter-wave applications, including device-level building blocks like ultra-broad-band modulators, power-efficient electro-optic combs, and system-level demonstrations of high-speed microwave photonic signal processers, integrated photonic millimeter-wave radars, and on-chip optical vector analyzers.

Spektrum

M2G • Integrated Passive Devices and Switches — *Continued*

We present a multiband reconfigurable spectral filter with a low insertion loss of < 1.5 dB to equalize optical spectra for ultra-wideband WDM systems. The proposed filter successful-ly equalized spectral non-flatness over the S/C/L bands. We also demonstrated > 1.3-Tbps/wavelength transmission through the proposed filter.

M2G.3 • 14:30 Invited

Integrated passive nonlinear optical isolators, *Alexander White[1]; Geun Ho Ahn; Kasper Van Gasse; Richard Luhtaru; Jakob Grzesik; Kiyoul Yang; Joel Guo; Theodore Morin; John Bowers[2]; Jelena Vuckovic[1]; [1]Stanford; [2]UCSB.*

In this talk, I will describe how nonlinear optics can be used to generate passive optical isolators -- filling a critical gap in integrated photonic infrastructure. Using the optical Kerr effect in high quality factor silicon nitride resonators, we demonstrate simultaneous isolation and laser stabilization.

Illusion

Green ICT Symposium — *Continued*

Harmonie 1

M2A • Novel Short-Reach & Access Systems — *Continued*

M1A.5 • 15:00
Practical Fiber Dispersion-Induced Limitations in 400, 200 and 100 Gbps/λ IM/DD WDM Systems in O-band at 40 km, *Charles St-Arnault; Zixian Wei; Ramón Gutiérrez-Castrejón; Santiago Bernal; Essam Berikaa; Weijia Li; Aleksandar Nikic; Benton Qiu; David Plant; McGill University.*

We report the first 400 Gbps/λ, O-band 40 km IM/DD transmission and investigate the effects of CD for 400, 200 and 100 Gbps systems at 40 km to establish wavelength ranges where CD is tolerable for these data rates

Harmonie 2

M2B • Multiband Transmission I — *Continued*

M2B.4 • 15:00
19.2-THz S+C+L WDM Inline-Amplified 160-km Transmission with Highly Rectangular Waveband MUX/DEMUX, *Fukutaro Hamaoka[1]; Masashi Ota[2]; Masanori Nakamura[1]; Kenya Suzuki[2]; Keita Yamaguchi[2]; Takeshi Umeki[3]; Satomi Katayose[3]; Osamu Moriwaki[2]; Takayuki Kobayashi[1]; Yutaka Miyamoto[1]; Etsushi Yamazaki[1]; [1]NTT Network Innovation Laboratories; [2]NTT Device Innovation Center; [3]NTT Device Technology Laboratories.*

We demonstrated a 19.2-THz triple-band transmission with 125-GHz-wide S/C and C/L-band boundaries using SCL-band MUX/DEMUX with compact cascaded AWGs fabricated using in-house silica-based planar lightwave circuit technology. A net bitrate of 166.5 Tb/s with 128-channel 144-GBaud PDM-PCS-64/144QAM was successfully transmitted over 160-km (2×80-km) G.652.D fibre.

M2B.5 • 15:15
Net 200 Gbps O-band IM/DD transmission over 80 km SMF using InP EML with sub 1-Vpp driving signal and QD-SOA, *Weijia Li[1]; Charles St-Arnault[1]; Zixian Wei[1]; Md Samiul Alam[1]; Syunya Yamauchi[2]; Hideaki Asakura[2]; Bruce Beggs[3]; Naim Ben-Hamida[3]; David Plant[1]; [1]McGill University; [2]Lumentum Operations LLC; [3]Ciena.*

We demonstrate a record net 200 Gbps IM/DD transmission over 80 km in the O-band using an InP EML with sub 1-Vpp driving swing and low-noise quantum-dot SOAs, achieving a BER below the 20% overhead SD-FEC threshold.

Harmonie 3

M2C • Low-Power Consumption DSP — *Continued*

M2C.5 • 15:00 **Invited**
Advances in Power-Optimized Coherent Transceivers for Metro-Edge and DCI Applications, *Chris Fludger[1]; Thomas Duthel[1]; Syed Bilal[1]; Bo Liu[1]; Jacqueline Sime[1]; Amir Rashidinejad[2]; Saleem Alreesh[1]; Tulasi Veguru[3]; Han Sun[2]; Robert Maher[3]; Dave Welch[3]; [1]Infinera GmbH; [2]Infinera Inc.; [3]Infinera Corporation.*

We review advances in coherent transceivers for Metro-Edge and DCI applications.

Harmonie 4

M2D • Optical Fibers: From Nanoparticles to Hollow Cores — *Continued*

M2D.2 • 15:00 **Invited**
Hollow-Core Fibres: Design, Fabrication and Characterisation, *Yingying Wang[1]; Shoufei Gao; Wei Ding; Yizhi Sun; [1]Jinan University/Linfiber. Tech.*

We summarize our recent work in novel designs, advanced fabrication and distributed characterization of low-loss anti-resonant hollow-core fibre (AR-HCF).

15:30–16:00 Coffee Break, Exhibition

Harmonie 5

M2E • Digital Twins — *Continued*

M2E.4 • 15:00 **Invited**

Applying Digital Twins to Optical Networks with Cloud-native SDN Controllers and Generative AI, *Ricard Vilalta; Allen Abishek; Lluis Gifre; Ramon Casellas; Ricardo Martinez; Raul Muñoz; Centre Tecnològic de Telecomunicacions de Catalunya (CTTC-CERCA).*

This paper presents optical networks using Network Digital Twins (NDT) integrated with cloud-native SDN controllers and intent based networking with generative AI. The framework optimizes network design, automation, and maintenance, enhancing efficiency and performance.

Harmonie 6

M2F • MWP Components — *Continued*

M2F.4 • 15:00

Simple Single-Side Band Generation Scheme, *Tobias Blatter[1]; Yannik Horst[1]; Michael Baumann[1]; Laurenz Kulmer[1]; Hande Ibili[1]; Boris Vukovic[1]; Yuriy Fedoryshyn[1]; Maurizio Burla[2]; Jasmin Smajic[1]; Juerg Leuthold[1]; [1]ETHZ – IEF; [2]TU Berlin / Radio-Frequency Technologies – Photonics.*

This paper introduces a novel SSB generation technique that minimizes hardware complexity and energy consumption. Tested with plasmonic-organic modulators, we show how it allows to extend direct detection transmission over 80 km or how it can save spectrum in a 230 GHz wireless link.

M2F.5 • 15:15

A Programmable Functionally-Integrated Photonic RF Memory, *Kai Xu[1]; Xinghan Li; Mengfan Cheng; Qi Yang; Ming Tang; Deming Liu; Lei Deng; [1]School of Optical and Electronic Information, Huazhong University of Science and Technology.*

We report a programmable photonic RF memory that integrates the functions of single-false-target, multi-false-target, and blinking-false-target range-velocity compound jamming for the first time. The high-resolution loop storage capacity reached record-breaking 600 loops in X/Ku-band, with multi-false-target number beyond 10 and blinking-false-target purity of 15 dB.

Spektrum

M2G • Integrated Passive Devices and Switches — *Continued*

M2G.4 • 15:00

2×2 Optical Switch on an InP Membrane on a Silicon (IMOS) Platform for Modular Switching on Chip, *Desalegn Wolde Feyisa; Salim Abdi; Xiao Li; Yuqing Jiao; Nicola Calabrettta; Patty (Ripalta) Stabile; Eindhoven university of Technology.*

We present the first optical switch integrated on InP membrane on the Silicon(IMOS) platform using SOAs with optimal OSNR and ER > 45 dB. NRZ-OOK routing shows 15 dB IPDR within 1 dB power penalty at 12.5 Gb/s and power penalty of < 1.4 dB at 40 Gb/s

M2G.5 • 15:15

Ultralow-crosstalk, Electro-optic Microdisk Optical Switch Fabric Incorporating Si-SiN-SIN Tri-layer Shuffle, *Bohao Sun[1]; Minjia Chen[1]; Chunhui Yao[1]; Peng Bao[1]; Ziyao Zhang[1]; Lingzhi Luo[1]; Zhitian Shi[1]; Keren Bergman[2]; Richard Penty[1]; Qixiang Cheng[1]; [1]University of Cambridge; [2]Columbia University.*

We present for the first time an 8×8 electro-optic microdisk switch incorporating a Si-SiN-SiN tri-layer shuffle. This device exhibits ultralow-crosstalk in the range of -42.8 to -51.9 dB with an on-chip loss of as low as 8.7 dB. Nanosecond-scale switching time and >86 GHz passband are also demonstrated.

Illusion

Green ICT Symposium — *Continued*

15:30–16:00 Coffee Break, Exhibition

Harmonie 1

16:00–17:30
M3A • QKD Systems
Presider: Vito Sorianello; CNIT

M3A.1 • 16:00 Invited
Secure Communication with Quantum Continuous Variables, *Eleni Diamanti; Sorbonne Université – CNRS.*

We provide an overview of recent developments on continuous-variable quantum key distribution in our group, including the development of a silicon photonics integrated receiver and the experimental benchmarking of a highly-modular open source platform dedicated to this technology.

Harmonie 2

16:00–17:30
M3B • Multiband Transmission II
Presider: Georg Rademacher; Stuttgart University

M3B.1 • 16:00
Band-wise Bidirectional S+C+L Transmission in Hybrid Raman-EDFA Link, *Inwoong Kim[1]; Takeshi Hoshida[2]; Olga Vassilieva[1]; Hiroyuki Irie[2]; Paparao Palacharla[1]; [1]Fujitsu Network Communications, Inc.; [2]Fujitsu Limited.*

We propose and optimize band-wise bidirectional S+C+L multi-band transmission in hybrid Raman-EDFA link. By counterpropagating S-band signals, we mitigate ISRS between bands and achieve uniform GSNR across bands with 27% power saving and 57% lower peak power per fibre facet compared to unidirectional transmission.

M3B.2 • 16:15
Ultrawideband optical fibre throughput in the presence of total optical power constraints from C to OESCLU spectral bands, *Mindaugas Jarmolovičius; Henrique Buglia; Eric Sillekens; Polina Bayvel; Robert Killey; University College London (UCL).*

Using a recently developed fast integral ultrawideband Gaussian noise model, we quantify the achievable throughput under total optical power constraints for systems ranging from C-band to fully populated OESCLU bands using optimum launch powers, showing conditions when expanding bandwidth provides no additional throughput.

Harmonie 3

16:00–17:30
M3C • Ultrafast Terrestrial FSO
Presider: Antonio D'Errico; Ericsson

M3C.1 • 16:00 Invited
Optical Phased Arrays for Wireless Connectivity, *Devin Brinkley; Jean-Laurent Plateau; Stephen Palese; Google X.*

Optical wireless communication (OWC) can deliver abundant and affordable internet. In this paper, we focus on recent developments in the silicon photonic integrated circuit industry enabling the use of the Optical Phased Array (OPA) for a cost-effective, high bandwidth OWC.

Harmonie 4

16:00–17:30
M3D • Coherent PON – I
Presider: Derek Nesset; Huawei Technologies R&D UK Ltd

M3D.1 • 16:00
Power budget analysis of 200 Gbit/s coherent PON downstream taking into account OLT requirements and ONT simplifications, *Md Mosaddek Hossain Adib; Christoph Füllner; Rene Bonk; Nokia Bell Labs.*

We perform an optical power budget analysis for a 200 Gbit/s coherent PON in downstream directions. From experiments we infer the complexity and performance trade-offs between the ONT receiver (LO, ADC, FEC) and the launch power from the OLT (amplifier gain).

M3D.2 • 16:15
Novel Preamble Synchronization schemes for Burst-Mode Coherent Optical Networks, *Syed Muhammad Bilal; Infinera.*

We present a novel burst preamble synchronization scheme for 100 Gb/s coherent time and frequency division multiplexed (TFDM) PON network. Numerical, simulative, and experimental analysis indicate that this scheme can provide much more reliable upstream burst frame detection as compared to the conventional schemes.

Harmonie 5

16:00–17:30
M3E • Longitudinal Power Profile Monitoring
Presider: Patricia Layec; Nokia Bell Labs

M3E.1 • 16:00
On the Signal Pattern Effect on Fiber-Longitudinal Power Monitor, *Takeo Sasai; Minami Takahashi; Masanori Nakamura; Etsushi Yamazaki; Yoshiaki Kisaka; NTT.*

We experimentally show that results of fiber-longitudinal power monitor have a strong dependency on probing signal patterns. By averaging power profiles estimated using multiple patterns, we observe a power-profile SNR improvement of 5.1 dB, reliably localizing a 0.72-dB loss anomaly even at optimal launch power.

M3E.2 • 16:15
Fiber Longitudinal Power Profile Estimation Accounting for SOA Nonlinearities, *Tarek Eldahrawy; Abel Lorences-Riesgo; Xin Yang; Flavio Sampaio; Hartmut Hafermann; Yann Frignac; Gabriel Charlet; Huawei Paris Research Center.*

We show how the presence of SOA nonlinearities from both single channel booster or WDM inline amplifiers degrade the estimated power profile. We therefore propose and demonstrate a solution based on SOA digital modelling and removing the SOA signal distortion before performing PPE .

Harmonie 6

16:00–17:30
M3F • Sensing and Microwave Photonics
Presider: Guillermo Carpintero; Universidad Carlos III de Madrid

M3F.1 • 16:00 **Invited**
Hybrid Integrated Microwave Photonics for Multi-Beam Antenna applications, *Chris Roeloffzen; Paul van Dijk; Peter Maat; Ilka Visscher; Marcel Hoekman; Lennart Wevers; Edwin Klein; Roelof Bernardus Timens; Charoula Mitsolidou; Ahmad Mohammad; Robert Grootjans; Furkan Şahin; Roel Botter; Carlos Ruiz Pineda; Rick Heuvink; Ronald Dekker; LioniX International.*

We present a hybrid integrated microwave photonic (iMWP) chip platform where Si3N4-based-TriPleX® and InP optical waveguides are combined to enable broadband and high frequency radio signal pro-cessing. A multi-beam iMWP beamformer for phased array antenna systems is fabricated and characterized.

Spektrum

16:00–17:30
M3G • Photonic Circuits for Integrated Neural Signal Processing
Presiders: Folkert Horst; IBM Research Europe – Zurich
Patty (Ripalta) Stabile; Technische Universiteit Eindhoven

M3G.1 • 16:00
TWDM Coherent Silicon Photonic Linear Circuits for Photonic Tensor Processors, *Stefanos Kovaios; Ioannis Roumpos; Apostolos Tsakyridis; Miltiadis Moralis-Pegios; David Lazovsky; Konstantinos Vyrsokinos; Nikos Pleros.*

We present a coherent Silicon photonic linear circuit that supports time and wavelength division multiplexing (TWDM), demonstrating tensor-vector multiplications with an average error 3.94% and an experimental accuracy of 90% for the iris classification task at 10 GBd.

M3G.2 • 16:15
Experimental Investigation of a Neuromorphic Accelerator based on Reconfigurable Photonic Chip for High-Speed Image Processing, *Charis Mesaritakis Prof[1]; Aris Tsirigotis[1]; George Sarantoglou[1]; Stavros Deligiannidis[2]; Erica Sanchez[3]; David Sanchez[3]; Ana Gutierrez[3]; Jose Capmany[4]; Adonis Bogris[2]; [1]University of the Aegean, Dept. Information and Communication Systems Engineering; [2]University of West Attica, Department of Informatics and Computer Engineering; [3]iPronics S.L.; [4]Universitat Politècnica de València (UPV).*

We propose a neuromorphic accelerator based on a reconfigurable photonic mesh functioning as an analog convolutional engine. Experimental results demonstrate a 97.7% accuracy on the MNIST dataset, surpassing state-of-the-art photonic accelerators while consuming 34% less power than GPU-based digital convolutional neural networks.

Illusion

Green ICT Symposium — *Continued*

Harmonie 1

M3A • QKD Systems — *Continued*

M3A.2 • 16:30
A Flexible Real-Time Quantum Key Distribution System for Fiber and Free-Space Links, *Jan Krause; Nino Walenta; Jonas Hilt; Ronald Freund; Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI.*

To enable QKD in various scenarios, we developed a 625 MHz real-time autonomous timebin-phase QKD system with custom clock synchronization. We demonstrate the system's performance and robustness under unstable link conditions, a variety of fiber and free-space links, and up to 34 dB channel loss.

M3A.3 • 16:45
Comparison of Methods for Distance-Adaptive Continuous-Variable Quantum Key Distribution, *Jonas Berl[1]; Erdem Eray Cil[2]; Utku Akin[1]; Laurent Schmalen[2]; Tobias Fehenberger[1]; [1]Adva Network Security GmbH; [2]Communications Engineering Lab (CEL), Karlsruhe Institute of Technology (KIT).*

We demonstrate that CV-QKD with a single error-correcting code is severely constrained in distance and compare three alternative strategies for distance-adaptivity. Numerical simulations show that rate-adaptive coding outperforms adding controlled amounts of trusted noise and optimizing the modulation variance.

Harmonie 2

M3B • Multiband Transmission II — *Continued*

M3B.3 • 16:30
Experimental validation of the closed-form GN model accounting for distributed Raman amplification in an S+C+L-band hybrid amplified long-haul transmission system, *Jiaqian Yang[1]; Henrique Buglia[1]; Eric Sillekens[1]; Mingming Tan[2]; Pratim Hazarika[3]; Dini Pratiwi[2]; Ronit Sohanpal[1]; Mindaugas Jarmolovičius[1]; Romulo Aparecido[1]; Ralf Stolte[4]; Wladek Forysiak[2]; Polina Bayvel[1]; Robert Killey[1]; [1]Optical Networks Group, UCL (University College London), London; [2]Aston Institute of Photonic Technologies, Aston University, Birmingham; [3]Corning Optical Communications, St David's Park, Ewloe; [4]Coherent / Finisar, New South Wales.*

The accuracy of a recently-developed closed-form GN nonlinear interference model is evaluated in experimental 1065 km S+C+L band WDM transmission with backward Raman pumping. The model accurately estimates the nonlinear interference and ASE with total SNR error of less than 0.6 dB.

M3B.4 • 16:45
101-Tb/s C+L+U-Band Transmission Over 5×80-km NZ-DSF with Closed-Form-GN-Model-Based Launch Power Optimisation, *Kosuke Kimura; Shimpei Shimizu; Takayuki Kobayashi; Akira Kawai; Masanori Nakamura; Masashi Abe; Takushi Kazama; Takeshi Umeki; Munehiko Nagatani; Hitoshi Wakita; Yuta Shiratori; Fukutaro Hamaoka; Hiroshi Yamazaki; Hiroyuki Takahashi; Yutaka Miyamoto.*

We demonstrate good agreement between SNR experimentally measured and estimated using a closed-form-expression of the GN model in C+L+U-band NZ-DSF transmission aided by a hybrid PPLN-OPA/EDFA U-band repeater. A total-net-bitrate of 101 Tb/s is achieved after 400-km transmission with launch power optimisation.

Harmonie 3

M3C • Ultrafast Terrestrial FSO — *Continued*

M3C.2 • 16:30
Field Demonstration of Turbulence-Resilient Coherent Free-Space Optical Communications Over an 800 m Link, *Douglas McDonald; Fraunhofer IOSB.*

We present a field demonstration of turbulence-resilient 10 Gbit/s 16-QAM coherent communications over an 800 m free-space link based on the pilot-assisted scheme. Turbulence is characterized by imaging the received beam, and results demonstrate the robustness of the scheme in moderate turbulence.

M3C.3 • 16:45
Reconfigurable Integrated Mode Regenerator for Free-Space Optical Communications, *Seyedmohammad Seyedinnavadeh; Alessandro di Tria; Flavio Novelli; Francesco Zanetto; Giorgio Ferrari; Marco Sampietro; Andrea Melloni; Francesco Morichetti; Politecnico di Milano.*

A reconfigurable integrated mode regenerator is presented, which can select and regenerate arbitrary free-space optical beams. Mode-selectivity is achieved through a first Mach-Zehnder interferometer mesh, while a second mesh re-transmits the signal on an arbitrary output mode. Experimental validation at 25 Gbps data-rate is shown.

Harmonie 4

M3D • Coherent PON – I — *Continued*

M3D.3 • 16:30
Preamble Design and Burst-Mode DSP for Upstream Reception of 200G Coherent TDM-PON, *Haide Wang[1]; Ji Zhou[1]; Jinyang Yang[1]; Zhiyang Liu[1]; Cheng Li[2]; Weiping Liu[1]; Changyuan Yu[2]; [1]Jinan University; [2]The Hong Kong Polytechnic University.*

Burst-mode DSP based on 10 ns preamble is proposed for upstream reception of the 200G coherent TDM-PON. The 128-symbol tone preamble is used for SOP, frequency offset, and sampling phase estimation, while the 192-symbol CAZAC preamble is used for frame synchronization and channel estimation.

M3D.4 • 16:45
Novel Simplified Intradyne Coherent Receiver using IQ Interleaved Polarization Insensitive Coding for Beyond 50G-PON, *Ryo Koma; Kazutaka Hara; Ryo Igarashi; Jun-ichi Kani; Tomoaki Yoshida; NTT Access Network Service Systems Laboratories.*

We propose a simplified intradyne receiver for polarization-insensitive detection with half the receiver bandwidth of conventional heterodyne scheme. Simulations confirm 43.8 dB optical budget for 100-Gb/s signals transmitted through 20 km-SMF in C-band. In addition, we conduct world's first demonstration of simplified intradyne coherent detection.

Harmonie 5

M3E • Longitudinal Power Profile Monitoring — *Continued*

M3E.3 • 16:30
Accuracy Comparison between Forward- or Backward-based Implementation of Longitudinal Power Profile Estimation, *Runa Kaneko; Takeo Sasai; Minami Takahashi; Masanori Nakamura; Etsushi Yamazaki; NTT Network Innovation Laboratories.*

We compared the performance of fibre-longitudinal power profile estimation using different implementation schemes: forward propagation of transmitted signals and backpropagation of received signals. Backpropagation-based method exhibits lower noise tolerance than forward-propagation-based method, resulting underestimation of power and degraded estimation errors in noisy systems.

M3E.4 • 16:45
Nonlinear Noise Estimation using Linear Least Squares-based Longitudinal Power Monitoring, *Lorenzo Andrenacci[1]; Gabriella Bosco[1]; Yanchao Jiang[1]; Antonino Nespola[2]; Stefano Straullu[2]; Stefano Piciaccia[3]; Dario Pilori[4]; [1]Politecnico di Torino; [2]LINKS Foundation; [3]CISCO Photonics Italy srl; [4]Politecnico di Torino.*

A novel method for closed-form nonlinear noise estimation relying on linear least squares-based longitudinal power monitoring is presented and experimentally validated in a C-band transmission over an EDFA-amplified 5-span 60-km SMF link.

Harmonie 6

M3F • Sensing and Microwave Photonics — *Continued*

M3F.2 • 16:30 **Tutorial**
Fibre Sensing with and for Optical Networks, *Ezra Ip; Yue-Kai Huang; Ming-Fang (Yvonne) Huang; Fatih Yaman; Ting Wang; NEC Laboratories America.*

In this tutorial we review fibre sensing solutions that are compatible with telecom optical networks. We review the tools that can be borrowed from telecommunications, the challenges in practical deployment, and present use cases for fibre sensing in real-world applications.

Spektrum

M3G • Photonic Circuits for Integrated Neural Signal Processing — *Continued*

M3G.3 • 16:30
Experimental Demonstration of 4-Port Photonic Reservoir Computing for Equalization of 4 and 16 QAM signals, *Sarah Masaad; Stijn Sackesyn; Stylianos Sygletos; Peter Bienstman.*

We experimentally demonstrate equalization of coherently modulated signals at 28 Gbaud using a passive, 16-node, integrated, 4-port photonic reservoir. The reservoir replaces computationally expensive DSP procedures for passive/active equalization and integrates with other DSP blocks achieving BERs on-par with legacy DSP for 4 and 16QAM signals

M3G.4 • 16:45
Digital-analog Hybrid Matrix Multiplication Processor for Optical Neural Networks, *Xiansong Meng[1]; Deming Kong; Hao Hu; Po Dong; Kw Kim; [1]Technical University of Denmark.*

We present a high-precision digital-analog hybrid optical matrix multiplication processor for neural network applications. 16-bit calculation precision is achieved in a high-definition image processing task, while no accuracy loss is observed in a convolutional neural network for handwritten digit recognition.

Illusion

Green ICT Symposium — *Continued*

Harmonie 1

M3A • QKD Systems — *Continued*

M3A.4 • 17:00
Quantum Key Distribution Seeded Optical-Transport-Networks-Layer-0 Encryption Scheme on A 100-Gb/s Coherent 64QAM System with Key Management Interface, *Kexin Wang[1]; Adrian Wonfor[2]; Ehsan Fazel[3]; Richard Penty[2]; Xu Wang[4]; [1]Heriot Watt University, Edinburgh; [2]University of Cambridge, United Kingdom; [3]Cisco International; [4]Heriot-Watt University, Edinburgh.*

We demonstrate the Time-domain Spectral Phase Encoding (TDSPE), seeded by secure keys from the Cambridge quantum network with a key management interface, to encrypt a 100-Gb/s coherent 64QAM optical signal on the Layer 0 of Optical Transport Networks (OTN-L0) at 20-GHz encoding rate.

M3A.5 • 17:15
Towards Quantum Communication Multiplexing in LP-modes Enabled by Photonic Lanterns, *Iñaki Beraza; Mujtaba Zahidy; Ronny Raphael Müller; Neethu Mariam Mathew; Lars Erik Grüner-Nielsen; Lars Søgaard Rishøj; Leif Katsuo Oxenløwe; Karsten Rottwitt; Michael Galili; DTU Electro.*

We report the first successful demonstration of multiplexing QKD in LP fiber modes (LP11a and LP11b). The system comprises 24 km of Two-mode fiber and reaches a secret key rate of 2.24 Mbps.

Harmonie 2

M3B • Multiband Transmission II — *Continued*

M3B.5 • 17:00 Invited
An Ideal Pairing: Multicore Fibres and Coherent O-band DWDM Transmission Supported by BDFA, *Daniel J. Elson[1]; Shohei Beppu[1]; Daiki Soma[1]; Noboru Yoshikane; Takehiro Tsuritani[1]; Yuta Wakayama[1]; [1]KDDI Research, Inc.*

Demand for high per-fibre bandwidth is soaring in DCI applications where space is at a premium. Specifically designing a 12-core fibre to take advantage of lower crosstalk in the O-band, the BDFA fibre has enabled a 115.2-THz aggregate bandwidth whilst maintaining a 250-µm cladding diameter

Harmonie 3

M3C • Ultrafast Terrestrial FSO — *Continued*

M3C.4 • 17:00
Multidimensional Encoding of Superimposed OAM Beams for Free-space Optical Communications, *Wenqian Zhao[1]; Yiwen Zhang[2]; Dong An[2]; Runzhou Zhang[3]; Kai Pang[3]; Zhongqi Pan[4]; Yang Yue[1]; [1]School of Information and Communications Engineering, Xi'an Jiaotong University, Xi'an 710049, China; [2]Institute of Modern Optics, Nankai University, Tianjin, 300350, China; [3]Department of Electrical Engineering, University of Southern California, Los Angeles, CA 90089, USA; [4]Department of Electrical and Computer Engineering, University of Louisiana at Lafayette, Lafayette, LA 70504, USA.*

A multidimensional encoding method through mode, phase, and intensity is demonstrated for superim-posed OAM beam. Decoding of the camera-captured images is realized by the trained support vector machine algorithm. Under the 10–2 m time-varying phase turbulence, an image-transmission accuracy of 99.38% can be achieved.

M3C.5 • 17:15
Net 5.4 Tb/s Optical Wireless Connectivity Enabled by MIMO-Free Mode Demultiplexer and Linear Equalizer Only, *Chao Li[1]; Zichen Liu[1]; Zhimu Huang[2]; Juncheng Fang[2]; Ting Lei[2]; Qibing Wang[1]; Xumeng Liu[1]; Lei Wang[1]; Zhixue He[1]; Shaohua Yu[1]; [1]Peng Cheng Laboratory, Shenzhen, China; [2]Shenzhen University.*

Net 5.4 Tb/s (240 Gb/s/λ×8λ × 3 mode) optical wireless connectivity over 1.8 m is experimentally demonstrated with below 6.7% HD-FEC limit of 3.8×10-3, enabled by MIMO-free mode MUX/DeMUX (crosstalk < -21.5 dB, loss < 11.5 dB in C-band) and linear FFE only.

Harmonie 4

M3D • Coherent PON – I — *Continued*

M3D.5 • 17:00 Invited
Advances in the Latest Coherent PON Technology and Industry Specification Development, *Zhensheng Jia.*

This paper explores the latest advancements in coherent PON technology, a promising solution for next-generation optical access networks. It delves into the technical aspects, performance enhancements, and ongoing industry efforts to standardize coherent PON specifications to facilitate widespread deployment and interoperability.

Harmonie 5

M3E • Longitudinal Power Profile Monitoring — *Continued*

M3E.5 • 17:00 Invited

Link Tomography: A Tool for Monitoring Optical Network and Designing Digital Twins, *Matheus Ribeiro Sena[1]; Robert Emmerich[2]; Behnam Shariati[2]; Ralf-Peter Braun[1]; Marc Geitz[1]; Johannes Karl Fischer[2]; Ronald Freund[2]; [1]Deutsche Telekom AG; [2]Fraunhofer Heinrich Hertz Institut (HHI).*

This paper explores the Link Tomography, a receiver-based DSP approach for monitoring optical networks and detecting anomalies. Delving into concepts and building methodologies, it addresses challenges related to network-wide applications while covering the role of Link Tomography in designing digital twins of optical networks.

Harmonie 6

M3F • Sensing and Microwave Photonics — *Continued*

Spektrum

M3G • Photonic Circuits for Integrated Neural Signal Processing — *Continued*

Illusion

Green ICT Symposium — *Continued*

Harmonie 1	Harmonie 2	Harmonie 3	Harmonie 4
19:30–23:00 50 Years of ECOC Celebration, Forum			

Harmonie 5	Harmonie 6	Spektrum	Illusion & Fantasie

17:45–19:15
Symposium 50 Years of ECOC
Organisers: Peter Krummrich (Technische Universität Dortmund); Sebastian Randel (Karlsruhe Institute of Technology)

Since its inception in 1975 in London, UK, the European Conference on Optical Communication (ECOC) has grown into a remarkable success story, becoming one of the most prestigious events in the field of optical communication. Over the past five decades, ECOC has consistently provided a platform for researchers, industry professionals, and academics to share their groundbreaking work, foster collaborations, and drive the field forward.

As we gather to celebrate the 50th edition of ECOC in the vibrant city of Frankfurt am Main, Germany, we reflect on the incredible journey of innovation and progress that has defined this conference. This milestone is not just a testament to the enduring relevance of ECOC, but also to the relentless pursuit of excellence by the global optical communication community.

To commemorate this special occasion, we are hosting a symposium that will delve into the rich history and future prospects of optical communication. We are honored to have four distinguished speakers, each a luminary in their own right, who have made significant contributions to the field. These experts will share their insights and perspectives on the evolution of optical communication technologies and the pivotal role that ECOC has played in shaping this dynamic landscape.

Join us as we celebrate the past, present, and future of optical communication, and honor the achievements that have brought us to this momentous 50th edition of ECOC. Together, we will explore the innovations that have transformed our world and look ahead to the exciting advancements that lie on the horizon.

See page 20 of this programme for a list of speakers and topics for this symposium.

19:30–23:00 50 Years of ECOC Celebration, Forum

Harmonie 1

09:00–10:30
Tu1A • Doped Fiber Amplifiers Improved Designs, Multimode and Multicore
Presider: Lutz Rapp; Adtran Networks SE

Tu1A.1 • 09:00
Multimode Fiber Amplifier with 44 Uncoupled OAM Modes, *Aaron Peterson-Greenberg[1]; Poul Kristensen[2]; Miranda Mitrovic[2]; Siddharth Ramachandran[1]; [1]Boston University; [2]OFS-Fitel.*

We present experimental and simulation performance metrics of a ring-core multimode Erbium-doped fiber amplifier that utilizes a topological confinement effect, demonstrating high gain amplification of a record number of 44 uncoupled orbital angular momentum modes.

Tu1A.2 • 09:15
Bismuth-Doped O-band Bidirectional Fiber Amplifier for High-Speed Passive Optical Networks, *Yetian Huang[1]; Hanzi Huang[1]; Haoshuo Chen[1]; Robert Borkowski[1]; Kovendhan Vijayan[1]; Jianxiang Wen[2]; Nicolas K. Fontaine[1]; Pat Iannone[1]; René-Jean Essiambre[1]; Yingxiong Song[2]; Tingyun Wang[2]; Roland Ryf[1]; [1]Nokia Bell Labs, NJ, USA; [2]Shanghai University.*

We experimentally demonstrate the first bismuth-doped, cross-gain-modulation-free, bidirectional single amplifier for O-band passive optical networks. It offers 20.8-dB downstream and 15.2-dB upstream power budget improvement, and 0.5-dB power budget penalty under upstream burst mode.

Harmonie 2

09:00–10:30
Tu1B • Advances in Network Control and Management
Presider: Anna Tzanakaki; National and Kapodistrian University of Athens

Tu1B.1 • 09:00
Interference Identification in Multi-User Optical Spectrum as a Service using Convolutional Neural Networks, *Agastya Raj[1]; Zehao Wang[2]; Frank Slyne[1]; Tingjun Chen[2]; Dan Kilper[1]; Marco Ruffini[1]; [1]Trinity College Dublin; [2]Duke University.*

We introduce a ML-based architecture for network operators to detect impairments from specific OSaaS users while blind to the users' internal spectrum details. Experimental studies with three OSaaS users demonstrate the model's capability to accurately classify the source of impairments, achieving classification accuracy of 94.2%

Tu1B.2 • 09:15
Dynamic Management of IP Virtual Network Topology over Multi-Granular (Wavelength and Waveband) Optical Networks, *Raul Muñoz[1]; Varsha Lohani[1]; Carlos Manso[1]; Lluis Gifre[1]; Ramon Casellas[1]; Andrea Sgambelluri[2]; Nicola Sambo[2]; Michael Enrico[3]; Hussein Zaid[4]; Carsten Schmidt-Langhorst[4]; Javier Vílchez[1]; Colja Schubert[4]; Ronald Freund[4]; Ricard Vilalta[1]; Ricardo Martinez[1]; Josep Maria Fabrega[1]; [1]Centre Tecnològic de Telecomunicacions de Catalunya (CTTC); [2]Scuola Superiore Sant'Anna; [3]HUBER+SUHNER Polatis; [4]Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute.*

This paper presents a multi-layer transport SDN controller architecture and resource assignment algorithm to manage dynamic IP full-mesh virtual network topologies over ultra-wideband WDM optical networks that combine wavelength and waveband switching by providing waveband channels between IP routers that are backfilled with wavelength channels.

Harmonie 3

09:00–10:30
Tu1C • Novel Opportunities for Integrated Photonics & Transceivers
Presider: Lars Zimmermann; IHP GmbH – Leibniz-Institut für innovative Mikroelectronik

Tu1C.1 • 09:00 Invited
Integrated Photonics for Radio Access: Where We Are, *Fabio Cavaliere; Alessandra Bigongiari; Antonio D'Errico; Antonio Tartaglia; Roberto Sabella; Ericsson.*

Integrated photonics is essential in radio access: current pluggable optics and upcoming co-packaged optics rely on it to increase capacity and energy efficiency. Photonic integrated circuits may perform in future functions such as radiofrequency generation and mixing. This paper discusses relevant technical and ecosystem challenges.

Harmonie 4

09:00–10:30
Tu1D • Intra-Data Center Systems
Presider: Salvatore Spadaro; Technical University of Catalonia (UPC)

Tu1D.1 • 09:00 Upgraded Invited
Plasmonic Ring Resonator Modulator Demonstrating IM/DD >400G per lane, *Tobias Blatter; Laurenz Kulmer; Chenrui Xu; Marcel Destraz; Yannik Horst; Benedikt Baeuerle; Juerg Leuthold.*

We demonstrate plasmonic ring resonator modulators operating at 480 Gbit/s with AIR of 461 Gbit/s in an IM/DD experiment. The modulator features low insertion loss of 1.2 dB, a flat bandwidth in excess of 110 GHz, and represents the first ring modulator with net rates of >400 Gbit/s

Harmonie 5

09:00–10:30
Tu1E • LiFi for Indoor and Underwater Communications
Presider: Chi-Wai Chow; National Yang Ming Chiao Tung University

Tu1E.1 • 09:00
102.2 Gbps Underwater Visible Light Laser Communication Utilizing a Tri-color Laser Transmitter and a Neural Network-based Reverse Signal Generator, *Zhilan Lu; Zengyi Xu; Yuning Zhou; Zhiteng Luo; Xianhao Lin; Yingjun Zhou; Jianyang Shi; Ziwei Li; Chao Shen; Junwen Zhang; Nan Chi; Fudan University.*

In this paper, we design a neural network-based reverse signal generator to acquire differential signal in underwater visible light laser communication to reduce system common-mode noise. Utilizing a self-designed integrated tri-color laser and polarization multiplexing techniques, we achieve a high trans-mission rate of 102.2 Gbps.

Tu1E.2 • 09:15
7.75 Gbit/s LiFi Transmitter Using High-Power VCSEL Arrays, *Malte Hinrichs[1]; Giulio Boniello[1]; Dominic Schulz[1]; Ronald Freund[2]; Volker Jungnickel[1]; [1]Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI; [2]Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI and Technical University of Berlin.*

We report on a wide-beam LiFi transmitter using multiple VCSEL arrays with digital drivers. We transmit a 3.75 GBd PAM-3 signal at a gross data rate of 5.625 Gbit/s. Single-driver OOK operation yields 7.75 GBd.

Harmonie 6

09:00–10:30
Tu1F • THz Processing and Coding
Presider: Magnus Karlsson; Chalmers University of Technology

Tu1F.1 • 09:00
Parameter Optimization in Iterative Soft Decoder and Achievement of High Net Coding Gain in Turbo Product Codes, *Shuto Yamamoto; Takeshi Kakizaki; Yoshihide Tonomura; Etsushi Yamazaki; NTT Corporation.*

We propose a parameter-optimization method based on minimizing cross entropy at each half iteration in a Chase-Pyndiah decoder. We show that the proposed method realizes the NCG of 12.15 dB in eBCH (128,113)-based TPC with zipper code whose OH is 30.9%.

Tu1F.2 • 09:15
Fermat Number Transform Based Chromatic Dispersion Compensation and Adaptive Equalization Algorithm , *Siyu Chen; Zheli Liu; Weihao Li; Zihe Hu; Mingming Zhang; Sheng Cui; Ming Tang.*

By introducing the Fermat number transform into chromatic dispersion compensation and adaptive equalization, the computational complexity has been reduced by 68% compared with the conventional implementation. Experimental results validate its transmission performance with only 0.8 dB receiver sensitivity penalty in a 75 km-40 GBaud-PDM-16QAM system.

Spektrum

09:00–10:30
Tu1G • Novel Modulators
Presider: Despoina Petousi; ADTRAN

Tu1G.1 • 09:00 **Invited**
BTO-enhanced Silicon Photonics for Next-Generation Transceivers, *Felix Eltes; Lumiphase AG.*

Barium titanate (BTO) integrated with commercial silicon photonics enable higher performance modulators in a scalable platform. With lower Vπ and insertion loss, as well as higher bandwidth than silicon modulators, BTO modulators can deliver the performance required for next generation transceivers.

Illusion

09:00–17:15
10th International Symposium on Optical Interconnects in Data Centres
Organisers: Tolga Tekin (Fraunhofer Institute for Reliability and Microintegration (IZM)); Richard Pitwon (Resolute Photonics Ltd.); Nikos Pleros (Aristotle University of Thessaloniki); Dimitrios Apostolopoulos (National Technical University of Athens); Paraskevas Bakopoulos (NVIDIA)

As part of the 50th European Conference on Optical Communication (ECOC 2024) in Frankfurt, we invite you to attend the 10th International Symposium on Optical Interconnects in Data Centres on Tuesday, September 24, 2024.

Hyperscale data centres are undergoing a paradigm shift with the rapid proliferation of Artificial Intelligence, necessitating disruptive innovations in optical interconnects. Addressing the power consumption bottleneck is critical for AI infrastructure providers.

Energy efficiency is being addressed at various levels within the hyperscale hierarchy. Innovations include novel WDM architectures, immersion cooling, optical and neuromorphic computing, and ultra-low-power optical phase change materials including EO polymers. We will also hear about the latest advances in Co-Packaged Optics versus Linear Drive pluggable optics.

With the increasing adoption of Quantum Dot lasers in mainstream transceivers, reliability has become increasingly important.

Furthermore, quantum technologies are making their way into hyperscale environments through Quantum Computing as a Service and quantum cryptography to safeguard critical communications to and from data centres.

Photonic Integrated Circuits (PICs) are the critical enabling technology throughout and we will hear on the latest advances in PIC technologies.

See page 23 of this programme for a list of speakers and topics for this symposium.

Harmonie 1

Tu1A • Doped Fiber Amplifiers Improved Designs, Multimode and Multicore — *Continued*

Tu1A.3 • 09:30
Hexagonal Cladding 19-core EDF for Improved Output Power of Cladding Pumped Amplification, *Koichi Maeda; Shigehiro Takasaka; Ryuichi Sugizaki; Masanori Takahashi; Furukawa Electric Co., Ltd..*

We fabricate a hexagonal cladding 19-core EDF to improve output power of cladding pumped amplification and confirm 1.1 dB higher output power of a circular cladding one. Output power improvement by hexagonal cladding is 0.7 dB based on normalized cladding pump power density.

Tu1A.4 • 09:45
Power-efficient Triple-cladding Coupled 4-core Fibre Amplifier, *Taiji Sakamoto; Ryota Imada; Masaki Wada; Kazuhide Nakajima; Access Network Service Systems Laboratories, NTT Corporation.*

We propose a triple-cladding multi-core amplifier to achieve a high core-to-cladding ratio with a reduced number of cores while maintaining a feasible cladding diameter. Our 4-core amplifier demonstrates the highest power conversion efficiency of 7.2% among reported C-band amplifiers with less than ten cores.

Harmonie 2

Tu1B • Advances in Network Control and Management — *Continued*

Tu1B.3 • 09:30 **Tutorial**
Control of optical networks: a reality check and future perspectives, *Piero Castoldi[1]; Filippo Cugini[2]; Alessio Giorgetti[3]; Francesco Paolucci[2]; Anna Lina Ruscelli[1]; Nicola Sambo[1]; Andrea Sgambelluri[1]; Luca Valcarenghi[1]; [1]Scuola Superiore Sant'Anna; [2]CNIT- National Inter-University Consortium for Telecommunications; [3]University of Pisa.*

This paper investigates the main highlights of optical network control evolution, focusing on Software-Defined Networking (SDN), NETCONF/YANG protocols, telemetry techniques, advancements in packet/optical networking, and the integration of Artificial Intelligence (AI) within optical networks.

Harmonie 3

Tu1C • Novel Opportunities for Integrated Photonics & Transceivers — *Continued*

Tu1C.2 • 09:30
A Packaged 1.6 Tb/s O-band Optical Transceiver Based on the Hybrid Integration of SiGe Electronics and InP-Polymer Photonics, *Efstathios Andrianopoulos[1]; Shengpu Niu[2]; Joris Van Kerrebrouck; Madeleine Weigel[3]; Zerihun Tegegne[4]; David De Felipe Mesquida[3]; Durvasa Gupta[3]; Kieran De Bruyn[2]; Joris Lambrecht[2]; Gertjan Coudyzer[2]; Marijn Verbeke[5]; Michael Theurer[3]; Martin Kresse[3]; Evrydiki Kyriazi[1]; Georgios Megas[1]; Christos Tsokos[1]; Christos Kouloumentas[6]; Maria Massaouti[1]; Martin Moehrle[3]; Patrick Runge[3]; Xin Yin[2]; Joost Van Kerkhof[4]; Norbert Keil[3]; Panos Groumas[6]; Hercules Avramopoulos[1]; Johan Bauwelinck[2]; [1]National Technical Univ. of Athens; [2]University Ghent IDLab; [3]Fraunhofer Heinrich Hertz Institut (HHI); [4]PHIX BV; [5]Nvidia; [6]Optagon Photonics.*

We present and experimentally demonstrate a packaged O-band 1.6 Tb/s capable optical transceiver based on SiGe electronic and InP-Polymer photonic integrated circuits, showing a single channel record-high bit-rate distance transmission product of 3720 Gb/s x km.

Tu1C.3 • 09:45
A 64 Gbaud/s Hybrid Integrated Silicon Photonic Transceiver with Co-Designed CMOS Driver and TIA for In-Package Optical I/O, *Jintao Xue[1]; Qianli Ma[2]; Sikai Chen[2]; Chao Cheng[1]; Shenlei Bao[1]; Wenfu Zhang[1]; Nan Qi[2]; Binhao Wang[1]; [1]The State Key Laboratory of Transient Optics and Photonics, Xi'an Institute of Optics and Precision Mechanics, Chinese Academy of Sciences; [2]Institute of Semiconductors, Chinese Academy of Sciences.*

A 64 Gbaud/s error-free hybrid integrated silicon photonic polarization-independent transceiver in 28 nm CMOS and SOI with 7.15 pJ/bit power efficiency is demonstrated for DWDM optical I/O. The transceiver utilizes 60 GHz dual-segment microring modulators (MRMs), dual-ring filters, and 40 GHz bidirectional photodiodes (PDs).

Harmonie 4

Tu1D • Intra-Data Center Systems — *Continued*

Tu1D.2 • 09:30
Coherent DWDM Single-Mode Transmission over Universal Fibre for Data Centre Interconnects, *Fabio Aparecido Barbosa[1]; Mareli Rodigheri[1]; Ming-Jun Li[2]; Filipe Marques Ferreira[1]; [1]University College London (UCL); [2]Corning Incorporated.*

Experimental DWDM 75x42-Gbaud DP-256-QAM transmission is demonstrated in the C-band over 50 km of Universal fibre, meeting conventional single-mode transmission performance while allowing for SDM upgrades as well as 850 nm VCSEL-based multimode transmission. Penalties due to multipath interference are analysed with offset at launching splice.

Tu1D.3 • 09:45
Silicon Photonics GeSi Electro Absorption Modulator for Beyond 300 Gb/s Per λ Links, *Armands Ostrovskis[1]; Grigorij Muliuk[2]; Minkyu Kim[2]; Toms Salgals[1]; Michael Koenigsmann[3]; Kristaps Rubuls[1]; Benjamin Krüger[3]; Arvids Sedulis[1]; Fabio Pittalà[3]; Sandis Spolitis[1]; Hadrien Louchet[3]; Robert Jahn[3]; Kazuo Yamaguchi[3]; Markus Gruen[3]; Vjaceslavs Bobrovs[1]; Peter De Heyn[2]; Xiaodan Pang[4]; Oskars Ozolins[5]; [1]Riga Technical University, Latvia; [2]IMEC, Leuven, Belgium; [3]Keysight Technologies Deutschland GmbH; [4]KTH Royal Institue of Technology; [5]Riga Technical University and RISE Research Institutes of Sweden and Department of Applied Physics, KTH Royal Institute of Technology.*

We demonstrate Silicon Photonics GeSi EAM modulator achieving beyond 300 Gb/s net data transmission rate. We show up to 160 Gbaud PAM4 and 256 Gbaud OOK transmission over 100 m of single-mode fiber satisfying 6.25% overhead hard-decision forward error correction threshold of 4.5×10-3

Tu1E • LiFi for Indoor and Underwater Communications
— Continued

Tu1E.3 • 09:30
Modified Angle Diversity Receiver with Wide Field-of-View for Short-Range High-Speed Optical Wireless Communication, *Ketema Mekonnen; Gerwin Gelinck; TNO/Holst Centre.*

We propose and experimentally demonstrate a modified angle-diversity receiver with >40 degree field-of-view and >3.3 Gb/s on-off-keyed data transmission capability for optical-wireless communication (OWC) by employing a scalable 2D arrangement of photodetectors. The receiver architecture simplifies practical deployment of OWC in mobile/nomadic consumer markets.

Tu1E.4 • 09:45
Wide Field-of-View Receivers for High-Capacity Optical Wireless Transmission, *Ton Koonen; Eduward Tangdiongga; Eindhoven University of Technology.*

In-depth analysis of the 4x4 photodiode matrix concept we have introduced before shows a robust field-of-view vs. power coupling performance against misalignment, performance advantages versus other OWC receiver concepts, and further receiver improvement by upscaling the matrix while maintaining its wide bandwidth, simplicity and energy-efficiency.

Tu1F • THz Processing and Coding
— Continued

Tu1F.3 • 09:30
Optimized Soft-Aided Decoding of OFEC and Staircase Codes, *Lukas Rapp[1]; Sisi Miao[2]; Laurent Schmalen[2]; [1]MIT; [2]Karlsruhe Institute of Technology (KIT).*

We propose a novel soft-aided hard-decision decoding algorithm for general product-like codes. It achieves error correcting performance similar to that of a soft-decision turbo decoder for staircase and OFEC codes, while maintaining a low complexity.

Tu1F.4 • 09:45
Experimental Demonstration of 16D Voronoi Constellation with Two-Level Coding over 50 km four-Core Fiber, *Can Zhao[1]; Bin Chen[1]; Jiaqi Cai[2]; Zhiwei Liang[1]; Yi Lei[1]; Junjie Xiong[3]; Lin Ma[3]; Daohui Hu[2]; Lin Sun[2]; Gangxiang Shen[2]; [1]Hefei University of Technology; [2]Soochow University; [3]Shanghai Jiao Tong University.*

A 16-dimensional Voronoi constellation concatenated with multilevel coding is experimentally demonstrated over a 50 km four-core fiber transmission system. The proposed scheme reduces the required launch power by 6 dB and provides a 17 dB larger operating range than 16QAM with BICM at the outer HD-FEC BER.

Tu1G • Novel Modulators
— Continued

Tu1G.2 • 09:30
75 GHz BW Ultra-High Speed O-band Hybrid CMBH Ridge EMLs for Next Generation Ethernet, *Prashanth Bhasker; Sumeeta Arora; Alex Robertson; Adrian Ni; Tom McCaully; Jeffrey Bloch; John E Johnson; Broadcom.*

We report hybrid CMBH-Ridge O-band EML with 75 GHz 3 dB BW at 55C using lumped electrodes and conventional wire bonding. PAM4 (240 Gbits/s), PAM6 (300 Gbits/s) and PAM8 (360 Gbits/s) eyes are demonstrated from 20C to 70C with 3.5 dB ER and 7 dBm output power.

Tu1G.3 • 09:45
Radiation-Hardened Silicon Traveling-Wave Mach-Zehnder Modulator for Beyond 50 Gb/s Readout Links in Particle Detectors, *Simone Cammarata[1]; Alberto Montanaro[2]; Vito Sorianello[2]; Fabrizio Palla[1]; Fabrizio Di Pasquale[3]; Claudio Jose Oton[3]; [1]Istituto Nazionale di Fisica Nucleare (INFN); [2]Photonic Networks and Technologies Lab – CNIT; [3]Istituto di Intelligenza Meccanica – Scuola Superiore Sant'Anna.*

Silicon photonics has a strong potential to enable the next generation of high-speed radiation-hard optical links in high-energy physics. This work presents a radiation-hardened-by-design silicon traveling-wave Mach-Zehnder modulator which supports BER-validated NRZ transmission beyond 50-Gb/s and targets radiation tolerances larger than 1-Grad(SiO2) total ionizing dose.

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— Continued

Harmonie 1

Tu1A • Doped Fiber Amplifiers Improved Designs, Multimode and Multicore — *Continued*

Tu1A.5 • 10:00
O-band Pump Optimized Bismuth Doped Fiber Amplifier with 3.8 dB Noise Figure, *Aleksandr Donodin[1]; Vitaly Mikhailov[2]; Jiawei Luo[2]; Wladek Forysiak[1]; David J. DiGiovanni[2]; Sergei Turitsyn[1]; [1]Aston University, Aston Institute of Photonics Technologies; [2]OFS Laboratories.*

We experimentally compare pumping schemes of an O-band bismuth-doped fiber amplifier to optimize its performance. We achieve maximum gain of 24.7 dB and record minimal NF of 3.8 dB. We also demonstrate amplified transmission of 400 Gb/s QSFP-DD LR-4 module over 20 km distance.

Tu1A.6 • 10:15
Machine Learning Model for EDFA Predicting SHB Effects, *Fatih Yaman[1]; Andrea D'Amico[1]; Eduardo Mateo[2]; Takanori Inoue[2]; Yoshihisa Inada[2]; [1]NEC Laboratories America; [2]NEC Corporation.*

Experiments show that machine learning model of an EDFA is capable of modelling spectral hole burning effects accurately. As a result, it significantly outperforms black-box models that neglect inhomogeneous effects. Model achieves a record average RMSE of 0.0165 dB between the model predictions and measurements.

Harmonie 2

Tu1B • Advances in Network Control and Management — *Continued*

Harmonie 3

Tu1C • Novel Opportunities for Integrated Photonics & Transceivers — *Continued*

Tu1C.4 • 10:00 Invited
Opportunities for Mechanically Actuated Photonics, *Kristinn Gylfason; KTH Royal Institute of Technology.*

Photonic integrated circuits (PICs) promise to be the optical equivalent of electronic integrated circuits (ICs). However, current PICs cannot match the number of devices per chip of electronic ICs due to active photonic components' large footprint and power consumption. By micromechanical actuation of PICs, we show compact devices with orders of magnitude power reduction compared to thermo-optic counterparts.

Harmonie 4

Tu1D • Intra-Data Center Systems — *Continued*

Tu1D.4 • 10:00
800 Gb/s SDM Optical Interconnect with Optical Circuit Switch for Intra-Data Centers using O-band PAM8, *Budsara Boriboon[1]; Ruben Luis[1]; Benjamin Puttnam[1]; Satoshi Shinada[1]; Nikolaos-Panteleimon Diamantopoulos[2]; Shinji Matsuo[2]; Hideaki Furukawa[1]; [1]National Institute of Information and Communications Technology (NICT); [2]NTT Device Technology Labs, NTT Corporation.*

We propose SDM optical interconnect using 4-core and 8-core MCFs with an optical circuit switch, emulating the spine-leaf network topologies in intra-data centers for high capacity, cabling management, and simple scalability. We can achieve 800 Gb/s with 75 GBaud PAM8 using 4λ DML channels.

Tu1D.5 • 10:15
400G coherent system for an amplifier free optical interconnect with bandwidth limited transceivers, *Guoxiu Huang[1]; Shinsuke Tanaka; Tomoo Takahara; Hisao Nakashima; [1]FUJITSU LIMITED.*

We experimentally verified the achievability of 120 GBaud THP-QPSK signal for 90 km transmission of an amplifier free optical link with narrow bandwidth transceivers. The performance comparison to Nyquist signals clearly shows the better performance as 18 dB link budget.

10:30–11:00 Coffee Break, Exhibition

Hall 5

11:00–12:30
Demo Session (Hall 5)

See page 22 of this programme for more information about this session.

11:00–13:30 Exhibition Only Time

Harmonie 5

Tu1E • LiFi for Indoor and Underwater Communications
— Continued

Tu1E.5 • 10:00
Optical Phased Array Enabled 200-Gbps Full-Duplex Optical Wireless Communication over Wide Range, *Qijie Xie; Yingzhi Li; Baisong Chen; Lingjun Zhou; Haolun Du; Ziming Wang; Quanxin Na; Lei Wang; Junfeng Song.*

We propose and demonstrate an optical phased array (OPA)-based optical wireless communication (OWC) system for full-duplex data transmission up to 200 Gbps. A silicon-based dual OPAs are monolithically integrated to form a transceiver antenna, providing flexible beam steering over 120° for the OWC system.

Tu1E.6 • 10:15
Visible Light Coherent Communication: First Demonstration of > 1-Tb/s Coherent Demodulation at 780 nm, *Takashi Kan; Shota Ishimura; Hidenori Takahashi; Takehiro Tsuritani; KDDI Research, Inc.*

We, for the first time, demonstrate >1-Tb/s visible light coherent communication. By using our developed coherent receivers at 780 nm, we achieve coherent demodulation of 1.2-Tb/s 12 WDM 12.5-Gbaud dual-polarization 16QAM signals. This is the largest capacity reported so far in the visible region.

Harmonie 6

Tu1F • THz Processing and Coding
— Continued

Tu1F.5 • 10:00 Invited
Photonics-Enabled Terahertz Signal Processing for Extreme Communications in 6G and Beyond, *Dat Pham; Yuya Yamaguchi; Naokatsu Yamamoto; Kouichi Akahane; National Institute of Information and Communications Technology (NICT).*

Photonic technology is crucial for enabling radio communication in high-frequency bands. This paper highlights essential photonic technologies for generating, receiving, and processing terahertz signals and reviews their recent demonstrations and developments.

Spektrum

Tu1G • Novel Modulators
— Continued

Tu1G.4 • 10:00 Invited
Thin-film Lithium Niobate Modulators, *Mian Zhang.*

Lithium niobate (LN), an outstanding and versatile material, has influenced our daily life for decades: from enabling high-speed optical communications to radio-frequency filtering used in cell phones. This half-century-old material is currently embracing a revolution in thin-film LN integrated photonics [1], achieving unprecedented modulator performances.

Illusion

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— Continued

10:30–11:00 Coffee Break, Exhibition

11:00–13:30 Exhibition Only Time

Harmonie 1

13:30–15:00
Tu3A • Photonic Devices for Quantum Communication
Presider: Takeshi Umeki; NTT Device Technology Laboratories, NTT Corporation

Tu3A.1 • 13:30 Invited
Quantum Light Sources, *Klaus Jons; Paderborn University.*

Quantum light sources have revolutionized quantum technologies, enabling advancements in communication, computing, sensing, and networks. Despite significant progress, challenges in efficiency, scalability, and standardization remain. Here we compare different types of sources with optically active epitaxial quantum dots, so called artificial atoms.

Harmonie 2

13:30–15:00
Tu3B • Space-Division Multiplexing I
Presider: Kohki Shibahara; NTT Network Innovation Laboratories

Tu3B.1 • 13:30 Invited
High Data-Rate Optical Transmission in Multi-Core/ Multi-Mode Fibers, *Ruben Soares Luis[1]; Benjamin Puttnam[1]; Georg Rademacher[2]; Hideaki Furukawa[1]; [1]National Institute of Information and Communications Technology (NICT); [2]Stuttgart University .*

We evaluate recent works on ultra high capacity supported by conventional and SDM fibers. We address the potential to improve them and reach the maximum achievable throughput by increasing the bandwidth and/or spatial multiplicity, and the expected impairments to overcome.

Harmonie 3

13:30–15:00
Tu3C • Novel Optical and Digital Signal Processing Techniques
Presider: Élie Awwad; Télécom Paris, Institut Polytechnique de Paris

Tu3C.1 • 13:30
A Time-interleaved Photonic-assisted ADC Using Quantum Dash Mode-locked Laser, *Yuxuan Xie[1]; Guocheng Liu[2]; Jiaren Liu[2]; Zhenguo Lu[2]; Philip Poole[2]; John Weber[2]; Pedro Barrios[2]; Mohamed Rahim[2]; Lawrence Chen[1]; [1]McGill University; [2]National Research Council Canada.*

We present a photonic-assisted analog-to-digital converter using time-interleaving, achieving sub-Nyquist rate sampling without aliasing. With a clock frequency of 2 GHz, we obtain an equivalent sampling frequency of 100 GS/s with an ENOB of up to 11 over an operating range from 0–12.5 GHz.

Tu3C.2 • 13:45
Wideband Tunable Idler Filtering in a Monolithically Integrated Silicon Photonic Wavelength Converter, *Hao Liu[1]; Kyle R.H.Bottrill[1]; Valerio Vitali[2]; Iosif Demirtzioglou[3]; Nura Adamu[1]; Cosimo Lacava[2]; Xingzhao Yan[1]; Mehdi Banakar[1]; Ying Tran[1]; Martin Ebert[1]; James Le Besque[1]; Callum Littlejohns[1]; David J.Thomson[1]; Periklis Petropoulos[1]; [1]Optoelectronics Research Centre, University of Southampton, Southampton, SO17 1BJ, UK; [2]Electrical, Computer and Biomedical Engineering Department, University of Pavia, Pavia, 27100, Italy; [3]Huawei Technologies, Paris Research Center, Optical Communication Technology Lab, 92100 Boulogne-Billancourt, France.*

We present a silicon photonic wavelength converter and integrated filter achieving wideband tunable filtering over 25 nm with a >52 dB pump and modulated signal suppression ratio. Operation of the device with telecommunication signals is demonstrated across the C-band.

Harmonie 4

13:30–15:00
Tu3D • Coherent PON – II
Presider: Lena Wosinska; Chalmers University of Technology

Tu3D.1 • 13:30
First Demonstration of 100G Self-coherent PON Based on Pre-Amplified Stokes Vector Direct Detection, *Yuhao Fang[1]; Honglin Ji[2]; Haojie Zhu[1]; Puzhen Yuan[1]; William Shieh[1]; [1]Westlake University, China; [2]Peng Cheng Laboratory, Shenzhen, China.*

We propose a novel 100G pre-amplified self-coherent PON (SC-PON) architecture and experimentally demonstrate the first 25-Gbaud 16-QAM SVDD SC-PON using a semiconductor optical amplifier (SOA). We achieve 33.6-dB budget for the downstream transmission over a 20-km SMF.

Tu3D.2 • 13:45
Adaptable Modulation and Baud Rates in Coherent TFDM PONs: Towards Versatile High-Speed Access Networks, *Haipeng Zhang; Zhensheng Jia; Karthik Choutagunta; Luis Alberto Campos; Curtis Knittle; CableLabs.*

We introduce a novel rate-flexible coherent TFDM PON architecture with adaptable modulation formats and baud rates. This enables accommodation of diverse end-user needs in high-speed coherent PONs. Demonstrations achieve 322.5 Gb/s aggregated capacity and support distributed splitting over various distances and split ratios.

Harmonie 5

13:30–15:00
Tu3E • Performance Monitoring Techniques
Presider: Andrea Carena; Politecnico di Torino

Tu3E.1 • 13:30
Regression assisted experimental validation for estimating distributed PDL in optical links, *Lina Shi; Fabien Boitier; Camille Delezoide; Petros Ramantanis; Patricia Layec; Nokia Bell Labs.*

We propose a regression-assisted method to estimate polarization-dependent loss (PDL) utilizing signal-to-noise ratio (SNR) statistical data. This approach accurately predicts PDL of multiple components in multi-span optical link reaching an estimation error of only 0.011 dB for in transit PDL element.

Tu3E.2 • 13:45
Integrating PPE and Input Refinement for Enhanced QoT Estimation and Optimization in an Optical Mesh Network, *Xin Yang[1]; Tarek Eldahrawy[2]; Chenyu Sun[2]; Abel Lorences-Riesgo[2]; Massimo Tornatore[1]; Gabriel Charlet[2]; Yvan Pointurier[2]; [1]Politecnico di Milano; [2]Huawei Technologies France, Paris Research Center.*

We propose and experimentally validate a novel method for improved power and insertion loss estimation, enabling anomalous loss detection, QoT estimation and optimization in a mesh network, achieving 0.7 dB average SNR increase and 1 dB network margin enhancement.

Harmonie 6

13:30–15:00
Tu3F • Wireless THz Comms
Presider: Shota Ishimura; KDDI Research, Inc.

Tu3F.1 • 13:30
Demonstration of 562.5-Gbps 2×2 MIMO Terahertz-Wave Signal Transmission at 322 GHz with SFO compensation, *Jianyu Long; Chen Wang; Jianjun Yu; Long Zhang; Bohan Sang; Ying Wu; Xiongwei Yang; Yi Wei; Kaihui Wang; Wen Zhou; Jiao Zhang; Junjie Ding; Min Zhu.*

In a photonics-aided 2×2 MIMO THz-over-fiber system, we experimentally demonstrate a record-breaking net rate/λ of 562.5-Gbps at 322 GHz over 20-km wired and 3-m wireless distance by using an SFO compensation algorithms.

Tu3F.2 • 13:45
Broadband Frequency-Hopping Coupled Optoelectronic Oscillator with Low Phase Noise and High Stability, *Hui Liu; Tian Zhang; Jian Dai; Kun Xu; Beijing University of Posts and Telecommunications.*

We present a flexible coupled optoelectronic oscillator capable of conducting both frequency hopping and phase locking operations while minimizing phase noise. A typical phase noise as low as -140 dBc/Hz@ 10 kHz across 2–18 GHz, and fractional Allan deviation of 6.1*10^-12 at 1 s were observed.

Spektrum

13:30–15:00
Tu3G • Heterogeneous Laser Integration
Presider: Woo-Young Choi; Yonsei University

Tu3G.1 • 13:30 **Invited**
Quantum Dot Lasers on Silicon by Heterogeneous Integration, *Jonathan Klamkin.*

Room-temperature continuous-wave quantum dot laser operation was achieved on silicon by metalorganic chemical vapour deposition direct heteroepitaxy. High quality quantum dots and the full laser structure were selectively grown on foundry-compatible patterned silicon photonic wafers by demonstrating a “zero-gap” interface between the gain and silicon nitride waveguide.

Illusion

10th International Symposium for Optical Interconnects in Data Centres
— Continued

Harmonie 1

Tu3A • Photonic Devices for Quantum Communication — *Continued*

Tu3A.2 • 14:00
High-Rate Local-Local-Oscillator Continuous-Variable Quantum Key Distribution Using Chip-Based Silicon Photonic Receiver, *Yiming Bian[1]; Yan Pan[2]; Xuesong Xu[1]; Liang Zhao[1]; Yang Li[2]; Wei Huang[2]; Lei Zhang[1]; Song Yu[1]; Yichen Zhang[1]; Bingjie Xu[2]; [1]Beijing University of Posts and Telecommunications; [2]Institute of Southwestern Communication.*

A local-Local-Oscillator continuous-variable quantum key distribution system with an 1.5 GHz bandwidth integrated silicon photonic receiver chip has been experimentally demonstrated, which extends the transmission distance to 25 km and achieves a secret key rate of 2.07 Mbps.

Tu3A.3 • 14:15
Twin-Field Quantum Key Distribution Using Devices on a Photonic Chip, *Han Du; Taofiq Paraiso; Mirko Pittaluga; Yuen San Lo; Joseph Dolphin; Andrew Shields; Toshiba Cambridge Research Laboratory.*

Harmonie 2

Tu3B • Space-Division Multiplexing I — *Continued*

Tu3B.2 • 14:00
Net 6.4-Tb/s (4-WDM × 4-SDM × 400 Gb/s/lane) O-band IM-DD Transmission over 2 km enhanced by NL-MLSE, *Hiroki Taniguchi; Shuto Yamamoto; Akira Masuda; Masanori Nakamura; Fukutaro Hamaoka; Yutaka Miyamoto; Etsushi Yamazaki; NTT Network Innovation Laboratories, NTT Corporation.*

IM-DD signals with 155-GBd PAM-8 for a net 400 Gb/s/lane are verified in a back-to-back configuration by applying our nonlinear-MLSE with high tolerance to nonlinear waveform distortion. 6.4-Tb/s O-band 2-km transmission is achieved with 16 lanes of 400 Gb/s/lane using 4-LAN-WDM and 4-core fibre.

Tu3B.3 • 14:15
Investigation of Mode-Dependent Loss in Coupled-Core Multi-Core Fiber Transmissions with Fiber Nonlinearities, *Chiara Lasagni[1]; Paolo Serena[1]; Alberto Bononi[1]; Antonio Mecozzi[2]; Cristian Antonelli[2]; [1]University of Parma; [2]University of L'Aquila.*

We analyze the impact of mode-dependent loss (MDL) on the signal-to-noise ratio (SNR) in coupled-core multi-core fiber transmissions, including its interplay with spatial mode dispersion (SMD) and fiber nonlinearities. We find different SNR statistics in linear and nonlinear regimes depending on the amount of SMD.

Harmonie 3

Tu3C • Novel Optical and Digital Signal Processing Techniques — *Continued*

Tu3C.3 • 14:00
Coupled-Band ESSFM for Low-Complexity DBP, *Stella Civelli; Debi Pada Jana; Enrico Forestieri; Marco Secondini.*

We propose a novel digital backpropagation (DBP) technique that combines perturbation theory, subband processing, and splitting ratio optimization. We obtain 0.23 dB, 0.47 dB, or 0.91 dB gains w.r.t. dispersion compensation with only 74, 161, or 681 real multiplications/2D-symbol, improving significantly on existing DBP techniques.

Tu3C.4 • 14:15
Experimental Demonstration of Zero-Shot Machine Learning Equalisation in Dual-Polarisation Coherent Transmission, *Samuel Lennard; Fabio A. Barbosa; Filipe M. Ferreira; University College London (UCL).*

We introduce the first machine learning-only equaliser for dual-polarisation IQ-modulated signals operating without online training or fine-tuning. Lab transmission of 30 Gbaud DP-16-QAM shows this equaliser matching or outperforming conventional DSP over a range of conditions, including different fibres and transmission frequencies.

Harmonie 4

Tu3D • Coherent PON – II — *Continued*

Tu3D.3 • 14:00 **Tutorial**
Simplified Transceivers for Coherent-Lite Systems, *Seb Savory; University of Cambridge.*

This tutorial covers coherent transceivers and their simplification for coherent-lite systems. We focus on systems where IM/DD remains the preferred cost-effective solution namely data centre and optical access networks. We explore the DSP, photonics and power consumption for coherent-lite systems, concluding with their future prospects.

Tu3E • Performance Monitoring Techniques — *Continued*

Tu3E.3 • 14:00
Monitoring of Chromatic Dispersion in Multiband Access and Metro Converged Optical Network, *Fabien Boitier[1]; Laia Nadal[2]; F. Javier Vílchez[2]; Petros Ramantanis[1]; Josep M. Fàbrega[2]; Alix May[1]; Michela Svaluto Moreolo[2]; Ramón Casellas[2]; Patricia Layec[1]; [1]Nokia Bell Labs; [2]Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA).*

We study the performance of chromatic dispersion monitoring over S, C and L band of different fibers with a multiband bandwidth/bitrate variable transceiver. We integrate our monitoring solution in an optical networking testbed to demonstrate its accuracy with heterogeneous fiber topology.

Tu3E.4 • 14:15
Pilot-Tone Assisted Mode-Coupling Crosstalk Monitoring in Mode-Division Multiplexing Systems, *Tianfeng Zhao; Feng Wen[1]; Shiyu Zong[1]; Jinlong Wei[2]; Junpeng Liang[2]; Mingming Tan[3]; Baojian Wu[1]; Bo Xu[1]; Kun Qiu[1]; [1]University of Electronic Science and Technology of China; [2]Peng Cheng Laboratory; [3]Aston University, Aston Institute of Photonics Technologies.*

The Pilot-tone-assisted crosstalk (PT-XT) monitoring scheme is demonstrated in MDM systems with only the low-bandwidth photodetector (PD) and simplified feature-extraction operations. The monitor-ing accuracy, characterised by the coefficient of determination R2, is experimentally achieved over 0.988 for a three-mode scenario.

Tu3F • Wireless THz Comms — *Continued*

Tu3F.3 • 14:00
Wireless THz Communications at 250 Gbit/s Using Self-Injection-Locked Kerr Soliton Microcombs as Photonic-Electronic Oscillators at the Transmitter and Receiver, *Dengyang Fang[1]; Huanfa Peng[1]; Yung Chen[1]; Joel Dittmer[1]; Axel Tessmann[2]; Sandrine Wagner[2]; Patrick Matalla[1]; Daniel Drayss[1]; Grigory Lihachev[3]; Andrey Voloshin[3]; Sebastian Skacel[4]; Matthias Lauermann[4]; Kallfass Ingmar[5]; Thomas Zwick[6]; Wolfgang Freude[1]; Tobias Kippenberg[3]; Sebastian Randel[1]; Christian Koos[1]; [1]Institute of Photonics and Quantum Electronics, Karlsruhe Institute of Technology; [2]Fraunhofer Institute for Applied Solid State Physics (IAF); [3]Institute of Physics, Swiss Federal Institute of Technology Lausanne (EPFL); [4]Vanguard Automation GmbH; [5]Institute of Robust Power Semiconductor Systems, University of Stuttgart; [6]Institute of Radio Frequency Engineering and Electronics (IHE), Karlsruhe Institute of Technology (KIT).*

We demonstrate wireless THz transmission and reception using self-injection-locked Kerr soliton microcombs as photonic-electronic oscillators both at the transmitter and receiver. We achieve record-high single-channel line rates of 250 Gbit/s transmitted over 55 m and demonstrate THz spread-spectrum transmission at signal-to-noise ratios (SNR) down to −16 dB.

Tu3F.4 • 14:15
Photonic Terahertz Chaos Enabling Private Communication, *Qiuzhuo Deng; Lu Zhang; Zhidong Lyu; Xiaodan Pang; Oskars Ozolins; Xianbin Yu.*

We propose photonic terahertz chaos encryption and synchronization scheme for private communications. Experiment demonstrates 5 Gbit/s wireless communication signal chaotic encryption at 120 GHz, with chaos synchronization correlation coefficient up to 90.6%.

Tu3G • Heterogeneous Laser Integration — *Continued*

Tu3G.2 • 14:00
Athermally Controlled III-V / Silicon C-Band Tunable Lasers Fabricated at Scale, *Theo Verolet[1]; Alexandre Horth[1]; Hossam Shoman[1]; Pierre Fanneau de la Horie[1]; Dorin Dogaroiu[1]; Jae Jang[1]; Andy Lim[1]; Jeewan Naik[1]; Mohammad Teimourpour[1]; Kishore Padmaraju[1]; Yury Deshko[1]; Ruizhi Shi[1]; Michael Schmidt[1]; Nicolas Fontaine[2]; Kwangwoong Kim[2]; Brian Stern[2]; Flavio Pardo[2]; Ajay Mistry[1]; Andreas Leven[1]; [1]Nokia; [2]Nokia Bell Labs.*

Using flip-chip bonding, we demonstrate 70~kHz linewidth extended-cavity lasers emitting over 13~dBm waveguide power. The integration of an athermal control system allows for sub-minute laser calibration time, and under closed-loop control the laser's frequency error is kept below 2.0~GHz across a 20°C temperature range.

Tu3G.3 • 14:15
Open-Access Heterogeneous Si-IIIV Laser Sources for LiDAR and Datacom Applications, *Erik Norberg[1]; Hanxing Shi; Hongwei Zhao; John Parker; Kim Nguyen; Si Zhu; Jared Bauters; Molly Piels; [1]OpenLight.*

We demonstrate tunable and DFB lasers heterogeneously integrated in a silicon photonics platform in a open-access BiCMOS foundry process. Si-IIIV DFBs with >40 mW output power and tunable lasers with fundamental linewidths of 8 kHz are presented together with volume manufacturing data and reliability results.

10th International Symposium for Optical Interconnects in Data Centres — *Continued*

Harmonie 1

Tu3A • Photonic Devices for Quantum Communication — *Continued*

Tu3A.4 • 14:30

A Reconfigurable Chip-Scale Quantum Key Distribution Receiver Based on Silicon Nitride, *Denis Fatkhiev; Hui Liu; Alexander Grebenchukov; Menno van den Hout; Aaron Albores-Mejia; Chigo Okonkwo; Idelfonso Tafur Monroy; Eindhoven University of Technology.*

A silicon nitride photonic integrated QKD receiver employing tunable couplers is demonstrated, enabling on-chip reconfigurability. The proposed approach achieves low quantum bit error rates below 1.5% across different receiver configurations, providing a migration strategy towards multi-protocol quantum-secured communication with optimized on-chip tuning.

Tu3A.5 • 14:45

Shortwave DPS-QKD Employing a SiN Micro-Ring Resonator as Compact Quantum State Analyser, *Florian Honz[1]; Paul Müllner[1]; Michael Hentschel[1]; Stefan Nevlacsil[1]; Jochen Kraft[2]; Martin Sagmeister[2]; Philip Walther[3]; Rainer Hainberger[1]; Bernhard Schrenk[1]; [1]AIT Austrian Institute of Technology; [2]ams-Osram AG; [3]Universersity of Vienna, Faculty of Physics.*

We show simplified DPS-QKD using a SiN micro-ring resonator operated at 852 nm. A raw-key rate of up to 25.3 kb/s is reached at a QBER suitable for secure-key extraction. Short-reach QKD operation is maintained for zero-touch link layouts with C-band telecom fiber.

Harmonie 2

Tu3B • Space-Division Multiplexing I — *Continued*

Tu3B.4 • 14:30 Invited

Space-Division Multiplexed Transmission from the Lab to the Field, *Cristian Antonelli; L'Aquila University.*

A fiber-optic infrastructure for space-division multiplexed transmission has been established in the Italian city of L'Aquila and is now expanding. In this paper we review lessons learned and achievements from half a decade of operating field-deployed multi-core and few-mode fibers for spatial multiplexing.

Harmonie 3

Tu3C • Novel Optical and Digital Signal Processing Techniques — *Continued*

Tu3C.5 • 14:30 Invited

Perspectives in programmable photonics (focus on algorithms), *Jose Capmany; Universidad politécnica de Valencia.*

We revise and address the recent developments in the area of programmable photonics, paying special attention to algorithms and the software layer required for its implementation. We introduce the concept of software-defined programmable photonics.

Harmonie 4

Tu3D • Coherent PON – II — *Continued*

15:00–15:30 Coffee Break, Exhibition

Harmonie 5

Tu3E • Performance Monitoring Techniques — *Continued*

Tu3E.5 • 14:30

Experimental Demonstration of Linear Least Squares-based Longitudinal Power Monitoring over a Raman-amplified C+L Link, *Lorenzo Andrenacci[1]; Stefano Straullu[2]; Antonino Nespola[2]; Gabriella Bosco[3]; Pierluigi Poggiolini[1]; Stefano Piciaccia[4]; Dario Pilori[1]; [1]Politecnico di Torino; [2]LINKS Foundation; [3]Politecnico di Torino; [4]CISCO Photonics Italy srl.*

We present the first experimental demonstration of a linear least squares-based longitudinal power monitoring algorithm over a C+L link with full backward Raman amplification, transmitting 64-GBaud PDM-QPSK signals over 9x60-km spans of SMF.

Tu3E.6 • 14:45

A Method for Analytically Quantifying the Equalization-Enhanced Phase Noise Penalty, *You Wang; Zhuopeng Xiao; Yanxiang Yang MdB; Qiang Zheng; Martí Sales-Llopis; Haoran Cheng MdB; Hong Yang; Huijian Zhang; Huawei Technologies Co. Ltd.*

We propose a method based on a novel model for quantifying the penalty of equalisation-enhanced phase noise with consideration of lasers' coloured frequency noise and spurious components. Both simulation and experimental results prove the method's effectiveness for various lasers and dispersion scenarios.

Harmonie 6

Tu3F • Wireless THz Comms — *Continued*

Tu3F.5 • 14:30

Demonstration of Ultra-High Efficiency 6×64 Massive MIMO Signal Transmission by Subspace Tracking and Intermediate Frequency over Fibre, *Junya Nishioka; Takatoshi Akamatsu; Keita Mochizuki; Masaki Noda; Mitsubishi Electric Corporation.*

We proposed PAST-IFoF as a novel optical transmission scheme accommodating massive MIMO signals efficiently for beyond-5G. 6×64 MIMO signal transmission with OFDM-16QAM signals of 200 MHz bandwidth was demonstrated by PAST-IFoF using a reasonably priced direct modulation laser. The performance satisfied the 3GPP EVM requirement.

Tu3F.6 • 14:45

Real-time Net 1-Tbit/s Transparent Photonic-THz Link Transmission with Simultaneous Multi-THz-Band Live Traffic, *Jiao Zhang[1]; Min Zhu[2]; Mingzheng Lei[1]; Bingchang Hua[1]; Yuancheng Cai[1]; Qing Zhong[2]; Junjie Ding[1]; Yucong Zou[1]; Jinbiao Xiao[2]; Bo Liu[3]; Jianjun Yu[4]; Yongming Huang[2]; Xiaohu You[5]; [1]Purple Mountain Laboratories; [2]Southeast University; [3]Nanjing University of Information Science & Technology; [4]Fudan University,; [5]Peng Cheng Laboratory.*

The first net rate of 1-Tbit/s transparent fiber-THz converge subsystem with simultaneous multi-THz-band at 110~500 GHz band is demonstrated in field, a 400 GbE streaming service platform with 3×3 4K displayers arrays is also deployed, making it a promising scheme to support 6G immersive communication.

Spektrum

Tu3G • Heterogeneous Laser Integration — *Continued*

Tu3G.4 • 14:30

Ultrafast tunable photonic integrated E-DBR Pockels laser, *Anat Siddharth[1]; Simone Bianconi[1]; Zheru Qiu[1]; Rui Wang[2]; Mohammad Bereyhi[2]; Tobias Kippenberg[1]; Johann Riemensberger[3]; [1]EPFL; [2]Luxtelligence SA; [3]NTNU – The Norwegian University of Science and Technology.*

We demonstrate a hybrid integrated frequency-agile laser based on an InP RSOA and an E-DBR manufactured with a wafer-scale LNOI process. Achieving high output power, kHz linewidth, and >10 GHz tuning range, it offers unprecedented agility and surpasses previous limitations in frequency-tunable laser systems.

Tu3G.5 • 14:45

Full C-band tunable integrated Erbium lasers via wafer-scale fabrication, *Xinru Ji[1]; Yang Liu; Zheru Qiu; Anat Siddharth; Rui Ning Wang; Taegon Kim; Joseph C. Olson; Tobias Kippenberg; [1]Ecole Polytechnique Federal de Lausanne – EPFL.*

We demonstrate an integrated Erbium-based tunable laser using wafer-scale fabrication and ion implantation of silicon nitride photonic integrated circuits, and achieve single-frequency lasing tunable from 1530 nm to 1575 nm covering the entire optical C-band and part of the L-band.

Illusion

10th International Symposium for Optical Interconnects in Data Centres — *Continued*

15:00–15:30 Coffee Break, Exhibition

Harmonie 1

15:30–17:00
Tu4A • Few Mode Fibers and Characterization Techniques
Presider: Marianne Bigot; Prysmian

Tu4A.1 • 15:30
Germanium-Free Graded-Index-Core Few-Mode Fiber, *Pierre Sillard[1]; Marianne Bigot[1]; Frank Achten[1]; Maroun Bsaibes[2]; Yves Quiquempois[2]; Laurent Bigot[2]; [1]Prysmian; [2]Laboratoire PhLAM, Université de Lille.*

A Germanium-free graded-index-core 6-spatial-mode fiber is designed, fabricated and characterized. The index profile of the core is tightly controlled to achieve low differential-mode-group delays (≤ 170 ps/km). Low Rayleigh scattering losses are also demonstrated (≤ 0.167 dB/km) but the total losses still need to be optimized.

Tu4A.2 • 15:45
Bend Loss Measurements and Simulations for the LP11a and LP11b Modes in a Few-Mode Fiber, *Robert Petersen[1]; Lars Grüner-Nielsen[2]; Poul Kristensen[3]; Karsten Rottwitt[1]; [1]Technical University of Denmark (DTU); [2]Technical University of Denmark (DTU) and Danish Optical Fiber Innovation; [3]OFS Fitel Denmark, ApS.*

A novel, simple setup for measuring the resolved bend loss of the LP11a and LP11b modes is reported. The results are compared to simulations. The setup utilizes mode selective excitation of either LP11a or LP11b by a combination of an LPG and polarization controllers.

Tu4A.3 • 16:00
Few-mode Multi-core Fibre for Random Coupling with All Propagation Modes , *Ryota Imada[1]; Kunimasa Saitoh[2]; Takanori Sato[2]; Taiji Sakamoto[1]; Kazuhide Nakajima[1]; [1]Nippon Telegraph and Telephone Corporation; [2]Hokkaido university.*

Simultaneous intra- and inter-mode group coupling is experimentally demonstrated for the first time. Random coupling between 21 spatial modes in a hexagonal

Harmonie 2

15:30–17:00
Tu4B • High-Speed Transmission
Presider: Yan Li; Beijing University of Posts and Telecommunications

Tu4B.1 • 15:30
Experimental Comparison of Average-Power Constrained and Peak-Power Constrained 64QAM under Optimal Clipping in 400 Gbps Unamplified Coherent Links, *Wing Chau Ng; Chuandong Li; Huawei Technologies Canada Co., Ltd..*

We experimentally demonstrated an end-to-end link budget optimization over clipping in 400 Gbps unamplified links, showing that the clipped MB distribution outperforms the peak-power constrained 64QAM by 1 dB link budget

Tu4B.2 • 15:45
Single-Carrier 1.6-Tb/s Transmission with Digital Inverse Multiplexing on 89-GHz Bandwidth Doublers, *Akira Kawai[1]; Masanori Nakamura[1]; Takayuki Kobayashi[1]; Munehiko Nagatani[2]; Hitoshi Wakita[2]; Yuta Shiratori[2]; Hiroshi Yamazaki[2]; Hiroyuki Takahashi[2]; Yutaka Miyamoto[1]; [1]NTT Network Innovation Laboratories; [2]NTT Device Technology Laboratories.*

We generated coherent signals at up to 168 Gbaud based on 32-GHz DACs and 89-GHz InP bandwidth doubler modules supported by a tailored digital pre-distortion scheme (digital inverse multiplexing). We achieved a net bit rate of 1.61 Tb/s at 144 Gbaud after 100-km transmission.

Tu4B.3 • 16:00
Single-Polarization 300-Gb/s 32-QAM 80-km Transmission using a SiP Modified CADD Receiver with 7.7-b/s/Hz Net ESE, *Jingchi Li[1]; Zhen Wang[1]; Xingfeng Li[1]; Xiong Ni[1]; Haoshuo Chen[2]; William Shieh[3]; Yikai Su[1]; [1]Shanghai Jiao Tong University; [2]Nokia Bell Labs, NJ, USA; [3]Westlake University, China.*

We experimentally demonstrate a single-polarization 300-Gb/s (net 242-Gb/s) OFDM 32-QAM signal transmis-

Harmonie 3

15:30–17:00
Tu4C • FSO for Satellite Communications
Presider: Liam Barry; Dublin City University

Tu4C.1 • 15:30
Optimising Optical Ground Station Locations for Satellite Communications through Atmospheric Turbulence with Adaptive Optics Mitigation, *Ollie Farley[1]; James Osborn; [1]Durham University.*

Optimisation of a hypothetical network of European optical ground stations is presented, including outages from cloud and atmospheric turbulence, with detailed simulation of turbulence mitigation by adaptive optics. We find turbulence outages without adaptive optics mitigation have a large impact on the network outage rate.

Tu4C.2 • 15:45
Semantic-Enhanced LEO Satellite-to-Ground Laser Communication System with Improved VQ-GAN, *Wenbin Chen[1]; Cheng Ju[2]; Tianxing Yuan[1]; Chunyao Chen[2]; Jin Li[1]; Min Zhang[1]; Danshi Wang[1]; [1]State Key Lab of Information Photonics and Optical Communications, Beijing University of Posts and Telecommunications (BUPT); [2]Còllege of Electronic Information, Qingdao University.*

We propose and experimentally demonstrate a 10 Gbps PM-QPSK semantic-enhanced LEO-Sat laser system. Experimental results show that the proposed system can save 60% communication overhead and achieve 4 dB receiver sensitivity gain under the same image transmission quality compared to the existing systems.

Tu4C.3 • 16:00 Invited
Current State, Prospects, and Opportunities for Reaching Beyond 100 Gbps per Carrier Using Coherent Optics in Satellite Communications, *Rajiv Boddeda; Daniel Alejandro Romero Arrieta; Sébastien Bigo; Samar Rabeh; Sylvain Almonacil; Amirhossein Ghazisaeidi; Eric Dutisseuil; Haïk Mardoyan; Jeremie Renaudier; Nokia Bell Labs.*

Harmonie 4

15:30–17:00
Tu4D • 6G and Network Convergence
Presider: Hideaki Furukawa; National Institute of Information and Communications Technology (NICT)

Tu4D.1 • 15:30 Invited
Full-stack Softwarization in Optical Access Network, *Takahiro Suzuki; Sang-Yuep Kim; Jun-ichi Kani; Tomoaki Yoshida; NTT Access Network Service Systems Laboratories.*

This paper reviews studies on full-stack softwarization in the optical access network, from the progress of softwarization of upper-layer control and management functions to the future prospects of lower-layer softwarization, with the aim of accommodating various types of services with high agility and flexibility.

Tu4D.2 • 16:00
Real-Time SDN Controlled hybrid Fiber Wireless FSO/mmWave X-haul with Zero-Touch Handover for Terres-trial 6G networks, *Maria Vargemidou[1]; Chris Vagionas[1]; Argyris Kokkinis[2]; George Michail[1]; Marios Gatzianas[1]; George Kalfas[1]; Agapi Mesodiakaki[1]; Wojtek Wasko[3]; Ahmed Khalil Abdulwahed[4]; Pietro Piscione[4]; Pietro Giuseppe Giardina[4]; Giada Landi[4]; Dimitris Syrivelis[3]; Stefanos Dris[3]; Paraskevas Bakopoulos[3]; Kostas Siozios[2];*

Harmonie 5

15:30–17:00
Tu4E • Optical Network Resilience
Presider: Bernhard Schrenk; AIT Austrian Institute of Technology

Tu4E.1 • 15:30
Low Complexity Setup for Fault Localization in Fiber Optical Spans, *Lutz Rapp; Florian Azendorf; Adtran Networks SE.*

A novel technique allowing for fault localization in fiber optical spans is presented and analyzed. Its implementation requires only minor hardware modifications which enables network-wide deployment. Performance characteristics are determined by theoretical considerations and the results are confirmed experimentally.

Tu4E.2 • 15:45
Optimization and Implementation of Real-time SNR Estimation Algorithms for Performance Monitoring in the Fronthaul Network, *Xia Sheng; Hao Liu; Xin Tian; Xishuo Wang; Kai Lv; Anxu Zhang; Yuyang Liu; Lipeng Feng; Yongsheng Gao; Jun Yang; Xiaoli Huo; Jujie Li.*

Two optimized SNR estimation algorithms are proposed for the impact of MPI on the SNR. The experimental results show that the proposed schemes can achieve accurate SNR estimation. The accuracy based on the MPI removal algorithm remains within ±0.5 dB under various temperatures and MPI intensities.

Tu4E.3 • 16:00
Power and Spectral Savings in Metro-Aggregation Networks Exploiting Coherent Point-to-Multipoint Transceivers, *Carlos Castro[1]; Jacqueline Sime[1]; Tobias Eriksson[2]; M. Sezer Erkilinc[2]; Mario Porrega[3]; João Pedro[4]; Marco Quagliotti[5]; Emilio Riccardi[5]; Chris Fludger[1]; Antonio Napoli[1]; [1]Infinera Germany; [2]Infinera Sweden; [3]Infinera Italy; [4]Infinera Portugal; [5]Telecom Italia.*

Harmonie 6

15:30–17:00
Tu4F • Advanced Radio-Over-Fiber & Fronthaul Systems
Presider: Colm Browning; Mbryonics Ltd.

Tu4F.1 • 15:30
Simplified RRH Employing Optical Frequency Multiplication for FR3 Carrier Frequency Translation into 6G Ku-Band, *Bernhard Schrenk; AIT Austrian Institute of Technology.*

Optical frequency modulation of a distributed low-frequency reference is demonstrated for down-converting FR3-band radio at the remote radio head, showing no penalty to a locally sourced high-frequency carrier. Centralized RF management and simplified synchronization of distributed network equipment are obtained while dispersion-induced fading is mitigated.

Tu4F.2 • 15:45
Power-Fading-Free and IF-Free High-Fidelity Transmission Incorporating Sub-6GHz and mmW Band with Alamouti Coding, *Yixiao Zhu[1]; Xiansong Fang[2]; Chenbo Zhang[2]; Xiaopeng Xie[2]; Fan Zhang[2]; Weisheng Hu[1]; [1]Shanghai Jiao Tong University; [2]Peking University.*

We propose a fading-free delta-sigma modulation scheme based on Alamouti coding to overcome dispersion-induced power fading obstacle, and generate dual-band signals at both sub-6GHz and millimeter-wave without up-conversion. We demonstrate high-fidelity transmission of 1048576-/262144-QAM signals at 25-/30-GHz carrier frequencies over 25-/10-km SSMF with direct detection.

Tu4F.3 • 16:00
Power-Over-Fiber Using a Pure-Silica Inner-Cladding Double-Clad Fiber and 976 nm Photovoltaic Power Converter for Improving Power Transmission Efficiency, *Yuya Yaguchi[1]; Yu Miyakawa[1]; Souya Sugiura[1]; Shin-Chun Lin[2]; Suresh Subramaniam[3]; Hiroshi Hasegawa[4]; Simon Fafard[5]; Denis Masson[5]; Motoharu Matsuura[1]; [1]The University of Electro-Communications*

Spektrum

15:30–17:00
Tu4G • Progress of Silicon Photonic and Plasmonic Technology
Presiders: Nobuhiko Nishiyama; Tokyo Institute of Technology
Francesco Da Ros; DTU

Tu4G.1 • 15:30 Invited
Integrated Optical Phased Array with a 180-Degree Field of View for Solid-State 2D Optical Beam Steering, *Hao Hu; Technical University of Denmark.*

We will review our recent progress on an integrated silicon optical phased array (OPA) that can simultaneously achieve aliasing-free 2D optical beam steering over the entire 180° field of view and a high-quality beam with a low side-lobe level of < -19 dB.

Tu4G.2 • 16:00 Invited
Large Switching Fabrics Enabled by Silicon Photonics, *Kazuhiro Ikeda; Ryotaro Konoike; Keijiro Suzuki; AIST.*

Silicon photonics switches are a promising solution for high-capacity, energy efficient, and highly integrated AI/ML switching applications. Various recent efforts are discussed, including a novel wavelength cross-connect switch with free-spectral-range-free contra-directional couplers for multi-band wavelength-division multiplexing.

Illusion

10th International Symposium for Optical Interconnects in Data Centres
— Continued

Tu4A • Few Mode Fibers and Characterization Techniques — *Continued*

3-mode 7-core fibre is successfully observed by considering mode coupling between non-adjacent cores via an intermediate core and its bending radius dependence.

Tu4A.4 • 16:15

Mitigation of Polarization-Induced Fading in Optical Vector Network Analyzer for the Characterization of km-scale Space-Division Multiplexing Fibers, *Besma Kalla[1]; Martina Cappelletti[2]; Menno van den Hout[1]; Vincent van Vliet[1]; Simon Rommel[1]; Luca Palmieri[2]; Thomas Bradley[1]; Chigo Okonkwo[1]; [1]High Capacity Optical Transmission Laboratory, Eindhoven University of Technology; [2]Department of Information Engineering, University of Padova.*

We propose an optimized optical vector network analyzer with automatic polarization control to stabilize the reference arm polarization throughout the sweep range. We demonstrate this technique, successfully removing the polarization-induced fading and measurement distortions in insertion loss by characterizing a 10 km multi-core fiber.

Tu4A.5 • 16:30

A Preliminary Investigation of Modal Dispersion Characterization of SDM Fibers Based on Reflective Measurements, *Martina Cappelletti[1]; Besma Kalla[2]; Menno van den Hout[2]; Simon Rommel[2]; Luca Schenato[1]; Marco Santagiustina[1]; Andrea Galtarossa[1]; Chigo Okonkwo[2]; Luca Palmieri[1]; [1]University of Padova; [2]Eindhoven University of Technology.*

We report theoretical and experimental results about the characterization of modal dispersion properties of SDM fibers based on single-ended reflective measurements. The study provides preliminary indications toward a quasi-distributed characterization of modal dispersion in SDM links.

Tu4B • High-Speed Transmission — *Continued*

sion over an 80-km SMF with a silicon photonic modified carrier-assisted differential detection receiver, achieving a highest net ESE per polarization of 7.7-b/s/Hz for an integrated direct detection receiver.

Tu4B.4 • 16:15

Single-Carrier 224-GBaud 2.3-Tbps Transmission Using 30-GHz DACs and Electro-Optic Bandwidth Quadrupler, *Hiroshi Yamazaki[1]; Munehiko Nagatani[1]; Hitoshi Wakita[2]; Yuta Shiratori[2]; Josuke Ozaki[3]; Yoshihiro Ogiso[3]; Masanori Nakamura[1]; Fukutaro Hamaoka[1]; Takayuki Kobayashi[1]; Hiroyuki Takahashi[2]; Toshikazu Hashimoto[2]; Yutaka Miyamoto[1]; [1]NTT Network Innovation Laboratories; [2]NTT Device Technology Laboratories; [3]NTT Device Innovation Center.*

We demonstrate a transmitter combining electronic and optical intermediate-frequency-involved multiplexing techniques. With DACs each generating signals with a bandwidth of only 30 GHz, 224-GBaud PCS-QAM signals could be generated, achieving net bit rates of 2.36 Tbps/λ back-to-back and 2.32 Tbps/λ after 80-km SSMF transmission.

Tu4B.5 • 16:30

46.4-Tb/s Full C-band 246-km Transmission with Net >2-Tb/s/λ WDM Signals Using >100-GHz-BW InP-based Tx Front-end, *Masanori Nakamura[1]; Hitoshi Wakita[2]; Munehiko Nagatani[2]; Yoshihiro Ogiso[3]; Fukutaro Hamaoka[1]; Yuta Shiratori[2]; Takeo Sasai[1]; Hiroyuki Takahashi[2]; Takayuki Kobayashi[1]; Yutaka Miyamoto[1]; [1]NTT*

Tu4C • FSO for Satellite Communications — *Continued*

High-capacity optical satellite links have already ushered in a new era of remote connectivity from anywhere across the world. In this paper, we review the status of the current state-of-the-art coherent technology which allows us to reach 100 Gbps or more capacity per wavelength

Tu4C.4 • 16:30

Simplest DSP Enabled Baud Rate Sampling Self-Homodyne Coherent Architecture for Inter-Satellite Communications, *Kun Li; Junda Chen[1]; Tianjin Mei; Zihe Hu; Mingming Zhang; Chen Liu; Ming Tang; [1]Huazhong University of Science & Technology.*

A SHD architecture based on optical injection locking was proposed for LEO inter-satellite communica-tions. Doppler frequency shift and laser linewidth distortion were compensated for in optical domain, allowing simplest DSP with baud rate sampling ADC and constant coefficient equalization, achieving 20~160 Gbps per wavelength transmission.

Tu4D • 6G and Network Convergence — *Continued*

Nikos Pleros[1]; Amalia Miliou[1]; [1]Dep. of Informatics, Center for Interdisciplinary Research and Innovation, Aristotle University of Thessaloniki; [2]Dep. of Physics, Aristotle University of Thessaloniki; [3]Nvidia; [4]Nextworks.

A fully-automated SDN-controlled real-time operation of a hybrid Fiber-Wireless 10 Gb/s FSO and 5 Gb/s mmWave link across 7 km-fiber and 0.5 m-radio distance resilient at all weather conditions is experimentally presented, supporting 25 μs beam-switching and zero-touch hard handover via tunable SFP+ transceivers and simple all-passive 1x2 C-/O-band diplexers.

Tu4D.3 • 16:15

Low Power Implementation of Remote Control Function of APN Transceiver for Mobile Fronthaul Integrated in All-photonics Network, *Yasuhiro Takizawa; Sumitomo Electric Industries, Ltd..*

We propose a new architecture for applying APN to mobile fronthaul and a remotely controlled APN Transceiver with low power consumption. We demonstrated the PON-based remote control and 30 km transmission with our own designed evaluation board, and estimated the power consumption.

Tu4D.4 • 16:30 Upgraded Invited

A 6G Transport Network converging THz and Optical network technologies empowered by Federated Learning techniques, *Markos Anastasopoulos[1]; Anna Tzanakaki[1]; Georgios Kaponis[1]; Yiyun Jian[2]; Lukasz Lopacinski[2]; Jesus Gutierrez Teran[2]; Ioanna Mesogiti[3]; Theodoropoulou Eleni Theodoropoulou[3]; George Limperopoulos[3]; [1]National and Kapodistrian University of Athens (NKUA); [2]IHP GmbH – Leibniz-Institut für innovative Mikroelectronik; [3]OTE.*

This paper reports the first experimental demonstration of an autonomously controlled 6G network integrating

Tu4E • Optical Network Resilience — *Continued*

We carried out a comprehensive study based on experimental models and real-life dynamic traffic. We showed savings in ASIC power consumption up to 44\% in topologies inspired by deployed networks from Telecom Italia (TIM) when moving from point-to-point to point-to-multipoint coherent transceivers.

Tu4E.4 • 16:15

Lyapunov-method-based Low-complexity OSNR Estimator with Raw Data from the Coherent Receiver, *Yuqi Li; Mingming Zhang; Yuxiang Duan; Haoze Du; Ming Tang; Jürgen Kurths.*

A novel approach utilizing Lyapunov exponent-based fractal analysis is proposed to estimate the optical signal-to-noise ratio. Directly operating on signal-processing-free raw data from a coherent receiver, the proposed estimator yields a low mean error of 0.74 dB in experiments.

Tu4E.5 • 16:30 Invited

Detection and Classification of Eavesdropping and Mechanical Vibrations in Fiber Optical Networks by Analyzing Polarization Signatures Over a Noisy Environment, *Stefan Karlsson[1]; Leyla Sadighi[2]; Carlos Natalino Da Silva[2]; Lena Wosinska[2]; Marco Ruffini[3]; Marija Furdek Prekratic[2]; [1]Swedish Defense Material Administration; [2]Chalmers University of Technology; [3]University of Dublin, Trinity College.*

We propose a machine-learning-based method to detect and classify eavesdropping and mechanical vibrations in an optical network based on state of polarization var-

Tu4F • Advanced Radio-Over-Fiber & Fronthaul Systems — *Continued*

(UEC); [2]North Carolina State University; [3]George Washington University; [4]Nagoya University; [5]Broadcom Ltd.

We present power-over-fiber transmission using a pure-silica inner-cladding double-clad fiber. We successfully achieved good bidirectional transmission characteristics of analog radio-over-fiber signals at 1550 nm band and improved power transmission efficiency of laser input light at 976 nm with a simple configuration using a single fiber.

Tu4F.4 • 16:15

An SNR-Enhanced Analog Mobile Fronthaul Link Employing Digital-Analog based Amplitude-and-Phase Modulation, *Yu Xia[1]; Chuanming Huang; Mengfan Cheng; Qi Yang; Deming Liu; Lei Deng; [1]Huazhong University of Science and Technology.*

We experimentally demonstrate a novel SNR-enhanced RoF scheme based on digital-analog modulation and phase-modulation-induced bandwidth expansion, achieving 18 dB SNR gain at half the spectral efficiency and 10 dB SNR gain at 3/4 spectral efficiency. EVM of 1.41% is realized for 256QAM-OFDM-DA-APM signal with 5 GHz carrier.

Tu4F.5 • 16:30 Invited

Optical Wireless Convergence in the B5G Era, *Yijie Tao[1]; Chathurika Ranaweera[2]; Ampalavanapillai Nirmalathas[1]; Lena Wosinska[3]; Christina Lim[1]; [1]The University of Melbourne; [2]Deakin University; [3]Chalmers University of Technology.*

The optical wireless convergence is increasingly becoming important in meeting the expo- nential demand for bandwidth and connectivity in wireless networks. This paper explores the role of optical wireless convergence in the B5G era, detailing its underlying architectures and technological advancements.

Tu4G • Progress of Silicon Photonic and Plasmonic Technology — *Continued*

Tu4G.3 • 16:30

Penalty Free and High Spectral Efficiency Silicon Photonics WDM Multiplexer with Wide Frequency Offset Tolerance, *Jun Matsui[1]; Tomoyuki Akiyama[1]; Motoyuki Nishizawa[1]; Guoxiu Huang[2]; Hisao Nakashima[2]; Shinsuke Tanaka[1]; Takeshi Hoshida[2]; [1]Photonics Electronics Technology Research Association (PETRA); [2]Fujitsu Ltd.*

Penalty-free multiplexing of Nyquist-shaped 64-GBd signals having 75-GHz spacing with ±3 GHz offset each is demonstrated by using control scheme to autonomously compensate fabrication errors. This scheme enables energy-efficient large-capacity multicarrier signal generation under bandwidth limitation on electro-optic devices.

10th International Symposium for Optical Interconnects in Data Centres — *Continued*

Network Innovation Laboratories; [2]NTT Device Technology Laboratories; [3]NTT Device Innovation Center.

We successfully demonstrated 200-GHz-spaced 4.6-THz WDM transmission with 23-channel >2-Tb/s net bitrate signals using 192-GBd probabilistically constellation-shaped-100QAM generated by an >100-GHz-BW InP-based Tx front-end, resulting in a total capacity of 46.4-Tb/s with 10.0-b/s/Hz spectral efficiency over 246-km (3×82-km) pure-silica-core fibres with only EDFAs.

Tu4B.6 • 16:45

Optimizing Bipolar Constellations for High-Rate Transmission in Short-Reach Fiber Links with Direct Detection, *Thomas Wiegart; Daniel Plabst; Norbert Hanik; Gerhard Kramer; Technical University of Munich.*

Bipolar modulation increases the achievable information rate of communication links with direct-detection receivers. This paper optimizes bipolar transmission with a modulator bias offset for short-reach fiber links. A neural network equalizer with successive interference cancellation is shown to gain over 100 Gbit/s compared to standard receivers.

Tu4C.5 • 16:45

Coherent Beam Combining of Wavelength-Division-Multiplexed channels at 10 Gbit/s , *Thomas Le Beux[1]; Laurent Bramerie[2]; Thierry Chartier[2]; Mathilde Gay[2]; Sébastien Lobo[2]; Laurent Lombard[1]; Pierre Pichon[1]; Bastien Rouzé[1]; [1]ONERA – The French Aerospace Lab; [2]Institut FOTON, Université de Rennes.*

An experimental study of the coherent beam combining of four wavelength-division-multiplexed channels was performed in an all-fibre system. Phase matching of all the channels was obtained by the LOCSET technique. Bit-error-rate measurements and eye diagrams show no penalties.

optical network technologies and THz links in a common transport network. The devel-oped management framework is empowered by Federated Learning to jointly optimize THz and multi-vendor optical networks supporting 6G services

Tu4E • Optical Network Resilience — *Continued*

iations. Tests in two real-world installations with links of different lengths demonstrate an accuracy of 86.5% in 7 distinct normal and malicious scenarios.

Tu4F • Advanced Radio-Over-Fiber & Fronthaul Systems — *Continued*

Tu4G • Progress of Silicon Photonic and Plasmonic Technology — *Continued*

Tu4G.4 • 16:45
Plasmonic Photonic Integrated Circuits: Technology, Performance, Applications, and Future Prospects, *Wolfgang Heni[1]; Benedikt Baeuerle[1]; Juerg Leuthold[2]; Claudia Hoessbacher[1]; [1]Polariton Technologies AG; [2]ETH Zurich / Institute of Electromagnetic Fields (IEF).*

Plasmonic photonic integrated circuits (plasmonic PICs) are a cutting-edge silicon-photonics solution, addressing the demands of the next era's high-speed integrated photonics. We report newest reliability data, performance and loss statistics, and show how plasmonic modulators enable future optical interconnects of 1.6 T, 3.2 T and beyond.

10th International Symposium for Optical Interconnects in Data Centres — *Continued*

17:15–18:45
Rump Session
Organisers: Peter Winzer (Nubis Communications); Rupert Ursin (QTlabs); David Neilson (Nokia Bell Labs)

Quantum technologies: Research hype or on track to commercial success?

The Rump Session is a very blunt discussion session in a hot topic area of interest to most conference attendees. The session takes place in the evening alongside some drinks. A group of outspoken and opinionated provocateurs stimulate lively audience discussions. The session is meant as an entertaining event that shines a critical light on a usually over-hyped technical topic area.

This year's Rump Session focuses on the hype around all things quantum. Quantum technologies claim to solve practically relevant problems at revolutionary levels of performance and have been devouring tens of billions invested by public and private sources over the past decades. Will these technologies live up to the high hopes put into them anytime soon, yield the expected return of investment, and create what is heralded as the second quantum revolution?

See page 126 of this programme for more information about this event.

Harmonie 1

09:00–10:30
W1A • QKD Security
Presider: Matthias Gunkel; Deutsche Telekom Technik GmbH, PG 1341

W1A.1 • 09:00 Invited
Photonic Quantum Technologies: From Quantum Optics to Quantum Networks, *Stefanie Barz; University of Stuttgart (D).*

I will explore photonic quantum systems and their applications in technologies. This includes quantum interference and its dependence on distinguishability and mixedness and well as the generation of multipartite entanglement and its application in quantum networks.

Harmonie 2

09:00–10:30
W1B • Fiber Capacity and Transmission
Presider: Chiara Lasagni; Università degli Studi di Parma

W1B.1 • 09:00
Closed-Form EGN Model with Comprehensive Raman Support, *Yanchao Jiang[1]; Antonino Nespola[2]; Stefano Straullu[2]; Alberto Tanzi[3]; Stefano Piciaccia[3]; Fabrizio Forghieri[3]; Dario Pilori[1]; Pierluigi Poggiolini[1]; [1]DET, Politecnico di Torino; [2]LINKS Foundation; [3]CISCO Photonics Italy srl.*

We present a series of experiments testing the accuracy of a new closed-form ultra-wide-band EGN model, carried out over a full-Raman 9-span C+L link. Transmission regimes ranged from linear to strongly non-linear with large ISRS. We found good correspondence between predicted and measured performance.

W1B.2 • 09:15
An Extended Closed Form of the ISRS GN Model for the Zero Dispersion Regime, *Filippos Balasis[1]; Daniel J. Elson[1]; Mindaugas Jarmolovičius[2]; Henrique Buglia[2]; Eric Sillekens[2]; Robert I. Killey[2]; Polina Bayvel[2]; Noboru Yoshikane[1]; Takehiro Tsuritani[1]; Yuta Wakayama[1]; [1]KDDI Research, Inc.; [2]Optical Networks Group, UCL (University College London), London.*

The closed form approximation of the ISRS GN model is extended to include the multi-channel interference and accurately operate in the zero-dispersion regime. The derived equations are validated via comparisons with the split-step Fourier method and the integral form of the model.

Harmonie 3

09:00–10:30
W1C • Spatial Division Multiplexing
Presider: Sjoerd van der Heide; EFFECT Photonics

W1C.1 • 09:00 Invited
DSP-based MDG Estimation in SDM Transmission, *Ruby Stella Bravo Ospina[1]; Jeremie Renaudier[1]; Darli Mello[2]; Amirhossein Ghazisaeidi[1]; [1]Nokia Bell Labs, France; [2]Unicamp – University of Campinas.*

We review the fundamentals of the MDG estimation techniques reported in the literature based on classical DSP and ML. The ML-based technique is shown to be a good candidate for practical SDM transmission, while the reverse MIMO TDE is preferable for offline laboratory experiments.

Harmonie 4

09:00–10:30
W1D • Challenges for Terrestrial FSO
Presider: Volker Jungnickel; Frauhofer HHI

W1D.1 • 09:00
Post-FEC BER Assessment with Optimized Decoding Latency for 400 Gbps Transmission Over a 1.8 km FSO Field Trial, *Manuel Freitas[1]; Marco Fernandes[1]; Bruno Brandão[1]; Nourdin Kaai[2]; Alina Tomeeva[2]; Bas van Der Wielen[2]; John Reid[2]; Daniele Raiteri[2]; Paulo Monteiro[1]; Gil Fernandes[1]; Fernando Guiomar[1]; [1]Instituto de Telecomunicações and University of Aveiro; [2]Aircision B.V.*

We experimentally assess the post-FEC BER performance of 400 Gbps FSO transmission over a 1.8 km field-trial, minimizing the LDPC decoding latency to achieve error-free communication with/without optical pre-amplification. Pre-amplification is shown to provide reliability gains exceeding 70%, typically necessitating 3× fewer decoding iterations.

W1D.2 • 09:15
Fiber-Based Focal Plane Array Beamformer as Air Interface of an Alignment-Tolerant Optical Fi-Wi-Fi Bridge, *Florian Honz; Bernhard Schrenk; AIT Austrian Institute of Technology.*

We demonstrate robust light coupling between two single-mode fibers for an out-door FSO link through a focal plane array beamformer with 61 fine-pitched fiber cores as antenna elements. We show that favourable coupling conditions are established for this 10 Gb/s Fi-Wi-Fi bridge after rough initial pointing.

Harmonie 5

09:00–10:30
W1E • Architecture from Submarine to Metro/Access Networks
Presider: Steinar Bjørnstad; Tampnet AS

W1E.1 • 09:00 Invited
Recent Metro/Access Converged Network Technology, *Shin Kaneko; Kazutaka Hara; Jun-ichi Kani; Tomoaki Yoshida; NTT Access Network Service Systems Laboratories, NTT Corporation.*

This paper reviews the main challenges and recent progress in research to actualize metro/access convergence by extending dense-wavelength-division-multiplexing metro technologies and architectures to cover access areas from the perspectives of the physical layer of end-to-end main-signal transmission and remote-control-and-management of optical-path endpoints.

Harmonie 6

09:00–10:30
W1F • Integrated Sensing and Comms
Presider: Chris Vagionas; Aristotle University of Thessaloniki (AUTh), Thessaloniki, Greece

W1F.1 • 09:00
Joint Optical Wireless Communication and LiDAR Sensing using A Highly Integrated Optical Phased Array, *Xuebing Zhang[1]; Amir Abbas Kashi[1]; Gijs Van Elzakker[1]; Harish Sasikumar[1]; Noor Schilder[1]; Mathias Prost[2]; Jon Ø Kjellman[2]; Roelof Jansen[2]; Marcus Dahlem[2]; Ruud Oldenbeuving[1]; Xavier Rottenberg[3]; Joonyoung Kim[4]; [1]imec-NL; [2]IMEC, Leuven, Belgium; [3]IMEC, Kapeldreef 75; [4]IMEC The Netherlands.*

A joint beam-steered OWC and LiDAR sensing system using a highly integrated SiN-Si OPA is experimentally demonstrated. The LiDAR direct frequency chirp and data modulation are implemented simultaneously. Our first proof-of-concept experiment presents the possibility of joint communication and distance sensing over a 20° angular-range.

W1F.2 • 09:15
LiDAR Demonstration Using an InP Optical Phased Array (OPA) with a 3D-printed Optical Beam-Shaping Element, *Stefan Singer[1]; Yilin Xu[1]; Sebastian T. Skacel[2]; Christoph Menzel[3]; Boris Baldischweiler[3]; Siegfried Ringwald[3]; Jan Niklas Caspers[4]; Simon Schneider[5]; Oliver Krayl[5]; David Reichenbacher[1]; Sebastian Randel[1]; Wolfgang Freude[1]; Christian Koos[1]; [1]Karlsruhe Institute of Technology (KIT); [2]Vanguard Automation GmbH; [3]SICK AG; [4]Bosch Sensortec GmbH; [5]Robert Bosch GmbH.*

We demonstrate an InP-based optical phased array (OPA) with on-chip amplifiers and a 3D-printed facet-attached microlens for shaping and deflection of the emitted beam. We demonstrate the viability of the OPA by combining it with a receiver in a light detection and ranging (LiDAR) experiment.

Spektrum

09:00–10:30
W1G • Integrated Devices for Future High-Capaciity Networks
Presider: Aleksandra Kaszubowska-Anandarajah; Trinity College Dublin

W1G.1 • 09:00
3D-Nanoprinted Fibre-to-Chip and Chip-to-Chip Coupler, *Huiyu Huang[1]; Zhitian Shi[1]; Giuseppe Talli[2]; Maxim Kuschnerov[2]; Richard Penty[1]; Qixiang Cheng[1]; [1]University of Cambridge; [2]Huawei Technologies Duesseldolf GmbH, European Research Center.*

We present a versatile off-chip coupling solution using 3D nanoprinting for both fibre-to-chip and chip-to-chip connections. The design employs elliptical-shaped reflectors that manage mode-sizeconversion over a wide bandwidth. We experimentally demonstrate 0.8 dB fibre-to-chip and 2.8 dB chipto-chip coupling loss over a 140 nm wavelength range.

W1G.2 • 09:15
Hybrid Integrated Self-Injection Locking Laser with 42 Hz Lin-ewidth Enabling Net 400 Gbit/s Self-Homodyne Coherent Transmission system tolerating 1 km fiber mismatch, *Dongwei Zhuang.*

We fabricate a hybrid integrated self-injection locked (SIL) laser, achieving a 42 Hz linewidth via a high-quality Si3N4 microring resonator, and utilize it to construct a net 400 Gb/s self-homodyne coherent transmission system, tolerating 1 km of fiber length mismatch without performing carrier phase recovery.

Illusion

W1A • QKD Security — *Continued*

W1A.2 • 09:30

NONBINARY: A High-Speed Information Reconciliation Algorithm for High Dimensional Quantum Key Distribution, *Ronny Mueller[1]; Jasper Riebesehl[1]; Davide Bacco[2]; Leif Oxenløwe[1]; Søren Forchhammer[1]; [1]Technical University of Denmark (DTU); [2]University of Florence.*

The Information Reconciliation phase in Quantum Key Distribution requires specialized error correction methods to achieve high secret key rates. We propose a novel algorithm, NONBINARY, for high-dimensional implementations. NONBINARY is one of the simplest and fastest algorithms so far, reaching speeds up to 750 Mbps.

W1A.3 • 09:45

Deep Reinforcement Learning based Decentralized Routing and Load-Balancing in Meshed QKD-Networks, *Tim Johann; Sebastian Kühl; Stephan Pachnicke; Kiel University.*

We present a deep reinforcement-learning (DRL) agent that routes encryption requests in a meshed QKD network autonomously in a decentralized manner without relying on a conventional shortest-path algorithm with linear weights. Our agent is able to reduce blocking of requests and simultaneously improves load-balancing.

W1B • Fiber Capacity and Transmission — *Continued*

W1B.3 • 09:30 **Tutorial**

Information Theory of the Optical Channel, *Gerhard Kramer; Technical University of Munich (DGFI-TUM).*

The tutorial explores information theory for long-haul and short-reach optical channels. The focus is on receiver algorithms that can approach capacity with reasonable complexity. The tutorial will begin with a brief review of information theory and architectures for coded modulation, such as multi-level coding and probabilistic amplitude shaping. Next, at the receiver, we distinguish algorithms that perform separate detection and decoding (SDD) and joint detection and decoding (JDD). The SDD achievable information rates are generally suboptimal but are attained with reasonable complexity. The JDD rates can be achieved by iterative (turbo) processing, which involves repeated cycles of detection and decoding across an SDD equalizer and a soft-input, soft-output decoder. Alternatively, one may use SDD with successive interference cancellation (SIC); the latter approach is preferable since one may use off-the-shelf codes. Various methods to combine SDD and SIC are reviewed and are used to compute information rates for long-haul and short-reach nonlinear optical channels.

W1C • Spatial Division Multiplexing — *Continued*

W1C.2 • 09:30

Experimental Demonstration of a Correlation-Avoidance CMA for Blind Space-Division Multiplexed MIMO Equalization, *Pamir Oezsuna[1]; Aymeric Arnould[1]; Nicolas Braig-Christophersen[1]; Emil Spoiden[1]; Robert Emmerich[1]; Ruben S. Luis[2]; Benjamin J. Puttnam[2]; Kazuhiko Aikawa[3]; Carsten Schmidt-Langhorst[1]; Colja Schubert[1]; Ronald Freund[4]; Georg Rademacher[5]; [1]Fraunhofer Heinrich-Hertz-Institut; [2]National Institute of Information and Communications Technology (NICT); [3]Fujikura Ltd.; [4]Fraunhofer Heinrich-Hertz-Institut, TU Berlin; [5]Fraunhofer Heinrich-Hertz-Institut, University of Stuttgart.*

We demonstrate blind 6x6 adaptive equalization of 32 GBd DP-QPSK 3-mode transmission over a 54 km FMF based on the singularity-free convergence ability of the correlation-avoidance CMA (CA-CMA). The CA-CMA is used for robust pre-convergence in a computation-efficient CMA-based blind MIMO equalization.

W1C.3 • 09:45

Low-Complexity MIMO Carrier Phase Recovery for Carrier-Phase-Asynchronous SDM-MIMO Transmission Based on the Unscented Kalman Filter, *Kohki Shibahara[1]; Megumi Hoshi[1]; Takayoshi Mori[2]; Ryota Imada[2]; Taiji Sakamoto[2]; Yusuke Yamada[2]; Kazuhide Nakajima[2]; Takayuki Kobayashi[1]; Yutaka Miyamoto[1]; [1]NTT Network Innovation Laboratories, NTT Corporation; [2]NTT Access Network Service Systems Laboratories, NTT Corporation.*

We propose simplified unscented-Kalman-filter-based MIMO-structured phase estimation technique, handling multiple phase errors in carrier-phase-asynchronous SDM-MIMO transmission. It improved tolerance against sum-linewidth-symbol-duration product by >15% while attaining up to 90%-reduced complexity. We also present useful SDM-MIMO applications under Tx/Rx-laser-asynchronous scenarios with transmission results over coupled-multicore-fibre cable.

W1D • Challenges for Terrestrial FSO — *Continued*

W1D.3 • 09:30

A Combined Alignment Method with Beam Incident Angle Measurement and Laser Nutation Alignment in Common Optical Path FSOC System, *Qirun Fan[1]; Hongyuan Huang; Qirui Xu; Xueyuan Ao; Yansheng Zou; Qi Yang; Ming Tang; Chen Liu; [1]Huazhong University of Science and Technology.*

We propose a combined alignment method based on deep learning angle measurement and laser nutation algorithm with multicore optical fiber in FSOC system. The experiment demonstrates average measurement precision of 19.92 μrad and three nutation cycles can reach the maximum coupling power.

W1D.4 • 09:45

High-power, High-speed (1W/20-Gbaud) Free-space Optical Communication Enabled by Photon-photon Resonance of Photonic-crystal Surface-emitting Laser, *Shota Ishimura[1]; Ryohei Morita[2]; Takuya Inoue[2]; Hidenori Takahashi[1]; Takehiro Tsuritani[1]; Menaka De Zoysa[2]; Kenji Ishizaki[2]; Masatoshi Suzuki[3]; Susumu Noda[2]; [1]KDDI Research, Inc.; [2]Kyoto University; [3]Waseda University.*

We demonstrate high-power, high-speed free-space optical communication using photon-photon resonance of photonic-crystal surface-emitting lasers for the first time. We achieve 20-Gbaud signal generation and watt-class output power at the same time.

Harmonie 5

W1E • Architecture from Submarine to Metro/Access Networks — *Continued*

W1E.2 • 09:30

Multicore-fiber Submarine Networks: Benefits and Opportunities, *Eduardo Mateo[1]; Daishi Masuda[2]; Masaaki Hirano[3]; [1]NEC Corporation; [2]OCC Corporation; [3]Sumitomo Electric Industries, Ltd.*

Submarine systems face challenges to achieve the capacity targets demanded for global networks. This paper analyses, quantitatively, solutions and opportunities that multicore fiber offers in terms of manufacturing scalability, connectivity, installation, maintenance and carbon-footprint of next generation Petabit-level systems.

W1E.3 • 09:45

Performance of WDM core networks where preexisting wavelength-routing nodes interwork with 400ZR+ interfaces, *Thierry Zami[1]; Nicola Rossi[1]; Bruno Lavigne[1]; Szilard Zsigmond[2]; [1]ASN/Nokia; [2]Nokia.*

This study examines to what extent core WDM fiber networks could efficiently rely (at least partly) on 400ZR+ interfaces handling 400 Gb/s 60.1 GBd 400ZR+ channels, especially for networks equipped with legacy wavelength-routing optical cross-connects.

Harmonie 6

W1F • Integrated Sensing and Comms — *Continued*

W1F.3 • 09:30

Experimental Evaluation of Passive 2D Optical Beam Scanners for FMCW LiDAR Applications, *Mennatallah Kandil[1]; Mathias Prost[2]; Ana Lebanov[2]; Jon Ø. Kjellman[2]; Wim Bogaerts[1]; Marcus Dahlem[2]; [1]Ghent University – IMEC; [2]Imec Leuven.*

We present the first experimental demonstration of a pixelated dispersive optical phased array (DOPA). For the same aperture design, the fabricated pixelated DOPA shows improved side lobe suppression ratio compared to the continuous DOPA by up to -6 dB around 1550 nm.

W1F.4 • 09:45

Resolution and Speed Trade-offs in FMCW LiDAR with MEMS Mirror Scanning and Advanced Signal Processing, *Sarah Cwalina[1]; Avinash Nittur Ramesh[2]; Norman Laske[3]; Maria Antonia Gonzalez Huici[2]; Patrick Runge[1]; Volker Jungnickel[1]; Ronald Freund[1]; [1]Fraunhofer Heinrich Hertz Institute HHI; [2]Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR; [3]Fraunhofer Institute for Silicon Technology ISIT.*

We address system trade-offs, e.g. between resolution and speed of a coherent scanning LiDAR. We analyze the performance of our real-time FMCW LiDAR prototype with a high-quantum-efficiency coherent receiver, two-dimensional micro-electro-mechanical-system (MEMS) scanning with different scan speeds and advanced signal processing for sparse point-cloud reconstruction.

Spektrum

W1G • Integrated Devices for Future High-Capaciity Networks — *Continued*

W1G.3 • 09:30

PPLN-based Wavelength Converters for Waveband Extension to U-band and Beyond, *Masashi Abe; Shimpei Shimizu; Takushi Kazama; Shunya Konno; Koji Enbutsu; Takahiro Kashiwazaki; Akira Kawai; Masanori Nakamura; Munehiko Nagatani; Hitoshi Wakita; Yuta Shiratori; Fukutaro Hamaoka; Hiroshi Yamazaki; Hiroyuki Takahashi; Takayuki Kobayashi; Yutaka Miyamoto; Takeshi Umeki; NTT Corporation.*

We've developed PPLN-based wavelength converters for U-band expansion, achieving 3-dB converted gain flatness and 6-dB noise figure for full U-band expansion. A converted 1.2-Tbps/ch. WDM signal is successfully transmitted over 100-km G.654.E fiber. We also demonstrate the extensibility beyond U-band up to 1719 nm.

W1G.4 • 09:45

Ultra-Fast Self-Adaptive Phase-Error Calibration for Dual MZI-based Silicon Photonic Switch Fabric, *Satoshi Suda; Hiroyuki Matsuura; Keijiro Suzuki; Kazuhiro Ikeda; Shu Namiki; Fumi Nakamura; Akihiro Noriki; Tadashi Murao; Takeru Amano; National Institute of Advanced Industrial Science and Technology.*

Fully automatic phase-error calibration across a 256 dual Mach-Zehnder-interferometers-based 8×8 non-blocking silicon photonic switch fabric with polarization diversity was demonstrated. We achieve an ultra-fast and highly accurate calibration by only sampling 3.6 measurement points for one switch state, close to the theoretical limit of 3.

Illusion

Harmonie 1

W1A • QKD Security — *Continued*

W1A.4 • 10:00
Efficiency Analysis of Two Key Relaying Architectures for QKD Networks, *María Álvarez Roa[1]; Simon Rommel[1]; Sebastian Verschoor [2]; [1] Eindhoven University of Technology; [2] Technical University of Eindhoven.*

We propose and compare, two architectures for managing, storing, and distributing cryptographic keys in QKD networks, addressing challenges such as success rate of key requests, key consumption and overhead. The study contrasts these architectures to analyze their respective advantages in enhancing QKD network performance

W1A.5 • 10:15
Attacks on BB84 with Two Identical and Measured Photons, *Mira Stephan; Fabian Klingmann; Philipp Meißner; René Kirrbach; Fraunhofer Institute for Photonic Microsystems.*

Quantum key distribution (QKD) systems often use attenuated lasers. Therefore, some pulses contain more than one photon. This contribution shows attacks on the BB84 protocol with two identical photons in a downstream QKD network. Phase covariant cloning is optimal but other attacks become more dangerous.

Harmonie 2

W1B • Fiber Capacity and Transmission — *Continued*

Harmonie 3

W1C • Spatial Division Multiplexing — *Continued*

W1C.4 • 10:00 Invited
SDM transmission using real-time Digital Signal Processing, *Mikael Mazur; Nokia Bell labs USA.*

We review recent progress on real-time digital signal processing implementations for coupled-mode systems extending beyond standard single-mode fibers. We focus on implementation specific constraints and discuss the path from FPGA-based proof-of-principle implementations to high-speed real-time ASICs.

Harmonie 4

W1D • Challenges for Terrestrial FSO — *Continued*

W1D.5 • 10:00 Invited
Free Space Optical Link Between Two Ships at Sea, *Katherine Newell; Michelle O'Toole; Krunal Patel; Johns Hopkins Applied Physics Laboratory.*

Free-space optics offers a promising capability for maritime communications, given favorable weather and robust pointing and tracking. We discuss a prototype system and present data from a link between two ships at sea from 2–12 km with data rates up to 7 Gbps.

10:30–11:00 Coffee Break, Exhibition

Harmonie 5

W1E • Architecture from Submarine to Metro/Access Networks — *Continued*

W1E.4 • 10:00
Analysis of Cable Capacity and Relative Cost/bit of Coupled-Core MCF and Uncoupled-Core MCF in Submarine Cables, *John Downie[1]; Lidia Galdino; [1]Corning Research and Development Corporation.*

Cable capacity and relative cost/bit are compared for coupled-core MCF and uncoupled-core MCF. Differential properties such as nonlinear tolerance, mode-dependent loss/gain, and crosstalk are included. Coupled-core MCF has no advantage for 4 cores, while small potential advantage with 7 cores requires high electrical power.

W1E.5 • 10:15
Fibre Cross Connect vs. Stacked-WDM Capacity and Cost Assessment in Fibre-rich Optical Core Networks, *Mijail Szczerban[1]; Thierry Zami[2]; Sarvesh Bidkar[1]; Colin Kelly[2]; David Neilson[1]; Roland Ryf[1]; Jesse Simsarian[1]; [1]Nokia Bell Labs; [2]Nokia.*

This article compares node cost and network capacity of stacked-WDM to fibre cross-connect (FXC) node architectures in fibre-rich scenarios. FXC-based architectures can achieve a cost reduction of up to 80% and provide higher network capacity in large connection request scenarios.

Harmonie 6

W1F • Integrated Sensing and Comms — *Continued*

W1F.5 • 10:00 Invited
Microwave photonics radars, *Luca Rinaldi[1]; Filippo Scotti[1]; Paolo Ghelfi[1]; Antonella Bogoni[2]; [1]CNIT- National Inter-University Consortium for Telecommunications; [2]Sant'Anna School of Advanced Studies/CNIT.*

In the last decade photonics-based radars have been explored demonstrating their potential, but a technological gap still exists that prevents their real exploitation. Here, we report the recent technologi-cal achievements, the current open issues, and the authors roadmap for reducing this gap

Spektrum

W1G • Integrated Devices for Future High-Capaciity Networks — *Continued*

W1G.5 • 10:00
High-performance Silicon Optical Phase Shifter Targeting Large-scale Programmable Photonic Circuits, *Huaqing Qiu[1]; Mathias Prost[1]; David Coenen[1]; Tangla David Kongnyuy[1]; Manuel Reza[1]; Guillaume Croes; Maliheh Ramezani[1]; Puvendren Subramaniam[1]; Herman Oprins[1]; Hao Hu[2]; Joost Brouckaert[1]; Roelof Jansen[1]; Marcus Dahlem[1]; [1]Interuniversity Microelectronics Centre (imec); [2]Technical University of Denmark.*

We leverage phase mismatch in sharp bends to enhance the performance of silicon thermo-optic phase shifters at 1550 nm. The measured insertion loss, power consumption, modulation bandwidth, and footprint are 0.14 dB, 3.4 mW/π, 10.5 kHz, and 42 µm × 42 µm, respectively.

W1G.6 • 10:15
Free-Space Optics-based Multi-Channel Variable Optical Attenuator for FIFO-less 4-Core Fiber Systems with Low-Insertion Loss, *Yuta Goto[1]; Asumi Kaya[2]; Taketoshi Takahata[2]; Tetsuya Kobayashi[2]; Hideaki Furukawa[1]; [1]NICT; [2]OPTOQUEST Co., Ltd.*

We newly develop a free-space optics-based multi-channel variable optical attenuator (VOA) without fan-in/fan-out devices for 4-core fiber system. We experimentally demonstrate the insertion loss up to 0.56 dB and dynamic range of attenuation of more than 50 dB on four cores of the VOA.

Illusion

10:30–11:00 Coffee Break, Exhibition

SC1: Novel Fibres, Fibre Devices and Amplifiers

W2A.1

Performance evaluation of a polarisation insensitive Mach-Zehnder fiber parametric amplifier with 38 channel transmission, *Mariia Bastamova[1]; Vladimir Gordienko[1]; Stylianos Sygletos[1]; Mingming Tan[1]; Aleksandr Donodin[1]; Long Nguyen[1]; Florent Bessin[2]; Sonia Boscolo[1]; Nick J. Doran[1]; Andrew D. Ellis[1]; [1]Aston University; [2]Université d'Angers.*

We examined the Mach-Zehnder fiber optical parametric amplifier as the first-stage amplifier within a recirculation loop to amplify an equivalent of 38× 35 GBaud polarisation-multiplexed 16QAM channels over distances up to 540 km. Record performance was achieved thanks to the Mach-Zehnder design and optimized pump phase modulation.

W2A.2

Design Optimization of a Double Stage Extended L-band EDFA Using Neural Networks Trained on Experimental Data, *Hamed Rabbani; Saber Jalilpiran; Sophie LaRochelle; Leslie A. Rusch; Université Laval.*

Designing a double-stage L-band amplifier with low pump powers, low noise figure, and flat gain is challenging. We tackle this with fast and accurate neural networks amplifier models trained on experimental data. Our approaches optimize for flat gain, while minimizing noise figure and pump power.

W2A.3

Ultrafast Predictions of Power Evolution and Gain Spectra in Bidirectional-Pumped Fiber Raman Amplifiers Employing Neural Networks-based Solvers, *Li Zhang[1]; Erwan Pincemin[2]; Naveena Genay[2]; Darko Zibar[1]; [1]Technical University of Denmark; [2]Orange Labs.*

We show that the learned neural networks-based solver of Raman amplifier (RA) equations enables ultrafast and accurate power evolution and gain spectra predictions in bidirectional-pumped RAs over the C-band.

W2A.4

Controllable U-band Raman Gain Shaping by Machine Learning based ASE-Sourced Pump Controller, *Wenxiu Hu; Nura Adamu; Kyle Bottrill; Periklis Petropoulos; Optoelectronics Research Centre, University of Southampton, Southampton SO17 1BJ, U.K.*

We present a technique to generate targeted Raman gain spectra (with an average 0.1% error) based on a neural network that shapes the ASE spectrum of an incoherent (EDFA-based) pump source.

W2A.5

Design guideline of 2LP-mode multicore fibre link under counter-propagation among cores., *Taro Iwaya; Yuto Sagae; Takashi Matsui; Kazuhide Nakajima; Access Network Service Systems Labs., NTT Corporation.*

We reveal for the first time that the inter-core crosstalk (XT) penalty varies with the input power under 2LP-mode counter-propagation different from single-mode counter-propagation. A slight improvement in the total figure-of-merit in a few-mode multi-core fibre can be achieved by optimizing the input power level.

W2A.6

Applicability of 125-µm cladding diameter quasi-single-mode photonic crystal fibre link for power-over-fibre and data transmission, *Kouhei Omoto[1]; Nobutomo Hanzawa; Masaki Wada; Kenji Kurokawa[2]; Takashi Matsui; Kazuhide Nakajima; [1]Access Network Service Systems Laboratories, NTT Corporation; [2]Kitami Institute of Technology.*

79 W × km power-over-fibre potential is achieved using quasi-single-mode photonic crystal fibre while maintaining a 125-µm cladding diameter. We also experimentally reveal the negligible effect of the fusion splice, although the data transmission distance is limited by the distributed modal crosstalk.

W2A.7

Multi-core fibre amplifier with PLC-type directional convertor for Bi-directional Transmission, *Masaki Wada[1]; Taiji Sakamoto; Takashi Matsui; Kazuhide Nakajima; [1]NTT Access Network Service Systems Laboratories.*

We demonstrate a 4-core erbium-doped fibre amplifier using a PLC with integrated propagation direction converter and pump combiner for bi-directional multi-core fibre transmission. We also show that the signal power deviation to each core is tolerable up to 1 dB by controlling the pump power.

W2A.8

MPI Characteristics of Polarization-Maintaining Fibre Optimized For Short-Length and Twisted-Bending Storage Application, *Satoshi Matsunaga; Hiroto Niiyama; Shoichiro Matsuo; Fujikura Ltd.*

Polarization-maintaining fibre for tight-storage application and MPI measurement system are proposed. The fibre has low macrobending loss (< 0.1 dB), low crosstalk (< −25 dB) at R=2 mm bending with twist, and low MPI at 0.3 m by controlling misalignment of slow axis.

W2A.9

MPO Pre-Terminated Multicore Fiber Trunk Cable, *Ayumi Inoue[1]; Kohei Haji[1]; Yuki Saito[1]; Takahiro Kikuchi[1]; Tetsu Morishima[1]; Kousuke Takeuchi[2]; Shuichiro Rikimi[1]; Junya Takano[1]; Takuji Nagashima[1]; Keiju Okabe[2]; Yuki Shimoda[1]; Fumiaki Sato[1]; Masato Tanaka[1]; Shintaro Mouri[1]; Hidehisa Tazawa[1]; Toshiki Taru[1]; Tetsuya Hayashi[1]; [1]Sumitomo Electric Industries, Ltd.; [2]Sumitomo Electric Optifrontier Co., Ltd.*

We present 288-core trunk cable with 3 break-out cords, each with 24 strands of 4-core fibers and pre-terminated with MPO connectors. The pre-terminated MCF trunk cable is considerably lighter and thinner compared to single-mode fiber trunk cables, and demonstrate satisfactory performance for short-reach optical interconnects.

W2A.10

A Voltage Sensor based on a Poled Few-Mode Fiber, *Lars Grüner-Nielsen[1]; Ninik Irawati[2]; João M. B. Pereira[3]; Graham Town[4]; Walter Margulis[5]; Lars Søgaard Rishøj[2]; Karsten Rottwitt[2]; [1]Danish Optical Fiber Innovation; [2]DTU Electro, Department of Electrical and Photonics Engineering, Technical University of Denmark; [3]RISE – Research Institutes of Sweden; [4]Macquarie University; [5]PUC-Rio.*

A voltage sensor is demonstrated using a poled few-mode fiber. This is done by measuring the differential phase change between the fundamental mode and a higher-order mode. Fourier filtering is used to remove noise caused by beating between additional modes.

W2A.11

Power Conversion Efficiency Improvement of Single Pump LD Multiband Multicore EDFA by Using Bandpass Pump Splitter, *Hitoshi Takeshita; Yusuke Shimomura; Wakako Maeda; NEC Corporation.*

We clarified that our developed bandpass pump splitter enables a 34.2% pump recycling efficiency of a C+L-band 7-core cladding-pumped EDFA with a single pump laser diode. We found that its improvement results in a 40.9% improvement in power conversion efficiency

W2A.12

High-Concentration Bend-Insensitive Erbium-doped Fiber for Amplified Pluggable Coherent Transceivers, *Hui Su; Corning Research and Development Corporation.*

A 26 cm long silica-based erbium-doped fiber configured in a 3 mm bend radius coil yields at least 15 dB of gain across the C-band with 100 mW pump power. We demonstrate a reach increase of 400G ZR coherent transmission from 60 km to 135 km.

SC2: Discrete Photonic Devices and Technologies

W2A.13

Integrated Lithium Tantalate Modulator, *Chengli Wang; Junyin Zhang; Tobias Kippenberg.*

We demonstrate an integrated lithium tantalate electro-optic Mach-Zehnder modulator exhibiting the voltage-length product of 3.7 Vcm and bandwidth of at least 67 GHz.

W2A.14

Performance and modelling of GaN-based µLEDs on 200-mm Silicon wafers, *Sultan El Badaoui[1]; Patrick Le Maitre[1]; Anthony Cibié[1]; Luc Maret[1]; Nicolas Delaunay[1]; Clement Ballot[1]; Julia Simon[1]; Bastien Miralles[1]; Bernard Aventurier[1]; Roch Espiau De Lamaestre[1]; Paolo De Martino[1]; Yannis Le Guennec[2]; [1]CEA-Leti, Université Grenoble Alpes; [2]GIPSA-lab.*

In this work, we present both characterization and modelling results on GaN µLEDs fabricated through a 200-mm ASIC compatible process. Such a process is a step forward

in the path to realize GaN-based interconnects for a compact, fast and efficient fiber-based communication system.

W2A.15

850 nm Single Mode Surface Emitting DFB Laser with High Output Slope Efficiency, *Nanguo Li[1]; Yuting Ma; Can Liu[2]; Yuanhao Zhang[1]; Juan Xia[1]; Qiaoyin Lu[1]; Weihua Guo[1]; [1]Wuhan National Laboratory for Optoelectronics, Huazhong University of Science and Technology, Wuhan 430074, China.; [2]Ori-chip Optoelectronics Technology LTD, Ningbo, China.*

High performance single-mode surface-emitting DFB laser based on surface-gratings filled with spin-on-glass has been demonstrated. By introducing phase-shifter in the etched area, the fabricated laser exhibited output power ~2 mW, SMSR ≥46 dB with grating coupling-coefficient ~560 cm-1, and slope-efficiency ≥0.3 W/A nearly 4 times of previous reports.

W2A.16

12-array Single-Mode VCSEL Chip Multiplexing to 12-mode Fiber with 3D-Printed, Free-Standing, Micro-scale Photonic Lantern, *Yoav Dana; Dan Marom; Ksenia Shukhin; Hebrew University Givat Ram Campus.*

We realize a 12-mode, 300 µm long photonic lantern by 3D-printing directly onto an InGaAs VCSEL chip and demonstrate spatial multiplexing of the incoherent laser sources to a 12-mode fiber with efficiency > –3.5 dB.

W2A.17

Dispersion-Compensation-Enabled Silicon Mach-Zehnder Modulator for CWDM6 Applications, *Shihuan Ran[1]; Yuanbin Liu[1]; Ting Miao[1]; Xinxi Zhu[1]; Yangbo Wu[2]; Yang Qin[2]; Yu Li[1]; Jianping Chen[1]; Linjie Zhou[1]; [1]Shanghai Jiao Tong University; [2]Huawei Technologies, Wireless BU, Shanghai 201206, China.*

We demonstrated an on-chip dispersion-compensation-enabled MZM based on input splitting ratio tuning, by introducing chirp signals with adjustable sign and magnitude. With the proposed scheme, the TDECQ of 112 Gbps PAM-4 signals after 12 km transmission is improved from 3.1 dB to 0.9 dB.

W2A.18

Low half-wave-voltage and high-bandwidth thin-film lithium niobate electro-optic modulator, *关宝 赵; 上海图灵.*

We successfully prepared monolithically integrated TFLN electro-optic modulators that feature a CMOS-compatible bias voltage, support data rates up to 110 GHz and half-wave-voltage down to 2 V. Our study high lights the potential of the proposed modulators for low driving-voltage and high-performance optical communication systems.

W2A.19

600-krad/s Polarization Tracking Using a DC-Stable Integrated Polarization Controller Based on Thin Film Lithium Niobate, *Weibin Chen[1]; Youxin Liu[1]; Ao Cui[1]; Junjiang Ye[1]; Kaixuan Chen[1]; Liu Liu[2]; Weibin Chen[1]; [1]South China Normal University; [2]Zhejiang University.*

We demonstrate a thin-film lithium niobate (TFLN) dynamic polarization controller (DPC) for ultra-fast polarization tracking. Experimental results show that when targeting a specific state of polarization (SOP) with S1 = 0, tracking speeds of 200-krad/s and 600-krad/s is achieved, using 2 and 4 stages, respectively.

W2A.20

Light turning connector optimized for 800G MMF extended reach with the use of Multi Aperture Single Mode 850 nm VCSELs, *Nikolay Ledentsov Jr.[1]; Oleg Makarov[1]; Ayano Kon[2]; Yuto Kujirai[2]; Yuki Saito[2]; Ilya Titkov[1]; Jörg-Reinhardt Kropp[1]; Nikolay Ledentsov[1]; [1]VI Systems GmbH; [2]Enplas Corporation.*

We present a novel design of light turning fiber connector that is compatible with multi-aperture single-mode VCSELs and study the influence of coupling tolerances on data transmission through extended reach of multi-mode-fiber. We demonstrate 50 Gbaud transmission to 400 m of MMF in tolerances comfortable for mass-production.

W2A.21

Ultrabroad 800-nm bandwidth integrated electro-optic Mach–Zehnder modulator for beyond 100 Gbaud/λ transmission over the entire O + C + 2 µm band, *Qiyuan Li[1]; Qiyuan Yi[1]; An Pan[1]; Chenglin Shang[1]; Jinlai Cui[2]; Yupeng Zhu[2]; Jun Zheng[2]; Sizhe Xing[3]; Junwen Zhang[3]; Nan Chi[3]; Cheng Zeng[1]; Jinsong Xia[1]; Li Shen[1]; [1]Huazhong University of Science and Technology; [2]Institute of Semiconductors, Chinese Academy of Sciences; [3]Fudan University.*

We demonstrate a broadband integrated Mach–Zehnder modulator with a record 800 nm bandwidth. The 3-dB electro-optic bandwidth exceeds 67/67/48 GHz for the O-/C-/2-µm bands, enabling high-speed data transmission beyond 100 Gbaud/λ across these wavebands.

W2A.22

Reconfigurable on-chip optical circuit switch for software-defined networking applications, *Zhenyun Xie; David Sánchez Jácome; Luis Torrijos Morán; Daniel Pérez López; iPronics, Programmable Photonics S.L.*

We present a self-configuration and reconfigurable optical circuit switch using a programmable integrated photonic processor. By employing a routing algorithm based on graph theory, we experimentally demonstrated 6x6 switching and 1x8 multicasting scenarios running on the same platform.

W2A.23

Silicon Nitride Waveguide-Based Reversible and Non-Volatile Phase Shift for Programmable Photonic Circuits, *Yuriko Maegami; Guangwei Cong; Rai Kou; Noritsugu Yamamoto; Toshihiro Narushima; Tai Tsuchizawa; Hitoshi Kawashima; Koji Yamada; National Institute of Advanced Industrial Science and Technology (AIST).*

We experimentally demonstrate a reversible and non-volatile optical phase shift in the SiN waveguide, which is given by thermal annealing using micro-heaters and UV irradiation. A non-volatile phase shift of 0.453π is observed in an asymmetric Mach-Zehnder interferometer with a 1000-µm-long phase shifter.

W2A.24

High Gain and Output Power in Atomic-Layer-Deposited Erbium-Doped Waveguide Amplifiers, *Hao Zhang; Shengyun Zhu; Xiaoyan Zhou[1]; Lin Zhang; [1]Tianjin University.*

We demonstrate erbium-doped waveguide amplifiers (EDWAs) composed of polymer and Er3+:Al2O3 films grown by atomic layer deposition (ALD). These amplifiers exhibit remarkable on-chip net gain of 18 dB and output power of 8.1 dBm, marking a significant milestone for ALD-based EDWAs for practical applications.

W2A.25

Wideband Nanosecond Photonic Integrated Wavelength Selec-tive Switch On 3-µm Silicon Waveguide Platform, *Yu Wang[1]; Srivathsa Bhat[2]; Timo Aalto[2]; Nicola Calabretta[1]; [1]Eindhoven University of Technology; [2]VTT Technical Research Centre of Finland.*

A wideband (S to L) nanosecond photonic integrated 1×2 electro-optic wavelength selective switch is fabricated and assessed on 3-µm silicon platform. Experimental results show that the device has 18.5 dB average extinction-ratio, 7.1 dB lowest insertion loss and < 0.7 dB power penalty at 25 Gbit/s signal.

W2A.26

A Wide-ranging, Continuously Tunable Optical Delay Line Using Thin-film Lithium Niobate Photonics, *Yifei Wang[1]; Junlie Hu[1]; Liang Wei[1]; Qi Wang[1]; Wei Ke[2]; Siyuan Yu[1]; Zhongjin Lin[1]; Xinlun Cai[1]; [1]Sun Yat-sen University, Guangzhou, China; [2]Liobate Technology Co., LTD, Nanjing.*

We experimentally demonstrate a wide-ranging, continuously tunable optical delay line using thin-film lithium niobate photonic integrated circuits. With a footprint of 22 mm × 7 mm, it achieves a delay time tuning range of 0 to 39.7 ps with a scanning speed of 2 kHz.

W2A.27

Plasmonic Photodetector with InGaAs Membrane on Si Waveguide using Ni-InGaAs Alloy, *Kentaro Komatsu[1]; Taketoshi Nakayama[1]; Tomohiro Akazawa[1]; Yosuke Wakita[1]; Hiroya Sakumoto[1]; Chao Zhang[1]; Yuto Miyatake[1]; Stéphane Monfray[2]; Frédéric Boeuf[2]; Rui Tang[1]; Kasidit Toprasertpong[1]; Shinichi Takagi[1]; Mitsuru Takenaka[1]; [1]The University of Tokyo; [2]STMicroelectronics.*

We demonstrate III-V/Si hybrid plasmonic waveguide photodetector with InGaAs membrane. Alloying between InGaAs and Ni enables the simple fabrication of plasmonic structure. We achieve 0.13 A/W responsivity at 1 V with 400 nA dark current, demonstrating the potential for low-voltage and high-speed InGaAs plasmonic photodetectors.

W2A.28

Unlocking Versatile and Non-Volatile Bandwidth Tunability in Silicon Photonic Contra-Directional-Coupler-Based Filter Devices, *Lorenzo Tunesi[1]; Mohammad Amin Mahdian[2]; Amin Shafiee[2]; Prof Vittorio Curri[1]; Andrea Carena[1]; Prof Paolo Bardella[1]; Mahdi Nikdast[2]; [1]DET, Politecnico di Torino; [2]Colorado State University.*

We present a novel bandwidth control mechanism using phase-change materials (Sb2Se3) to enable wide bandwidth tunability in silicon photonic grating-assisted contra-directional couplers. The bandwidth dynamic range, obtained using experimentally validated simulation models, is 9.1 nm , surpassing the 3.2 nm achievable with conventional thermal control methods.

W2A.29

Extremely Low Noise APD with InAs/AlAs Atomic Layer Superlattice, *Ryota Takemura; Harunaka Yamaguchi; Daiki Tsubouchi; Ryota Fujihara; Akitsugu Niwa; Eitaro Ishimura; Satoshi Nishikawa; Shinya Tokizaki; Yasunori Miyazaki.*

This paper proposes an extremely low-noise APD structure with thin-film multiplication layers suitable for optical communications, using an atomic-scale InAs/AlAs layered structure (superlattice). Ionization rate ratio as low as 0.01 and excess noise factor of 1.9 at a multiplication factor of 10 are achieved.

W2A.30

60-GHz-Bandwidth Silicon Optical Modulator Utilizing Electro-Optic Frequency-Domain Equalizer, *Yuya Yamaguchi[1]; Atsushi Matsumoto[1]; Pham T. Dat[1]; Shingo Takano[2]; Yu Kataoka[2]; Junichiro Ichikawa[2]; Ryo Shimizu[2]; Naokatsu Yamamoto[1]; Kouichi Akahane[1]; Atsushi Kanno[3]; Tetsuya Kawanishi[4]; [1]National Institute of Information and Communications Technology (NICT); [2]Sumitomo Osaka Cement Co., Ltd.; [3]Nagoya Institute of Technology; [4]Waseda University.*

We demonstrated a high-speed silicon modulator by integrating an electro-optic frequency-domain equalizer. The equalizer improved the modulator's 3-dB bandwidth from 20 GHz to 60 GHz. Additionally, we evaluated the optical spectrum under modulation with frequency values of up to 110 GHz.

W2A.31

Polarization-Insensitive Optical Switches Utilizing Mode-Insensitive Devices, *Yating Wu[1]; Xiaoyan Liu; Tao Chu; [1]Zhejiang University.*

We present a method for polarization-insensitive photonic circuits by transforming fundamental modes of TE and TM polarizations into multiple modes with a single polarization. Silicon thermo-optic and electro-optic switches were fabricated with a polarization-dependent loss of 0.4 and 0.1 dB, respectively.

W2A.32

Wide temperature C-band SOA with NF lower than 6.5 dB, *Matteo Silva; Ian Lealman; Karolis Prizgintas; David Barrow; Ben Royall; Pantelis Aivaliotis; Huawei.*

We report experimental results on single polarization 3-section SOAs. By individually tuning each section bias, we have demonstrated full C band operation over a temperature range of 25–75°C with gain between 18–20.5 dB, NF < 6.5 dB & output power > 8.7 dBm.

SC3: Photonic Integrated Circuits, Assemblies and Packaging

W2A.33

Automating Photonic Systems-in-Package Assembly for High Performance Glass Interposers, *Kevin Shortiss[1]; How Yuan Hwang[2]; Josue Parra[1]; Sharon Butler[2]; Hsiang-Chu Wang[3]; Mohammadamin Ghomashi[4]; Yanlu Li[4]; Wilfried Noell[3]; Moritz Seyfried[5]; Peter O'Brien[2]; [1]ficonTEC Ireland; [2]Tyndall National Institute; [3]Focuslight Technologies Inc.; [4]imec – Ghent University; [5]ficonTEC Service Gmbh.*

Interest in high performance glass interposers has been growing, due to the advantages which have been demonstrated over standard silicon interposers. In this paper, we demonstrate fully automated micro-optics and laser sub-assembly alignment and laser-assisted bonding processes which are compatible with glass interposers.

W2A.34

Solving Integral and Differential Equations with Photonic Iterative Processor, *Minjia Chen[1]; Chunhui Yao[1]; Yizhi Wang[1]; Adrian Wonfor[1]; Shuai Yang[1]; Jie Ma[2]; Ting Yan[2]; Richard Penty[1]; Qixiang Cheng[1]; [1]University of Cambridge, United Kingdom; [2]GlitterinTech Limited.*

We demonstrate, for the first time, an integral and differential equation solver with a photonic iterative processor that processes signals recursively in the optical domain via loopbacks. Such an iterative solver significantly reduces the amount of memory access while achieves a computational accuracy of >98%.

W2A.35

Self-calibrated Microring Weight Function for Optical Analog Computing, *Jose Rafael Garcia Echeverria[1]; Daniel Musat[2]; Ataollah Mahsafar[2]; Kaveh Rahbardar Mojaver[1]; David Rolston[3]; Glenn Cowan[2]; Odile Liboiron-Ladouceur[1]; [1]McGill University, Montréal; [2]Concordia University, Montreal; [3]Axonal Networks.*

This paper presents a microring-based weight function for optical analog computing applications, achieving 9.3 bits accuracy and 11.3 bits precision. A proportional-integrative-derivative (PID) controller monitoring the microring's through and drop ports performs real-time self-calibration for temperature perturbations within the photonic circuit.

W2A.36

Parametric Unitary Operators Experimentally Demonstrated on a Software-Defined Photonic Integrated Processor, *David Sanchez-Jacome; Maria Rodriguez-Losada; Erica Sanchez-Gomaris; Daniel Perez-Lopez; iPronics Programmable Photonics S.L.*

We present the implementation of unitary operators as place and route elements that can be used on a commercially available photonic integrated processor. The flexibility of these operators is demonstrated by measuring 120° and 90° optical hybrids and a multicast switch for optical communication systems.

W2A.37

Integrated Turnkey Electro-Optic Frequency comb Generator Covering Entire S-, C- and L-Bands, *Junyin Zhang[1]; Chengli Wang[1]; Grigory Lihachev[1]; Jianqi Hu[1]; Connor Denney[2]; Mikhail Churaev[1]; Gabriel Santamaria-Botello[2]; Johann Riemensberger[3]; Tobias Kippenberg[1]; [1]EPFL; [2]Colorado School of Mines; [3]Norwegian University of Science and Technology.*

We demonstrate a fully hybrid integrated electro-optic comb generator based on thin-film Lithium Tantalate featuring robust turnkey operation and record-broad $>$200 nm span covering the entire telecommunications S, C, and L-bands, with a compact footprint below 1 cm^2.

W2A.38

Experimental Investigation of a M-QAM Receiver Based on Recurrent Optical Spectrum Slicing and Direct Detection, *Kostas Sozos[1]; Francesco Da Ros[2]; Metodi Yankov[2]; Stavros Deligiannidis[1]; George Sarantoglou[3]; Charis Mesaritakis[3]; Adonis Bogris[1]; [1]University of West Attica, Department of Informatics and Computer Engineering; [2]DTU Electro, Department of Electrical and Photonics Engineering, Technical University of Denmark; [3]University of the Aegean, Dept. Information and Communication Systems Engineering.*

We propose and experimentally evaluate a passive neuromorphic processor performing self-coherent reception and equalisation of complex modulations, based on recurrent optical filters and simple low-bandwidth direct detection. Followed by lightweight electronic equalisation, the receiver successfully demodulates 32 GBd QAM signals at 50 km in C-band.

W2A.39

Semi-Cooled Operation at 106 GBaud of 8λ LAN-WDM Directly-Modulated Membrane Laser Array Exhibiting PPR, *Nikolaos Panteleimon Diamantopoulos; Takuro Fujii; Hidetaka Nishi; Koji Takeda; Tomonari Sato; Shinji Matsuo; NTT Device Technology Labs, NTT Corporation.*

We present the first DML array exhibiting the photon-photon resonance (PPR) effect for wavelength-division multiplexed (WDM) short-reach interconnects. Semi-cooled (50C) operation of an 8-channel LAN-WDM membrane laser array on SiO2/Si at 106 GBaud NRZ over 2-km transmissions is demonstrated with ~154 fJ/bit laser-bias energies.

W2A.40

Microcomb Enabled One-step Wavelength Multicasting Based on Silicon Nitride Dual-coupled Microresonators, *Wenchan Dong.*

We report microcomb enabled single pump one-to-ten wavelength multicasting at 10 GBaud based on silicon nitride dual-coupled microresonators with ~1 GHz intrinsic linewidth. The dual-coupled microreso-nators with alternate narrow and broad resonance linewidths support optical comb and signals pro-cessing simultaneously.

W2A.41

16-Channel CWDM ELSFP Module for Co-Packaged Optics, *Taketsugu Sawamura; Kohei Umeta; Yuki Shiroishi; Hideyuki Nasu; Furukawa Electric Co., Ltd.*

For the first time, we demonstrate a 16-channel ELSFP module integrated with two 8-channel CWDM TOSAs. The ELSFP module achieves optical power of >20 dBm per channel at a housing temperature of 55 ºC.

W2A.42

Silicon Photonic Programmable Processor Based on Mach-Zehnder and Micro-ring modulators, *Shuyue Zhang[1]; Qiang Zhang[2]; Yuchen Shi[1]; Shilan Zhou[1]; Zhujun Wei[1]; Hui Yu[2]; [1]Zhejiang University; [2]Zhejiang Lab, Hangzhou 311121, China.*

We demonstrated a programmable photonic integrated chip. It consists of a cascaded Mach-Zehnder modulators and multi microring modulators. By tuning the operation states of them reconfigurably, it can be employed for generating high-speed microwave pulse trains, synthesising high-frequency electrical signals, and digital optical communication.

W2A.43

Electro-Optic Frequency Combs Using Cascaded Silicon Phase Modulators for High-Capacity Super-Channel Transmissions, *Erwan Weckenmann; Abdolkhalegh Mohammadi; Alireza Geravand; Simon Levasseur; Leslie Rusch; Wei Shi; Department of Electrical and Computer Engineering, COPL, Université Laval, Québec, Canada.*

Using three cascaded silicon phase modulators, a high-repetition-rate electro-optic frequency comb is generated and filtered to isolate two optical carriers spaced by 150 GHz, with a 0.16 dB non-uniformity and 60 dB tone-to-noise ratio, ideal for 300 Gbaud dual-carrier transmission.

W2A.44

Translucent Photonic Frequency-Domain Neuron with Unamplified Concatenation of Neural Sub-Circuits, *Margareta Vania Stephanie[1]; Lam Pham[1]; Tibor Grasser[2]; Michael Waltl[2]; Bernhard Schrenk[1]; [1]AIT Austrian Institute of Technology; [2]Institute for Microelectronics, TU Wien.*

We demonstrate frequency-domain neural signal processing for linear weighted summation and non-linear ReLU activation, using a flexible interconnect to synthesize both sub-circuits. We show that neural network sub-circuits can drive each other without amplification and confirm a low 1.5% penalty in accuracy for concatenated operation.

W2A.45

Electro-absorption Modulation of a III–V-on-Silicon DFB Laser co-integrated with SOA boosters at 32 Gbps NRZ, *Joan Manel Ramirez[1]; Amin Souleiman[2]; claire Besancon[3]; Alexandre Shen; Delphine Neel[3]; nicolas vaissiere[1]; Stéphane Malhouitre[4]; Jean Decobert[3]; Karim Hassan[4]; David Bitauld[3]; kamel Merghem[2]; [1]III-V lab / Nokia Bell Labs; [2]Telecom Sud-Paris; [3]III-V lab; [4]CEA-LETI.*

We demonstrate III-V-on-Si Externally-Modulated Lasers co-integrated with SOAs, delivering up to 16 mW of on-chip power, 22 GHz of 3-dB bandwidth and can transmit NRZ-OOK signals at 32 Gbps over a 5 km SSMF.

W2A.46

Hybrid optoelectronic tensor core with high computing precision, *Liangjun lu; Yue Wu; Jianping Chen; Linjie Zhou.*

We propose and experimentally demonstrate a hybrid optoelectronic tensor core, realizing a compu-ting precision beyond 8 bits for arbitrary matrix-vector multiplication, and an accuracy of 95.4% (vs. 96.1% digital) in the MNIST dataset recognition task.

W2A.47

1.9-pJ/bit 0.5-mm2 High-Speed Optical Transmitter including Silicon Slow-Light Modulator and Current-Mode BiCMOS Driver, *Keisuke Kawahara[1]; Tai Tsuchizawa[2]; Noritsugu Yamamoto[2]; Yuriko Maegami[2]; Koji Yamada[2]; Shinsuke Hara[3]; Toshihiko Baba[1]; [1]Yokohama National University; [2]National Institute of Advanced Industrial Science and Technology; [3]National Institute of Information and Communications Technology.*

A high-speed optical transmitter including a silicon slow-light Mach-Zehnder modulator and a current-mode BiCMOS driver was EO co-designed and integrated. We experimentally achieved a 1.9-pJ/bit total efficiency and a 0.5-mm2 footprint.

W2A.48

High-speed Optical Receiver using High-frequency and Integrated Design based on Flip-chip Mounting Technique for 200-Gbit/s/λ 20-km Transmission, *Shohei Kosuga; Shigeru Kanazawa; Toshihide Yoshimatsu; Yasuhiko Nakanishi; Takuya Kanai; Mingchen Chen; Hirotaka Nakamura; NTT Innovative Devices Corporation.*

We designed and fabricated a high-speed optical receiver with a 3-dB bandwidth of above 55 GHz thanks to a high-frequency and integrated design based on a flip-chip mounting technique. We achieved a 200-Gbit/s/λ 20-km transmission with the low CD penalty of 0.3 dB or less.

W2A.49

2.4-THz Bandwidth Optical Coherent Receiver Based on a Photonic Crystal Microcomb, *Callum Deakin[1]; Jizhao Zang[2]; Xi Chen[1]; Di Che[1]; Lauren Dallachiesa[1]; Brian Stern[1]; Nicolas Fontaine[1]; Scott Papp[2]; [1]Nokia Bell Labs; [2]National Institute of Standards and Technology, Boulder, Colorado.*

We demonstrate a spectrally-sliced single-polarization optical coherent receiver with a record 2.4-THz bandwidth, using a 200-GHz tantalum pentoxide photonic crystal microring resonator as the local oscillator frequency comb.

W2A.50

Automatic Spectral Flattening by Two-Step Parameter Control for Mach-Zehnder-Modulator-Based Comb Generator, *Tatsuki Ishijima; Shun Harada; Takahide Sakamoto; Tokyo Metropolitan University.*

We propose and experimentally demonstrate a two-step parameter control method, which auto-matically optimizes the condition for optical flat comb generation using a Mach-Zehnder modulator. Combining heuristic parameter estimation and analytical spectral flattening steps, spectrally-flattened 25-GHz-spaced optical comb is automatically generated.

W2A.51

32 Antennas Optical Phased Array Integrated on Silicon Nitride Platform, *Tommaso Cassese; Saeed Arsanjani; Muhammad Shaukat Khan; Jochen Bardong; Albert Frank; Silicon Austria Labs GmbH.*

This work presents a fully controllable 32 antennas optical phased array integrated on a commercially available silicon nitride platform. Operating at 1550 nm with 2D steering, it exhibits a horizontal field of view of 25°, a horizontal and vertical resolution of 0.7° and 0.08° respectively.

W2A.52

Reliable and Robust Configuration of One-chip Wavelength Locker for high Frequency Stability Operation in ±0.5 GHz, *Junichi Suzuki[1]; Kiyotomo Hasegawa[2]; Kei Masuyama[1]; Nobuo Ohata[1]; [1]Mitsubishi Electric Corporation, Information Technology R & D Center; [2]Mitsubishi Electric Corporation, High Frequency & Optical Device Works.*

To ensure the reliability of TO-CAN-type light sources for coherent applications, a one-chip wave-length locker with a low temperature dependence reduced to 1.4 pm/K was fabricated and a high lasing frequency stability of ±0.5 GHz could be achieved in a pseudo-long-term reliability test was demonstrated.

SC4: Signal Processing for Optical Communication and Computing

W2A.53

Advanced Adaptive Constant Modulus Algorithms for Singularity Avoidance Over Wide Polarization Mode Dispersion Range in Optical Fibre Access Systems Beyond 100 Gbps, *Peter Akachi Nwakamma[1]; Gwillerm Froc[2]; Cédric Ware[3]; Yves Jaouën[3]; [1]Mitsubishi Electric R&D Center Europe | Telecom Paris; [2]Mitsubishi Electric R&D Center Europe; [3]Telecom Paris.*

An enhanced correlation avoidance constant modulus algorithm is proposed for singularity avoidance over a wide range of polarization mode dispersion in the optical access beyond 100 Gbps. We show up to 7 dB improvement in singularity avoidance compared to other schemes.

W2A.54
Adapting Spiking Neural Networks for Enhanced Optical Signal Equalization in Communication Systems, *Diego Arguello Ron; Aston University, Aston Institute of Photonics Technologies.*

A version of the Receptance Weighted Key Value (RWKV) language model, that integrates spiking linear transformations and reconfigured for the regression task of signal equalization is employed to compensate the nonlinearity from the transmission of PDM 34.4 Gbaud 16QAM over 10x50 km of TWC fiber.

W2A.55
Field-Enhanced Filtering in MIMO Learned Volterra Nonlinear Equalisation of Multi-Wavelength Systems, *Nelson Castro; Sonia Boscolo; Andrew Ellis; Stylianos Sygletos; Aston Institute of Photonic Technologies, Aston University.*

We propose a novel MIMO-WDM Volterra-based nonlinear-equalisation scheme with adaptive time-domain nonlinear stages enhanced by filtering in both the power and optical signal waveforms. This approach efficiently captures the interplay between dispersion and non-linearity in each step, leading to 46% complexity reduction for 9x9-MIMO operation.

W2A.56
Complex-Valued Kernel-based Phase and Amplitude Distortion Compensation in Parametrically Amplified Optical Links, *Long Nguyen; Sonia Boscolo; Stylianos Sygletos; Aston Institute of Photonic Technologies, Aston University.*

We develop a complex-valued kernel-adaptive-filtering based method for phase and amplitude distortion compensation in cascaded fibre-optical parametric amplifier (FOPA) links. Our algorithm predicts and cancels both distortions induced by pump-phase modulation across all amplification stages, achieving more than an order of magnitude improvement in BER.

W2A.57
Experimental Demonstration of a FI-ADC with a Parallel DSP Scheme for High-Speed Optical Communications, *Gustavo Zoireff; Centro Atomico Bariloche and Instituto Balseiro.*

We propose a DSP architecture for a frequency-interleaving analog-to-digital converter (FI-ADC) based on parallel processing. Experimental results show successful recovery of 16 GBaud data signals using a FI-ADC built from a 4 GHz/10 GSps scope, representing a promising solution for future high-speed optical transceivers

W2A.58
A New Tandem Learning Rule for Efficient Training of Spiking Neural Network Equalizers for IM/DD Optical Transmission, *Shuangxu Li; Georg Böcherer; Stefano Calabrò; Maximilian Schädler; Tianyuan Kong; Huawei Technologies Duesseldorf GmbH, Munich Research Center, 80992, Munich, Germany.*

A spiking neural network (SNN) equalizer for IM/DD optical transmission is trained using tandem learning, offloading the training to an artificial neural network (ANN). Optimal performance is achieved, outperforming a linear equalizer by 1~dB. The proposed learning rule is suitable for neuromorphic hardware.

W2A.59
Successive Interference Cancellation for Optical Fiber Using Discrete Constellations, *Alex Jäger; Gerhard Kramer; Technical University of Munich (TUM).*

Successive interference cancellation is used to detect discrete modulation symbols transmitted over a 1000 km fiber-optic link. A transmitter and receiver are presented that have linear complexity in the number of transmitted symbols and achieve the information rates of previous studies that use continuous modulations.

W2A.60
Normalized-Interpolated-Power Gardner Phase Detector for Optical Fiber Transmission Systems with Severe Bandwidth Limitation, *Zhongxing Tian[1]; Huan Huang[1]; Ji Huang[1]; Hansheng Xu[1]; Zeyu Feng[1]; Yuhan Gong[2]; Qingyu He[2]; Ming Luo[2]; Lin Sun[1]; Gordon Ning Liu[1]; Gangxiang Shen[1]; Yi Cai[1]; [1]Soochow University; [2]National Key Laboratory of Optical Communication Technologies and Networks.*

We propose a normalized-interpolated-power Gardner timing recovery scheme for signals with severe bandwidth limitation. We experimentally demonstrate effective timing synchronization of a 60-GBd QPSK signal with a 3-dB bandwidth down to 7.5 GHz.

W2A.61
Error-Correlation based DFE Error Propagation Suppression for 200G Intra-Datacentre Interconnects, *Xue Zhao[1]; Jing Zhang[1]; Jiahao Zhou[1]; Chenye Wang[1]; Shaohua Hu[1]; Zhaopeng Xu[2]; Bo Xu[1]; Kun Qiu[1]; [1]University of Electronic Science and Technology of China (UESTC); [2]Peng Cheng Laboratory, Shenzhen, China.*

We propose and experimentally demonstrate an error-correlation based DFE in a 256-Gb/s PAM-4 signal transmission over 0.5-km SSMF. The results show that the proposed method reduces the occurrences of burst errors by 12 times, resulting in one order of magnitude BER decrease.

W2A.62
Identification of Abnormal Noise Location Using Scattering Parameters in Nonlinear Fourier Transform, *Takumi Motomura; Hideaki Shimpo; Akihiro Maruta; Ken Mishina; Osaka University.*

We propose a novel method to identify abnormal noise location by using the variances of the scattering parameters in the nonlinear Fourier transform. The nonlinear spectrum-based method achieves a kilometer-order estimation accuracy with a lower computational complexity compared to that in the eigenvalue-based method.

W2A.63
A Novel PAPR Reduction Algorithm Enabled Digital Multi-Band P2MP Transmission with Link Loss Enhancement, *Sunningchang Zhang[1]; Yang Zou; Linsheng Zhong; Junyu Wu; Weiqi Lu; Xiaoxiao Dai; Suyi Wang; Yaqi Wang; Songtao Chen; Zhiwen Fan; Qi Yang; Mengfan Cheng; Lei Deng; Zhijun Yan; Deming Liu; [1]HUST.*

We proposed a novel PAPR reduction algorithm for Digital Multi-band (DMB) P2MP system. A DMB transmission over 20-km SSMF at 460.8 Gb/s was demonstrated. Each subcarrier was modulated by 16QAM and received individually. 1.04 dB link loss gain over clipping was achieved at 7%HD-FEC threshold.

W2A.64
In-Service Transceiver Calibration with Extracting IQ Difference via Offloaded Adaptive Multi-layer Filters, *Masaki Sato; Hidemi Noguchi; Matsui Matsui; Jun'ichi Abe; Kohei Hosokawa; NEC Corporation.*

We demonstrated in-service transceiver calibration for 128-GBd PM-PCS-64QAM via adaptive multi-layer filters over 120-km SMF. After compensating the Tx/Rx-IQ difference only, Q-penalties of 0.1 dB with 2 ps Tx-IQ skew, 3 ps Rx-IQ-skew, 2 dB IQ peaking error, and 60-GHz Rx-IQ bandwidth imbalance were achieved.

W2A.65
A Mathematical Model for Phase-Noise-Induced Burst Errors in Systems with Pilot-Aided Carrier-Phase-Recovery, *Chunpo Pan[1]; Hao Ding[2]; Meng Qiu[1]; Xuefeng Tang[1]; Chuandong Li[1]; [1]Huawei Technologies Canada Co., Ltd.; [2]Huawei Technologies.*

A mathematical model for pilot-aided carrier-phase recovery is proposed, whose accuracy is verified by both simulations and experiments. The model may be used to predict the occurrence of rare phase-noise-induced burst errors, and guide the design of the pilot pattern, interleaver, and forward-error-correction modules.

W2A.66
Hybrid Neural Network Receiver for Direct Detection of Minimum-phase Signal, *Xiangyong Dong; Zhenming Yu; Hongyu Huang; Kaixuan Sun; Kun Xu; Beijing University of Posts and Telecommunications.*

We propose a hybrid neural network receiver for direct detection of minimum-phase signal, outperforming the Kramers-Kronig receiver. The results show that it reduces the required CSPR for HD-FEC by 3 dB, lowers sampling rate for complex field reconstruction, and effectively compensates for propagation-related impairments.

W2A.67
Energy / Footprint Efficient Photonic Signal Processing of Raw Photocurrents in Phase-Agnostic Coherent Receiver, *Bernhard Schrenk; AIT Austrian Institute of Technology.*

Signal recovery is demonstrated for a phase-diversity coherent receiver with free-running LO. After a direct translation of unamplified photocurrents to the optical

frequency domain, the signal is processed in a compact silicon micro-ring resonator, at half the energy cost.

W2A.68

Perturbation-based Sequence Selection for Probabilistic Amplitude Shaping, *Mohammad Taha Askari; Lutz Lampe; The University of British Columbia.*

We introduce a practical sign-dependent sequence selection metric for probabilistic amplitude shaping and propose a simple method to predict the gains in signal-to-noise ratio (SNR) for sequence selection. The proposed metric provides a 0.5 dB SNR gain for single-polarized 256-QAM transmission over a long-haul fiber link.

W2A.69

Black-box Optimization of Parametrically Modeled Digital Circuitry for Optical Communications, *Tsuyoshi Yoshida[1]; Hayato Sano[1]; Shota Koshikawa[1]; Alifu Xiafukaiti[1]; Magnus Karlsson[2]; Erik Agrell[2]; [1]Mitsubishi Electric Corporation; [2]Chalmers University of Technology.*

An efficient development method is required for large-scale digital signal processing implementations. The proposed design method with parametric modeling and multi-objective optimization reduces the optimization time from 300 years by brute-force search to around 2 weeks by a heuristic solver using approximation and machine learning.

W2A.70

Cost-Effective Equalizer-Free 2-Bit Quantized 50 Gb/s PtP Using Turbo Reed-Solomon FEC, *Abir Hannachi[1]; Luiz Anet Neto[2]; Ramesh Pyndiah[2]; Rodolphe Legouable[1]; Jean Claude Carlach[1]; [1]orange innovation ; [2]IMT Atlantique.*

We present a cost-effective, equalization-free 50 Gb/s downstream point-to-point optical access transmission approach based on a 2-bit quantized input Reed-Solomon turbo code. Coding gains >2 dB are achieved compared to the solution currently adopted by the standard.

W2A.71

Integrated Compensation Method for Ultra-Fast RSOP and Phase Noise Based on Stochastic Gradient Descent Four-Parameter Algorithm in Coherent Optical Communication Systems, *Zeyu Xu; Xianfeng Tang; Yang Xiao; Shirui Zhang; Shunan Xu; Zhihan Li; Zhongyuan Wang; Yexin Zhang; Linan Shan; Lixia Xi; Xiaoguang Zhang.*

This paper demonstrates a stochastic gradient descent four-parameter algorithm to achieve integrated compensation for RSOP and phase noise in coherent optical communication systems. The experimental results show superior advantages in ultra-fast RSOP tracking speed up to 20 Mrad/s and the elimination of singularity issues.

W2A.72

The Odd Symmetry CD Compensation Technique for Extend-ing C-Band Transmission in Single Side Band Intensity Modu-lation, *Tao Zeng[1]; Yingmei pan; Shan Hu; Wei Li; Ziqing Liu; Ming Luo; [1]China information and communication technology Group Corporation.*

This paper presents an odd-symmetry chromatic-dispersion compensation technique, which enhances the C-band transmission length by combining with an optic or electrical single sideband filter. It can be selectively used at the transmitting or receiving end, both preserving simple intensity modulation and direct detection infrastructure.

SC5: Optical Transmission Systems

W2A.73

Experimental Demonstration of Machine Learning Transformer Based Equalization of Channel Nonlinearities, *Naveenta Gautam[1]; Prankush Agarwal[1]; C. Alex Kaylor[1]; Brejesh Lall[2]; Amol Choudhary[2]; Stephen E. Ralph[1]; [1]Georgia Institute of Technology; [2]Indian Institute of Technology Delhi.*

We experimentally demonstrate a Machine Learning (ML) Transformer-based nonlinear equalization for WDM 16QAM coherent optical communication systems. Q factor gains as high as 1.7 dB are demonstrated for multi-span links. Performance and computational efficiency are superior to digital backpropagation and other ML techniques.

W2A.74

Performance-Complexity Tradeoffs of First-order Regular Perturbation-based Models, *Astrid Barreiro[1]; Gabriele Liga; Alex Alvarado; [1]Eindhoven University of Technology.*

We report on a comparative study of the alternatives to reduce the complexity of the first-order regular perturbation (FRP) model enhanced via a gradient-based optimization. We show that magnitude-based pruning of the optimized coefficients leads to a 91% complexity reduction compared to conventional FRP.

W2A.75

Impact of launch power optimisation in hybrid-amplified links, *Henrique Buglia[1]; Eric Sillekens[1]; Lidia Galdino[2]; Robert I. Killey[1]; Polina Bayvel[1]; [1]University College London (UCL); [2]Corning Optical Communications.*

Per-channel launch power optimisation in a hybrid-amplified link with optimised pump powers and wavelengths is described. Compared to using the optimum spectrally uniform launch power, an average SNR gain of 0.13~dB is obtained against 0.56~dB for the same system operating with lumped amplifiers only.

W2A.76

Analysis of Crosstalk Drift in Spatial Light Modulator-based Mode Multiplexing for Multimode Fibres , *Zun Htay[1]; Rekha Yadev[2]; Fabio Babosa[1]; Filipe Ferreira[1]; [1]University College London; [2]University College London .*

We investigate the crosstalk drift with time in space division multiplexing transmission over a 45 mode OM3 fibre. Mode (de-)multiplexing is achieved using phase holograms in the Fourier domain. System stability is experimentally evaluated over a 9-hour transmission period.

W2A.77

Investigation of SOA Nonlinear Impairments Dependency on Transmission System Parameters, *Xiaohui Zhao; Maha Bouhadida[1]; Hartmut Hafermann; Loig Godard; Iosif Demirtzioglou; Abel Lorences-Riesgo; Zhenzhen Zhang; Massimo Tornatore; Yann Frignac; Gabriel Charlet; [1]Huawei Technologies.*

Using accurate numerical model, validated with experimental measurements, we study the influence of different transmission system parameters, such as modulation format, chromatic dispersion, signal channel loading, bandwidth and state of polarization, on the SOA nonlinearity.

W2A.78

Transmission Distance Extension by Bidirectionally Pumped Raman Amplification Using Incoherent Forward Pumps, *Shigehiro Takasaka; Daichi Ogata; Junji Yoshida; Norihiro Ohishi; Furukawa Electric Co., Ltd.*

We demonstrate a C-band 50 Gbaud 16-QAM WDM transmission under bidirectionally pumped distributed Raman amplification, where the forward pumps are only semiconductor incoherent sources. Compared with the EDFA-only amplification, the transmission distance is extended from 1,800 km to 3,200 km.

W2A.79

Impact and Mitigation of Reflections in 400G Single-Fiber Bidirectional Coherent Systems for Future Mobile Transport, *Pablo Torres-Ferrera[1]; Marco Distefano[2]; Gianluca Gambari[2]; Federica Gatti[2]; Roberto Magri[2]; Antonio Tartaglia[2]; Rafal Kapuscinski[1]; M. Sezer Erkilinç[1]; Federico Pevere[1]; Tobias Eriksson; Johan Bäck[1]; Magnus Olson[1]; João Pedro[1]; Vittorio Curri[3]; Christopher Fludger[1]; Antonio Napoli[1]; [1]Infinera; [2]Ericsson; [3]Politecnico di Torino.*

We perform experimental evaluation and analytical modelling of the sensitivity penalty caused by discrete and distributed reflections in single-fiber bidirectional coherent systems for next-generation mobile transport. We explore digital subcarrier multiplexing efficacy on this scenario and propose power optimization strategies, offering insights for network enhancement.

W2A.80

201.6 Tbit/s S+C+L-Band Transmission over 2×75 km SSMF with Doped Fiber Amplification, *Xu Zhang[1]; Ming Luo[1]; Qingyu He[1]; Ping Du[2]; Yan Wu[2]; Liang Mei[2]; Zhixue He[3]; Xi Xiao[4]; Shaohua Yu[3]; [1]State Key Laboratory of Optical Communication Technologies and Networks; [2]Fiberhome Telecommunication Technologies Co. Ltd; [3]Peng Cheng Laboratory; [4]National Optoelectronics Innovation Center.*

We experimentally demonstrate a total GMI throughput of 201.6 Tbit/s over 2×75 km G.654.E fiber transmission by delivering 74 Gbaud PCS-256QAM and PCS-64QAM signals in 19.8 THz S, C and L-band with doped fiber amplifiers.

W2A.81

Mitigating Equalization-Enhanced Phase Noise Using Adaptive Post Equalization, *Sebastian Jung; Tim Janz; Stephan ten Brink; Insitute of Telecommunications, University of Stuttgart.*

A simple but efficient post-equalization is presented which mitigates undesired equalization-enhanced phase noise (EEPN). The proposed feed-forward architecture is able to achieve a gain of up to 1 dB in simulation of 100 GBd 16-QAM coherent transmission over a link of 5000 km of fiber.

W2A.82

On the Relevance of the Frequency Dependent Behavior of the Polarization Dependent Loss Introduced by WSSs, *Nicola Rossi; Thierry Zami; Bruno Lavigne; Alcatel Submarine Networks (ASN).*

We examine how channels routed by Wavelength Selective Switches (WSS) are affected by higher Polarization Dependent Loss (PDL) from WSS near the edges of channel spectral slots. We find non-negligible impact on the Signal-to-Noise Ratio for steep PDL increase modeled by an inverse filtering function.

W2A.83

Beyond 6.4-Tb/s PAM4/PS-PAM8 MDM-WDM Transmission with Degenerate-Mode-Diversity Receiver over Weakly-Coupled FMF and Low-Crosstalk Mode MUX/DEMUX, *Yu Yang; Gang Qiao; Honglin Ji; Zhaopeng Xu; Tonghui Ji; Qi Wu; Shangcheng Wang; Lulu Liu; Baolong Zhu; Mingqing Zuo; Chengbin Long; Lei Shen; Jie Luo; Weisheng Hu; Juhao Li.*

We first propose a high-speed mode group IM-DD transmission system with a degenerate-mode-diversity receiver over weakly-coupled multiple-ring-core FMF and low-crosstalk mode MUX/DEMUX, based on which a record 224-Gb/s per lane and beyond 6.4-Tb/s PAM4/PS-PAM8 MDM-WDM transmission is experimentally demonstrated for optical interconnections.

W2A.84

Optimum Launch Power in Multiband Systems, *Yanchao Jiang[1]; Fabrizio Forghieri[2]; Stefano Piciaccia[2]; Gabriella Bosco[1]; Pierluigi Poggiolini[1]; [1]DET, Politecnico di Torino; [2]CISCO Photonics Italy srl.*

We investigate the residual throughput penalty due to ISRS, after power-optimization, in multiband systems. We show it to be mild. We also revisit the launch power optimization "3-dB rule". We find that using it is possible but not advisable due to increased GSNR non-uniformity.

W2A.85

A Multi-Functional Signal Shaping Scheme Enabled by Sequence Selection For Coherent Optical Transmissions, *Bohan Sang[1]; Chen Wang[1]; Jianyu Long[1]; Ze Dong[2]; Xiongwei Yang[1]; Long Zhang[1]; Kaihui Wang[1]; Wen Zhou[1]; Jianjun Yu[1]; [1]Fudan University; [2]Beijing Institute of Technology.*

We propose a novel sequence selection method to realize probabilistic shaping, nonlinearity $\&$ band-limitation tolerance, and multi-dimensional demodulation in one shot without distribution matcher. The scheme is experimentally evaluated in coherent fiber transmission. It can achieve 25$\%$ reach improvement compared to traditional PS schemes.

W2A.86

Phase-Noise-Robust MIMO Neural Network Equalization in 100-Gbaud PS-DP-16QAM WDM Transmission over 6400-km Fiber, *Chen Wang[1]; Bohan Sang[1]; Long Zhang[1]; Jianyu Long[1]; Xiongwei Yang[1]; Wen Zhou[1]; Kaihui Wang[1]; Yong Chen[2]; Weizhang Chen[2]; Bing Ye[2]; Bo Liu[3]; Xiangjun Xin[3]; Jianjun Yu[1]; [1]Fudan University; [2]ZTE Corp.; [3]Beijing University of Posts and Telecommunications.*

We have experimentally demonstrated WDM 100-Gbaud DP-PS-16QAM signal transmission over 6400-km fiber utilizing a novel phase-noise-robust MIMO-NN equalizer integrated with low-complexity BMLPR. Results show that our proposal outperforms traditional DSP by 48.84% with 11.52% com-plexity reduction.

W2A.87

140 GBd S-C-L-Band Transmission System Enabled by TFLN Coherent Driver Modulator and InP Coherent Receiver Engine, *Robert Emmerich[1]; Jonas Gläsel[1]; Alexander Schindler[2]; Patrick Runge[1]; Colja Schubert[1]; Martin Schell[1]; Ronald Freund[1]; [1]Fraunhofer Heinrich Hertz Institute HHI; [2]Technical University of Berlin.*

We demonstrate 128/140-Gbaud QPSK/16QAM S-C-L-band b2b transmission with commercially available components. The broadband thin film lithium niobate high-bandwidth coherent driver modula-tor and the InP intradyne coherent receiver with integrated 128 GBd class SiGe transimpedance amplifier are further characterised over an optical bandwidth of 200 nm.

W2A.88

A Record 131 Gb/s IM/DD Optical Data Link at 2-Micron Waveband Using Only Commercial Components, *Jianwei Tang; Yihang Li; Chen Cheng; Xi Wang; Bang Yang; Tianfeng Zhao; Yaguang Hao; Linsheng Fan; Qi Wu; Zhongliang Sun; Junpeng Liang; Zhaopeng Xu; Yanfu Yang; Ke Xu; Jinlong Wei; Weisheng Hu.*

We propose and experimentally demonstrate a record-breaking IM/DD transmission system with a capacity of 131.4 Gb/s over 100-m solid-core fiber at the 2-micron waveband, enabled by optimum probabilistically shaped PAM modulation and receiver-only equalization.

SC6: Architecture, Modelling and Performance of Optical Networks

W2A.89

Fiber Parameter Change Monitoring in Single Span SSMF Links Using Koopman Operators, *Shahzeb Aamir[1]; Sander Wahls[2]; [1]Delft Center for Systems and Control, Delft University of Technology, Netherlands; [2]Karlsruhe Institute of Technology, Institute of Industrial Information Technology, Germany.*

Koopman-based fiber parameter estimation is computationally efficient and only requires input-output data from an operational link. However, the Kerr parameter estimate becomes biased for longer fibers. Surprisingly, we observe that parameter changes are nevertheless tracked accurately. This can be exploited for link monitoring.

W2A.90

An Operator's Perspective on the Introduction of Domain Knowledge-Assisted Adaptive Margin Ahead of Network Upgrade, *Rana Kumar Jana[1]; Andrew Lord[2]; Anand Srivastava[1]; Abhijit Mitra[1]; [1]Indraprastha Institute of Information Technology Delhi (IIIT-Delhi); [2]Applied Research, Adastral Park, BT, UK.*

We report the advantage of adaptive margin allocation on network upgrades while effectively utilizing the monitoring data from optical performance monitoring equipment. Results indicate domain knowledge-assisted adaptive margin allocation can save the margin requirement by 50% and initiate 57.3% less upgrades than hard margin scenarios.

W2A.91

Cost-Effective Network-Facility Upgrade Scheme Enabling Incremental Transition to Multiband Optical Networks, *Hayato Yuasa; Yojiro Mori; Hiroshi Hasegawa; Nagoya University.*

We propose a cost-effective network-facility upgrade scheme enabling incremental transition to multiband networks utilizing wavelength conversion. The proposed scheme defines a mesh-type sub-network that allows optical paths to cost-effectively bypass multiple congested links. Simulations show capacity enhancement with a relatively small number of wavelength converters.

W2A.92

Extension of the Local-Optimization Global-Optimization (LOGO) Launch Power Strategy to Multi-Band Optical Networks, *Andrea D'Amico[1]; Bruno Correia[2]; Vittorio Curri[2]; [1]NEC Laboratories America, Inc.; [2]Politecnico di Torino.*

We propose extending the LOGO strategy for launch power settings to multi-band scenarios, maintaining low complexity while addressing key inter-band nonlinear effects and accurate amplifier models. This methodology simplifies multi-band optical multiplex section control, providing an immediate, descriptive estimation of optimized launch power.

W2A.93

Multi-Span Optical Power Spectrum Evolution Modeling using ML-based Multi-Decoder Attention Framework, *Agastya Raj[1]; Zehao Wang[2]; Frank Slyne[1]; Tingjun Chen[2]; Dan Kilper[1]; Marco Ruffini[1]; [1]Trinity College Dublin; [2]Duke University.*

We implement a ML-based attention framework with component-specific decoders, improving optical power spectrum prediction in multi-span networks. By reducing the need for in-depth training on each component, the framework can be scaled to multi-span topologies with

minimal data collection, making it suitable for brown-field scenarios.

W2A.94

Accuracy Enhancement of an Optical Network Digital Twin Based on Open-Source Field Data, *Ambashri Purkayastha[1]; Camille Delezoide[1]; Mounia Lourdiane[2]; Cedric Ware[3]; Patricia Layec[1]; [1]Nokia Bell Labs, France; [2]SAMOVAR, Télécom SudParis, Institut Polytechnique de Paris; [3]LTCI, Télécom Paris, Institut Polytechnique de Paris.*

We propose a two-stage hybrid QoT model for twinning a real transport network and evaluate it on recently published field data. Accounting for partial calibration of key parameters, we improve the SNR prediction accuracy by more than a factor of two.

W2A.95

ML-based Joint Nonlinear Noise and Mode Dependent Loss Monitoring in SDM Transmission, *Ruby Stella Bravo Ospina; Amirhossein Ghazisaeidi[1]; Roya Gholamipourfard[1]; [1]Nokia Bell Labs, France.*

We propose an ANN for jointly monitoring the NL noise and the MDL in an 8-mode transmission. We show that, from a few parameters accessible after DSP, the noise contribution from nonlinearities and MDL can be accurately estimated for spatially white or colored noise sources.

W2A.96

Multi-Core Fibre based Filterless Space-Division Multiplexing (SDM) Networks with Adaptive Network Topologies, *Yiran Teng[1]; Ruizhi Yang[1]; Ning Zhang[2]; Shuangyi Yan[1]; Dimitra Simeonidou[1]; [1]University of Bristol; [2]CSA Catapult.*

This paper proposes a filterless SDM network using multi-core fibres with adaptive network topologies. Detailed simulations validate the effectiveness of the proposed network architecture in reducing both hardware cost and service blocking probability.

W2A.97

A Three-Stage ROADM Node Architecture based on NxN Partial Wavelength Selective Switch, *Yunfei Wu; Ruishan Chen; Huawei Technologies Co., Ltd.*

We propose a three-stage ROADM node architecture to support scaling to 64 degrees and beyond, and demonstrate an enabling 64x64 wavelength selective switch that supports partial wavelengths in C band. The fabricated P-WSS shows loss < 9.5 dB and 0.5 dB bandwidth > 143 GHz for 150 GHz channel.

W2A.98

Spectrum Resolved SNR Monitoring: Practical Improvement and Applications, *Qingyi Guo; Zhiping Jiang; Huawei Technologies Canada, Co., LTD.*

We improve the recently proposed spectrum resolved SNR scheme with practical considerations and demonstrate it with filter frequency offset. We also demonstrate this method to be a powerful tool for more monitoring applications including fiber nonlinear noise SPM and XPM in-band spectra, PDL and MPI.

W2A.99

Blind state of polarisation monitoring using variational autoencoders-inspired adaptive filter, *louis tomczyk; Élie Awwad; Diane Prato; Cédric Ware; Telecom Paris, Institut Polytechnique de Paris.*

We demonstrate that probabilistically shaped modulations make the Constant Modulus Algorithm unfit for State of Polarisation monitoring in coherent optical communications. Accordingly, we study the potential of Variational AutoEncoders-inspired equalisers for this purpose.

W2A.100

Experimental Assessment Multiband Lossless ROADM Architecture for Optical Metro Access , *Shiyi Xia; Henrique Freire Santana; Pablo Pavon-Marino; Nina Skorin-Kapov; Zhouyi Hu; Marijn Rombouts; Oded Raz; Nicola Calabretta.*

We experimentally assess an SOA-based multiband lossless multi-degree reconfigurable optical add/drop multiplexer(MB-ROADM) for metropolitan networks. Results show -33.8 dB cross-talk, lossless and error-free transmission with average power penalties of 1.2 dB and 1.8 dB at 10-9 for C-band channels at 53 Gbps and for O-band at 25 Gbps, respectively.

W2A.101

On High-Power Optical Amplification in Hollow Core Fibers for Energy Efficiency and Network Throughput Maximization, *Giovanni Simone Sticca; Memedhe Ibrahimi; Nicola Di Cicco; Francesco Musumeci; Massimo Tornatore.*

We investigate how to optimally set the EDFA output power in Hollow Core Fiber (HCF) networks. We show that, using high-power amplification, HCF allows 2.4x increase in throughput and 52% decrease in transponders along with a 41% reduction in EDFAs power consumption per Tbps.

W2A.102

Spatio-Temporal Graph Attention Networks for Alarm Root Cause Recognition in Optical Transport Network, *Weijie Yang[1]; Chunyu Zhang[1]; Xunjie Jiang[2]; Yanlin Fan[2]; Zhongbo Bi[2]; Jiansheng Xiong[2]; Xue Xiao[1]; Min Zhang[1]; Danshi Wang[1]; [1]State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Posts and Telecommunications; [2]China Unicom Intelligent Network Innovation Centre.*

We propose a root alarm recognition scheme based on graph attention network, which can capture the spatio-temporal information of alarms. The F1-score for root alarm recognition in real backbone network is 0.9567, and the output spatio-temporal subgraph can provide interpretable support for recognition results.

W2A.103

Unsupervised Anomaly Detection and Localization with Gener-ative Adversarial Networks, *khouloud Abdelli[1]; Matteo Lonardi; Jurgen Gripp; samuel Olsson; Fabien Boitier; Patricia Layec; [1]Nokia Bell Labs.*

We propose a novel unsupervised anomaly detection approach using generative adversarial networks and SOP-derived spectrograms. Demonstrating remarkable efficacy, our method achieves over 97% accuracy on SOP datasets from both submarine and terrestrial fiber links, all achieved without the need for labelled data.

W2A.104

Maximising Throughput Through Demand-Aware Optical Network Growth, *Rasoul Sadeghi[1]; Robin Matzner[1]; Yi-Zhi Xu[2]; Alejandra Beghelli[1]; David Saad[3]; Polina Bayvel[1]; [1]University College London; [2]University of Electronic Science and Technology of China (UESTC); [3]Aston University.*

We investigate optical network growth by adding specific links to maximise throughput. Comparing message passing (MP) for combined routing and topology optimization with demand-weighted cost (DWC) approaches, we find that MP achieves maximum throughput in most of the over 100 networks analysed.

W2A.105

Experimental Investigation of Longitudinal Power Profile Estimation Accuracy in Fibre Links with Large Effective Core Area, *Minami Takahashi[1]; Takeo Sasai; Masanori Nakamura; Etsushi Yamazaki; [1]NTT Network Innovation Laboratories.*

We experimentally investigated the accuracy of longitudinal power profile estimation across fibres with different effective core areas. Despite weaker Kerr nonlinearity, G.654 fibres achieved accuracy comparable to a G.652.D fibre at respective optimal launch powers, with root-mean-square errors of 0.67 dB and 0.80 dB.

W2A.106

Optical Delay Interferometer System for the Measurement of Optical Phase Noise and Polarization Fluctuation, *Shiro Ryu; Meiji University.*

The system using an optical delay interferometer outputs a composite signal of phase noise and polarization fluctuation components. In this paper, we clarified the frequency characteristics of the system. We also succeeded in the separation of the composite signal into two components in transmission experiments.

W2A.107

Robust and Wide-range Frequency Dependent Crosstalk Calibration for High-speed Coherent Optical Transceiver, *Longquan Dai[1]; Songtao Chen[2]; Ziheng Zhang; Zicai Cao; Yifu Chen; Zhuofan Zhang; Rui Xue; Yaqin Wang; Shuchang Yao; Qi Yang; Mengfan Cheng; Deming Liu; Lei Deng; [1]Huazhong University of Science and Technology; [2]Fiberhome Telecommunication Technologies Co., LTD, Wuhan 430073, China.*

We demonstrate a robust, accurate, and wide-range frequency-dependent crosstalk calibration method for coherent optical transceivers. Without any additional instrument, the calibration error is within 2 dB under 20 dB crosstalk

ripple-fluctuation, and the calibration range can reach -40 dB to -5 dB which is the maximum reported so far.

W2A.108

A Transient Fault Diagnosis Framework for Optical Link Flaps Identification and Localization, *Qingyi Guo; Yang Lan; Choloong Hahn; Junho Chang; Xuefeng Tang; Wing Chau Ng; Zhuhong Zhang; Zhiping Jiang; Huawei Technologies Canada, Co., LTD.*

We propose a framework for dynamic fault diagnosis based on receiver DSP, and demonstrate its use in various link failure scenarios such as fiber bending, patch cord disconnecting, channel add/drop and fast SOP change, with commercial cards in an 8-span optical system.

SC7: Access, Indoor and Short-Reach Systems for Data Centres and Mobile Networks

W2A.109

Demonstration of 200G Coherent DSCM-based Bidirectional Transmission in All-Optical Metro-Access Integrated Network , *Yongzhu Hu; An Yan; Guoqiang Li; Wangwei Shen; Sizhe Xing; Junhao Zhao; Ziwei Li; Chao Shen; Jianyang Shi; Nan Chi; Junwen Zhang.*

We experimentally demonstrate the feasibility of digital subcarrier multiplexing (DSCM)-based coherent bidirectional transmission in the all-optical metro-access integrated network (MAIN) using 12.5 GBaud/SC × 4SCs DP-QPSK signal, achieving 40.6 dBm power budget and > 35 dB dynamic range.

W2A.110

Single-Lane 225 Gbit/s PAM-8 Transmission over 50 km with >29 dB Power Budget for Long-Reach PONs Using a Quantum-Dot SOA, *Ahmed Galib Reza[1]; Lakshmi Narayanan Venkatasubramani[1]; Vladimir S. Mikhrin[2]; Alexey Gubenko[2]; Liam Barry[1]; [1]Dublin City University; [2]Innolume GmbH.*

We demonstrate single-lane 225 Gbit/s PAM-8 O-band transmission over a 50 km SMF for 30 GHz bandwidth-limited long-reach PONs. We report a power budget of about 29.4 dB at the SD-FEC limit of 2×10^-2 by employing a high-gain InAs/InGaAs quantum-dot SOA and Volterra nonlinear equalizer.

W2A.111

Nanosecond Scale Wavelength Switching of High Capacity Coherent Transmission at 720 Gbit/s Based on a Monolithic InP Tunable Laser, *Marcos Troncoso-Costas[1]; Lakshmi Narayanan Venkatasubramani[2]; Caolán Murphy[3]; Gaurav Jain[3]; Yiming Li[4]; Mohammed Patel[4]; M. Deseada Gutierrez-Pascual[3]; Shane Duggan[3]; Luc Augustin[5]; Stefanos Andreou[5]; Frank Smyth[3]; Andrew Ellis[4]; Francisco Diaz-Otero[6]; Liam Barry[2]; [1]Dublin City University, University of Vigo; [2]Dublin City University; [3]Pilot Photonics Ltd.; [4]Aston University, Aston Institute of Photonics Technologies; [5]Smart Photonics; [6]University of Vigo.*

Using an integrated tunable laser we show sub-fJ/bit switching and record settling times for high symbol rate high-order coherent systems. Achievable information rates of 7.9 bit/symbol were obtained after < 20 ns for 4 different wavelengths at 90 GBaud dual polarisation 16QAM.

W2A.112

Demonstration of a Hybrid Fiber/FSO/mmWave Transport for 6G Robust Backhauling, *Evrydiki Kyriazi[1]; Panagiotis Toumasis[1]; George Brestas[1]; Argyris Ntanos[1]; Aristeidis Stathis[1]; Giannis Poulopoulos[1]; Giannis Giannoulis[1]; Dimitris Diakakis[2]; Ioanna Mesogiti[2]; Eleni Theodoropoulou[2]; George Limperopoulos[2]; Janez Sterle[3]; Dimitris Apostolopoulos[1]; Hercules Avramopoulos[1]; [1]School of Electrical & Computer Engineering, National Technical University of Athens; [2]OTE Hellenic Telecommunications Organization S.A., Athens; [3]Internet Institute LTD, Ljubljana, Slovenia.*

A hybrid 6G-backhaul solution combining fiber, FSO, and mmWave technologies is demonstrated. Results showed dynamic flexibility between three links through a WSS, enhancing availability and supporting high-capacity up to 80 Gbps, and low-latency applications, via a portable 5GC solution.

W2A.113

Ultimate low-latency and low-footprint 50G PAM4 Fronthaul Utilizing AR-HCF and CDR-based SFP56 Module, *Dawei Ge[1]; Yifan Xiong[2]; Siyuan Liu[3]; Wei Ding[2]; Dong Wang[1]; Baoluo Yan[4]; Rui Zhang[4]; Shoufei Gao[2]; Yingying Wang[5]; Dechao Zhang[1]; Han Li[1]; Zhangyuan Chen[3]; [1]China Mobile Research Institute; [2]Jinan University; [3]Peking University; [4]ZTE Corp.; [5]LinFiber Tech. (NanTong) Co.,Ltd.*

Employing ultimate-low latency anti-resonant hollow-core fibre and high-performance CDR in 50G SFP56 modules, we showcase a pioneering 53.1252 Gbps PAM4 fronthaul experiment. It achieves a notable 30.42% latency reduction and 24.99% footprint reduction compared to SMF+DSP-based module system.

W2A.114

High-efficiency All-Digital Real-time Delta-sigma Transmitter for Mobile Fronthaul , *Linsheng Zhong[1]; Yizhou Wang[1]; Yuanxiang Wang[1]; Ruiyan Zhao; Xueyuan Ao[1]; Sunningchang Zhang[1]; Yang Zou[1]; Xiaoxiao Dai[1]; Mengfan Cheng[1]; Lei Deng[1]; Deming Liu[1]; Suyi Wang; Yaqin Wang; Songtao Chen; Zhiwen Fan; Qi Yang[1]; [1]School of Optical and Electronic Information, Huazhong University of Science and Technology.*

A 25-GSa/s high-efficiency all-digital real-time 4-th order DSM transmitter with a record conversion efficiency of 37.5% was realized in an FPGA. A 9.375 Gbps 64-QAM signal with the center frequency of 6.25 GHz is transmitted over 20-km SSMF at 1310 nm, demonstrating an EVM of 4.1%.

W2A.115

Coexistence Options and Performance Analysis of 100 Gbit/s Coherent PON in Brownfield DWDM Networks, *Gabriele Di Rosa[1]; Martin Kuipers[2]; Jim Zou[1]; Ognjen Jovanovic[1]; Jörg-Peter Elbers[1]; [1]Adtran Networks SE; [2]Adtran GmbH.*

We study system architectures for the coexistence of future coherent PON and DWDM networks. Considering deployed optical filters, we observe filtering penalties < 1 dB at a laser frequency accuracy < 12 GHz when using a cost-effective architecture.

W2A.116

Up to 300-Gb/s Flexible-Rate Coherent PON with Ultra-Simple Polarization-Diverse Transceiver in Downstream, *Xiansong Fang[1]; Yixiao Zhu[2]; Xiang Cai[1]; Xingang Huang[3]; Weisheng Hu[4]; Fan Zhang[1]; [1]Peking University; [2]Shanghai Jiao Tong University; [3]ZTE Corporation; [4]Peng Cheng Laboratory.*

We propose and experimentally demonstrate an ultra-simple polarization-diverse transceiver architecture for low-cost, multi-format, and flexible-rate coherent PON. With residual carrier modulation-based phase recovery and conjugate combination, we demonstrate 100 to 300 Gbps access using 4/16/64-QAM in FLCS-CPON with extended frequency offset tolerance of 45 GHz.

W2A.117

Demonstration of a Highly Reliable Si-Photonics-Based In-Vehicle Optical Network (SiPhON) for Autonomous Driving, *Hiroyuki Tsuda[1]; Ryogo Kubo[1]; Masayuki Iwase[2]; Masahito Morimoto[2]; Keisuke Kawahara[2]; Daisuke Noguchi[2]; Yasushi Amamiya[3]; Yongwi Kim[3]; Yoshiaki Nakano[4]; Takuo Tanemura[4]; Masayuki Murata[5]; Shinichi Arakawa[5]; [1]Keio University; [2]Furukawa Electric Co., Ltd.; [3]MegaChips Corporation; [4]The University of Tokyo; [5]Osaka University.*

We have demonstrated a novel optical network (SiPhON) suitable for self-driving, where a master and four gateways are connected in a double ring topology. The raw 4k-camera data is transmitted through the network to an AI processor, which successfully recognizes the road signs and obstacles.

W2A.118

Energy Consumption Comparison of IM/DD, Coherent, and Kerr-comb-WDM Architectures for Intra-Datacenter Applications, *Dayu Shi; Puzhen Yuan; Haojie Zhu; William Shieh; Westlake University, China.*

This paper models and compares the energy consumption in intra-datacenter scenarios for SDM-based IM/DD, OFDM-based coherent, and Kerr-comb-based WDM transceivers to explore the most energy-efficient architecture for accommodating increasing datarates.

W2A.119

Adder Convolutional Neural Network Equalizer for RRM-based O-band Optical Amplification-free 200 GBd OOK Transmission, *Yevhenii Osadchuk[1]; Dan Li[2]; Armands Ostrovskis[3]; Toms Salgals[3]; Kristaps Rubuls[3]; Sandis Spolitis[3]; Vjaceslavs Bobrovs[3]; Darko Zibar[1]; Francesco Da Ros[1]; Xiaodan Pang[4]; Oskars Ozolins[5];*

[1] Technical University of Denmark (DTU); [2] Department of Applied Physics, KTH Royal Institute of Technology; [3] Riga Technical University; [4] Department of Applied Physics, KTH Royal Institute of Technology and RISE Research Institutes of Sweden and Riga Technical University; [5] Riga Technical University and RISE Research Institutes of Sweden and Department of Applied Physics, KTH Royal Institute of Technology.

We experimentally investigate the performance of adder convolutional neural network (AdderCNN) equalization for ring modulator-based 200 GBd OOK transmission. Replacing multiplications by additions, AdderCNN outperforms the decision-feedback equalizer by 0.8 dB of RoP in 500 m transmission, showing potential for hardware implementation avoiding feedback connections.

W2A.120

Real-time Interoperability Demonstration of Silicon-Photonics-Based OSFP 800GBASE-DR8 LPO and LRO Transceivers over 10 km Fiber Transmission, *Xia Sheng; Hao Liu; Linchun Li; Chunfu Wu; Xishuo Wang; Kai Lv; Anxu Zhang; Yuyang Liu; Lipeng Feng; Minsheng Gao; Haitao Zeng; Xiaoli Huo; Jujie Li.*

We have experimentally demonstrated the performance of the silicon-photonics-based 800GBASE-DR8 OSFP LPO and LRO transceivers. The real-time transmission and interoperability verification are carried out for the first time in three scenarios including B2B, 1 km, and 10 km fiber transmission under various ambient temperatures.

W2A.121

Experimental Assessments of Clock Distribution-enabled Picoseconds Time Synchronization for Optical Switching Networks, *Yisong Zhao[1]; Daohang Dang MdB[1]; Bingli Guo[1]; Changsheng Yang[1]; Yuanzhi Guo[1]; He Zhang[2]; Wenzhe Li[3]; Buzheng Wei[2]; Guojun Yuan[3]; Shikui Shen[2]; Shanguo Huang[1]; Xuwei Xue[1]; [1] State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Posts and Telecommunications (BUPT); [2] China Unicom Research Institute; [3] Institute of Computing Technology, Chinese Academy of Sciences.*

A clock distribution enhanced time synchronization scheme is proposed and experimentally demonstrated for optical packet switching networks with timeslot alignment requirements. This scheme implements 148 ps root-mean-square synchronization accuracy and 3.01 ps@10000 s long-term stability, which shortens the protection interval between timeslots to 5.8 ns.

W2A.122

Field Trial of Flex-Rate PON with Adjustable Power Splitters for ODN Throughput Optimization and Fault Recovery, *Michael Straub[1]; Eric ten Have[2]; Christoph Schweikert[3]; Christoph Füllner[1]; Agnivo Gosai[4]; William J. Miller[4]; Oberon Deichmann[4]; Peter Wigley[4]; Rene Bonk[1]; [1] Nokia Bell Labs; [2] Corning Optical Communications GmbH & Co. KG,; [3] TelemaxX Telekommunikations GmbH,; [4] Corning Incorporated.*

The concept of combining flexible-rate passive optical networks with power-adjustable splitters was experimentally verified over field fibers. Various use cases were demonstrated and analyzed for enhancing user throughput and fault recovery to exploit flexibility in optical access networks.

W2A.123

First Real-Time Softwarization of Flexible-Rate Coherent DSP Enabling Converged Heterogeneous PON Service, *Sangyeup Kim[1]; Takahiro Suzuki; Jun-ichi Kani; Tomoaki Yoshida; [1] NTT.*

We demonstrate the first GPU platform to softwarize flexible-rate coherent DSP; it can receive 2-, 4-, 8- and 16-PSK frames by changing the coding description. Receiver sensitivity is measured in real-time for Gbaud-class rate frames, with LDPC thresholds of −50.5, −46.5, −40.5 and −33.5 dBm, respectively.

W2A.124

Power Consumption and CO2 Emission Optimization for Future Passive Optical Networks, *Aude Rodriguez; Fabienne Saliou; Stéphane Le Huérou; Pômme Broggi; Michal Szymanski; Gaël Simon; Jérémy Potet; Philippe Chanclou; Orange.*

We study the Passive Optical Network (PON) electric power consumption sources and its existing and non-existing energy saving methods. Forecasts covers the next 20 years and different split ratios. For his duration, a carbon footprint is also estimated.

W2A.125

Demonstration of 12,288 × 12,288 Optical Circuit Switch with 17.2 Pbps Throughput for Intra-datacentre Networks, *Takuma Kuno; Yojiro Mori; Hiroshi Hasegawa; Nagoya University.*

We propose a novel three-stage optical switch architecture to realize high-port-count optical circuit switches for intra-datacentre networks. Numerical simulations show the scalability of the proposed switch architecture. Experiments successfully confirm the 17.2 Pbps performance of a 12,288 × 12,288 switch prototype.

W2A.126

Optical-amplification-free 212.5 Gbaud/λ On-Off Keying Link Operating Error-free using TFLN MZM Modulator, *Armands Ostrovskis[1]; Said El-Busaidy[2]; Toms Salgals[1]; Michael Koenigsmann[2]; Kristaps Rubuls[1]; Benjamin Krüger[2]; Arvids Sedulis[1]; Fabio Pittalà[2]; Lu Zhang[3]; Xianbin Yu[3]; Rafael Puerta[4]; Sandis Spolitis[1]; Richard Schatz[5]; Katia Gallo[5]; Hadrien Louchet[2]; Robert Jahn[2]; Kazuo Yamaguchi[2]; Markus Gruen[2]; Vjaceslavs Bobrovs[1]; Marcel Zeiler[2]; Xiaodan Pang[6]; Oskars Ozolins[7]; [1] Riga Technical University, Latvia; [2] Keysight Technologies Deutschland GmbH; [3] Zhejiang University; [4] Ericsson Research, Ericsson AB, Sweden; [5] KTH Royal Institue of Technology; [6] Department of Applied Physics, KTH Royal Institute of Technology and RISE Research Institutes of Sweden and Riga Technical University; [7] Riga Technical University and RISE Research Institutes of Sweden and Department of Applied Physics, KTH Royal Institute of Technology.*

We demonstrate 200/212.5/224 Gbaud OOK optical interconnect based on TFLN MZM modulator for computing applications. We achieve error-free performance for 200/212.5 Gbaud OOK after transmission over 500 meters of SMF. The transmitter can enable error-free transmission with low-complexity DSP and without FEC.

W2A.127

Hardware- and DSP-Efficient 200-Gb/s Coherent PON Insensitive to Frequency Offset and Phase Noise for Burst Mode Upstream, *Guangying Yang[1]; Yixiao Zhu[1]; Xiansong Fang[2]; Ziheng Zhang[1]; Lina Man[1]; Weisheng Hu[1]; Fan Zhang[2]; Zhuang Ma[3]; Xingang Huang[3]; [1] Shanghai Jiao Tong University; [2] Peking University; [3] ZTE Corporation.*

We propose a hardware- and DSP-efficient simplified coherent PON insensitive to frequency offset and phase noise leveraging unipolar PAM-M modulation. We demonstrate a 40-ns preamble for burst mode detection. Power budgets of 31.8 dB and 42.8 dB are achieved after 25-km transmission at 200-Gb/s and 100-Gb/s, respectively.

W2A.128

SDM-DSCM Transmission over Weakly-Coupled 7-Core Few-Mode Fibre with Flexible Multidimensional Subcarrier Allocation for Cost-Effective Spine-Leaf Datacentre Network, *Yu Yang; Gang Qiao; Jiaxin Liu; Baolong Zhu; Honglin Ji; Mingqing Zuo; Jinglong Zhu; Chengbin Long; Zhaopeng Xu; Tonghui Ji; Qi Wu; Shangcheng Wang; Lulu Liu; Lei Shen; Jie Luo; Weisheng Hu; Juhao Li.*

We first propose an SDM-DSCM optical network with flexible multidimensional subcarrier allocation and experimentally achieve 8-subcarrier 14×200-Gbps aggregate capacity over 10-km weakly-coupled 7-core FMF and 10-km single-core FMF with 42-dB power budget, which can support 16 and 64 servers in spine and leaf layer.

W2A.129

800G Dynamic Subcarrier Allocation for Reconfigurable Point-to-Multi-Point Networks, *Jacqueline Sime[1]; Chris Fludger[1]; Thomas Duthel; Bo Liu; Antonio Napoli; Amir Rashidinejad; Aditya Kakkar; Vince Dominic; Parmijit Samra; Han Sun; Azmina Somani; Dave Welch; [1] Infinera GmbH.*

We demonstrate a real-time dynamically reconfigurable 800G point-to-multi-point network using 32x25 Gbit/s digital subcarriers. Upstream and downstream frequency locking is used with two 400G hub transceivers to create a 32 subcarrier continuum with 360 MHz guard-bands and channel reallocation in under 25 ms.

W2A.130

Impact of Alien Wavelength from Visual Fault Locators (red light) on G- & XG(S)-PON Upstream transmissions, *Philippe Chanclou; Stéphane Le Huérou; Fabienne Saliou; Gaël Simon; Jérémy Potet; Orange.*

We characterize the impact of visual fault location at 650 nm, on the upstream flow of several generations of passive optical network in function of optical budget. This

alien behaviour could impact customers sharing the infrastructure.

SC8: Sensing and Microwave Photonics

W2A.131

Forward-Transmission Distributed Vibration Sensing with Frequency Shift and Time Delay using Single Fiber, *Guo Zhu[1]; Fei Liu; Xu Yang; Xian Zhou; [1]University of Science and Technology Beijing (USTB).*

This work proposes a single-fiber-based forward-transmission distributed vibration sensing scheme. Proof-of-concept experiment demonstrates the capability to accurately localize vibration events along fibers exceeding 120 km without repeaters. It features include a 14% improvement in position accuracy and significant saving in optical fiber.

W2A.132

Coherent φ-OTDR using Linear Frequency Modulated Pulse with Time Gated High Saturation Power SOA Amplification, *Conor Russell; Cleitus Antony; Paul Townsend; Tyndall National Institute.*

We demonstrate a coherent φ-OTDR system using high saturation power SOA amplification and linear frequency modulated pulse compression achieving 90 pε/√Hz sensitivity at a distance of 25 km and a spatial resolution of 10 m.

W2A.133

Hybrid-Integrated Dual-Wavelength Laser Frequency Locked to an Integrated Coil-Resonator for Optical Fiber Sensing, *Mohamad Idjadi[1]; Stefano Grillanda[1]; Nicolas Fontaine[1]; Kaikai Liu[2]; Kwangwoong Kim[1]; Tzu-Yung Huang[1]; Cristian Bolle[1]; Rose Kopf[1]; Mark Cappuzzo[1]; Daniel J. Blumenthal[2]; [1]Nokia Bell Labs; [2]University of California – Santa Barbara.*

We demonstrate dual-frequency stabilization of a hybrid-integrated multi-channel laser to an integrated high Q-factor silicon nitride (SiN) coil resonator with more than 40 dB frequency noise suppression. The frequency locked channels are utilized for a proof-of-concept fiber sensing experiment.

W2A.134

A 2.5 – 2.7 GHz Frequency-tunable Band-pass Delta-sigma Modulator in a 0.25 µm SiGe BiCMOS for Fiber-Wireless Digital Distributed Antenna Systems, *Seunghyun Jang; Electronics & Telecommunications Research Institute (ETRI).*

This paper presents 2.5 GHz–2.7 GHz band-pass DSM in SiGe BiCMOS for fiber-wireless DAS systems. Utilizing multi-feedback-coefficient controls and frequency-tunable resonators, the BPDSM ensures modulator stability with a low fs. Experimental results confirm consistent performance across a wide frequency range and suggest potential for lower transmission rates.

W2A.135

2000 Fibre Bragg Gratings Interrogated with Correlation-Aided Optical Time Domain Reflectometry with Direct Detection , *Vishal Chandraprakash Rai; Florian Azendorf.*

We investigate a low-cost direct detection correlation-aided optical time domain reflectometry approach for fibre sensing. The approach was verified by interrogating 2000 fibre gratings in 100 meters of standard single-mode fibre with a spacing of 5 cm over a 20 K temperature range

W2A.136

Threat Classification on Deployed Optical Networks Using MIMO Digital Fiber Sensing, Wavelets, and Machine Learning, *Khouloud Abdelli[1]; Henrique Pavani Pereira Ramos[2]; Christian Dorize[2]; Sterenn Guerrier[2]; Haik Mardoyan[2]; Patricia Layec[2]; Jeremie Renaudier[2]; [1]Nokia Bell Labs, Germany; [2]Nokia Bell Labs, France.*

We demonstrate mechanical threats classification including jackhammers and excavators, leveraging wavelet transform of MIMO-DFS output data across a 57-km operational network link. Our machine learning framework incorporates transfer learning and shows 93% classification accuracy from field data, with benefits for optical network supervision.

W2A.137

Fast-convergence Physics-informed Correlation-enhanced Neural Network in DML-DD Link for Analog RoF Fronthaul, *Yikun Zhang; Yixiao Zhu; lina man; dangui huang; qunbi zhuge; weisheng hu.*

We propose a physics-informed correlation-enhanced neural network (CorrNet) for composite second-order distortion compensation in C-band DML-DD link. For 10-GHz 64-QAM signal A-RoF transmission over 15-km SSMF, CorrNet achieves 1-dB ROP sensitivity improvement compared with Volterra-based feedforward equalizer, and 72.7% epochs reduction compared with fully-connected NN.

W2A.138

300-GHz-band Frequency Hopping with a Single Tunable Laser Diode for Secure THz Communication, *Naoto Masutomi[1]; Shenghong Ye[1]; Bo Li[1]; Ryota Kaide[1]; Ming Che[1]; Yuya Mikami[1]; Yuta Ueda[2]; Kazutoshi Kato[1]; [1]Graduate School of Information Science and Electrical Engineering, Kyushu University; [2]NTT Device Technology Laboratories, NTT Corporation.*

The novel technique of generating THz waves using photomixing with a single tunable laser diode was applied to the frequency-hopping spread spectrum (FHSS) system for secure THz communication. Experimental results successfully demonstrated the 300-GHz-band FHSS system with 200-ns-interval frequency hopping.

W2A.139

Demonstration of Beyond 100G Fiber–Radio–Fiber Bridge at W-Band Based on Full Photonic Up- and Down-Conversions, *Boyu Dong; Yinjun Liu; Dianyuan Ping; Junhao Zhao; Zhongya Li; Yaxuan Li; Ouhan Huang; Junlian Jia; Jianyang Shi; Nan Chi; Junwen Zhang.*

We demonstrated a fiber-radio-fiber bridge operating at the W-Band, employing full photonic conver-sions with high-speed PD and TFLN-MZM. Our system achieved successful transmission of 120-Gbps 16-QAM and 130-Gbps 32-QAM through 10-km SSMF, 1-m wireless link and an additional 5-km SSMF.

W2A.140

First Demonstration of Switched RoF Concept Using MEMS Optical Switch and High-linearity Installed Hollow Core Fiber Cables, *Ryuta Murakami; Kojiro Nishimura; Satoru Okamoto; Yoshihiko Uematsu; Takashi Kurimoto; Naoaki Yamanaka; Keio University.*

We have proposed Switched RoF which inserted optical switch in the middle of A-RoF transmission for beyond 5G mobile front haul. Feasibility of adopting MEMS optical switch with installed hollow core fiber and no QoE degradation by handover using optical switching was confirmed.

W2A.141

A Novel Widely Tunable Optoelectronic Oscillator Integrated on Thin Film Lithium Niobate Platform, *Rui Ma[1]; Zijun Huang[1]; Peng Hao[2]; X. Steve Yao[2]; Xinlun Cai[1]; [1]State Key Laboratory of Optoelectronic Materials and Technologies, School of Electronics and Information Technology, Sun Yat-sen University; [2]Photonics Information Innovation Center and Hebei Provincial Center for Optical Sensing, College of Physics Science and Technology, Hebei University.*

A novel widely tunable photonic integrated thin film lithium niobate optoelectronic oscillator is firstly demonstrated, realizing by integrating a Mach-Zehnder interferometer, a Mach-Zehnder modulator and an add-drop micro-ring resonator, with frequencies tuned from 20 to 35 GHz and the phase noise of -85 dBc/Hz@10 kHz.

W2A.142

Long-range FMCW LiDAR employing phase-noise compensation and optical frequency comb, *Takahiro Nagata[1]; Muhammad Suhail Ahmad Sharifuddin[1]; Yuto Kusaka[1]; Chao Zhang[2]; Fumihiko Ito[1]; Atsushi Nakamura[3]; Yusuke Koshikiya[3]; [1]Graduate School of Natural Science and Technology, Shimane University; [2]Interdisciplinary Faculty of Science and Engineering, Shimane University; [3]Access Network Service Systems Laboratories, NTT Corporation.*

We propose a frequency-modulated continuous-wave LiDAR employing phase-noise compensation and a wavelength-swept optical frequency comb. Ranging of 3 km in the incoherent region with a depth accuracy of around 18.9 cm was successfully performed, where the acquired 0th-order intermediate frequency lies outside the receiver bandwidth.

W2A.143

Photonic Continuous-Wave Terahertz Computed-Tomography for Non-Destructive Detection, *Zuomin Yang; Lu Zhang; Zhidong Lyu; Xing Fang; Xianbin Yu; Zhejiang University.*

We propose a photonic terahertz continuous-wave computed-tomography (CT) system based on an optical frequency comb and specialized imaging algorithms, achieving non-destructive CT detection with a 0.5 mm error and enhanced image quality at 300 GHz.

W2A.144

>11-dB SNR and 3-dB Sensitivity Enhancement for Fronthaul with Delta-Sigma Modulation and Equal Length Level Conversion, *Zijun Yan; Yixiao Zhu; Gengming Lin; Yikun Zhang; Qunbi Zhuge; Weisheng Hu.*

We propose an equal length level conversion scheme to convert delta-sigma modulation (DSM) output from 6-level to 4-level with approximately equivalent entropy. Compared to 4-level DSM systems, our proposed scheme achieves 11.6-dB gain in wireless signal SNR and 3.0-dB enhancement in received optical power sensitivity.

W2A.145

Joint Communication and Optical Multipath Interference Location for RoF Mobile Fronthaul Enabled by Digital LFM Carrier, *Chuanming Huang[1]; Rui Xue[1]; Mengfan Cheng[2]; Qi Yang[2]; Deming Liu[1]; Lei Deng[2]; [1]School of Optical and Electronic Information, Huazhong University of Science and Technology; [2]School of Optical and Electronic Information, Huazhong University of Science and Technology; Shenzhen Huazhong University of Sci. and Technol. Research Institute.*

We experimentally demonstrate a joint optical multipath interference (MPI) location and millimetre-wave communication system based on the digital linear frequency modulation carrier. 9.78 cm range resolution MPI reflection length location and 20 Gb/s 16QAM at 30 GHz transmission over 10-km SSMF are achieved with < 1 dB power penalty.

W2A.146

Fully Coherent Mobile Fronthaul Transmission with a Very Large Loss Budget by Using Injection-Locked Heterodyne Detection , *Keisuke Kasai[1]; Koichi Shirahata[1]; Masato Yoshida[1]; Toshihiko Hirooka[1]; Masataka Nakazawa[1]; Toshiyuki Kobayashi[2]; Uichiro Azuma[2]; [1]Tohoku University; [2]Nihon Dengyo Kosaku Co., Ltd.*

We demonstrate that injection-locked-heterodyne-detection (IL-HD) has a 9 dB larger loss budget than self-heterodyne detection in a fully coherent transmission. With IL-HD, a 16 Gbit/s-256 QAM signal was transmitted over a 10 km-SMF and 20 m wirelessly at 28 GHz-IF.

W2A.147

Demonstration of Power-Over-Hollow-Core-Fiber With 5G NR Signals for Optically Powered Remote Antenna Units, *Souya Sugiura[1]; Kai Murakami[1]; Yuki Gomi[1]; Takeshi Takagi[2]; Kazunori Mukasa[2]; Motoharu Matsuura[3]; [1]The University of Electro-Communications (UEC); [2]Furukawa Electric Co., Ltd.; [3]The Universisity of Electro-Communications / Keio University.*

We demonstrate power-over-hollow-core-fiber transmission with 5G NR signals. Due to the ultra-low-nonlinearity, 5G NR signal and high-power feed light can be simultaneously transmitted over a single fiber. We successfully achieve good signal transmission characteristics and optically power a downlink photodiode module without external power supply.

W2A.148

High Sensitivity Biochemical Sensors Based on a Mach-Zehnder Interferometer with a Slot Bus Waveguide and Double Slot Hybrid Plasmonic Waveguide, *Simeng Zhu; Weiqing Cheng; Bocheng Yuan; Yizhe Fan; Yiming Sun; Ahmet Seckin Hezarfen; John Marsh; Lianping Hou.*

We present compact and highly sensitive biochemical sensors utilizing a Mach-Zehnder interferometer with a slot bus waveguide and double slot hybrid plasmonic waveguide, achieving an experimental sensitivity of 908 nm/RIU.

W2A.149

Tunable Dual-band Microwave Photonic Filters Covering 37.2 GHz to 186.1 GHz Utilizing Chirped Sampled Gratings, *Simeng Zhu; Bocheng Yuan; Yizhe Fan; Yiming Sun; John Marsh; Lianping Hou.*

We present a microwave photonic filter featuring dual independently tunable passbands. Constructed with linearly chirped sampled Bragg gratings incorporating two equivalent phase shifts, supplemented by microheaters, this filter exhibits a tunable frequency range spanning from 37.2 GHz to 186.1 .

W2A.150

High-Precision Phase Measurement with Rydberg Atom- Induced Effects for Phase-Modulated Signal Reception, *Hyun Joon Lee[1]; Jung Hoon Oh[1]; Jang-Yeol Kim; Key-Seok Yoon[1]; In-Kui Cho[1]; [1]Electronics and Telecommunications Research Institute.*

Spectroscopic techniques using Rydberg atoms allow highly precise phase measurement of a radio-frequency (RF) field. In this study, we utilize this atom-based method to measure RF field phase shifts. The results show a measurement accuracy of 1.5 degrees, with 10% a deviation from theoretical predictions.

W2A.151

Low-Noise Hybrid InP/Si3N4 Comb Laser Enabling Sub-Hz Linewidth Fully Integrated Microwave Photonic Generator, *Jiachen Li[1]; Liuyan Han[1]; Dong Wang[1]; Dechao Zhang[1]; Han Li[1]; Minghua Chen[2]; [1]Department of Fundamental Network Technology, China Mobile Research Institute; [2]Department of Electronic Engineering, Tsinghua University.*

We demonstrate a Ku-band fully integrated microwave photonic generator (FI-MWPG) prototype using a novel low-noise hybrid InP/Si3N4 comb laser based on the self-injection-locking mechanism. The FI-MWPG experimentally exhibits an ultra-narrow RF Lorentzian linewidth of 0.8 Hz and a stable frequency of only 16 kHz@5 mins.

W2A.152

Current Leakage Monitoring and Localization Based on Polari-zation Sensing Integrated in Communication Transceiver, *Yingmei Pan; Tao Zeng[1]; Te Ke; Ziqing Liu; Shan Hu; Wei Li; Ming Luo; [1]China information and communication technology Group Corporation.*

We demonstrate a sensing technique to monitor 50 Hz leakage AC current using a coherent transceiver, which involves estimating the polarization rotation induced by the Faraday effect and locating the leakage current source by comparing the sensing signal phase at both ends of the fibre.

SC9: Free-Space Optics and Optical Wireless Technologies

W2A.153

Coherent Terrestrial Free-Space Optical Communications using Optical and Electrical Automatic Amplifier Gain Control for Mitigation of Atmospheric Turbulence-Induced Fading, *Vincent van Vliet; Menno van den Hout; Eduward Tangdiongga; Chigo Okonkwo; Eindhoven Hendrik Casimir Institute, Eindhoven University of Technology, Eindhoven, The Netherlands.*

The probability of operating a 5 km 25 GBd DP-16-QAM terrestrial FSO link with strong emulated turbulence-induced fading below 190 Gb/s GMI-based data rate is reduced by more than one order of magnitude by supplementing optical pre-amplification with automatic-gain-controlled electrical amplification.

W2A.154

High-speed and robust underwater wireless optical communi-cation using RGB Airy beam transmitter, *Junhui Hu[1]; Zeyuan Guo[2]; Shumin Xiao[2]; Shaohua Yu[3]; Nan Chi[1]; Chao Shen[1]; [1]Key Lab of EMW Information (MoE), Fudan University, Shanghai 200433, China; [2]Harbin Institute of Technology, Shenzhen; [3]Pengcheng Lab.*

A laser transmitter utilizing a high-efficient full-color Airy beam metasurface over a wide band (440–640 nm) for stable underwater communication has been demonstrated. The 20 Gbps RGB UWOC link enables error-free 4K video transmission in disturbed water channels.

W2A.155

Analog-Digital Mixed Laser Frequency Tracking-Lock for Space Based communication Arbitrary Doppler-Shift compensation, *Fang Wei[1]; Weijie Ren; Jianfeng Sun; Zhichao Qu; Haiwen Cai; Yi Yan; Quan Li; [1]Shanghai Optoelectronics Science and Technology Innovation Center.*

An arbitrary frequency difference locking method for LOL is realized by coarse thermal frequency tuning and fine frequency control based on IQ modulator. We experimentally demonstrate the frequency lock of the oscillator laser to the to the carrier of modulated signals.

W2A.156

Optical Wireless Channel Measurements using a Visible Light Sounder, *Abderrahmen Trichili; Grahame Faulkner; Dominic O'Brien; University of Oxford.*

Optical wireless communication channels lack proper measurements. Here, we present the design of a visible light channel sounder composed of a highly sensitive silicon photomultiplier. Initial calibration channel measurements conducted in an engineering setup are reported.

W2A.157

Separation of the Control and Payload Signals by Two-Layer Intensity Modulation to Coordinate Multiple OWC Cells, *Jiun-Yu Sung; Eduward Tangdiongga; Ton Koonen.*

OWC routers should support data flow management. This causes synchronization issues for multi-cell coordination. Two-layer intensity modulation separates the control and payload signals; therefore, data flows can be centrally managed. Data rate of 9.6 Gb/s (payload) and 8.33 Mb/s (control) is demonstrated with1.7-m OWC transmission.

W2A.158

Enhancing IM-DD MDM FSO Systems Through Deep Learning-Based Turbulence Prediction, *Kuo Wang[1]; Mikael Mazur[2]; Martin Lavery[3]; [1]University of Glasgow; [2]Nokia Bell Labs; [3]University of Glasgow.*

This paper presents a method that utilizes deep learning to evaluate sequential crosstalk matrices with IM-DD, predicting turbulence intensity and the speed of its shifts. This technique opens the opportunity for environmentally reactive free-space communication systems for optimising link stability.

W2A.159

Demonstration of High-Sensitivity Indoor Optical Wireless Communications Using Carrier-Assisted Differential Detection, *Jianghao Li; Junyu Wu; Honglin Ji; William Shieh.*

We propose carrier-assisted differential detection for indoor optical wireless communications to enable the recovery of double sideband complex-valued signals without LO lasers. Experimental results show a successful 50-Gb/s OFDM signal transmission over 7.5-m optical wireless link at the minimum ROP of ~ -23 dBm.

W2A.160

Beam-Forming and -Steering in Optical Wireless Communica-tion using Piezoelectric Actuators and Micro-Lenses, *Eduardo Muller; Yuchen Song; Ton Koonen; Eduward Tangdiongga; Eindhoven University of Technology.*

We demonstrated significant improvements of the beam steering in a OWC system, with the use silicon micro-lenses. Achieving angles of 51.3° horizontally and 22.4° vertically, at 10 Gbps data rate, by moving the light source, using piezo-electric actuators, on the focal plane of a lens.

W2A.161

Interference-Tolerant Duobinary-Coded Time-Domain Hybrid PAM with Adaptive Bitrate and Key for Flexible and Secure VLC, *Hodaka Amano[1]; Fumiya Kobori[1]; Ayumu Kariya[1]; Keita Tanaka[1]; Keiji Shimada[1]; Reika Suketomo[1]; Kiichiro Kuwahara[1]; Tomotaka Kimura[2]; Eduward Tangdiongga[3]; Takahiro Kodama[1]; [1]Kagawa University; [2]Doshisha University; [3]Eindhoven University of Technology.*

We experimentally demonstrated a 15% increase in throughput by bandwidth compression with duobinary coding for time-domain hybrid PAM signals, reducing inter-symbol interference of PAM2 and PAM4. Moreover, advanced encryption standard for a highly secure VLC system, varying keys per symbol block, demonstrated power penalty-free operation.

W2A.162

All-Fiber Wavelength-Tuned Beam Steering for Indoor Optical Wireless Communications, *Xinda Yan[1]; Yiwen Zhang[2]; Chia Wei Hsu[2]; Ton Koonen[1]; Eduward Tangdiongga[1]; [1]Eindhoven University of Technology; [2]University of Southern California.*

The output speckle pattern of a MMF patch cord is magnified by a cylindrical lens, and by wavelength tuning horizontal beam steering over a steering angle of 34° is achieved over 2.3 m reach, providing a novel passive beam steering scheme for indoor OWC.

W2A.163

Ultra-Reliable 25G-400G+ Wireless Transmission Over Dense Fog Conditions Enabled by Hybrid FSO-mmWave, *Bruno Brandao; Paulo Pires; Marco Fernandes; Gil Fernandes; Fernando Guiomar; Paulo Monteiro; INSTITUTO DE TELECOMUNICACOES.*

By performing rate-adaptive modulation of a hybrid mmWave (28 GHz) and FSO (1550 nm) system, we demonstrate ultra-reliable transmission in the range of 25–425 Gbps, supporting fog-induced link losses (generated in an atmospheric chamber) of more than 50 dB.

W2A.164

CNN-Assisted Geometric Misalignment Detection and Compensation for Underwater Optical Wireless Transceivers with In-line Twin Beam and Single Camera Monitoring, *Keita Tanaka[1]; Fumiya Kobori[1]; Ayumu Kariya[1]; Kiichiro Kuwahara[1]; Tomoya Ishikawa[1]; Yoshio Tanaka[1]; Ken'ichi Fujimoto[1]; Tomotaka Kimura[2]; Takahiro Kodama[1]; [1]Kagawa University; [2]Doshisha University.*

We experimentally demonstrated the detection and compensation of geometric misalignment between transmitters and receivers in underwater transmission of spatially multiplexed time-domain hybrid PAM signals. BERs equivalent to the optimum point were achieved using in-line twin-beam collective monitoring and extracting aberration features through CNN-based machine learning.

W2A.165

Experimental Analysis of Atmospheric Turbulence Effects on Free Space Optical Communication with Simulation, *Tae-in Oh[1]; Byungju Lim[2]; Young-chai Ko[1]; [1]Korea University; [2]Pukyong National University.*

This study investigates the impact of atmospheric turbulence on free space optical (FSO) communication systems through experimental measurements and simulations. Comparisons between simulated and measured bit error rate (BER) reveal insights into channel model thresholds, emphasizing the significance of considering atmospheric conditions in FSO deployment.

W2A.166

Multi-Mode Based Beam Shaping via Offset Launch for Multi-User Indoor 10 Gb/s Real-Time OWC with >12 cm Coverage, *Chao Li[1]; Zichen Liu[1]; Xu Zhang[2]; Chao Yang[2]; Ming Luo[2]; Wu Liu[2]; Tao Zeng[2]; Xumeng Liu[1]; Lei Wang[1]; Zhixue He[1]; Shaohua Yu[1]; [1]Peng Cheng Laboratory, Shenzhen, China; [2]China Information and Communication Technologies Group Corporation.*

Real-time 10 Gb/s optical wireless communication over 4.2 m free-space using coherent dual-polarization QPSK modulation and multi-mode based beam shaping (MM-BS) via offset-launch is experimentally demonstrated for multi-user scenario, achieving −38.8 dBm receiver sensitivity and > 12 cm coverage area.

W2A.167

Enabling Low-Cost Fronthaul Transmission with 4 Gbps VCSEL-APD Free Space Optic Link, *Tongyun Li; University of Cambridge.*

A real-time VCSEL-APD optical wireless digitized RF fronthaul is demonstrated, achieving a 40 dB RF dynamic range, 1.6% EVM and 160 MHz RF bandwidth over a 10 m optical wireless link with a 4 Gbps underlying data rate. A relaxed alignment tolerance is suitable for cell-free MIMO deployment.

W2A.168

Demonstration of a Linear Optical Wireless Adaptive Transmitter with 13.8 dB Dynamic Optical Control Range, *Rene Kirrbach Dr.; Mira Stephan; Fabian Klingmann; Alexander Lenkin; Philipp Meißner; Fraunhofer IPMS.*

We demonstrate an optical wireless adaptive transmitter (ATX) with a DCO-OFDM data rate of up to 1.12 Gbit/s and a link range of 0.25 m… 25 m. The ATX improves the range by a factor of 5. Optical simulations illustrate the significant coverage improvement.

SC10: Control and Management of Optical Networks

W2A.169

Shared-Protected Backup Paths Assignment with Mode Group Division Multiplexing in Optical Networks, *Jiaheng Xiong; Qiaolun Zhang; Ruikun Wang; Alberto Gatto; Francesco Musumeci; Massimo Tornatore.*

We evaluate the resource efficiency of Mode Group Division Multiplexing (MGDM) with shared path protection (SPP) in optical networks. On our case studies, SPP with MGDM obtains significant savings in terms of both additional backup spectrum occupation and MIMO-computing

resources compared to other few-mode-transmission scenarios.

W2A.170

Burst-mode EDFA assisted Flexible End-to-end Optical Path Configuration in Multi-domain, Multi-vendor Disaggregated Optical Networks, *Yusuke Hirota; Takahiro Hashimoto; Takeshi Makino; Yuta Goto; Hideaki Furukawa; National Institute of Information and Communications Technology (NICT).*

We experimentally demonstrate a burst-mode EDFA-assisted cloud-native orchestration for flexible optical path transmission with three multi-vendor disaggregated networks, including 1,000 km fiber and 90 km field fiber. We confirmed that our burst-mode EDFA is suitable for flexible provisioning, including Optical Spectrum as a Service (OSaaS).

W2A.171

KPI Estimation-based Path Computation in Support of Deterministic Services in Optically Interconnected Infrastructures, *Albert Pagès; Enric Guasch; Fernando Agraz; Salvatore Spadaro; Universitat Politècnica de Catalunya (UPC).*

Deterministic services require of bounded KPIs when being provisioned for proper operation. We present a KPI estimation-aided path computation strategy for optically interconnected infrastructures. A deterministic service blocking reduction of 60% is achieved.

W2A.172

LLM-Assisted Decision Making for Optical Path Provisioning, *Ryuta Shiraki; Kyoto University.*

The large-language model (LLM) is used for the first time to realize better decision making in optical path provisioning. Its effectiveness is demonstrated in RWA and RSA scenarios. Its explainability and intent-based strategy enable the optical network operator to easily realize spectrally efficient network control.

W2A.173

Toward Optimal Traffic Scheduling in All-Optical Data Centre Networks: A Feature Fusion Approach, *Ao Yu[1]; Cuiyang Feng[2]; Mohamed Cheriet[3]; Pan Hui[1]; [1]The Hong Kong University of Science and Technology (Guangzhou); [2]China University of Mining and Technology (Beijing); [3]École de technologie supérieure (ÉTS).*

We first propose a feature-fusion traffic scheduling approach tailored to integrate rule-based and learning-based methods in all-optical data centre network management. Results show that it achieves compelling QoS across diverse and practical network conditions.

W2A.174

Data Governance Framework for Telemetry Sharing, *Angela Mitrovska; Behnam Shariati; Pooyan Safari; Johannes Karl Fischer; Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI.*

We propose a novel solution based on the Eclipse Dataspace Components (EDC) Connector to enable regulated and policy-driven telemetry data sharing in telco ecosystems. We present its architecture, several compatible use-cases, and results validating its effectiveness. Finally, we experimentally demonstrate it using our multi-vendor infrastructure.

W2A.175

A Transformer-Based Inverse Design for GSNR Optimization of C+L Band Transmission Systems, *Behnam Behinaein Hamgini; Md Ghulam Saber[1]; Hossein Najafi[1]; Qingyi Guo[1]; Zhiping Jiang[1]; Zhuhong Zhang[1]; [1]Huawei Technologies Canada Co., Ltd..*

We present an inverse design based on Transformers and show applications for GSNR optimization in C+L band transmission. We show that Transformers outperform feed-forward models in accuracy of launch power prediction specifically at higher target GSNRs and has the ability to identify near-optimum launch powers.

W2A.176

Relevance of Latency in Ethernet Networking for AI Infrastructure, *Guangcan Mi; Xiang He; Xiaolong Zheng; Huawei Technologies Co., Ltd.*

We broke down the Ethernet link latency, investigated its impact to AI training time by simulating an 8192-server AI cluster network, showing less than 0.01% performance degradation for 20 µs of added link latency. The result was verified in a real-world testbed.

W2A.177

Demonstration of Collaborative Centralized and Distributed Control Plane in an All Optical Metro Spine-Leaf Network, *Bojun Zhang[1]; Jiawei Zhang[1]; Yuanhang Shi[1]; Shaoxiong Feng[1]; Jichen Zhang[1]; Xin He[1]; Haoyang Chen[1]; Bitao Pan[1]; Zhiqun Gu[1]; Zeshan Chang[2]; Yuefeng Ji[1]; [1]Beijing University Of Posts And Telecommunications; [2]Huawei Technologies Co., Ltd.*

We demonstrate a collaborative centralized and distributed control plane to provide multi-granularity connections based on optical circuit switching and optical timeslot switching in an all-optical metro spine-leaf network. Precise time and frequency synchronization are verified in an integrated FPGA and SDN based testbed.

SC11: Quantum Communications and Quantum Computing

W2A.178

Co-existence of Quantum Key Distribution and Classical Transmission in a Field-Deployed Uncoupled-Core Four-Core Fiber, *Qi Wu; Domenico Ribezzo; Giammarco Di Sciullo; Divya A. Shaji; Tetsuya Hayashi; Ruben Luis; Davide Bacco; Yixiao Zhu; Weisheng Hu; Antonio Mecozzi; Cristian Antonelli.*

We investigate the coexistence of quantum key distribution (QKD) and classical transmission in a field-deployed uncoupled-core four-core fiber. We experimentally characterize inter-core spontaneous Raman scattering, finding that QKD is feasible in one core with 25-dB channel loss, with three cores used for full C-band transmission.

W2A.179

Parameter Optimization of Rate-Adaptive Continuous-Variable Quantum Key Distribution Systems, *Erdem Eray Cil[1]; Jonas Berl[2]; Laurent Schmalen[1]; [1]Communications Engineering Lab (CEL), Karlsruhe Institute of Technology (KIT); [2]Adva Network Security GmbH.*

We propose an optimization method for rate-adaptive CV-QKD systems, improving the SKR by up to 15%. A single information reconciliation setup can generate secret keys up to a distance of 112 km. This enables a unified reconciliation system, thereby facilitating the commercialization of CV-QKD.

W2A.180

Advancements in Quantum Communication Systems Using Orbital Angular Momentum (OAM), *Eamonn Ahmad, Miet, CEng.; CSA Catapult.*

This paper presents advancements in quantum communication systems leveraging Photonic Crystal Surface Emitting Lasers (PCSELs) for efficient generation of beams with orbital angular momentum (OAM). High-sensitivity Avalanche Photodiodes (APDs) achieve unprecedented sensitivity in detecting low light levels crucial for quantum communication applications.

W2A.181

CVQKD with composable security over 20 km SMF using a 10 kHz linewidth local oscillator laser, *Hou-Man Chin; Ulrik Lund Andersen; Tobias Gehring; Technical University of Denmark (DTU).*

We present the results of our experimental polarisation diverse continuous variable quantum key distribution system operating over 20 km SMF at 100 Mbaud, implemented using a 10 kHz laser as a free running local oscillator. A composable finite size key is achieved with 2x10^8 states

W2A.182

Noise Analysis and Co-propagation of Continuous-variable Quantum Key Distribution with 14 Classical Channels Over 25.7 km Received With a Real-time Bob, *João Frazão[1]; Vincent van Vliet[1]; Menno van den Hout[1]; Kadir Gümüş[1]; Alessandro Gagliano[2]; Paola Parolari[2]; Alberto Gatto[2]; Paolo Martelli[2]; Aaron Albores-Mejia[1]; Boris Škorić[1]; Chigo Okonkwo[1]; [1]Eindhoven University of Technology; [2]Politecnico di Milano.*

Real-time CV-QKD Bob achieves peak 0.65 Mbps secret key rates over 25.7 km of fiber while co-propagating 14 adjacent classical channels. Performance degrades at higher classical launch powers due to higher excess noise from crosstalk and possible nonlinear optical effects.

W2A.183

Bi-directional Coexistence of C-band Quantum Channel with Four DWDM Classical Channels for Practical Deployment, *Obada Alia; Albert Huang; Marco Pistoia; Charles Lim; JPMorgan Chase & Co.*

We demonstrate the bi-directional coexistence of a quantum channel with service, key management sys-

tem, management, and data channels all operating in the C-band. We showcase the stability of the QKD system in passive-only and active testbeds over 35 and 50 km single-mode fibers.

W2A.184

Tx-Rx Mode Mismatch Effects in Gaussian-Modulated CV QKD, *Mateusz Kucharczyk[1]; Michał Jachura[1]; Marcin Jarzyna[2]; Konrad Banaszek[1]; Amirhossein Ghazisaeidi[3]; [1]University of Warsaw; [2]Palacký University in Olomouc; [3]Nokia Bell Labs, France.*

The impact of technical limitations on pulse shaping used to generate a CV QKD signal is quantified in terms of the attainable secure key rate. Optimization of key spectral efficiency for Gaussian-modulated CV QKD with truncated and discretized root-raised cosine profiles is discussed.

W2A.185

Physical Layer Security applied on QAM & OFDM Optical and Radio over Fiber links based on Quantum Key Distribution., *Thomas Nikas[1]; Eleftherios Rousas; Georgios Pekridis; Aikaterini Mandilara; Sotirios Karabetsos; Dimitris Syvridis; [1]Department of Informatics, National and Kapodistrian University of Athens.*

Feasible techniques for exploiting and seamlessly integrating high-rate QKD keys to encrypt the parameters of conventional modulation schemes like M-QAM and OFDM are proposed and experimen-tally evaluated on Fiber as well as Radio over Fiber transmission, depicting a robust and efficient Physical Layer Security solution.

W2A.186

Timebin-Phase BB84 Quantum Key Distribution Using Telecom-Wavelength Fiber-Coupled SPADs, *Jan Krause; Pascal Rustige; Nino Walenta; Patrick Runge; Martin Schell; Ronald Freund; Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI.*

Single-photon avalanche detectors (SPADs), which operate without cryogenic cooling, are a core component for practical QKD systems. We demonstrate 13-hour continuous key generation with our timebin-phase BB84 QKD system using our InGaAs/InP SPAD, yielding 1.88±0.10% QBER and 85±8 bit/s SKR over 41.6 km fiber.

W2A.187

Integration of a C-band Digital Coherent CV-QKD Signal into Fully Loaded 9.23-THz C+L-band DWDM Signals with a Total WDM Power of +19 dBm, *Tetsuo Kawakami; Hiroki Kawahara; Toshihiko Okamura; Wakako Maeda; NEC Corporation.*

We demonstrated the coexistence of a C-band digital coherent CV-QKD signal with fully loaded 9.23-THz C+L-band 123λ classical signals with a total power of +19 dBm. The estimated secret key rate was 79.1 kbps over a 20 km G.654.E fiber Link.

W2A.188

Three-Dimensional Quantum Noise Stream Cipher with Time Domain Masking, *Masato Yoshida; Keisuke Kasai; Toshihiko Hirooka; Masataka Nakazawa; Tohoku University.*

We propose a three-dimensional quantum noise stream cipher (3D-QNSC) that newly uses time-domain masking as well as amplitude and phase QAM encryption. We demonstrate a real-time 560 km transmission using FPGA-based transmitter/receiver and successfully obtain BER of 0.5 for all-bits of 3D-QNSC signal against eavesdropper.

W2A.189

Chip based Bright Heralded Single-Photon Source with Ideal Purity, *Haoyang Wang[1]; Huihong Yuan[2]; Qiang Zeng[2]; Lai Zhou[2]; Haiqiang Ma[1]; Zhiliang Yuan[2]; [1]Beijing University of Posts and Telecommunications; [2]Beijing Academy of Quantum Information Sciences.*

We demonstrate an unprecedentedly bright heralded single-photon source with ideal single photon purity and proposed an explicit theoretical limit of purity of heralded single-photon sources. The measured coincidence rate exceeds 1.5~MHz, and the lowest g_h(2)(0) is 0.000945 which has never achieved by on-chip SFWM sources.

12:30–14:00 Lunch Break (on your own)

Illusion

12:30–14:00
Women in Photonics
Organisers: Anna Lena Schall-Giesecke (Fraunhofer IMS and University of Duisburg-Essen); Elena Noeke (1&1 Versatel Düsseldorf); Anjali Sharma (University of the Bundeswehr Munich)

Empowerment Bridge: Taking Cognizance from Leading Ladies in Photonics and Optics

Join us for a special event that honors and celebrates professional women in the dynamic fields of optics and photonics. Discover the remarkable achievements and innovative ideas of female mentors and role models, and seize the chance to network with fellow participants and potential mentors.

Engage in a thought-provoking panel discussion featuring distinguished speakers from academia and industry. They will share their insights and visions on promoting fairness in the workplace, discuss the challenges they've overcome, and reveal invaluable lessons from their journeys. This event is your opportunity to be inspired and to foster mentorship opportunities that drive gender diversity within the photonics and optics industry.

After the panel, enjoy a networking lunch designed to facilitate meaningful connections and the exchange of ideas. The lunch is sponsored by OPTICA.

Don't miss out on this inclusive and empowering experience. Register your interest when you sign up for ECOC online. This event is open to all registered attendees of ECOC.

See page 28 of this programme for more information about this event.

Harmonie 1

14:00–15:30
W3A • Fibers for Nonlinearity and Amplification
Presider: Xiaoyi Bao; University of Ottawa

W3A.1 • 14:00
Continuous Wave Fiber Optical Parametric Amplifier Tuneable across ~590 nm Range with Gain of up to 52 dB, *Vladimir Gordienko; Hani Kbashi; Mariia Bastamova; Aleksandr Donodin; Andrew Ellis; Nick Doran; Aston University.*

We experimentally demonstrate a continuous wave fiber optical parametric amplifier with narrowband gain tuneable within the range of 1310–1900 nm and demonstrate its amplification and wavelength conversion capability with gain of up to 52 dB.

W3A.2 • 14:15
High Gain Incoherently Pumped Discrete Raman Amplifiers for U-band Coherent Transmission Systems, *Dini Pratiwi[1]; Daniele Orsuti[2]; Mingming Tan[1]; Ben Puttnam[2]; Ruben Luís[2]; Aleksandr Donodin[1]; Ian Phillips[1]; Luca Palmieri[3]; Hideaki Furukawa[2]; Wladek Forysiak[1]; [1]Aston University; [2]NICT Japan; [3]University of Padova.*

We investigate high gain incoherently pumped U-band discrete Raman amplifiers, achieving up to 22.3 dB net gain with HNLF and 4.2–5.8 dB noise figure, and demonstrate their use in a C+L+U-band coherent transmission system using 516x24.5 GBd/s DP-64/256QAM channels with a total GMI data rate of 136.2 Tb/s.

W3A.3 • 14:30 Invited
Liquid-Core Fibers: a base for tunable nonlinear frequency con- version, *Markus Schmidt.*

Liquid-core fibers represent a novel platform for nonlinear frequency conversion with unique properties beyond their solid-core counterparts. In particular, their ability to shape the waveguide dis-persion through an extreme thermo-optical response and strong core diameter sus-

Harmonie 2

14:00–15:30
W3B • Space-Division Multiplexing II and Modeling
Presider: Gernot Goeger; Huawei Technologie Dusseldorf GmbH

W3B.1 • 14:00
Experimental Evaluation of Multi-core Fiber Performance for SDM Submarine Systems at Distances up to 20512 km, *Alexis Carbo Meseguer; Richard Garuz; Alexandru Vladimir Trifu; Sebastien Dupont; Julien Courty; Jean-Christophe Antona; Marc Baulin; Vincent Letellier; Alcatel Submarine Networks (ASN).*

We conducted an experimental study of multi-core fibers for subsea systems at distances from 9230 to 20512 km. Then we set an equivalent testbed in single-core to quantify within 8% the penalty in capacity of commercially available Fan-In Fan-Out devices.

W3B.2 • 14:15
A Fast Simulator of Fiber-optic Propagation and its Application to Nonlinearity Compensation, *Paolo Serena; Chiara Lasagni; Alberto Bononi; Università degli Studi di Parma.*

We propose a numerical implementation of fiber propagation in the nonlinear regime that is faster than the split-step Fourier method for multi-channel transmissions filling the C band. We show the performance of a low-complexity nonlinear compensator based on this concept.

W3B.3 • 14:30 Invited
Long-Distance Space-Division-Multiplexed Transmission Using High-Mode-Count Multi-Mode Fibers, *Menno van den Hout[1]; Giammarco Di Sciullo[2]; Ruben Luis[3]; Ben Puttnam[3]; Nicolas Fontaine[4]; Roland Ryf[4]; Haoshuo Chen[4]; Mikael Mazur[4]; David Neilson[4]; Pierre Sillard[5]; Frank Achten[5]; Ali Mefleh[6]; Jun Sakaguchi[3]; Cristian Antonelli[2]; Chigo Okonkwo[1]; Hideaki Furukawa[3]; Georg Rademacher[7]; [1]Eindhoven University of Technology;*

Harmonie 3

14:00–15:30
W3C • Devices & Applications of Optical Frequency Tuning
Presider: Romain Brenot; Huawei Paris Research Center

W3C.1 • 14:00 Tutorial
Optical Frequency Combs from device to applications, *Alexander Gaeta.*

I will review the underlying principles of optical Kerr-comb generation and its application to data communications and microwave generation.

Harmonie 4

14:00–15:30
W3D • Ultra-Highspeed PON
Presider: Michela Svaluto Moreolo; Centre Tecnològic de Telecomunicacions de Catalunya (CTTC)

W3D.1 • 14:00
Optimization of Time and Frequency Allocations in a 200-Gb/s TFDMA-PON with End-User Diversity, *Jie Luan Liang; Xi Chen; Di Che; Nokia Bell labs USA.*

We propose a mathematical model to optimize the time and frequency allocations in a subcarrier multiplexing (SCM) based TFDMA PON with user diversity. We verify its effectiveness by experimentally comparing its achievable rate with SCM-based TDMA.

W3D.2 • 14:15
Advanced Equalization in 112 Gb/s Upstream PON Using a Novel Fourier Convolution-based Network, *Chen Shao MdB[1]; Elias Giacoumidis[2]; Patrick Matalla[3]; Jialei Li[1]; Shi Li[2]; Tobias Käfer[1]; Sebastian Randel[3]; Andre Richter[2]; Michael Färber[1]; [1]Karlsruhe Institute of Technology, AIFB; [2]VPIphotonics GmbH; [3]Karlsruhe Institute of Technology, IPQ.*

We experimentally demonstrate a novel, low-complex Fourier Convolution-based Network based equalizer for 112 Gb/s upstream PAM4-PON. At a BER of ~ 5e–3, FConvNet enhances the receiver sensitivity by 2 and 1 dB compared to a 51-tap Sato equalizer and benchmark machine learning algorithms, respectively.

W3D.3 • 14:30 Upgraded Invited
100 Gbit/s PAM-4 PON with >41 dB Extended Optical Budget with Multipath Interference Analysis, *Kovendhan Vijayan[1]; Robert Borkowski; Amitkumar Mahadevan; Doutje Van Veen; Vincent Houtsma; [1]Nokia Bell Labs, NJ, USA.*

We experimentally demonstrate the feasibility of 100 Gbit/s PAM-4 PON with an extended optical power budget of 41.2 dB. We also study stimulated Brillouin

Harmonie 5

14:00–15:30
W3E • Network Automation
Presider: Yvan Pointurier; Huawei Technologies France S.A.S.U

W3E.1 • 14:00
Open Implementation of a Large Language Model Pipeline for Automated Configuration of Software-Defined Optical Networks, *Nicola Di Cicco; Memedhe Ibrahimi; Sebastian Troia; Francesco Musumeci; Massimo Tornatore; Politecnico di Milano.*

We leverage LLMs to develop a natural-language interface to a software-defined optical network testbed. Results show over 80% accuracy in translating human intent to the appropriate network configurations. Our code is public.

W3E.2 • 14:15
Large Language Model-Driven AI Agent in SDN Controller Towards Intent-Based Management of Optical Networks, *Anni Zhou; Yuchen Song; Yao Zhang; Min Zhang; Danshi Wang; State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Posts and Telecommunications Beijing, China.*

The digital twin (DT) for optical networks within the SDN controller facilitates regular performance prediction and optimization. With DT, intent-based management is achieved through the LLM-driven AI agent, including intent translation, standard command generation, and operation execution within 2s.

W3E.3 • 14:30
LLM-enabled Full-stack Configuration Automation of SDM Transport Network, *Cen Wang; KDDI Research, Inc.*

Through leveraging language understanding power of GPT4.0 and GPT3.5-turbo, we design, evaluate and experimentally validate a full-stack configuration automation framework on a deployed SDM network including configuration generation and configuration error analysis tasks with 100 and 91.05 scores, respectively.

Harmonie 6

14:00–15:30
W3F • Integrated Sensing and Comms
Presider: Patryk Urban; West Pomeranian University of Technology in Szczecin

W3F.1 • 14:00
Dual comb enabled simultaneously multi-path sensing and communication over fiber access network, *Jingchuan Wang; Huan He; Yaxi Yan; Liwang Lu; Li Wang; Zhiyong Zhao; Hwa Yaw Tam; Alan Pak Tao Lau; Chao Lu.*

We propose a dual-comb-enabled integrated sensing and communication method that allows for real-time interrogation of all paths across access networks without adding complexity at the user end. We demonstrate a 0.5 m sensing resolution and no communication penalty across various modulation schemes and link lengths.

W3F.2 • 14:15
Integrated Vibration Sensing and Self-Homodyne Coherent Transmission Using a 100 kHz Linewidth Telecom Laser and Weakly-Coupled 7-core Fiber, *Yaguang Hao; Quanxin Na; Dongwei Zhuang; Linsheng Fan; Qun Zhang; Chen Cheng; Bing Yue; Jianyu Wang; Yanfu Yang; Jiali Li; Weisheng Hu; Xueyang Li.*

We demonstrate an integrated system for simultaneous vibration sensing and self-homodyne coherent transmission utilizing a 100 kHz linewidth laser and 55.9 km weakly coupled 7-core fibre. Dual functionalities are achieved through shared transceiver hardware, DSP algorithms, and channels, eliminating the need for narrow linewidth lasers.

W3F.3 • 14:30 Invited
Long Term Monitoring of Fibre-Optic Submarine Networks, *Jean Pierre von der Weid[1]; Roque André Ciufo Poeys[2]; [1]Pontifical Catholic University of Rio de Janeiro; [2]Petróleo Brasileiro S/A.*

Submarine optical networks are expected to be operating for decades due to its high implementation costs. Monitoring results with OTDR over 25 years on the Petrobras Campos Basin network are presented, showing age-

Spektrum

14:00–15:30
W3G • Integrated Light Sources
Presider: Jean Teissier; Coherent Laser Enterprise

W3G.1 • 14:00
High Power 1.55 µm Buried Ridge DFB and MOPA Sources, *François Duport; Alexandre Larrue; Nicolas Vaissière; Antoine Elias; Gauillaume Daccord; Delphine Lanteri; Jean-Pierre Legoec; Michel Garcia; Jean Decobert; Olivier Parillaud; Frérédic Pommereau; Frédéric van Dijk; III-V Lab.*

We present high power DFB lasers and MOPAs using buried ridge slab coupled optical waveguides for improved heat dissipation. This configuration enables high power (""> 300"" mW) continuous wave operation with narrow linewidth (""< 30"" kHz) and low relative intensity noise (""< -165"" dB/Hz).

W3G.2 • 14:15
Narrow linewidth O-Band Quantum Dot DFB laser, *Mikhail Buyalo; Sergei Poltavtsev; Vasilii Belykh; Sergey Mikhrin; Vladimir Mikhrin; Alexey Gubenko; Innolume GmbH.*

We report on measurements of record-narrow optical line with FWHM down to 92 kHz (Lorentz part down to 6 kHz) in O-band InAs/GaAs QD DFB laser. This achievement together with high power and wave-length tunability makes QD platform appealing for LiDAR and coherent datacom applications.

W3G.3 • 14:30
Hybrid Integrated Multi-lane Erbium-doped Si3N4 Waveguide Amplifiers, *Zheru Qiu[1]; Xinru Ji[1]; Yang Liu[1]; Martin Hafermann[2]; Taegon Kim[3]; Joseph C. Olson[3]; Rui Ning Wang[1]; Carsten Ronning[2]; Tobias Kippenberg[1]; [1]EPFL; [2]Friedrich Schiller University Jena; [3]Applied Materials.*

We present the integration of four individual erbium-doped waveguide optical amplifiers on a Si3N4 pho-

Fantasie

14:00–17:30
Satellite Symposium
Organisers: Jörg-Peter Elbers (Adtran); Christian Fuchs (DLR)

Satellite communications are undergoing rapid changes: As GEO satellites and MEO constellations are now being complemented by innovative LEO constellations, the integration of terrestrial and non-terrestrial networks is paving the way for ubiquitous connectivity and enhanced resiliency. Optical link technologies are revolutionizing the field and enable multi-Tb/s network capacities. Commercial-of-the-shelf technologies offer opportunities to accelerate development timelines and leverage economies of scale.

This special symposium will feature two panel sessions dedicated to discussing the future directions of satellite communication and the pivotal role of optical intersatellite and ground-to-satellite links. Don't miss this opportunity to gain insights from industry leaders and experts shaping the future of global connectivity.

See page 24 of this programme for a list of speakers and topics for this symposium.

W3A • Fibers for Nonlinearity and Amplification — *Continued*

ceptibility allows the implementation of unique and reconfigurable dispersion landscapes.

W3A.4 • 15:00 Invited

O-band Bismuth Doped Fibre Amplifiers, *Vitaly Mikhailov; OFS Laboratories.*

We reviewed state of the art BDFAs for O-band amplification. Pump wavelength selection and amplifiers performance with different pump sources were compared. BDFA designed for medium and high power, as well as low noise applications are demonstrated.

W3B • Space-Division Multiplexing II and Modeling — *Continued*

[2]Università degli Studi dell'Aquila; [3]NICT Japan; [4]Nokia Bell Labs, NJ, USA; [5]Prysmian; [6]KPN; [7]Universität Stuttgart.

This presentation reviews the challenges of long-distance transmission using high-mode-count multi-mode fibers and demonstrates how a mode permutation technique can be used to extend the transmission reach of a 15-mode fiber to 1001~km for 16-QAM signals.

W3B.4 • 15:00

Single-Carrier 2.56 Tb/s (3-mode x 128-GBd x DP-16QAM) Transmission over a 53.7 km Few Mode Fiber, *Nicolas Braig-Christophersen[1]; Aymeric Arnould[1]; Robert Emmerich[1]; Fabian Chowanek Meng.[1]; Ruben S. Luis[2]; Ben J. Puttnam[2]; Kazuhiko Aikawa[3]; Juan Carlos Alvarado Zacarias[4]; Rodrigo Amezcua-Correa[4]; Pamir Oezsuna[1]; Ruby S. B. Ospina[5]; Hideaki Furukawa[2]; Carsten Schmidt-Langhorst[1]; Georg Rademacher[6]; Colja Schubert[1]; Ronald Freund[7]; [1]Fraunhofer Heinrich Hertz Institut (HHI); [2]National Institute of Information and Communications Technology (NICT); [3]Fujikura Ltd.; [4]CREOL – University of Central Florida; [5]Nokia Bell Labs; [6]Stuttgart University, Fraunhofer Heinrich Hertz Institut; [7]TU Berlin, Fraunhofer Heinrich Hertz Institut.*

We investigate high-symbol rate SDM transmission using 16 to 128 GBd QPSK, 16-QAM and 64-QAM modulation over a 3 mode fiber. An aggregated net rate of 2.56 Tb/s was obtained after 53.7 km transmission using 128 GBd 16-QAM signals.

W3C • Devices & Applications of Optical Frequency Tuning — *Continued*

W3C.2 • 15:00

Tunable TOSA with Tuning Range Covering the C++ and L++ Band Simultaneously, *Zifeng Chen[1]; Quanan Chen[2]; Chun Jiang[2]; Jiajun Lou[1]; Juan Xia[1]; Qiaoyin Lu[1]; Weihua Guo[1]; [1]Huazhong university of science and technology; [2]Ningbo Ori-chip Optoelectronics Technology LTD.*

A novel C + L-band tunable TOSA based on multi-channel interference widely tunable lasers has been demonstrated. Innovative co-packaging integrates two laser-chips and a Z-Block, enabling a tuning-range of 240 ITU-grids over 100 nm. High side-mode suppression-ratios > 44 dB and fiber-coupled output powers > 15 dBm.

W3D • Ultra-Highspeed PON — *Continued*

scattering (SBS) suppression relevant to high launch power conditions and multipath interference (MPI) to which PAM-4 signals are sensitive.

W3D.4 • 15:00 Invited

The road towards 100G and 200G-Passive Optical Networks, *Rene Bonk[1]; Ed Harstead[2]; [1]Nokia, Bell Labs; [2]Nokia.*

Status, paths and challenges towards realization and standardization of 100G or 200G-PONs are described, and technology options, be it intensity-modulation and direct-detection or a coherent solution, are highlighted and analyzed.

W3E • Network Automation — *Continued*

W3F • Integrated Sensing and Comms — *Continued*

W3G • Integrated Light Sources — *Continued*

Satellite Symposium — *Continued*

ing effects in fibre attenuation and splices. Monitoring requirements and strategies are discussed.

tonic integrated circuit hybrid integrated with a four-lane semiconductor pump laser diode chip. Each amplifier achieves 15 dB on-chip gain and >15 mW on-chip output power.

W3E.4 • 14:45

An Interpretable Alarm Multi-Root-Cause Localization Method based on Graph Structure in Optical Networks, *Yidi Wang; Yue Pang; Yuchen Song; Chunyu Zhang; Lifang Zhang; Min Zhang; Danshi Wang.*

The proposed interpretable alarm multi-root-cause localization method, based on graph structures, rapidly synthesizes existing experience and outputs results with robust traceability and verification. It maintains an accuracy above 86% for alarm localization with up to three root causes.

W3G.4 • 14:45

Monolithically Grown Quantum Dot Laser with 105°C reliability on CMOS compatible Silicon, *Xiangjie Zhao; Shiyong Zhang.*

Single-mode Fabry-Perot (FP) quantum dot laser was monolithically grown on (100) Silicon substrate. Its optical power reaches 33 mW at 25°C 120 mA. The laser was aged at 105°C 100 mA for 5000 hours showing less than 5% power degradation of 25°C performance.

W3E.5 • 15:00 Invited

Scaling and Autonomous Operation of Future Transport Networks, *Jesse Simsarian[1]; David Neilson[1]; Colin Kelly[2]; Mijail Szczerban[2]; John Katransky[2]; Brad McKay[2]; Roland Ryf[1]; Thierry Zami[3]; [1]Nokia Bell Labs; [2]Nokia; [3]Alcatel Submarine Networks (ASN), Nokia.*

Capacity growth of terrestrial optical networks is continuing by deploying multiple fibers per direction for spatial division multiplexing. We discuss introducing spatial switching to manage these fibers and methods to achieve autonomous network operation with AI and network digital twins.

W3F.4 • 15:00

In-service PON safety surveillance by a sustainable interferometric sensor, *Marco Fasano[1]; Andrea Madaschi[1]; Paola Parolari[1]; Marianna Hovsepyan[2]; Francesco Carpentieri[2]; Pierpaolo Boffi[1]; [1]Politecnico di Milano (POLIMI); [2]Open Fiber.*

Detection of vandalisms and hazards affecting cabinets or building terminals at the user side is demonstrated by an interferometric sensor embedded in the deployed PON cable, monitoring the PON integrity with a simple implementation in terms of cost and complexity.

W3G.5 • 15:00 Invited

Illuminating Tomorrow: Photonic Crystal Surface Emitting Lasers (PCSELS) Advantages and Pitfalls, *N.N. Paper(116315).*

Harmonie 1

W3A • Fibers for Nonlinearity and Amplification — *Continued*

Harmonie 2

W3B • Space-Division Multiplexing II and Modeling — *Continued*

W3B.5 • 15:15
126-Tb/s 2-Core Fibre Transmission over 114.6 km × 5 Spans with Ultra-Low-Loss Fibre Bundle Fan-in/Fan-out, *Kosuke Komatsu[1]; Shohei Beppu[1]; Daiki Soma[1]; Dai Sasaki[2]; Tsutomu Okamoto[2]; Michael Lorenz[3]; Qiulin Ma[4]; Noboru Yoshikane[1]; Takehiro Tsuritani[1]; Martin Böttcher[3]; Ansgar Meissner[3]; Lidia Galdino[5]; Kevin Bennett[5]; Sergejs Makovejs[5]; Yuta Wakayama[1]; [1]KDDI Research, Inc.; [2]Orbray Co., Ltd.; [3]Heraeus Quarzglas Bitterfeld GmbH & Co. KG, Heraeus Comvance; [4]Heraeus Quartz North America LLC, Heraeus Comvance; [5]Corning Incorporated.*

Full C+L-band 2-core fibre transmission is experimentally demonstrated with five spans for a total distance of 573 km. The transmission capacity of 126 Tb/s is achieved with the longest span length for weakly-coupled multi-core fibres, which is enabled by ultra-low-loss fibres and fan-in/fan-out devices.

Harmonie 3

W3C • Devices & Applications of Optical Frequency Tuning — *Continued*

W3C.3 • 15:15
Ultra-broadband On-Chip Spectrometer with > 325 nm Operational Bandwidth, *Chunhui Yao[1]; Wanlu Zhang[1]; Peng Bao[1]; Minjia Chen[1]; Ting Yan[2]; Richard Penty[1]; Qixiang Cheng[1]; [1]University of Cambridge; [2]GlitterinTech Limited.*

In this paper, we present an ultra-broadband on-chip spectrometer utilizing only a few dispersion-engineered micro-ring resonators, achieving a > 325 nm operational bandwidth with a < 20 pm resolution. This, to the best of our knowledge, sets a new record in the operational bandwidth for on-chip.

Harmonie 4

W3D • Ultra-Highspeed PON — *Continued*

15:30–16:00 Coffee Break, Exhibition

Harmonie 1

16:00–17:30
W4A • QKD Networks
Presider: Caterina Vigliar; Technical University Denmark (DTU)

W4A.1 • 16:00
Minimal Impact Network-Wide Heuristics for the Coexistence of Classical and CV-QKD Signals in the C-Band, *Venkata Virajit Garbhapu[1]; Cédric Ware[1]; Mounia Lourdiane[2]; [1]LTCI, Télécom Paris, Institut Polytechnique de Paris; [2]SAMOVAR, Télécom SudParis, Institut Polytechnique de Paris, 91011 Évry, France.*

We investigate the coexistence of classical and CV-QKD channels. We accurately calculate the Raman noise affecting CV-QKD and optimize its wavelength placement. The results show that applying the right heuristic significantly reduces the blocking probability of WDM channels with minimal impact on the CV-QKD SKR.

Harmonie 2

16:00–17:30
W4B • Machine Learning in Optical Networks
Presider: Michael Düser; Deutsche Telekom AG

W4B.1 • 16:00
Decentralized Training over 100 km Based on Optical Transport Network for Artificial Intelligence, *Jiang Sun[1]; Dong Wang[1]; Bin Qi[2]; Tao Gao[2]; Dechao Zhang[1]; Wenbo Chen[2]; Han Li[1]; [1]China Mobile Research Institute; [2]Huawei Technologys CO.LTD..*

A decentralized training method based on Optical Transport Network (OTN) is proposed.The efficiency of decentralized training interconnected by OTN is only deteriorated by 3.75 % as transmission distance is extended from 0 km to 100 km experimentally.

Harmonie 3

16:00–17:30
W4C • Equalisation and Performance Monitoring for High Rate Transmissions
Presider: Haeyoung Rha; Miroandl

W4C.1 • 16:00
Study of EEPN effect in 800G QAM16 DSP for coherent plug-gables, *Hai Xu; Charles Chen; Shih-Cheng Wang; Marvell.*

We experimentally compare the EEPN-induced penalty to OFEC, LDPC, LDPC with PCS for 800G DP-QAM16. We incorporate a laser phase noise model in an 800G system simulation and show that it achieves a good agreement with measured laser frequency characteristics and measured Q factor distribution.

Harmonie 4

16:00–17:30
W4D • 50G PON
Presider: Stephan Pachnicke; Kiel University

W4D.1 • 16:00 Upgraded Invited
Field trial of the first G-PON, XGS-PON, 50G-PON triple-MPM reaching >35 dB ODN OPL with 20 km reach, *Fabienne Saliou[1]; Gaël Simon[1]; Joseph Zandueta[1]; Rodriguez Aude[1]; Stéphane Le Huerou[1]; Philippe Chanclou[1]; Jérémy Potet[1]; Guillaume Vu-Brugier[2]; [1]Orange S.A.; [2]Huawei Technologies.*

A triple coexistence G-XGS-50G-PON system demonstrates more than 35 dB of OPL with 20 km of reach. More than 41 Gbit/s downstream and 21 Gbit/s upstream traffic are exchanged in a field trial with commercial users, on existing 1:128 FTTH ODN in France.

Harmonie 5

W3E • Network Automation — *Continued*

Harmonie 6

W3F • Integrated Sensing and Comms — *Continued*

W3F.5 • 15:15
Distributed Acoustic Sensing over XGS-PON by using "coded" Enhanced Scattering Fibre, *Benyuan Zhu[1]; Yaowen Li[2]; Paul Westbrook[1]; Kenneth Feder[1]; Zhou Shi[1]; Ting Wang[2]; David DiGiovanni[1]; [1]OFS; [2]NEC Labs America.*

We demonstrate distributed-acoustic-sensing (DAS) over 10G passive-optical-network (XGS-PON) system. The vibrations from 3 distributed fibres are identified by "coded" enhanced-scatter-fibres (ESF) and fibre delay-lines. The sensing performance and crosstalk between DAS and XGS-PON signals within co-existing DAS over XGS-PON system are investigated.

Spektrum

W3G • Integrated Light Sources — *Continued*

Fantasie

Satellite Symposium — *Continued*

15:30–16:00 Coffee Break, Exhibition

Harmonie 5

16:00–17:30
W4E • Network Programmability
Presider: Shuangyi Yan; University of Bristol

W4E.1 • 16:00 Invited
Data Processing Unit (DPU) and P4 Programmability in Support of the Edge Continuum, *Filippo Cugini[1]; Rana Abu Bakar[2]; Andrea Sgambelluri[2]; Nicola Sambo[2]; Lorenzo De Marinis[2]; Alessio Giorgetti[3]; Piero Castoldi[2]; Juan Jose Vegas Olmos[4]; Francesco Paolucci[2]; [1]CNIT; [2]Scuola Superiore Sant'Anna; [3]University of Pisa; [4]Nvidia.*

A comprehensive framework for pervasive telemetry and accelerated networking is presented. The framework is suitable for effective integration of optical, packet, and computing resources, leveraging DPU and P4 programmability in support of edge-to-edge continuum.

Harmonie 6

16:00–17:30
W4F • Remote Sensing
Presider: tbc

W4F.1 • 16:00
Machine Learning-Driven Earthquake Early Warning Using Optical Fiber Mesh Networks, *Hasan Awad[1]; Fehmida Usmani[2]; Emanuele Virgillito[1]; Rudi Bratovich[3]; Stefano Straullu[4]; Francesco Aquilino[4]; Roberto Proietti[1]; Rosanna Pastorelli[3]; Vittorio Curri[1]; [1]Politecnico di Torino; [2]National University of Sciences & Technology (NUST); [3]SM-Optics; [4]LINKS Foundation.*

We demonstrate interconnected meshed optical networks as sensing-localization grid for earthquake early detection. We integrate ground displacement data from seven local earthquakes, magnitudes four to six, into a

Spektrum

16:00–17:30
W4G • Integrated Receivers
Presider: Johan Bauwelinck; imec – Ghent University

W4G.1 • 16:00 Upgraded Invited
IM/DD Silicon Receiver Subassembly with Opto-Electrical Bandwidth of 84 GHz, *Anna Peczek; Matthias Wietstruck; Georg Winzer; Christian Mai; Stefan Lischke; Mohammad Mahdi Khafaji; Sebastian Schultze; Thomas Voß; Patrick Krüger; Aleksandra Kroh; Lars Zimmermann.*

We report on performance of silicon direct detection subassembly achieving 112 GBaud PAM4 at 1300 nm. The chip was realized by direct Al-Al wafer bonding integrating a BiCMOS TIA and germanium waveguide- integrated photodiodes. We demonstrated a receiver efficiency of 1.8 pJ/bit.

Fantasie

Satellite Symposium — *Continued*

W4A • QKD Networks — *Continued*

W4B • Machine Learning in Optical Networks — *Continued*

W4C • Equalisation and Performance Monitoring for High Rate Transmissions — *Continued*

W4D • 50G PON — *Continued*

W4A.2 • 16:15

Coexistence of Commercial CV-QKD and DWDM 100G/400G Transmission in Amplified FOADM-based Metro Links, *Antonio Melgar[1]; Jose Manuel Rivas-Moscoso[2]; Jeison Tabares[3]; Michela Svaluto Moreolo[4]; Borja Villanueva[3]; Sebastián Etcheverry[3]; Pablo Armingol[2]; Jesús Folgueira[2]; Masab Iqbal[4]; [1]Telefónica CTIO; [2]Telefónica CTIO; [3]LuxQuanta Technologies S.L.; [4]Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA).*

We assess the viability of CV-QKD system integration into amplified FOADM-based metro links deployed conforming to network operators standards, allowing fiber infrastructure sharing. Through experiments and simulations, we determine classical-channel power bounds and quantum-channel frequency allocation enabling QKD and full C-band DWDM channel coexistence.

W4A.3 • 16:30

Quantum Secured Communications with Firewall-Integrated Entanglement-Based Quantum Key Distribution, *Rui Ming Chua[1]; Aleksei Ponasenko[2]; Vadim Rodimin[2]; Karen Sloyan[2]; Jaideep Singh[2]; Rodrigo Piera[2]; Anton Trushechkin[3]; Yury Kurochkin[2]; Alexander Ling[4]; James Grieve[2]; [1]National University of Singapore, Technology Innovation Institute United Arab Emirates; [2]Technology Innovation Institute (TII); [3]Heinrich Heine Universität Düsseldorf, Steklov Mathematical Institute; [4]Centre for Quantum Technologies, National University of Singapore.*

Entanglement-based quantum key distribution systems are compatible with wavelength multiplexed multi-user networks. We demonstrate a transportable system generating in 18 hours, 20.6 Mbits of secret key within a 2 nm bandwidth channel over 11.58 km of fiber, with basic key provisioning to 10G IPSec encryption.

W4B.2 • 16:15

GPU-Based, Real-Time, Optical Subcarrier Multiplexing Directed Towards Distributed Neural Network Computing, *Manuel dos Santos Neves[1]; Daniele Orsuti[2]; Divya Shaji[3]; Ruben Soares Luis[4]; Budsara Boriboon[4]; Benjamin J. Puttnam[4]; Satoshi Shinada[4]; Paulo Monteiro[1]; Fernando Guiomar[1]; Hideaki Furukawa[4]; Cristian Antonelli[5]; [1]Instituto de Telecomunicacoes, Universidade de Aveiro, Portugal; [2]Department of Information Engineering, University of Padova, Via G. Gradenigo 6/B, 35131, Padova; [3]University of L'Aquila and CNIT, 67100, L'Aquila; [4]Photonic Network System Lab., NICT; [5]L'Aquila University.*

We demonstrate a direct detection digital subcarrier multiplexing scheme using GPU-based real-time signal processing at 4x922 Mb/s. Our work showcases an architecture for optical communication between remote data centers aimed at enabling distributed computing of neural networks by targeted resource allocation through digital subcarriers.

W4B.3 • 16:30 **Tutorial**

Machine-Learning-Assisted Optical Network Failure Management: Challenges and Pitfalls, *Francesco Musumeci; Politecnico di Milano.*

This tutorial overviews ML application to optical-network failure management, including failure detection, root-cause identification, and localization. Advanced aspects, such as model explainability, data scarcity, uncertainty quantification, will be also discussed to highlight the potential of ML-based solutions and the risks for practitioners when adopting them.

W4C.2 • 16:15

Mitigation of Equalization Enhanced Phase Noise Using Feedforward Timing Error Correction, *Meng Qiu[1]; Xuefeng Tang[1]; Yongchao Chen[2]; Jinyao He[2]; Chuandong Li[1]; [1]Huawei Technologies Canada Co., Ltd.; [2]Huawei Technologies Co., Ltd..*

We propose a feedforward timing error correction (FTEC) block to mitigate the equalization enhanced phase noise (EEPN) effect, and demonstrate its effectiveness in a 140-Gbaud coherent optical transmission experiment.

W4C.3 • 16:30

Measuring the Transceiver's Back-to-Back BER-OSNR Characteristic Using Only a Variable Optical Attenuator, *Toru Mano[1]; Andrea D'Amico[2]; Yue-Kai Huang[2]; Giacomo Borraccini[2]; Hideki Nishizawa[1]; Ting Wang[2]; Vittorio Curri[3]; Koichi Takasugi[1]; [1]NTT Network Innovation Laboratories; [2]NEC Laboratories America; [3]Politecnico di Torino.*

We propose a transceiver back-to-back BER-OSNR characterization method that requires only a single VOA; it leverages the receiver SNR degradation caused by received power attenuation. Experiments using commercial transceivers show that the measurement error is less than 0.2 dB in the Q-factor.

W4D.2 • 16:30

High Power Integrated DFB-EAM-SOA for beyond 35 dB Optical Path Loss 50G-PON and Raman Scattering Estimations, *Gaël Simon[1]; Jérémy Potet[1]; Dylan Chevalier[1]; Fabienne Saliou; Philippe Chanclou[1]; Takumi Fujigaki[2]; Daiki Tanabe[2]; Toru Hirayama[2]; Yoshinori Kannan; Luiz Anet Neto[3]; [1]Orange; [2]Sumitomo Electric Device Innovations; [3]IMT Atlantique.*

We evaluate the performances of a TOSA-packaged integrated DFB-EAM-SOA achieving +13.3 dBm mean launch power at 50 Gb/s. Up to 38.5 dB optical path losses are achieved, exceeding the class D requirements for future deployment. We discuss the non-linear effects triggered by such high-power levels.

W4E • Network Programmability — *Continued*

W4F • Remote Sensing — *Continued*

W4G • Integrated Receivers — *Continued*

Satellite Symposium — *Continued*

Waveplate model to enhance a machine-learning algorithm that accurately detects primary waves and improves nearby urban safety.

W4F.2 • 16:15
Ultrasensitive fibre Sensor based on Random Optical Parametric Oscillator, *Pedro Tovar Braga[1]; Jean Pierre von der Weid[2]; Yuan Wang[1]; Xiaoyi Bao[1]; [1]University of Ottawa, Canada; [2]Pontifical Catholic University of Rio de Janeiro.*

A ultrasensitive fibre sensor exploring random optical parametric oscillation is proposed and experimentally verified, achieving >10 dB signal-to-noise ratio at locations beyond 25 km. It features 1-m spatial resolution and temperature/strain sensitivities of 65.8 μ°C and 80.6 pε/√Hz, leveraged from Modulation Instability and Rayleigh scattering.

W4E.2 • 16:30
Field Trial of Intelligent Network-level Energy Saving Strategy over Large-scale Database of Commercial Transport Networks, *Xinyu Chen[1]; Liuyan Han[1]; Minxue Wang[1]; Jiang Sun[1]; Yong Gao[2]; Xuegang Ou[2]; Faxian Li[2]; Dechao Zhang[1]; Han Li[1]; [1]China Mobile Research Institute; [2]ZTE Corporation.*

We propose a novel AI-based prediction-guided traffic migration scheme for energy conservation in transport networks, validated in the first field trial for network-level energy-saving based on a massive online traffic database of 1966 network elements. 7.7% energy-saving profit is realized without affecting service quality.

W4F.3 • 16:30
Single-Channel Integrated Sensing and Communication Based on Spontaneous Brillouin Scattering, *Simeng Jin; Jingwei Song; Zhisheng Yang; Xiaobin Hong; Yan Li; Jian Wu; State Key Laboratory of Information Photonics and Optical Communications, Beijing University of Posts and Telecommunications (BUPT).*

An SC-ISAC system integrating DSCM-based communication and GO-coded BOTDR sensing is implemented. Whilst offering a large dynamic range of measurands, the system effectively reduces mutual interference between the communication and sensing signals, enabling optimal performance comparable to communication and sensing systems operating independently.

W4G.2 • 16:30
DSP-Free Optical Phase Locked Loop Receiver for Energy Efficient Coherent Intra-Data Center Communications, *Junqian Liu; Aaron Wissing; Ghazal Movaghar; Hector Andrade; Stephen Misak; Aaron Maharry; James Dalton; Luis Valenzuela; Giovanni Gilardi; Ranjeet Kumar; Guan-lin Su; Ansheng Liu; Yuliya Akulova; Larry Coldren; Adel Saleh; James Buckwalter; Clint Schow.*

We report the first integrated O-band QPSK analog optical phase-locked loop receiver enabling 112 Gb/s (56 Gbaud) links with DSP-free homodyne carrier recovery on an on-chip local oscillator laser. BERs below HD-FEC thresholds were achieved with 8.8 pJ/bit receiver power consumption.

W4A • QKD Networks — *Continued*

W4B • Machine Learning in Optical Networks — *Continued*

W4C • Equalisation and Performance Monitoring for High Rate Transmissions — *Continued*

W4D • 50G PON — *Continued*

W4A.4 • 16:45
Free space daylight ground-ground QKD in the near-IR, *Alberto Comin; Airbus Central R&T.*

We report a daylight km-range free space QKD demonstration at 850 nm obtaining a QBER of 1.9% and a raw key-rate of 14 kbit/s. We used the BB84 protocol with polarisation encoding and two supporting optical beams for classical communication and clock synchronisation.

W4A.5 • 17:00 Invited
Lithium niobate-on-insulator photonics – an emerging platform for quantum communication and computation, *Robert Chapman; Tristan Kuttner; Jost Kellner; Alessandra Sabatti; Andreas Maeder; Giovanni Finco; Fabian Kaufmann; Rachel Grange; ETH Zurich.*

Lithium niobate-on-insulator is an emerging integrated photonics platform with great promise for quantum information science and technology. With this platform, we have demonstrated on-chip generation and manipulation of path-entangled photon-pairs with periodically poled waveguides, and quantum logic gates based on quantum interference.

W4C.4 • 16:45
Modified 8×2 Widely Linear MIMO Equalizer for 118 GBaud PCS-128QAM Transmission with Improved Convergence Speed and Frequency Offset Tolerance, *Ziheng Zhang[1]; Yaqin Wang[2]; Longquan Dai[1]; Zicai Cao[1]; Yifu Chen[1]; Zhuofan Zhang[1]; Rui Xue[1]; Songtao Chen[2]; Wenhai Yu[2]; Jing Dai[2]; Shuchang Yao[2]; Ming Luo[3]; Qi Yang[1]; Mengfan Cheng[1]; Deming Liu[1]; Lei Deng[1]; [1]Huazhong University of Science and Technology; [2]Fiberhome Telecommunication Technologies Co., LTD, Wuhan 430073, China; [3]China Information and Communication Technologies Group Corporation (CICT).*

We demonstrate 96GBaud-DP-PCS-64QAM and 118GBaud-DP-PCS-128QAM signal transmissions using the modified 8×2 WL-MIMO equalizer. Compared with the conventional equalizer using the same complexity, the ROSNR and convergence speed are improved by 2.75 dB and 67% respectively, and the FO tolerance is above 2 GHz in the 96GBaud-DP-PCS-64QAM case.

W4C.5 • 17:00
Flexible Constellation Truncating and Shaping Enabled by HiDM for 1.6 T Implementation and Beyond, *Yizhao Chen[1]; Shaobin Fan[2]; Danhui Chen; Zhuo Wang; Weiqin Zhou; Yongben Wang; [1]State Key Laboratory of Mobile Network and Mobile Multimedia Technology, ZTE corporation, Shenzhen, China; [2]China United Network Communications Corporation Limited, China.*

We propose a modified HiDM scheme to realize constellation truncating. The truncated modulation format is verified to achieve an extra reach extension of 4.6% in WDM systems, serving as an attractive tool for 1.6 T implementation and beyond.

W4C.6 • 17:15
Demonstration of Blind Joint Clock Recovery in a 1.92 Tbit/s Transmission Over 50 km Randomly-Coupled 4-Core Fiber, *Patrick Matalla; Lennart Schmitz; Jonas Krimmer; Dengyang Fang; Christian Koos; Sebastian Randel.*

W4D.3 • 16:45
Shot-Noise-Induced Deviation of the Linear Relation Between TDEC and Sensitivity for 50G PON, *Wouter Lanneer[1]; Dora van Veen[2]; Vincent Houtsma[2]; Michiel Verplaetse[1]; Robert Borkowski[2]; Christoph Füllner[3]; Yannick Lefevre[1]; [1]Nokia Bell Labs, Belgium; [2]Nokia Bell Labs, NJ, USA; [3]Nokia Bell Labs, Germany.*

We study the relation between TDEC and receiver sensitivity for APD-based receivers for 50G PON. Simulation and experimental results show that the APD shot noise enhancement induces a deviation of the conventional linear relation for increasing optical powers.

W4D.4 • 17:00
Real-Time 50G TDM-PON Prototype Supporting both Asymmetric and Symmetric ONUs with Class C+ Power Budget in Three-Generation MPM Combo Type, *Ning Wang[1]; Junwei Li[1]; He Yuan[2]; Nannan Zhang[1]; Borui Li[2]; Dechao Zhang[1]; [1]China Mobile Research Institute; [2]Huawei Technologies Co. Ltd..*

We demonstrate the first real-time 50G TDM-PON prototype supporting both asymmetric and symmetric ONUs under the same link with class C+ power budget by using APD and MAC-assisted adaptive oDSP at the OLT receiver. This equipment also supports MPM coexistence with GPON and 10G PON.

W4D.5 • 17:15
Real-time Evaluation of a Novel Analogue Equaliser Integrated Circuit Targeting 50G PON ONU Simplification, *Derek Nesset[1]; Ivan Cano[1]; Gaël Simon[2]; Fabienne Saliou[2]; Youxi Lin[1]; Tom Wettlin[1]; Yuan He[1]; Philippe Chanclou[2]; [1]Huawei Technologies; [2]Orange.*

W4E • Network Programmability — *Continued*

W4E.3 • 16:45
Weather-Adaptive Multi-Step Forecasting of State of Polarization Changes in Aerial Fibers Using Wavelet Neural Networks, *Khouloud Abdelli[1]; Matteo Lonardi; Jurgen Gripp; Samuel Olsson; Fabien Boitier; Patricia Layec; [1]Nokia Bell Labs.*

We introduce a novel weather-adaptive approach for multi-step forecasting of multi-scale SOP changes in aerial fiber links. By harnessing the discrete wavelet transform and incorporating weather data, our approach improves forecasting accuracy by over 65% in RMSE and 63% in MAPE compared to baselines.

W4E.4 • 17:00
Service Provision and Fault Recovery Powered by Ultra-fast QoT Inference and Online Learning on a Field Deployed Meshed WDM-over-SDM Network, *Cen Wang; KDDI Research, Inc.*

Powered by 0.25 s/service (10× faster) QoT inference and accuracy-enhancement online learning, we demonstrated crosstalk-aware, maximum 160-channel service provision, soft and hard failure recovery on a field deployed, lightpath-, core- and spectrum-selective, meshed network with in-total 135 km step-index 4-core fibers.

W4E.5 • 17:15
Dual-domain-aware Real-time Controller Achieves sub-25ms Optical Path Switching for AI-assisted Remote Operation, *Hirotaka Ujikawa; Yuka Okamoto[1]; Che Huang[1]; Hiroshi Ou[1]; Tomoya Hatano[1]; Kenji Miyamoto[1]; Tatsuya Shimada[1]; Tomoaki Yoshida[1]; [1]NTT Access Network Service Systems Laboratories.*

W4F • Remote Sensing — *Continued*

W4F.4 • 16:45
Simple Few-Mode Sensor with Temperature-Strain Discrimination, *Lars Grüner-Nielsen[1]; Mads Vandborg[2]; Ninik Irawati[2]; Karsten Rottwitt[2]; Mikael Lassen[3]; [1]Danish Optical Fiber Innovation; [2]DTU Electro, Department of Electrical and Photonics Engineering, Technical University of Denmark; [3]Danish Fundamental Metrology A/S.*

A simple few-mode interference sensor is introduced. Using interference from beating between the fundamental mode and two different higher-order modes, temperature-strain discrimination is possible. By use of a Fourier filter, it is possible to detect both beat patterns simultaneously

W4F.5 • 17:00 Invited
Leveraging Fiber Sensing Applications for Next-Generation Optical Transport Networks, *Tiejun Xia; Glenn Wellbrock; Verizon.*

Trials of distributed fiber optic sensing using existing telecom fiber by multiple field teams have shown that telecom carriers can gain significant benefits by leveraging this technology to enhance network operations, ensure fiber infrastructure integrity and create new services.

W4G • Integrated Receivers — *Continued*

W4G.3 • 16:45
A Monolithic CMOS 2R Burst Mode Receiver Packaged in TO-CAN with 19 ns Settling Time, *Dan Li[1]; Shuaizhe Ma[1]; Wanqing Zhao Zhao[1]; Jia Li[1]; Ruixuan Yang[1]; Yuye Yang[1]; Xi Liu[1]; Feiyang Zhang[1]; Jianyu Yang[1]; Wenbo Shi[1]; Lei Jing[2]; Xiaoyan Gui[1]; Bing Zhang[1]; Li Geng[1]; Dan Li[1]; Yifei Xia[3]; [1]Xi'an Jiaotong University; [2]Huawei Technologies; [3]Xi'an Jiaotong University.*

This paper reports the first monolithic CMOS 2R BM RX with 19 ns settling time. Realized in a single 40 nm CMOS chip, the low power consumption and small die area allow it to be packaged within a commercial TO-CAN.

W4G.4 • 17:00
All-Silicon Hybrid-integrated 128-GBd Analog Demultiplexing Optical Receiver, *Jakob Declercq; Joris Lambrecht; Bart Moeneclaey; Cheng Wang; Xin Yin; Ghent University – IMEC.*

We report a 100-to-128 GBd NRZ/PAM-4 analog demultiplexing optical receiver, incorporating an O-band silicon photodetector, a SiGe TWTIA and a 256-GS/s SiGe ADEMUX. Without receiver DSP, we demonstrate fiber transmission up to 50 km.

Satellite Symposium — *Continued*

Harmonie 1

W4A • QKD Networks — *Continued*

Harmonie 2

W4B • Machine Learning in Optical Networks — *Continued*

Harmonie 3

W4C • Equalisation and Performance Monitoring for High Rate Transmissions — *Continued*

We present for the first time a digital joint clock recovery in feedforward architecture, that is tolerant to spatial-and-polarization-mode dispersion. We demonstrate clock recovery for a 60-GBd 16-QAM signal over a 50-km randomly-coupled 4-core fiber (RC-4CF).

Harmonie 4

W4D • 50G PON — *Continued*

We evaluate the performance of a novel prototype analogue equaliser IC in a 50G-PON application scenario and compare with digital signal processing. We obtain a link budget of 33 dB and the analogue IC offers 2.2 dB ONU sensitivity margin to the 50G-PON standards.

19:00–23:00 Conference Dinner, Palmengarten

Harmonie 5

W4E • Network Programmability — *Continued*

We propose a rapid coordinated control to cope with dynamic load variations in computing and network domains to assure 100-ms end-to-end delay for AI-assisted remote operation. By pre-determining the switch-over destinations, we successfully achieved sub-25ms control from congestion detection to switching complete without dropping images.

Harmonie 6

W4F • Remote Sensing — *Continued*

18:00–20:00
EPIF – 15th European Photonic Integration Forum
Organisers: Kevin Willliams (JePPIX); Wim Bogaerts (ePIXfab)

Once again, JePPIX has joined forces with ePIXfab to organize the 15th edition of the European Photonic Integration Forum (EPIF). EPIF takes place during ECOC, the exact time slot will be announced shortly.

This year's event will revolve around hypes. Can quantum, LiDAR and AI be qualified as such? How do hype cycles shape the photonics industry and startup landscape? And what have we learned from the dot.com bubble? EPIF will be moderated by Kevin Williams (JePPIX) and Wim Bogaerts (ePIXfab) and will enjoy contributions from several well-known profiles in the integrated photonics industry. Interviews with keynote speakers will be followed by an engaging panel discussion.

The event is now also visible on our website: European Photonic Integration Forum (EPIF) – Jeppix.

See page 126 of this programme for more information about this event.

Spektrum

W4G • Integrated Receivers — *Continued*

18:00–20:00
Photonics in Germany
Organisers: Georg Rademacher (Director Institute of Electrical and Optical Communications, University of Stuttgart)

This panel focuses on current and future trends in photonics research in Germany. Experts from academia, industry and government will discuss current research programs and how they foster strong interactions between industry and academia. Additionally, paths for future research and international collaborations will be discussed. The panel discussion will be followed by a networking reception. Please join this opportunity to engage with leading researchers from Germany over cold beverages to explore new and exciting research opportunities!

See page 127 of this programme for more information about this event.

Illusion

Satellite Symposium — *Continued*

18:00–20:00
Hack Your Research!
Organisers: Besma Kalla (Eindhoven University of Technology); Menno van den Hout (Eindhoven University of Technology); Vincent van Vliet (Eindhoven University of Technology); Amol Delmade (Dublin City University); Giammarco Di Sciullo (University of L'Aquila)

Tools and Tricks for Today's Telecommunications Techies (formerly Lab Automation Hackathon)

Join us at Hack Your Research for an exciting event featuring multiple interactive demos showcasing the most powerful techniques that expert researchers and professionals use to enhance their productivity and simplify their lives. Take this chance to upgrade your work methods and engage in stimulating discussions while enjoying plenty of food and drinks in an informal, relaxed, and fun environment.

See page 126 of this programme for more information about this event.

Harmonie 1

09:00–10:30
Th1A • Advances in Hollow Core Fibers Beyond low Loss
Presider: Patrice Mégret; UMONS

Th1A.1 • 09:00
SMF-Matched, Hollow-Core DNANF with, *Ghafour Amouzad Mahdiraji[1]; Jaroslaw Rzegocki[1]; Ian Davidson[1]; Gianluca Guerra[1]; Gregory Jasion[1]; Seyed Mohammad Abokhamis Mousavi[1]; Konstantin Vidiajev[1]; Chiang Ping Saw[1]; Abdallah Ali[2]; Austin Taranta[1]; Francesco Poletti[1]; [1]University of Southampton, Optoelectronics Research Centre Southampton; [2]Microsoft Azure Fibre.*

We report a novel hollow core fibre with outer and mode-field diameters matched to SMF, to facilitate integration in short-reach applications. The fibre is effectively single-moded, bend-robust and has loss of < 2 dB/km between 1300 and 1565 nm.

Th1A.2 • 09:15
Simultaneous Power and Data Transmission over 1.21 km of Nested Antiresonant Nodeless Fibre, *Douglas McCulloch[1]; K. R. H. Bottrill[1]; Y. Jung[1]; I. A. Davidson[1]; H. C. Mulvad[1]; H. Sakr[2]; J. Meng[1]; F. Poletti[1]; P. Petropoulos[1]; [1]Optoelectronics Research Centre, University of Southampton; [2]Microsoft Azure Fibre.*

A hollow-core Nested Antiresonant Nodeless Fibre is used for the transmission of power and data simultaneously over a distance of 1.21 km with a total link optical-electric conversion efficiency of 17%. The data were received at a bit error rate of below 1e-11.

Harmonie 2

09:00–10:30
Th1B • Hollow-Core Fiber and SOA
Presider: Michael Galili; Technical University of Denmark

Th1B.1 • 09:00
Towards Ultra-High-Capacity Long-Haul Fibre Communication: First Demonstration of Real-time 1.2 Tb/s OTN Transmission at 3-Watt/Channel Launch Power over 20-km AR-HCF, *Baoluo Yan[1]; Peng Li[2]; Yong You[1]; Jun Chu[2]; Hu Shi[1]; Lei Zhang[2]; Yiqi Li[1]; Jie Luo[2]; Yan Zhao[1]; Zhenqian Yang[1]; Hui Zhao[1]; Yong Chen[1]; Kezhi Qiao[1]; Haifeng Liu[3]; Bo Liu[3]; [1]WDM System Department of Wireline Product R&D Institute, ZTE Corporation; [2]State Key Laboratory of Optical Fibre & Cable Manufacture technology, YOFC; [3]Institute of Modern Optics, Nankai University.*

We present, for the first time, the real-time error-free transmission of coherent single-carrier 1.2 Tb/s (net line-side bit rate 1.499 Tb/s) PCS-64QAM with 3-Watt/channel launch power over a 20-km AR-HCF. The weak ISRS in HCF has also been verified using S+C+L-band 19-THz dummy-light.

Th1B.2 • 09:15
C+L-band 4 Tb/s (500 Gb/s/λ × 8λ) WDM IM/DD Optical Interconnection over Anti-resonant Hollow-core Fiber Enabled by Ultra-high Bandwidth TFLN Modulator, *Chao Yang[1]; Chao Li[2]; Yuhan Gong[1]; Ming Luo[1]; Jin Tao[1]; Lei Wang[2]; Zichen Liu[2]; Ying Zhu[3]; Shoufei Gao[4]; Yizhi Sun[4]; Wei Ding[4]; Zhixue He[2]; Xi Xiao[3]; Shaohua Yu[2]; [1]China Information Communication Technologies Group Corporation; [2]Peng Cheng Laboratory, Shenzhen, China; [3]National Optoelectronics Innovation Center; [4]Institute of Photonics Technology and College of Physics & Optoelectronic Engineering, Jinan University.*

Record 4-Tb/s PAM-16 8λ WDM IM/DD optical interconnection using self-developed ultra-high bandwidth TFLN modulator is experimentally demonstrated over 1.4-km low-dispersion AR-HCF at C+L-band with BER < 25% SD-FEC threshold of 4.6×10-2 for beyond 3.2-T application.

Harmonie 3

09:00–10:30
Th1C • Phase-Retrieval, Self-Coherent, and Direct-Detect
Presider: Darli Mello; University of Campinas

Th1C.1 • 09:00
Net 835-Gb/s/λ Carrier- and LO-Free 100-km Transmission Using Channel-Aware Phase Retrieval Reception, *Hanzi Huang[1]; Haoshuo Chen[2]; Qian Hu[2]; Di Che[2]; Yetian Huang[1]; Brian Stern[2]; Nicolas Fontaine[2]; Mikael Mazur[2]; Lauren Dallachiesa[2]; Roland Ryf[2]; Zhengxuan Li[1]; Yingxiong Song[1]; [1]Shanghai University; [2]Nokia Bell Labs, NJ, USA.*

We experimentally demonstrate the first carrier- and LO-free 800 G/λ receiver enabling direct compatibility with standard coherent transmitters via phase retrieval, achieving net 835-Gb/s transmission over 100-km SMF and 8.27-b/s/Hz net optical spectral efficiency.

Th1C.2 • 09:15
Direct-Detection Receiver for 16-QAM Modulated Signals, *Dagmawi Alemayehu Bekele; Phanofi ApS.*

We demonstrate a novel receiver for detecting 16-QAM modulated signals. The received signal is split into branches for phase and intensity detection. The signal in the phase branch is converted into a PAM7 signal, and a standard PAM4 signal is detected in the intensity branch.

Harmonie 4

09:00–10:30
Th1D • Metro-Access, Fronthaul & 6G
Presider: Paola Parolari; Politecnico di Milano

Th1D.1 • 09:00 **Invited**
Coexistence of Analogue Radio and Digital Coherent Transmission Over Access/Metro Networks fibre for Bandwidth-Efficient Fronthaul Beyond 5G, *Devika Dass[1]; Frank Slyne[1]; Dan Kilper[2]; Liam Barry[3]; Marco Ruffini[1]; [1]CONNECT, School of Computer Science and Statistics, Trinity College Dublin; [2]CONNECT, School of Engineering, Trinity College Dublin; [3]School of Electronic Engineering, Dublin City University.*

We experimentally study the coexistence of heterogeneous Analog Radio-over-fiber and Digital-Coherent Optical signals transparently across a converged metro/PON network. Our simplified setup, based on RF generation by optical heterodyning, enables transmission of 5.8 Gb/s mmWave signals and 400 Gb/s coherent optical, within the original ROADM channel bandwidth.

Harmonie 5

09:00–10:30
Th1E • Network Architectures and Resource Allocation
Presider: Karl Tran; Genexis Group

Th1E.1 • 09:00 Invited
Digital Subcarrier-based Point-to-Multipoint Trees in ROADM-based Networks, *Nina Skorin-Kapov[1]; Pablo Pavon-Marino[2]; Marco Quagliotti[3]; Emilio Riccardi[3]; Antonio Napoli[4]; João Pedro[5]; Oscar Gonzalez de Dios[6]; [1]University Center of Defense, San Javier Air Force Base; [2]Universidad Politécnica de Cartagena; E-lighthouse Network Solutions ; [3]Telecom Italia; [4]Infinera Germany; [5]INFINERA UNIPESSOAL LDA; [6]Telefonica I+D.*

Subcarrier-based Point-to-Multipoint (P2MP) connections significantly reduce transceiver costs compared to Point-to-Point but are not natively supported by commercial ROADMs and generally occupy more spectrum. We propose forming linear hub-ended P2MP-trees which can be established by a simple presented ROADM modification while also reducing spectral occupation.

Harmonie 6

09:00–10:30
Th1F • Remote Sensing
Presider: Oskars Ozolins; RISE – Research Institutes of Sweden AB

Th1F.1 • 09:00
First Field Demonstration of Hollow-Core Fibre Supporting Distributed Acoustic Sensing and DWDM Transmission, *Ezra Ip[1]; Ming-Fang (Yvonne) Huang[1]; Yue-Kai Huang[1]; Junqiang Hu[1]; Giacomo Borraccini[1]; Abdrea d'Amico[1]; Glenn Wellbrock[2]; Tiejun Xia[2]; Jamie Lynn[3]; Danny Peterson[4]; Brian Mangan; Kyle Dube[4]; Benyuan Zhu[4]; Ting Wang[1]; Koji Asahi[3]; [1]NEC Laboratories America; [2]Verizon; [3]NEC Corporation; [4]OFS.*

We demonstrate a method for measuring the backscatter coefficient of hollow-core fibre (HCF), and show the feasibility of distributed acoustic sensing (DAS) with simultaneous 9.6-Tb/s DWDM transmission over a 1.6-km field-deployed HCF cable.

Th1F.2 • 09:15
Remote Sensing for Power Grid Fuse Tripping Using AI-Based Fiber Sensing with Aerial Telecom Cables, *Zhuocheng Jiang[1]; Yue Tian; Wataru Kohno; Sarper Ozharar; Yangmin Ding; Ting Wang; Yiyun Yao; Fei Ding; [1]NEC Laboratories America.*

For the first time, we demonstrate remote sensing of pole-mounted fuse-cutout blowing in a power grid setup using telecom fiber cable. The proposed frequency-based AI model achieves over 98% detection accuracy using distributed fiber sensing data.

Spektrum

09:00–10:30
Th1G • Devices for High-Speed Transmission
Presider: Dan Marom; Hebrew University

Th1G.1 • 09:00
AlGaAsSb APDs for 1550 nm Lidar with High Sensitivity and Reliability, *Wei Xiang[1]; Shiyong Zhang[1]; Chen Chen[1]; Jiahao Wu[2]; Yun Ding[2]; Kai Wang[1]; [1]Department of Hisilicon Optoelectronics, HUAWEI Technologies co. Ltd., China; [2]B&P Laboratory, HUAWEI Technologies Co., Ltd., China.*

We demonstrate AlGaAsSb APDs with gain of 127 and low excess noise factor of 4.0. Compared to commercial InP APDs in a 1550 nm Lidar system, a 66% reduction of laser pulse energy is required for detection of objects at 220 metre distance at room temperature.

Th1G.2 • 09:15
Ultrahigh gain-bandwidth product Ge/Si avalanche photodetector assisted by nonuniform electric field distribution, *Hengzhen Cao; Daoxin Dai; zhejiang university.*

We demonstrated a lateral Ge/Si avalanche photodetector with record ultrahigh gain-bandwidth product of 3036 GHz. A PN-type multiplication region was introduced for achieving nonuniform electric field distribution. The device exhibits a bandwidth of 33 GHz and a gain of 92 under -24 dBm optical power.

Fantasie

09:00–12:30
Optical Networking Symposium
Organisers: Piero Castoldi (Scuola Superiore Sant'Anna, Pisa)

The evolution towards 6G mobile access (terrestrial, mobile, satellite, …) will push of an evolution of the optical network infrastructure in wired segments to support many types of new diversified services. This evolution will also bring new challenges for high-capacity optical transport architectures and technologies both for the medium/long haul segment but also penetrating edge network segments closer to the to the mobile base stations and the computation/storage available in the cloud/edge continuum.

The optical network architecture, and its hardware and software components should match the increased resulting aggregated traffic, the slicing features, in terms of network capacity, latency (also supporting synchronization capabilities), packet loss, access to computing, density of connected devices, energy consumption, security, network availability and reliability, The optical network of the future must be able to cope with such capabilities, easing the interoperability among vendors and allowing operators to offer new services.

The WINE symposium aims to explore such future landscape of optical networking and its control plane evolution exploring a few technologies that can address these challenges and determine a scientific and industrial impact. WINE aims to gather experts, researchers, and practitioners to discuss directions of optical networking advancements.

See page 25 of this programme for a list of speakers and topics for this symposium.

Th1A • Advances in Hollow Core Fibers Beyond low Loss — *Continued*

Th1A.3 • 09:30
15 km Continuous Length and Low Loss Hollow Core Fiber in 1 um, C and L Bands, *Peng Li; Guoqun Chen; Jun Chu; Liyan Zhang; Lei Zhang; Jie Luo; Zhipei Li; Ran Gao; Xiangjun Xin.*

We conducted a comprehensive analysis of the optical characteristics and manufacturing challenges about hollow core fiber, ultimately selecting the second window as the optimal choice for large-scale production. Consequently, we achieved a significant milestone by successfully fabricating a 10 km and 15 km continuous length low-loss HCFs.

Th1A.4 • 09:45
Tailoring Light Coupling to Hollow-Core Fibres: Hyperbolic Micro-Lens based on Gradient-Index Section, *Joseph Zandueta[1]; Fabienne Saliou[1]; Philippe Chanclou[1]; Laurent Bramerie[2]; Mathilde Gay[2]; Achille Monteville[3]; Laurent Provino[3]; Monique Thual[2]; [1]orange innovation; [2]Institut Foton, CNRS UMR 6082, Université de Rennes; [3]Photonics Bretagne.*

We present a hyperbolic micro-lens design for mode-field adaptation, enhancing butt-coupling efficiency of a 1310 nm laser diode beam into a hollow-core fibre (HCF). Our results show a 6.5 dB improvement with -3.3 dB transmission efficiency.

Th1B • Hollow-Core Fiber and SOA — *Continued*

Th1B.3 • 09:30
Experimental Characterization and Quantitative Modeling of Transmission Impairments of Ultra-Wideband SOAs, *Hartmut Hafermann[1]; Qi Wu; Loig Godard; Iosif Demirtzioglou; Xiaohui Zhao; Shenze Wang; Nayla El Dahdah; Zhenzhen Zhang; Weili Yang; Romain Brenot; Yann Frignac; Gabriel Charlet; [1]Huawei Technologies France, Paris Research Center.*

We experimentally characterize SOA nonlinear transmission penalty using a real-time transceiver. Novel realistic models accurately predict the nonlinear penalty in system simulations. A closed-form Gaussian Noise model with working point-dependent effective parameters quantitatively explains the observations.

Th1B.4 • 09:45
Demonstration of Beyond Terabit/s/lambda Nonlinearity-free Transmission over the Hollow-core Fibre, *Yang Hong[1]; Sylvain Almonacil[1]; Haik Mardoyan[1]; Carina Castineiras Carrero[1]; Sergio Osuna[2]; Javier R. Gomez[3]; David R. Knight[4]; Jeremie Renaudier[1]; [1]Nokia Bell Labs, France; [2]Nokia, Networks Infrastructure Division; [3]Lyntia; [4]OFS Laboratories.*

We demonstrate nonlinearity-free transmission of Terabit/s/lambda PCS-64QAM signals through an HCF-based optical recirculating loop, which yields ~17.4% higher capacity than SMF-based loop under 23-dBm launch power (~13.5 dBm/channel) after 25 loops. Both lab experiment and field trial show HCF exhibits ~1.6-us/km lower latency than SMF.

Th1C • Phase-Retrieval, Self-Coherent, and Direct-Detect — *Continued*

Th1C.3 • 09:30
Colorless and Polarization-Invariant Unitary Self-Homodyne Coherent Detection in Silicon Photonics, *Yixiao Zhu[1]; Xiansong Fang[2]; Fang Zhou[3]; Ning Zhang[3]; Jinchao Dang[3]; Xiaopeng Xie[2]; Weisheng Hu[1]; Fan Zhang[2]; [1]Shanghai Jiao Tong University; [2]Peking University; [3]SiFotonics Technologies Co. Ltd.*

We propose the first colorless coherent detection featuring invariant to arbitrary polarization rotation of both signal and remote LO. We demonstrate dual-channel 1.85-Tb/s and 10.11-Tb/s self-homodyne detection in SiP platform over 10-km SSMF and 2-km 7-core MCF without optical filtering or polarization control.

Th1C.4 • 09:45
Linearization of Directly Modulated Lasers for Carrier-less Amplitude and Phase (CAP) Modulation, *Yee Hui Low[1]; Nikos Bamiedakis; David George Cunningham; Richard Vincent Penty; [1]Centre for Photonic Systems, Electrical Engineering Division, Engineering Department, University of Cambridge.*

We experimentally demonstrate for the first time a laser linearization method of directly modulated lasers (DMLs) for carrier-less amplitude and phase (CAP) modulation. The method enables 25 Gb/s CAP-4 and 32 Gb/s CAP-16 transmissions using a VCSEL specified for 10 Gb/s operation.

Th1D • Metro-Access, Fronthaul & 6G — *Continued*

Th1D.2 • 09:30 Invited
Future Converged Fixed/Mobile Access Networks in the 6G Era (Invited), *Fabienne Saliou; Philippe Chanclou; Gaël Simon; Jérémy Potet; Orange S.A..*

Enhanced connectivity, performance, efficiency, and flexibility on both 6G and future optical access networks are key factors that will be allowed by AI, Edge Computing, HS-PON/PtP, vHSPON/PtP, All-Photonic-Networks, extended CTI, Open-RAN and many more features.

Harmonie 5

Th1E • Network Architectures and Resource Allocation — *Continued*

Th1E.2 • 09:30

Flexible and Intelligent Latency Management Scheme Using Joint Resource Optimization in PTMP Fronthaul Networks, *Xi Chen[1]; Yixiao Zhu[1]; Yicheng Xu; Mengfan Fu; Leyan Fei; Weisheng Hu; Qunbi Zhuge; [1]Shanghai Jiao Tong University.*

We propose and demonstrate a flexible and intelligent latency management scheme for PTMP fronthaul networks. The latency is controlled by the optimization of power allocation and FEC decoding. The RMSE of latency is reduced by 73.8%. Multi-objective optimization provides Pareto solutions adapted to different needs.

Th1E.3 • 09:45

Field Trial of Transparent Multi-band Multi-domain Disaggregated IPoWDM Networks, *Roberto Morro[1]; Emilio Riccardi[1]; Anna Chiado' Piat[1]; Annachiara Pagano[1]; Alessio Giorgetti[2]; Evangelos Kosmatos[3]; Shiyi Xia[4]; Henrique Freire Santana[4]; Nicola Calabretta[4]; Pol Gonzalez Pacheco[5]; Luis Velasco[5]; Andrea Sgambelluri[6]; Pablo Pavon-Marino[7]; Enrique Fernandez[8]; Jordi Ortiz[7]; Alexandros Stavdas[3]; Chris Matrakidis[3]; Filippo Cugini[9]; Laia Nadal[10]; Ramon Casellas[10]; Oscar Gonzales De Dios[11]; [1]TIM; [2]University of Pisa, Italy; [3]OpenLightComm; [4]Eindhoven University of Technology; [5]UPC; [6]Scuola Superiore Sant'Anna; [7]UPCT; [8]E-lighthouse network soultions; [9]CNIT- National Inter-University Consortium for Telecommunications; [10]Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA); [11]Telefonica.*

First field trial of IPoWDM optical continuum between access, horseshoe aggregation, and metro mesh networks operating over multiple bands. Hierarchical control plane is extended to enforce transparent end-to-end paths across multiple domains, bands, and layers.

Harmonie 6

Th1F • Remote Sensing — *Continued*

Th1F.3 • 09:30

Earthquake Detection using State-of-Polarisation Sensing on Aerial Cable, *Kristina Shizuka Yamase Skarvang[1]; Daniel J. Elson[2]; Shohei Beppu[2]; Daiki Soma[2]; Steinar Bjørnstad[3]; Dag Roar Hjelme[1]; Yuta Wakayama[2]; [1]Norwegian University of Science & Technology – NTNU; [2]KDDI Research, Inc.; [3]Tampnet.*

We present the first observation of an earthquake using state-of-polarisation monitoring on an aerial cable. Vibration enhanced by the power poles propagates to the fibre cable, motivating the use of densely distributed terrestrial networks for environmental sensing extending information on local geological conditions

TH1F.4 • 09:45

Coherent Optical Supervisory Channel Enabling Per-Span Real-Time Gigabit/s Transmission and Distributed Sensing, *Mikael Mazur[1]; Ruben Luis[2]; Benjamin Puttnam[2]; Nicolas Fontaine[1]; Roland Ryf[1]; Georg Rademacher[3]; Lauren Dallachiesa[1]; Haoshup Chen[1]; David Winter[1]; Erik Borjeson[4]; Per Larsson-Edefors[4]; Hideaki Furukawa[2]; David Neilson[1]; [1]Nokia Bell labs USA; [2]NICT Japan; [3]University of Stuttgart; [4]Chalmers University of Technology.*

We demonstrate a real-time coherent optical supervisory channel over ~90 km field fiber in Tokyo, Japan. The data signal is frequency multiplexed with a chirped pulse waveform, enabling distributed acoustic sensing and data transmission with DSP-based integrated link sensing in one device.

Spektrum

Th1G • Devices for High-Speed Transmission — *Continued*

Th1G.3 • 09:30 **Tutorial**

Plasmonic-based devices for ultrafast communication, *N.N. Paper(116342); Juerg Leuthold[1]; [1]ETH Zurich.*

Plasmonics is a powerful technology enabling electro-optical modulators and detectors with bandwidths in excess of 500 GHz. This tutorial is designed as an overview on the theory as well as on the latest developments. The summary below is meant as reference for the cited literature.

Fantasie

Optical Networking Symposium — *Continued*

Harmonie 1

Th1A • Advances in Hollow Core Fibers Beyond low Loss — *Continued*

Th1A.5 • 10:00 Invited

High energy transmission in hollow core fibers, *Rodrigo Amezcua Correa; CREOL, University of Central Florida.*

Recent developments in hollow fiber design have enable high energy transmission not possible in solid core fibers. We discuss single-mode narrow-linewidth multi-kW laser transmission not antiresonant hollow core fibres.

Harmonie 2

Th1B • Hollow-Core Fiber and SOA — *Continued*

Th1B.5 • 10:00 Invited

Beyond 200 Terabit per Second S+C+L-band Transmission over Ultra-Wideband Anti-Resonant Hollow-Core Fibre, *Zhixue He[1]; Chao Li[1]; Xumeng Liu[1]; Zichen Liu[1]; Qibing Wang[1]; Siyue Jin[1]; Hui Chen[1]; Ming Luo[2]; Xu Zhang[2]; Shoufei Gao[3]; Yingying Wang[3]; Wei Ding[3]; Lei Wang[1]; Shaohua Yu[1]; [1]Peng Cheng Laboratory, Shenzhen, China; [2]China Information Communication Technologies Group Corporation; [3]Jinan University.*

Supported by our recent progress in fabrication and characterization of low-loss, broadband anti-resonant hollow-core fiber (AR-HCF), we demonstrate the great potential of AR-HCF in ultra-high-capacity coherent DWDM transmission by exploiting its wider usable bands, achieving record capacity of beyond 200 Tb/s in entire S+C+L-band.

Harmonie 3

Th1C • Phase-Retrieval, Self-Coherent, and Direct-Detect — *Continued*

Th1C.5 • 10:00

5-Dimensional Coherent Receiver with Modulated Remote LO, *Yixiao Zhu[1]; Xiansong Fang[2]; Jiayu Zheng[2]; Weisheng Hu[1]; Fan Zhang[2]; [1]Shanghai Jiao Tong University; [2]Peking University.*

We propose the first 5-dimensional coherent receiver leveraging a DSB- or SSB-modulated remote local oscillator and digital field reconstruction. We experimentally demonstrate single-channel net 1.2-Tb/s PS-256-QAM signal 25-km single-mode fiber transmission within only 47.5-GHz electrical bandwidth, achieving a 25.3-b/s/Hz net electrical spectral efficiency.

Th1C.6 • 10:15

CNN Outperforms MMSE Filtering at Equal Complexity While Combating Chromatic Dispersion in PAM, *Shen Li; Amir Omidi; Benoît Paquin; Zibo Zheng; Alireza Geravand; Wei Shi; Ming Zeng; Leslie Rusch; ECE Department, COPL, Université Laval.*

To combat chromatic dispersion in short reach direct detection, we improve on traditional linear filters minimizing mean square error. We demonstrate experimentally a convolutional neural network at equal complexity reducing required SNR by over 1 dB, and by 2 dB combined with unequally spaced PAM4.

Harmonie 4

Th1D • Metro-Access, Fronthaul & 6G — *Continued*

Th1D.3 • 10:00

Experimental Demonstration of 291 Gb/s/λ DSCM-WDM Metro-access Networks Leveraging SOA-based OADM Nodes, *Zhouyi Hu; Vincent van Vliet; María Freire-Hermelo; Shiyi Xia; Menno van den Hout; Chigo Okonkwo; Nicola Calabretta; Eindhoven University of Technology.*

For the first time, we experimentally demonstrate SOA-based optical add/drop multiplexer (OADM) nodes for dynamic wavelength drop & add operations in high-speed coherent DSCM-WDM metro-access networks. Results show 291 Gb/s/λ net data rate coherent DSCM transmission with highly flexible switching, supporting up to 5 nodes.

Th1D.4 • 10:15

Demonstration of 200 Gbps Coherent DSCM PON Fronthaul Transmission and Scheduling by an Open RAN Intelligent Controller, *Dongxu Zhang; Xiaofeng Hu; Xiaoan Huang; Kaibin Zhang; Nokia Shanghai Bell.*

This paper presents a proof-of-concept demonstration of RAN Intelligent Controller scheduled fronthaul over a coherent PON testbed. The optical transport layer supports flexible digital subcarrier configurations, offering a maximum capacity over 200 Gbps, and can be programmed through the O-RAN specified E2 interface.

10:30–11:00 Coffee Break, Conference Center

Th1E • Network Architectures and Resource Allocation — *Continued*

Th1E.4 • 10:00
DRL-Assisted Dynamic QoT-Aware Service Provisioning in Multi-Band Elastic Optical Networks, *Yiran Teng[1]; Carlos Natalino[2]; Farhad Arpanaei[3]; Alfonso Sánchez-Macián[3]; Paolo Monti[2]; Shuangyi Yan[1]; Dimitra Simeonidou[1]; [1]University of Bristol; [2]Chalmers University of Technology; [3]Universidad Carlos III de Madrid.*

We propose a DRL-assisted approach for service provisioning in multi-band elastic optical networks. Our simulation environment uses an accurate QoT estimator based on the GN/EGN model. Results show that the proposed approach reduces request blocking by 50% compared with heuristics from the literature.

Th1E.5 • 10:15
ADMIRE_SCALE: A Scalable Routing with Hierarchical Rein-forcement Learning in Large-Scale IPoDWDM Networks, *Ziyi Wu[1]; JiaWei Zhang; Huangxu Ma; Zheng Zhang; Zhiqun Gu; Yuefeng Ji; [1]BeiJing University of Post and Telecommunication.*

We propose ADMIRE_SCALE, a distributed collaborative data-driven and model-driven routing engine in large-scale IPoDWDM networks. By problem decomposition and the introduction of hierarchical reinforcement learning, more than 60% training time and decision-making time saving have been achieved in two real-world network topologies compared to ADMIRE.

Th1F • Remote Sensing — *Continued*

Th1F.5 • 10:00
SOP-based Sensing for Detecting Different Anomalous Events: Practical Implementation Considerations, *Saverio Pellegrini[1]; Giuseppe Rizzelli[1]; Leonardo Minelli[1]; Lorenzo Andrenacci[1]; Dario Pilori[1]; Gabriella Bosco[1]; Claudio Crognale[2]; Stefano Piciaccia[2]; Roberto Gaudino[1]; [1]DET, Politecnico di Torino; [2]CISCO Photonics Italy srl.*

We show the measured time evolution of the State of Polarization (SOP) for various experimentally generated events on an installed metropolitan fiber, discussing the sample rate requirements for future SOP-based sensing systems and the consequent impact on the related telemetry system.

Th1F.6 • 10:15
A Sub-THz ISAC System with Simultaneous Real-Time 125.516-Gbps Communication Rate and Offline 10-mm Sensing Resolution Enabled by Photonics, *Qingzhi Zhou[1]; Mingzheng Lei[2]; Junhao Zhang[1]; Hao Li[1]; Bingchang Hua[2]; Yuancheng Cai[2]; Jiao Zhang[2]; Junjie Ding[2]; Bo Liu[3]; Zewei Zhang[1]; Jiale Zheng[1]; Jianjun Yu[4]; Min Zhu[1]; [1]National Mobile Communications Research Laboratory, Southeast University, Nanjing 210096, China; [2]Purple Mountain Laboratories, Nanjing 211111, China; [3]Nanjing University of Information Science & Technology, Nanjing 210044, China; [4]Key Laboratory for Information Science of Electromagnetic Waves, Fudan University, Shanghai, 200433, China.*

We demonstrate a photonic sub-THz integrated sensing and communication system. Real-time 125.516-Gbps data rate and offline 10-mm ranging resolution are achieved simultaneously in the 120–150 GHz band, enabled by a 2×2 MIMO fiber-wireless-fiber communication architecture and homologous sensing down-conversion mechanism.

Th1G • Devices for High-Speed Transmission — *Continued*

Optical Networking Symposium — *Continued*

10:30–11:00 Coffee Break, Conference Center

Harmonie 1

11:00–12:30
Th2A • QKD Field Trials
Presider: Catherine White; BT PLC

Th2A.1 • 11:00
Entanglement-Based Quantum Key Distribution with Time and Frequency Dissemination on the Niedersachsen Quantum Link, *Ann-Kathrin Kniggendorf; Ali Hreibi; Alexander Kuhl; Jochen Kronjäger; Stefan Kück; Physikalisch-Technische Bundesanstalt (PTB).*

The intercity fibre network testbed for time and frequency dissemination (TFD) between PTB in Braunschweig and Leibniz University in Hannover, Germany, was successfully equipped for concur-rent quantum key distribution and time and frequency dissemination, using commercial TFD and QKD systems and a separable fibre configuration.

Th2A.2 • 11:15
Field Demonstration of a Fully Managed, L1 Encrypted 3-Node Network with Hybrid Relayed-QKD and Centralized Symmetric Classical Key Management, *Nikolaos Makris[1]; Konstantinos Tsimvrakidis[1]; Alkinoos Papageorgopoulos[1]; Persefoni Konteli[1]; Yannick Gautier[2]; Marco Terenziani[2]; Eric Daudin[2]; Dimosthenis Ntoulias[2]; Thanasis Fragkioudakis[2]; Ian Meletios[2]; Michele Mosca[3]; Dale Hobbs[3]; Tony Rosati[3]; Ilias Papastamatiou[4]; Ognjen Prnjat[4]; Kostas Koumantaros[4]; Dimitris Mitropoulos[4]; Jean-Robert Morax[5]; Bruno Huttner[5]; Kostas Christodoulopoulos[1]; George T. Kanellos[1]; Dimitris Syvridis[1]; [1]NKUA , Department of Informatics and Telecommunications ; [2]Nokia; [3]EvolutionQ Inc.; [4]GRNET S.A. – National Infrastructures for Research and Technology; [5]ID QUANTIQUE S.A.*

We successfully demonstrated a fully-managed, field-deployed, three-node QKD ring network with L1-OTNsec encryption. The network employs a hybrid scheme of QKD and classical yet quantum-safe central-

Harmonie 2

11:00–12:30
Th2B • Submarine and Long-Haul
Presider: Jeremie Renaudier; Nokia Bell Labs

Th2B.1 • 11:00
16.1 Tb/s, 363 km, Unrepeatered C-band Transmission with Bidirectional Raman Amplification without ROPA, *Daniele Orsuti[1]; Ruben S. Luís[2]; Benjamin J. Puttnam[2]; Manuel S. Neves[2]; Divya A. Shaji[2]; Budsara Boriboon[2]; Luca Palmieri[1]; Hideaki Furukawa[2]; Cristian Antonelli[3]; [1]Department of Information Engineering, University of Padova, Via G. Gradenigo 6/B, 35131, Padova; [2]National Institute of Information and Communications Technology (NICT); [3]L'Aquila University.*

We report C-band unrepeatered transmission of 175 x 24.5 GBaud channels over a record distance of 363 km using bidirectional Raman amplification without ROPA, achieving a net throughput of 16.1 Tb/s.

Th2B.2 • 11:15
First Single-Carrier Transmission at Net Data Rates of 1.6 Tb/s over 9075 km and 2.4 Tb/s over 1210 km Using 300 GBd Dual-Polarization Signals and Probabilistic Constellation Shaping, *Haïk Mardoyan[1]; Daniel Drayss[2]; Sylvain Almonacil[1]; Dengyang Fang[2]; Alban Sherifaj[2]; Amirhossein Ghazisaeidi[1]; Mohamed Kelany[2]; Carina Castineiras Carrero[1]; Christian Koos[3]; Jeremie Renaudier[1]; [1]Nokia Bell Labs; [2]Institute of Photonics and Quantum Electronics (IQP), Karlsruhe Institute of Technology, Karlsruhe; [3]Institute of Microstructure Technology (IMT), Karlsruhe Institute of Technology, Eggenstein-Leopold-Shafen.*

We report long-haul transmissions of single-carrier 300 GBd dual-polarization signals with optical arbitrary waveform generation and measurement. We demonstrate net 1.6 Tb/s over 9075 km with PCS-16QAM and 2.4 Tb/s over 1210 km with PCS-36QAM.

Harmonie 3

11:00–12:30
Th2C • VCSEL Arrays & Optical Multiport Packaging
Presiders: Daniel Kuchta; IBM Research; Janet Chen; Nvidia

Th2C.1 • 11:00 Upgraded Invited
An Ultra-Compact CPO Transceiver based on 1060-nm Single-Mode VCSEL Array and Multi-Core Fibre, *Tomonori Azuma[1]; Kazuya Nagashima[2]; Liang Dong[3]; Wataru Yoshida[2]; Yoshihiro Harada[1]; Kensho Nishizaki[2]; Makoto Miyoshi[1]; Xiaodong Gu[3]; Takatoshi Yagisawa[1]; Hideyuki Nasu[2]; Fumio Koyama[3]; [1]Fujitsu Optical Components Limited; [2]Furukawa Electric Co., Ltd.; [3]Tokyo Institute of Technology.*

We propose an ultra-compact CPO transceiver based on 1060-nm coupled-cavity single-mode VCSEL array and single-mode MCF, with double-sided FC-bonding and direct MCF butt-coupling. The fabricated 25-Gb/s × 16-channel CPO is as small as < 1 cm3. We demonstrate 2-km optical transmission covering inside of data-centres.

Harmonie 4

11:00–12:30
Th2D • Atmospheric Turbulence Mitigation for FSO
Presider: Eduward Tangdiongga; Technische Universiteit Eindhoven

Th2D.1 • 11:00 Invited
Can DSP mitigate the effect of turbulence on FSO signals?, *Fernando Guiomar; Marco Fernandes; Manuel Freitas; Bruno Brandão; Gil Fernandes; Paulo Monteiro; Instituto de Telecomunicações, University of Aveiro.*

FSO systems are known to be strongly impaired by atmospheric turbulence. Resorting to a 1.8 km multi-Terabit field-trial experiment, we expose the crucial role played by data-rate adaptability and the respective associated DSP challenges and practical implementation issues.

Harmonie 5

11:00–12:30
Th2E • Optical Node Architectures
Presider: Alexandros Stavdas; OpenLightComm

Th2E.1 • 11:00
Demonstration of Spatial- and Wavelength-Channel Routing with Polarity Management Using Spatial Cross-Connects Based on Hermetically Sealed 19-CF Core Selective Switch Modules and Cladding-Pumped 19-CF EDFA Modules, *Takuma Izumi[1]; Ryohei Otowa[2]; Yusuke Matsuno[3]; Kyosuke Nakada[1]; Yuji Hotta[2]; Tsubasa Sasaki[3]; Rika Tahara[1]; Koichi Maeda[3]; Yasuki Sakurai[2]; Ryuichi Sugizaki[3]; Masahiko Jinno[1]; [1]Kagawa University; [2]santec AOC corporation; [3]Furukawa Electric Co., Ltd.*

We demonstrate spatial-channel and wavelength-channel routing, spatial-channel protection, and software-based polarity management of a core selective switch (CSS) in a spatial-channel network testbed. The testbed comprises three spatial cross-connects that are constructed using hermetically sealed compact 19-CF CSS modules and cladding-pumped 19-CF EDFA modules.

Th2E.2 • 11:15
Cross-optical-and-electrical Layer Hitless Rate Adjustment Based on Probabilistic Shaping and Real-time In-line Rate Indicator, *Sheng Liu[1]; Tao Gui[2]; Dawei Ge; Yunbo Li; Dong Wang; Liuyan Han; Dechao Zhang; Han Li; [1]China Mobile Research Institute; [2]Huawei Technologies Co. Ltd.*

Cross-optical-and-electrical-layer hitless data rate adjustment, facilitated by probabilistic shaping and real-time in-line data rate indicators, is proposed, practically capable of getting close to the Shannon limit in field by reducing the link margin. Hitless rate adjustment is experimentally demonstrated with ~1.1 dB clipping penalty.

Harmonie 6

Spektrum

11:00–12:30
Th2G • Resonator-Based Modulators
Presider: Eric Bernier; Huawei Technologies Canada, Co., LTD.

Th2G.1 • 11:00
Graphene-Organic Ring Modulator for High Data Rate Optical Communications, *Xinzhi Zhang[1]; Ping Ma; Yannik Horst; Tobias Blatter; Daniel Chelladurai; Wolfgang Heni; Bertold I. Bitachon; Alexandros Emboras; Tatsuhiko Watanabe; Andreas Messner; Patrick Habegger; Nikolaus Floery; Daniel Rieben; Lukas Novotny; Delwin L. Elder; Larry R. Dalton; Juerg Leuthold; [1]ETH Zurich.*

An efficient ring modulator based on the graphene-organic platform is presented. High speed data modulation of 128 GBd is demonstrated. Our active device features a length of 50 µm and on-chip losses as low as 2 dB. The device is compatible with the silicon-on-insulator platform.

Th2G.2 • 11:15
BTO-on-SiN Platform for 200 GBd Communications in the O- and C-band, *Manuel Kohli[1]; Daniel Chelladurai[1]; Laurenz Kulmer[1]; Tobias Blatter[1]; Yannik Horst[1]; Killian Keller[1]; Michael Doderer[1]; Joel Winiger[1]; David Moor[1]; Andreas Messner[1]; Tatiana Buriakova[2]; Clarissa Convertino[3]; Felix Eltes[3]; Yuriy Fedoryshyn[1]; Ueli Koch[1]; Juerg Leuthold[1]; [1]ETH Zurich / Institute of Electromagnetic Fields (IEF); [2]Ligentec SA; [3]Lumiphase AG.*

We introduce the BTO-on-SiN technology as a universal platform for next-generation Tbit/s transmitters. Using nano-scaled plasmonics, we demonstrate a BTO IQ modulator in the C-band and a racetrack modulator with 2 dB on-chip losses in the O-band operating at 224 and 200 GBd, respectively.

Fantasie

Optical Networking Symposium
— Continued

Th2A • QKD Field Trials — *Continued*

ly-generated symmetric keys to support point-to-point and relay consumers.

Th2A.3 • 11:30 Invited

Pan-European QKD Deployments within the EuroQCI Initiative, *Felix Wissel[1]; Keith Elder[2]; Daniel Giemsa[3]; Matthias Gunkel[3]; Oleg Nikiforov[3]; [1]Deutsche Telekom Geschäftskunden GmbH; [2]Deutsche Telekom Global Business Solutions Belgium; [3]Deutsche Telekom Technik GmbH.*

This paper provides an introduction to EuroQCI and its history including a view on the funding landscape and current programmes. We give insight into the current state of play concerning selected deployment initiatives and conclude with lessons learnt and an outlook to next steps.

Th2B • Submarine and Long-Haul — *Continued*

Th2B.3 • 11:30

Silicon Carbide-on-Insulator Dark-Pulse Kerr Comb for DWDM Ultra-Long-Haul Fiber Communications, *Smaranika Swain[1]; Yi Zheng[1]; Aliun Yi[2]; Yang Liu[1]; Liping Zhou[2]; Chengli Wang[2]; Metodi Plamenov Yankov[1]; Michael Galili[1]; Kristen Yvind[1]; Xin Ou[2]; Minhao Pu[1]; Leif Katsuo Oxenløwe[1]; [1]Technical University of Denmark; [2]Shanghai Institute of Microsystem and Information Technology.*

We present the first demonstration of using a Si-COI-based optical frequency comb for long-haul transmission and find error-free performance of polarization division multiplexed 25-GBaud probabilis-tically-constellation-shaped QAM signal after 8100 km. The experiment demonstrates the highest spectral efficiency for the longest DWDM comb-based fiber transmission.

Th2B.4 • 11:45

Experimental Investigation into Split Nonlinearity Compensation in Single and Multi-channel WDM Systems, *Ronit Sohanpal; Eric Sillekens; Jiaqian Yang; Rômulo Aparecido; Zhixin Liu; Robert Killey; Polina Bayvel; Optical Networks Group, UCL (University College London), London.*

We experimentally investigated the performance of split nonlinearity compensation schemes for single and multi-channel WDM systems. We show that split NLC SNR gains of more than 0.4 dB at 5540 km can be achieved compared to transmitter- or receiver-side DBP alone when signal-ASE beating limits transmission performance.

Th2C • VCSEL Arrays & Optical Multiport Packaging — *Continued*

Th2C.2 • 11:30

1.6 Tbps Coarse-Wavelength-Division-Multiplexing O/E Converter for Active Optical Package, *Naoki Matsui[1]; Akihiro Noriki[2]; Haruhiko Kuwatsuka[2]; Fumi Nakamura[2]; Satoshi Suda[2]; Takayuki Kurosu[2]; Takeru Amano[2]; Satoshi Ishikawa[1]; Hiromichi Yoshikawa[1]; Reona Motoji[1]; Dan Maeda[1]; Tomoya Sugita[1]; Hirotaka Uemura[1]; [1]KYOCERA corporation; [2]National Institute of Advanced Industrial Science and Technology (AIST).*

We developed a 1.6 Tbps optical/electrical (O/E) converter with an organic interposer. This converter supports coarse-wavelength-division multiplexing and includes polarization insensitive receiver circuits. It embeds all photonic functions into a package substrate, paving the way for a new class of co-packaged optics

Th2C.3 • 11:45

Solder-Reflow Resistant Thermoplastic Resin Single-Mode Micro-Lens Array for Integrated Photonic Packaging, *Kamil Gradkowski[1]; Gabrie Hoogland[2]; Florian Jung[2]; Young Joon Choi[2]; Jos van Gisbergen[2]; Peter Johnson[2]; Richard Pitwon[3]; Alexander Hartwig[4]; Ronald Koh[5]; Peter O'Brien[1]; [1]Tyndall National Institute; [2]SABIC; [3]Resolute Photonics; [4]DELO Industrial Adhesives; [5]TNC Optics & Technologies.*

We demonstrate a pluggable optical coupling between a fibre array and a photonic integrated circuit (PIC) using single-mode microlens arrays (MLAs) moulded from a solder-reflow resistant thermo-plastic resin. This demonstration offers a potential for co-packaged optics, with easy to scale, and relatively low cost MLAs.

Th2D • Atmospheric Turbulence Mitigation for FSO — *Continued*

Th2D.2 • 11:30

Strong Atmospheric Turbulence Compensation Using Adaptive Optics and Mode Diversity Reception over a 15.6 km Horizontal Free Space Optical Communication Link, *Wenjie Guo[1]; Kejia Xu[1]; Yan Li[1]; Chao Liu[2]; Bin Lan[3]; Kaihe Zhang[4]; Zhengjie Wang[1]; Shuai Wei[1]; Jingwei Song[1]; Hongxiang Guo[1]; Zhisheng Yang[1]; Jian Wu[1]; [1]Beijing University of Posts and Telecommunications; [2]National Laboratory on Adaptive Optics Institute of Optics and Electronics, Chinese Academy of Sciences Chengdu, China; [3]Key Laboratory on Adaptive Optics, Chinese Academy of Sciences, Sichuan Chengdu 610209, China; [4]Institute of Optics and Electronics, Chinese Academy of Sciences, Sichuan Chengdu 610209, China.*

This study experimentally validates the effectiveness of adaptive optics (AO) combined with mode diversity reception (MDR) for turbulence compensation in a 15.6 km outdoor horizontal free-space optical (FSO) communication link.

Th2D.3 • 11:45

Enhanced Atmospheric Turbulence Resiliency in Free Space Optical Communication with Silicon-Photonics Based Grating Coupler Array and Maximal-Ratio-Combining (MRC) Algorithm, *Tzu-Chieh Wei[1]; Yuan-Zeng Lin[1]; Pin-Cheng Kuo[1]; Yin-He Jian[1]; Chi-Wai Chow[1]; David W. U. Chan[2]; Yeyu Tong[3]; Chien-Hung Yeh[4]; Hon Ki Tsang[2]; [1]National Yang Ming Chiao Tung University; [2]Chinese University of Hong Kong; [3]Hong Kong University of Science and Technology; [4]Feng Chia University.*

We propose and demonstrate an atmospheric-turbulence-mitigation scheme using an integrated vertical-grating-coupled Germanium-Silicon (GeSi) photodiode (PD) array processed with maximal-ratio-combining (MRC). Experimental results show improved outage probability at data-rate 46.4-Gbit/s, achieving hard-decision-forward-error-correction (HD-FEC) bit-error-rate (BER) threshold.

Th2E • Optical Node Architectures
— Continued

Th2E.3 • 11:30 Invited

Optical Switching Challenges for the Post-Moore's Law Era, *Shu Namiki; AIST.*

This invited talk will review the historical background why the demise of Moore's law and the scaling of large language models is leading to the increased interest in optical switching and discuss the opportunities and challenges of optical switches with respect to different switching speeds.

Th2G • Resonator-Based Modulators
— Continued

Th2G.3 • 11:30

A 40 Gb/s NRZ O-band Silicon Disk Modulator with 5.4 THz FSR and 60 GHz/mW Heater Efficiency, *Minkyu Kim; Javad Rahimi; Guy Lepage; Rafal Magdziak; Peter De Heyn; Dimitrios Velenis; Filippo Ferraro; Yoojin Ban; Joris Van Campenhout; imec.*

We present a disk modulator with 5.4 THz free spectral range (FSR), 19.5 GHz bandwidth, and 55 pm/V modulation efficiency, targeting high-channel-count low-power DWDM optical links. We demonstrate 40 Gb/s NRZ operation with 0.8 Vpp voltage swing, and a thermal tuning efficiency of 60 GHz/mW.

Th2G.4 • 11:45

Segmented MZM Enhanced Silicon Coupling-Modulated Ring Resonator Modulator Operating up to 170-GBaud for Coherent Applications, *Xi (Vivian) Chen[1]; Ajay Mistry[2]; K. Padmaraju[2]; M. Malinowski[2]; K.W. Kim[1]; D. Che[1]; R. Shi[2]; D. Gill[2]; R. Sukkar[2]; R. Younce[2]; A. Horth[2]; T. Verolet[2]; Y. Dziashko[2]; H. Guan[2]; A. Seyoum[2]; J. Naik[2]; A. El Sayed[2]; A. Rylyakov[2]; M. Schmidt[2]; Z. Luo[2]; R. Patel[2]; P. Magill[2]; G. Burrell[2]; P. Galli[2]; J. Basak[2]; D. Chapman[2]; A. Mikami[2]; Y. Man[2]; M. Ziebell[2]; A. Leven[2]; N. A. F. Jaeger[3]; [1]Nokia Bell Labs; [2]Nokia Advanced Optics; [3]The Univ. of British Columbia.*

We present a high bandwidth, silicon ring-resonator modulator, based on coupling modulation via a dual-segment traveling-wave Mach-Zehnder modulator. We modulate using 150-GBaud and 170-GBaud multi-level signalling, achieving a net data rate up to 341-Gb/s.

Optical Networking Symposium
— Continued

Harmonie 1

Th2A • QKD Field Trials — *Continued*

Th2A.4 • 12:00
Comparison of Discrete and Continuous Variable Quantum Key Distribution in Passive Optical Networks, *Alessandro Gagliano[1]; Eliana Mazza[1]; Alberto Gatto[1]; Pierpaolo Boffi[1]; João dos Reis Frazão[2]; Aaron Albores-Mejia[2]; Chigo Okonkwo[2]; Michela Svaluto Moreolo[3]; Paolo Martelli[1]; Paola Parolari[1]; [1]Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano; [2]High-Capacity Optical Transmission Laboratory, Eindhoven University of Technology; [3]Centre Tecnològic de Telecomunicacions de Catalunya (CTTC/CERCA).*

Integrating quantum key distribution (QKD) into passive optical networks (PONs) poses challenges due to high losses from passive splitters and spontaneous Raman scattering noise from coexisting classical channels. This paper compares the performance of upstream discrete-variable and continuous-variable QKD systems in single-fibre bidirectional PONs.

Th2A.5 • 12:15
Coherent Quantum Key Distribution Across National Scale Telecommunication Infrastructure, *Mirko Pittaluga[1]; Yuen San Lo[1]; Adam Brzosko[1]; Robert Woodward[1]; Matthew Winnel[1]; Thomas Roger[1]; James Dynes[1]; Piotr Rydlichowski[2]; Domenico Vicinanza[3]; Guy Roberts[3]; Andrew Shields[1]; [1]Toshiba Europe Ltd; [2]Poznan Supercomputing and Networking Centre; [3]GÉANT Vereniging.*

Presented is the first successful integration of coherent Quantum Communications into standard telecommunication infrastructure, spanning 254 km between Frankfurt and Strasbourg. Using the Twin-Field Quantum Key Distribution protocol, a secure key exchange of 110 bit/s was achieved. This milestone advances quantum internet prospects.

Harmonie 2

Th2B • Submarine and Long-Haul — *Continued*

Th2B.5 • 12:00
Unrepeatered C-Band Transmission of 35.1 Tb/s Capacity over 300 km using Real Time 125 GBd PCS-64-QAM, *Alexis Busson; Hans Bissessur; Farana Hedaraly; Alexandru Trifu; Alain Hugbart; Alcatel Submarine Networks.*

We present a 125 GBd high baud rate record C-band unrepeatered experiment with 39 channels at 900 Gb/s single carrier net rate carrying PCS-64-QAM with real-time transponder over 300 km of low-loss high effective-area optical fibre, applying co-Raman propagation and third-order counter-Raman amplifi-cation.

Th2B.6 • 12:15
Experimental Evaluation of an Unrepeatered Link Using C, L, and U Transmission Bands, *Divya A. Shaji[1]; Daniele Orsuti[1]; Ruben S. Luis[1]; Benjamin J. Puttnam[1]; Manuel S. Neves[1]; Budsara Boriboon[1]; Dini Pratiwi[2]; Ian Phillips[2]; Mingming Tan[2]; Aleksandr Donodin[2]; Wladek Forysiak[2]; Luca Palmieri[3]; Antonio Mecozzi[4]; Cristian Antonelli[4]; Hideaki Furukawa[1]; [1]National Institute of Information and Communications Technology, Tokyo, Japan; [2]Aston University, Aston Institute of Photonics Technologies; [3]Department of Information Engineering, University of Padova, Via G. Gradenigo 6/B, 35131, Padova; [4]University of L'Aquila, Italy.*

We investigate C+L+U bands unrepeatered transmission of 520 × 24.5 GBaud PM-16QAM signal over 257.1 km. The system uses distributed Raman amplification as well as erbium doped fiber amplifiers for the C+L bands and lumped Raman amplifiers for the U band.

Harmonie 3

Th2C • VCSEL Arrays & Optical Multiport Packaging — *Continued*

Th2C.4 • 12:00
A 1.6-Tbps (16-ch x 100 Gbps PAM-4) Single-mode VCSEL array for Multi-core Fiber-based Co-packaged Optics, *Liang Dong[1]; Xiaodong Gu[2]; Fumio Koyama[1]; [1]Tokyo Institute of Technology; [2]Tokyo Institute of Technology/Ambition Photonics Inc..*

We demonstrate 16-ch x 100 Gbps PAM-4 single-mode 1060-nm VCSEL array for 1.6 Tbps multi-core fibre Co-packaged Optics. A high modulation-bandwidth of 33 GHz and single-mode operation has been realized thanks to the metal aperture coupled-cavity. A potential of higher-speed-operations of 90 Gbps NRZ and 130 Gbps PAM-4 is exhibited.

Harmonie 4

Th2D • Atmospheric Turbulence Mitigation for FSO — *Continued*

Th2D.4 • 12:00
Integrated Photonic Transceiver for Adaptive Mitigation of Atmospheric Turbulence in Free Space Optical Links, *Andres Martinez[1]; Seyedmohammad Seyedinnavadeh[1]; Francesco Zanetto[1]; Filippo Morandi[1]; Angelo Milani[2]; Alessandro D Acierno[2]; Laura Resteghini[2]; Francesco Morichetti[1]; Andrea Melloni[1]; [1]Politecnico di Milano (POLIMI); [2]Huawei Technologies Italia Srl.*

We present an adaptive optical transceiver implemented using an integrated programmable optical processor to reduce scintillation effects in Free Space Optical communications. We validated the transceiver performance on intensity-modulated signal at up to 25 Gbaud transmitted through an indoor setup emulating a midrange-distance link.

Th2D.5 • 12:15
Experimental Demonstration of a Narrow and Low-Divergence "Pin-Like" Beam in a 2-Gbit/s OOK FSO Link under Turbu-lence Effects when Using a Limited-Size Receiver Aperture, *Zile Jiang; Xinzhou Su; Huibin Zhou; Yue Zuo; Yuxiang Duan; Muralekrishnan Ramankrishnan; Abdulrahman Alhaddad; Hongkun Lian; Yingning Wang; Ruoyu Zeng; Zixun Zhao; Jan Tepper; Francesco Nardo; Moshe Tur; Volker Ziegler; Alan Willner.*

We demonstrate a 2-Gbit/s FSO link using pin-like beam under emulated turbulence. With a 3-mm-diameter receiver aperture, the BER of the pin-like beam is below 1e-5 under all 100 random turbulence realizations, while the Gaussian beam has a 3% outage probability (BER > 3.8e-3).

12:30–14:00 Lunch Break (on your own)

Harmonie 5

Th2E • Optical Node Architectures
— Continued

Th2E.4 • 12:00
Demonstration of a 126 nm, S+C+L band ROADM in a field-deployed fiber network, *Ruben Soares Luis[1]; Jiaqian Yang[2]; Benjamin Puttnam[1]; Eric Sillekens[2]; Mindaugas Jarmolovicius[2]; Romulo Aparecido[2]; Robert Killey[2]; Satoshi Shinada[1]; Polina Bayvel[2]; Hideaki Furukawa[1]; [1]National Institute of Information and Communications Technology (NICT); [2]Optical Networks Group, UCL (University College London), London.*

We demonstrate a multiband ROADM handling 126 nm, >155 Tb/s, S+C+L-band signals in a field deployed, metropolitan optical link. We show high-capacity S, C or L-band add&drop, bypass and grooming scenarios using a scalable architecture-on-demand approach.

Harmonie 6

Spektrum

Th2G • Resonator-Based Modulators
— Continued

Th2G.5 • 12:00 Invited
Terabit All-Silicon Micrometer-Scale Coherent Modulator, *Alireza Geravand; Zibo Zheng; Farshid Shateri; Simon Levasseur; Leslie A. Rusch; Wei Shi; Université Laval.*

An all-silicon micrometer-scale coherent modulator with transmission rates exceeding 1 Tb/s per lambda over 80 km and symbol rates up to 180 GB is demonstrated. The compact footprint enabled shoreline bandwidth densities exceeding 5 Tb/s/mm.

Fantasie

Optical Networking Symposium
— Continued

12:30–14:00 Lunch Break (on your own)

Harmonie 1	Harmonie 2	Harmonie 3	Harmonie 4
	14:00–15:30 Post Deadline Session	14:00–15:30 Post Deadline Session	14:00–15:30 Post Deadline Session
15:45–16:30 Closing Session, Harmonie 5			

Harmonie 5	Harmonie 6	Spektrum	Fantasie
		14:00–15:30 **Post Deadline Session**	
15:45–16:30 Closing Session, Harmonie 5			

Special Events

Rump Session

Tuesday, 24. September, 17:15–18:45, Illusion

Quantum technologies: Research hype or on track to commercial success?

The Rump Session is a very blunt discussion session in a hot topic area of interest to most conference attendees. The session takes place in the evening alongside some drinks. A group of outspoken and opinionated provocateurs stimulate lively audience discussions. The session is meant as an entertaining event that shines a critical light on a usually over-hyped technical topic area.

This year's Rump Session focuses on the hype around all things quantum. Quantum technologies claim to solve practically relevant problems at revolutionary levels of performance and have been devouring tens of billions invested by public and private sources over the past decades. Will these technologies live up to the high hopes put into them anytime soon, yield the expected return of investment, and create what is heralded as the second quantum revolution?

Organisers:

- Peter Winzer (Nubis Communications)
- Rupert Ursin (QTlabs)
- David Neilson (Nokia Bell Labs)

Sponsor:

HUAWEI

Founded in 1987, Huawei is a leading global provider of information and communications technology (ICT) infrastructure and smart devices. We have 207,000 employees and operate in over 170 countries and regions, serving more than three billion people around the world. We are committed to bringing digital to every person, home and organization for a fully connected, intelligent world.

EPIF – 15th European Photonic Integration Forum

Wednesday, 25. September, 18:00–20:00, Harmonie 6

Once again, JePPIX has joined forces with ePIXfab to organize the 15th edition of the European Photonic Integration Forum (EPIF). EPIF takes place during ECOC, the exact time slot will be announced shortly.

This year's event will revolve around hypes. Can quantum, LiDAR and AI be qualified as such? How do hype cycles shape the photonics industry and startup landscape? And what have we learned from the dot.com bubble? EPIF will be moderated by Kevin Williams (JePPIX) and Wim Bogaerts (ePIXfab) and will enjoy contributions from several well-known profiles in the integrated photonics industry. Interviews with keynote speakers will be followed by an engaging panel discussion.

The event is now also visible on our website: European Photonic Integration Forum (EPIF) – Jeppix[1].

Organisers:

- Kevin Willliams (JePPIX)
- Wim Bogaerts (ePIXfab)

Hack Your Research!

Wednesday, 25. September, 18:00–20:00, Illusion

Tools and Tricks for Today's Telecommunications Techies (formerly Lab Automation Hackathon)

Join us at Hack Your Research for an exciting event featuring multiple interactive demos showcasing the most powerful techniques that expert researchers and professionals use to enhance their productivity and simplify their lives. Take this chance to upgrade your work methods and engage in stimulating discussions while enjoying plenty of food and drinks in an informal, relaxed, and fun environment.

At this event, researchers will present a variety of tools, focusing mainly on free and open- source software built in easy-to-learn languages, such as Python. These tools enable you to automate menial tasks, build graphical user interfaces, visualize data, and much more —all aimed at making your life easier. After inspiring lightning talks, demos are set up around informal discussion tables, providing plenty of time for engaging conversations and questions.

Hack Your Research is an opportunity to tap into available public resources, and learn about the latest tools developed by PhD students and researchers alike. Whether you are a student or a highly experienced researcher, everyone is welcome to share and discover tools to boost their research productivity. Come and learn from the trial-and-error experiences of others, connect with peers and experts and get a kickstart in enhancing your productivity!

Organisers:

- Besma Kalla (Eindhoven University of Technology, Netherlands)
- Menno van den Hout (Eindhoven University of Technology, Netherlands)
- Vincent van Vliet (Eindhoven University of Technology, Netherlands)
- Amol Delmade (Dublin City University, Ireland)
- Giammarco Di Sciullo (University of L'Aquila, Italy)

Advisory Committee:

- Nicolas Fontaine (Nokia Bell Labs, USA Binbin Guan, Microsoft, USA)
- Roland Ryf (Nokia Bell Labs, USA)
- Jochen Schroeder (Chalmers University of Technology, Sweden)
- Marco Eppenberger (PsiQuantum, USA)

1 https://www.jeppix.eu/event/european-photonic-integration-forum-epif/

Photonics in Germany

Wednesday, 25. September, 18.00–20.00, Spektrum

This panel focuses on current and future trends in photonics research in Germany. Experts from academia, industry and government will discuss current research programs and how they foster strong interactions between industry and academia. Additionally, paths for future research and international collaborations will be discussed. The panel discussion will be followed by a networking reception. Please join this opportunity to engage with leading researchers from Germany over cold beverages to explore new and exciting research opportunities!

Organiser:

- Georg Rademacher (Director Institute of Electrical and Optical Communications, University of Stuttgart)

Confirmed Speakers:

- Mikael Gast (Deputy Head of Department Networking and Security of Digital Systems, Federal Ministry of Education and Research)
- René Bonk (Head of Department Converged Access Systems, Nokia Bell Labs Stuttgart)
- Christoph Glingener (CTO, Adtran)
- Christian Koos (Professor, Institute of Photonics and Quantum Electronics, Karlsruhe Institute of Technology)
- Andreas Gladisch (VP Emerging Technologies, Deutsche Telekom)
- Ronald Freund (Head of Department Photonic Networks and Systems, Fraunhofer Heinrich Hertz Institute)

EPIC & ECOC Career booth

Job opportunities

At the EPIC & ECOC career booth you can meet companies that are looking for new talent, talk to them about their company culture and the challenges and projects they are working on. Participants of the hackathon are also invited to participate in a booth tour through to know first-hand the technology and the job opportunities of a selected group of companies exhibiting at ECOC.

More Information: https://epic-photonics.com/events/epic-ecoc-career-booth/

We are offering a Booth Tour for young students

https://epic-photonics.com/events/ecoc-booth-tour-for-young-talent/

Interested? Register now:

https://docs.google.com/forms/d/e/1FAIpQLSdW53xhMdBW733Sov5oDcWapY-nt9_mdI9m9w2UUGUohXZEmA/viewform

Author List

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General Information

Conference Venue & Hours

Congress Center Messe Frankfurt
Ludwig-Erhard-Anlage 1
60327 Frankfurt am Main
Germany

Sunday, 18 September 08:00–20:00
Monday, 19 September 08:00–23:00
Tuesday, 20 September 08:00–20:00
Wednesday, 21 September . . . 08:00–23:00
Thursday, 22 September 08:00–17:00

Exhibition Venue & Hours

Messe Frankfurt
Ludwig-Erhard-Anlage 1
60327 Frankfurt am Main
Germany

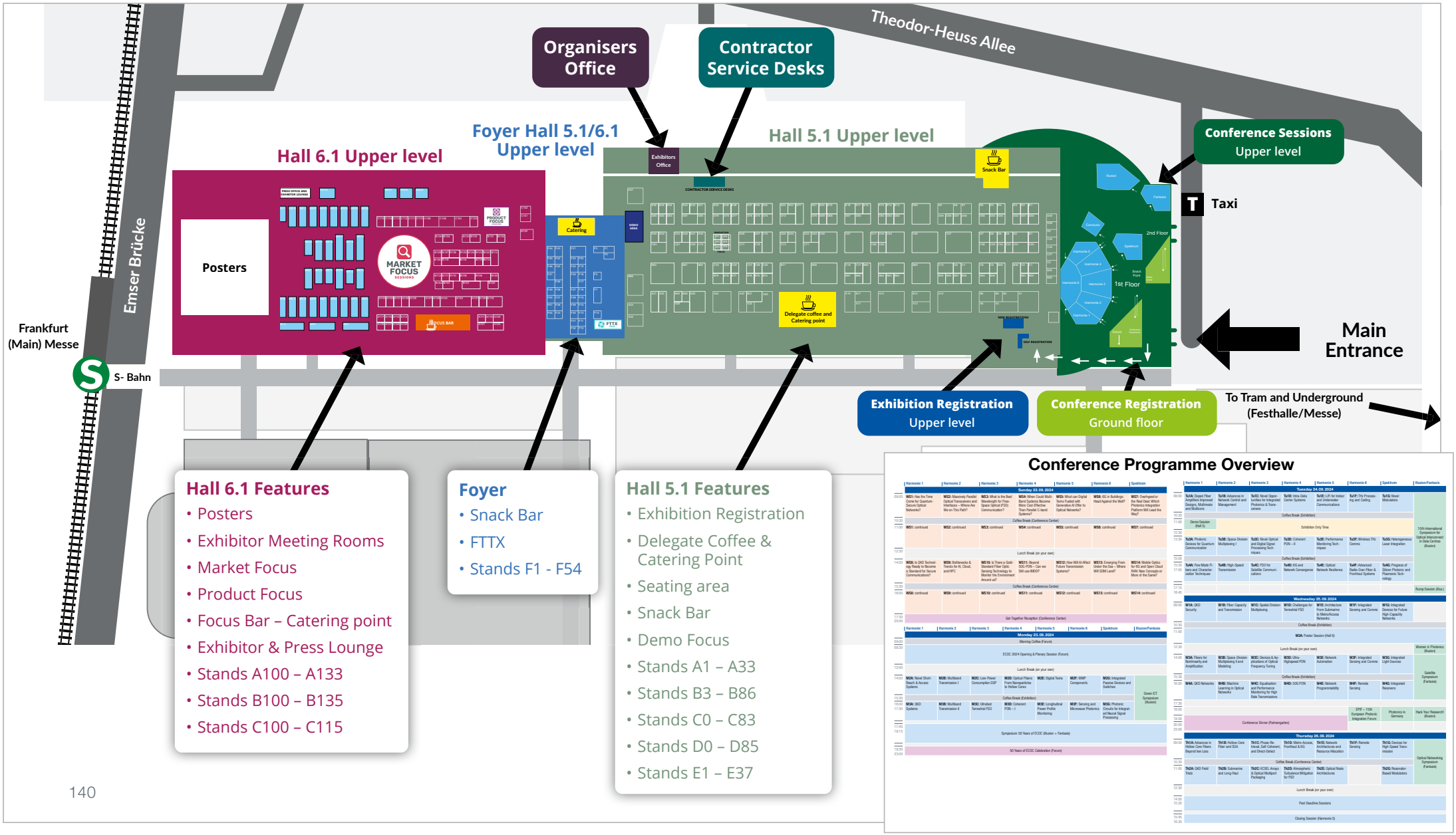
Monday, 19 September 09:30–17:00
Tuesday, 20 September 09:30–17:00
Wednesday, 21 September . . . 09:30–16:00

Media Reception / Speaker Room

Upper Level Congress Center

Sunday, 18 September 08:00–17:00
Monday, 19 September 08:00–17:00
Tuesday, 20 September 08:00–17:00
Wednesday, 21 September . . . 08:00–18:00
Thursday, 22 September 08:00–15:00

Venue Overview



Hall 6.1 Features

- Posters
- Exhibitor Meeting Rooms
- Market Focus
- Product Focus
- Focus Bar – Catering point
- Exhibitor & Press Lounge
- Stands A100 – A133
- Stands B100 – B135
- Stands C100 – C115

Foyer

- Snack Bar
- FTTX
- Stands F1 - F54

Hall 5.1 Features

- Exhibition Registration
- Delegate Coffee & Catering Point
- Seating area
- Snack Bar
- Demo Focus
- Stands A1 – A33
- Stands B3 – B86
- Stands C0 – C83
- Stands D0 – D85
- Stands E1 – E37

Conference Programme Overview

ECOC Exhibition 2024

MARKET FOCUS SESSIONS

Sponsored by:

Acacia CISCO

PRODUCT FOCUS SESSIONS

Sponsored by:

OPEN XR FORUM

FTTX FOCUS

ECOC EXHIBITION INDUSTRY AWARDS 2024

Welcome to ECOC Exhibition 2024, Europe's largest exhibition dedicated to fibre optic communication technology, and welcome to Frankfurt! Over 300 international exhibitors await you in the exhibition halls this year, along with our range of interactive features and seminars, all free to attend, to ensure you get the most out of your time at ECOC.

Exhibition Highlights

Back for it's eighteenth year, the **Market Focus theatre**, sponsored by Acacia, now part of Cisco, will once again form a hub of discussion, with over 50 sessions as well as two panel discussions , Market Focus showcases the very latest news and developments from global leaders within the industry.

As new technologies continue to emerge, and increased pressure is being placed on the networks than ever, the need for efficient and resilient optical networks has never been greater, Market Focus gives you a unique opportunity to hear the latest trends, exciting predictions and the next steps to be taken to achieve connectivity goals.

The Product Focus theatre gives you the chance to hear about some of the latest innovative products, watch live demonstrations and join in-depth sessions from EPIC, Infinera, Avicena, Ligentec, EXFO, IPEC and more.

The Product Focus theatre is also the home of the **ECOC Exhibition Industry Awards** run in conjunction with Optical Connections. The Awards highlight significant achievements in advancing the business of optical communications, transport, networking, fibre-based products, photonic integration circuits and related developments. The 2024 winners will be announced live in the Product Focus theatre on Tuesday 24th Semptember.

The **FTTx Focus** area brings together the very latest fibre to the 'x' in a dedicated area, showcasing a range of products.

The Demo Focus zone features a wide range of demonstrations, taking place on Tuesday 24th September 10:30 - 12:00.

Don't forget to join the conversation across the three days of the exhibition, by following on social media for previews, product launches, photos and highlights. Tweet us @ecoc_exhibition to share your own news, photos and event plans, and tag us using #ecoc2024 and we will reshare as many as we can.

Thank you to our exhibitors, sponsors, partners, speakers and visitors for your continued support once again this year.

We hope your time with us is well-spent and you find everything you are looking for. We look forward to welcoming you back next year for ECOC Exhibition 2025 in Copenhagen, Denmark.

The ECOC Exhibition Team

Find more details in the Show Guide
Pick up a copy of the ECOC Exhibition Show Guide for full exhibitor listings and session timetables.

Show Team	**Emma Harvey**	Commercial Director
	Charlotte Minter	Operations Director
	Lianne Bull	Operations Manager
	Catherine Williams	Marketing Manager
	Michelle Dampier	Event Administrator
	Mark Gardner	Account Manager

EXHIBITION HALL 6.1

MARKET FOCUS SESSIONS

Sponsored by:

Acacia

CISCO

Now in its eighteenth year, the Market Focus theatre has continued to be one of the highlights of the ECOC Exhibition and a key place to get up-to-date knowledge from across the industry and discover the latest commercial trends in optical communications.

Pick up a copy of the Exhibition Show Guide for the full timetable and session details

This year we have streamlined our programme to cover the whole value chain of technologies, from optical components to optical network providers that span both telecommunications as well as data centre and data communication media services.

Hear from more than 50 expert speakers from across the industry. View the full Market Focus programme in the Exhibition Show Guide and online at ecocexhibition.com.

Market Focus Highlights

Day	Start	Finish	Title	Presenter	Company
Mon	10:00	10:15	Terrestrial core networks: Future needs for cable density and high fiber count cables	Michael Lebby	Lightwave Logic Inc
Mon	11:20	11:35	Optical Compute Interconnect: Co-packaged optics for AI and compute infrastructure	Christian Urricariet	Intel
Mon	12:40	12:55	Navigating Optical Parallelism: Comb Lasers or Laser Arrays for Next-Generation Interconnects	Frank Smyth	Pilot Photonics
Mon	13:00	13:15	Optics for AI/ML Architectures	Mark Nowell	Cisco
Mon	15:20	15:35	Next generation of fiber access	Frank Effenberger	Futurewei Technologies
Mon	16:00	16:30	Interview -Nokia and Infineon – merger of two giants in our field – exploring the impact, trends and opportunities for the industry	Jose Pozo, Michael Lebby, David Welch	
Tue	10:00	10:15	Advances in Optical Components for Datacom and Telecom Transceivers	Dr. Julie Eng	Coherent Corp
Tue	12:00	12:15	Quantum dot lasers at 300 mm for silicon photonics and datacentre optical interconnect applications	Dr Ben Stevens	IQE
Tue	12:40	12:55	Evolution of Optical Transport Networks: Innovations, Trends and Challenges of the next Decade	Sascha Vorbeck	Deutsche Telekom
Tue	13:00	13:15	Is the Future of LiDAR still so bright you have to wear shades?	Chris Phare	Voyant
Tue	14:40	14:55	Next Generation VCSEL devices for LPO and CPO	Roman Koerner	TRUMPF
Tue	13:40	13:55	Will You Need CPO In 3 Years?	Rajiv Pancholy	Broadcom Inc.
Tue	15:40	16:30	Panel Session: Next gen networking optics like 1.6 or 3.2T	Moderator: Frank Chang (Source Photonics) Andy Bechtelsheim (Arista), Dr Julie Eng (Coherent Corp), Guangcan Mi (Huawei Data Center Group), Di Zhang (Kuaishou Technology) and Craig Thompson (Nvidia)	
Wed	11:00	11:15	Energy Efficient Optics for Sustainable Scaling of AI Networks	Brian Smith	Lumentum
Wed	11:40	11:55	Data Center Interconnects in the Era of AI	Dr Loi Nguyen	Marvell
Wed	12:00	12:55	Panel Session: Linear Optics Comes of Age	Moderator: Karen Liu (Nubis Communications) Samuel Kocsis (Amphenol), Karl Muth (Broadcom), Hacene Chaouch (Arista), Tom Palkert (Macom)	
Wed	15:00	15:15	Transitioning PON to Coherent Technology for 100G and beyond	Edward Walter	Ciena

EXHIBITION HALL 6.1

PRODUCT FOCUS SESSIONS

Sponsored by:

OPEN XR FORUM

This year's Product Focus theatre, sponsored by Open XR Forum, is packed with innovative and informative presentations from companies including EPIC, Marvell, Infinera, Open XR Forum, Avicena, Chroma Germany, VLC Photonics and more.

Pick up a copy of the Exhibition Show Guide for the full timetable and session details

View the full Product Focus programme in the Exhibition Show Guide and online at ecocexhibition.com.

Product Focus Highlights

Day	Start	Finish	Title	Presenter	Company
Mon	11:20	11:50	Coherent Pluggable Technology Advancing Next Generation Optical Networks	Bo Zhang	Marvell
Mon	14:10	14:40	Real-world applications and deployment scenarios of ICE-X Intelligent Coherent Pluggables	Fady Massoud	Infinera
Mon	15:30	16:00	Integrating Active Components in Low-Loss Photonic Integrated Circuits (PICs)	Michael Geiselmann	Ligentec
Tue	10:00	11:30	The Open XR Forum Industry Update	Multiple	Infinera - Open XR Forum
Tue	11:45	12:55	ECOC Exhibition Industry Awards		ECOC Exhibition
Tue	13:40	14:40	Special Requirements for Optical Connectivity in AI	Multiple	IPEC
Tue	15:30	17:00	ITU-T SG15 – Standards update on higher speed PON, latest OTN technologies and interoperable optical interfaces	Moderator: Glenn Parsons, Ericsson, Chair of ITU-T Study Group 15 Frank Effenberger, Futurewei Technologies Fabio Cavaliere, Ericsson Bert Klaps, Huawei Technologies Düsseldorf GmbH	ITU
Wed	10:30	13:00	EPIC TechWatch	Multiple	EPIC
Wed	13:10	13:40	50G PON – Technological enablers, application scenarios and deployments.	Maxim Kuschnerov	Huawei Technologies
Wed	15:10	15:40	KD7251: Automotive Optical Multi-Protocol Transceiver	Rubén Pérez-Aranda	KD Approaching Shannon's Limit

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