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The information in this program is as of 14 February 2024. All times reflect Pacific Daylight Time (PDT, UTC-07:00).

In an effort to support sustainability and Go Green Initiatives, OFC will not be printing update sheets. Please consult the conference app for the latest changes.

Technical Registrants: Download digest papers by visiting ofcconference.org and clicking on the "Download Digest Papers" on the home page. Recorded presentations are available from the same page by clicking "View Presentations."

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Conference Schedule at a Glance

All times reflect Pacific Daylight Time (PDT, UTC-07:00).	Sunday, 24 March	Monday, 25 March	Tuesday, 26 March	Wednesday, 27 March	Thursday, 28 March
Optica Executive Forum at OFC 2024	07:30–19:00				
Registration	07:30–19:00	07:30–18:00	07:00–18:00	07:30–17:00	07:30–16:00
Programming					
Short Courses	08:30–17:00	08:30–17:30			
Workshops	13:00–18:30				
Hack Your Research! Tools and Tricks for Today's Telecommunications Techies	19:00–21:00				
Technical Sessions		08:00–18:30	14:00–18:30	08:00–18:30	08:00–18:30
Symposium: Green Transformation: Where Do We Stand?		08:00–12:30			
Special Session: Frontiers of Optical Network Architecture Summit		14:00–16:00			
Demo Zone		14:00–16:00			
Open Networking Summit: Open and Disaggregated Optical Networking: Where We've Been and What's Coming Next		16:30–18:30			
Special Session: Moore's Law: A Photonics Perspective for the Next Decade			14:00–16:00		
Rump Session: How Much Optics Does AI Need?			19:30–21:30		
Poster Sessions				10:30–12:30	10:30–12:30
Symposium: Embracing Fiber Sensing: What's the "Killer App" for Large-Scale Deployments?				14:00–18:30	
Symposium: PICs for Quantum Communication and Quantum Computing: Challenges and Opportunities				14:00–18:30	
Postdeadline Papers					16:30–18:30
Exhibition and Show Floor Activities					
Show Floor Activities (Exhibit-Only Time)			10:00–17:00 (10:00–14:00)	10:00–17:00 (12:30–14:00)	10:00–16:00 (12:30–14:00)
Career Zone			10:00–16:45	10:00–16:30	10:00–15:45
Suzanne R. Nagel Lounge			10:00–17:00	10:00–17:00	10:00–16:00
Conversation with the Plenary Speakers			10:15–10:45		
Market Watch - Expo Theater I Sponsored by cisco			10:45–14:45	14:15–15:45	10:15–13:30
Other Expo Theater I Programming, Theater II and Theater III Programming			10:15–17:00	10:15–17:00	10:15–16:00
Data Center Summit – Expo Theater II			12:00–15:45		
Network Operator Summit - Expo Theater I				10:15–14:00	
Special Events					
Simulating Datacom/Telecom Applications Following Standards Specifications	13:30–17:30				
Hack Your Research! Tools and Tricks for Today's Telecommunications Techies	19:00–21:00				
Student Party		19:00–21:00			
Plenary Session			08:00–10:00		
The Art of Writing the Perfect OFC Paper			10:15–12:00		
Awards Ceremony and Luncheon Supported by CORNING			12:30–14:00		
Conference Reception			18:30–20:00		
OFC Fun Run				06:00–07:00	
The Journal Review Process: All You Need to Know!				12:30–14:00	
Challenges and Solutions for Realizing Quantum Fiber-Based Networks				12:45–13:45	
Photonics Society of Chinese (PSC) Heritage Workshop and Networking Social				17:00–19:00	

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General Information

Customer Service and Conference Information

Convention Center Lobby

Please visit the Customer Service and Conference Information desk to get information on:

- Parking
- Coat and Baggage Check
- General conference information
- Lost and Found (for after-hours Lost and Found, please go to Registration in Lobby D.

Exhibition

Exhibit Halls A-H

Schedule plenty of time to roam the Exhibition, visit with the hundreds of companies represented and see the latest products and technologies.

Exhibition Hours

Tuesday, 26 March Exhibit-Only Time	10:00–17:00 10:00–14:00
Wednesday, 27 March Exhibit-Only Time	10:00 -17:00 12:30–14:00
Thursday, 28 March Exhibit-Only Time	10:00–16:00 12:30–14:00

Event Policies and Terms/Code of Conduct

All guests, attendees, speakers, and exhibitors are subject to the Event Policies and Terms, including the Code of Conduct. The full text is available at **ofcconference.org/eventpolicies**. Conference management reserves the right to take any and all appropriate actions to enforce the Code of Conduct, up to and including ejection from the conference individuals who fail to comply with the policy.

First Aid Station

Box Office E

A first aid station will be operated according to the schedule below. In addition, information regarding local medical facilities will be available.

First Aid Station Hours

Sunday, 24 March	08:00–17:00
Monday, 25 March	08:00–17:00
Tuesday, 26 March	08:00–17:00
Wednesday, 27 March	08:00–17:00
Thursday, 28 March	08:00–17:00

Emergencies - Contact Security Command Center on house phone at ext. 5911 or call +1 619.525.5911.

Media Center

Rooms 4, 5A and 5B

The Media Center consists of a media room, 5A, and semi-private space for one-on-one interviews and/or briefings with media and analysts, room 5B. The media room is restricted to registered media/analysts holding a media badge. Room 4 is available for exhibiting companies to host news conferences.

Media Center Hours

Sunday, 24 March	12:00–16:00
Monday, 25 March	07:30–18:00
Tuesday, 26 March	07:30–18:00
Wednesday, 27 March	07:30–18:00
Thursday, 28 March	07:30–16:00

Career Zone

Exhibit Hall B1

Looking for a job? Or interested in exploring career options? The Career Zone connects employers and skilled job seekers from all areas of optical communications. Conference attendees are encouraged to visit the Career Zone and be prepared to discuss your future with representatives from the industry's leading companies.

Job Seekers
Meet Participating Companies

Tuesday, 26 March	10:00–16:45
Wednesday, 27 March	10:00–16:30
Thursday, 28 March	10:00–15:45

Register Online at **ofcconference.org/careerzone** or visit the Career Zone to:

- Search job postings freely
- Post your résumés online confidentially
- Network and schedule interviews with employers/recruiters

Employers

Didn't sign up for the onsite Career Zone? It's not too late.

Participate online at ofcconference.org/careerzone to:

- Post jobs online
- Review résumés before, during or after the conference
- Create alerts to inform you of newly submitted résumés and openings

For more information, call +1 888.491.8833 or email careercenter@ofcconference.org.

Conference App

OFC offers more than 110 sessions featuring 140+ invited speakers and 16 tutorial presentations in the technical conference, along with hundreds of exhibitors. Manage your conference experience by downloading the conference app to your smartphone or tablet. (See steps below).

Schedule
Search for conference presentations by day, topic, speaker or program type. Plan your schedule by setting bookmarks on programs of interest. Technical attendees can access technical papers within session descriptions.

Exhibit Hall
Search for exhibitors alphabetically and set bookmark reminders to stop by booths. View the interactive exhibit floor map.

Technical Digest Papers
Full technical registrants can navigate directly to the technical papers from the conference app. Locate the session or talk in "Event Schedule" and click on the "Download PDF" link in the description.

IMPORTANT: Log in with your registration email and password to access the technical papers. Access is limited to Full Conference attendees.

Download the Conference App!
Plan your day with a personalized schedule and browse exhibitors, maps and general show information while engaging with fellow attendees. Download the conference app one of three ways:

1. Search for 'OFC Conference' in the Google Play or Apple App stores.
2. Go to ofcconference.org/app
3. Scan the QR code

Conference App Help Desk
Need assistance? Find an App Coach near registration or contact our Conference App support team, available 24 hours a day Monday through Friday, and from 09:00 to 21:00 EST on weekends, at +1 888.889.3069, option 1.

Registration

Lobby D

Hours:

Sunday, 24 March	07:30–19:00
Monday, 25 March	07:30–18:00
Tuesday, 26 March	07:00–18:00
Wednesday, 27 March	07:30–17:00
Thursday, 28 March	07:30–16:00

Join the Conversation!

Get the latest updates from OFC via X (formerly Twitter) at @OFCConference. Use #OFC24 and join in the conversation today!

Speaker Ready Room

Room 11

All speakers and presiders are required to report to the Speaker Ready Room at least two hours before their sessions begin. Computers will be available to review uploaded slides.

Speaker Ready Room Hours*

Sunday, 24 March	13:00–17:00
Monday, 25 March	07:00–18:00
Tuesday, 26 March	10:00–18:00
Wednesday, 27 March	07:00–18:00
Thursday, 28 March	07:00–15:30

*Market Watch and Network Operator Summit speakers should go directly to Exhibit Hall C in Expo Theater I to upload their presentations.

Sponsoring Society Exhibits

Exhibit Hall F

Catch up on the latest product and service offerings of the OFC sponsoring societies by visiting their booth or member lounge located in the back of Exhibit Hall F. **IEEE** is the world's largest technical professional organization dedicated to advancing technology for the benefit of humanity. **Optica** is the leading professional association in optics and photonics, home to accomplished science, engineering, and business leaders from all over the world.

IEEE ComSoc IEEE Communications Society
IEEE Photonics Society
OPTICA Advancing Optics and Photonics Worldwide | Formerly OSA

Wireless Internet Access

OFC is pleased to provide free wireless internet service throughout the San Diego Convention Center for all attendees and exhibitors. The wireless internet can be used for checking email, downloading the conference app, and downloading the OFC Technical Papers, etc.

- Wi-Fi Network: OFC
- Password: OFC_2024

OFC Management advises you to write your name on all of your conference materials (Conference Program, Buyers' Guide, and Short Course Notes). There is a cost for replacements.

Conference Materials

Technical Digest

The Technical Digest, composed of the 3-page summaries of invited and accepted contributed papers, and tutorial presentation notes, will be accessible on the OFC website. The Technical Digest is included with a technical conference registration.

Accepted and presented papers are published in the IEEE Xplore Digital Library and on the Optica Publishing Group platform. In addition OFC further supports the visibility of the paper by indexing in Ei Compendex, Scopus and Google Scholar.

Online Access to Technical Digest

Technical attendees have EARLY (at least one week prior to the meeting) and FREE continuous online access to the Technical Digest. These tutorial slides and 3-page summaries of invited and accepted contributed papers can be downloaded individually or by downloading daily .zip files. (.zip files are available for 60 days after the conference).

1. Visit the conference website at ofcconference.org
2. Select the purple "Download Digest Papers" button on the right side of the web page
3. Log in using your email address and password used for registration. You will be directed to the conference page where you will see the .zip file links at the top of the page. [Please note: if you are logged in successfully, you will see your name in the upper right-hand corner.]

Access is limited to Full Conference attendees only. If you need assistance with your login information, please use the "forgot password" utility or "Contact Help" link.

Postdeadline Papers

The 3-page summaries of accepted Postdeadline Papers will be available to download online on Tuesday, 26 March. The papers will be presented Thursday, 28 March, 16:30–18:30.

Short Course Notes

Notes typically include a copy of the presentation and any additional materials provided by the instructor. Each course has a unique set of notes, which are distributed on-site to registered course attendees only. Notes are not available for purchase separately from the course.

Buyers' Guide

The Buyers' Guide comprises 50-word descriptions and contact information for exhibiting companies, a cross-referenced product-category index, general conference services information and extensive details regarding exhibit floor activities. Guides will be given to every OFC attendee as part of registration.

Captured Session Content

We are delighted to announce that all technical sessions, including workshops, panels, symposia and special sessions, are being digitally captured for on- demand viewing and accessible with your technical registration. All captured session content will be posted for on demand viewing within 24 hours of being recorded.

To access the presentations, select the "View Presentations" button prominently displayed on the conference homepage (ofcconference.org). As access is limited to Full Conference attendees only, you will be asked to validate your credentials based on your registration record.

Short Course Schedule

Sunday, 24 March 2024

08:30–12:30

SC105: Modulation Formats and Receiver Concepts for Optical Transmission Systems
Peter Winzer, *Nubis Communications, USA,* and Vivian Chen; *Nokia Bell Labs, USA*

SC203: 400, 800Gb/s and Beyond Optical Communications Systems: Design and Design Trade-offs
Ezra Ip, *NEC Labs, USA,* Chongjin Xie, *Alibaba Group, USA*

SC208: Optical Fiber Design for Telecommunications and Specialty Applications
David J. DiGiovanni, *OFS Labs, USA*

SC216: An Introduction to Optical Network Design and Planning
George Rouskas, *North Carolina State University, USA*

SC328: Standards for High-Speed Optical Networking
Tom Huber, *Nokia, USA*

SC395: Modeling and Simulation of Optical Transmitter and Receiver Components for Coherent Communications
Harald Rohde, *Nokia, Germany,* and Howard Wang, *Nokia, USA*

SC432: Hands on: Silicon Photonics Component Design and Fabrication
Lukas Chrostowski, *University of British Columbia, Canada*

SC461: High-capacity Data Center Interconnects for Cloud-scale Networking
Dirk van den Borne, *Juniper Networks, Germany*, Sander L. Jansen, *ADVA Optical Networking, Germany,* Mark Filer, *Stealth Startup, USA*

SC463: Optical Transport SDN: Architectures, Applications, and Actual Implementations
Achim Autenrieth, *ADVA Optical Networking SE, Germany*, Jörg-Peter Elbers, *ADVA Optical Networking SE, Germany*

SC469: Hands-on: Laboratory Automation and Control Using Python (Beginner)
Jochen Schröder, *Chalmers University of Technology Sweden*, Binbin Guan, *Microsoft USA*, Roland Ryf, *Nokia Bell Labs, USA*

SC470: Secure Optical Communications
Andrew Shields, *Toshiba Research Labs, UK*, Helmut Grießer, *ADVA Optical Networking, Germany*

09:00–12:00

SC177: High-speed Semiconductor Lasers and Modulators
John Bowers, *University of California, Santa Barbara, USA*

SC359: Networking for Datacenters and Machine Learning
Hong Liu and Ryohei Urata, *Google, USA*

SC459: Multimode Photonic Devices, Characterization and Applications
Nicolas Fontaine, *Nokia Bell Labs, USA*

13:00–16:00

SC408: Space Division Multiplexing for Optical Communication Systems and Networks
Roland Ryf, *Nokia Bell Labs, USA*

SC512: Modern Subsea Cable Systems
Mei Du, *Tata Communications, USA*

13:00–17:00

SC514: FEC Techniques for Optical Communications NEW
Georg Böcherer, *Huawei Technologies, Germany*

SC267: Silicon Microphotonics: Technology Elements and the Roadmap to Implementation
Lionel Kimerling, *MIT, USA*

Monday, 25 March 2024

08:30–12:30

SC160: Microwave Photonics
Jose Capmany, *Polytechnic University of Valencia, Spain*

SC341: Sub-carrier Modulation and Superchannels for Terabit-class DWDM Transceivers
Sander L. Jansen, *ADVA Optical Networking, Germany,* Dirk van den Borne, *Juniper Networks, Germany*

SC369: Hands-on Test and Measurement for Signals with Complex Optical Modulation
Fabio Pittala and Michael Koenigsmann, *Keysight, Germany*

SC393: Digital Signal Processing for Coherent Optical Transceivers
Chris Fludger, *Infinera, Germany*

SC433: Introduction to Photodetectors and Optical Receivers
Andreas Beling, *University of Virginia, USA*

SC443: Optical Amplifiers: From Fundamental Principles to Technology Trends
Peter Andrekson, *Chalmers University of Technology, Sweden*, Michael Vasilyev, *University of Texas, Arlington, USA*

SC444: Optical Communication Technologies for for F5G evolution
Dr. Xiang Liu, *Huawei Technologies, China*

SC448: Evolving Software Defined Optical Network: Architecture and Design Principles
Ramon Casellas, Ph.D., IEEE SM; OSA M, *CTTC, Spain*

SC452: FPGA Prototyping for Optical Subsystems
Noriaki Kaneda, *Nokia, USA*, Robert Elschner, *Fraunhofer HHI, Germany*

SC453A: Hands-on: Fiber Optic Handling, Measurements, and Component Testing
Steve Baldo, *Seikoh Giken, USA*, Chris Heisler, *Santec California Corporation, USA*, Jérome Allaigre, *Data-Pixel, France*, Julien Maille, *Data-Pixel, France*

SC454: Hands on: Silicon Photonics Design - Circuits
Wim Bogaerts, *University of Ghent, Belgium*

SC473: Photonic Switching Systems
David Neilson, *Nokia Bell Labs, USA*, Benjamin Lee, *NVIDIA, USA*

SC483: Machine Learning in Optical Networks
Massimo Tornatore, *Politecnico di Milano, Italy*, Darko Zibar, *DTU FOTONIK, Denmark*

SC487: Hands-On: Laboratory Automation and Control using Python (Advanced)
Jochen Schröder, *Chalmers University of Technology, Sweden*, Nicolas Fontaine, *Nokia Bell Labs USA*, Binbin Guan, *Microsoft USA*

SC513: Data Center Short Links – Link Design, Modeling, Test and Measurements
Petar Pepeljugoski, *IBM Research, USA*, Greg D. Le Cheminant, *Keysight Technologies, USA*

SC525: Photonic and Electronic Packaging - Materials, Processes, Equipment and Reliability NEW
Peter O'Brien, *Tyndall National Institute, Ireland*

SC527: Optical Satellite Networks NEW
Vincent Chan, *MIT, USA*

09:00–12:00

SC465: Transmission Fiber and Cables
John Hedgpeth, *Corning Optical Communications, USA*

13:30–16:30

SC114: Technologies and Applications for Passive Optical Networks (PONs)
Yuanqiu Luo, *Futurewei, USA*

SC217: Applications of Radio-over-fiber Technologies Including Future 5G Networks
Dalma Novak, *Octane Wireless, USA*

SC261: ROADM Technologies and Network Applications
Thomas Strasser, *Molex, USA*

SC447: The Life Cycle of an Optical Network: From Planning to Decommissioning
Andrew Lord, *British Telecom, UK*

SC485: Advanced Fiber Access Networks
Jun Shan Wey, *Verizon, USA*, Rajesh Yadav, *Verizon, USA*

SC526: Optical Wireless Technologies, Systems and Applications NEW
Harald Haas, *University of Strathclyde, Scotland*

SC528: Hands-on Fiber Optic OFCnet Course: Practical Fiber Optic Network Testing in a Realistic Network Environment NEW
Gwenn Amice, *EXFO, USA,* Christine Tremblay, *École de Technologie Supérieure, Canada*

13:30–17:30

SC325: Highly Integrated Monolithic Photonic Integrated Circuits
Chris Doerr, *Doerr Consulting, LLC, USA*

SC327: Fiber Transmission and Design of Long-haul Communication Systems
René-Jean Essiambre, *Nokia Bell Labs, USA*

SC347: Reliability and Qualification of Fiber-Optic Components, Modules and Equipment
David R. Maack, *David Maack Consulting, USA*

SC357: Circuits and Equalization Methods for Coherent and Direct Detection Optical Links
Alexander Rylyakov, *Nokia, USA*, Sudip Shekhar, *University of British Columbia, Canada*

SC384: Background Concepts of Optical Communication Systems
Alan Willner, *University of Southern California, USA*

SC431: Photonic Technologies in the Datacenter
Clint Schow, *University of California, USA*

SC451: Optical Fiber Sensors
Alexis Mendez, *MCH Engineering, USA*, William Shroyer, *SageRider, Inc., USA*

SC453B : Hands-on: Fiber Optic Handling, Measurements, and Component Testing
Steve Baldo, *Seikoh Giken, USA*, Chris Heisler, *Santec California Corporation, USA*, Jérome Allaigre, *Data-Pixel, France*, Julien Maille, *Data-Pixel, France*

Special Programming

All times reflect Pacific Daylight Time (PDT, UTC-07:00).

Workshops

Sunday, 24 March, 13:00–15:30

S1A: How Can OFC, with a Real Life Test-Bed, Accelerate Innovation in the Design and Operation of the Next Generations Optical Photonic Networks?

Room: 2

Organizers: Cees de Laat, *University of Amsterdam, Netherlands*; Reza Nejabati, *University of Bristol, UK*; Andrew Lord, *British Telecom, UK;* Gwen Amice, EXFO, Canada

Started in 2023 OFCnet brings a new opportunity to the exhibition and demonstrate products, concepts, solutions, research and architectures in live high speed optical networks connected to the leading research and education networks worldwide. This increased focus on designing and building next generation optical networks will expand exposure on connectivity, emerging and next generation network technologies such as quantum networks, programmable and software defined optical networks and their applications such as big data, security and distributed classical and quantum computing. This workshop brings together the innovators and researchers that work on the mentioned topics to further enrich the OFCnet community and expand the contributing parties. We discuss: How should this initiative develop to ensure OFCnet enriches future community participation?

Panelists:
Chris Janson, *Nokia, USA*
Joe Mambretti, *Northwestern University, USA*
Corey McClelland, *Qubitekk, USA*
Mehdi Namazi, *QuConn, USA*
Jerome Prieur, *Aurea Technology, USA*
David Rodgers, *EXFO, USA*
Jean-Robert Morax, *ID Quantique, Switzerland*

Rump Session Speakers:
Ben Dixon, *MIT Lincoln Laboratory, USA*
Jorg-Peter Elbers, *Adtran, Germany*
Prem Kumar, *Northwestern University, USA*
Julia Larikova, *Infinera, USA*
Dimitra Simeonidou, *University of Bristol, UK*

S1B: How Can Generative AI be used for Network Operations?

Room: 6C

Organizers: Ashwin Gumaste, *Infinera Corp, USA*; Ricard Vilalta, *CTTC, Spain*; Anurag Sharma, *Google Inc., USA*

Recently, conversational generative AI chatbots have taken the concept of democratizing AI to the next level. They can now automate routine tasks and generate creative content that is nearly unparalleled. This has thrown many user communities into a professional, ethical, and situational dilemma. There are already many ongoing initiatives that are using generative AI to create logical, relational, and process-oriented content that is valuable to end users. From a network perspective, generative AI can be used for a wide range of activities, including compiling reports, automating the network, building tools to resolve network outages, optimizing business processes, and many more. Generative AI can manifest as a tool that network planners/operators use as an outsourced aid, or as an in-house tool that can be used for complete network ops. In simple cases, generative AI can be used to respond to outage tickets, connecting users to commonly experienced problems. Generative AI can in this case become the backbone of an auto-response system, communicating with users of a network on one side and the operations team on the other, while precisely and in a timely fashion identifying failures in network behavior. Over time, generative AI can start to run networks autonomously – where it can detect faults, gather customer feedback, create reports, and take action on those reports with minimal or no human intervention. Imagine a network that can run itself, diagnosing faults, responding to customer requests for bandwidth, and even responding to requests from other generative AI instances, doing all of this efficiently and effectively. When generative AI identifies issues in a network, it can execute the DevOps process by creating its own patches or code snippets to resolve the issues, making the network more efficient, resilient, and restorative. Similarly, generative AI can be used to automatically generate Request for Proposal (RFP) documents by identifying the network's needs and matching them with available technologies.

Some of the above use cases may seem like a SciFi movie ensemble, but these are all aspects of the network that can be impacted, albeit in small increments over time. The question is, which parts of network automation and network operations can be handled by generative AI, and what is the path to get there? We discuss these and similar topics with industry and academic experts. The topics to be discussed will include, but are not limited to:

- Generative AI for network operations
- Generative AI for failure detection and resolution
- Challenges in generative AI for business continuity
- Adapting generative AI for network ops
- Using generative AI framework for network service development
- Can we trust generative AI for network ops? What safeguards can be put in place?
- Legalities and boundary conditions on the use of generative AI from the perspective of data integrity, privacy, and anomalies.

Speakers:
Dash Debabrata, *Arista, USA*
Oscar Gonzales de Dios, *Telefónica, Spain*
Mallik Tatipamula, *Ericsson, USA*
Walid Wakim, *Infinera Corp., USA*
Jin Wang, *AT&T, USA*
AE Natarajan, *Juniper, USA*

S1C: Multi-Fiber/Multi-Core is Inevitable, Do We Even Need the S-band?

Room: 6D

Organizers: Lidia Galdino, *Corning Inc., UK*; Erwan Pincemin, *Orange Labs, France*; Jesse Simsarian, *Nokia Bell Labs, USA*

Installed fiber capacity had been steadily increasing for decades, driven by adding optical bandwidth (in the C- and L-bands) and improved spectral efficiency with coherent transceivers. With these techniques now reaching fundamental physical limitations, high fiber count cables are now being deployed to continue capacity scaling.To further increase capacity, we have a choice of whether to increase cable/duct fiber density, or to increase the core count per fiber, or to transmit in more transmission windows (e.g., O, E, S, U) ... or all three!

This workshop will discuss challenges, opportunities, and risks of each strategy.

- Are high fiber count cables and ducts just 'kicking the can down the road? Is deploying new fiber infrastructures (with sometimes some heavy and costly civil engineering) in line with the objective of sustainable development and carbon dioxide reduction imposed by governments to telecom operators?
- Is the installation of high fiber count fiber cables or multicore/multimode fiber cables is of nature to make decrease the cost of loan/rented fiber infrastructure for service providers?
- Are telecom operators ready for large infrastructure projects while they are just finishing deployment of FTTH infrastructure?
- Are the transmission techniques (in particular, digital signal processing) and related components / sub-systems (e.g. ROADM…) sufficiently mature to address transmission on multicore and/or multimode fibers given the related propagation impairments (core / mode coupling)?
- Is scaling by increasing the number of cores per fiber a long-term solution; will this ever give us more than one order of magnitude in capacity?
- Is there a need to develop more amplifier bands beyond C and L-band given the known impairments (e.g. Stimulated Raman Scattering) in ultra-wideband transmission and the cost of amplifier development?
- Will the need for multiple amplifiers and components that operate in different bands create unnecessary inventory problems?
- Is ultra-wideband transmission using the 50 THz SMF window inevitable, or a research fad?
- Will hollow core fiber solve the capacity scaling problem, in particular for multiband transmission?

How do the above considerations depend on the perspectives of the different network operators, e.g., communications service providers, multiple-system operators, or hyperscale cloud providers.This workshop will explore all sides of this debate with industry representatives from both communications service providers, hyperscale cloud providers, system and device manufacturers, and academic researchers.

Speakers:
Binbin Guan, *Microsoft, USA*
Takemi Hasegawa, *Sumitomo Electric Industries Ltd., Japan*
Sergejs Makovejs, *Corning, UK*
Todd McWhirter, *Zayo Group, USA*
David Neilson, *Nokia Bell Labs, USA*
Pierluigi Poggiolini, *Politecnico di Torino, Italy*
Emilio Riccardi, *Telecom Italia, Italy*
Yusuke Sasaki, *NEC Corporation, Japan*
Zhuhong Zhang, *Huawei, Canada*
Ligia Zorello, *Meta, UK*

S1D: Are Coherent Transceivers About to Experience a Bandwidth Crunch?

Room: 6E

Organizers: David Millar, *Infinera Canada, Canada*; Toshiaki Koike-Akino, *Mitsubishi Electric Research Labs, USA*; Di Che, *Nokia Bell Labs, USA*

As future spectral efficiency growth prospects are limited, scaling to 1.6 Tb/s and beyond will be achieved almost entirely by increasing transceiver bandwidth. Single-wave line rates will hit the bandwidth ceiling if we cannot achieve a penalty-free transceiver bandwidth scaling of 2x every generation. When will this happen? If this does happen, what will transceivers look like? Multi-wave optics? Ever more power-constrained pluggables? Can we scale bandwidth indefinitely?

Speakers:
Long Chen, *Cisco, USA*
Romain Hersent, *III-V Labs, France*
Andreas Leven, *Nokia, Germany*
Yoshihiro Ogiso, *NTT, Japan*
Mohammad Pasandi, *Ciena, Canada*
Tony Wang, *Marvell, USA*
Glenn Wellbrock, *Verizon, USA*
Chongjin Xie, *Alibaba, China*
Mian Zhang, *Hyperlight, USA*
Mehrdad Ziari, *Infinera, USA*

S1E: Co-packaged Optics: Is it Only for the Cloud or Also for the Edge AI Services?

Room: 6F

Organizers: Shu Namiki, *AIST, Japan*; Nicola Calabretta, *Technische University Eindhoven, Netherlands*; Mahdi Nikdast, *Colorado State University, USA*

The rapid evolution of artificial intelligence (AI) technologies with numerous parameters, including large language model (LLM)-based services, presents critical issues on yet further scaling the network and interconnect of data centers in the age of AI. Recently, co-packaged optics (CPO) and optical switching have attracted considerable attention as ways to address the bottlenecks of I/O and switching in data center networks. Consequently, a question has arisen whether advances in CPO, including optical -layer switching, will enable further scaling of AI clusters.

Another important issue pertains to the operations of various LLM-based services that process enormous amounts of data. Most of these data are collected through Internet-of-Things (IoT) devices or mobile networks, while cloud data centers tend to be situated in locations remote from edges. Indeed, with a continuous increase in the volume of edge data, moving and storing data not only consumes significant amounts of energy but also incurs undesirable levels of latency. This will lead to an issue in regard to how and where such data are collected, transferred, stored, and processed for training and inference tasks. Then, the compute and network resources must not be treated separately but optimized holistically by redressing the allocation of edge and cloud computing. To achieve this, the flow of data must be optimized by identifying the roles of CPO and optical-layer switching at all levels of interconnect, from the chip-scale, on-board, rack-scale, and intra-/inter-data center (DC) levels to even mobile-edge and wide-area levels. Thus, such an approach may completely change the landscape of digital infrastructure.

This workshop will bring together AI-DC architects and optical networking experts from both industry and academia to discuss the future of AI-related digital infrastructure along with expectations and target specs of emerging optical network technologies, including CPO and optical-layer switching. The workshop comprises two technical sessions followed by a panel. In the first session, requirements for networks and interconnect will be discussed from the perspectives of various systems, whereas the second session will be a discussion of CPO and optical switch technologies. The panel will serve as a cross-examination between the two sessions.

Speakers Session 1:
Keren Bergman, *Columbia University, USA*
Zuowei Shen, Google, USA
Shintaro Mizuno, *NTT, Japan*
M. Ashkan Seyedi, *NVIDIA Corporation, USA*

Speakers Session 2:
Joris Van Campenhout, *IMEC, Germany*
Katsumi Fukumitsu, *Fujitsu, Japan*
Ling Liao, *Intel Capital, USA*
Peter Winzer, *Nubis Communications, USA*
Ming Wu, *University of Berkeley, USA*

S1F: Neural Networks for Optical Fiber Transmission: Hype or Hope?
Room: 7

Organizers: Ming-Fang (Yvonne) Huang, *NEC Labs America, USA*; Yi Cai, *Soochow University, China*; Amirhossein Ghazisaeidi, *Nokia Bell Labs, France*

Neural network (NN) based machine learning has been investigated for applications in optical fiber communications for many years. The studies covered almost all aspects of the field including optical transmission modeling, optical link optimization, linear and nonlinear impairment mitigation, etc. Despite the extensive research, practical applications of neural network-based machine learning in optical fiber communications remain elusive. This workshop would like to discuss a crucial question: Can NNs replicate their successes in this field, as they have in natural language processing with ChatGPT?

The workshop shall cover but not limited to the following scopes:

1. Implementation complexity challenges faced by the NN based machine learning to be practical for high-speed optical communications;
2. Requirements on order and length of the PRBS dataset employed for the training and testing;
3. Requirement on training and testing dataset ratio;
4. Verification of the tracking bandwidth of the NN for dynamic transmission system effects ;
5. Ethical considerations of using NN-based machine learning in optical fiber communications, such as data privacy and security concerns.

Speakers:
Alan Lau, *Hong Kong Polytechnic University, Hong Kong*
Takeo Sasai, *NTT Network Innovation Labs, Japan*
Faith Yaman, *NEC Labs America, USA*
Lilin Yi, *Shanghai Jiao Tong University, China*

Sunday, 24 March, 16:00–18:30

S2A: Will Heterogeneous Integration Meet the Needs of Future Applications and their Performance Requirements?
Room: 2

Organizers: Dan Pitt, *Palo Alto Innovation Advisors, USA;* Mengjie Yu, *University of Southern California, USA;* Patrick Lo, *Advanced Micro Foundry Pte Ltd, Singapore;* Lukas Chrostowski, *University of British Columbia, Canada*

Heterogeneous Integration opens new capabilities for technologies, use cases, and market participants. Integrating devices developed separately and often on different substrates (as, for example, III-V semiconductors and Silicon Photonics) into a single composite device enables miniaturization, simplifies interconnection, saves materials, and reduces energy consumption. It fosters the creation of new optical products that serve new applications with more demanding performance requirements. In this session we explore how well (and when) the various approaches to heterogeneous integration will meet these challenging needs., and the status and challenges for the service providers (e.g., type of integration platforms, process/tools maturity, and how to handle non-traditional Si materials).

Speakers:
Alex Chikhaoui, *X-Celeprint, Ireland*
Ivan Huang, *Avicena, USA*
Michael Lebby, *Lightwave Logic, USA*
Sylvie Menezo, *Scintil, France*
Edward Preisler, *Tower Semiconductor, USA*
Jing Zhang, *IMEC and Ghent University, Belgium*
Mian Zhang, *Hyperlight, USA*

S2B: Will Optical Switches Become a Key Element in High-Performance AI/ML Datacenter Networks?

Room: 6C

Organizers: Wenhua Lin, *Intel Corp., USA*; Qixiang Cheng, *Cambridge University, UK*; Kazuhiro Ikeda, *AIST, Japan*

The application of optical switching in data center networks has been extensively studied. Google's recent announcement showcasing the implementation of an optical circuit switch in a production data center has re-sparked interest in the requirements and challenges associated with optical switching. In addition, generative AI models are extensively advancing with the number of parameters exponentially increasing. This requires GPU clusters with a very high bandwidth density and low energy consumption, which has revamped research on photonic switch fabrics co-integrated and optically interconnected with multiple GPUs/TPUs/CPUs. This workshop discusses the challenges and opportunities of optical switching for large-scale data center networks, especially for GPU clusters and HPC networks, from system networking perspective (capacity demand, latency, fast configuration and control scheme, flexibility and scalability, cost, power consumption), optical switch architectures (switch radix, topology, size and scale, performance), to device performance (loss, bandwidth, switching speed, crosstalk, and integration platform). We will explore innovative photonic technologies and network architectures for enabling the optical switching for AI/ML applications. Some of the topics that we intend to dive into in this workshop are:

1. What are the requirements and challenges for broad adoption of optical circuit switching?
2. How do optical and electrical switch systems co-exist to enable the scaling and optimize the cost-to-performance metric for AI/ML systems?
3. Will semiconductor-based optical switches (e.g. Silicon Photonics) play a significant role in large-scale integrated optical switches, after the MEMS-based OCS systems deployment? What hurdles need to be overcome?
4. Is there a role of fast optical switching in AI/ML systems? What are the requirements for fast optical switching?
5. Novel system architectures and packaging techniques involving co-packaged optics, optical interposers and I/Os, with GPU/CPU/TPU for future AI/ML computing?

Speakers: Session 1
Keren Bergman, *Columbia University, USA*
Ben Lee, *NVIDIA, USA*
Shu Namiki, *AIST, Japan*
George Papen, *UCSD/Google, USA*
Stefano Stracca, *Ericsson, Italy*

Speakers: Session 2
Darius Bunandar, *Lightmatter, USA*
Richard Penty, *Cambridge University, USA*
Daniel Perez-Lopez, *iPronics, Spain*
Ming Wu, *University of California, Berkeley, USA*

S2C: Which Types of Fiber Will Be the Most Suitable for Network Operators in the Near Future?

Room: 6D

Organizers: TJ Xia, *Verizon Communications Inc, USA*; Mattia Cantono, *Google LLC, USA*; Binbin Guan, *Microsoft, USA;* Atsushi Nakamura, *NTT, Japan*

In recent years, the development of new types of fiber has made a lot of progress. Hollow-core fiber (HCF) has shown low attenuation and wide optical bandwidth comparable to traditional single mode fiber with lower latency, while multi-core fiber (MCF) has shown capability to support long-distance transmission and enable submarine cables for 1+Pbps systems.These types of new fiber provide certain advantages compared with traditional fiber, also, require further improvement in performance, scalability and progress in the whole ecosystem. As network operators and fiber service providers are considering new fiber cable deployment to support continuous data-bandwidth growth and new applications, it is a good time to examine and compare which fibers will be most suitable for long-term growth and short-term deployment. Fiber developers, fiber cable manufacturers and fiber network operators will share their latest thoughts on this particular topic at the workshop.

Speakers Session 1:
Mark Allen, *Ciena, USA*
Kazuhide Nakajima, *NTT, Japan*
Pascal Pecci, *Meta, France*
Max Salsi, *Google, USA*
Glenn Wellbrock, *Verizon, USA*

Speakers Session 2:
Rodrigo Amezcua Correa, *University of Central Florida CREOL, USA*
Lidia Galdino, *Corning, UK*
Yuki Kawaguchi, *Sumitomo Electric Industries, Japan*
Madoka Ono, *Tohuka University, Japan*
Han Damsgaard, *OFS Fitel LLC, USA*
Francesco Poletti, *Southampton University, UK*

S2D: Coherent Optics for Next Generation 100G/200G PON: Single-Carrier or Multi-Carrier?

Room: 6E

Organizers: Haipeng Zhang, *CableLabs, USA*; Ashkan Seyedi, *NVIDIA Corporation, USA*; Lilin Yi, *Shanghai Jiao Tong University, China*; Jim Zou, *ADVA, Germany*; Dario Pilori, *Politecnico di Torino, Italy*

Coherent technology is considered as a future-proof solution for future generation PON thanks to its high spectral efficiency and superior receiver sensitivity, which enables higher capacity, extended reach, and larger splitting ratio in PON applications. Several coherent PON technologies have been studied and developed, including coherent time-division-multiplexing (TDM) PON, coherent wavelength-division-multiplexing (WDM)-PON, and coherent time-and-frequency-division multiplexing (TFDM)-PON.

A question commonly raised among network operators and equipment vendors is that for future coherent PON, will it adopt single-carrier solutions, which use only TDM bandwidth sharing, or will it utilize multi-carrier configurations, either wavelength or frequency division multiplexed (WDM/FDM)?

Although TDM-PON offers a practical and relatively simple solution, it may need a new scheduling algorithm for latency reduction in a big covering group. On the other hand, multi-carrier PON can provide a

more flexible bandwidth allocation, but they will introduce additional cost and operational complexity.

This workshop will bring together experts from academia, industry, and standardization bodies to discuss topics such as benefits, challenges, technical feasibility, and economics of adopting single carrier versus multi-carrier solutions in the next generation coherent PON.

Speakers:
Md Mosaddek Hossain Adib, *Nokia Bell Labs, Germany*
Roberto Gaudino, *Politecnico di Torino, Italy*
James Harley, *Ciena, Canada*
David Hillerkuss, *Infinera, Germany*
Maxim Kuschnerov, *Huawei, Germany*
Jeffery Lee, *Coherent Inc., Germany*
Maryam Niknamfar, *Charter Communications, USA*
Bhushan Padhiar, *AT&T Labs, USA*
Matthew Schmitt, *CableLabs, USA*
Tom Williams, *Acacia Communications / Cisco, USA*

S2E: Will Linear Pluggable Optics (LPO) Have a Future Beyond 112G?
Room: 6F

Organizers: Jiangqiang Li, *LightsAI, USA*, Andreas Matiss, *Corning, USA,* Katharine Schmidtke, *Eribel Systems, USA,* Clint Schow, *University of California, Santa Barbara, USA*

Linear drive targets the elimination of DSP/retimers between host ASICs and optical engines for potential cost/power/latency benefits. Linear drive is well suited to co-packaged optics (CPO) or near package optics (NPO) applications that offer tight integration with short electrical links between the IC and optics. However, there has also been intense promotion, advocacy and compelling demonstrations of linear drive applied to traditional pluggable optics. Although the early results for linear pluggable optics (LPO) are encouraging, considerable challenges remain to be overcome to enable widespread adoption. Examples include signal integrity limits and specifications, interoperability, testability, and ecosystem establishment. This workshop will provide a forum for sharing opinions and insights from different segments of the ecosystem: end users, standardization bodies, and suppliers of ICs, transceivers and optical components, and systems. This workshop will address the following questions.

- Which use case will LPOs be highly possible to land?
- Will there be a broad window to adopt 100G/lane LPOs? Are 200G/lane LPOs feasible?
- What are the limits imposed by signal integrity and what specifications are needed?
- Will LPOs have a strong impact on deployment, commissioning and operation practices for end users?
- Are AOCs a more promising form factor to implement linear drive?
- How much power/cost/latency savings are expected for LPOs?
- Will LPOs be ecosystem friendly?
- Will interoperability between LPOs and traditional pluggables be required?
- Will LPOs transfer design complexity from transceivers to hosts?
- Which types of optical engines are best suited for implementing LPOs: VCSEL, SiPh, DML or EML?
- Will it be feasible to push toward direct drive in pluggables by further eliminating in-module drivers?
- Will new modulator materials (TFLN, BTO, etc.) help enable the adoption of LPOs and the evolution to 200G/lane?
- Will LPOs be a step on the way to CPO or an alternative to CPO?
- How much know-how and standardization legacy from LPOs can be transferred to CPO?

Speakers:
Andy Bechtolsheim, *Arista, USA*
Darron Young, *Meta, USA*
Chris Cole, *Quintessent Inc., USA*
Ryan Latchman, *MACOM, USA*
Ashkan Seyedi, *Nvidia, USA*
Davide Tonietto, *Huawei, Canada*
Chongjin Xie, *Alibaba, China*
Xiang Zhou, *Google, USA*

S2F: QKD – An End-Game or Just a Stepping Stone to the Quantum Internet?
Room: 7

Organizers: Andrew Lord, *British Telecom, UK;* Tobias Gehring, *Technical University of Denmark, Denmark;* Gregory Kanter, *NuCrypt, USA*

Some see QKD as the end-game - all other quantum comms applications are vague and lacking usefulness (e.g., quantum digital payments, quantum money, etc). Others see trusted-node QKD networks as a stepping stone, ultimately leading to a secure network based on quantum repeaters. Yet others believe that the security benefits are not worthwhile since PQC is a more practical solution and see trusted node QKD networks as merely an early stage testbed for a quantum internet with the true goal being to connect quantum computers. Which of these viewpoints is the most realistic or are they all valid? Or, are none of them actually likely to find long-term applications?

Speakers:
Noel Goddard, *QuConn, USA*
Bruno Huttner, *IDQuantique, Switzerland*
Prem Kumar, *Northwestern University, USA*
Robert Keys, *Ciena, USA*
John Prisco, *SafeQuantum, USA*
Andrew Shields, *Toshiba, UK*
Feihu Xu, *USTC, China*

Hack Your Research! Tools and Tricks for Today's Telecommunications Techies (formerly Lab Automation Hackathon)

Sunday, 24 March, 19:00–21:00
Room: 6A

Organizers: Henrique Buglia, *University College London, UK; Marco Eppenberger, PsiQuantum, USA;* Menno van den Hout, *Eindhoven University of Technology, Netherlands;* Vincent van Vliet, *Eindhoven University of Technology, Netherlands*

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*

Learn the most powerful techniques expert researchers and professionals use to enhance productivity and make life easier. Join us and take this chance to upgrade your work methods and discuss while enjoying lots of food and drinks in an informal, relaxed, and fun way.

Our everyday research is most fun and productive when concentrating on creative problem-solving. Good news: tools are available for almost all other tasks to make your engineering life easier. Many software packages written by the large community allow you to quickly and easily automate menial tasks, build graphical user interfaces, visualize data, and much more! This event aims to bring awareness of these packages by hosting multiple interactive demos of primarily free and open-source software built in easy-to-learn languages such as Python. The demos are set up around informal discussion tables with plenty of time for inspiring discussion and questions, alternated with lighting talks and videos showing the usage of these tools.

This event is an opportunity to learn how to tap into and use the available public resources and learn about the newest tools developed by Ph.D. students and researchers. From students to highly experienced experts, everybody is welcome to learn and share ways to boost their research. Benefit and learn from the trial-and-error of others and get a kickstart in productivity!

Symposia

Three symposia are scheduled for OFC 2024. Please refer to the abstract section or conference app for full details.

PICs for Quantum Communication and Quantum Computing: Challenges and Opportunities

Wednesday, 27 March 14:00–18:30
Room: 9

Organizers: Eleni Diamanti, *CNRS, France*; Michael Kues, *Univ. of Hannover, Germany*; Cheryl Sorace-Agaskar, *MIT Lincoln Laboratory, USA*; Michael Vasilyev, *Univ. of Texas at Arlington, USA*; Jianwei Wang, *Peking Univ., China*; Rui Wang *Univ. of Bristol, UK*

Recent advancements in quantum technology have led to the transition from lab-scale demonstrations to practical applications. Quantum technologies, including quantum communication and cryptography, quantum random number generation, and quantum processing accessible on the cloud, have gradually matured to provide commercial services. Photonic Integrated Circuits (PICs) have emerged as a crucial technology for quantum communication and computing due to their compact size, robustness, and ability to accommodate multiple elements on a single chip. Various PIC platforms are being developed to enable different quantum modalities and architectures. However, significant progress is still needed regarding hybrid integration to expand and mature PIC platforms, as well as the development of supporting infrastructure (electronic control, packaging, etc.) for leveraging PICs in quantum communication and computing systems. This symposium will focus on the potential benefits of PICs in these applications, the field's current state, including desired system architectures, and the key challenges in PIC development that need to be overcome.

Key questions that this symposium aims to discuss include:

- How can PICs accelerate the development of photonic-based quantum technologies?
- Will PICs be the solution for complex quantum information processing and what are the critical challenges in realizing large-scale photonic chips?
- How can PIC chips and integrated systems contribute to developing a quantum internet? Will it play a central role?
- What would be the commercially available and sustainable business model for PIC development suitable for quantum systems and networks?
- Can a viable supply chain for quantum PICs at a global scale be envisioned?
- Can photonic-electronic co-packaging offer advantages for enabling hybrid quantum chips?

This symposium will delve into these questions, focusing specifically on the role of PICs in quantum technologies. The first session will discuss PICs for quantum communication, followed by a panel discussion. The second session will explore photonic integration technologies for quantum computing and quantum interconnect, concluding with a panel discussion.

Session I: Photonics Integration for Quantum Communications.
This session will provide a broad overview and in-depth discussions of key emerging research areas, including PIC for quantum communications and quantum memories. The scope is to leverage the advances of PICs to explore the capabilities enabled by this technology and identify the benefits and challenges in achieving quantum communication devices and systems compatible with existing telecom technologies. The panel will discuss the current state of the art, the key research challenges and the perspective from industry and foundries on developing applications and services with a quantum advantage.

Session II: Photonics Integration for Quantum Computing and Quantum Interconnects
This session will explore another set of research areas - PICs for quantum computing and quantum interconnects. The talks will cover PICs for photonics-based quantum computers, quantum transducer technologies for interfacing flying qubits and matter qubits, and novel PIC architectures for non-photonics-based quantum computing. The panel will discuss recent research advancements in these areas, development and vision from the relevant industry, and challenges ahead to realize useful quantum computing.

Speakers:
Davide Bacco; *University of Florence, Italy*
PIC for Quantum Communication

Bryan DeBono; *Quantinuum, USA*
Trapped-Ion Quantum Computing with Integrated Photonics

Benjamin Dixon; *MIT Lincoln Laboratory, USA*
Fully Packaged Multichannel Cryogenic Quantum Memory Module

Danielius Kramnik; *University of California Berkeley, USA*
Monolithic Integration of Electronic-Photonic Quantum Systems-on-Chip on a CMOS Platform

Blair Morrison; *Xanadu, Canada*
Universal and Fault-Tolerant Photonic Quantum Computing

Ségolène Olivier; *CEA-LETI, France*
Integrated Quantum Photonics/Foundry Talk

Philip Sibson; *KETS Quantum, UK*

Chi Xiong; *IBM TJ Watson Research Center, USA*
Scalable Microwave-to-Optical Transducers for Quantum Computing and Network

Wenmiao Yu; *Quantum Dice, UK*
Commercialising Qrngs - From Lab to Product

Green Transformation: Where Do We Stand?
Monday, 25 March, 08:00–12:30
Room: 2

Organizers: Saifuddin Faruk, *Bangor University, UK*; Naveena Genay, *Orange Labs, France*; Luca Valcarenghi, *Scuola Superiore Sant'Anna, Italy*; Ting Wang, *NEC Labs, USA*

Part 1:
Green ICT: Are next-generation telecommunication systems "green" enough? On a global scale, ICT power consumption equals about 5% of the global energy consumption, and this percentage is increasing over time. For example, it is estimated that the power consumption of optical transport infrastructure in telecommunication providers increases by about 12 percent per year.

Part 2:
ICT for Green Transformation: The massive utilization of ICT, encompassing data center networks, holds the potential to significantly reduce greenhouse gas (GHG) emissions across various sectors, as exemplified during the COVID-19 pandemic with lockdowns resulting in decreased emissions, notably in the transportation sector. For instance, expanding fiber-optic connectivity to every corner and facet of our digital landscape might enable vertical sectors, including those reliant on data center networks, to transition to more eco-friendly practices. The symposium will not only explore how ICT, encompassing data center networks, can contribute to reducing GHG emissions but also delve into the energy efficiency methodologies and strategies for carbon footprint reduction and carbon footprint improvement that have been implemented by vendors and operators within the ICT industry.

Speakers:

Session I

Lieven Levrau; *Nokia, France*
IOWN GF Energy Efficiency Program: Powering a Sustainable Future

Asahi Koji; *NEC, Japan*
Energy Efficient in Open Optical Transport

Paolo Gemma; *ITU-T, Italy*
Assessment of Fixed Network Energy Efficiency

Andreas Gladisch; *Deutsche Telekom AG Laboratories, Germany*
Rethinking Telcos Central Offices for Green Transformation

Session II

Alessandro Percelsi; *TIM, Italy*
How ICT can Postively Impact the Environment

Fabio Cavaliere; *Ericsson, Italy*
Can Photonics Help in Reducing the Power Consumption in Radio Access Networks?

Nicola Sambo; *Scuola Superiore Sant'Anna, Italy*
Solutions to Increase Energy Efficiency of Optical Networks

Masaki Kozai; *NTT, Japan*
Effective Use of Renewable Energy in Data Centers

Embracing Fiber Sensing: What's the "Killer App" for Large-Scale Deployments?
Wednesday, 27 March, 14:00–18:30
Room: 6C

Organizers: Ezra Ip, *NEC, USA*; Sander Jansen, *Adtran, USA*; Jeremie Renaudier, *Nokia Bell Labs, France*

Fiber sensing technology has revolutionized the capabilities of telecommunication networks around the world. With coherent detection technology, there are a variety of potential applications for fiber sensing, from enhancing network efficiency to detecting anomalies in real time. Despite the vast potential benefits, few providers have fully embraced this technology on a large scale, prompting the question of what could be "killer apps" for fiber sensing to be implemented first. This symposium will address this question by examining real-world applications of fiber sensing in global telecom networks, including best practices for field deployment, large-scale implementation considerations, and the use of AI, ML, and digital twin technologies for processing sensing data. The symposium will also explore the potential returns on investment and revenue generation associated with fiber sensing adoption, providing attendees with

the knowledge they need to make informed decisions about this cutting-edge technology. By the end of the workshop, participants will have a comprehensive understanding of the current state of fiber sensing technology and its potential for successful implementation in global telecom networks.

Speakers:

Session I

Ezra Ip, *NEC, USA;* Sander Jansen, *Adtran, USA;* Jeremie Renaudier, *Nokia Bell Labs, France*
Fiber Sensing for the Telecommunication Industry in a Nutshell

Paul Dickinson; *FOSA/Duraline, USA*
Existing and Emerging Market Opportunities for Distributed Fiber Optic Sensing

Andrew Lord; *British Telecom, UK*
How Can Sensing on Telecoms Fibres Bring Revenues to Operators?

Yoshifumi Wakisaka; *NTT, Japan*
Environmental Monitoring Using Widely Deployed Telecommunication Optical Fiber Cables and Distributed Acoustic Sensing

Session II

Glenn Wellbrock, *Verizon, USA*
The "Killer App" is that the Fiber Already Exists!

Michael Morgan; *Exelon, USA*
Fiber Sensing Use Cases and Applications for an Electric Utility

Kang-Kuen Lee, *Hong Kong Polytechnik University, Hong Kong*
Progression from Discrete Fiber Bragg Grating Sensors to Distributed Optical Fibre Sensing in the Railway Industry

Paul Westbrook; *OFS, USA*
Monitoring and Sensing Applications Enabled by Enhanced Scattering Fibers in Future Telecom Networks

Panels

Nine panels are scheduled for OFC 2024. Please refer to the abstract section for full descriptions.

The Role of Digital Twins in Optical Networking
Date: Monday, 25 March, 10:30–12:30
Room 7

Organizers: Kostas Christodoulopoulos, *University of Athens, Greece*; Yvan Pointurier, *Huawei, France*; Chongjin Xie, *Alibaba Group, USA*

The Road Towards 3.2 Tb/s Intra-Data Center Communications
Date: Monday, 25 March, 14:00–16:00
Room 6E

Organizers: Stephan Pachnicke, *Christian-Albrechts Universität zu Kiel, Germany*; Juthika Basak, *Nokia Corp., USA*; James Chien, *Marvell, USA*

Wideband Optical Amplifiers for Datacenters, Hyperscale Networks and Telecom Networks
Date: Monday, 25 March, 16:30–18:30
Room 7

Organizers: Vladimir Gordienko, *Aston University, UK*; Michael Vasilyev, *University of Texas at Arlington, USA*; Raja Ahamd, *Cisco Systems Inc, USA*; Seongwoo Yoo, *University of Glasgow, UK*

Can New Access Technology and Architectures Support the Beyond 5G Network Vision
Date: Tuesday, 26 March, 14:00–16:00
Room 7

Organizers: Chathu Ranaweera, *Deakin University, Australia*; Annachiara Pagano, *TIM, Italy*; Lihua Ruan, *Chinese University of Hong Kong, China*, Marco Ruffini, *Trinity College Dublin, Ireland*

Beyond Two-Core Fibers: Single-Core vs Multi-Core Amplifiers in Long-Haul SDM Links
Date: Tuesday, 26 March, 14:00–16:00
Room 6E

Organizers: Atsushi Nakamura, *NTT, Japan;* Victor Kopp, *Chiral Photonics, USA*; Masato Tanaka, *Sumitomo Electric Industries Ltd, Japan*; Bera Pálsdóttir, *OFS Fitel Denmark I/S, Denmark*

Cutting-Edge Technologies for Interconnecting AI/ML Clusters
Date: Tuesday, 26 March, 16:30–18:30
Room 6E

Organizers: Brandon Buscaino, *Nokia, USA*; Norm Swenson, *Norman Swenson Consulting, USA*; Qiong Zhang, *Amazon, USA*

Next Generation Disaggregated Data Centers Using Future Chip to System Photonic Technologies
Date: Wednesday, 27 March, 08:00–10:00
Room 6E

Organizers: George Michelogiannakis, *Lawrence Berkeley National Laboratory, USA*; Liam Barry, *Dublin City University, Ireland*

Photonic Components for In-Physics Computing
Date: Wednesday, 27 March, 08:00–10:00
Room 7

Organizers: Joyce Poon, *Max Planck Institute of Microstructure Physics, Germany*; Patrick Runge, *Fraunhofer HHI, Germany*; Wei Shi, *Laval University, Canada*

Role of Optics for Space Communication
Date: Wednesday, 27 March, 14:00–16:00
Room 7

Organizers: Chi-Wai Chow, *National Yang Ming Chiao Tung University, Taiwan*, Stephanie Ralph, *Georgia Tech, USA,* Katherine Newell, *Johns Hopkins University Applied Physics Lab, USA,* Yi Sun, *OFS Fitel LLC, USA*

Special Sessions

Frontiers of Optical Network Architecture Summit

Monday, 25 March, 14:00–16:00
Room 3

Organizers: Jun Shan Wey, *Verizon, USA*; Vincent Chan, *MIT, USA*

Evolving Optical Network Architecture Towards the Next Decade

Over the past five decades, we have witnessed optical networks growing from simple connectivity to today's hyper-connected network providing all sorts of services.

In the early decades, telecommunications operators led the development and drove the optical industry forward, building massive optical networks connecting homes, businesses, metropolitans, countries, and continents. A new era arrived when web-scale operators propelled the industry to another tremendous growth period, providing intra and inter datacenter, metro, long-haul, and transoceanic connectivity. Another turning point is now emerging. As telecommunications networks are adopting datacenter design concepts, such as openness and disaggregation, and web-scale operators are starting to provide some form of telecommunications services, the topic of whether a common architecture is the right future direction is calling for an in-depth debate.

This summit will examine how the optical network will evolve in the next decade. How will the web-scale architectural approach be adopted in future telecommunications network infrastructure? Should there be a common architecture or should there be separate ones? How to design a service-based architecture with dynamically tailored network configurations? How do web-scale operators incorporate key requirements to build smart networks: open and modular, commodity hardware, intelligence in software, scalable and efficient, and highly programmable? What will be the profitable business cases? Does the cost of the network have to be bundled with the applications for a sustainable business?

Five invited speakers representing traditional telcos, web-scale operators, system and component vendors will discuss their views and debate the most promising path forward. The audience will have an opportunity to join the conversation through interactive Q&A and real-time polls.

Speakers:

Ori Gerstel; *Cisco, Israel*
The Future of Optical Networking in Service Provider Networks: Defined by External Factors

Hiromi Oohashi; *Furukawa Electric, Japan*
Next-Generation Optical Devices for Future Network

Greg Steinbrecher, *Meta, USA*
Reconfigurable Photonics and Flexible AI Systems

Masahito Tomizawa; *NTT Innovation Devices Corp., Japan*
An Operator's View on the Future Optical Networks, and Enabling Device Technologies: *Innovative Optical and Wireless Network Program*

Glenn Wellbrock, *Verizon, USA*
More Fiber, Less Equipment

Moore's Law: A Photonics Perspective for the Next Decade

Tuesday, 26 March, 14:00–16:00
Room 6D

Organizers: Di Che, *Nokia Bell Labs, USA*; Paul Gunning, *BT, UK*; Kaida Kaeval, *Tallinn Univ. of Technology, Estonia*; Emerson Moura, *Cisco Systems, Brazil*

Gordon Moore observed that the cost of a silicon transistor got cheaper the smaller you could make it. Moore's Law states that the number of transistors on a silicon integrated circuit doubles every 18 to 24 months. Across six decades, the silicon semiconductor industry has been able to pack more and more transistors

Functional groups of transistors form CPU/GPU/NPU/TPU silicon chips of great capability. But will all this potentiality be stranded on these chips, like remote islands cut off from the outside world? Where can photonics help?

Moore's Law is entering the Angstrom node era, so what are the prospects for electronics and photonics over the next decade? What exciting technologies will have been implemented and deployed when we re-convene for our retrospective workshop at OFC 2034? Our invited experts will provide their best insights on how the continued advancement of Moore's Law will directly impact:

FUNDAMENTALS

- Does Moore's Law apply to photonics - and if so, what are the limits?
- Opportunities from Quantum technologies.

APPLICATIONS

- Aggregate bisection bandwidths of silicon switching ASICs approach hundreds of Terabit/s;
- Migration from copper to optical backplanes within chassis;
- Evolution of compact pluggable transceivers, co-packaged optics and other advanced technologies;
- Advancements in A/D & D/A and DSP logic ASICs;
- High-bandwidth, low-latency, low-jitter, error-free interconnects to support the evolution of AI and photonic AI 'logic chips'.

ECOSYSTEM DEVELOPMENT

- Datacom and non-datacom;
- Business opportunities and technology outlook;
- Refreshment cycles e.g. shorter versus longer operational lifetimes; system dependability.

SUSTAINABILITY

- The need for lower energy per bit (fJ/bit?…aJ/bit?) whether computed, switched, transmitted, or stored;
- Space reduction and power consumption;
- Perhaps we don't need to evolve Moore's Law; the focus should be on better Network efficiency and better existing resource utilization.

Speakers

Andreas Bechtolsheim; *Arista, USA*
Keeping up with Moore's Law

Amit Nagra, *Intel, USA*
Keeping up with and Enabling Moore's Law: Role of Photonics I/O

Katharine Schmidtke; *Eribel Systems, USA*
Moore's Law Redefined for AI/HPC Systems

Rebecca Schaevitz; *Lightmatter, USA*
Breaking Down the Interconnect Bottleneck - A Third Dimension

Vladimir Stojanovic; *Ayar Labs, USA*
In-Package Optical I/O: Bridging the Gap Between Moore's Law and Amdahl's Law in Modern Compute Systems

Anna Tauke-Pedretti; *DARPA, USA*
A Path towards Scaling Photonic Circuits

Demo Zone

Monday, 25 March, 14:00–16:00
Room 6A

The Demo Zone features live demonstrations of research projects and proof-of-concept implementations related to novel optical communication devices, systems, and networks.

Demos:
Please refer to the abstract section for full descriptions.

M3Z.1 Frank Slyne, *Trinity College, Dublin, Ireland*
Demonstration of Cooperative Transport Interface using open-source 5G OpenRAN and virtualised PON network

M3Z.2 Zu-Kai Weng, *National Institute of Information and Communications Technology, Japan*
Demonstration of Robust Mobile Free Space Optical System using High-speed Beam Tracking and 2D-PDA-based Spatial-Diversity Reception

M3Z.3 Mihail Balanici, *Fraunhofer HHI, Germany*
Live Demonstration of Autonomous Link-Capacity Adjustment in Optical Metro-Aggregation Networks

M3Z.4 Joaquin Fernando Chung Miranda, *Argonne National Laboratory, USA*
Orchestration of Entanglement Distribution over a Q-LAN using the IEQNET Controller

M3Z.5 Saverio Pellegrini, *Politecnico di Torino, Italy*
Real-Time Demonstration of Anomalous Vibrations Detection in a Metro-like Environment using a SOP-based Algorithm

M3Z.6 Alberto Gatto, *Politecnico di Milano - DEIB, Italy*
Quantum-Assisted Digital Signature in an SDN-controlled Optical Network

M3Z.7 Mario Wenning, *Adva Network Security GmbH, Technical University of Munich, Germany*
Quantum Key Management System with Dynamic Routing for Meshed QKD Networks

M3Z.8 Luis Velasco, *Universitat Politecnica de Catalunya, Spain*
Deployment of Secure Machine Learning Pipelines for Near-Real-Time Control of 6G Network Services

M3Z.9 Vignesh Karunakaran, *Adtran Networks SE, TU Chemnitz, Germany*
TAPI-based Telemetry Streaming in Multi-domain Optical Transport Network

M3Z.10 Huy Quang Tran, *Nokia Bell Labs, France*
Demonstration of a Compositional Learning Framework for Open and Disaggregated Optical Network Control

M3Z.11 Haoshuo Chen, *Nokia Bell Labs, USA*
Artificial Intelligence (AI)-Powered Robot for Optical Network Operation Automation

M3Z.12 Luis Velasco, *Universitat Politecnica de Catalunya, Spain*
Distributed Multi-Agent System fed with Telemetry Data for Near-Real-Time Service Operation

M3Z.13 Luis Velasco, *Universitat Politecnica de Catalunya, Spain*
Experimental Demonstration of Optical Encryption Using Quantum Keys: Two Scenarios

Open Networking Summit: Open and Disaggregated Optical Networking: Where We've Been and What's Coming Next

Monday, 25 March, 16:30–18:30
Room: 6E

Organizers: Lynn Nelson, *AT&T, USA;* Shen Shikui, *China Unicom, China;* Norman Swenson, *Infinera, USA*

Open and disaggregation have grown in popularity and appeal across networking segments, including optical networks, in the past few years. With open and disaggregated networks, operators/hyperscalers can use best-in-class equipment and avoid vendor lock-in, thereby gaining faster innovation, flexibility, and scalability as their network needs grow. Deployment status varies by network segments, working distances, and geographic regions, including data center networks with backbone long-haul and metro, core networks, and customer premises equipment (CPE) in metro and edge layer. Operators/hyperscalers from different geographic regions also have different attitudes and adopt varied approaches.

This summit aims to gather service providers, cloud providers, equipment vendors, and component vendors across the eco-system to share learnings and experiences, highlight innovation, and discuss the future of open and disaggregated optical networking, including software-defined networking (SDN), southbound interfaces, information modeling, interoperable DSP, IP over DWDM, and coherent pluggable transceivers.

Topics to be targeted by this summit include but will not be limited to:

1. In what segments of the network have openness and disaggregation been applied, i.e., long-haul/backbone, metro, or access?
2. What were the anticipated pros and cons of openness and disaggregation? Were those realized in deployment? (e.g., Have the projected cost savings been realized?)

3. Will openness and/or disaggregation help or hinder convergence of different network segments (e.g., metro and long-haul) and layers (IP + optical)?
4. Will nascent interoperable DSP stimulate increased adoption of openness and disaggregation in optical networks?
5. Will openness and disaggregation be a key enabler for IP over WDM?
6. What advances are needed in managing smart coherent pluggables in routers to enable IP over WDM?

Speakers:
Sebastien Gareau, *Ciena, Canada*
Steven J. Hand, *Infinera, USA*
Emerson Moura, *Cisco, Brazil*
Kirsten Rundberget, *AT&T, USA*
Chongjin Xie, *Alibaba Group, China*

Rump Session: How Much Optics Does AI Need?

Tuesday, 26 March, 19:30–21:30
Room: 6F

Organizers: Peter Winzer, *Nubis Communications, USA*; Shu Namiki, *AIST, Japan*; Laurent Schares, *IBM, USA*

Description
AI systems have attracted enormous interest over the past couple of years and commensurate investments into the AI infrastructure for data processing and movement. This rump session will debate how deep optical technologies should penetrate AI clusters. This year's rump session will address a broad range of aspects concerning the role of optics in AI clusters. Everybody is invited to participate in two hours of lively (and not recorded) discussions.

Postdeadline Paper Presentations

Thursday, 28 March, 16:30–18:30
Rooms: 6C, 6D, 6E, 6F

Discover the best and most cutting-edge research in optical communications. The OFC 2024 Technical Program Committee has accepted a limited number of Postdeadline Papers for oral presentation. The purpose of Postdeadline Papers is to give participants the opportunity to hear new and significant material in rapidly advancing areas. Only those papers judged to be truly excellent and compelling in their timeliness were accepted.

Lists of accepted papers with their presentation times will be posted throughout the convention center, in the OFC Conference App and online on Tuesday, 26 March. Please visit ofcconference.org and click the "Download Digest Papers" button to access these papers.

Special Events

Simulating Datacom/Telecom Applications Following Standards Specifications

Sunday, 24 March, 13:30–17:30
Room 31C

Organizers: Optica Foundation and VPIphotonics

This training will show you how to conceptualize and investigate optical transmission systems based on recommendations from standardization committees or multi-source agreements (MSAs) using professional simulation software. You will learn to model photonic components on different abstraction levels up to entire optical transmission systems corresponding to specifications. Then, evaluate the defined parameters and efficiently automate the design and analysis for new recommendations using the VPIphotonics Design Suite. We will investigate several standardized applications ranging from data center interconnects to high-capacity core network links. We will explore characterization and measurement concepts, demonstrate how to examine the impact of performance-limiting effects, and assess how to mitigate or compensate for them using machine learning algorithms.

Topics include:

- Examine a professional simulation software design environment
- Model photonic component characteristics
- Simulate application scenarios following standards specifications (e.g., 400G ZR, 800G FR-4, TDECQ)
- Investigate new mitigation techniques using machine learning algorithms

This training targets students, early-stage professionals, engineers, and researchers who want to learn how to utilize a professional simulation and design environment. Basic knowledge of the various transmission systems' technologies, concepts, and methodologies is helpful.

This interactive course includes a 4-hour session of lectures, guided labs, and independent work with 1-on-1 support. Attendees will be provided access to the software in a cloud-based environment using their private laptops. Arrive by 1:00 pm for software setup.

Separate sign-up is required.

Optica Executive Forum at OFC 2024

Monday, 25 March, 07:30–19:00
Hilton San Diego Bayfront

Executive Forum - The Premier Annual Event for Leaders in Optical Networking and Communications

Co-located with OFC, the Premier Event in Telecom and Data Center Optics' this is an Optica Industry Event. The Executive Forum features C-level panelists in an informal, uncensored setting discussing the latest issues facing the industry and your business. Leaders from top companies discuss critical technology advancements and business opportunities that will shape the network in 2024 and the future.

For over 25 years, the Optica Executive Forum has been the premier annual event for leaders in optical networking and communications. The forum will be co-located with OFC 2024, the largest and most important gathering of the optical communications community. The Optica Executive Forum is hosted by Optica's corporate membership engagement program. The Executive Forum features C-level speakers in an informal, unscripted setting discussing the latest business issues facing the industry and your company. Leaders from top companies discuss the business opportunities that will shape the network in 2024 and the future.

Separate fee is required.

Student Party

Monday, 25 March, 19:00–21:00
Location: Coin-Op Game Room

Join us at the Student party for an evening of food, drinks, and networking! Don't forget to bring your ID/Passport to the venue.

Separate sign-up is required. Please visit ofcconference.org to reserve your spot.

Conversation with the Plenary Speakers

Tuesday, 26 March, 10:15–10:45
Theater III, Exhibit Hall

Join OFC General Chairs Chris Fludger, Roland Ryf and Dimitra Simeonidou for a conversation with Plenary Speakers, Anita Döhler, Inder Monga and David J. Richardson.

The Art of Writing the Perfect OFC Paper

Tuesday, 26 March, 10:30–12:00
Room: 6A

Organizers: Georg Rademacher, *National Inst. of Information & Comm Tech, Japan;* Paolo Monti, *Chalmers University of Technology, Sweden.*

Join OFC committee members, journal editors, and distinguished researchers for an interactive workshop on how to write a highly scored OFC paper. We will discuss the qualities of great OFC submissions and the common reasons why papers are rejected from OFC. The workshop will kick off with a few short talks followed by smaller breakout/brainstorming sessions and end with some time for networking.

Conference Reception

Tuesday, 26 March, 18:30–20:00
Ballroom 20

Enjoy food and drinks with your friends and colleagues during the conference reception. Tickets for this event are included with all full conference registrations. Additional tickets may be purchased at Registration for USD 85.

OFC Fun Run

Wednesday, 27 March, 06:00–07:00
Bottom of San Diego Convention Center Stairs (front entrance)

Pack your running shoes and meet up for an early morning, 3 mile run or walk with fellow OFC colleagues. Can't make it in person? No problem, join us virtually! Take a selfie, tag #OFC24 and #werunOFC and share it with the rest of the OFC X community @OFCConference.

The Journal Review Process: All You Need to Know!

Wednesday, 27 March, 12:30–14:00
Room: 6A

Journal publications play a critical role in our industry. They serve as repositories where new results, ideas, and demonstrations are reported, providing a permanent resource for others in their research and design endeavors. This event offers a unique behind-the-scenes look into the journal publications process, allowing attendees to pose questions and interact with Editors and Reviewers from some of the highest-impact factor journals in optical communications and networking. The focus will be on understanding what happens once a new research paper is submitted to an IEEE or Optica journal.

The event will feature informative presentations and roundtable discussions hosted by individuals intimately involved in the review and publication process, eager to answer questions and engage with the audience. Importantly, for those interested in further insights, the event will guide participants in becoming involved in the review process for the most prestigious journal publications in the field of optical telecommunications.

A roundtable discussion with Editors from JLT, PTL, and JOCN will follow the presentations. Separate sign-up is required.

Organizers

Andrew Lord, *Editor-in-Chief, Journal of Optical Communications and Networking, Sr. Manager of Optical Networks Research, British Telecom, UK*

Boon S. Ooi, *Editor-in-Chief, IEEE Photonics Technology Letters, Professor of Electrical and Computer Engineering, KAUST, Saudi Arabia*

Sorin Tibuleac, *Journal of Lightwave Technology (JLT) Associate Editor, Director, Adtran, USA*

Challenges and Solutions for Realizing Quantum Fiber-Based Networks

Wednesday, 27 March, 12:45–13:45
Room: 3

You are invited to join the Optica Technical Group on Fiber Optics Technology and Applications for a panel discussion during lunch on Monday. Attendees will have the opportunity to hear from our featured panelists as they discuss recent developments and opportunities of quantum communications.

Please RSVP for this technical group event at bit.ly/OFCQuantumPanel to let us know you will be attending.

Photonics Society of Chinese Heritage (PSC) Workshop and Networking Social

Wednesday, 27 March, 17:00–19:00
Room 15

Optics for AI Compute Era: Opportunities and Potential Disruptions

Generative AI is gaining market momentum while AI Compute drives accelerated high bandwidth optical connectivity upgrades. On one hand, conventional pluggable optics suppliers are gaining huge boost from recent AI compute data center build-out by hyper data center operators; on the other hand, the accelerated AI compute is also driving potential disruption with architectures requiring high bandwidth density optical solutions integration deeper into compute and memory nodes with new technology like co-packaged optics. In this workshop, we will have invited speakers to discuss their view of AI-driven opportunities and potential disruptions to the optical industry, with representatives from AI data center operators, incumbent major optical suppliers, and new start-up companies focusing on disruptive solutions for AI.

All are welcome to hear a select panel of industry experts present and answer questions on this year's hot topic. Networking dinner offsite will follow the event.

Partners: Optica, China International Optoelectronic Expo (CIOE) and Infostone

Plenary Session

Tuesday, 26 March, 08:00–10:00
Ballroom 20

How 6G will Impact Netowking

Anita Döhler, *Chief Executive Officer, Next Generation Mobile Networks Alliance (NGMN), Germany*

This presentation explores NGMN's pivotal role in advancing the Mobile Industry towards next-generation networks, encompassing Operator led requirements on 6G, sustainability, and cloud-native. With a prerequisite to deliver new use cases that create value and exceptional end-user experiences this presentation looks at trade-offs that will need to be made, for example energy consumption versus bit rates and identifies the critical role optical communications will play in enabling these Operator led requirements, for example disaggregation, resilience and energy efficiency.

Anita Döhler brings a wealth of international experience across diverse business sectors, including senior leadership roles within mobile network operators, technology vendors, and consulting firms. Between 2016 and 2020, she held prominent senior management positions at Accenture Industry X.0. Prior to her tenure at Accenture, Döhler amassed 16 years of experience at Vodafone Group, and earlier in her career, she contributed her expertise to E-Plus and Philips, among other notable organizations. Döhler holds a Dipl.-Ing. degree in Telecommunication Engineering and has also earned an Executive MBA degree. She is also a Systemic Business Coach.

Döhler is passionate about propelling technological innovation for the betterment of humanity and societies, with a steadfast commitment to supporting the world's foremost operators, vendors and research institutes.

Networking Alchemy: Transforming Science Through Connectivity

Inder Monga, Executive Director, ESnet, and Scientific Networking Division Director, Berkeley Lab, USA

Scientists are driven to answer some of the world's most fundamental questions – from the origin of the universe to the future of humanity and our biosphere. Answers lie hidden in the deluge of data being gathered 24/7 from experiments, observations, and simulations. Energy Sciences Network (ESnet), the Department of Energy's data circulatory system, seeks to harness and accelerate the creativity of vital research collaborations while pushing the boundaries of networking in experimenting with what a quantum computing network might look like. This talk will describe global-scale science and its workflows, innovations being explored to meet its rapidly evolving needs, and the engineering behind the science networks of today and the future.

Indermohan (Inder) S. Monga is the Director of Berkeley Lab's Scientific Networking Division and Executive Director of Energy Sciences Network (ESnet), the Department of Energy's high-performance network user facility. Optimized for large-scale science, ESnet connects and provides services to more than 50 DOE research sites, including National Laboratories, supercomputing facilities, and scientific instruments, as well as peers with 271 research and commercial networks worldwide. In addition to managing ESnet, Monga works to advance the science of networking for collaborative and distributed research applications by contributing to ongoing research projects, including quantum networking. He is the holder of 25 patents.

Emerging Fiber Technologies for Future Optical Networks

David J. Richardson, *Partner Researcher, Microsoft, USA*

Major advances have been made in recent years on the development of radically new transmission fibers offering improved optical properties and systems performance relative to conventional single mode fiber technology, with some of the most promising, including hollow core fiber, now deployed in the field. I review progress in these emerging technologies and discuss where they are likely to prove most disruptive and impactful in future optical networks.

David Richardson joined Microsoft as a Partner Researcher in February 2023 following their acquisition of Lumenisity Ltd, a spinout company that he co-founded in 2016 to develop hollow core fiber cables and solutions for telecoms and datacoms. Prior to joining Microsoft, Richardson had a remarkable 34-year career at the esteemed Optoelectronics Research Centre at the University of Southampton. For the last 24 years of his tenure there, he held the position of Deputy Director, leading a sizable research group that worked on the forefront of optical fiber technology and its applications in telecommunications, high-power lasers and sensing.

Throughout his career, Richardson has collaborated extensively with companies and universities worldwide, resulting in an impressive body of work that includes over 500 journal papers and 20 patents. He is a Fellow of both the Royal Society and of the Royal Academy of Engineering.

Awards Ceremony and Luncheon

Tuesday, 26 March, 12:30–14:00
Ballroom 20

Supported by CORNING

Join conference co-sponsors Optica, IEEE Communications Society, and IEEE Photonics Society for a special luncheon to recognize award and honor recipients from each society. This is a ticketed event.

The following awards and recognitions will be presented at the event.

2024 John Tyndall Award

First presented in 1987, this award recognizes outstanding contributions in any area of optical-fiber technology that have met the test of time and been of proven benefit to science, technology, or society. It is jointly presented by the IEEE Photonics Society and Optica and is funded by Corning, Incorporated.

Optica 2024 Fellows

Recognizes Optica members who have served with distinction in the advancement of optics and photonics through distinguished contributions to education, research, engineering, business leadership, and society.

IEEE Photonics Society 2024 Fellows

Recognizes IEEE members who have achieved extraordinary accomplishments that have contributed to the advancement or application of engineering, science, and technology, bringing the realization of significant value to society.

IEEE Communications Society 2024 Fellows

Recognizes the extraordinary contributions and accomplishments of IEEE members. Fellows are honored for their outstanding technical, educational, and leadership achievements.

IEEE/Optica Journal of Lightwave Technology Best Paper Award

Recognizes the top cited original paper published in the Journal in 2021, as determined by a variety of citation metrics and databases. It is presented by the Journal's Coordinating and Steering Committees. Copies of the winning paper will be available at OFC and will be made open access in the IEEE Xplore Digital Library.

IEEE Photonics Award

Established in 2002, the award is presented for outstanding achievements in photonics. Recipients are selected by the Technical Field Awards Council of the IEEE Awards Board.

David Richardson Medal

Established in 1966, the medal recognizes significant contributions to optical engineering, primarily in the commercial and industrial sector. It is presented by Optica and endowed by Cary Instruments (formerly Applied Physics Corporation) and Gary Duck.

Jane M. Simmons Memorial Speakership

Established in 2021 in honor of Jane M. Simmons' high-impact contributions to optical network architecture, design, and planning, the speakership recognizes an invited speaker at OFC. The recognition is endowed by the Simmons Family. The OFC community is encouraged to contribute to the fund by visiting optica.org/donate.

The Corning Outstanding Student Paper Competition

Endowed through the Optica Foundation by Corning Incorporated, the paper competition recognizes innovation, research excellence, and presentation abilities in optical communications. All students submitting their papers during the regular "call for papers" process for OFC are eligible for the competition. Finalists present their work to the OFC Program and General Chairs in a private session before the conference.

The Corning Women in Optical Communications Scholarship

Endowed through the Optica Foundation by Corning Incorporated, these scholarships recognize three outstanding women graduate students studying optical communications and networking.

The Tingye Li Innovation Prize

Presented to an early career professional who has demonstrated innovative research, the prize honors the global impact Tingye Li made to the field of optics and photonics. It is administered by the Optica Foundation, and endowed by Alliance Fiber Optic Products, Inc., AT&T, Optica, IEEE Photonics Society, IEEE Communications Society, Thorlabs, Inc, the Li Family, and supporters of the Tingye Li Memorial Fund.

Exhibition and Show Floor Activities

The OFC Exhibition is the perfect place to build and maintain professional contacts and broaden your knowledge about the companies that lead our industry in product development and technological advances. Hundreds of exhibits showcase the entire supply chain continuum – from communications systems and equipment to network design and integration tools and components and devices. In addition, three exhibit hall theaters feature presentations by experts from major global brands and key industry organizations. Get high-level perspectives on hot topics like intra and inter-data center connectivity, infrastructure, access networks, optical systems and components, standards and industry updates.

Learn about the state of the industry, emerging trends and recommended courses of action for how to tackle today's toughest business challenges.

Exhibition

Halls A-H
Exhibit Hall Regulations

- All bags are subject to search.
- Neither photography nor videotaping is permitted in the exhibit hall without the express written consent of OFC 2024 Show Management. Non-compliance may result in the surrendering of film and removal from the hall.
- Children under 18 are not permitted in the exhibit hall during set-up and teardown.
- Children 14 and under must be accompanied by an adult at all times.
- Strollers are not allowed on the show floor at any time.
- Soliciting in the aisles or in any public spaces is not permitted.
- Distribution of literature is limited to exhibitors and must be done from within the confines of their booths.
- Smoking is not permitted inside the San Diego Convention Center. You are welcome to step outside the Convention Center to smoke in designated smoking areas only, but please be considerate of others when you do.
- Alcohol is not permitted in the exhibit hall during set-up and tear-down.

Exhibit Hall Coffee Breaks

The exhibit floor is the perfect place to build and maintain professional contacts, and these breaks provide ideal networking opportunities. Complimentary coffee will be served in the exhibit hall at these times:

	Exhibit Hours	Coffee Breaks
Tuesday, 26 March	10:00–17:00	10:00–10:30 16:00–16:30
Wednesday, 27 March	10:00–17:00	10:00–10:30 16:00–16:30
Thursday, 28 March	10:00–16:00	10:00–10:30

Elevated Coffee Break Station Infinera
Booth 4217

Suzanne R. Nagel Lounge

Booth 1739
Sponsored by Infinera

Named in honor of the first woman chair of OFC, the Suzanne R. Nagel lounge is a dedicated networking space offering attendees the opportunity to meet colleagues, explore new business opportunities and have complementary expert headshots taken. Attendees can participate in small professional development sessions throughout the week focused on topics ranging from résumé writing to navigating the industry with confidence. Visit ofcconference.org/NagelLounge for a detailed schedule.

Lounge Hours

Tuesday, 26 March	10:00–17:00
Wednesday, 27 March	10:00–17:00
Thursday, 28 March	10:00–16:00

Poster Presentations

Exhibit Hall B1
Wednesday, 27 March, 10:30–12:30
Thursday, 28 March, 10:30–12:30

Poster presentations are an integral part of the technical program and offer an opportunity for lively discussion between the poster presenters and attendees.

Poster descriptions available in the abstract section.

Please refer to your Buyers' Guide and Addendum for more details on the exhibition and other activities on the show floor, including participating company information, a map of the exhibit hall and specific presentation schedules for many of the programs. Check the conference app for regular updates to show floor programming.

Expo Theater I Programming, *Exhibit Hall B2*

Sponsored by CISCO

Market Watch

This three-day panel discussion series engages the latest application topics and business issues in optical communications. Presentations and panel sessions feature esteemed guest speakers from industry, research and the investment community.

The program will be located on the exhibit floor. Attendees can easily attend the sessions and tour the exhibit hall. Audience members are encouraged to participate in the question-and-answer segments that follow the presentations.

Market Watch and Theater I Schedule

Tuesday, 26 March	
10:45–12:15	**MW Panel I:** State of the Industry
12:30–14:00	**MW Panel II:** Inside the Data Center Focused on AI/ML
14:15–15:45	**MW Panel III:** Coherent Technology Advancements to Address Next-Gen Networking Requirements
16:00–17:00	**CISCO:** Who Controls the DCO's in Routers?
Wednesday, 27 March	
14:15–15:45	**MW Panel IV:** Next Generation PON Technologies
16:00–17:00	**OIF:** Coherent Optics Unleashed: From 400ZR Success to 800ZR/LR Advancements and 1600ZR Kick-off - An OIF Update
Thursday, 28 March	
10:15–11:45	**MW Panel V:** Disaggregation Inside the DC
12:00–13:30	**MW Panel VI:** Disaggregation for Networks Operators
13:45–14:45	**OIF:** Energy Efficient Interfaces - Reining in Power Consumption Trends for Next-Generation Optical Networking
15:00–16:00	**COBO:** An Ecosystem Perspective on Scaling Integrated Photonics for the AI Revolution

Network Operator Summit

This dynamic program presents the inside perspective of service providers and network operators, their issues and drivers, and how their requirements may impact the industry's future. Everyone in the supply chain, from equipment manufacturers to components, will want to hear what's next in meeting the needs of all network operators.

Network Operator Summit Schedule

Wednesday, 27 March	
10:15–10:45	**Network Operator Summit: Keynote:** Masahisa Kawashima, *NTT, IOWN Development Office, IOWN Technology Director, Japan*
10:45–12:15	**NOS Panel I:** Optical Network Automation
12:30–14:00	**NOS Panel II:** Optics for 5G/6G

Expo Theater II Programming, *Exhibit Hall E*

Sponsored by Amphenol

Data Center Summit

This program focuses on next-generation optical technologies for intra and/or inter-data center connectivity. It discusses evolving data center requirements for technologies, equipment, applications and deployment scenarios in hyperscale and enterprise.

Theater II Schedule

Tuesday, 26 March	
10:45–11:45	**OCP:** Next generation Optical Interconnects for AI Clusters: Beyond Linear Drive Optics
12:00–12:30	**Data Center Summit Keynote:** Rich Baca, *Principal, Strategic Accounts, Ciena, USA*
12:30–14:00	**Data Center Summit Panel I:** ML/AI and Future Networks to Support It
14:15–15:45	**Data Center Summit Panel II:** Lowering Power Consumption in Optical Solutions
16:00–17:00	**IEEE Future Directions:** Photonics in Current and Future Machine Learning Network Infrastructure

Please refer to your Buyers' Guide and Addendum for more details on the exhibition and other activities on the show floor, including participating company information, a map of the exhibit hall and specific presentation schedules for many of the programs. Check the conference app for regular updates to show floor programming.

Wednesday, 27 March	
10:15–11:15	**Ethernet Alliance:** Ethernet Interconnect Solutions: Will the Advancement in Coherent Signaling Leverage DataCom Connectivity Solutions into the Telecom Closet?
11:30–12:30	**CableLabs:** Empowering Access Networks with Coherent Optics
12:45–13:45	**ITU-T SG15:** Standards Update on Higher Speed PON, Latest OTN Technologies and Interoperable Optical Interfaces
14:00–15:00	**IOWN** GF's Open APN for the Evolution of Mobile Networks and Cloud-and-Edge Computing
15:15–16:15	**Amphenol:** Exploring the Role of Interconnects in Energy Efficient Data Centers
Thursday, 28 March	
11:30–12:30	**IPEC:** Low-Latency High-Speed Optical Interconnection Technologies for AI Compute Era
12:45–13:45	**AIM Photonics:** Presents PICs, Heterogeneous Integration, and Packaging for Next-Generation Silicon Photonic Applications
14:00–15:00	**Broadband Forum:** Meeting Rural Broadband Needs with High Capacity PON

Expo Theater III Programming, *Exhibit Hall G*

Schedule

Tuesday, 26 March	
10:15–10:45	**Conversation with the Plenary Speakers**
11:00–12:00	**MOPA:** Mobile Optics (MOPA) for the 6G Era
13:00–13:30	**Infinera:** Architecting the Network for the Terabit Era and in the Shadow of Shannon
13:45–14:15	**OFCnet:** Telecom Fiber Networks as the Core of the Next Generation TerraScope
14:30–15:30	**F5G (ETSI):** F5G Intelligent and Green Networks towards 2030
15:45–16:30	**OFCnet Panel:** Quantum Key Distribution High-Speed Optical-Layer Encryption

Wednesday, 27 March	
10:15–10:45	**Open XR Optics Forum:** Open XR Optics Forum Update
11:00–11:45	**OFCnet Panel:** Quantum Entanglement and Quantum Memory for Next Generation Quantum Networks
12:00–12:45	**OFCnet Panel:** Beyond Point-to-Point Quantum Key Distribution
13:00–13:30	**OFCnet Panel:** Software Define Infrastructures
13:45–14:45	**OpenROADM:** Open ROADM MSA Updates and Demonstration
15:45–16:15	**ATOP:** The Road to 200G per Lane
Thursday, 28 March	
11:00–11:30	**OFCnet Panel:** Optical Benchmarks
11:45–12:15	**OFCnet Panel:** Optical Infrastructures and Services
14:45–15:45	**HyperLight:** Current State and Future of Thin-Film Lithium Niobate Photonics

Please refer to your Buyers' Guide and Addendum for more details on the exhibition and other activities on the show floor, including participating company information, a map of the exhibit hall and specific presentation schedules for many of the programs. Check the conference app for regular updates to show floor programming.

Other Show Floor Programming

OFCnet, Booth 923

OFC's high-speed optical network, OFCnet, enables select demonstrations of networking products, solutions and architectures.

This live network is built to showcase emerging technologies, including quantum networking, network element interoperability, SDN and programmability, and networking for big data/big science applications.

OFCnet enables booth-to-booth fiber connectivity for on-site optical demonstrations while extending CENIC to the OFC Exhibitor show floor. This connectivity provides new opportunities for exhibitors collaborating with affiliated academic institutions to highlight advancements and capabilities in a live, real-time, fully operational network environment.

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Demonstrations

Live demonstrations from the following organizations and companies will be connected through OFCnet. Please refer to the Buyers' Guide for more details.

Anritsu
AUREA Quantum
CESnet
Ciena/FABRIC/SDSC
Ciena/ID Quantique
Ciena/Toshiba
ICAIR/Northwestern University
NEC/Verizon/OFS
Nokia/ID Quantique
NTT/IOWN Networking Hub
Nucrypt/Quantum Opus
Open ROADM MSA/IOWN
QuNett/University of Maryland
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OFCnet is supported by:

Please refer to your Buyers' Guide and Addendum for more details on the exhibition and other activities on the show floor, including participating company information, a map of the exhibit hall and specific presentation schedules for many of the programs. Check the conference app for regular updates to show floor programming.

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Subcommittees

Track D: Devices, Components, and Fibers

D1: Advanced Prototyping, Packaging and Integration

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Janet Chen, *Meta, USA*
Molly Piels, *OpenLight Photonics, USA*
Sylvie Menezo, *SCINTIL Photonics, France*
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Joris Van Campenhout, IMEC, Belgium
Anbin Wang, *Alibaba, China*
Liming Wang, *Google, USA*
Xi Xiao, *NOIEC, China*
Vivian Yang, *Sicoya, China*

D2: Passive Components

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Stefano Camatel, *Finisar Corporation, Australia*
Lukas Chrostowski, *Univ. of British Columbia, Canada*
Thalia Dominguez Bucio, *University of Southampton, UK*
Christi Madsen, *Texas A&M University, USA*
Sagi Mathai, *Hewlett Packard Labs, USA*
Miloš Popović, *Boston Univ., USA*
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Keita Yamaguchi, *NTT, Japan*
Mengjie Yu, *University of Southern California, USA*
Linjie Zhou, *Shanghai Jiao Tong Univ, China*

D3: Active Components

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Omer Khayam, *Google LLC, USA*
Gong-ru Lin, *National Taiwan University, Taiwan*
Hai-Feng Liu, *HG-Genuine, China*
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Yi Luo, *Tsinghua University, China*
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M. Ashkan Seyedi, *NVIDIA Corporation, USA*
Wei Shi, *Université Laval, Canada*
Yuichi Tohmori, *Tsurugi-Photonics Foundation, Japan*

D4: Fiber and Propagation Physics

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Jose Antonio-Lopez, *Creol, USA*
Camille-Sophie Bres, *Ecole Polytechnique Federale de Lausanne, Switzerland*
Jin-Xing Cai, *Subcom, USA*
Ivana Gasulla Mestre, *Universitat Politecnica de Valencia, Spain*
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Pierre Sillard, *Prismian Group, France*
Toshiki Taru, *Sumitomo Electric Industries Ltd., Japan*
Natalie Wheeler, *University of Southampton, UK*
Aramais Zakharian, *Corning, USA*

D5: Fiber Devices, Fiber Lasers and Amplifiers, and Nonlinear Waveguides

Yi Sun, *OFS Fitel LLC, USA, Subcommittee Chair*
John Ballato, *Clemson University, USA*
Lawrence Chen, *McGill University, Canada*
Vladimir Gordienko, *Aston University, UK*
Victor Kopp, *Chiral Photonics, USA*
Xiaoying Li, *Tianjin University, China*
Atsushi Nakamura, *NTT, Japan*
Sergei P. Nikitin, *T8 Sensor, Russia*
Masato Tanaka, *Sumitomo Electric Industries Ltd, Japan*
Michael Vasilyev, *The University of Texas at Arlington, USA*
Seongwoo Yoo, *Glasgow University, UK*
Changyuan Yu, *The Hong Kong Polytechnic University, Hong Kong*

Track S: Subsystems and Systems

S1: Datacom Subsystems and Systems

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Jingchi Cheng, *Huazhong University of Science and Technology, China*
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S2: Transmission Subsystems

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David Millar, *Infinera Canada, Canada*
Dario Pilori, *Politecnico di Torino, Italy*
Ke (Desmond) Wang, *RMIT Australia, Australia*
Jiang Xu, *Hong Kong University of Science and Technology, Hong Kong*

S3: Transmission Systems

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Masanori Nakamura, *NTT Network Innovation Laboratories, Japan*
Yuta Wakayama, *KDDI R&D Laboratories, Japan*

S4: Optical Processing, Microwave and Fiber-Sensing

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Prince Anandarajah, *Dublin City University, Ireland*
Bill Corcoran, *Monash University, Australia*
Tomoyuki Kato, *Fujitsu, Japan*
Tetsuya Kawanishi, *Waseda University, Japan*
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Stanislav Zvanovec, *Czech Technical University in Prague, Czech Republic*

S5: Free-Space (FSO), Ranging (LIDAR), and Radio-over-Fiber (Rof)

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Eduward Tangdionga, *Technische University Eindhoven, Netherlands*
Jhih-Heng Yan, *Chunghwa Telecom, Taiwan*

Track N: Networks and Services

N1: Advances in Development of Systems, Networks and Services

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Saifuddin Faruk, *Bangor University, UK*
Binbin Guan, *Microsoft, USA*
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Ting Wang, *NEC-Labs, USA*
Tiejun (TJ) Xia, *Verizon Communications Inc., USA*
Qiong (Jo) Zhang, *Amazon, USA*

N2: Optical Networking for Data Center and Computing Applications

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Mahdi Nikdast, *Colorado State University, USA*
Nikos Pleros, *Aristotle Univ., of Thessaloniki, Greece*
Volker Sorger, *George Washington University, USA*

N3: Architectures and Software-defined Control for Metro and Core Networks

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Marija Furdek, Chalmers University of Technology, Sweden
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N4: Optical Access Networks for Fixed and Mobile Services

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N5: Market Watch, Network Operator Summit & Data Center Summit (Invited Program Only)

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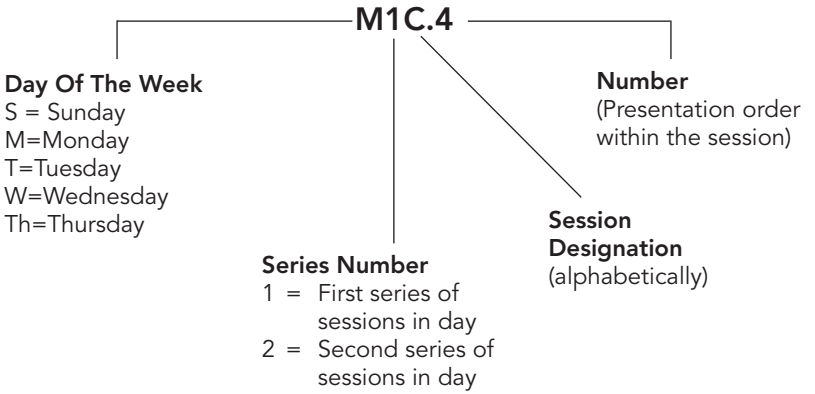
NOTES

Explanation of Session Codes



The first letter of the code denotes the day of the week (Sunday=Sunday, Monday=M, Tuesday=Tu, Wednesday=W, Th=Thursday). The second element indicates the session series in that day (for instance, 1 would denote the first parallel sessions in that day). Each day begins with the letter A in the third element and continues alphabetically through a series of parallel sessions. The lettering then restarts with each new series. The number on the end of the code (separated from the session code with a period) signals the position of the talk within the session (first, second, third, etc.). For example, a presentation coded M1C.4 indicates that this paper is being presented on Monday (M) in the first series of sessions (1), and is the third parallel session (C) in that series and the fourth paper (4) presented in that session.

Invited Invited Presentation

Tutorial Tutorial Presentation

★ Top-Scored Top Scored Paper

Agenda of Sessions — Sunday, 24 March

	Room 2	Room 6C	Room 6D	Room 6E	Room 6F	Room 7
08:30–12:30	**SC105, SC203, SC208, SC216, SC328, SC395, SC432, SC461, SC463, SC469, SC470**					
09:00–12:00	**SC177, SC359, SC459**					
12:00–13:00	**Lunch Break** *(on own)*					
13:00–15:30	**S1A • Workshop: How Can OFC, with a Real Life Test-Bed, Accelerate Innovation in the Optical Photonic Networks?**	**S1B • Workshop: How Can Generative AI be Used for Network Operations?**	**S1C • Workshop: Multi-Fiber/Multi-Core Is Inevitable, Do We Even Need the S-Band?**	**S1D • Workshop: Are Coherent Transceivers About to Experience a Bandwidth Crunch?**	**S1E • Workshop: Co-Packaged Optics: Is it Only for the Cloud or Also for the Edge AI Services?**	**S1F • Workshop: Neural Networks for Optical Fiber Transmission: Hype or Hope?**
13:00–16:00	**SC408, SC512**					
13:00–17:00	**SC267, SC514 (new)**					
13:30–17:30	**Simulating Datacom/Telecom Applications Following Standards Specifications,** *Room 31C*					
15:30–16:00	**Coffee Break,** *Upper Level Corridors*					
16:00–18:30	**S2A • Workshop: Will Heterogeneous Integration Meet the Needs of Future Applications?**	**S2B • Workshop: Will Optical Switches Become a Key Element in High-Performance AI/ML Datacenter Networks?**	**S2C • Workshop: Which Types of Fiber Will Be the Most Suitable for Network Operators in the Near Future?**	**S2D • Workshop: Coherent Optics for Next Generation 100G/200G PON: Single-Carrier or Multi-Carrier?**	**S2E • Workshop: Will Linear Pluggable Optics (LPO) Have a Future Beyond 112G?**	**S2F • Workshop: QKD – An End-Game or Just a Stepping Stone to the Quantum Internet?**
19:00–21:00	**Hack Your Research! Tools and Tricks for Today's Telecommunications Techies,** *Room 6A*					

Short Courses are an excellent training opportunity to learn about new products, cutting-edge technology and vital information at the forefront of communications. They are offered Sunday and Monday and require an additional fee. Go to ofcconference.org/shortcourse for a list of available short courses and the format in which they will be offered.

Key to Shading

Short Courses

Agenda of Sessions — Monday, 25 March

	Room 1A	Room 1B	Room 2	Room 3	Room 6C
07:30–08:00	**Coffee Break** *(Upper Level Corridors)*				
07:30–19:00	**Optica Executive Forum at OFC 2024,** *Hilton San Diego Bayfront*				
08:00–10:00	**M1A • Fiber Sensing Devices**	**M1B • Fiber-Based Nonlinear-Optic and Optoelectronic Devices**	**M1C • Green Transformation: Where Do We Stand? I**	**M1D • High Power and Narrow Linewidth Lasers**	**M1E • DSP and Multiplexing Techniques**
08:30–12:30	**SC160, SC341, SC369, SC393, SC433, SC443, SC444, SC448, SC452, SC453A, SC454, SC473, SC483, SC487, SC513, SC525 (new), SC527 (new)**				
09:00–12:00	**SC465**				
10:00–10:30	**Coffee Break** *(Upper Level Corridors)*				
10:30–12:30	**M2A • Multi-Mode Propagation in Optical Fibers**	**M2B • Datacom: Coding and Equalization**	**M2C • Green Transformation: Where Do We Stand? II**	**M2D • VCSELs and Modulator Technologies**	**M2E • SDM Amplifiers and Multiplexers**
12:30–14:00	**Lunch Break** *(on own)*				
13:30–16:30	**SC114, SC217, SC261, SC447, SC485, SC526 (new), SC528 (new)**				
13:30–17:30	**SC325, SC327, SC347, SC357, SC384, SC431, SC451, SC453B**				
14:00–16:00	**M3A • Hybrid Integration and Packaging**	**M3B • SDM Devices and Mode Manipulation**	**M3C • Quantum Dots Lasers and Comb Generation**	**M3D • Frontiers of Optical Network Architecture Summit**	**M3E • Coherent and Direct Detect Datacenter Transmission**
14:00–16:00	**M3Z • Demo Zone,** *Room 6B*				
16:00–16:30	**Coffee Break** *(Upper Level Corridors)*				
16:30–18:30	**M4A • Silicon Photonics**	**M4B • Integrated Devices for Sensing and Metrology**	**M4C • Machine Learning and Neural Networks**	**M4D • Resilience in Access Networks**	**M4E • Data Centre and Submarine**
19:00–21:00	**Student Party,** *Coin-Op Gaslamp*				

Key to Shading

Short Courses

Short Courses are an excellent training opportunity to learn about new products, cutting-edge technology and vital information at the forefront of communications. They are offered Sunday and Monday and require an additional fee. Go to ofcconference.org/shortcourse for a list of available short courses and the format in which they will be offered.

Room 6D	Room 6E	Room 6F	Room 7	Room 8	Room 9
Coffee Break *(Upper Level Corridors)*					
Optica Executive Forum at OFC 2024, *Hilton San Diego Bayfront*					
M1F • Multi Band Transmission Systems	**M1G • Optical Networks for Disaggregated and Composable Computing Systems**	**M1H • Machine Learning for Estimation and Forecasting**	**M1I • Next Generation Coherent PON**	**M1J • Waveguide Mode Converters and Fiber-to-Chip Couplers**	**M1K • Distributed Sensing I**
SC160, SC341, SC369, SC393, SC433, SC443, SC444, SC448, SC452, SC453A, SC454, SC473, SC483, SC487, SC513, SC525 (new), SC527 (new)					
SC465					
Coffee Break *(Upper Level Corridors)*					
M2F • Sub-Millimeter Wave and THz Communication	**M2G • Photonic Switched Data Center Networks**	**M2H • High-Speed Transceivers and Transmission**	**M2I • Panel: The Role of Digital Twins in Optical Networking**	**M2J • Quantum Protocols, Simulations and Analysis**	**M2K • Distributed Sensing II**
Lunch Break *(on own)*					
SC114, SC217, SC261, SC447, SC485, SC526 (new), SC528 (new)					
SC325, SC327, SC347, SC357, SC384, SC431, SC451, SC453B					
M3F • Radio-Over-Fiber and 6G Access	**M3G • Panel: The Road Towards 3.2 Tb/s Intra-Data Center Communications**	**M3H • Advancement in Quantum Key Distribution Systems I**	**M3I • Transmission Optimization**	**M3J • Hollow-Core Fibers**	**M3K • Emerging Modulator Technologies**
M3Z • Demo Zone, *Room 6B*					
Coffee Break *(Upper Level Corridors)*					
M4F • Advanced Optical Communication Technologies	**M4G • ONS: Open and Disaggregated Optical Networking: Where We've Been and What's Coming Next**	**M4H • Advancement in Quantum Key Distribution Systems II**	**M4I • Panel: Wideband Optical Amplifiers for Datacenters, Hyperscale Networks and Telecom Networks**	**M4J • Integrated Optics for Communication and Sensing**	**M4K • Nonliner Transmission**
Student Party, *Coin-Op Gaslamp*					

Agenda of Sessions — Tuesday, 26 March

	Room 1A	Room 1B	Room 2	Room 3	Room 6C	Room 6D	Room 6E
07:30–08:00	**Plenary Session Coffee Break,** *Upper Level, Ballroom 20 Lobby*						
08:00–10:00	**Tu1A • Plenary Session,** *Ballroom 20*						
10:00–17:00	**Exhibition and Show Floor Programs,** *Exhibit Hall* (concessions available)						
10:00–14:00	**Exhibit-only Time,** *Exhibit Hall* (coffee service 10:00–10:30)						
10:00–16:45	**Career Zone,** *Exhibit Hall B1*						
10:30–12:00	**The Art of Writing the Perfect OFC Paper,** *6A*						
12:30–14:00	**Awards Ceremony and Luncheon,** *Upper Level, Ballroom 20*						
14:00–16:00	**Tu2A • Optical Transmission Techniques**	**Tu2B • Nonlinear Photonic Devices and Material Platforms**	**Tu2C • Quantum Components and Quantum PICs**	**Tu2D • High Speed Transmitters**	**Tu2E • Advanced Optical Fibers**	**Tu2F • Moore's Law: A Photonics Perspective for the Next Decade**	**Tu2G • Panel: Beyond Two-Core Fibers: Single-Core vs Multi-Core Amplifiers in Long-Haul SDM Links**
16:00–16:30	**Coffee Break,** *Exhibit Hall* **Elevated Coffee Break** *Sponsored by* Infinera, *Booth 4217*						
16:30–18:30	**Tu3A • CPO and Ecosystems**	**Tu3B • 6G and Emerging Applications**	**Tu3C • Quantum Information Generation, Distribution and Processing**	**Tu3D • High Speed Photodectors**	**Tu3E • High Bit Rate High Capacity Transmission**	**Tu3F • Optical Neural Networks**	**Tu3G • Panel: Cutting-Edge Technologies for Interconnecting AI/ML Clusters**
17:15–18:15	**Exhibitor Reception,** *Center Terrace*						
18:30–20:00	**Conference Reception,** *Ballroom 20BCD*						
19:30–21:30	**Rump Session: How Much Optics Does AI Need?,** *Room 6F*						

Room 6F	Room 7	Room 8	Room 9	Exhibit Hall Theater I	Exhibit Hall Theater II	Exhibit Hall Theater III
Plenary Session Coffee Break, *Upper Level, Ballroom 20 Lobby*				**Exhibit Hall Opens 10:00**		
Tu1A • Plenary Session, *Ballroom 20*				**MW1 • MW Panel I: State of the Industry** 10:45–12:15 **MW2 • MW Panel II: Inside the Data Center Focused on AI/ML** 12:30–14:00 **MW3 • MW Panel III: Coherent Technology Advancements to Address Next-Gen Networking Requirements** 14:15–14:45 **CISCO: Who Controls the DCO's in Routers?** 16:00–17:00	**Next Generation Optical Interconnects for AI Clusters: Beyond Linear Drive Optics** 10:45–11:45 **DCS1 • Keynote** 12:00–12:30 **DCS2 • Panel I: ML/AI and Future Networks to Support it** 12:30–14:00 **DCS3 • Panel II: Lowering Power Consumption in Optical Solutions** 14:15–15:45 **Photonics in Current and Future Machine Learning Network Infrastructure** 16:00–17:00	**Conversation with the Plenary Speakers** 10:15–10:45 **MOPA: Mobile Optics (MOPA) for the 6G Era** 11:00–12:00 **Infinera: Architecture the Network for the Terabit Era and in the Shadow of Shannon** 13:00–13:30 **OFCnet Panel: Telecom Fiber Networks as the Core of the Next Generation TerraScope** 13:45–14:15 **F5G Intelligent and Green Networks towards 2030** 14:30–15:30 **OFCnet Panel: Quantum Key Distribution High-Speed Optical-Layer Encryption** 15:45–16:30
Exhibition and Show Floor Programs, *Exhibit Hall* (concessions available)						
Exhibit-only Time, *Exhibit Hall* (coffee service 10:00–10:30)						
Career Zone, *Exhibit Hall B1*						
The Art of Writing the Perfect OFC Paper, *6A*						
Awards Ceremony and Luncheon, *Upper Level, Ballroom 20*						
Tu2H • Transceiver and Transmission Impairments Mitigation	**Tu2I • Panel: Can New Access Technology and Architectures Support the Beyond 5G Network Vision**	**Tu2J • Fiber Sensing Applications I**	**Tu2K • Indoor Optical Wireless Communication**			
Coffee Break, *Exhibit Hall* **Elevated Coffee Break** *Sponsored by* Infinera, *Booth 4217*						
Tu3H • Advanced Optical Subsystems	**Tu3I • Disaggregated and Software Defined Access Networks**	**Tu3J • Fiber Sensing Applications II**	**Tu3K • High Capacity Radio-over-Fiber Communication**			
Exhibitor Reception, *Center Terrace*						
Conference Reception, *Ballroom 20BCD*						
Rump Session: How Much Optics Does AI Need?, *Room 6F*				**Exhibit Hall Closes 17:00**		

Agenda of Sessions — Wednesday, 27 March

	Room 1A	Room 1B	Room 2	Room 3	Room 6C	Room 6D	Room 6E
06:00–07:00	**OFC Fun Run,** *San Diego Convention Center Front Entrance*						
07:30–08:00	**Coffee Break,** *Upper Level Corridors*						
08:00–10:00	**W1A • Integrated Filters for Communication Systems**	**W1B • Monitoring and Sensing**	**W1C • Network Control and Orchestration**	**W1D • Doped Fiber Amplifiers and High Power Laser**	**W1E • Digital Subsystems for SDM and SCM Transmissions**	**W1F • Optical Computing and Memory**	**W1G • Panel: Next Generation Disaggregated Data Centers Using Future Chip to System Photonic Technologies**
10:00–17:00	**Exhibition and Show Floor Programs,** *Exhibit Hall,* (coffee service 10:00–10:30)						
10:00–16:30	**Career Zone,** *Exhibit Hall B1*						
10:30–12:30	**W2A • Posters Session I, In-Person,** *Exhibit Hall B1* **W2B • Posters Session II, Remote,** *eGallery on OFC website* **Lunch Break** *(on own; concessions available in Exhibit Hall)*						
12:30–14:00	**Exhibit-only Time,** *Exhibit Hall* **The Journal Review Process: All You Need to Know!,** *Room 6A*						
12:45–13:45	**Challenges and Solutions for Realizing Quantum Fiber-Based Networks,** *Room 3*						
14:00–16:00	**W3A • Transmitters and Recievers**	**W3B • Optical Signal Processing**	**W3C • Network Planning and Operation**	**W3D • Laser Stabilization and Comb Sources**	**W3E • Embracing Fiber Sensing: What's the "Killer App" for Large-Scale Deployments? I**	**W3F • Submarine Long-Haul and Repaterless Transmission**	**W3G • Coherent DWDM pluggables**
16:00–16:30	**Coffee Beak,** *Upper Level Corridors and Exhibit Hall* **Elevated Coffee Break** *Sponsored by* Infinera, *Booth 4217*						
16:30–18:30	**W4A • THz Processing and Communications**	**W4B • FSO for Turbulent and Underwater Channels**	**W4C • Coding and Modulation**	**W4D • Amplifier Architecture for Data Transmission**	**W4E • Embracing Fiber Sensing: What's the "Killer App" for Large-Scale Deployments? II**	**W4F • Optical Architectures and Subsystems for Accelerating ML/AI Applications**	**W4G • Space Communication**
17:00–19:00	**Photonics Society of Chinese (PSC) Heritage Workshop and Networking Social,** *Room 15*						

Room 6F	Room 7	Room 8	Room 9
OFC Fun Run, *San Diego Convention Center Front Entrance*			
Coffee Break, *Upper Level Corridors*			
W1H • Short-Reach Transmission	**W1I • Panel: Photonic Components for In-Physics Computing**	**W1J • Access, Metro and Mobile Convergence**	**W1K • Photonic Integration and Integrated Receivers**
Exhibition and Show Floor Programs, *Exhibit Hall,* (coffee service 10:00–10:30)			
Career Zone, *Exhibit Hall B1*			
W2A • Posters Session I, In-Person, *Exhibit Hall B1* **W2B • Posters Session II, Remote,** *eGallery on OFC website* **Lunch Break** *(on own; concessions available in Exhibit Hall)*			
Exhibit-only Time, *Exhibit Hall* **The Journal Review Process: All You Need to Know!,** *Room 6A*			
Challenges and Solutions for Realizing Quantum Fiber-Based Networks, *Room 3*			
W3H • Large Capacity Interconnect	**W3I • Panel: Role of Optics for Space Communication**	**W3J • Multi-Core Fiber Design and Transmission Characteristics**	**W3K • PICs for Quantum Communication and Quantum Computing: Challenges and Opportunities I**
Coffee Beak, *Upper Level Corridors and Exhibit Hall* **Elevated Coffee Break** *Sponsored by* Infinera, *Booth 4217*			
W4H • Datacom Modulation and Linear Transceivers	**W4I • AI-Based Automation**	**W4J • Multi-Core Fiber Characterization and Connection**	**W4K • PICs for Quantum Communication and Quantum Computing: Challenges and Opportunities II**
Photonics Society of Chinese (PSC) Heritage Workshop and Networking Social, *Room 15*			

Exhibit Hall Theater I	Exhibit Hall Theater II	Exhibit Hall Theater III
Exhibit Hall Opens at 10:00		
NOS1 • Network Operator Summit: Keynote 10:15–10:45 **NOS2 • NOS Panel I: Optical Network Automation** 10:45–12:15 **NOS3 • NOS Panel II: Optics for 5G/6G** 12:30–14:00 **MW4 • MW Panel IV: Next Generation PON Technologies** 14:15–15:45 **Coherent Optics Unleashed: From 400ZR Success to 800ZR/LR Advancements and 1600ZR Kick-off** 16:00–17:00	**Ethernet Interconnect Solutions: Will The Advancement in Coherent Signaling Leverage DataCom Connect** 10:15–11:15 **CableLabs: Empowering Access Networks with Coherent Optics** 11:30–12:30 **ITU-T SG15 - Standards Update on Higher Speed PON, Latest OTN Technologies and Interoperable Optical Interfaces** 12:45–13:45 **IOWN GF's Open APN for the Evolution of Mobile Networks and Cloud-and-Edge Computing** 14:00–15:00 **Amphenol: Exploring the Role of Interconnects in Energy Efficient Data Centers** 15:15–16:15	**Open XR Optics Forum: Open XR Optics Forum Update** 10:15–10:45 **OFCnet Panel: Quantum Entanglement and Quantum Memory for Next Generation Quantum Networks** 11:00–11:45 **OFCnet Panel: Beyond Point-to-Point Quantum Key Distribution** 12:00–12:45 **OFCnet Panel: Software Define Infrastructures** 13:00–13:30 **Open ROADM MSA Updates and Demonstration** 13:45–14:45 **ATOP: The Road to 200G per Lane** 15:45–16:15
Exhibit Hall Closes at 17:00		

Agenda of Sessions — Thursday, 28 March

	Room 1A	Room 1B	Room 2	Room 3	Room 6C	Room 6D	Room 6E
07:30–08:00	**Coffee Break,** *Upper Level Corridors*						
08:00–10:00	**Th1A • Programmable Circuits/Switches and Control Technologies**	**Th1B • Datacom: VCSELs, Multi-Lambda Sources, Spatial Multiplexing**	**Th1C • Wireless and Access Quantum Networks**	**Th1D • Integrated Nonlinear-Optical Devices and Amplifiers**	**Th1E • Advanced PON Technology**	**Th1F • Optical Methods and Sensing**	**Th1G • Open Line Systems and Digital Twins**
10:00–16:00	**Exhibition and Show Floor Programs,** *Exhibit Hall, (coffee service 10:00–10:30)*						
10:00–15:45	**Career Zone**, *Exhibit Hall B1*						
10:30–12:30	**Th2A • Posters Session III, In-Person,** *Exhibit Hall B1* **Lunch Break** *(on own; concessions available in Exhibit Hall)*						
12:30–14:00	**Exhibit-only Time,** *Exhibit Hall*						
14:00–16:00		**Th3B • Practical Security Demonstration**	**Th3C • Free Space Optical Communication**	**Th3D • Photonic Integration for Novel Applications**	**Th3E • MCF Based Transmission**	**Th3F • Sub-THz and mm-wave Signal Processing**	**Th3G • Optical Computing and Accelerators**
16:00–16:30	**Coffee Break,** *Upper Level Corridors*						
16:30–18:30	**Postdeadline Paper Sessions,** *Room 6C, 6D, 6E, 6F*						

Room 6F	Room 7	Room 8	Room 9	Exhibit Hall Theater I	Exhibit Hall Theater II	Exhibit Hall Theater III
Coffee Break, *Upper Level Corridors*				**Exhibit Hall Opens at 10:00**		
Th1H • MMF Based Transmission	**Th1I • Next Generation ROADMs, Multiband and SDM Networking**	**Th1J • Short-Reach Transmission Systems**		**MW5 • MW Panel V: Disaggregation Inside the DC** 10:15–11:45 **MW6 • MW Panel VI: Disaggregation for Network Operators** 12:00–13:30 **Energy Efficient Interfaces - Reining in Power Consumption Trends for Next-Generation Optical Networking** 13:45–14:45 **An Ecosystem Perspective on Scaling Integrated Photonics for the AI Revolution** 15:00–16:00	**Low-Latency High-Speed Optical Interconnection Technologies for AI Compute Era** 11:30–12:30 **AIM Photonics Presents PICs, Heterogeneous Integration, and Packaging for Next-Generation Silicon Photonic Applications** 12:45–13:45 **Meeting Rural Broadband Needs with High Capacity PON** 14:00–15:00	**OFCnet Panel: Optical Benchmarks** 11:00–11:30 **OFCnet Panel: Optical Infrastructures and Services** 11:45–12:15 **Current State and Future of Thin-Film Lithium Niobate Photonics** 14:45–15:45
Exhibition and Show Floor Programs, *Exhibit Hall, (coffee service 10:00–10:30)*						
Career Zone, *Exhibit Hall B1*						
Th2A • Posters Session III, In-Person, *Exhibit Hall B1* **Lunch Break** *(on own; concessions available in Exhibit Hall)*						
Exhibit-only Time, *Exhibit Hall*						
Th3H • Photonics Manufacturing Technologies	**Th3I • Survivability and Fault Management**	**Th3J • Machine Learning DSP**				
Coffee Break, *Upper Level Corridors*						
Postdeadline Paper Sessions, *Room 6C, 6D, 6E, 6F*				**Exhibit Hall Closes at 16:00**		

Room 1A	Room 1B	Room 2	Room 3	Room 6C	Room 6D

07:30–08:00 Coffee Break, *Upper Level Corridors*

08:00–10:00 M1A • Fiber Sensing Devices

Presider: Yi Sun; OFS Fitel LLC, USA

M1A.1 • 08:00 Invited

Single Frequency Fiber Laser Strain Sensors: Principles and Applications, Geoffrey A. Cranch[1], Logan L. Richardson[1], Caitlin Williams[1], Gary Miller[1], Ryan Seeley[2], Evan Hardester[2]; [1]*US Naval Research Laboratory, USA;* [2]*Sequent Logic, USA.* Single frequency fiber laser sensors achieve displacement resolutions approaching attometer levels, operating at the fundamental limit of performance. These devices have found applications in structural health monitoring, medical and undersea monitoring. This presentation will review the operating principles of these devices and discuss recent demonstrations.

08:00–10:00 M1B • Fiber-Based Nonlinear-Optic and Optoelectronic Devices

Presider: Michael Vasilyev; Univ. of Texas at Arlington, USA

M1B.1 • 08:00

Demonstration of a Stable, High-Performance Mach-Zehnder Polarization-Insensitive Fiber Optical Parametric Amplifier, Florent Bessin[1,2], Vladimir Gordienko[2], Filipe Ferreira[3], Nick J. Doran[2]; [1]*Université d'Angers, LPHIA, SFR MATRIX, F-49000 Angers, France, France;* [2]*Aston Inst. of Photonic Technologies, Aston Univ., B4 7ET Birmingham, UK, UK;* [3]*Optical Networks Group, Univ. College London, London, WC1E 6BT, UK.* We demonstrate a Mach-Zehnder architecture for polarization-insensitive fiber optical parametric amplifiers to obtain a noise figure of ~4.5dB and reduction of nonlinear crosstalk as compared to previously demonstrated PI-FOPAs while demonstrating net gain up to 24dB.

M1B.2 • 08:15

Employment of Polarization Diversity Architecture to Mitigate an Impact of Pump Phase Modulation in FOPA, Mariia Bastamova[1], Vladimir Gordienko[1], Nick J. Doran[1], Andrew Ellis[1]; [1]*Aston Univ., UK.* We demonstrate via simulations and experiments that a FOPA polarization-diverse architecture allows to mitigate an impact of pump phase modulation on amplified signals and thus reduce or almost eliminate the signal required-OSNR penalty.

08:00–10:00 M1C • Green Transformation: Where Do We Stand? I

Presider: Md Saifuddin Faruk; Bangor Univ., UK and Naveena Genay; Orange Labs, France and Luca Valcarenghi; Scuola Superiore Sant'Anna, Italy and Ting Wang; NEC Laboratories America Inc., USA

M1C.1 • 08:00 Invited

IOWN GF Energy Efficiency Program: Powering a Sustainable Future, Lieven Levrau[1]; [1]*Nokia Corporation, France.* This paper discusses challenges for optimizing energy efficiency in telecommunications networks, encompassing areas like data centers, network protocols, equipment, AI-driven management, and efficient data collection, with a focus on reducing environmental impact and operational costs.

08:00–10:00 M1D • High Power and Narrow Linewidth Lasers

Presider: M. Ashkan Seyedi; NVIDIA Corporation, USA

M1D.1 • 08:00 ★ Top-Scored

CW-WDM MSA Compatible 100-mW (up to 50°C), 400-GHz Spacing Highly-Reliable CW-DFB 8-Channel Laser Array, Ryosuke Hatai[1], Kouji Nakahara[1], Atsushi Nakamura[1], Takayuki Nakajima[1], Yoshihiko Kobayashi[1], Takeo Kageyama[1], Shigehisa Tanaka[1]; [1]*Lumentum Japan, Inc, Japan.* We demonstrate a CW-WDM MSA compatible 8-channel 400-GHz spacing 100-mW CW-DFB laser array, with uniform channel spacings (±100 GHz) from 20 to 75°C, small channel-to-channel power deviations (0.56 dB) and over 2000-hour-operation reliability at 80°C.

M1D.2 • 08:15

High Efficiency High-Power Uncooled CWDM4 Wavelength CW-DFB Lasers, Milind Gokhale[1], Mark A. Emanuel[1], Benjamin Li[1]; [1]*Casela Technologies USA, USA.* We demonstrate high 75°C power conversion efficiencies of 19% to 26% at 100 mW (1mm cavity) and 16% to 22% at 200 mW (2mm cavity) for CW-DFB lasers with single-mode operation across CWDM4 wavelengths.

08:00–10:00 M1E • DSP and Multiplexing Techniques

Presider: Yi Cai; Soochow Univ., China

M1E.1 • 08:00 Tutorial

Electrical and Optical Multiplexing Technique for High Symbol Rate Signal Generation, Hiroshi Yamazaki[2,1]; [1]*NTT Device Technology Labs, Japan;* [2]*NTT Network Innovation Laboratories, Japan.* This tutorial describes multiplexing technologies for generating high-speed optical signals with bandwidths exceeding those of DACs. Both electrical and optical approaches are covered based on a common analytical framework. Recent experimental results are also reviewed.

Hiroshi Yamazaki received M.S. from Kyoto University and Dr. Eng. from Tokyo Institute of Technology. He is currently a Distinguished Researcher at NTT Network Innovation Laboratories and Device Technology Laboratories, where he is involved in research on devices and subsystems for high-speed optical transmission. He has authored/co-authored >140 papers.

08:00–10:00 M1F • Multi-Band Transmission Systems

Presider: Lidia Galdino; Corning Inc, UK

M1F.1 • 08:00

Modeling and Experimental Verification in S+C+L+U Quadrable-Band WDM Transmission System Using C+L-Band Transceivers and Wavelength Converters, Hidenobu Muranaka[1], Tomoyuki Kato[1], Tomohiro Yamauchi[1], Hiroyuki Irie[1], Hiroki Ooi[1], Yu Tanaka[1], Shimpei Shimizu[2], Takayuki Kobayashi[2], Takushi Kazama[2,3], Masashi Abe[3], Takeshi Umeki[2,3], Yutaka Miyamoto[2], Takeshi Hoshida[1]; [1]*Fujitsu Limited, Japan;* [2]*NTT Network Innovation Laboratories, Japan;* [3]*NTT Device Technology Laboratories, Japan.* We experimentally verify wideband WDM transmission modeling in over 17-THz S+C+L+U quadrable-band transmission using PPLN-based wavelength converters. We confirmed within 3.3-dB errors between modeling after 80-km SSMF transmission of DP-16QAM and DP-QPSK signal.

M1F.2 • 08:15

Performance Enhancement of Long-Haul C+L+S Systems by Means of CFM-Assisted Optimization, Yanchao Jiang[1], Antonello Nespola[2], Alberto Tanzi[3], Stefano Piciaccia[3], Mahdi Ranjbar Zefreh[3], Fabrizio Forghieri[3], Pierluigi Poggiolini[1]; [1]*Politecnico di Torino, Italy;* [2]*LINKS Foundation, Italy;* [3]*CISCO Photonics Italy srl, Italy.* We investigate C+L+S long-haul systems using a closed-form-model for launch power and Raman pump optimization. We show a potential 4x throughput increase over standard C-band systems in 1000km links, using moderate S-only Raman amplification.

Room 6E	Room 6F	Room 7	Room 8	Room 9

07:30–08:00 Coffee Break, *Upper Level Corridors*

08:00–10:00
M1G • Optical Networks for Disaggregated and Composable Computing Systems

Presider: Shu Namiki; Natl Inst of Adv Industrial Sci & Tech, Japan

M1G.1 • 08:00 Invited

Programmable Silicon Photonics for the Implementation of Topological Systems, Andrea Blanco-Redondo[1]; [1]*CREOL, The College of OPtics and Photonics, Univ. of Central Florida, USA.* Topological photonics offers a platform to explore both fundamental physics and applications in integrated photonics. In this talk we unveil our latest results on the implementation of topological models in programmable integrated photonic platforms.

08:00–10:00
M1H • Machine Learning for Estimation and Forecasting

Presider: Ashwin Gumaste; Indian Inst. of Technology, Bombay, India

M1H.1 • 08:00

Machine Learning-Based Polarization Signature Analysis for Detection and Categorization of Eavesdropping and Harmful Events, Leyla Sadighi[1], Stefan Karlsson[2], Carlos Natalino[1], Marija Furdek[1]; [1]*Chalmers Univ. of Technology, Sweden;* [2]*Swedish Defense Material Administration, Sweden.* We propose a methodology that uses polarization state changes and machine learning to detect and classify eavesdropping, harmful, and non-harmful events in the optical fiber network. Our solution achieves 92.3% accuracy over 13 experimental scenarios.

M1H.2 • 08:15

Autonomous Capacity Adjustment with Dynamic Margin Allocation for Optical Enterprise Links, Mihail Balanici[1], Behnam Shariati[1], Pooyan Safari[1], Geronimo Bergk[2], Johannes Fischer[1]; [1]*Fraunhofer HHI, Germany;* [2]*Horváth AG, Germany.* This work presents a novel machine learning-based dynamic capacity allocation scheme for efficient bandwidth provisioning of optical links. It offers an average hourly capacity saving of over 75% compared to traditional static capacity allocation mechanisms.

08:00–10:00
M1I • Next Generation Coherent PON

Presider: Haipeng Zhang; CableLabs, USA

M1I.1 • 08:00

Preamble Design for Joint Frame Synchronization, Frequency Offset Estimation and Channel Estimation in Burst Mode Coherent PONs, Yongxin Sun[1], Hexun Jiang[1], Lilin Yi[1], Weisheng Hu[1], Qunbi Zhuge[1]; [1]*Shanghai Jiao Tong Univ., China.* We propose a preamble jointly achieving frame synchronization, frequency offset and channel estimation for burst-mode detection in coherent PON. The DSP converges within a 272-symbol preamble in a 15GBaud experiment.

M1I.2 • 08:15 Tutorial

Unlocking the Potential of Coherent Passive Optical Networks: Use Cases, Key Technologies, and Specification Development, Zhensheng Jia[1]; [1]*Technology Group, CableLabs, USA.* Coherent PON enables extended reach, higher split ratio and capacity for optical access P2MP architecture. Key enabling technologies including upstream burst processing, coherent optics optimization, and specifications for cost-effective mass deployment are covered in this tutorial.

08:00–10:00
M1J • Waveguide Mode Converters and Fiber-to-Chip Couplers

Presider: Lukas Chrostowski; Univ. of British Columbia, Canada

M1J.1 • 08:00

3D Self-Aligning, Polarization-Independent Fiber-to-Chip Couplers, Ramesh K[1,2], Trisha Chakraborty[1], Thomas E. Murphy[1], Karen E. Grutter[2]; [1]*Univ. of Maryland College Park, USA;* [2]*Laboratory for Physical Sciences, USA.* We demonstrate low-loss (<1 dB), broadband (BW~100 nm near λ~1550 nm) and polarization-independent fiber-to-chip couplers using 3D nano-printed polymer structures on Si_3N_4-on-SiO_2 platform.

M1J.2 • 08:15

Broadband and Low-Loss Metamaterial Silicon Nitride Edge Coupler, An He[1], Jinlong Xiang[1], Yaotian Zhao[1], Yuchen Yin[1], Yvjia Zhang[1], Xuhan Guo[1], Yikai Su[1]; [1]*Shanghai Jiao Tong Univ., China.* We report a SiN edge coupler based on metamaterial structure with simple fabrication process, the coupling loss with SMF is 1.60/2.21 dB at 1310/1550 nm. The loss is smaller than 1.86/2.80 dB in O/S+C+L band.

08:00–10:00
M1K • Distributed Sensing I

Presider: Mikael Mazur; Nokia Bell Labs, USA

M1K.1 • 08:00

Distributed Acoustic Sensing Over Passive Optical Networks Using Enhanced Scatter Fiber, Benyuan Zhu[1], Paul Westbrook[1], Kenneth Feder[1], zhou shi[1], Ping Lu[2], Rober Dyer[2], Xiaoguang Sun[2], Jie Li[2], Daniel Peterson[2], David DiGiovanni[1]; [1]*OFS Laboratories, USA;* [2]*OFS, USA.* Simultaneous fiber-optic sensing and NG-PON data transmissions over a 1x16 splitter is demonstrated by enhanced scatter fiber. Acoustic signals from a single distribution fiber are identified. The crosstalk between sensing and data channels is studied.

M1K.2 • 08:15

Correlation-Based OTDR for High-Resolution Monitoring in Passive Optical Networks, Zhiyi Zhong[2], Wu Liu[2], Ming Luo[2], Ming Li[1], Xi Xiao[2,3]; [1]*Fiberhome Telecommunication Technologies Co., Ltd, China;* [2]*National Key Laboratory of Optical Communication Technologies and Networks, China;* [3]*National Information Optoelectronics Innovation Center, China.* Utilizing correlation detection and comical optical transceivers, we detected <-58 dBm reflection signals with <10 cm spatial resolution in typical PON scenarios. Optical power monitoring and fault diagnosis are accomplished through analyzing the correlation results.

Room 1A

M1A • Fiber Sensing Devices—Continued

M1A.2 • 08:30
Optical Fiber Tags Based on Encoded FBG Array, Xiangpeng Xiao[1,2], Weiliang Zhao[1], Yibo Liu[1], Ke Ai[1], Peng Wang[2], Lei Deng[1,3], Chen Liu[1,3], Qi Yang[1,3], Qizhen Sun[1,2], Zhijun Yan[1,2]; *[1]Huazhong Univ of Science and Technology, China; [2]HUST-Wuxi Research Inst., China; [3]Jinyinhu Laboratory, China.* We proposed an optical fiber tag for identifying the massive passive optical networks, which were encoded by the FBG array with 7 wavelengths and 5 intensity grades, and achieved 5^7 optical tag identification.

M1A.3 • 08:45
Three-Dimensional-Printed Hollow Fabry-Perot Fiber Sensor for Ultra-High Sensitivity Ultrasound Detection, Anqi Wang[1], Xuhao Fan[1], DongChen Xu[1], Geng Chen[1], Chenhao Dai[1], Zhi Zhang[1], Wei Xiong[1], Qizhen Sun[1]; *[1]Huazhong Univ of Science and Technology, China.* We demonstrate a hollow Fabry-Perot (FP) fiber sensor fabricated by 3D-printing technology for highly sensitive ultrasound detection. The sensor has a sensitivity of 167 mV/kPa which is 38 times higher than a solid FP fiber sensor.

M1A.4 • 09:00 Tutorial
Micro-Structured Fibers for Ultrasound and Acoustic Wave Detection, Xiaoyi Bao[1]; *[1]Univ. of Ottawa, Canada.* Micro-structured fibers with smaller dimension (nano- to micrometers) and specialty materials are good candidates for high frequency and broadband ultrasound and acoustic wave detection for micro-cracks and photo-acoustic imaging in medical applications.

Room 1B

M1B • Fiber-Based Nonlinear-Optic and Optoelectronic Devices—Continued

M1B.3 • 08:30 Invited
All-Fiber Optoelectronics, Lei Wei[1]; *[1]Nanyang Technological Univ., Singapore.* The combination of insulating, semiconducting, and metallic elements in well-defined geometries with intimate interfaces is essential to achieve all-fiber optoelectronics. Here, we present the development of optoelectronic fibers, from the fundamentals to in-fiber device demonstration.

M1B.4 • 09:00
Waveband-Shift-Free Optical Phase Conjugation in Fiber Loop Mirror Across 35-nm Bandwidth, Vladimir Gordienko[1], Sonia Boscolo[1], Mariia Bastamova[1], Nick J. Doran[1], Andrew Ellis[1]; *[1]Aston Univ., UK.* We experimentally demonstrate waveband-shift-free optical phase conjugation across the full C-band by employing a nonlinear optical loop mirror to demultiplex signals and phase-conjugated copies with an extinction ratio of at least 17dB across 35nm.

Room 2

M1C • Green Transformation: Where Do We Stand? I—Continued

M1C.2 • 08:30 Invited
Energy Efficient in Open Optical Transport, Koji Asahi[1]; *[1]NEC Corporation, Japan.* We will share energy efficient use cases using open optical systems and our activities on them.

M1C.3 • 09:00 Invited
Assessment of Fixed Network Energy Efficiency, Paolo Gemma[1]; *[1]Huawei Technologies Italia SRL, Italy.* Abstract not available.

Room 3

M1D • High Power and Narrow Linewidth Lasers—Continued

M1D.3 • 08:30 Invited
Development of High-Power DFB Lasers with High Reliability, Yuanfeng Mao[1], Yuanbing Cheng[1], Guangcan Chen[1], Yanbo Li[1], Bo Wu[1]; *[1]Huawei Technologies Co.,Ltd, China.* High-power DFB lasers in O, S, C and L-band have been developed. RIN below -160 dB/Hz and linewidth less than 25 kHz of the lasers are obtained. Over 5000 hours of accelerated aging test has also been performed.

M1D.4 • 09:00
Ten-Channel High Power DFB Laser Array with High Single Mode Stability and Low RIN, Yuanhao Zhang[1], Qianru Lu[1], Can Liu[1], Minwen Xiang[1], Guojiong Li[1], Juan Xia[1], Qiaoyin Lu[1], Weihua Guo[1]; *[1]Huazhong Univ. of Science & Technology, China.* A high power 10-channel single-mode DFB laser array with 200-GHz-spacing is demonstrated. Output power over 85mW, SMSR over 55dB and RIN below -155dBc/Hz have been realized for all channels of the fabricated laser array.

Room 6C

M1E • DSP and Multiplexing Techniques—Continued

M1E.2 • 09:00
A Robust Timing Recovery Algorithm for Faster-Than-Nyquist Digital Multi-Band System, Hao Deng[1], Wanzhen Guo[1], Yi Cai[2], Jian Zhao[1]; *[1]South China Univ. of Technology, China; [2]Soochow Univ., China.* We propose a novel timing-recovery algorithm (TRA) for faster-than-Nyquist digital-multi-band systems, and experimentally demonstrate that the proposed TRA works for different compression ratios and outperforms conventional TRAs in dispersion and DGD tolerance and convergence speed.

Room 6D

M1F • Multi-Band Transmission Systems—Continued

M1F.3 • 08:30 Tutorial
Practical Considerations for Ultra-Wideband Line System Development, Julia Larikova[1]; *[1]Infinera Corporation, USA.* with the coherent transmission hitting the Shannon limit and spectral efficiency constrains, it is important to find other ways of extending fiber capacity using new but practical ways. The most realistic way to increase it by using optical line system with SuperC and SuperL amplification and Wavelength selective switches, allowing capacity increase on the order of 30% with a max capacity as high as 100Tbps on a single fiber without the need for novel fiber types.

Julia Larikova is Vice President of Product Line Management at Infinera. She has worked in the field of Telecommunications for 25 years, holding various positions in Engineering, Architecture and PLM. She holds Biomedical Engineering graduate degrees from Moscow State University, Electrical Engineering Masters from State University of New York and continues to work on her PhD at Northwestern University.

Room 6E

M1G • Optical Networks for Disaggregated and Composable Computing Systems—Continued

M1G.2 • 08:30
Optically Networked Heterogeneous Data-Centric Computing System with Silicon Photonics Transceivers, Dae-Ub Kim[1], Jyung Chan Lee[1], Sanghwa Yoo[1], Jongtae Song[1], Kyeong-Eun Han[1], Jiwook Youn[1], Bup Joong Kim[1], Chanho Park[1], Joon Ki Lee[1]; *[1]Electronics and Telecom Research Inst, Korea (the Republic of).* An architecture is proposed for optically networked heterogeneous computing system supporting CXL standard. The proposed system is applied to AI applications and achieves a performance degradation of less than 2% compared with the server solution.

M1G.3 • 08:45
Beyond the Beachfront: Integration of Silicon Photonic I/Os Under a High-Power ASIC, Subal Sahni[1], Abhijit Abhyankar[1], Ankur Aggarwal[1], Nikos Bamiedakis[1], Zoltan Bekker[1], Mohamed Benromdhane[1], Nadav Bergstein[1], Ties Bos[1], Christopher Davies[1], Andrew Gimlett[1], Xiaoping Han[1], Kelin Lee[1], Kavya Mahadevaiah[1], Hakki Ozguc[1], Kevin Park[1], Jeremy Plunkett[1], Sujit Ramachandra[1], Jason Redgrave[1], Ajmer Singh[1], Matteo Staffaroni[1], Angelina Totovic[1], Saurabh Vats[1], Phil Winterbottom[1], Darren Woodhouse[1], Waleed Younis[1], Shifeng Yu[1], David Lazovsky[1]; *[1]Celestial AI, USA.* We present a photonics platform targeting optical connectivity at the point of compute in high-power ASICs. The platform uses bias-controlled electro-absorption modulators and is differentiated by broad temperature stability coupled with high bandwidth density.

M1G.4 • 09:00
First Line-Rate End-to-End Post-Quantum Encrypted Optical Fiber Link Using Data Processing Units (DPUs), Abraham Cano Aguilera[1,2], Rana Abu Bakar[3], Faris Alhamed[3], Carlos Rubio Garcia[1], Jose Luis Imaña Pascual[4], Idelfonso Tafur Monroy[1], Filippo Cugini[3], Juan José Vegas Olmos[2]; *[1]Technical Univ. of Eindhoven, Netherlands; [2]Software Architecture, NVIDIA, Israel; [3]National Inter-Univ. Consortium for Telecommunications, Italy; [4]Universidad Complutense de Madrid, Spain.* We demonstrate the first 92.3-Gbits/s line-rate, end-to-end post-quantum cryptography optical fiber link based on HW accelerators and processing offloading.

Room 6F

M1H • Machine Learning for Estimation and Forecasting—Continued

M1H.3 • 08:30
Analysis of Unwanted Biases in ML-Based QoT Classification Tasks, Carlos Natalino[1], Behnam Shariati[2], Pooyan Safari[2], Johannes Fischer[2], Paolo Monti[1]; *[1]Department of Electrical Engineering, Chalmers Univ. of Technology, Sweden; [2]Fraunhofer HHI, Germany.* We address the problem of mitigating biases in models used for the quality of transmission prediction. The proposed method reduces the relative accuracy difference between samples with different feature values by up to 45%.

M1H.4 • 08:45
Modeling the Input Power Dependency of Transceiver BER-ONSR for QoT Estimation, Toru Mano[1], Yue-Kai Huang[2], Giacomo Borraccini[2], Ezra Ip[2], Andrea D'Amico[2], Zehao Wang[3], Hideki Nishizawa[1], Gil Zussman[4], Tingjun Chen[3], Koji Asahi[5], Daniel C. Kilper[6], Vittorio Curri[7], Koichi Takasugi[1]; *[1]NTT, Japan; [2]NEC Labs America, USA; [3]Duke Univ., USA; [4]Columbia Univ., USA; [5]NEC, Japan; [6]Trinity College Dublin, Ireland; [7]Politecnico di Torino, Italy.* We propose a method to estimate the input power dependency of the transceiver BER-OSNR characteristic. Experiments using commercial transceivers show that estimation error in Q-factor is less than 0.2 dB.

M1H.5 • 09:00
Topology-Driven Edge Predictions with Graph Machine Learning for Optical Network Growth, Akanksha Ahuja[1], Sam Nallaperuma Herzberg[1], Albert Rafel[2], Paul Wright[2], Andrew Lord[2], Seb Savory[1]; *[1]Univ. of Cambridge, UK; [2]BT, UK.* Graph representation learning on real-world optical core networks outperforms edge prediction heuristics by 10 times, achieving up to 93.4% accuracy on BT(UK), COST(EU), and CORONET(USA) by learning from 10% training data.

Room 7

M1I • Next Generation Coherent PON—Continued

Dr. Zhensheng Jia is a CableLabs Fellow and Director of Advanced Optical Technologies. He has over 20 years of experience driving innovations in broadband fiber optic communications and networking. Dr. Jia has published 190+ peer-reviewed papers, 1 authored book, 11 book chapters, and he also holds 180 granted patents. Currently, he leads the development of coherent passive optical network technology to enable next-generation 100Gbps and beyond access networks. Dr. Jia is a Fellow of Optica (formerly Optical Society of America).

Room 8

M1J • Waveguide Mode Converters and Fiber-to-Chip Couplers—Continued

M1J.3 • 08:30
A Partially Etched Silicon Spot-Size-Converter for O Band High NA Fibers, Min Teng[1], Hao Wu[1], Feng Wang[1], Jiangpeng Chen[1], Ning Cheng[1], Xuezhe Zheng[1]; *[1]InnoLight Technology Ltd, China.* An O band partially etched silicon edge coupler for 3.3 μm MFD fiber is proposed to enhance coupling efficiency and fabrication tolerance. It's experimentally demonstrated with < 1.25 dB/facet coupling loss and <0.1 dB PDL.

M1J.4 • 08:45 ★ Top-Scored
Towards Polarization Insensitive Photonic Integrated Circuits: Polarization Dependent Loss Reduction of CMOS-Integrated Monolithic SiPh Components, Yusheng Bian[1]; *[1]GlobalFoundries, USA.* We present recent advancements in reducing polarization-dependent-losses (PDLs) for crucial SiPh components. Our link-budget analysis unveils an almost 1.5dB reduction in total PDL for representative receiver circuits, resulting in a mere 0.35dB TE-TM-path insertion-loss imbalance.

M1J.5 • 09:00
Low-Loss and Broadband Adiabatic Polarization Splitter Rotator on a CMOS-Integrated Silicon Photonics Platform, Won Suk Lee[1], Sujith Chandran[1], Yusheng Bian[1]; *[1]GlobalFoundries, USA.* We experimentally demonstrate an adiabatic polarization-splitter-rotator on a monolithic SiPh platform. Our measurements indicate an insertion-loss of <0.6 dB and polarization-dependent-loss of <0.3 dB across the O-band, accompanied by a polarization extinction exceeding 45 dB.

Room 9

M1K • Distributed Sensing I—Continued

M1K.3 • 08:30
Forward-Transmission Based Distributed Fiber Sensing Compatible with C+L Unidirectional Communication Systems, Jianwei Tang[1,2], Xueyang Li[1], Chen Cheng[2], Yaguang Hao[1,2], Bang Yang[2], Jiali Li[1], Zhixue He[1], Yanfu Yang[1,2], Weisheng Hu[1]; *[1]Department of Circuits and System, Peng Cheng Laboratory (PCL), China; [2]School of Electronics and Information Engineering, Harbin Inst. of Technology (Shenzhen), China.* We propose forward-transmission based distributed fiber sensing that is compatible with C+L unidirectional communication systems and relaxes the requirement of remote timing synchrony. We demonstrate detection and accurate localization of polarization perturbation utilizing telecom transceivers.

M1K.4 • 08:45
Multimodal Traffic Monitoring Using Two Co-Routed Field Deployed Fibers in Metropolitan Environments, Yaxi Yan[1], Kausthubh Chandramouli[1], Zhang Jingming[1], Chao Lu[1], Alan P. Lau[1]; *[1]The HK Polytechnic Univ., Hong Kong.* We present simultaneous monitoring of vehicle and railway traffic and coarse weight estimation by combining and analyzing spectra of vibration traces from two distributed fiber sensors on two co-routed field deployed fibers in metropolitan environments.

M1K.5 • 09:00
Inline Fiber Type Identification Using in-Service Brillouin Optical Time Domain Analysis, Ezra Ip[1], Yue-Kai Huang[1], Giacomo Borraccini[1], Toru Mano[2], Tatsuya Matsushima[2], Hideki Nishizawa[2], Andrea D'Amico[1], Vittorio Curri[3], Daniel C. Kilper[4], Zehao Wang[5], Gil Zussman[6], Tingjun Chen[5], Koji Asahi[7]; *[1]NEC Laboratories America Inc., USA; [2]NTT Network Innovation Labs, Japan; [3]Politecnico di Torino, Italy; [4]CONNECT Centre, Trinity College Dublin, Ireland; [5]Duke Univ., USA; [6]Columbia Univ., USA; [7]NEC Corporation, Japan.* We proposed the use of BOTDA as a monitoring tool to identify fiber types present in deployed hybrid-span fiber cables, to assist in network planning, setting optimal launch powers, and selecting correct modulation formats.

Room 1A

M1A • Fiber Sensing Devices—Continued

Dr. Bao's research includes distributed sensors and instrumentation, nanofiber device for low noise lasers and sensors, nonlinear and quantum effects in fibers. She is fellow of OSA, SPIE, and Royal Society of Canada, two CAP Outstanding Achievement.

Room 1B

M1B • Fiber-Based Nonlinear-Optic and Optoelectronic Devices—Continued

M1B.5 • 09:15
Positive (>0 dB) Wavelength Conversion Efficiency in Temperature-Tuned Five-Segment Highly-Nonlinear Fiber Without Pump Dithering, Hamed Rabbani[1], Cheng Guo[1], Michael Vasilyev[1]; [1]*Univ. of Texas at Arlington, USA.* By temperature tuning, we align zero-dispersion wavelengths of several fiber segments while detuning their Brillouin frequencies. Despite 2.5-fold fiber length increase, we obtain 2-dB higher Brillouin threshold, enabling >0 dB conversion efficiency without pump modulation.

M1B.6 • 09:30 Invited
Nonlinear Optics in Silicon Core Fibers: Progress and Trends, Anna C. Peacock[1]; [1]*Univ. of Southampton, UK.* Recent advances in the development and application of silicon core fibers for nonlinear photonics is reviewed. Focus will be placed on novel device designs that benefit from the fiber geometry and integration with existing components.

Room 2

M1C • Green Transformation: Where Do We Stand? I—Continued

Room 3

M1D • High Power and Narrow Linewidth Lasers—Continued

M1D.5 • 09:15
Reducing the Linewidth of Hybrid Integrated III-v/Silicon Laser by Utilizing High-Q Multimode-Waveguide-Based Silicon Ring Resonator, Xinhang Li[1], Yuyao Guo[1], Siyu E[1], Yihao Fan[1], Minhui Jin[1], Weihan Xu[1], Liangjun Lu[1], Yu Li[1], Jianping Chen[1], Linjie Zhou[1]; [1]*Shanghai Jiao Tong Univ., China.* We demonstrate a hybrid integrated self-injection locking laser (SIL) with an intrinsic linewidth of 1.25 kHz and an external cavity laser (ECL) of 5.3 kHz by leveraging a high-Q multimode-waveguide-based silicon microring resonator (MRR).

M1D.6 • 09:30
Hertz-Linewidth, High-Power, Frequency-Agile Photonic Integrated E-DBR Laser, Anat Siddharth[1], Alaina Attanasio[2], Grigory Lihachev[1], Rui N. Wang[1], Zheru Qiu[1], Scott Kenning[2], Sunil Bhave[2], Johann Riemensberger[1], Tobias J. Kippenberg[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland;* [2]*Purdue Univ., USA.* We demonstrate hybrid integration of an RSOA with an extended-distributed Bragg reflector (E-DBR) laser cavity implemented on a Si3N4 chip with monolithically integrated piezoactuators. The laser exhibits intrinsic linewidth of 4 Hz with laser frequency tuning over 1.0 GHz at up to 1 MHz triangular chirp rate.

M1D.7 • 09:45
Multi-Wavelength DFB Laser with High Mode Stability and Uniform Spacing via REC Technique, Zhenxing Sun[1], Jie Zhao[1], Yue Zhang[1], Zijiang Yang[1], Kaifei Tang[1], Rulei Xiao[1], Xiangfei Chen[1]; [1]*Nanjing Univ., China.* The multi-wavelength DFB lasers with four and six wavelengths simultaneously emitted are experimentally demonstrated for the emerging optical I/O technology. The proposed structure shows high mode stability and high uniform wavelength spacing of 100 GHz.

Room 6C

M1E • DSP and Multiplexing Techniques—Continued

M1E.3 • 09:15
Clock Recovery of a 180 Gbaud Faster-Than-Nyquist Signal Enabled by a Novel Adaptive Equalizer-Aided Algorithm, Yo Nakamura[1], Guoxiu Huang[1], Hisao Nakashima[1], Takeshi Hoshida[1]; [1]*Fujitsu Limited, Japan.* We proposed a novel adaptive equalizer-aided clock recovery algorithm for faster-than-Nyquist coherent optical systems and experimentally demonstrated good performance for Tomlinson-Harashima pre-coded 16QAM signal until 180Gbaud under the system with 10dB bandwidth of 65GHz.

M1E.4 • 09:30
Optimization of Pilot-Aided Joint Phase Recovery for Frequency Comb-Based Wideband Transmission, Gabriele Di Rosa[1], Ognjen Jovanovic[1], Muhammad Ahmed Leghari[1], Jasper Müller[1], Benjamin Wohlfeil[2], Jörg-Peter Elbers[1]; [1]*Advanced Technology, Adtran Networks SE, Germany;* [2]*Advanced Technology, Adtran Networks SE, Germany.* We numerically investigate joint pilot-aided phase recovery for frequency comb-based long-haul wideband transmission. We report net information rate gains by optimizing the pilot overhead and phase estimation algorithm, outperforming per-channel processing at lower complexity.

M1E.5 • 09:45
Carrier Frequency Offset Estimation Using Godard Timing Recovery in Coherent Optical Systems, Trung-Hien Nguyen[1], Sami Mumtaz[1], Abel Lorences-Riesgo[1], Marti Sales-Llopis[2], Clement Jauffret[1], Celestino Sanches Martins[1], Zhihang Wu[1], Yann Frignac[1], Gabriel Charlet[1], Yu Zhao[1]; [1]*Optical Communication Technology Lab., Huawei Technologies France, Paris Research Center, France;* [2]*HiSilicon Optoelectronics Co., Ltd., China.* Based on conventional timing recovery (TR) algorithm, we propose a novel method for carrier frequency offset (CFO) estimation by exploiting the available spectrum information from TR. We experimentally validate our proposal in 4-subcarrier 100-GBaud coherent systems.

Room 6D

M1F • Multi-Band Transmission Systems—Continued

M1F.4 • 09:30 ★ Top-Scored
264.7 Tb/s E, S, C + L-Band Transmission Over 200 km, Benjamin J. Puttnam[1], Ruben S. Luis[1], Yetian Huang[2], Ian Phillips[3], Dicky Chung[4], Nicolas K. Fontaine[2], Budsara Boriboon[1], Georg Rademacher[1], Mikael Mazur[2], Lauren Dallachiesa[2], Haoshuo Chen[2], Wladek Forysiak[3], Ray Man[4], Roland Ryf[2], David Neilson[2], Hideaki Furukawa[1]; [1]*National Inst Info & Comm Tech (NICT), Japan;* [2]*Nokia Bell Labs, USA;* [3]*Aston Univ., UK;* [4]*Amonics PLC, Hong Kong.* We experimentally investigate an extended reach E, S, C + L-band transmission system covering 27 THz with mid-span doped fiber and distributed Raman amplification, measuring 264.7 Tb/s from GMI and 250.8 Tb/s after decoding after 200 km transmission.

M1F.5 • 09:45
Accurate SNR Estimation in C+L-Band 10-THz Hybrid Raman-EDFA Amplified Transmission Using Two-Stage Power Profile Calculation Accounting for Pump Depletion, Kosuke Kimura[1], Shimpei Shimizu[1], Takayuki Kobayashi[1], Masanori Nakamura[1], Yutaka Miyamoto[1]; [1]*NTT Network Innovation Laboratories, NTT corporation, Japan.* We propose an accurate power profile calculation method for GN-model-based SNR estimation and demonstrate an average SNR estimation error of 0.22 dB in C+L-band 101-ch WDM 96-Gbaud PCS-36QAM signal 1120-km hybrid Raman-EDFA amplified transmission.

08:30–12:30 SC160, SC341, SC369, SC393, SC433, SC443, SC444, SC448, SC452, SC453A, SC454, SC473, SC483, SC487, SC513, SC525 (new), SC527 (new)

09:00–12:00 SC465

10:00–10:30 Coffee Break *(Upper Level Corridors)*

Room 6E

M1G • Optical Networks for Disaggregated and Composable Computing Systems—Continued

M1G.5 • 09:15 Invited

Network Aware Composable Computing, Georgios S. Zervas[1]; [1]*Univ. College London, UK.* Abstract not available.

Room 6F

M1H • Machine Learning for Estimation and Forecasting—Continued

M1H.6 • 09:15 ★ Top-Scored

Multi-Span Optical Power Spectrum Prediction Using ML-Based EDFA Models and Cascaded Learning, Zehao Wang[1,2], Yue-Kai Huang[2], Shaobo Han[2], Ting Wang[2], Daniel C. Kilper[3], Tingjun Chen[1]; [1]*Duke Univ., USA;* [2]*NEC Laboratories America, USA;* [3]*CONNECT Centre, Ireland.* We implement a cascaded learning framework using component-level EDFA models for optical power spectrum prediction in multi-span networks, achieving a mean absolute error of 0.17dB across 6 spans and 12 EDFAs with only one-shot measurement.

M1H.7 • 09:30

Network-Wide QoT Estimation Using SGD with Gradient Transfer Between Wavelengths, Kayol S. Mayer[1], Jonathan A. Soares[1], Marcos Paulo A. Dal Maso[1], Christian E. Rothenberg[1], Dalton S. Arantes[1], Darli A. A. Mello[1]; [1]*Unicamp, Brazil.* We propose an SGD-based QoT estimation technique that operates on a network-wide scale by transferring gradients among neighboring wavelengths. Simulation results indicate effective and low-complexity QoT estimation using only transponder SNR telemetry.

M1H.8 • 09:45

Demonstration of ROADM Status Visualization Based on Receiver DSP and Digital Twin Modeling, Meng Cai[1], Xiaomin Liu[1], Mengfan Fu[1], Xiaobo Zeng[1], Yichen Liu[1], Yihao Zhang[1], Lilin Yi[1], Weisheng Hu[1], Qunbi Zhuge[1]; [1]*Shanghai Jiao Tong Univ., China.* We propose a coherent receiver-based telemetry to visualize ROADM status. 100% accuracy of failure localization and 0.67 GHz RMSE of failure estimation are achieved in an 847-km fiber link with 6 WSS nodes.

Room 7

M1I • Next Generation Coherent PON—Continued

M1I.3 • 09:15

Symmetric Bidirectional 200 Gb/s/λ PON Solution Demonstrated Over Field Installed Fiber, Istvan B. Kovacs[1], Md Saifuddin Faruk[1], Adrian Wonfor[1], Seb Savory[1]; [1]*Univ. of Cambridge, UK.* We demonstrate 200 Gb/s/λ bidirectional coherent PON solution with simplified ONU on field installed fiber. We achieve 30.5/37 dB power budget for the downstream transmission with single-ended/balanced photodiode and 30.1 dB for the upstream transmission.

M1I.4 • 09:30

Demonstration of Auxiliary Management and Control Channel Transmission and Data-Channel Signal Compensation for Beyond 100G FDM Coherent PON, Wangwei Shen[1], Jiaye Wang[1], Sizhe Xing[1], Guoqiang Li[1], Zhongya Li[1], An Yan[1], Ziwei Li[1], Chao Shen[1], Jianyang Shi[1], Nan Chi[1], Junwen Zhang[1]; [1]*Fudan Univ., China.* We propose and demonstrate the transmission of AMCC and a novel signal-compensation method for data-channel in coherent FDM-PON. Sensitivity improvement of 6 dB is demonstrated with 150G capacity over 20-km fiber for FDM-PON with AMCC.

M1I.5 • 09:45 ★ Top-Scored

Hybrid, Multi-Format, Flexible-Rate Coherent PON Supporting Ultimate-Simplified Coherent and Full-Coherent Receivers with Compatible OLT in Downstream, An Yan[1], Guoqiang Li[1], Sizhe Xing[1], Yongzhu Hu[1], Wangwei Shen[1], Junhao Zhao[1], Ziwei Li[1], Chao Shen[1], Jianyang Shi[1], Nan Chi[1], Junwen Zhang[1]; [1]*Fudan Univ., China.* We propose and demonstrate a hybrid, multi-format and flexible-rate coherent PON system supporting ultimate-simplified coherent and full-coherent receivers based on the compatible OLT setup, achieving 50 to 300 Gbps access in FLCS-CPON based on 4/16/64-QAMs.

Room 8

M1J • Waveguide Mode Converters and Fiber-to-Chip Couplers—Continued

M1J.6 • 09:15

Broadband Polarization Beam Splitter Rotator Using Only Silicon Nitride, Fatemeh Ghaedi Vanani[1,2], Alireza Fardoost[1], Guifang Li[1], Christopher Doerr[2]; [1]*Univ. of Central Florida, USA;* [2]*Aloe Semiconductor, USA.* We designed and fabricated a CMOS-compatible polarization beam splitter and rotator purely in Si_3N_4, achieving experimentally an insertion loss of ~1.5dB and a polarization extinction ratio greater than 15dB from 1280 to 1320nm.

M1J.7 • 09:30

Dual-Band Polarization Beam Splitter Based on Cascaded Multimode Anti-Symmetric Apodized Bragg Gratings, Guanglian Cheng[1], Qiyuan Yi[1], Zengfan Shen[1], Zhiwei Yan[1], Qiyuan Li[1], Xinzhe Xiong[1], Fanglu Xu[1], Shuang Zheng[1], Yi Zou[2], Chaotan Sima[1], Li Shen[1], Shuai Cui[1], Yuan Yu[1]; [1]*Huazhong Univ. of Science and Techn, China;* [2]*The School of Information Science and Technology, ShanghaiTech Univ., China.* We design and demonstrate a dual-band polarization beam splitter with insertion losses of 0.5/1.2dB and 3.1/1.1dB for TE/TM-polarizations at 1550 and 2000nm, respectively. The measured bandwidths for extinction ratio >20dB are ~115/100nm for 1.55/2μm waveband.

M1J.8 • 09:45

A High-Speed Compact Polarization Controller in Silicon Photonics, Juan E. Villegas[2,1], Srinivasa Reddy[2], Mahmoud Rasras[2]; [1]*Technology Innovation Inst., United Arab Emirates;* [2]*New York Univ. Abu Dhabi, United Arab Emirates.* An ultra-compact (17 μm) 1550 nm inverse-designed silicon polarization converter with an insertion loss < 0.5 dB and extinction ratio > 25 dB is demonstrated and used to build a polarization controller with 20Gbit/s modulation.

Room 9

M1K • Distributed Sensing I—Continued

M1K.6 • 09:15

Real-Time Urban Sensing by in-Fiber Interferometric System Over Field-Deployed Uncoupled 4-Core Fiber Cable, Marco Fasano[1], Tetsuya Hayashi[2], Takuji Nagashima[2], Antonio Mecozzi[3,4], Cristian Antonelli[3,4], Pierpaolo Boffi[1]; [1]*Politecnico di Milano, Italy;* [2]*Sumitomo Electric Industries, Ltd, Japan;* [3]*Univ. of L'Aquila, Italy;* [4]*CNIT, Italy.* We demonstrate urban anthropic events monitoring through a sustainable and cost-effective interferometer sensor built by exploiting two cores of an uncoupled 4-core fiber in the first deployed multi-core fiber cable in L'Aquila, Italy.

M1K.7 • 09:30 Invited

Structured Light Enhanced Shape Sensing in Multimode Fibers, Sara Angelucci[1], Lubomir Skvarenina[1], Zhaozhong Chen[1], Adam Valles[2], Alasdair Clark[1], Martin P. Lavery[1]; [1]*Univ. of Glasgow, UK;* [2]*ICFO-Institut de Ciencies Fotonique, Spain.* Intermodal coupling and phase noise distorts optical fields as they propagate in fiber, limiting the accuracy of optical sensors. Utilising structured-light illumination and mode-demultiplexing for all-optical feature extraction, machine learning can be used to accurately determine the shape of few or multimode fibers.

08:30–12:30 SC160, SC341, SC369, SC393, SC433, SC443, SC444, SC448, SC452, SC453A, SC454, SC473, SC483, SC487, SC513, SC525 (new), SC527 (new)

09:00–12:00 SC465

10:00–10:30 Coffee Break *(Upper Level Corridors)*

Room 1A

10:30–12:30
M2A • Multi-Mode Propagation in Optical Fibers
Presider: Georg Rademacher; Universität Stuttgart, Germany

M2A.1 • 10:30
Scaling to 100 Modes by Exploiting Topological Confinement, Vineetha Ashok[1], Aaron Peterson-Greenberg[1], Zelin Ma[1], Isabelle L. Boegholm[1], Cheng Peng[1], Poul Kristensen[2], Siddharth Ramachandran[1]; *[1]Boston Univ., USA; [2]OFS-Fitel, Denmark.* By conducting a systematic study of the phenomenon of topological confinement for light transport, we demonstrate a record of 100 unmixed modes over ~22m of fiber with average nearest-neighbor crosstalk of -36 dB.

M2A.2 • 10:45
Differential Modal Delay Controlling of 4-LP Mode Optical Fiber by High-Density Cable with Low Cabling Loss, Masashi Kikuchi[1], Takayoshi Mori[1], Yusuke Yamada[1]; *[1]NTT Corporation, Japan.* We first clarified the design of low-loss-increment cable with 4-LP-mode fiber. We numerically and experimentally confirmed the feasibility of differential modal delay control and a 25 ps/km controllability potential with low cabling loss.

M2A.3 • 11:00
Comparison of Polarization Rotations Caused by Fiber Bending in Single- and Multi-Mode-Fibers, Christian M. Spenner[1], Klaus Petermann[2], Peter Krummrich[1]; *[1]TU Dortmund, Germany; [2]TU Berlin, Germany.* We measure mode group resolved polarization rotations caused by fiber bending in a 10-mode-GI-Fiber. For the fundamental mode of the GI-Fiber, we observe faster rotations than predicted from simulations.

Room 1B

10:30–12:30
M2B • Datacom: Coding and Equalization
Presider: Robert Borkowski; Nokia Bell Labs, USA

M2B.1 • 10:30 Tutorial
Probabilistic Shaping for Direct-Detection Optical Systems, Joseph M. Kahn[1], Ethan M. Liang[1]; *[1]Stanford Univ., USA.* We study probabilistic shaping for direct-detection systems that modulate the intensity or Stokes vector and are limited by thermal or amplifier noise, obtaining analytical formulas for the optimal (non-Gaussian) input distributions and corresponding shaping gains.

Joseph Kahn is a Professor of Electrical Engineering at Stanford University. Achievements include: first synchronous (i.e., coherent) detection in fiber optics (1989); first probabilistic shaping in optical communications (1999); first electronic compensation of fiber Kerr nonlinearity (2002), leading to digital backpropagation (2008); and elucidation of principal modes in multimode fibers (2005), leading to statistics of strongly coupled modes (2011).

Room 2

10:30–12:30
M2C • Green Transformation: Where Do We Stand? II
Presider: Md Saifuddin Faruk; Bangor Univ., UK and Naveena Genay; Orange Labs, France and Luca Valcarenghi; Scuola Superiore Sant'Anna, Italy and Ting Wang; NEC Laboratories America Inc., USA

M2C.1 • 10:30 Invited
How ICT can Positively Impact the Environment, Alessandro Percelsi[1]; *[1]TIM S.p.A., Italy.* In many sectors, ICT can significantly decrease global GHG emissions, optimizing resource use. However, ICT industry relies on high resource-demanding infrastructures: sustainable processes and efficiency are mandatory for ICT operators to reach full environmental benefits.

M2C.2 • 11:00 Invited
Can Photonics Help in Reducing the Power Consumption in Radio Access Networks?, Fabio Cavaliere[1], Alessandra Bigongiari[1], Antonio Tartaglia[1]; *[1]Ericsson, Italy.* We discuss the challenges of future radio access networks in meeting the growth of traffic without a parallel explosion of energy consumption. The opportunities offered by integrated photonics technologies are analyzed.

Room 3

10:30–12:30
M2D • VCSELs and Modulator Technologies
Presider: Connie Chang-Hasnain; Berxel Photonics, USA

M2D.1 • 10:30
Lithographic Aperture VCSELs Enabling Beyond 100G Datacom Applications, Stefano Tirelli[1], Elisabetta Corti[1], Eimantas Duda[1], Antoine Pissis[1], Mirko Hoser[1], Matthias Paul[1], Evgeny Zibik[1]; *[1]Coherent II-VI Laser Enterprise GmbH, Switzerland.* This paper reports the first demonstration of lithographic aperture VCSELs with bandwidth above 29 GHz. Large-signal measurements and preliminary lifetime data are reported, putting forward lithographic aperture as an enabling technology for applications beyond 100G.

M2D.2 • 10:45
Cryogenic Oxide-VCSEL at 2.8 K Demonstrates Record Bandwidth f_{-3dB} > 50 GHz, P_{out} > 14 mW and PAM-4 Data Rate up to 128 Gb/s, Haonan Wu[1], Wenning Fu[1], Zetai Liu[1], Yulin He[1], Milton Feng[1]; *[1]Electrical and Computer Engineering, Nick Holonyak, Jr. Micro and Nanotechnology Laboratory, USA.* We report record speed-power and ultrahigh linearity performance for a 6.8 um oxide-aperture VCSEL operated at 2.8 K. The device demonstrates data rate up to 128 Gb/s PAM-4 and 64 Gb/s NRZ.

M2D.3 • 11:00 Invited
Toward 200G per Lane VCSEL-Based Multimode Links, Ramana Murty[1], Jingyi Wang[1], Sizhu Jiang[1], David Dolfi[1], Tak Wang[1], Derek Vaughan[1], Laura Giovane[1]; *[1]Broadcom Corporation, USA.* Progress in the development of multimode 850 nm VCSELs is demonstrated at 100 GBd PAM4 operation, and at 53.125 GBd PAM4 with transmission over 100 m of OM3 fiber. Continued advances will help introduce the next generation of multimode links.

Room 6C

10:30–12:30
M2E • SDM Amplifiers and Multiplexers
Presider: Atsushi Nakamura; NTT Corporation, Japan

M2E.1 • 10:30 Invited
Energy Efficient Multicore Fiber Amplifiers, Yong-min Jung[1], Sijing Liang[1], John D. Downie[2], Sergejs Makovejs[3], Merrion Edwards[3], Periklis Petropoulos[1]; *[1]Univ. of Southampton, UK; [2]Corning Research and Development Corp., Corning, USA; [3]Corning Optical Communications, Corning Inc., UK.* Energy-efficient multicore fiber (MCF) amplifiers are crucial for establishing future high-capacity submarine transmission systems. This paper reviews recent advancements and explores future directions in MCF amplifier development, highlighting their potential for cost-effective and power-efficient operation.

M2E.2 • 11:00
Advancements in Fanout Technology for SDM Applications, Victor I. Kopp[1], Jongchul Park[1], Jing Zhang[1], Jon Singer[1], Dan Neugroschl[1]; *[1]Chiral Photonics Inc, USA.* Real-world SDM deployment requires the development of a supporting ecosystem. Recent technological advancements allow for volume production of key components of this ecosystem, MCF fanouts, which meet demanding performance requirements.

Room 6D

10:30–12:30
M2F • Sub-Millimeter Wave and THz Communication
Presider: Bernhard Schrenk; AIT Austrian Inst. of Technology, Austria

M2F.1 • 10:30 ★ Top-Scored
300 GHz Photonic-Wireless Transmission with Aggregated 1.034 Tbit/s Data Rate Over 100 m Wireless Distance, Hongqi Zhang[1], Zuomin Yang[1], Zhidong Lyu[1], Hang Yang[1], Lu Zhang[1], Xiaodan Pang[2], Oskars Ozolins[2], Xianmin Zhang[1], Xianbin Yu[1]; *[1]Zhejiang Univ., China; [2]Royal Inst. of Technology, Sweden.* We present a long-distance ultrafast THz photonic-wireless communication system by combining frequency-, polarization- and spatial-division multiplexing techniques. An aggregated net rate of 1.034 Tbit/s over record 100 m at 300 GHz is successfully demonstrated.

M2F.2 • 10:45
Dual-Sideband Receiver Enabling 160 Gbps Direct SubThz-to-Optical Conversion Over 1400 m, Tobias Blatter[1], Laurenz Kulmer[1], Boris Vukovic[1], Yannik Horst[1], Marcel Destraz[2], Jasmin Smajic[1], Juerg Leuthold[1]; *[1]ETH Zurich, Switzerland; [2]Polariton Technology, Switzerland.* A dual-sideband reception scheme for RF links providing up to 3 dB sensitivity improvement is introduced and tested to bridge 1400 m wireless distance between 160 Gbps fiber networks at an RF of 226 GHz.

M2F.3 • 11:00 Invited
THz Communication Enabled by Photonics, Cyril Renaud[1]; *[1]Univ. College London, UK.* This presentation will look at the contribution of photonic solutions for THz wireless communication. We will review the most recent results and explore some of the possible routes that could be investigated through photonic technologies.

Room 6E

10:30–12:30
M2G • Photonic Switched Data Center Networks
Presider: Odile Liboiron-Ladouceur; McGill Univ., Canada

M2G.1 • 10:30 Invited
Photonic Switched Networking for Data Centers and Advanced Computing Systems, Paraskevas Bakopoulos[1], Giannis Patronas[1], Nikos Terzenidis[1], Zsolt-Alon Wertheimer[1], Prethvi Kashinkunti[1], Dimitris Syrivelis[1], Eitan Zahavi[1], Louis Capps[1], Nikos Argyris[1], Luke Yeager[1], Julie Bernauer[1], Elad Mentovich[1]; [1]*NVIDIA, Greece*. We explore optical switching to extend network programmability to the physical layer. We present applications of our Layer-1 SDN for improving fabric resilience against hardware failures and saving network power and cost in Deep-Learning training.

M2G.2 • 11:00 ★ Top-Scored
Mode-Selective Reconfigurable Optical Add-Drop Multiplexers Experimentally Validated with 40 Gbps NRZ/PAM4, Kaveh Hassan Rahbardar Mojaver[1], Sunami Sajjanam Morrison[1], S. Mohammad Reza Safaee[1], Odile Liboiron-Ladouceur[1]; [1]*McGill Univ., Canada*. We experimentally demonstrate a mode-selective ROADM for two transverse-electric modes using a mode-selective phase shifter in the switch. We show 40 Gbps NRZ transmission and 20 GBaud PAM4 transmission for two simultaneously transmitted optical modes.

Room 6F

10:30–12:30
M2H • High-Speed Transceivers and Transmission
Presider: Di Che; Nokia Bell Labs, USA

M2H.1 • 10:30 Invited
Toward 1.6T Low-Power Coherent DSP: Challenges, and Lessons Learned From Preceding Generations, Shu Hao Fan[1]; [1]*Marvell Semiconductor Inc., USA*. We reviewed the progression of coherent mixed-signal ASIC technology since 40nm silicon and identified the critical path toward beyond-terabit-per-wavelength pluggable modules. Challenge in aspects of ASIC design and optical components was explored.

M2H.2 • 11:00 ★ Top-Scored
240GBd-16QAM Single-Carrier Coherent Transmission Over 120km SSMF for a Bandwidth Limited System with 1sps Speed and Simple DSP, Guoxiu Huang[1], Yo Nakamura[1], Hisao Nakashima[1], Takeshi Hoshida[1]; [1]*Fujitsu Limited, Japan*. The transmission over 120km SSMF of 240GBd-16QAM coherent system with optical bandwidth of 148GHz was experimentally demonstrated. The novel transceiver DSP was simply implemented at 1sample/symbol speed for low power consumption with high transmitter output.

Room 7

10:30–12:30
M2I • Panel: The Role of Digital Twins in Optical Networking

Organizers
Kostas Christodoulopoulos, *University of Athens, Greece*
Yvan Pointurier, *Huawei, France*
Chongjin Xie, *Alibaba Group, USA*

Speakers
David Boertjes, *Ciena, USA*
Haoshuo Chen, *Nokia Bell Labs, USA*
Gabriel Charlet, *Huawei, France*
Darli Mello, *University of Campinas, Brazil*
Behnam Shariati, *Fraunhofer HHI, Germany*
Shikui Shen, *China Unicom, China*

A digital twin creates a virtual model of a physical system to understand it, predict its evolution, and optimize it while it operates. Digital twins are receiving increasing attention and have been used in a wide range of fields, i.e., from the manufacturing industry to electrical power systems and from aerospace engineering to smart cities, to name a few.

With the proliferation of elastic and programmable optical transceivers, high-order modulation formats, flexible grids, and intelligent orchestration layers, optical networks are rapidly evolving in the direction of openness and disaggregation, flexible transmission, function virtualization, and further automation/autonomy. Typically, optical networks are operated rather statically, while the increase in complexity and flexibility hinders their dynamic and automated adaptation.

This panel aims to present state-of-the-art research activities on the vital role that digital twins can play in alleviating the plethora of challenges inherent in designing and operating complex single-vendor or disaggregated optical networks. Digital twins have the potential to bridge the gap between the network management/control, and the actual physical system, providing a means to understand, predict, and evaluate the behavior and performance of the network as it operates.

Topics to be targeted by the panel include but will not be limited to:

- Fault prediction, detection, identification and localization
- Evaluation of fault mitigation actions
- Evaluation of what-if scenarios for channel and network optimization
- Physical layer (evolution) emulation and QoT estimation
- Evaluation, processing, and understanding of the effects of dynamic actions on the physical layer
- Application to optical transport networks and Industry 4.0

Room 8

10:30–12:30
M2J • Quantum Protocols, Simulations and Analysis
Presider: Eleni Diamanti; CNRS, France

M2J.1 • 10:30
Secure Architecture for Quantum Key Distribution Networks, Bruno Huttner[1]; [1]*ID Quantique SA, Switzerland*. We present a new architecture, designed to improve security of QKD networks. The Trusted Nodes are divided into Core Nodes, which XOR the keys from various QKD devices, and Edge Nodes, connected to key users.

M2J.2 • 10:45
A Machine Learning-Assisted Quantum and Classical Co-Existence System, Mark Yang[1], Rui Wang[1], Alex Seferidis[1], Tireni Omigbodun[1], Sima Bahrani[1], Romerson Oliveira[1], Reza Nejabati[1], Dimitra E. Simeonidou[1]; [1]*High Performance Networks group, Univ. of Bristol, UK*. A machine learning framework is presented for the coexistence of C-band quantum and classical channels over the same fibre with various fibre lengths, co-existence powers, channel allocations, and identifying the region where co-existence is viable.

M2J.3 • 11:00
Relayed-QKD and Switched-QKD Networks Performance Comparison Considering Physical Layer QKD Limitations, Nikolaos Makris[1], Alkinoos Papageorgopoulos[1], Persefoni Konteli[1], Iliana Tsoni[1], Konstantinos Tsimvrakidis[1], Ilias Papastamatiou[2], Konstantinos (Kostas) Christodoulopoulos[1], George T. Kanellos[1], Dimitris Syvridis[1]; [1]*Informatics and Telecommunications, National and Kapodistrian Univ. of Athens, Greece;* [2]*GRNET S.A. – National Infrastructures for Research and Technology, Greece*. We experimentally evaluate the SKR generation for unoptimized QKD pairs in switched QKD and compare the performance of the switched-QKD with relayed-QKD networks to reveal they perform better for short distances and at large networks.

Room 9

10:30–12:30
M2K • Distributed Sensing II
Presider: Mikael Mazur; Nokia Bell Labs, USA

M2K.1 • 10:30
Distributed Vibration Sensing and Simultaneous Self-Homodyne Transmission of Single-Carrier net 5.36 Tb/s Signal Using 7-Core Fiber, Jianwei Tang[1,2], Xueyang Li[1], Chen Cheng[2], Linsheng Fan[2], Yaguang Hao[1,2], Bing Yue[1], Jiali Li[1], Zhixue He[1], Yanfu Yang[1,2], Weisheng Hu[1]; [1]*Department of Circuits and System, Peng Cheng Laboratory (PCL), China;* [2]*School of Electronics and Information Engineering, Harbin Inst. of Technology (Shenzhen), China*. We demonstrate self-homodyne coherent transmission of a space-division multiplexed dual-pol 120-Gbaud 16 QAM signal achieving a single-carrier net data rate of 5.36 Tb/s, and simultaneously distributed vibration sensing using a 41.4 km weakly-coupled 7-core fiber.

M2K.2 • 10:45
Comparison Between Phase and Polarization Sensing Using Coherent Transceivers Over Deployed Metro Fibers, Lorenzo Andrenacci[1], Dario Pilori[1], Saverio Pellegrini[1], Leonardo Minelli[1], Gabriella Bosco[1], Claudio Crognale[2], Stefano Piciaccia[2], Roberto Gaudino[1]; [1]*Dipartimento di Elettronica e Telecomunicazioni, Politecnico di Torino, Italy;* [2]*Cisco Photonics, Italy*. We experimentally compare SOP and phase extraction under identical system conditions over a deployed 32-km unamplified metro fiber link for vibrations sensing applications using coherent receivers.

M2K.3 • 11:00
Pressure Wave Detection and Localization in Deployed Underground Fiber Using Coherent Correlation OTDR, Florian Azendorf[1], André Sandmann[1], Michael Eiselt[1]; [1]*Advanced Technology, Adtran Networks SE, Germany*. A deployed fiber with in-house and underground sections is interrogated with a coherent correlation OTDR. The origin and propagation speed of a hammer-generated pressure wave in the underground section is detected and acoustic signals are monitored.

Room 1A

M2A • Multi-Mode Propagation in Optical Fibers—Continued

M2A.4 • 11:15
Broadband Characterization of Randomly Coupled 19-Core Multicore Fiber, Lauren Dallachiesa[1], Nicolas K. Fontaine[1], Roland Ryf[1], Mikael Mazur[1], Haoshuo Chen[1], Georg Rademacher[2], Ruben S. Luis[3], Benjamin J. Puttnam[3], Hideaki Furukawa[3], Ayumi Inoue[4], Takuji Nagashima[4], Tetsuya Hayashi[4]; [1]*Nokia Bell Labs, USA;* [2]*Univ. of Stuttgart, Germany;* [3]*NICT, Japan;* [4]*Sumitomo Electric Industries, Japan*. We evaluate 19-core randomly-coupled multi-core fiber using swept wavelength interferometry in the O-, E-, C- and L-bands. We show a differential mode delay reduction when unspooling the fiber and increased randomization length at shorter wavelengths.

M2A.5 • 11:30 Invited
Mode Coupling in Optical Fibers, Luca Palmieri[1]; [1]*Universita degli Studi di Padova, Italy.* Mode coupling plays a crucial role in spatial-division-multiplexed transmission systems. This paper review and explores new approaches to modelling and characterization of mode coupling modelling in multicore and multimode fibers.

Room 1B

M2B • Datacom: Coding and Equalization—Continued

M2B.2 • 11:30
Trellis Shaping-Based Sequence Selection for Inter-Datacenter Single-Span Links, Xiang Li[1], Junyang Tang[1], Zenpeng Gong[1], Pengpeng Wei[1], Xuemeng Hu[1], Tianye Huang[1], Xiao Xiao[2]; [1]*China Univ. of Geosciences, China;* [2]*Zhongrui Sulian (Wuhan) Science and Technolo, China.* We propose trellis shaping technique to implement sequence selection for fiber nonlinearity mitigation in inter-datacenter single-span link. A gain in AIR of 0.2 bits/4D-symbol compared with MB shaping is achieved experimentally over a five-channel 80-km fiber link.

M2B.3 • 11:45
4-Lambda LAN-WDM 1.6-Tb/s 2-km Transmission with Nonlinear Maximum Likelihood Sequence Estimation., Hiroki Taniguchi[1], Masanori Nakamura[1], Fukutaro Hamaoka[1], Shuto Yamamoto[1], Yutaka Miyamoto[1], Etsushi Yamazaki[1]; [1]*NTT Network Innovation Laboratories, Japan.* We demonstrate, for the first time, a capacity of 1.6 Tb/s over 2 km of single-mode fiber on the O-band LAN-WDM grid with 4-lane 400-Gb/s/lane signals with 155-GBd PAM-8 signals enhanced by NL-MLSE.

Room 2

M2C • Green Transformation: Where Do We Stand? II—Continued

M2C.3 • 11:30 Invited
Solutions to Increase Energy Efficiency of Optical Networks, Nicola Sambo[1]; [1]*Scuola Superiore Sant'Anna, Italy.* Power consumption of devices and network functionalities in optical infrastructures is reviewed. Then, possible short-, medium-, and long-term solutions to reduce and make energy consumption scalable are discussed.

Room 3

M2D • VCSELs and Modulator Technologies—Continued

M2D.4 • 11:30
Single-Mode VCSEL with Zn-Diffusion Apertures and Strong Immunity Against Optical Feedback for Improved Data Transmission, Min-Long Wu[1], Cheng-Wei Lin[1], Jin-Wei Shi[1]; [1]*National Central Univ., Taiwan.* We demonstrate state-of-the-art performances of single-mode VCSELs, including wide-bandwidth (27GHz), high-power (6.7mW), low-RIN (-137dB/Hz), and invariant 56Gbps eye patterns under strong optical feedback (-6dB). It achieves error-free 46Gbit/sec transmission through 0.5km MMF without using equalizers.

M2D.5 • 11:45
59-fJ/bit Si Photonic Crystal Slow-Light Modulator with FinFET-Compatible Driving Voltage, Keisuke Kawahara[1], Tai Tsuchizawa[2], Noritsugu Yamamoto[2], Yuriko Maegami[2], Koji Yamada[2], Toshihiko Baba[1]; [1]*Yokohama National Univ., Japan;* [2]*National Inst. of Advanced Industrial Science and Technology, Japan.* Si Mach-Zehnder modulator with slow-light enhancement of photonic crystal phase shifter consumes a low bit energy of 59 fJ/bit and transmits a 64-Gbaud NRZ signal with a FinFET-compatible driving voltage of 0.87 V.

Room 6C

M2E • SDM Amplifiers and Multiplexers—Continued

M2E.3 • 11:15
Fiber Bundle Fan-in/Fan-out (FIFO) for Coupled MCF with High-Δ 4-Core Fiber Pitch Converter, Masanori Takahashi[1], Tsubasa Sasaki[1], Ryuichi Sugizaki[1]; [1]*Furukawa Electric, Japan.* Low-loss fiber bundle FIFO with stretched high-Δ 4-core fiber pitch converter is developed. Core pitch and insertion loss of the FIFO are reduced to 18.4 μm and 0.84 dB including splice loss to CC-MCF.

M2E.4 • 11:30 Invited
Energy-Efficient Cladding-Pumped Amplifier for Coupled Multi-Core Fiber Transmission, Taiji Sakamoto[1], Masaki Wada[1], Ryota Imada[1], Kazuhide Nakajima[1]; [1]*NTT Access Network Service Systems Laboratories, Japan.* We review energy-efficient cladding-pumped multi-core amplification technologies and experimentally demonstrate the advantages of using a coupled-12-core amplifier for improving the amplification efficiency.

Room 6D

M2F • Sub-Millimeter Wave and THz Communication—Continued

M2F.4 • 11:30
Demonstration of 200 Gbps D-Band Wireless Delivery in a 4.6 km 2×2 MIMO System, Yi Wei[1], Jianjun Yu[1], Mingxu Wang[1], Xianming Zhao[2], Xiongwei Yang[1], Weiping Li[1], Peng Tian[1], Yang Han[1], Qiutong Zhang[1], Jingwen Tan[1], Bing Zhang[1], Feng Zhao[3], Wen Zhou[1], Kaihui Wang[1]; [1]*Fudan Univ., China;* [2]*Harbin Inst. of Technology, China;* [3]*Xi'an Univ. of Posts and Telecommunications, China.* A 4.6-km 2×2 MIMO wireless system at D-band is experimentally demonstrated with a total data rate of 200 Gbps and a record-breaking capacity-distance product of 920 Gbps*km at D-band.

M2F.5 • 11:45
Demonstration of W-Band 2×2 MIMO Millimeter Delivery Employing CMA and MRC Technology with Over 7dB Gain, Qiutong Zhang[1], Jianjun Yu[1,2], Weiping Li[1], Min Zhu[2,4], Jiao Zhang[2,4], Junjie Ding[2,4], Xianming Zhao[3], Jiaxuan Liu[1], Yi Wei[1], Kaihui Wang[1], Wen Zhou[1], Bo Liu[1], Feng Zhao[5], Jianguo Yu[6]; [1]*Fudan Univ., China;* [2]*Purple Mountain Laboratories, China;* [3]*Harbin Inst. of Technology, China;* [4]*Southeast Univ., China;* [5]*XUPT, China;* [6]*BUPT, China.* We demonstrate 32 GBaud QPSK signal transmission over a 2 m wireless range at 93.5 GHz using CMA and MRC techniques with over 7 dB gain in a photon-assisted millimeter wave 2×2 MIMO communication system.

Room 6E

M2G • Photonic Switched Data Center Networks—Continued

M2G.3 • 11:15
Intra-Datacenter Optical Circuit Switch Architecture with Multi-Band Transmission Technologies, Takuma Kuno[1], Reiji Higuchi[1], Kazato Satake[1], Hayato Yuasa[1], Yojiro Mori[1], Hiroshi Hasegawa[1]; *[1]Nagoya Univ., Japan.* This paper proposes an optical circuit switch architecture using multi-band transmission. We experimentally confirmed the performance of 1,280×1,280 switch with 32-Gbaud dual-polarization QPSK signals aligned on 33-GHz grid in the C- and L- bands.

M2G.4 • 11:30
Demonstration of Hitless OCS Provision for Multi-Modal Traffic in a Centralized Scheduling Hybrid Optical/Electrical Datacenter Network, Shi Feng[1], Jiawei Zhang[1], Jun Dai[1], Yashe Liu[2], Xiaorun Wang[1], Yuefeng Ji[1]; *[1]Beijing Univ. of Posts and Telecomm, China; [2]Huawei Technologies Co., Ltd, China.* We demonstrate a hitless OCS provision in a centralized scheduling hybrid optical/electrical datacenter network through a real-time FPGA-based testbed. Experimental results show that it achieves a low packet delay and flow completion time accelerations.

M2G.5 • 11:45
Converged Inter/Intra All-Optical DC Network Externally Distributing Optical Carriers to Coherent Transceivers, Ritsuki Hamagami[1], Masamichi Fujiwara[1], Naotaka Shibata[1], Shin Kaneko[1], Jun-ichi Kani[1], Tomoaki Yoshida[1]; *[1]NTT Access Network Service Systems Laboratories, NTT, Japan.* We propose a DCN that directly connects server racks distributed among DCs through ROADM-based nodes. External light sources are introduced to coherent transceivers to avoid laser-diodes being operated under high temperature conditions on top-of-rack switches.

Room 6F

M2H • High-Speed Transceivers and Transmission—Continued

M2H.3 • 11:15 ★ Top-Scored
AMUX-Based Bandwidth Tripler with Time-Interleaved Nonlinear Digital Pre-Distortion Enabling 216-GBd PS-PAM8 Signal, Masanori Nakamura[1], Munehiko Nagatani[1,2], Hiroshi Yamazaki[1,2], Teruo Jyo[2], Miwa Mutou[2], Yuta Shiratori[2], Hitoshi Wakita[2], Hiroki Taniguchi[1], Shuto Yamamoto[1], Fukutaro Hamaoka[1], Takayuki Kobayashi[1], Hiroyuki Takahashi[1,2], Yutaka Miyamoto[1]; *[1]NTT Network Innovation Laboratories, Japan; [2]NTT Device Technology Laboratories, Japan.* We propose an analog filterless InP-DHBT AMUX-based bandwidth tripler with a time-interleaved nonlinear digital pre-distortion for tripler and optical frontend impairments, achieving a net-bitrate 496.9-Gb/s signal generation and 483.9-Gb/s 11-km transmission with single-carrier 216-GBd PS-PAM8.

M2H.4 • 11:30 ★ Top-Scored
467 Gbit/s Net Bitrate IM/DD Transmission Using 176 GBd PAM-8 Enabled by SiGe AMUX with Excellent Linearity, Qian Hu[1], Tobias Tannert[2], Markus Grözing[2], Gregory Raybon[1], Robert Borkowski[1], Fred Buchali[3], Xi Chen[1], Pat Iannone[1], Georg Rademacher[2], Roland Ryf[1]; *[1]Nokia Bell Labs, USA; [2]Univ. of Stuttgart, INT, Germany; [3]Nokia, Network Infrastructure – Optical Networks Division, Germany.* Using a SiGe analog multiplexer (AMUX) integrated circuit we generate a PAM-8 signal at 176 GBd by time-interleaving two 88 GBd tributaries. High-quality signal is obtained after interleaving thanks to the excellent linearity of the AMUX. We successfully demonstrate net bitrates up to 467 Gbit/s after 2 km fiber transmission.

M2H.5 • 11:45
Reach Extension of Net-200G/λ IM-DD PAM4 Links to Beyond-100km with Low-Complexity Using OE-EQ, Paikun Zhu[1], Yuki Yoshida[1], Kouichi Akahane[1], Ken-ichi Kitayama[1,2]; *[1]National Inst of Information & Comm Tech, Japan; [2]Hamamatsu Photonics Central Research Laboratory, Japan.* We report C-band net-202Gb/s/λ IM-DD PAM4 transmission over single-span up-to-100.9km SSMF using only a single-drive intensity modulator, one PD, one ADC, low-complexity DSP and practical FEC, based on a theory-backed optoelectronic equalization (OE-EQ) technique.

Room 7

M2I • Panel: The Role of Digital Twins in Optical Networking—Continued

Room 8

M2J • Quantum Protocols, Simulations and Analysis—Continued

M2J.4 • 11:15 Invited
Quantum Network Protocols, Elham Kashefi[1]; *[1]Univ. of Edinburgh, UK.* Abstract not available.

M2J.5 • 11:45
Quantum Networks: Exploring Scalability, Topology, and Error Correction, Hyeongrak Choi[1], Marc G. Davis[1], Álvaro G. Iñesta[2], Dirk R. Englund[1]; *[1]Research Laboratory of Electronics, Massachusetts Inst. of Technology, USA; [2]QuTech, Delft Univ. of Technology, Netherlands.* We introduce Quantum Tree Networks, a k-ary tree topology for scalable, error-corrected entanglement routing. Using sublinear qubit overhead and network-level simulations, we demonstrate efficient routing and congestion avoidance.

Room 9

M2K • Distributed Sensing II—Continued

M2K.4 • 11:15
Homebrew: Optical Polarization Change Detection for Ground Motion Sensing, Joseph Catudal[1], Zhenhao Zhou[1], Weijun Pan[1], Paul Barford[1], Dante Fratta[1], Herb Wang[1]; *[1]Univ. of Wisconsin-Madison, USA.* We examine laser light polarization measurements using our own novel polarimeter design for ground motion sensing and show that efficacy is highly dependent on the coupling of fiber routes to vibration sources.

M2K.5 • 11:30 ★ Top-Scored
Distributed Strain Sensing by Optical Frequency Domain Reflectometry with Longest Common Substring Algorithm, Xiang Zheng[1], Weilin Xie[1,2], Qiang Yang[1], Jiang Yang[1], Congfan Wang[1], Wei Wei[1,2], Yi Dong[1,2]; *[1]Beijing Inst. of Technology, China; [2]Yangtze Delta Region Academy of Beijing Inst. of Technology, China.* We report a spectrum shift extraction method in optical frequency domain reflectometry based on longest common substring algorithm, allowing for an improvement in the accuracy and the range over 56% of the effective sweep range.

M2K.6 • 11:45
Repeaterless Brillouin OTDR Sensing Over 250 km Using Erbium Doped Fiber Amplifier, Neethu Mariam Mathew[2], Mads H. Vandborg[2], Jesper B. Christensen[1], Zepeng Wang[2], Lars Grüner-Nielsen[2], Lars S. Rishøj[2], Benjamin Marx[3], M. Ali Allousch[3], Tommy Geisler[4], Mikael Lassen[1], Karsten Rottwitt[2]; *[1]Danish Fundamental Metrology, Denmark; [2]DTU Electro, Denmark; [3]Luna Innovation, Germany; [4]OFS Denmark, Denmark.* We demonstrate a Brillouin OTDR sensing range of 251 km using two sections of remotely pumped Erbium doped fiber amplifiers. The temperature shift is measured with an accuracy of 3.3ºC at 251 km.

Room 1A

M2A • Multi-Mode Propagation in Optical Fibers—Continued

M2A.6 • 12:00 Invited

Advances in Few-Mode Fiber Manufacturing and Characterization, Frank Achten[1], Marianne Bigot-Astruc[1], Pierre Sillard[1]; [1]*Prysmian Group, Netherlands.* A review of recent advances in manufacturing and characterizing low-differential-mode-group-delay few-mode fibers is presented. These fibers can support up to 10 mode groups, i.e., 55 spatial modes.

Room 1B

M2B • Datacom: Coding and Equalization—Continued

M2B.4 • 12:00

912-Gbits/s/Channel PDM-PS-256QAM NANF Transmission Using IQ-Crosstalk Robust MIMO Equalizer Integrated with Decision-Directed CPE, Chen Wang[1], Jianyu Long[1], Kaihui Wang[1], Wen Zhou[1], Lei Shen[2], Peng Li[2], Jianjun Yu[1]; [1]*Fudan Univ., China;* [2]*Yangtze Optical Fiber and Cable, China.* We realized 912-Gbits/s/channel coherent PDM-PS-256QAM transmission over 2-km NANF utilizing a novel multiple-input multiple-output real-valued equalizer embedded with the decision-directed carrier phase estimation algorithm.

M2B.5 • 12:15

Investigation of Concatenated KP4 FEC with Single-Parity-Check Codes for Short-Reach IM/DD Systems, Tom Wettlin[1], Stefano Calabro[1], Nebojsa Stojanovic[1], Youxi Lin[1], Talha Rahman[1]; [1]*Huawei Technologies, Germany.* We investigate the concatenation of KP4 FEC with short single-parity-check codes. This represents an intermediate solution in terms of performance, complexity and latency between standalone KP4 FEC and concatenated schemes based on stronger soft-decision codes.

Room 2

M2C • Green Transformation: Where Do We Stand? II—Continued

M2C.4 • 12:00 Invited

Effective Use of Renewable Energy in Data Centers, Masaki Kozai[1]; [1]*NTT Corp., Japan.* This presentation will introduce a technology that adjusts demand to fluctuating renewable energy generation by optimizing the temporal and spatial placement of workloads between distant data centers.

Room 3

M2D • VCSELs and Modulator Technologies—Continued

M2D.6 • 12:00

112 Gbaud Optical PAM8 Modulation Based on Segmented Thin Film Lithium Niobate Modulator, Yang Liu[1], Qiansheng Wang[1], Changqing Wang[1], Dingyi Wu[1], Peiqi Zhou[1], Ye Liu[1], Hongguang Zhang[1], Daigao Chen[1,2], Xi Xiao[1,2]; [1]*National opto-electronics innovation center, China;* [2]*State Key Laboratory of Optical Communication Technologies and Networks, China Information and Communication Technologies Group Corporation (CICT), China.* We experimentally demonstrate an optical transmission of 112 Gbaud PAM8 based on a segmented thin film lithium niobate modulator in an IMDD link. The Vpp of two single-ended RF signals are 2.5V and 3.5 V.

M2D.7 • 12:15

An Ultimate-High Linear Silicon Modulator Based on All-Optical Linearization Method, Fan Jingyang[1], Qiang Zhang[2], Shengyu Fang[1], Xingyi Jiang[1], Shuyue Zhang[1], Hui Yu[2]; [1]*College of Information Science and Electronic Engineering, Zhejiang Univ., China;* [2]*Zhejiang Lab, China.* We proposed an ultimate-high linear silicon-based modulator based on all-optical linearization method, which demonstrates an SFDR as high as 131/127 dB×Hz$^{6/7}$ at 1/10 GHz.

Room 6C

M2E • SDM Amplifiers and Multiplexers—Continued

M2E.5 • 12:00

Ultra-Wideband Mode Selective Couplers for Weakly-Coupled WDM-MDM Transmission, Chengbin Long[1], Jian Cui[2], Yuyang Gao[1], Gang Qiao[1], Baolong Zhu[1], Jiarui Zhang[1], Yu Yang[3], Lei Shen[4], Jie Luo[4], Yongqi He[1], Zhangyuan Chen[1,3], Juhao Li[1,3]; [1]*Peking Univ., China;* [2]*Department of Networks, China Mobile Communications Group Co., Ltd., Beijing 100033, China., China;* [3]*Peng Cheng Laboratory, China;* [4]*State Key Laboratory of Optical Fiber and Cable Manufacture Technology, China.* Ultra-wideband mode selective couplers satisfying strict phase-matching conditions across S+C+L bands for mode multiplexing/demultiplexing of a 4-LP-mode FMF are designed and fabricated with side-polishing processing, based on which weakly-coupled FMF transmission is experimentally demonstrated.

M2E.6 • 12:15 ★ Top-Scored

Characterization of Ten-Mode EDFA Using Swept Wavelength Interferometer and Digital Holography, Yetian Huang[1,2], Hanzi Huang[1], Yan Wu[1], Haoshuo Chen[2], Jianxiang Wen[1], Lauren Dallachiesa[2], Nicolas K. Fontaine[2], Cheng Guo[2], Mikael Mazur[2], Rene Essiambre[2], Yingxiong Song[1], Tingyun Wang[1], Roland Ryf[2]; [1]*Shanghai Univ., China;* [2]*Nokia Bell Labs, USA.* We characterize the spatially and spectrally resolved gain profiles of a ten-mode EDFA over C+L band via Rayleigh backscattering measured by a coherent swept wavelength interferometer. Wavelength-dependent mode-dependent gain is characterized employing digital holography.

Room 6D

M2F • Sub-Millimeter Wave and THz Communication—Continued

M2F.6 • 12:00

Expanded Gain-Switched Comb Source for 180 – 260 GHz Sub-THz Analog Radio-Over-Fiber 6G Wireless System, Amol Delmade[1], Cristian Vargas[2], Alison Kearney[2,1], Simon Nellen[3], Robert B. Kohlhaas[3], Martin Schell[3], David Coffey[2], Frank Smyth[2], Liam P. Barry[1]; [1]*Dublin City Univ., Ireland;* [2]*Pilot Photonics Pvt., Ireland;* [3]*Fraunhofer Inst. for Telecommunications, Heinrich Hertz Inst. (HHI), Germany.* We demonstrate the successful generation and transmission of low-subcarrier spacing (up to 500 kHz) 6G compatible sub-THz OFDM signals in the 180 to 260 GHz frequency band using an expanded gain-switched laser comb source and waveguide-integrated photodiode antenna.

M2F.7 • 12:15

Dual Band Wireless Transmission Over 75-150GHz Millimeter Wave Carriers Using Frequency-Locked Laser Pairs, Zichuan Zhou[1], Amany Kassem[1], James Seddon[1], Eric Sillekens[1], Izzat Darwazeh[1], Polina Bayvel[1], Zhixin Liu[1]; [1]*Univ. College London, UK.* We generate and transmit 75-GHz-bandwidth OFDM signals over the air using three mutually frequency-locked lasers, achieving minimal frequency gap between the wireless W and D bands using optical-assisted approaches, resulting in 173.5 Gb/s detected capacity.

12:30–14:00 Lunch Break *(on own)*

13:30–16:30 SC114, SC217, SC261, SC447, SC485, SC526 (new), SC528 (new)

13:30–17:30 SC325, SC327, SC347, SC357, SC384, SC431, SC451, SC453

Room 6E

M2G • Photonic Switched Data Center Networks—Continued

M2G.6 • 12:00 Invited

Performance of Radix Sort Using All-to-all Optical Interconnection Network in an Eight-FPGA Cluster, Kenji Mizutani[1,2], Yutaka Urino[2], Takanori Shimizu[2], Hiroshi Yamaguchi[2], Shigeru Nakamura[2], Tatsuya Usuki[1], Kiyo Ishii[1], Ryosuke Matsumoto[1], Takashi Inoue[1], Shu Namiki[1], Michihiro Koibuchi[3]; [1]*AIST, Japan;* [2]*PETRA, Japan;* [3]*NII, Japan.* This paper presents a high-throughput dataflow processing using all-to-all communication with eight FPGAs. We demonstrated a parallel radix sorting throughput of 37.2 GB/s for 32-bit key range and 16-GiB data size.

Room 6F

M2H • High-Speed Transceivers and Transmission—Continued

M2H.6 • 12:00 Invited

Recent Advances in High Symbol-Rate Transceivers, Sebastian Randel[1]; [1]*Karlsruher Institut für Technologie, Germany.* We discuss how the efficiency of optical transceivers in terms of cost and energy per bit can be further scaled by increasing the symbol rate. We address challenges and review alternatives like multi-wavelength transceivers and analog multiplexing.

Room 7

M2I • Panel: The Role of Digital Twins in Optical Networking—Continued

Room 8

M2J • Quantum Protocols, Simulations and Analysis—Continued

M2J.6 • 12:00 Invited

Quantum Simulations Using Single-Photon Quantum Walks, Peng Xue[1]; [1]*Southeast Univ. (China), China.* A quantum walk is the generalization of a classical random walk in the quantum world. One of the most popular applications of quantum walks is quantum simulations. In the past, the research on quantum walking focused on the unitary evolution of quantum systems. In this talk, we provide a detailed proposal of non-Hermitian quantum walks, in which we characterize and demonstrate the non-Hermitian skin effect and non-Hermitian bulk-boundary correspondence.

Room 9

M2K • Distributed Sensing II—Continued

M2K.7 • 12:00 Invited

Applications of Functional Nanomaterials in Sensing and Fiber Optics Devices, Devanarayanan Meena Narayana Menon[1], Alberto Rovera[1], Davide Janner[1]; [1]*Politecnico di Torino - DISAT, Italy.* Nanomaterials in different forms revolutionized sensing and opened new perspectives for fiber-optics devices. We will cover the most recent advancements in fiber optics devices based on thin-films, 2D/nanostructured materials, and the relative optical interrogation/usage scheme.

12:30–14:00 Lunch Break *(on own)*

13:30–16:30 SC114, SC217, SC261, SC447, SC485, SC526 (new), SC528 (new)

13:30–17:30 SC325, SC327, SC347, SC357, SC384, SC431, SC451, SC453

Room 1A

14:00–16:00
M3A • Hybrid Integration and Packaging
Presider: Li Yang; Suzhou Dawning Semi Technology Co., Ltd., China

M3A.1 • 14:00
High-Power Micro-Ring Modulator and Multi-Channel Coupled Ring Resonator for WDM Design on a 300-mm Monolithic Foundry Platform, Qidi Liu[1], Abdelsalam Aboketaf[1]; [1]*GlobalFoundries, USA.* We present scaled, bidirectional silicon photonic ring modulator and multi-channel coupled ring resonator models, offering advanced simulation capabilities for high-power and thermal time constant analysis, facilitating comprehensive on-chip EO system design with GlobalFoundries PDK.

M3A.2 • 14:15
304 Channel MicroLED Based CMOS Transceiver IC with Aggregate 1 Tbps and sub-pJ per bit Capability, Bardia Pezeshki[1], Suresh Rangarajan[1], Alex Tselikov[1], Emad Afifi[1], Ivan Huang[1], Jeff Pepper[1], Sarah Zou[1], Howard Rourke[1], Rowan Pocock[1], Alasdair Fikouras[1], Farzad Khoeini[1], Vahid Mirkhani[1], Steve Novak[1], Rob Kalman[1]; [1]*Avicena Tech Corp, USA.* 1Tbps 16nm-CMOS transceiver IC with microLED array-based transmitter and hybrid silicon detector array runs at about 1pJ/bit using 304 channels at 3.3Gbps per lane. Initial results are shown for single lane and in various configurations.

Room 1B

14:00–16:00
M3B • SDM Devices and Mode Manipulation
Presider: Stefano Camatel; Finisar Corporation, Australia

M3B.1 • 14:00 Tutorial
Photonic Lanterns, 3-D Waveguides, Multiplane Light Conversion, and Other Components That Enable Space-Division Multiplexing, Nicolas K. Fontaine[1]; [1]*Nokia Bell Labs, USA.* These three spatial mode multiplexing devices have demonstrated capability to combine over 1000 spatial separated beams into spatially overlapped modes with sub dB losses and capability towards mass production. This tutorial will compare the strengths and weaknesses of each device and highlight some of the hero transmission experiments they have enabled.

Nicolas K. Fontaine received the Ph.D. degree from the University of California, Davis, CA, USA, in 2010. Since 2011, he has been at Bell Laboratories in NJ, USA. He is an avid jazz pianist and enjoys hiking or skiing through the mountains wherever he can find them (certainly not in NJ).

Room 2

14:00–16:00
M3C • Quantum Dots Lasers and Comb Generation
Presider: Hai-Feng Liu; HG Genuine Optics Tech Co Ltd, USA

M3C.1 • 14:00 Invited
Uncooled O-Band InAs/GaAs Quantum Dot Photonics Platform for Optical Communications, Alexey Kovsh[1]; [1]*Alfalume Inc., USA.* The progress in SiPh and other light modulation technologies helped to revive CW InAs/GaAs QD lasers. It positions GaAs tech as an alternative to traditional InP material system, bringing various advantages which will be discussed.

Room 3

14:00–16:00
M3D • Frontiers of Optical Network Architecture Summit
Presider: Vincent Chan; Massachusetts Inst. of Technology, USA and Jun Shan Wey; Verizon Communications Inc, USA

M3D.1 • 14:00 Invited
The Future of Optical Networking in Service Provider Networks: Defined by External Factors, Ori Gerstel[1]; [1]*Cisco - Israel, Israel.* The evolution of optical networking in service providers was fueled by technology achievements, such as coherent transmission and ROADM advancements. Its future is likely to be defined by factors that are outside the SP optical networking domain: collaboration of optical networks and routers will fundamentally change how optical networks are built and operated, sophisticated software control systems and webscale applications driving the roadmap for optical components and network architectures.

M3D.2 • 14:20 Invited
An Operator's View on the Future Optical Networks, and Enabling Device Technologies: ~Innovative Optical and Wireless Network Program~, Masahito Tomizawa[1]; [1]*NTT Innovative Devices, Japan.* In this presentation, future vision of optical networks is discussed from the viewpoint of service requirements from operators, demanding higher capacity & quality, and lower latency & power consumption. Also enabling device technologies are introduced, where photonics and electronics convergence (PEC) is focused. This presentation is in conjunction with Innovative Optical and Wireless Networks (IOWN) program.

Room 6C

14:00–16:00
M3E • Coherent and Direct Detect Datacenter Transmission
Presider: Jeffrey Rahn; Meta Platforms Inc, USA

M3E.1 • 14:00
Bidirectional 100G-PAM4 Transceiver for 60-km O-Band Transmission, Fabio Bottoni[1], Alessandro Cavaciuti[1], Dirk Lutz[2]; [1]*Cisco Photonics Italy Srl, Italy;* [2]*Eoptolink, China.* We experimentally demonstrate a real-time 100G PAM4 bidirectional optical transceiver suitable for 60km links (ER+). The transceiver design is based on a O-Band EML, commercial DSP and do not use any kind of optical amplifiers.

M3E.2 • 14:15
8.5 Tbps Net SiP O-Band Coherent Transmission Over 10 km Using a Quantum-Dot Mode-Locked Comb Laser, Santiago Bernal[1], Mario Dumont[2], Essam Berikaa[1], Charles St-Arnault[1], Yixiang Hu[1], Ramon Gutierrez-Castrejon[1,3], Zixian Wei[1], Antonio D'Errico[4], Alessandra Bigongiari[4], Luca Giorgi[4], Stefano Stracca[4], Robert Brunner[4], Stephane Lessard[5], Fabio Cavaliere[4], John Bowers[2], David V. Plant[1]; [1]*McGill Univ., Canada;* [2]*Department of Electrical and Computer Engineering, Univ. of California Santa Barbara, USA;* [3]*Inst. of Engineering, Universidad Nacional Autónoma de México UNAM, Mexico;* [4]*Ericsson, Italy;* [5]*Ericsson, Canada.* We report the first O-band coherent transmission using a comb laser and a silicon photonics modulator. We achieved greater than 8.5 Tbps using 19 lines over 10km at 56 Gbaud DP-32QAM.

Room 6D

14:00–16:00
M3F • Radio-Over-Fiber and 6G Access
Presider: Chi-Wai Chow; National Yang Ming Chiao Tung University, Taiwan

M3F.1 • 14:00 Tutorial
Past and Future Development of Radio Over Fiber, Christina Lim[1], Ampalavanapillai Nirmalathas[1], Chathurika Ranaweera[2], Tingting Song[1], Yijie Tao[1], Sampath Edirisinghe[3]; [1]*Univ. of Melbourne, Australia;* [2]*Deakin Univ., Australia;* [3]*Univ. of Sri Jayewardenepura, Sri Lanka.* This tutorial provides an overview of Radio-over-Fiber technology focussing on the development, evolution, and challenges on the physical layer implementation incorporating photonic transport of mm-wave to THz wireless signals.

Christina Lim is a Professor at the University of Melbourne Australia and the Research Group Leader for the Photonics and Electronics Research Group in the department. She was an elected member of the IEEE Photonics Society Board of Governors (2015-2017), an Optica and IEEE Fellow. Currently she is the Deputy Editor for IEEE/Optical Journal of Lightwave Technology.

Room 6E

14:00–16:00
M3G • Panel: The Road Towards 3.2 Tb/s Intra-Data Center Communications

Organizers
Juthika Basak, *Nokia Corp., USA*
James Chien, *Marvell, USA*
Stephan Pachnicke, *Christian-Albrechts Universität zu Kiel, Germany*

Speakers
Andreas Bechtolsheim, *Arista, USA*
Ben Lee, *NVIDIA, USA*
Xiang Liu, *Huawei, China*
Radha Nagarajan, *Marvell Technology, USA*
Yawei Yin, *Microsoft, USA*

The bandwidth demands of hyperscale data center operators have been increasing tremendously over the last years. First prototypes of 1.6 Tb/s (8 channel, 200 Gb/lambda) modules have been demonstrated recently. As the explosive bandwidth demands driven by new applications such as (generative) artificial intelligence (AI) show no sign of stopping, this panel aims to highlight the requirements for next generation 1.6 Tb/s and beyond connectivity, i.e. aiming at 3.2 Tb/s, from the data center operators' perspective. Also, it shall provide clarity on the desired module specifications by discussing recent advances in electronic and especially photonic integration.

Topics will include the following questions:

- What are the needs of hyperscale data center operators in cloud and AI infrastructure?
- How much parallelism (number of wavelengths, spatial channels) do we need?
- What are ultimate and practical limits of symbol and per lambda rates?
- How will nonlinear crosstalk and residual CD be solved?
- What power consumption per module can be handled?

This panel will comprise experts from hyperscalers, switch and module vendors as well as chip suppliers sharing their views on next generation intra-data center networks. Interaction between speakers and audience through Q&A is highly encouraged in a controverse panel discussion.

Room 6F

14:00–16:00
M3H • Advancement in Quantum Key Distribution Systems I
Presider: Tobias Gehring; Technical University of Denmark, Denmark

M3H.1 • 14:00 ★ Top-Scored
Wavelength-Versatile Quantum Key Distribution for Reconfigurable Classical-Quantum Networks, Robert I. Woodward[1], Benjamin Griffiths[1], Yuen San Lo[1], James Dynes[1], Andrew Shields[1]; [†]*Toshiba Europe Ltd., UK.* We report a high-speed GHz-clocked quantum key distribution (QKD) system, tunable over 65 nm using a novel injection-locked laser design. This paves the way to automatic optimsation of quantum channels in hybrid classical-quantum networks.

M3H.2 • 14:15 Tutorial
Recent Advances in Measurement-Device-Independent Quantum Key Distribution, Xiongfeng Ma[1]; [†]*Tsinghua Univ., China.* Measurement-device-independent quantum key distribution enhances the implementation security. In this tutorial talk, I shall review its security proof and various optical implementations, highlighting the twin-field and mode-pairing schemes that offer quadratic key-rate improvement.

Xiongfeng Ma earned his B.Sc. degree from Peking University in 2003 and a Ph.D. from the University of Toronto in 2008. Currently, he is a Changjiang Distinguished Professor at Tsinghua University and an APS fellow. Xiongfeng's primary research interest lies in quantum information science, particularly in quantum cryptography, quantum computing, and quantum foundation.

Room 7

14:00–16:00
M3I • Transmission Optimization
Presider: Fatima Garcia Gunning; Tyndall National Inst., Ireland

M3I.1 • 14:00
Closed-Form Coherent Gaussian Noise Model Applicable to Arbitrary Flexible Grid and Heterogeneous Links, Fangyuan Zhang[1], Alex W. MacKay[1]; [†]*Ciena Corporation, Canada.* A closed-form expression of the coherent contribution of Gaussian noise nonlinear interference is presented. This model shows good agreement with a complete Gaussian noise model and a split-step model and applies in arbitrary link configurations.

M3I.2 • 14:15
Recalibration Learning: Enabling Universal Transfer of ML Model of Gain and NF for Remote Optically Pumped Amplifiers, Arthur Minakhmetov[1], Benjamin Prieur[1], Maël Le Monnier[1], Delphine Rouvillain[1], Bruno Lavigne[1]; [†]*Alcatel Submarine Networks, France.* We demonstrate a novel, physical assumptions-based method – recalibration learning, that transfers Gain and Noise Figure ML models across remote optically pumped amplifiers. Spectral measurements over just two configurations on a target device ensure reliable transfer.

Room 8

14:00–16:00
M3J • Hollow-Core Fibers
Presider: Jose Antonio-Lopez; Univ. of Central Florida, CREOL, USA

M3J.1 • 14:00 ★ Top-Scored
10.9km Hollow Core Double Nested Antiresonant Nodeless Fiber (DNANF) with 0.33dB/km Loss at 850nm, Abubakr Isa Adamu[1], Muhammad Rosdi Bin Abu Hassan[1], Yong Chen[1], Eric Numkam Fokoua[1], Marcelo Alonso[1], Hesham Sakr[1], Francesco Poletti[1], David J. Richardson[1], Marco Petrovich[1]; [†]*Microsoft Corp, UK.* We report a double-nested antiresonant hollow core fiber designed for ~850nm operation. The measured fiber loss is 0.33dB/km at 850nm across a single span of 10.9km.

M3J.2 • 14:15
First Penalty-Free Real-Time Co-Frequency Co-Time Full-Duplex Optical Fiber Transmission with 202.1Tb/s Net Capacity Enabled by Hollow-Core 5-Element NANF, Dawei Ge[1], Yifan Xiong[2], Yan Wu[3], Yizhi Sun[2], Yancai Luan[3], Dong Wang[1], Shoufei Gao[2], Dechao Zhang[1], Liang Mei[3], Yingying Wang[2], Wei Ding[2], Han Li[1], Zhangyuan Chen[4]; [1]*China Mobile Research Inst., China;* [2]*Jinan Univ., China;* [3]*Fiberhome Telecommunication Technologies Co., LTD, China;* [4]*Peking Univ., China.* By leveraging extremely-low distributed Rayleigh backscattering in AR-HCF, we report the first real-time 202.1-Tb/s co-frequency co-time full-duplex transmission over a 466-m 5-element NANF based on ultra-wide 12-THz C+L-band EDFAs, exhibiting identical performance to unidirectional transmission.

Room 9

14:00–16:00
M3K • Emerging Modulator Technologies
Presider: Omer Khayam; Google LLC, USA

M3K.1 • 14:00 Invited
Silicon-Organic Hybrid (SOH) Integration - From Lab to Fab, Christian Koos[2,1], Wolfgang Freude[2], Sebastian Randel[2], Stefan Bräse[2], Peter Erk[2,1], Carsten Eschenbaum[2,1], Artem Kuzmin[2], Adrian Mertens[1], Adrian Schwarzenberger[2], Hend Kholeif[2], Alexander Kotz[2], Sidra Sarwar[2], Stefan Singer[2]; [†]*SiOriX, Germany;* [2]*Karlsruhe Inst. of Technology (KIT), Germany.* Silicon-organic hybrid (SOH) integration can complement intrinsically scalable silicon photonic circuits by novel functionalities, obtained through theory-guided material engineering. This presentation will give an overview of our recent progress in exploring the potential of the SOH platform and in bringing the technology from laboratory demonstrations to industrial applications.

Room 1A

M3A • Hybrid Integration and Packaging—Continued

M3A.3 • 14:30
Dust Insensitive, Low Loss, and Low Mating Force Multi-Fiber Expanded Beam Optical Ferrule and Connectors, Changbao Ma[1]; [1]*3M Company, USA.* A new, multi-fiber, expanded beam optical ferrule, with state-of-the-art IL<0.7 dB (typical 0.34 dB), RL>55 dB for single mode (1310 nm), and IL<0.3 dB (typical 0.14 dB), RL>40 dB for multimode (850 nm), is reported.

M3A.4 • 14:45 Invited
Photonics for Fault-Tolerant Quantum Computing, Mark G. Thompson[1]; [1]*PsiQuantum, USA.* Abstract not available.

Room 1B

M3B • SDM Devices and Mode Manipulation—Continued

M3B.2 • 15:00 ★ Top-Scored
Towards Tbps Single-λ Interconnect by a Multimode Integrated Optical I/O on Silicon for Few-Mode Fibers, Hao Chen[1], Wu Zhou[1], Yeyu Tong[1]; [1]*Microelectronics, The Hong Kong Univ. of Science and Technology (Guangzhou), China.* A six-channel multimode integrated optical I/O supporting two orthogonal polarizations of LP_{01}, LP_{11a}, and LP_{11b} modes in a few-mode fiber was experimentally demonstrated, showing chip-to-fiber coupling efficiencies > –6.1dB for future Tbps-per-wavelength optical interconnects.

Room 2

M3C • Quantum Dots Lasers and Comb Generation—Continued

M3C.2 • 14:30 ★ Top-Scored
Feedback Tolerant Quantum Dot Lasers Integrated with 300mm Silicon Photonics, Duanni Huang[1], Shane Yerkes[1], Guan-Lin Su[1], Karan Mehta[1], Marcus Cramer[1], William O'Brien[1], Razi Dehghannasiri[1], Stan Dobek[1], Chelsea Mackos[1], Timothy Ward[1], Pari Patel[1], Ranjeet Kumar[1], Songtao Liu[1], Xinru Wu[1], Xiaoxi Wang[1], Junyi Gao[1], Mark Isenberger[1], Harel Frish[1], Haisheng Rong[1]; [1]*Intel Corporation, USA.* We demonstrate the first quantum dot lasers integrated with 300mm silicon photonics. The measured devices show a linewidth enhancement factor near zero and are resilient to optical feedback up to -16dB of back reflection.

M3C.3 • 14:45
Tbps IM/DD Transmission Over 10 km SMF with O-Band Quantum Dot Laser Comb for DCIs, Lakshmi Narayanan Venkatasubramani[1], Ahmed Galib Reza[1], Anil R. Gautam[1], Haixuan Xu[2], Mikhail Buyalo[3], Alexey E. Gubenko[3], Yonglin Yu[2], Liam P. Barry[1]; [1]*Dublin City Univ., Ireland;* [2]*Wuhan National Laboratory for Optoelectronics, Huazhong Univ. of Science and Technology, China;* [3]*Innolume GmbH, Germany.* We report a record-high Tbps DWDM transmission over 10km using a packaged 1.3 μm InAs/InGaAs quantum dot comb laser. The BER below the HD-FEC level is achieved for 1.4 Tbps PAM4 and 1 Tbps PS-PAM8 transmissions.

M3C.4 • 15:00
Low Threshold and 10kHz-Class Narrow Linewidth 1.55 um-Band Quantum Dot Laser Diode on InP(311)B Substrate, Atsushi Matsumoto[1], Ryota Yabuki[2], Shinya Nakajima[1], Toshimasa Umezawa[1], Siim Heinsalu[2], Yuichi Matsushima[2], Kouichi Akahane[1], Naokatsu Yamamoto[1], Katsuyuki Utaka[2]; [1]*National Inst of Information & Comm Tech, Japan;* [2]*Waseda Univ., Japan.* We demonstrated low threshold current of 8.8 mA and 15.0 mA in pulsed and CW operation, and the extremely narrow linewidth of 12.2 kHz at room temperature in a fabricated 1.55 μm-band QD-DFB-LD.

Room 3

M3D • Frontiers of Optical Network Architecture Summit—Continued

M3D.3 • 14:40 Invited
Next-Generation Optical Devices for Future Network, Hiromi Oohashi[1]; [1]*Furukawa Electric Co., LTD, Japan.* To achieve the next-generation network architecture, we'll introduce the development of some key optical components, especially light sources and transmission fibers, to expand the possibility of increasing transmission capacity and reducing power consumption.

M3D.4 • 15:00 Invited
Reconfigurable Photonics and Flexible AI Systems, Gregory Steinbrecher[1]; [1]*Meta Platforms Inc, USA.* As AI systems evolve, the distinction between the scale-out network connecting nodes and the scale-up interconnect inside is being lost. How can optical interconnects help best leverage the ever-more-expensive components inside and outside a node?

Room 6C

M3E • Coherent and Direct Detect Datacenter Transmission—Continued

M3E.3 • 14:30 Invited
Technologies Enabling Ultrafast Short-Reach Transmission, Qian Hu[1]; [1]*Nokia Bell Labs, USA.* This paper reviews technologies for ultrahigh symbol rate transmission in short-reach optical links, including high-speed signal generation and sampling, broadband optical signal modulation, as well as advanced digital signal processing.

M3E.4 • 15:00
Experimental Demonstration of Amplifier-Less 82GBaud PAM4 Transmission Over 40 km Using APD at O Band, Haiqiang Wei[1], Kemo Ran[2], Kang Ping Zhong[1], Alan P. Lau[1], Changyuan Yu[1], Chao Lu[1]; [1]*Hong Kong Polytechnic Univ., China;* [2]*MACOM Technology Inc, China.* We experimentally demonstrated an amplifier-less transmission of a record high 82Gbaud PAM4 signal over 40km using O-band APD with a receiver sensitivity of -15.8dBm.

Room 6D

M3F • Radio-Over-Fiber and 6G Access—Continued

M3F.2 • 15:00 Invited
VCSEL-Based Optical Wireless Transmission: New Research Prospects, Ernesto Ciaramella[1], Giulio Cossu[1], Lorenzo Gilli[1]; [1]*Scuola Superiore Sant'Anna di Pisa, Italy.* The fundamental features of VCSELs make them very suitable for various types of optical wireless communications, especially over short links. We present a range of promising applications for these devices in new OWC areas.

Room 6E

M3G • Panel: The Road Towards 3.2 Tb/s Intra-Data Center Communications—Continued

Room 6F

M3H • Advancement in Quantum Key Distribution Systems I—Continued

Room 7

M3I • Transmission Optimization—Continued

M3I.3 • 14:30 Invited

Optical Network Design with High Symbol Rate Flexible Coherent Transceivers, Thomas Richter[2], Steven Searcy[2], Philippe Jennevé[1], Valeria Arlunno[1], Sorin Tibuleac[2]; [1]*Cisco Systems Inc, USA;* [2]*Adtran Networks North America, USA*. We highlight commercial flexible coherent transceivers, including their features and capabilities for optical networks, and present the versatility of a 140-GBd transceiver in typical optical link configurations from short reach to subsea.

M3I.4 • 15:00

Monitoring Data Augmentation of Spectral Information Using VAE and GAN for Soft-Failure Identification, Lars E. Kruse[1], Sebastian Kühl[1], Annika Dochhan[1], Stephan Pachnicke[1]; [1]*Christian-Albrechts-Universität zu Kiel, Germany*. We propose data augmentation of monitoring information using VAE and GAN to reduce the amount of required soft-failure training data. Results show that only 5 samples per failure type are needed for F1-scores above 0.9.

Room 8

M3J • Hollow-Core Fibers—Continued

M3J.3 • 14:30

Fast, Reliable and Portable Low-Loss Antiresonant Hollow-Core Fiber Fusion Splicing, Tristan Kremp[1], Yue Liang[2], Alan H. McCurdy[2], Shoichi Yoshinaga[2], Brian J. Mangan[1]; [1]*OFS Laboratories, USA;* [2]*OFS Fitel, LLC, USA*. Using a fully automated rotational alignment algorithm and a portable 3-electrode arc-discharging fusion splicer, we achieve median splice losses of 0.13 dB between antiresonant hollow-core fibers within 120 seconds with 100% success rate.

M3J.4 • 14:45 Invited

Non-Destructive Characterization of Hollow Core Fiber, Leonard Budd[1], Austin Taranta[1], Eric Numkam Fokoua[1], Francesco Poletti[1]; [1]*Univ. of Southampton, UK*. We summarize our recent work developing a technique for accurate and non-destructive measurement of the microstructure geometry of nested and double nested antiresonant fibers. We present results showing microstructure variation along a 2.2 km fiber.

Room 9

M3K • Emerging Modulator Technologies—Continued

M3K.2 • 14:30

High-Performance Thin-Film Lithium Niobate Mach-Zehnder Modulator on 8-Inch Silicon Substrate, Jingjie Zhou[1], Qingyu Cong[1], Liming Lv[2], Zhanshi Yao[3], Shiyang Zhu[3], Yuxi Wang[3], Zhaoyi Li[1], Zuowen Fan[1], Xianfeng Zeng[4], Ting Hu[1], Lianxi Jia[1,4]; [1]*School of Microelectronics, Shanghai Univ., China;* [2]*Shanghai Industrial μTechnology Research Inst., China;* [3]*Huawei Technologies, China;* [4]*Shanghai Inst. of Microsystem and Information Technology, Chinese Academy of Sciences, China*. We first report the thin-film lithium niobate (TFLN) electro-optic Mach-Zehnder modulator (MZM) on an 8-inch silicon substrate fabricated in the back-end-of-line (BEOL) of CMOS foundry. It operates at 1550 nm with electro-optical response of only 1.5 dB roll-off at 67 GHz.

M3K.3 • 14:45

High Efficiency Single-Sideband Modulator Using Coupled Bragg Grating Resonators on Thin-Film Lithium Niobate, Nuo Chen[1], Bo Xiong[1], Hengsong Yue[1], Kangping Lou[1], Tao Chu[1]; [1]*Zhejiang Univ., China*. We demonstrate an efficient single-sideband thin-film lithium niobate modulator with periodically cascaded Bragg gratings. The device achieves the highest modulation efficiency that has been reported (0.19 V/cm) with a compact phase-shifter length (542 μm).

M3K.4 • 15:00

Thin-Film Lithium Niobate Modulator for a Flat Frequency-Response Over 110 GHz Bandwidth with Integrated Electro-Optic Frequency-Domain Equalizer, Yuya Yamaguchi[1], Pham Tien Dat[1], Naokatsu Yamamoto[1], Kouichi Akahane[1], Atsushi Kanno[2,1], Tetsuya Kawanishi[3,1]; [1]*NICT, Japan;* [2]*Nagoya Inst. of Technology, Japan;* [3]*Waseda Univ., Japan*. We demonstrated an optical modulator with an ultra-flat frequency-response over 110 GHz by using a thin-film lithium niobate platform and the integration of an electro-optic frequency-domain equalizer. The half-wave voltage was 2.4 V, and we measured an extinction ratio exceeding 40 dB.

Room 1A

M3A • Hybrid Integration and Packaging—Continued

Room 1B

M3B • SDM Devices and Mode Manipulation—Continued

M3B.3 • 15:15
Ultra-Compact and Ultra-Broadband Mode (De)Multiplexer Utilizing an Asymmetrical Coupler with SWG and Cascaded Tapered Waveguide, Zakriya Mohammed[1], Bruna Paredes[2], Mahmoud Rasras[2]; [1]*Electrical and Computer Engineering, New York Univ.-Tandon School of Engineering, USA;* [2]*Electrical and Computer Engineering, New York Univ., United Arab Emirates.* A 25 µm two-mode (de)multiplexer on a silicon-on-insulator platform is demonstrated. Operating in 200 nm bandwidth, it achieves low insertion-loss (< 0.9 dB), minimal crosstalk (< 18.8 dB), and clear eye diagrams at 64 Gbit/s.

M3B.4 • 15:30 Invited
Multi-Dimensional Light Field Manipulation on Diverse Integrated Photonic Platforms, Jian Wang[1]; [1]*Wuhan National Laboratory for Optoelectronics, Huazhong Univ. of Science and Technology, China.* We review advances in multi-dimensional (frequency, time, complex amplitude, polarization, spatial structure) light field manipulation on diverse integrated photonic platforms (silicon, silica, polymer, III-V, metal, fiber). Silicon photonic integrated circuits, femtosecond laser direct writing 3D photonic chips, InP active photonic integrated devices, and metasurfaces for shaping light are demonstrated. Potential applications and future perspectives are discussed.

Room 2

M3C • Quantum Dots Lasers and Comb Generation—Continued

M3C.5 • 15:15
On-Chip InP/LiNbO3 Microcomb Laser, Zhengdong Gao[1], Jingwei Ling[1], Shixin Xue[1], Qili Hu[1], Kaibo Zhang[1], Usman Javid[1], Raymond Lopez-Rios[1], Jeremy Staffa[1], Qiang Lin[1]; [1]*Univ. of Rochester, USA.* We report a chip-scale InP/LiNbO3 laser that directly emits mode-locked microcomb on demand, with spectral bandwidth ~50 nm, individual comb linewidth ~600 Hz, frequency tuning rate > 2.4 × 1017 Hz/s, and 100% utilization of optical power for comb generation.

M3C.6 • 15:30
Silicon Carbide Soliton Microcmb Generation for Narrow-Grid Optical Communications, Jingwei Li[1], Haipeng Zhang[2], Ruixuan Wang[1], Zhensheng Jia[2], Qing Li[1]; [1]*Carnegie Mellon Univ., USA;* [2]*CabelLabs, USA.* We demonstrate efficient soliton microcomb generation in silicon carbide microresonators with a record-low on-chip pump power of 6.5 mW. The microcomb exhibits a near 100 GHz free spectral range, enabling its application in optical communications.

M3C.7 • 15:45 ★ Top-Scored
6.48 Tb/s Transmissions Using 50 GHz Integrated Lithium Niobate Flat-Top Electro-Optic Combs, Chuang Xu[1], Yikun Chen[2], Kangping Zhong[1], Ke Zhang[2], Chao Lu[1], Cheng Wang[2], Alan P. Lau[1]; [1]*The Hong Kong Polytechnic Univ., China;* [2]*City Univ. of Hong Kong, Hong Kong.* We demonstrate 6.48 Tb/s transmission using 50-GHz integrated lithium niobate flat-top electro-optic (EO) combs over a 53-km field-deployed link and show their flexibility in generating combs with variable frequency spacing and using multiple laser sources.

Room 3

M3D • Frontiers of Optical Network Architecture Summit—Continued

M3D.5 • 15:20 Invited
More Fiber, Less Equipment, Glenn Wellbrock[1], Tiejun J. Xia[1]; [1]*Verizon, USA.* Fiber will go even deeper into the network, but fewer and smaller boxes will be used as we continue to integrate connectivity with processing. This paper will provide examples at all layers of next gen networks.

Room 6C

M3E • Coherent and Direct Detect Datacenter Transmission—Continued

M3E.5 • 15:15 ★ Top-Scored
Performance Comparison of QD-SOA, QW-SOA, Bulk-SOA and PDFA for Multi-Tbps O-Band WDM Links, Charles St-Arnault[1], Santiago Bernal[1], Ramon Gutierrez-Castrejon[1,4], Essam Berikaa[1], Zixian Wei[1], Janina Rautert[2], Sergey V. Poltavtsev[2], Alexey E. Gubenko[2], Vasilii V. Belykh[2], Vladimir S. Mikhrin[2], Alexey Kovsh[3], David V. Plant[1]; [1]*McGill Univ., Canada;* [2]*Innolume GmbH, Germany;* [3]*Alfalume Inc., USA;* [4]*Inst. of Engineering, Univ. National Autonoma de México, Mexico.* We experimentally compare QD-SOA to QW-SOA, bulk-SOA, and PDFA for coherent and IM/DD in the O-band at 10 km. A 1.152 Tbps/λ WDM coherent transmission is achieved with the QD-SOA.

M3E.6 • 15:30 Invited
Design Tradeoffs for Coherent Pluggable Optics at 800G and Beyond, Eric S. Maniloff[1]; [1]*Ciena Corporation, Canada.* As coherent pluggable optics scale to 800Gb/s, new applications will be addressed. This paper provides an overview of these applications, and the details of how module implementations differ to address different applications' unique requirements.

Room 6D

M3F • Radio-Over-Fiber and 6G Access—Continued

M3F.3 • 15:30
First Demonstration of 4×4 Distributed MIMO Communication with 3GPP-Compliant 5G Smartphone Utilizing SCM/WDM-Based if-Over-Fiber MFH Link, Shinji Nimura[1], Kazuki Tanaka[1], Kamya Y. Yazdandoost[1], Ryo Inohara[1], Masatoshi Suzuki[1,2], Takehiro Tsuritani[1]; [1]*KDDI Research, Japan;* [2]*Department of Electronic and Physical Systems, Waseda Univ., Japan.* We successfully demonstrated the real-time bi-directional 5G-compliant 4×4 Distributed-MIMO communication for the first time utilizing SCM/WDM-based IF-over-Fiber mobile fronthaul link architecture and commercially available smartphone for realizing future antenna distribution mobile communication systems.

M3F.4 • 15:45
Mitigation of Dispersion-Induced Power Fading in Broadband Intermediate-Frequency-Over-Fiber Transmission Using Space-Time Block Coding, Jinwoo Park[1], Joungmoon Lee[1], Inho Ha[1], Sang-kook Han[1]; [1]*Yonsei Univ., Korea (the Republic of).* STBC with optical I-Q modulator for dispersion-induced power fading mitigation is proposed and experimentally demonstrated in broadband IFoF system. 9.5GHz bandwidth IFoF signal transmission with 8.5% EVM in fading-affected band of 50km transmission was demonstrated.

Room 6E

M3G • Panel: The Road Towards 3.2 Tb/s Intra-Data Center Communications—Continued

Room 6F

M3H • Advancement in Quantum Key Distribution Systems I—Continued

M3H.3 • 15:15
No-Guard-Band Integration of Digital Coherent CV-QKD System Into 400 Gbit/s 75 GHz Grid DWDM Systems, Tetsuo Kawakami[1]; [1]*NEC Corporation, Japan*. We demonstrated no-guard-band integration of a digital coherent Continuous-variable QKD system into OpenZR+-compliant DWDM transmission systems. The estimated secret key rate was 19.9 kbit/s over a 75 km EDFA amplified SMF link.

M3H.4 • 15:30
Composable Finite Size Key Generation in a Polarization Diverse Continuous Variable Quantum Key Distribution System, Hou-Man Chin[1], Ulrik L. Andersen[1], Tobias Gehring[1]; [1]*Technical Univ. of Denmark, Denmark*. We report on a polarization diverse continuous variable quantum key distribution system. Composable finite size key generation was assessed using 7.6×10^8 quantum states measured over 20 random states of polarization, secret key generation was achieved with 2×10^7 states.

M3H.5 • 15:45
Quantum Cryptography with Injection-Locked Dual-Wavelength Diode Laser, Yung-Hsuan Li[1], Szu-En Lai[1], Gong-Ru Lin[1,2]; [1]*National Taiwan Univ., Taiwan;* [2]*NTU-Tektronix Joint Research Center, Taiwan*. Master-to-slave injection-locked dual-mode diode laser is proposed for providing the single-photon DPS-QKD transmission at a shifted key rate of 1 Gbit/s with >3000-sec decoding stability under an interferometric visibility of 99.2% and dual-wavelength usage security.

Room 7

M3I • Transmission Optimization—Continued

M3I.5 • 15:15
Optical Line Physical Parameters Calibration in Presence of EDFA Total Power Monitors, Giacomo Borraccini[1], Yue-Kai Huang[1], Andrea D'Amico[1], Thomas Ferreira de Lima[1], Ezra Ip[1], Vittorio Curri[2], Ting Wang[1], Koji Asahi[3]; [1]*NEC Laboratories America Inc., USA;* [2]*Department of Electronics and Telecommunications, Politecnico di Torino, Italy;* [3]*1st Networks Solution Division, NEC Corporation, Japan*. A method is proposed in order to improve QoT-E by calibrating the physical model parameters of an optical link post-installation, using only total power monitors integrated into the EDFAs and an OSA at the receiver.

M3I.6 • 15:30
Spectrum Resolved SNR Monitoring of in-Service Channel, Qingyi Guo[1], Xuefeng Tang[1], Yang Lan[1], Zhiping Jiang[1]; [1]*Huawei Technologies Canada, Canada*. We propose and experimentally demonstrate a novel scheme to monitor the spectrum resolved SNR with receiver ADC buffer data. SNR accuracy of 0.2dB can be achieved, and filtering impact can be separated from link noise.

Room 8

M3J • Hollow-Core Fibers—Continued

M3J.5 • 15:15
Bend Insensitive Hollow Core DNANF with SMF-Matching Mode Field Diameter and 125µm Outer Diameter for Low Loss Direct Interconnection in Short Reach Applications, Ghafour A. Amouzad Mahdiraji[1], Jaroslaw Rzegocki[1], Ian Davidson[1], Gianluca Guerra[1], Gregory T. Jasion[1], Seyed Mohammad A. Mousavi[1], Yong-min Jung[1], Austin Taranta[1], Kyle Bottrill[1], Periklis Petropoulos[1], Francesco Poletti[1,2]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK;* [2]*Microsoft Azure Fiber, UK*. We present the first 125µm outer diameter hollow-core fibre with a 10.6µm mode-field diameter allowing direct low-loss splicing to G652 SMF. We demonstrate O-to-C-band transmission and bend-insensitive single-mode operation, attractive for low-latency sub-1km communications.

M3J.6 • 15:30 Invited
Fabrication Methods for Hollow Core Fibres, James M. Stone[1]; [1]*Univ. of Bath, UK*. I will present recent work on fabrication techniques for hollow core optical fibres.

Room 9

M3K • Emerging Modulator Technologies—Continued

M3K.5 • 15:15 ★ Top-Scored
256 GBd Barium-Titanate-on-SiN Mach-Zehnder Modulator, Manuel Kohli[1], Daniel Chelladurai[1], Laurenz Kulmer[1], Killian Keller[1], Yannik Horst[1], Tobias Blatter[1], Joel Winiger[1], David Moor[1], Tatiana Buriakova[2], Michael Zervas[2], Clarissa Convertino[3], Felix Eltes[3], Yuriy Fedoryshyn[1], Ueli Koch[1], Juerg Leuthold[1]; [1]*ETH Zurich, Switzerland;* [2]*Ligentec SA, Switzerland;* [3]*Lumiphase AG, Switzerland*. We demonstrate a 110-GHz BTO Mach-Zehnder modulator integrated on foundry-produced silicon nitride for 340 Gbit/s data links. This approach, featuring nano-scale plasmonics and highly nonlinear BTO, proves to be a viable platform for next-generation Tbit/s links.

M3K.6 • 15:30
Linear-Drive Amplifier-Less 112 Gbit/s PAM4 Operation of a Silicon-Organic Hybrid (SOH) Mach-Zehnder Modulator at 265 mV_{pp}, Adrian Schwarzenberger[4,1], Stefan Singer[4,1], Carsten Eschenbaum[4,1], Malte Martens[4,1], Adrian Mertens[1], Georges Dagher[2], Luca Valenziano[5], Sidra Sarwar[3], Hend Kholeif[4], Alexander Kotz[4], Thomas Zwick[5], Stefan Bräse[3], Wolfgang Freude[4], Sebastian Randel[4], Christian Koos[4,1]; [1]*Silorix GmbH, Germany;* [2]*Multilane Inc., Lebanon;* [3]*Inst. of Organic Chemistry (IOC), Karlsruhe Inst. of Technology (KIT), Germany;* [4]*Inst. of Photonics and Quantum Electronics (IPQ) and Inst. of Microstructure Technology (IMT), Karlsruhe Inst. of Technology (KIT), Germany;* [5]*Inst. of Radio Frequency Engineering and Electronics (IHE), Karlsruhe Inst. of Technology (KIT), Germany*. We demonstrate an optically packaged silicon-organic hybrid Mach-Zehnder modulator operating at PAM4 data rates of up to 112 Gbit/s. The device is directly driven by a CMOS SerDes chip without additional optical and RF amplifiers.

M3K.7 • 15:45
110 GHz Plasmonic Lithium Niobate Phase Modulator, Yilun Wang[1], Jihao Zhao[1], Xiaoyan Gao[1], Qiansheng Wang[2], Xi Xiao[2], Jian Cheng[1], Dingshan Gao[1], Wentao Gu[1], Wenchan Dong[1], Qizhi Yan[1], Liao Chen[1], Yu Yu[1], Chi Zhang[1], Xinliang Zhang[1]; [1]*Wuhan National Laboratory for Optoelectronics and School of Optical and Electronic Information, Huazhong Univ. of Science and Technology, China;* [2]*National Information Optoelectronics Innovation Center, China*. An ultra-compact lithium niobate phase modulator based on the plasmonic slot waveguide is demonstrated with a length of ~16 µm, featuring a bandwidth exceeding 110 GHz and a high-rate operation beyond 90 Gbaud.

Room 6B

14:00–16:00
M3Z • Demo Zone

M3Z.1
Demonstration of Cooperative Transport Interface Using Open-Source 5G Open-RAN and Virtualised PON Network, Frank Slyne[1], Kevin O'Sullivan[2], Merim Dzaferagic[1], Bruce Richardson[2], Marcin Wrzeszcz[2], Brendan Ryan[2], Niall Power[2], Robin Giller[2], Marco Ruffini[1]; *[1]Trinity College Dublin, Ireland; [2]Intel Corporation Ireland, Ireland.* We demonstrate a real-time, converged 5G-PON through the Cooperative Transport Interface, synchronising 5G and PON-DBA upstream schedulers. This innovative approach, implemented using 5G and PON open network implementations, significantly enhances network resource allocation, reducing latency.

M3Z.2
Demonstration of Robust Mobile Free Space Optical System Using High-Speed Beam Tracking and 2D-PDA-Based Spatial-Diversity Reception, Zu-Kai Weng[1], Yuki Yoshida[1], Toshimasa Umezawa[1], Abdelmoula Bekkali[2], Michikazu Hattori[2], Atsushi Matsumoto[1], Atsushi Kanno[3,1], Naokatsu Yamamoto[1], Tetsuya Kawanishi[4,1], Kouichi Akahane[1]; *[1]National Inst. of Information and Communications Technology, Japan; [2]Toyo Electric Corporation, Japan; [3]Nagoya Inst. of Technology, Japan; [4]Waseda Univ., Japan.* We show the first-ever live demonstration of a robust mobile free space optical system using three-stage high-speed beam tracking technology including 2-dimensional photodetector array based spatial diversity combining, which enables the mobility support in 6G.

M3Z.3
Live Demonstration of Autonomous Link-Capacity Adjustment in Optical Metro-Aggregation Networks, Mihail Balanici[1], Pooyan Safari[1], Behnam Shariati[1], Aydin Jafari[1], Johannes Fischer[1], Ronald Freund[1]; *[1]Fraunhofer HHI, Germany.* We demonstrate a real-time ML-assisted network automation pipeline for dynamic, autonomous link-capacity allocation based on traffic-flow forecasting for optical metro aggregation networks. Its performance is compared to that of a classic, static bandwidth provisioning scheme.

M3Z.4
Orchestration of Entanglement Distribution Over a Q-LAN Using the IEQNET Controller, Joaquin F. Chung Miranda[1], Anirudh Ramesh[1,2], Shariful Islam[1], Gregory S. Kanter[3], Cristian Pena[4], Si Xie[4], Raju Valivarthi[5], Neil Sinclair[5], Panagiotis Spentzouris[4], Maria Spiropulu[5], Prem Kumar[2], Raj Kettimuthu[1]; *[1]Argonne National Laboratory, USA; [2]Northwestern Univ., USA; [3]NuCrypt LLC, USA; [4]Fermilab, USA; [5]Caltech, USA.* We will demonstrate orchestration of entanglement distribution over a quantum local area network (Q-LAN) using a quantum network controller. Our controller enables multiple users to share a Q-LAN composed of commercial equipment for quantum communications.

M3Z.5
Real-Time Demonstration of Anomalous Vibrations Detection in a Metro-Like Environment Using a SOP-Based Algorithm, Saverio Pellegrini[1], Leonardo Minelli[1], Lorenzo Andrenacci[1], Dario Pilori[1], Gabriella Bosco[1], Benjamin Koch[2], Reinhold Noé[2], Claudio Crognale[3], Stefano Piciaccia[3], Roberto Gaudino[1]; *[1]Dipartimento di Elettronica e Telecomunicazioni, Politecnico di Torino, Italy; [2]Novoptel GmbH, Germany; [3]CISCO Photonics, Italy.* We demonstrate the real-time applicability of SOP-based anomalous vibrations detection. The proposed demo will engage the audience by showing the time evolution of two proposed metrics, with user-set parameters and different fiber-induced mechanical vibrations.

M3Z.6
Quantum-Assisted Digital Signature in an SDN-Controlled Optical Network, Alessio Giorgetti[2], Nicola Andriolli[2], Elisabetta Storelli[6], Marco Ferrari[2], Gennaro Paduanelli[6], Antonino Cacicia[7], Alberto Tarable[2], Rudi P. Paganelli[2], Emilio Paolini[3], Giada Sajeva[7], Marco Brunero[4], Alessandro Gagliano[1], Paolo Martelli[1], Pietro Noviello[6], Giovanni Schmid[5], Alberto Gatto[1]; *[1]Politecnico di Milano - DEIB, Italy; [2]IEIIT, Consiglio Nazionale delle Ricerche - CNR, Italy; [3]Scuola Superiore Sant'Anna - SSSA, Italy; [4]Cohaerentia SRL, Italy; [5]ICAR, Consiglio Nazionale delle Ricerche - CNR, Italy; [6]Exprivia SPA, Italy; [7]Demetrix SRL, Italy.* This demo presents a quantum-assisted digital signature protocol implementation exploiting Quantum Key Distribution devices and Software Defined Networking (SDN) control. The demonstration shows an innovative practical employment of quantum technology in real-world scenarios.

M3Z.7
Quantum Key Management System with Dynamic Routing for Meshed QKD Networks, Mario Wenning[1,2], Jonas Berl[1,3], Tobias Fehenberger[1], Ciarán Mullan[1], Helmut Grießer[1], Piotr Rydlichowski[4], Laurent Schmalen[3], Carmen Mas-Machuca[2,5]; *[1]Adva Network Security GmbH, Germany; [2]Chair of Communication Networks, Technical Univ. of Munich, Germany; [3]Communications Engineering Lab, Karlsruhe Inst. of Technology, Germany; [4]Poznan Supercomputing and Networking Center, Poland; [5]Chair of Communication Networks, Univ. of the Bundeswehr Munich, Germany.* For an emulated QKD network, a decentralized key management system is automatically deployed as VNF. We show that dynamic key re-routing overcomes failures in the key distribution layer of meshed QKD-secured OTNs under realistic conditions.

M3Z.8
Deployment of Secure Machine Learning Pipelines for Near-Real-Time Control of 6G Network Services, Pol Gonzalez[1], Adam Zahir[2], Chiara Grasselli[3], Alejandro Muñiz[4], Milan Groshev[2], Sima Barzegar[1], Franco Callegati[3], Davide Careglio[1], Marc Ruiz[1], Luis Velasco[1]; *[1]Universitat Politecnica de Catalunya, Spain; [2]Universidad Carlos III, Spain; [3]Univ. of Bologna, Italy; [4]Telefonica I+D, Spain.* A ML function orchestrator deploying secure ML pipelines to support near-real-time control of network services is demonstrated. A distributed ledger supports the initial key exchange to establish secure connectivity among the agents in the pipeline.

M3Z.9
TAPI-Based Telemetry Streaming in Multi-Domain Optical Transport Network, Vignesh Karunakaran[1,2], Carlos Natalino[3], Behnam Shariati[4], Piotr Lechowicz[3], Johannes Fischer[4], Achim Autenrieth[1], Paolo Monti[3], Thomas Bauschert[2]; *[1]Adtran Networks SE, Germany; [2]Chair of Communication Networks, TU Chemnitz, Germany; [3]Department of Electrical Engineering, Chalmers Univ. of Technology, Sweden; [4]Fraunhofer HHI, Germany.* We demonstrate a TAPI-based telemetry streaming framework for automated service provisioning and monitoring in multi-domain optical networks. The demo showcases ML-based anomaly detection and network management across domains adhering to recommended YANG and protocol standards.

M3Z.10
Demonstration of a Compositional Learning Framework for Open and Disaggregated Optical Network Control, Huy Q. Tran[1], Javier Errea[1], Trung H. Thieu[1], Quan Pham Van[1], Nakjung Choi[1], Dominique Verchere[1], Adlen Ksentini[2], Djamal Zeghlache[3]; *[1]Nokia Bell Labs, USA; [2]EURECOM Research Inst., France; [3]Institut Polytechnique de Paris, France.* We introduce an automated Compositional Learning Framework, which can dynamically combine ML models to create a composite ML service. It leverages the MLOps principle to streamline drift-aware ML workflows. We showcase its applicability in a dynamic Routing Modulation and Spectrum Allocation scenario with the open disaggregated control platform.

M3Z.11
Artificial Intelligence (AI)-Powered Robot for Optical Network Operation Automation, Xiaonan Xu[1], Haoshuo Chen[1], Michael Scheutzow[1], Jesse E. Simsarian[1], Roland Ryf[1], Gin Qua[1], Amey Hande[1], Rob Dinoff[1], Mijail Szczerban[1], Mikael Mazur[1], Lauren Dallachiesa[1], Nicolas K. Fontaine[1], Jim Sandoz[1], Mike Coss[1], David Neilson[1]; *[1]Nokia Bell Labs, USA.* We demonstrate an artificial intelligence (AI)-powered robot for optical network operation automation and showcase three demos: 1) robot-driven event classification, 2) modified LC duplex connector for robotic operation, and 3) AI inference acceleration using an FPGA.

M3Z.12
Distributed Multi-Agent System fed with Telemetry Data for Near-Real-Time Service Operation, Pol Gonzalez[1], Faris Alhamed[2], Sima Barzegar[1], Francesco Paolucci[3], Juan José Vegas Olmos[4], Marc Ruiz[1], Luis Velasco[1]; *[1]Universitat Politecnica de Catalunya, Spain; [2]Scuola Superiore Sant'Anna (SSSA), Italy; [3]CNIT, Italy; [4]NVIDIA, Denmark.* Near-real-time routing decisions on multiple flows will be demonstrated. Decision making is based on precise end-to-end delay telemetry processed by a P4 collector. Distribution of roles will exhibit reduced response times to provide multi-objective operation.

M3Z.13
Experimental Demonstration of Optical Encryption Using Quantum Keys: Two Scenarios, Morteza Ahmadian[1], Rafael Vicente[2], Juan Brito[2], Álvaro López-García[2], Antonio Pastor[3], Jose R. Moscoso[3], Jaume Comellas[1], Marc Ruiz[1], Vicente Martín[2], Luis Velasco[1]; *[1]Universitat Politecnica de Catalunya, Spain; [2]Universidad Politécnica de Madrid (UPM), Spain; [3]Telefonica I+D, Spain.* Optical encryption using Quantum keys retrieved from real QKD and QRNG systems will be demonstrated. Retrieved keys are expanded to the required bitrate and then used to encrypt the input bit stream at line speed.

16:00–16:30 Coffee Break *(Upper Level Corridors)*

NOTES

Room 1A

16:30–18:30
M4A • Silicon Photonics
Presider: Molly Piels; OpenLight, USA

M4A.1 • 16:30
AIM Photonics Design Enablement: a Design-Assembly-Test Platform Advancing the Silicon-Photonics Ecosystem, Amit Dikshit[1,2], Jin Wallner[1,2], Mohammad Jobayer Hossain[1,2], Mohammad Rakib Uddin[1,2], Javery Mann[1,2], Anthony Aiello[1,2], Lewis G. Carpenter[1,2], Yukta Timalsina[1,2], Colin McDonough[1,2], Nicholas Fahrenkopf[1,2], Gerald Leake Jr[1,2], Christopher Baiocco[1,2], Christopher Striemer[1,2], Maria Halepis[1,2], Daniel Coleman[1,2], Amir Begovic[3], Hao Yang[4], Michael Zylstra[4], Jerome Jahn[4], Jordan Goldstein[4], Christopher V. Poulton[4], Todd Stievater[5], Nathan Tyndall[5], Michael Fanto[6], David Harame[1,2]; [1]*AIM Photonics, USA;* [2]*Research Foundation SUNY, USA;* [3]*Rensselaer Polytechnic Inst., USA;* [4]*Analog Photonics, USA;* [5]*Naval Research Laboratory, USA;* [6]*Air Force Research Laboratory Information Directorate, USA.* AIM Photonics design enablement platforms supporting photonic integrated circuit design, interposer-based assembly, and design-for-test for a 300 mm CMOS-compatible silicon-photonics foundry are presented.

M4A.2 • 16:45 Invited
Optical Interconnects: Path to High Volume Manufacturing, Pooya Tadayon[1]; [1]*Intel, USA.* A fundamental challenge to be solved for widespread adoption of co-package photonics is a high-yielding and low-cost assembly process. In this talk, we will explore recent advances in this area, including Intel's glass-based optical bridge technology.

Room 1B

16:30–18:30
M4B • Integrated Devices for Sensing and Metrology
Presider: Kazuhiro Ikeda; AIST, Japan

M4B.1 • 16:30 Invited
Large-Scale Optical Phased Array Based on a Multi-Layer Silicon-Nitride-on-Silicon Photonic Platform, Liangjun Lu[1], Weihan Xu[1], Yuyao Guo[1], Chuxin Liu[1], Jianping Chen[1], Linjie Zhou[1]; [1]*Shanghai Jiao Tong Univ., China.* We review our recent progress on a chip-scale LiDAR transmitter on a multi-layer Si_3N_4-on-Si photonic platform. Experimental results show the high optical power budget of the chip and the feasibility for FMCW ranging.

Room 2

16:30–18:30
M4C • Machine Learning and Neural Networks
Presider: Bill Corcoran; Monash Univ., Australia

M4C.1 • 16:30
Experimental Demonstration of Imperfection-Agnostic Local Learning Rules on Photonic Neural Networks with Mach-Zehnder Interferometric Meshes, Luis Z. El Srouji[1], Mehmet Berkay On[1], Yun-Jhu Lee[1], Mahmoud Abdelghany[1], S. J. Ben Yoo[1]; [1]*Univ. of California, Davis, USA.* Mach-Zehnder Interferometric meshes are attractive for low-loss photonic matrix multiplication but are challenging to program. Using least-squares optimization of directional derivatives, we experimentally demonstrate that desired matrix updates can be implemented agnostic to hardware imperfections.

M4C.2 • 16:45
Neural Network with Optical Frequency-Coded ReLU, Margareta Vania Stephanie[1], Lam Pham[1], Alexander Schindler[1], Michael Waltl[2], Tibor Grasser[2], Bernhard Schrenk[1]; [1]*AIT Austrian Inst. of Technology, Austria;* [2]*TU Wien, Austria.* We demonstrate a photonic rectified linear unit (ReLU) function accomplished through frequency-coded neural signals. We show operation of an optical neuron with weighted sum and ReLU activation to perform with a 1% penalty in accuracy.

Room 3

16:30–18:30
M4D • Resilience in Access Networks
Presider: Annachiara Pagano; Telecom Italia, Italy

M4D.1 • 16:30
A Physical-Layer Rogue ONU Identification Method Based on Hardware Fingerprint Technology, KaiYu Liu[1,2], Danming Huang[1,2], Chengzhe Tang[1,2], Lei Deng[1,2], Qi Yang[1,2], Xiaoxiao Dai[1,2], Deming Liu[1,2], Mengfan Cheng[1,2]; [1]*National Engineering Research Center for Next Generation Internet Access System, School of Optical and Electronic Information, Huazhong Univ. of Science and Technology (HUST), China;* [2]*Jinyinhu Laboratory, China.* We propose a method for identifying rogue ONUs based on hardware fingerprint technology. By directly detecting waveform fingerprints, the experimental results show that the average identification accuracy within 16 ONUs can reach 96.74%.

M4D.2 • 16:45 Invited
Can the PON Legacy Infrastructure Host Quantum Key Distribution Services?, Paola Parolari[1], Alessandro Gagliano[1], Alberto Gatto[1], Pierpaolo Boffi[1], Paolo Martelli[1]; [1]*Politecnico di Milano, Italy.* The integration of quantum key distribution in the legacy access infrastructure is analyzed considering the optical distribution network characteristics and the coexistence of multiple passive optical network standards providing classical channels, sources of Raman crosstalk.

Room 6C

16:30–18:30
M4E • Data Centre and Submarine
Presider: Stephan Pachnicke; Christian-Albrechts Universität zu Kiel, Germany

M4E.1 • 16:30 Invited
AWS Inter-Datacenter Transport Network, Saurabh Kumar[1]; [1]*Amazon Web Services, USA.* Abstract not available.

Room 6D

16:30–18:30
M4F • Advanced Optical Communication Technologies
Presider: Hai Xu; Marvell Semiconductor Inc., USA

M4F.1 • 16:30 Invited
Photonic Layer Encryption in High Speed Optical Communications, Dan Sadot[1,2], Eyal Wohlgemuth[2], Ido Attia[1,2], Ohad Balasiano[1,2], Isaac Jonas[1,2], Elimelech Keller[2], Hamutal Shalom[2]; [1]*Ben Gurion Univ. of the Negev, Israel;* [2]*CyberRidge, Israel.* Combining multi-THz optical spectrum spreading, photonic phase encoding, and negative OSNR transmission, forms photonic shield that prevents data recording for offline deciphering. This supports post-quantum security by eliminating raw data availability for quantum computers processing.

Room 6E

16:30–18:30
M4G • ONS: Open and Disaggregated Optical Networking: Where We've Been and What's Coming Next

Open and disaggregation have grown in popularity and appeal across networking segments, including optical networks, in the past few years. With open and disaggregated networks, operators/hyperscalers can use best-in-class equipment and avoid vendor lock-in, thereby gaining faster innovation, flexibility, and scalability as their network needs grow. Deployment status varies by network segments, working distances, and geographic regions, including data center networks with backbone long-haul and metro, core networks, and customer premises equipment (CPE) in metro and edge layer. Operators/hyperscalers from different geographic regions also have different attitudes and adopt varied approaches.

This summit aims to gather service providers, cloud providers, equipment vendors, and component vendors across the eco-system to share learnings and experiences, highlight innovation, and discuss the future of open and disaggregated optical networking, including software-defined networking (SDN), southbound interfaces, information modeling, interoperable DSP, IP over DWDM, and coherent pluggable transceivers.

Topics to be targeted by this summit include but will not be limited to:

1. In what segments of the network have openness and disaggregation been applied, i.e., long-haul/backbone, metro, or access?
2. What were the anticipated pros and cons of openness and disaggregation? Were those realized in deployment? (e.g., Have the projected cost savings been realized?)
3. Will openness and/or disaggregation help or hinder convergence of different network segments (e.g., metro and long-haul) and layers (IP + optical)?
4. Will nascent interoperable DSP stimulate increased adoption of openness and disaggregation in optical networks?
5. Will openness and disaggregation be a key enabler for IP over WDM?
6. What advances are needed in managing smart coherent pluggables in routers to enable IP over WDM?

Organizers
Lynn Nelson, *AT&T, USA*
Shen Shikui, *China Unicom, China*
Norman Swenson, *Infinera, USA*

Presenters
Sebastien Gareau, *Ciena, Canada*
Steven J. Hand, *Infinera, USA*
Emerson Moura, *Cisco, Brazil*
Kirsten Rundberget, *AT&T, USA*
Chongjin Xie, *Alibaba Group, China*

Room 6F

16:30–18:30
M4H • Advancement in Quantum Key Distribution Systems II
Presider: Rui Wang; University of Bristol, UK

M4H.1 • 16:30
Squeezing Recovery After Detection with a Completely Free-Running Local Oscillator, Huy Q. Nguyen[1], Hou-Man Chin[1], Adnan A. Hajomer[1], Ulrik L. Andersen[1], Tobias Gehring[1]; [1]*Danmarks Tekniske Universitet, Denmark.* We performed the first measurement and recovery of squeezed light using a free-running coherent receiver with a separate laser, 98% of the squeezing was preserved in our method relative to measurements with a shared laser.

M4H.2 • 16:45
Savitzky-Golay-Filter-Based Phase Recovery for CV-QKD, Elisabeth Llanos Pla[1], Pol Adillon[1], Samael Sarmiento-Hernández[1], Jeison Tabares[1], Sebastian Etcheverry[1]; [1]*Luxquanta Technologies SL, Spain.* A Savitzky-Golay filter (SGF) is employed to reduce the excess noise introduced by a pilot-tone-based phase recovery in CV-QKD. Results show an improvement of 29.2% in the secret key rate at 10.9 km when the SGF is used.

Room 7

16:30–18:30
M4I • Panel: Wideband Optical Amplifiers for Datacenters, Hyperscale Networks and Telecom Networks

Organizers
Raja Ahamd, Cisco Systems Inc, USA
Vladimir Gordienko, Aston University, UK
Seongwoo Yoo, University of Glasgow, UK
Michael Vasilyev, University of Texas at Arlington, USA

Speakers
Tad Hafmeister, Google, USA
Kazuaki Kiyota, Furukawa Electric, Japan
Vitaly Mikhailov, OFS, USA
David Neilson, Nokia, USA
Chongjin Xie, Alibaba, China

This panel will address the maturity of the amplifier technologies beyond C- and L-bands, as well as their suitability for hyperscale datacenters and telecom networks of the near future. For the last three decades EDFA has been a key enabler of long-haul communications. As the bandwidth demand keeps growing, opening spectral regions beyond the traditional telecom bands of EDFA becomes important. The importance of amplifier technologies for these regions is further emphasized by the recent advances in hollow core fibers that have low-loss windows much wider than C- and L-bands. In parallel to the telecom market, the hyperscale datacenter campuses are undergoing a rapid expansion in size and capacity, with ever-increasing intra-datacenter distances and modulation formats complexity. As a result, huge efforts are underway to develop novel optical fiber-based and on-chip amplifiers suitable for such datacenter networks.

Several solutions for amplification outside of the C- and L- bands have been discussed, e.g., SOAs, Bi-, Tm-, and Pr- doped fiber amplifiers, Raman amplifiers, etc. This panel brings together experts from industry and academia to discuss the advantages and challenges that these solutions face, as well as explore their readiness for the network applications.

Room 8

16:30–18:30
M4J • Integrated Optics for Communication and Sensing
Oskars Ozolins, RISE Research Institutes of Sweden, Sweden

M4J.1 • 16:30
Silicon Photonic Four-Channel Dual-Polarization Coherent Receiver Module for FMCW LiDAR Application, Chang Liu[1], Fan Qi[1], Pengfei Cai[1], Su Li[1], Jiaxing Zhao[1], Yanhui Duan[1], Chingyin Hong[1], Dong Pan[1]; [1]*SiFotonics Technologies Co., Ltd., China.* We demonstrate a four-channel dual-polarization FMCW LiDAR receiver module using a silicon photonic coherent receiver chip. The sensitivity of the module is better than -80dBm. The ranging operation within a distance of 81.9m is demonstrated.

M4J.2 • 16:45
Photon-Counting Laser Ranging with Dual-Comb Asynchronous Optical Sampling, Yun Meng[1], Yanqing Shi[1], Kai Zou[1], Youjian Song[1], Xiaolong Hu[1]; [1]*Tianjin Univ., China.* We report on laser ranging using dual-comb asynchronous optical sampling and a fractal SNSPD, achieving ranging precision of 7.7 micrometer and 65 nm with acquisition time of 1 ms and 1 s, respectively.

Room 9

16:30–18:30
M4K • Nonliner Transmission
Presider: Alexei Pilipetskii; SubCom LLC, USA

M4K.1 • 16:30
Enhancing Generalization in Neural Channel Model for Optical Fiber WDM Transmission Through Learned Encoding of System Parameters, Chuyan Zeng[1], Zekun Niu[1], Hang Yang[1], Minghui Shi[1], Weisheng Hu[1], Lilin Yi[1]; [1]*Shanghai Jiao Tong Univ., China.* We propose a learned encoding method to enhance neural channel model generalization by integrating system parameters as side information. This approach achieves large-scale generalization, encompassing optical fiber transmission launch power and distance.

M4K.2 • 16:45
Pruning Attention in Transformers for Nonlinear Channel Compensation in Optical Systems, Behnam Behinaein Hamgini[1], Hossein Najafi[1], Ali Bakhshali[1], Zhuhong Zhang[1]; [1]*Huawei Technologies Canada, Canada.* We study pruning attention in Transformers for optical nonlinear channel compensation. We show the impact of statistical pruning on the performance and complexity of nonlinear equalization and compare it with a physics-informed pruning scheme.

Room 1A

M4A • Silicon Photonics—Continued

M4A.3 • 17:15
Low-Loss, Multi-Reticle Stitched SiN Waveguides for 300mm Wafer-Level Optical Interconnects, Pengfei Xu[1], Chiara Marchese[1], Guy Lepage[1], Negin Golshani[1], Ruben Van Eenaeme[1], Andrea Mingardi[1], Joost Van Ongeval[1], Rafal Magdziak[1], Luc Halipre[1], Darko Trivkovic[1], Peter Verheyen[1], Maumita Chakrabarti[1], Dimitrios Velenis[1], Andy Miller[1], Filippo Ferraro[1], Yoojin Ban[1], Joris Van Campenhout[1]; *[1]imec, Belgium.* We present 56-cm long LPCVD SiN waveguides traversing a full 300mm wafer, targeting future optically interconnected wafer-scale multi-chip compute systems. High-precision reticle stitching (loss below 0.01dB/interface) enables intra-wafer waveguide loss of just 0.15dB/cm in the O-band.

Room 1B

M4B • Integrated Devices for Sensing and Metrology—Continued

M4B.2 • 17:00
Single-Shot Ultra-Broadband Spectrometer with Cascaded Nanobeam Mirrors, Chunhui Yao[1], Chumeng Yao[1], Peng Bao[1], Jie Ma[2], Ting Yan[2], Richard V. Penty[1], Qixiang Cheng[1,2]; *[1]Univ. of Cambridge, UK; [2]GlitterinTech Limited, China.* We present a novel reconstructive spectrometer with cascaded nanobeam mirrors. A compact SiN spectrometer is demonstrated achieving <0.5 nm resolution across 160 nm bandwidth with only 15 sampling channels, yielding a record-high spectral pixel-to-channel ratio.

M4B.3 • 17:15 Invited
Waveguide Raman Sensing for Chemical Detection in Industrial Processes, Dorian Sanchez[1], Christopher Lieutaud[1], Priscille Bonnassies[1], Yasmine Ibrahimi[1], Chardel Ompala[1], Nabila Imatoukene[2], Jerome Michon[1]; *[1]InSpek SAS, France; [2]URD Agro-Biotechnologies Industrielles (ABI), CEBB, AgroParisTech, France.* Waveguide-enhanced Raman spectroscopy (WERS) is a promising method for detecting chemical and biological compounds with high sensitivity and selectivity on a chip-scale platform, but has so far been limited to demonstrations in research laboratories. We present the implementation of a fibre-coupled WERS sensing system in an industrial bioproduction process.

Room 2

M4C • Machine Learning and Neural Networks—Continued

M4C.3 • 17:00
Sub-pJ/MAC Silicon Photonic GeMM for Optical Neural Networks Using a Time-Space Multiplexed Coherent Xbar, Stefanos Kovaios[1], Ioannis Roumpos[1], Apostolos Tsakyridis[1], George Giamougiannis[1], Miltiadis Moralis-Pegios[1], Mathias Berciano[2], Filippo Ferraro[2], Dieter Bode[2], Ashwyn Srinivasan[2,3], Marianna Pantouvaki[2,4], Nikos Pleros[1]; *[1]Aristotle Univ. of Thessaloniki, Greece; [2]IMEC, Belgium; [3]Xanadu Quantum Technologies, Canada; [4]Microsoft Research Center, UK.* We present a time-space multiplexed Silicon Photonic Neural Network that acts as a General Matrix Multiply (GeMM) engine, using a 2×2 photonic Xbar prototype for demonstrating experimental results at 20GBd and an accuracy of 93.3% at an energy efficiency of 0.2pJ/MAC.

M4C.4 • 17:15
Integrated Neuromorphic Information Processing with Electrically-Injected Microring Spiking Neuron, Jinlong Xiang[1], Yaotian Zhao[1], Xuhan Guo[1], Yikai Su[1]; *[1]Shanghai Jiao Tong Univ., China.* We experimentally demonstrate, for the first time, a CMOS-compatible electrically injected microring spiking neuron, capable of reproducibly emulating the typical neural dynamics including excitability threshold, temporal integration, refractory period, and spike inhibition.

Room 3

M4D • Resilience in Access Networks—Continued

M4D.3 • 17:15
Proactive Congestion Control Within 1-ms Delay at Mobile Midhaul Utilizing Parallel Traffic Prediction and Fast Switchover of CU and Optical Path, Yuka Okamoto[1], Hirotaka Ujikawa[1], Kota Asaka[1], Tatsuya Shimada[1], Tomoaki Yoshida[1]; *[1]NTT Access Network Service Systems Laboratories, NTT Corporation, Japan.* We propose a proactive congestion control method that utilizes parallel traffic prediction and fast switchover of the CU and optical path. Our prototype controller can perform these tasks within a 1-ms delay at the MMH.

Room 6C

M4E • Data Centre and Submarine—Continued

M4E.2 • 17:00
Novel in-Line Triage Methodology for High-Speed Optical Transceivers in Hyperscale Datacenters, Elaine Chou[1], Arun Mohan[1], Chris Berry[1], Chet Powers[1], Mario Morales[1]; *[1]Meta, USA.* A novel in-line triage methodology has been developed by leveraging data collected from optical transceivers and network switches. A success rate of ~68% was achieved by correlating diagnosis from triage to failure analysis from vendors.

M4E.3 • 17:15
Non-Intrusive DAS Coexisting in Telecom Networks, Jan Kristoffer Brenne[1], Anthony Sladen[2], Pascal Pecci[3], Jan Petter Morten[1], Julian Pelaez[2], Joacim Jacobsen[1], Alain Calsat[4], Philippe Plantady[4], Jean-Paul Ampuero[2], Diane Rivet[2], Herve Février[5]; *[1]Alcatel Submarine Networks Norway, Norway; [2]Université Côte d'Azur, CNRS, Observatoire de la Côte d'Azur, IRD, Géoazur, France; [3]Meta, France; [4]Alcatel Submarine Networks, France; [5]Landelles Consulting, USA.* We describe DAS interrogation for non-intrusive coexistence with live C-band WDM channels. The scheme facilitates consistent high sensing sensitivity range >100 km. Surface vessels, seabed fishing gear and earthquakes are localized from the 2Africa network.

Room 6D

M4F • Advanced Optical Communication Technologies—Continued

M4F.2 • 17:00
Probabilistically Shaped 64-QAM Transmission via Distortion-Aware Phase Retrieval, Hanzi Huang[2,1], Haoshuo Chen[2], Peiji Song[2], Cheng Guo[2], Qi Gao[1], Yetian Huang[2,1], Nicolas K. Fontaine[2], Mikael Mazur[2], Lauren Dallachiesa[2], Roland Ryf[2], Zhengxuan Li[1], Yingxiong Song[1]; *[1]Shanghai Univ., China; [2]Nokia Bell Labs, USA.* We experimentally demonstrate 50-GBaud probabilistically shaped 64-QAM transmission with 5.6-bits/symbol entropy over 80-km SSMF using carrierless intensity-only detection via a distortion-aware phase retrieval receiver, resulting net capacity over 200 Gb/s.

M4F.3 • 17:15
Double-Stage Carrier Frequency Offset Estimation Using the Eigenvalue and Scattering Coefficient *b* in the Nonlinear Fourier Transform, Taisuke Chino[1], Takumi Motomura[1], Akihiro Maruta[1], Ken Mishina[1]; *[1]Osaka Univ., Japan.* We propose a novel method to estimate the carrier frequency offset (CFO) using the eigenvalue and scattering coefficient *b* in the NFT. Our experiments demonstrate fine CFO estimation below 10 kHz for the proposed method.

Room 6E

M4G • ONS: Open and Disaggregated Optical Networking: Where We've Been and What's Coming Next—Continued

Room 6F

M4H • Advancement in Quantum Key Distribution Systems II—Continued

M4H.3 • 17:00
Assessing the Impact of Patterning Effect on Quantum Key Distribution, Tao Wang[1], Yixin Wang[1], Yanwen Zhu[1], Sheng Liu[2], Jie Zhang[1]; [1]*Beijing Univ. of Posts and Telecommunications, China;* [2]*China Mobile Research Inst., China.* We assessed the impact of patterning effect on SKR in QKD while considering statistical fluctuations. Through numerical simulations, compared to WCS, HSPS demonstrated superior resistance to patterning effect and can transmit over longer distances.

M4H.4 • 17:15
First Demonstration of a Group-IV Emitter on Photonic BiCMOS Supplying a Quantum Communication Link, Florian Honz[1], Michael Hentschel[1], Stefan Jessenig[3], Jochen Kraft[3], Philip Walther[2], Bernhard Schrenk[1]; [1]*AIT, Austria;* [2]*Faculty of Physics, Vienna Center for Quantum Science and Technology (VCQ), Univ. of Vienna, Austria;* [3]*ams-OSRAM AG, Austria.* We implement a silicon-on-insulator light emitter as optical supply for a QKD transmitter and transfer it to an electronic BiCMOS wafer. A secure key is established over short reach in co-existence with shortwave data transmission.

Room 7

M4I • Panel: Wideband Optical Amplifiers for Datacenters, Hyperscale Networks and Telecom Networks—Continued

Room 8

M4J • Integrated Optics for Communication and Sensing—Continued

M4J.3 • 17:00 Invited
Integrated Photonic Processors for Optical Free-Space Links, SeyedMohammad SeyedinNavadeh[1], Andres I. Martinez[1], Alessandro di Tria[1], Emanuele Sacchi[1], Francesco Zanetto[1], Giorgio Ferrari[1], Marco Sampietro[1], David B. Miller[2], Andrea Melloni[1], Francesco Morichetti[1]; [1]*Politecnico di Milano, Italy;* [2]*Stanford Univ., USA.* Programmable photonic integrated processors offer a large potential for the generation, manipulation, and detection of free-space optical beams (FSO). Applications are shown on the automated setting of optimal orthogonal MIMO channels and transmission through time-varying FSO links.

Room 9

M4K • Nonliner Transmission—Continued

M4K.3 • 17:00 Invited
The Information Capacity of the Fiber-Optic Channel: Bounds and Prospects, Mark Shtaif[1], Cristian Antonelli[2], Xi Chen[3], Antonio Mecozzi[2]; [1]*Tel Aviv Univ., Israel;* [2]*Univ. of L'Aquila, Italy;* [3]*Nokia Bell-Labs, USA.* We discuss the challenges in assessing the theoretical limits to the throughput of fiber-optic communications systems and argue that the uncertainty of available information capacity limits is within a range of 1.17 bits. We show that record experiments are within 20 to 30 percent from these limits in single-mode fiber systems. Finally, we relate to the challenge of predicting the scaling of capacity with bandwidth.

Room 1A

M4A • Silicon Photonics—Continued

M4A.4 • 17:30
Toward Large-Scale Nonvolatile Electrical Programmable Photonics with Deterministic Multilevel Operation, Rui Chen[1], Virat Tara[1], Jayita Duta[1], Minho Choi[1], Justin Sim[1], Julian Ye[1], Jiajiu Zheng[1], Zhuoran Fang[1], Arka Majumdar[1]; *[1]Univ. of Washington, USA.* We present a deterministic multilevel scheme by electrically controlling multiple phase-change material (PCM) Sb_2S_3 segments through individual PIN heaters. PCMs are integrated on 300-mm silicon photonic fab dies back-end-of-line, promising for fast-prototyping and massive production.

M4A.5 • 17:45
Hybrid Integrated Multi-Lane Erbium-Doped Si3N4 Waveguide Amplifiers, Zheru Qiu[1,2], Xinru Ji[1,2], Yang Liu[1,2], Martin Hafermann[3], Taegon Kim[4], Joseph C. Olson[4], Rui N. Wang[1,2], Carsten Ronning[3], Tobias J. Kippenberg[1,2]; *[1]Swiss Federal Inst. of Technology Lausanne (EPFL), Switzerland; [2]Center for Quantum Science and Engineering, Switzerland; [3]Inst. of Solid State Physics, Friedrich Schiller Univ. Jena, Germany; [4]SPG Group, Applied Materials Inc., USA.* We present the integration of four individual erbium-doped waveguide optical amplifiers on a Si3N4 photonic integrated circuit hybrid integrated with a four-lane semiconductor pump laser diode chip. Each amplifier achieves 15 dB on-chip gain.

Room 1B

M4B • Integrated Devices for Sensing and Metrology—Continued

M4B.4 • 17:45
Common Cavity Waveguide Coil-Resonator Stabilized Hybrid Integrated WDM Laser with 89 Hz Integral Linewidth, Kaikai Liu[1], Mohamad H. Idjadi[2], Stefano Grillanda[2], Kwangwoong Kim[2], Cristian Bolle[2], Mark Cappuzzo[2], Roland Ryf[2], Nicolas K. Fontaine[2], Mikael Mazur[2], Daniel Blumenthal[1]; *[1]UC Santa Barbara, USA; [2]Nokia Bell Labs, USA.* We stabilize a hybrid-integrated multi-wavelength laser to a photonic-integrated 4.0-meter-coil resonator, with 48 MHz FSR, achieving an 89 Hz integral linewidth and 4.3×10^{-13} frequency stability at 10.5 ms for 2 different wavelength channels.

Room 2

M4C • Machine Learning and Neural Networks—Continued

M4C.5 • 17:30
Reconfigurable All-Optical Integrated Nonlinear Activator with Switchable Response Functions for Photonic Neural Network, Bei Chen[4], Jian Wang[4], Zichao Zhao[1], Xiaowen Xiong[2], Jianyi Yang[1], Ming Li[4], Ninghua Zhu[4,3]; *[1]College of Information Science and Electronic Engineering, Zhejiang Univ., China; [2]Department of Electronic Engineering, Tsinghua Univ., China; [3]Xiongan Inst. of Innovation, Chinese Academy of Sciences, China; [4]Inst. of Semiconductors, Chinese Academy of Sciences, China.* We experimentally demonstrate a reconfigurable all-optical integrated nonlinear activator with switchable response functions, including Gaussian, Radial Basis, Softplus, leaky ReLU, Swish and clamped ReLU functions, especially all triggered by low-power inputs.

M4C.6 • 17:45
Device Dependent Distortion Correction in Time-Stretch Photonic Analog to Digital Converters Using Deep Neural Networks, Mandeep Singh[1], Joydip Dutta[1], Sreeraj S J[1], Viswanathan Sankar[1], Balaji Srinivasan[1], Lakshmi Narasimhan Theagarajan[1], Deepa Venkitesh[1]; *[1]Electrical Engineering, Indian Inst. of Technology, Madras, India.* We experimentally demonstrate a novel deep learning-aided time-stretch photonic front end architecture to overcome device-dependent distortions to improve the signal-to-noise and distortion ratio by more than 24 dB, and reduce the bandwidth requirements of the back-end electronic ADC by three times.

Room 3

M4D • Resilience in Access Networks—Continued

M4D.4 • 17:30
2.5 Gbps Error-Free Physical Layer Key Distribution Based on Signal Hiding Over 80-km SSMF, Kongni Zhu[1], Yuang Li[1], Mingrui Zhang[1], Yajie Li[1], Zhao Yongli[1], Jie Zhang[1]; *[1]Beijing Univ. of Posts and Telecomm, China.* We propose a physical layer key distribution scheme with signal hiding and concatenated coding. Experimental results demonstrate that an error-free key can be obtained with the key generation rate of 2.5 Gbps over the 80-km standard single-mode fiber.

Room 6C

M4E • Data Centre and Submarine—Continued

M4E.4 • 17:30
First Impact Movement Characterization of Shallow Buried Live Subsea-Cable, Steinar Bjørnstad[2,3], Kristina Shizuka Yamase Skarvang[1], Dag Roar Hjelme[1], Asbjørn Tunheim[2], Frode Fjermestad[2], Eivind Østerli[2]; *[1]NTNU, Norway; [2]Tampnet, Norway; [3]Simula Research Laboratory, Norway.* Revealing availability threats and security attacks using State of Polarisation monitoring shows impact characteristics from a cable trencher passing over, moving a subsea cable carrying live traffic while dBQ value dips 0.6 dB.

M4E.5 • 17:45 Invited
Next Generation SDM Submarine Networks: From Telecom to Climate Change, Olivier Courtois[1]; *[1]Alcatel Submarine Networks, France.* We review recent advancements in spatial division multiplexing (SDM) towards next generation Pb/s submarine cables, highlighting the transformative impact of these technologies on global communication networks and reporting their novel applications in climate change monitoring.

Room 6D

M4F • Advanced Optical Communication Technologies—Continued

M4F.4 • 17:30
Detector-on-Demand for Flexible Homodyne Transmission, Bernhard Schrenk[1], Fotini Karinou[2]; *[1]AIT Austrian Inst. of Technology, Austria; [2]Microsoft Research Ltd, UK.* We demonstrate a segmented coherent detector configuration that enables polarization-insensitive or -multiplexed reception in half- or full-duplex operation mode for single-λ or ultra-dense WDM configurations with up to 91 Gb/s/sub-λ OFDM data rate.

M4F.5 • 17:45 Invited
Opportunities and Challenges of Optical Communications in Autonomous Driving Vehicles, Gordon N. Liu[1]; *[1]Soochow Univ., China.* Autonomous driving vehicles require high bandwidth due to the increased sensors and improved architectures. Optical communications provide several advantages over copper cables in intra-vehicle networks, but face many challenges, especially because of the harsh environment.

Room 6E

M4G • ONS: Open and Disaggregated Optical Networking: Where We've Been and What's Coming Next—Continued

Room 6F

M4H • Advancement in Quantum Key Distribution Systems II—Continued

M4H.5 • 17:30 **Tutorial**

Recent Developments in Quantum Key Distribution, Christoph Marquardt[1]; [1]*Max Planck Inst. Science of Light, Germany.* I will introduce the principles and requirements of quantum key distribution in realistic scenarios and applications. Furthermore I will highlight advances and developments in the field in the technical and architectural domain.

Christoph Marquardt owns the Chair of Optical Quantum Technologies at the Friedrich-Alexander-Universität Erlangen-Nürnberg and is the head of the quantum information processing group at the Max Planck Institute for the Science of Light in Erlangen. The topics of his research cover a broad range of quantum optics and quantum information experiments, from nonlinear photonics to satellite-based quantum key distribution. Christoph Marquardt served in advisory groups for the European Union and German government and is a co-founder of the start-up KEEQuant. He is active in several EU and national quantum communication research projects and is taking care of the architecture of the German BMBF QuNet initiative.

Room 7

M4I • Panel: Wideband Optical Amplifiers for Datacenters, Hyperscale Networks and Telecom Networks—Continued

Room 8

M4J • Integrated Optics for Communication and Sensing—Continued

M4J.4 • 17:30

Fabrication-Tolerant High-Speed 5-bit Silicon Optical True Time Delay Line in the O-Band, Ziheng Ni[1], Yixuan Wang[1], Liangjun Lu[1], Yuanbin Liu[1], Jianping Chen[1], Linjie Zhou[1]; [1]*Shanghai Jiao Tong Univ., China.* We demonstrated a high-speed 5-bit silicon optical true time delay line based on fabrication-tolerant electro-optic push-pull optical switches, which shows a lower phase deviation and a lower insertion loss compared with the conventional design.

M4J.5 • 17:45

Power Monitoring and Thermal Crosstalk Compensation for ORR-Based Optical Beamformer, Bin Shi[1], Ripalta Stabile[1], Eduward Tangdiongga[1]; [1]*Technische Universiteit Eindhoven, Netherlands.* We demonstrate thermal-crosstalk-compensated ORR-based beamformer on InP photonic integrated circuit, through an automatic voltage control method that uses on-chip power monitoring for continuous delay tuning, with <1s reconfiguration time.

Room 9

M4K • Nonliner Transmission—Continued

M4K.4 • 17:30

Improved Physics-Based Raman Amplifier Model in C+L Networks Through Input Parameter Refinement, Yihao Zhang[1], Xiaomin Liu[1], Qizhi Qiu[1], Yichen Liu[1], Lilin Yi[1], Weisheng Hu[1], Qunbi Zhuge[1]; [1]*Shanghai Jiao Tong Univ., China.* We propose an input parameter refinement scheme for the physics-based Raman amplifier model. Experiments over C+L band are conducted. Results show the scheme can lower the physical model's maximum estimation error by ~2.13 dB.

M4K.5 • 17:45

Autoencoder Learning of Constellation Shaping Robust to Semiconductor Laser Noise and Nonlinearity in Fiber-THz System, Xiang Liu[2,1], Jiao Zhang[1,2], Min Zhu[2,1], Zhigang Xin[2,1], Weidong Tong[2,1], Yunwu Wang[2,1], Bingchang Hua[1], Yuancheng Cai[1], Mingzheng Lei[1], Junjie Ding[1], Xingyu Chen[1], Bo Liu[3], Jianjun Yu[4,1]; [1]*Purple Mountain Laboratories, China;* [2]*Southeast Univ., China;* [3]*Nanjing Univ. of Information Science and Technology, China;* [4]*Fudan Univ., China.* We experimentally demonstrate the robustness of autoencoder-based constellation shaping against semiconductor laser noise and nonlinearity. Up to 46% lower BER and 1.5 dB gain are achieved in the fiber-THz system at 320 GHz.

Room 1A

M4A • Silicon Photonics—Continued

M4A.6 • 18:00 Invited

Fully Integrated Coherent Lidar Chip, Mehdi Asghari[1]; [1]*SiLC Technologies, Inc., USA.* In this presentation we will report on our latest progress in integrating multiple channels and solid state scanning into a single chip and applications of the technology to different markets from 1m to Km range.

Room 1B

M4B • Integrated Devices for Sensing and Metrology—Continued

M4B.5 • 18:00

Wafer-Level Fabrication of Vacuum-Gap Fabry–Pérot Resonators with Quality Factors Exceeding One Billion, Naijun Jin[1], Yifan Liu[2,3], Dahyeon Lee[2,3], Haotian Cheng[1], Charles McLemore[2,3], Samuel Halladay[1], Yizhi Luo[1], David Mason[1], Scott Diddams[3,4], Franklyn Quinlan[2,3], Peter Rakich[1]; [1]*Yale Univ., USA;* [2]*National Inst. of Standards and Technology, USA;* [3]*Department of Physics, Univ. of Colorado Boulder, USA;* [4]*Electrical, Computer and Energy Engineering, Univ. of Colorado Boulder, USA.* We present a wafer-level fabrication method for high-Q, compact vacuum-gap Fabry–Pérot resonators. with quality factors surpassing one billion at 1560 nm, these resonators are well-suited in a range of applications as frequency references.

M4B.6 • 18:15

Co-Packaged Micro Reference Cavity with Photonic Integrated Circuits, Haotian Cheng[1], Naijun Jin[1], Zhaowei Dai[1], Chao Xiang[2], Joel Guo[2], Yishu Zhou[1], Scott Diddams[3,4], Franklyn Quinlan[3], John Bowers[2], Owen Miller[1], Peter Rakich[1]; [1]*Yale Univ., USA;* [2]*Department of Electrical and Computer Engineering, Univ. of California, Santa Barbara, USA;* [3]*National Inst. of Standards and Technology, USA;* [4]*Department of Physics, Univ. of Colorado Boulder, USA.* A compact co-packaged micro Fabry-Perot reference cavity integrated with photonic circuits achieves a redirected signal, 14.2 dB back-reflection suppression, and 79.5\% cavity mode matching efficiency.

Room 2

M4C • Machine Learning and Neural Networks—Continued

Room 3

M4D • Resilience in Access Networks—Continued

Room 6C

M4E • Data Centre and Submarine—Continued

M4E.6 • 18:15

Delay-Minimized Distributed Sequence Routing for Satellite Optical Networks, Qiancheng Zhao[1], Ruijie Zhu[1], Yudong Zhang[1], Wenchao Zhang[1], Chao Xi[2], Bo Yang[2]; [1]*Zhengzhou Univ., China;* [2]*Space Star Technology CO., LTD, China.* A sequence routing algorithm based geographical information is proposed to reduce delay in satellite optical networks. The simulation results show that compared with the static topological routing algorithm, the average delay is reduced by 30%.

Room 6D

M4F • Advanced Optical Communication Technologies—Continued

19:00–21:00 Student Party, *Coin-Op Gaslamp*

Room 6E

M4G • ONS: Open and Disaggregated Optical Networking: Where We've Been and What's Coming Next—Continued

Room 6F

M4H • Advancement in Quantum Key Distribution Systems II—Continued

Room 7

M4I • Panel: Wideband Optical Amplifiers for Datacenters, Hyperscale Networks and Telecom Networks—Continued

Room 8

M4J • Integrated Optics for Communication and Sensing—Continued

M4J.6 • 18:00
W-Band Wireless Transmission Based on 98 GHz Packaged Silicon Photonics Optical Clock Generator, Antonio Malacarne[1], Alberto Montanaro[1], Fawad Ahmad[2], Gaurav Pandey[2], Antonio D'Errico[3], Marco Romagnoli[1], Antonella Bogoni[2,1], Claudio Porzi[2]; [1]*Photonics Networks and Technologies National Laboratory, CNIT, Italy;* [2]*TeCIP, Sant'Anna School of Advanced Studies, Italy;* [3]*Ericsson Research, Italy.* A fully packaged CMOS-compatible photonic integrated frequency-tunable optical clock synthesizer is used for 93 GHz wireless transmission of complex modulation formats up to 4 Gb/s data rate, with noise performance suitable for upcoming 6G networks.

M4J.7 • 18:15
Beamforming Demonstration of Hybrid Photonic Integrated Circuit Based on a Blass Matrix for Radar Receivers, Federico Camponeschi[1], Valentina Gemmato[1], Filippo Scotti[2], Luca Rinaldi[2], Ahmad Mohammad[3], Chris Roeloffzen[3], Paul van Dijk[3], Paolo Ghelfi[2]; [1]*Scuola Superiore SantAnna, Italy;* [2]*CNIT, Italy;* [3]*Lionix, Netherlands.* This paper reports the first-ever beamforming demonstration of a hybrid photonic integrated circuit operating as RF down-converter based on an optical Blass-matrix architecture for a Scan-on-Receive synthetic aperture radar intended for Earth observation from space.

Room 9

M4K • Nonliner Transmission—Continued

M4K.6 • 18:00
Fast and Accurate DNN-Based Approach in Maximizing Ultra-Wideband Fiber-Optic Systems Throughput, Zelin Gan[1], Mykyta Shevchenko[2], Sam Nallaperuma Herzberg[1], Seb Savory[1]; [1]*Univ. of Cambridge, UK;* [2]*Univ. College London, UK.* We present a fast and accurate physical layer model assisted by a neural network to maximize the throughput for ultra-wideband systems. The proposed approach significantly saves computation time and keeps the same precision.

M4K.7 • 18:15
1200-km Transmission of 4096-ary Eigenvalue-Modulated Signal Using a Neural Network-Based Demodulator and SD-FEC, Ryotaro Harada[1], Tsuyoshi Yoshida[2], Daisuke Hisano[1], Akihiro Maruta[1], Ken Mishina[1]; [1]*Osaka Univ., Japan;* [2]*Mitsubishi Electric Corporation, Japan.* We experimentally demonstrate the transmission of a 4096-ary eigenvaluemodulated signal using a neural network-based demodulator and SD-FEC. The experimental results indicate a successful operation with an error-free transmission through a 1200-km optical fiber line.

19:00–21:00 Student Party, *Coin-Op Gaslamp*

NOTES

07:30–08:00 Plenary Session Coffee Break, *Upper Level, Ballroom 20 Lobby*

Ballroom 20

08:00–10:00
Tu1A • Plenary Session
Presider: Jiajia Chen; TikTok, USA; Johannes Fischer; Fraunhofer Heinrich-Hertz Inst., Germany; Tetsuya Hayashi; Sumitomo Electric, Japan

Tu1A.1 • 08:30 (Plenary)
How 6G Will Impact Networking, Anita Döhler[1]; [1]*NGMN Alliance, Germany.* This presentation explores NGMN's pivotal role in advancing the Mobile Industry towards next-generation networks, encompassing Operator led requirements on 6G, sustainability, and cloud-native. With a prerequisite to deliver new use cases that create value and exceptional end-user experiences this presentation looks at trade-offs that will need to be made, for example energy consumption versus bit rates and identifies the critical role optical communications will play in enabling these Operator led requirements, for example disaggregation, resilience and energy efficiency.

Tu1A.2 • 09:00 (Plenary)
Networking Alchemy: Transforming Science Through Connectivity, Inder Monga[1]; [1]*Berkeley Lab, USA.* Scientists are driven to answer some of the world's most fundamental questions – from the origin of the universe to the future of humanity and our biosphere. Answers lie hidden in the deluge of data being gathered 24/7 from experiments, observations, and simulations. Energy Sciences Network (ESnet), the Department of Energy's data circulatory system, seeks to harness and accelerate the creativity of vital research collaborations while pushing the boundaries of networking in experimenting with what a quantum computing network might look like. This talk will describe global-scale science and its workflows, innovations being explored to meet its rapidly evolving needs, and the engineering behind the science networks of today and the future.

Tu1A.3 • 09:30 (Plenary)
Emerging Fiber Technologies for Future Optical Networks About the Speaker, David J. Richardson[1]; [1]*Microsoft, USA.* Major advances have been made in recent years on the development of radically new transmission fibers offering improved optical properties and systems performance relative to conventional single mode fiber technology, with some of the most promising, including hollow core fiber, now deployed in the field. I review progress in these emerging technologies and discuss where they are likely to prove most disruptive and impactful in future optical networks.

10:00–17:00 Exhibition and Show Floor Programs, *Exhibit Hall (concessions available)*

10:00–14:00 Exhibit-only Time, *Exhibit Hall (coffee service 10:00–10:30)*

10:00–16:45 Career Zone, *Exhibit Hall B1*

10:30–12:00 The Art of Writing the Perfect OFC Paper, *6A*

12:00–14:00 Awards Ceremony and Luncheon, *Upper Level, Ballroom 20*

Show Floor Programming

Next Generation Optical Interconnects for AI Clusters: Beyond Linear Drive Optics
10:45–11:45, *Theater II*

MW1 • MW Panel I: State of the Industry
10:45–12:15, *Theater I*

MOPA: Mobile Optics (MOPA) for the 6G Era
11:00–12:00, *Theater III*

DCS1 • Keynote
12:00–12:30, *Theater II*

MW2 • MW Panel II: Inside the Data Center Focused on AI/ML
12:30–14:00, *Theater I*

DCS2 • Panel I: ML/AI and Future Networks to Support it
12:30–14:00, *Theater II*

Infinera: Architecting the Network for the Terabit Era and in the Shadow of Shannon
13:00–13:30, *Theater III*

OFCnet Panel: Telecom Fiber Networks as the Core of the Next Generation TerraScope
13:45–14:15, *Theater III*

Room 1A

14:00–16:00
Tu2A • Optical Transmission Techniques
Presider: Antonio Tartaglia; Ericsson, Italy

Tu2A.1 • 14:00 Tutorial
"Tight Sync" in Precision Time Protocol (PTP), Requirements and Impact at Optical Component Level, Stefano Ruffini[1], Shane McKeown[1]; [1]*Calnex Solutions, UK*. Accurate time sync is required by various applications (e.g., 5G). This talk will go through the challenges in distributing accurate timing, including the impact to performance from some optical technologies, and options to verify performance of optical modules.

Stefano Ruffini graduated in telecommunication engineering from the University of Rome La Sapienza. Strategic Technology Manager at Calnex Solution, Stefano is currently contributing to ITU-T SG15 Q13 (serving as Rapporteur) and other relevant synchronization standardization bodies and forums. He has published several international journal papers. He is member of the Steering Groups of the ITSF and WSTS.

Room 1B

14:00–16:00
Tu2B • Nonlinear Photonic Devices and Material Platforms
Presider: Kazuhiro Ikeda; AIST, Japan

Tu2B.1 • 14:00 Invited
Subwavelength Photonic Structures for Nonlinear Optical Functionalities, Paula Nuño Ruano[1], Jianhao Zhang[2], David González-Andrade[1], Hiba El Batoul Ferhart[1], Thi Thuy Duong Dinh[1], David Medina Quiroz[1], Pavel Cheben[2], Delphine Marris-Morini[1], Eric Cassan[1], Laurent Vivien[1], Norberto Daniel Lanzillotti-Kimura[1], Carlos A. Alonso Ramos[1]; [1]*C2N-CNRS, France;* [2]*CNRS, Canada*. Periodic subwavelength patterning of silicon enables the control of nonlinear effects with unprecedented flexibility. Here, we will present our most recent results on nonlinear supercontinuum generation and nonlinear Brillouin interactions in subwavelength silicon waveguides.

Tu2B.2 • 14:30
IMDD Data Transmission with Microresonator Soliton Crystals, Kenny Y. Ong[1], Xavier X. Chia[1], Aadhi Abdhul Rahim[1], George Chen[1], Dawn Tan[1,2]; [1]*Singapore Univ. of Technology and Design, Singapore;* [2]*Inst. of Microelectronics, A*STAR, Singapore*. Intensity modulated direct detection data transmission using microresonator multi-soliton and 2-soliton crystal are demonstrated. We achieve error free transmission of 10Gb/s NRZ data and BERs in the region of 10^{-4} with 28.05GBd/s PAM4 data.

Room 2

14:00–16:00
Tu2C • Quantum Components and Quantum PICs
Presider: Cheryl Sorace-Agaskar; MIT Lincoln Lab, USA

Tu2C.1 • 14:00
An Integrated Photonic-Electronic Quantum Coherent Receiver for Sub-Shot-Noise-Limited Optical Links, Volkan Gurses[1], Debjit Sarkar[1], Samantha Davis[2], Ali Hajimiri[1]; [1]*Electrical Engineering, California Inst. of Technology, USA;* [2]*Physics, California Inst. of Technology, USA*. We demonstrate an integrated quantum-limited coherent receiver with co-packaged silicon photonics and electronics. The fully integrated receiver has 2.57 GHz bandwidth, 14.5 dB shot noise clearance, 587 μW knee power, and 2.7 × 0.8 mm^2 footprint. with this system, we measure squeezed vacuum showing 0.156 ± 0.039 dB sub-shot-noise-level sensitivity.

Tu2C.2 • 14:15
Photon-Number-Resolving and Ultra-Fast Multipixel SNSPD Arrays for Quantum Photonic Platforms, Giovanni Resta[1,2], Lorenzo Stasi[1,2], Matthieu Perrenoud[2], Rob Thew[2], Hugo Zbinden[2], Félix Bussières[1]; [1]*ID Quantique SA, Switzerland;* [2]*Univ. of Geneva, Switzerland*. We report on a high-efficiency multipixel SNSPD array detecting at >1.5 GHz and that has excellent photon-number resolving (PNR) capability at 1550 nm. This device enables ultrafast QKD with > 60 Mbps secret key rate, and also PNR detection with high *n*-photon efficiencies for photonic quantum processors with various types of photon sources.

Tu2C.3 • 14:30
Stand-Alone 3C-SiC-Based Single-Photon Source Modules for Quantum Key Distribution, Byung-Seok Choi[1], Ju Hee Baek[1], Kap-Joong Kim[1], Joong-Seon Choe[1], Kyongchun Lim[1], Minchul Kim[1], Chun Ju Youn[1]; [1]*Electronics and Telecom Research Inst, Korea (the Republic of)*. We propose the stand-alone 3C-SiC-based single photon source modules for Quantum Key Distribution. They emit single-mode-fiber-coupled single photons at high count rates and operate at room temperature near the telecom O-band.

Room 3

14:00–16:00
Tu2D • High Speed Transmitters
Presider: Yuichi Tohmori; Tsurugi Photonics Foundation, Japan

Tu2D.1 • 14:00 ★ Top-Scored
Demonstration of 155 Gbaud PAM4 and PAM6 EML with Narrow High-Mesa EA Modulator for 400 Gbps per Lane Transmission, Asami Uchiyama[1], Shinya Okuda[1], Toshiya Tsuji[1], Yohei Hokama[1], Mizuki Shirao[1], Kenichi Abe[1], Takeshi Yamatoya[1], Yasuhiro Yamauchi[1]; [1]*Mitsubishi Electric Corporation, Japan*. We experimentally demonstrated 400 Gbps-per-lane EML with narrow high-mesa EA modulator. TDECQ less than 3.3 dB at 310 Gbps (155 Gbaud PAM4) and clear eye diagram at 400 Gbps (155 Gbaud PAM6) were achieved.

Tu2D.2 • 14:15
Process-Tolerant III-v/Si Membrane Distributed Reflector Lasers and 50-Gb/s Direct Modulation at 80°C, Koji Takeda[1], Takuro Fujii[1], Yoshiho Maeda[1], Toru Segawa[1], Shinji Matsuo[1]; [1]*NTT Device Technology Labs, Japan*. We demonstrate distributed reflector lasers based on a III-V/Si membrane platform that includes quantum well intermixed distributed Bragg reflectors offering tolerance to fabrication errors. The laser was used to transmit 50-Gb/s PAM4 signals at 80°C.

Tu2D.3 • 14:30
Uncooled Operation of Directly Modulated Membrane Laser with Buried Sapphire Layer on Si Substrate, Tatsurou Hiraki[1], Yoshiho Maeda[1], Takuro Fujii[1], Koji Takeda[1], Takuma Aihara[1], Toru Segawa[1], Yasutomo Ota[2,3], Satoshi Iwamoto[4], Yasuhiko Arakawa[2], Shinji Matsuo[1]; [1]*NTT Device Technology Labs, Japan;* [2]*Inst. for Nano Quantum Information Electronics, The Univ. of Tokyo, Japan;* [3]*Department of Applied Physics and Physico-Informatics, Keio Univ., Japan;* [4]*Inst. of Industrial Science, The Univ. of Tokyo, Japan*. A membrane laser with a buried sapphire layer on Si has 3-dB bandwidths of 40-25 GHz at 25-80°C. The laser demonstrates 80-Gbit/s PAM4 operations up to 80°C at an energy cost of 0.77 pJ/bit.

Room 6C

14:00–16:00
Tu2E • Advanced Optical Fibers
Presider: Takashi Matsui; NTT Corporation, Japan

Tu2E.1 • 14:00 ★ Top-Scored
Record Low Loss Optical Fiber with 0.1397 dB/km, Shin Sato[1], Yuki Kawaguchi[1], Hirotaka Sakuma[1], Tetsuya Haruna[1], Takemi Hasegawa[1]; [1]*Sumitomo Electric Industries, Ltd., Japan*. We have achieved low loss record of 0.1397 dB/km at 1566 nm wavelength and 0.1406 dB/km at 1550 nm on a Ge-free silica-core fiber that has been achieved by the further reduction of fictive temperature.

Tu2E.2 • 14:15 Invited
Advanced Low-Loss Optical Fibers for High-Capacity Transmissions: From Data Center to Undersea Systems, Benyuan Zhu[1], Tommy Geisler[2], Peter Borel[2], Rasmus Vincentz Skougaard Jensen[2], Matthias U. Stegmaier[2], Bera Palsdottir[2], David Peckham[3], David DiGiovanni[1]; [1]*OFS Laboratories, USA;* [2]*OFS Fitel Denmark, Denmark;* [3]*OFS, USA*. We review recent progresses of advanced ultra-low-loss (ULL) fibers, introducing an 85 um^2 effective-area fiber with record-low-attenuation of 0.1474 dB/km at 1550 nm. We also highlight system demonstrations using ULL fibers and their relevance to DCI/metro and undersea network.

Room 6D

14:00–16:00
Tu2F • Moore's Law: A Photonics Perspective for the Next Decade
Presider: Paul Gunning; British Telecommunications, UK

Tu2F.1 • 14:00 Invited
Keeping up with Moore's Law, Andreas Bechtolsheim[1]; [1]*Arista Networks, Inc., USA*. This presentation discusses how Photonics can keep up with Moore's law given that the dimensions of Photonics devices for generating, propagating and modulating light do not benefit from the ever shrinking feature sizes of advanced process technologies.

Tu2F.2 • 14:20 Invited
Moore's Law Redefined for AI/HP, Katharine Schmidtke[1], Hans-Juergen Schmidtke[1]; [1]*Eribel Systems LLC, USA*. Examining the impact of AI workloads on system performance, we reapply Moore's law at the system level to uncover the implications for photonic components and the drivers that will propel the photonic industry forward.

Room 6E

14:00–16:00
Tu2G • Panel: Beyond Two-Core Fibers: Single-Core vs Multi-Core Amplifiers in Long-Haul SDM Links

Organizers
Victor Kopp, *Chiral Photonics, USA*
Atsushi Nakamura, *NTT, Japan*
Bera Pálsdóttir, *OFS Fitel Denmark I/S, Denmark*
Masato Tanaka, *Sumitomo Electric Industries Ltd, Japan*

Speakers
Dan Neugroschl, *Chiral Photonics, USA*
Philippe Perrier, *Meta, USA*
Massimiliano Salsi, *Google, USA*
Ryuichi Sugizaki, *Furukawa, Japan*
Hitoshi Takeshita, *NEC, Japan*
Yuta Wakayama, *KDDI, Japan*

Space division multiplexing (SDM) is a promising approach for overcoming the capacity crunch of current fiber-optic transmission systems. In recent years, SDM transmission using uncoupled multi-core fibers (MCFs) with standard cladding diameter has attracted much attention, mainly for its potential application in long-haul submarine networks. Two-core links envisioned as a first generation of multi-core SDM will use bidirectional transmission and well-developed and tested single-core erbium-doped optical fiber amplifiers (EDFAs).

EDFAs for the next generation of MCF-SDM can be implemented in single-core and multi-core fibers (MCFs). The former typically requires a pair of fan-in/out devices and consists of conventional single-core EDFAs and related components. The latter utilizes multi-core components such as MC-EDFs, MC-WDM couplers, MC-GFFs, and MC-isolators. Which approach will be adopted depends on the transmission scheme of MCF systems and on the availability of suitable components. The choices that are made will determine the direction of the development of future optical fiber networks.

The panelists will discuss the pros and cons of both approaches utilizing single-core and multi-core amplifiers from different perspectives and will provide insight into future MCF networks.

Topics will include the following:

- Unidirectional MCF transmission vs. bidirectional MCF transmission
- Single-core amplifier vs. multi-core amplifier
- Core-pumped amplifier vs. cladding-pumped amplifier

Room 6F

14:00–16:00
Tu2H • Transceiver and Transmission Impairments Mitigation
Presider: Dario Pilori; Politecnico di Torino, Italy

Tu2H.1 • 14:00 Tutorial
Probabilistic Shaping for Nonlinearity Mitigation, Lutz Lampe[1]; [1]*Univ. of British Columbia, Canada*. In its broad application, signal shaping can serve as a method for mitigating nonlinearity in optical fiber communication, complementing established techniques for nonlinearity compensation. We will explore recent findings on widely used probabilistic constellation shaping aimed at minimizing nonlinear effects.

Lutz Lampe is a Professor in the Department of Electrical and Computer Engineering at the University of British Columbia, Canada. His research focuses on signal design, detection and estimation, and employing learning-from-data methods in communication systems. He has made contributions in the fields of (optical) wireless, power-line, and optical-fiber communications.

Room 7

14:00–16:00
Tu2I • Panel: Can New Access Technology and Architectures Support the Beyond 5G Network Vision

Organizers
Annachiara Pagano, *Telecom Italia, Italy*
Chatu Ranaweera, *Deakin University, Australia*
Lihua Ruan, *Chinese University of Hong Kong, Shenzhen, China*
Marco Ruffini, *Trinity College Dublin, Ireland*

Speakers
Rene Bonk, *Nokia Bells Lab, USA*
Denis Khotimsky, *Verizon, USA*
Idelfonso Monroy, *Eindhoven University of Technology, Netherlands*
Fabienne Saliou, *Orange Labs, USA*
Elaine Wong, *The University of Melbourne, Australia*
Jim Zou, *ADVA, Germany*

Passive optical networks are still mostly developed and used with residential broadband in mind. However, technological advancements, such as development of coherent technology, can give new potential to the fibre access networks. Beside the increase in capacity, the flexibility and the increased budget, these can support new architectures, which can be used to support future services. For example xHaul transport for mmWave and THz communications, including Analogue Radio over Fibre, or ubiquitous ultra-low latency connectivity to nodes located at the very edge of the network. This panel brings together experts among operators, vendors and academics to discuss how PON architectures should evolve, what supporting technology will be available in the near to medium term and whether it can fully support future beyond 5G network vision.

Room 8

14:00–16:00
Tu2J • Fiber Sensing Applications I
Presider: Ting Wang; NEC Laboratories America Inc., USA

Tu2J.1 • 14:00 Invited
Digital Coherent Sensing Over Deployed Fibers for Advanced Network Telemetry, Sterenn Guerrier[1], Christian Dorize[1], Henrique Pavani[1,2], Haik Mardoyan[1], Elie Awwad[2], Jeremie Renaudier[1]; [1]*Nokia Bell Labs, France;* [2]*Télécom Paris, France*. We discuss the performance of Coherent-MIMO-DFS over deployed optical networks in various configurations and address technological challenges such as adaptation to various fiber types, disturbance identification.

Tu2J.2 • 14:30
Enabling Endogenous DAS in P2MP Digital Subcarrier Coherent Transmission System with Enhanced Frequency Response, Zihe Hu[1], Can Zhao[1], Yizhao Chen[1], Mingming Zhang[1], Junda Chen[1], Weihao Li[1], Luming Zhao[1], Ming Tang[1]; [1]*HUST, China*. We propose an endogenous DAS in P2MP digital subcarrier coherent transmission systems. By redesigning and reusing FrFT-based synchronization pilots, vibrations up to 12 kHz are successfully detected over 10-km-long fiber, along with 100-Gb/s 16QAM transmission.

Room 9

14:00–16:00
Tu2K • Indoor Optical Wireless Communication
Presider: James Lott; Technical Univ. Berlin, Germany

Tu2K.1 • 14:00 ★ Top-Scored
519.21Gbps Optical Interconnect Using 50-Channel Pre-Equalized WDM Visible Light Laser Communication System, Xianhao Lin[1], Haoyu Zhang[1], Zhilan Lu[1], Zhiteng Luo[1], Chao Shen[1], Jianyang Shi[1], Junwen Zhang[1], Ziwei Li[1], Hui Chen[2], Zhixue He[2], Shaohua Yu[2], Nan Chi[1]; [1]*Fudan Univ., China;* [2]*Peng Cheng Lab, China*. We demonstrate a record-breaking 519.21Gbps transmission using an integrated WDM visible light laser communication system and hardware pre-equalization for the first time. It is a promising solution for next generation optical interconnects in data centers.

Tu2K.2 • 14:15 ★ Top-Scored
All-in-one to-can-Packed RGB-LD Lamp Enables 40-Gbit/s White-Lighting Wireless DMT Link, Gong-Ru Lin[1], Chih-Hsien Cheng[2], Po-Lun Chen[1], Pin-Wei Ho[1], Szu-En Lai[1], Yi-Chien Wu[1], Yu-Sheng Liao[3], Yu-Chieh Chi[3], Atsushi Matsumoto[2], Kouichi Akahane[2]; [1]*National Taiwan Univ., Taiwan;* [2]*National Inst. of Information and Communications Technology, Japan;* [3]*SANway Optoelectronics tech. Corp., Taiwan*. White-lighting lamp beam with an all-in-one TO-can-packaged RGB-LD chip is performed with an illuminance of >300 lux, a CRI of >80, and a CCT of 6500K for free-space-optical wireless 16-QAM DMT link at 38.4 Gbit/s.

Tu2K.3 • 14:30
Flexible WDM VLC System with LEDs as Multi-Gb/s Receivers and Beacon Emitters for Integrated Localization, Bernhard Schrenk[1]; [1]*AIT Austrian Inst. of Technology, Austria*. Multi-color in-door VLC is demonstrated at 5.3-Gb/s λ-bonded pencil-beam transmission after receiver localization through multi-purpose LEDs. Flexible spectrum allocation with <65-ms switching time and the robustness to optical reflections at the VLC fronthaul are proven.

Show Floor Programming

OFCnet Panel: Telecom Fiber Networks as the Core of the Next Generation TerraScope
13:45–14:15, *Theater III*

MW3 • MW Panel III: Coherent Technology Advancements to Address Next-Gen Networking Requirements
14:15–14:45, *Theater I*

DCS3 • Panel II: Lowering Power Consumption in Optical Solutions
14:15–15:45, *Theater II*

F5G Intelligent and Green Networks towards 2030
14:30–15:30, *Theater III*

Room 1A

Tu2A • Optical Transmission Techniques—Continued

Tu2A.2 • 15:00 Invited

Optical and THz Broadband Integrated Circuits for Mode-Dependent Free-Space Communications, Alan E. Willner[1]; [1]*Univ. of Southern California, USA.* Integrated circuits may be important role in future mode-dependent free-space communications. This presentation will describe broadband optical and THz structures that can generate data-carrying beams on unique spatial modes. One example is tunable pixel-array-based metasurfaces.

Room 1B

Tu2B • Nonlinear Photonic Devices and Material Platforms—Continued

Tu2B.3 • 14:45

Foundry Compatible, Efficient Wafer-Scale Manufacturing of Ultra-Low Loss, High-Density Si3N4 Photonic Integrated Circuits, Xinru Ji[1], Rui N. Wang[1], Yang Liu[1], Johann Riemensberger[1], Zheru Qiu[1], Tobias J. Kippenberg[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland.* We demonstrate ultra-low propagation loss, lithographic precision, and wafer-scale manufacturing for high-density Si_3N_4 photonic integrated circuits using an efficient DUV-based subtractive approach. We show a propagation loss as low as 1.4 dB/m at 1.55 μm.

Tu2B.4 • 15:00

1 Million Intrinsic Q-Factor Microring Resonators From PVD Aluminum Nitride on SiO_2-on-Si Substrate, Amy Tong[1], Wing Wai Chung[1], Charmaine Goh[1], Landobasa Y. M. Tobing[1], Leh Woon Lim[1], Yuriy Akimov[3], Zhan Jiang Quek[1], Aravind Anthur[2], Jia Sheng Goh[1], Huamao Lin[1], Navab Singh[1], Qingxin Zhang[1], Doris K. T. Ng[1]; [1]*Inst. of Microelectronics (IME), Agency for Science, Technology and Research (A*STAR), Singapore;* [2]*Inst. of Materials Research and Engineering (IMRE), Agency for Science, Technology and Research (A*STAR), Singapore;* [3]*Inst. of High Performance Computing (IHPC), Agency for Science, Technology and Research (A*STAR), Singapore.* We present PVD AlN microring resonators on SiO_2-on-Si substrate with intrinsic Q-factor >1 million at C-band. To the best of our knowledge, this is the highest intrinsic Q-factor reported for PVD AlN on SiO_2-on-Si substrate.

Room 2

Tu2C • Quantum Components and Quantum PICs—Continued

Tu2C.4 • 14:45

Multi-Channel System with High-Performance Fractal Superconducting Nanowire Single-Photon Detectors, Zifan Hao[1], Kai Zou[1], Yun Meng[1], Thomas Descamps[2], Adrian Iovan[2], Val Zwiller[2], Xiaolong Hu[1]; [1]*Tianjin Univ., China;* [2]*Royal Inst. of Technology (KTH), Sweden.* We report on an eight-channel fractal SNSPD system in the wavelength range of 940 nm with minimal polarization sensitivity. The best channel exhibits 96% system detection efficiency and 19 cps dark-count rate.

Tu2C.5 • 15:00 Invited

Advances in Photonic Integration for Quantum Communications, Taofiq Paraiso[1]; [1]*Toshiba Research Europe Ltd, UK.* We review recent progress in the development of photonic integrated circuits for high speed, real-time quantum random number generation and quantum key distribution.

Room 3

Tu2D • High Speed Transmitters—Continued

Tu2D.4 • 14:45

A Co-Planar Stripline Mach-Zehnder Modulator Enabling 160 GBd PAM-4 on an Indium Phosphide Platform, James A. Hillier[1], Qian Hu[2], Haoshuo Chen[2], Arezou Meighan[4], Luc Augustin[3], Michael Wale[1,5], Kevin Williams[1], Weiming Yao[1]; [1]*Eindhoven Hendrik Casimir Inst., Eindhoven Univ. of Technology, Netherlands;* [2]*Nokia Bell Labs, USA;* [3]*SMART Photonics, Netherlands;* [4]*Infinera Optics B.V., Netherlands;* [5]*Department of Electronic and Electrical Engineering, Univ. College London, UK.* Large signal measurements are undertaken on electro-optic Mach-Zehnder modulators using a co-planar-stripline design, realised for the first time on a generic InP platform, demonstrating a 320 Gbit/s line rate with a bit error rate of 1.62×10^{-2}.

Tu2D.5 • 15:00

A 64 Gb/s NRZ O-Band Ring Modulator with 3.2 THz FSR for DWDM Applications, Chuan Xie[1], Mayank Raj[1], Anish Joshi[1], Zakriya Mohammed[1], Gareeyasee Saha[1], Zhaowen Wang[1], Parag Upadhyaya[1], Yohan Frans[1]; [1]*Advanced Micro Devices (AMD), USA.* We demonstrate the highest BW-FSR product O-band Si microring modulator to date. The device achieves 3.2 THz FSR, 41 GHz BW, 44 pm/V modulation efficiency, and operates at 64 Gb/s NRZ.

Room 6C

Tu2E • Advanced Optical Fibers—Continued

Tu2E.3 • 14:45

Reduced Single-Coating Diameter Fiber, Pierre Sillard[1], Cyril Mentzler[1], Adrian Amezcua[1]; [1]*Prysmian Group, France.* We report the fabrication of a colored 170μm single-coating diameter fiber with standard 125μm cladding diameter. This fiber shows good optical properties, including microbending sensitivity, and improved mechanical properties compared to reduced dual-coating diameter fibers.

Tu2E.4 • 15:00

Record Length of 2000km Weakly-Coupled 7-Core MCF Produced From a Single Large-Scale MCF Preform, Tobias Tiess[1], Michael Lorenz[1], Jong-Won Lee[2], Maximilian Schmitt[2], Jimmy E. Beavers[2], Evan Green[2], Nicolaj L. Andersen[3], Andreas C. Samson[3], Frederik N. Andersen[3], Sarah Cwalina[4], Kai Habel[4], Qiulin Ma[2], Martin Boettcher[1], Kay Schuster[1]; [1]*Heraeus Quarzglas Bitterfeld, Germany;* [2]*Heraeus Quartz North America LLC, USA;* [3]*Heraeus Comvance Denmark ApS, Denmark;* [4]*Fraunhofer-Institut für Nachrichtentechnik HHI, Germany.* We present the design and fabrication of more than 2000km of MCF drawn from a single large-scale MCF preform. The fiber was fabricated without any online fiber breaks and exhibits excellent geometrical conformity.

Room 6D

Tu2F • Moore's Law: A Photonics Perspective for the Next Decade—Continued

Tu2F.3 • 14:40 Invited

Breaking Down the Interconnect Bottleneck - a Third Dimension, Rebecca K. Schaevitz[1]; [1]*Lightmatter, USA.* Passage™ is a fundamental shift in design and packaging that replaces silicon substrates with a programmable silicon photonic interposer, enabling the scale up and out required by the AI/ML network topologies of new data centers.

Tu2F.4 • 15:00 Invited

In-Package Optical I/O: Bridging the Gap Between Moore's Law and Amdahl's Law in Modern Compute Systems, Vladimir Stojanovic[1]; [1]*Ayar Labs, USA.* The growing gap between the performance of processing silicon and the modern application needs can only be bridged by large-scale distributed computation. Low latency, high-bandwidth density and high-radix of in-package optical I/O enables new fabrics and highly performant distributed system architectures.

Room 6E

Tu2G • Panel: Beyond Two-Core Fibers: Single-Core vs Multi-Core Amplifiers in Long-Haul SDM Links—Continued

Room 6F

Tu2H • Transceiver and Transmission Impairments Mitigation—Continued

Tu2H.2 • 15:00
In-Service Transmitter Calibration via Offloaded 4×2 WL MIMO Equalizer with Compensating IQ Imbalance, Masaki Sato[1], HIdemi Noguchi[1], Junichiro Matsui[1], Jun'ichi Abe[1], Emmanuel Le Taillandier de Gabory[1]; *[1]NEC Corporation, Japan*. In-service Tx-IQ imbalance calibration estimated with 4×2 MIMO equalizer for 96-Gbaud PM-PCS-64QAM was demonstrated over 120 km SMF. Q-penalties of 0.1 dB with 2 ps IQ skew and ±2.5 dB IQ peaking error were achieved.

Room 7

Tu2I • Panel: Can New Access Technology and Architectures Support the Beyond 5G Network Vision—Continued

Room 8

Tu2J • Fiber Sensing Applications I—Continued

Tu2J.3 • 14:45
High-Efficiency ISAC to Enable Sub-Meter Level Vibration Sensing for Coherent Fiber Networks, Jingchuan Wang[1], Liwang Lu[1,2], Li Wang[1], Yaxi Yan[1,2], Alan P. Lau[1], Chao Lu[1]; *[1]The Hong Kong Polytechnic Univ., Hong Kong; [2]Zhejiang Normal Univ., China*. We demonstrate 0.5 m resolution vibration sensing and 60 GBaud 16-QAM data transmission with negligible crosstalk over 10 km fiber using a new integrated communication and distributed acoustic sensing scheme with shared spectrum and transmitter.

Tu2J.4 • 15:00 ★ Top-Scored
Anomaly Detection and Localization in Optical Networks Using Vision Transformer and SOP Monitoring, Khouloud Abdelli[1], Matteo Lonardi[1], Jurgen Gripp[2], Diego Correa[2], Samuel Olsson[2], Fabien Boitier[1], Patricia Layec[1]; *[1]Nokia Bell Lab, Germany; [2]Nokia, USA*. We introduce an innovative vision transformer approach to identify and precisely locate high-risk events, including fiber cut precursors, in state-of-polarization derived spectrograms. Our method achieves impressive 97% diagnostic accuracy and precise temporal localization (6-ms- RMSE).

Room 9

Tu2K • Indoor Optical Wireless Communication—Continued

Tu2K.4 • 14:45
Optical Beam Steerable and Beam Dividable of Non-Orthogonal Multiple Access (NOMA) Signal with Low-Density Parity-Check (LDPC) for Multi-User Optical Wireless Communication System, Yin-He Jian[1], Chih-Chun Wang[1], Jian-Wen Chen[1], Tzu-Chieh Wei[1], Chi-Wai Chow[1], Chien-Hung Yeh[2]; *[1]National Yang Ming Chiao Tung Univ., Taiwan; [2]Feng Chia Univ., Taiwan*. We propose a spatial-light-modulator (SLM)-enabled optical beam steerable and beam dividable optical-wireless-communication (OWC) using orthogonal-frequency-division-multiplexing non-orthogonal-multiple-access (OFDM-NOMA) and low-density-parity-check (LDPC). Three-layer successive-interference-cancellation (SIC) is experimentally demonstrated.

Tu2K.5 • 15:00
30 Gbit/s Visible Light Communication System with Optimized Color Temperature, Pedro Loureiro[1], Fernando P. Guiomar[1], Gil Fernandes[1], Sandra Correia[1], Maria André[2], Paulo Monteiro[1]; *[1]Instituto De Telecomunicacoes, Portugal; [2]CICECO, Portugal*. We jointly optimize the bit rate and correlated color temperature (CCT) of a diffuse light RGB-VLC system using laser diodes. Bit rates of 27-33 Gbit/s and CCT of 2500-6500K are experimentally demonstrated, respecting the lighting recommendations for a set of potential application scenarios.

Show Floor Programming

OFCnet Panel: Telecom Fiber Networks as the Core of the Next Generation TerraScope
13:45–14:15, *Theater III*

MW3 • MW Panel III: Coherent Technology Advancements to Address Next-Gen Networking Requirements
14:15–14:45, *Theater I*

DCS3 • Panel II: Lowering Power Consumption in Optical Solutions
14:15–15:45, *Theater II*

F5G Intelligent and Green Networks towards 2030
14:30–15:30, *Theater III*

Room 1A

Tu2A • Optical Transmission Techniques—Continued

Tu2A.3 • 15:30
Liquid Cooling for Optical Networking Equipment, Behzad Mohajer[1], Peter Ajersch[1], Michael Bishop[1], Simon Shearman[1], Peter Saturley[1], Marko Nicolici[1]; [1]*Ciena, Canada.* This article provides insights into a successful upgrade of an air-cooled coherent metro router into a Hybrid Liquid/Air-cooled system. Additionally, an innovative solution is presented for integrating liquid-cooling into the body of pluggable optical modules.

Room 1B

Tu2B • Nonlinear Photonic Devices and Material Platforms—Continued

Tu2B.5 • 15:15
Low-Loss and Thermal-Stable Ta_2O_5 Photonic Platform with Low-Temperature Process, Zhaoting Geng[1], Weiren Cheng[1], Zhenyu Liu[1], Mingjian You[1], Xiaolun Yu[1], Pengzhuo Wu[1], Ning Ding[1], Xingyu Tang[1], Yihan Liu[1], Li Shen[2], Qiancheng Zhao[1]; [1]*Southern Univ. of Science and Technology, China;* [2]*Huazhong Univ. of Science and Technology, China.* We demonstrate a Ta_2O_5 photonic platform with a propagation loss of 0.5dB/cm and a thermo-optic coefficient of 2.3×10^{-6} /K at 1550 nm. The process temperature is below 350C, friendly to integration with other optoelectronic components.

Tu2B.6 • 15:30
Monolithically Integrated Magneto-Optical Isolators, Circulators and Phase Shifters on SiN Photonics, Lei Bi[1], Wei Yan[1], Yucong Yang[1], Zixuan Wei[1], Di Wu[1], Zijian Zhang[1], Xiaoyi Song[1], Jun Qin[1]; [1]*Univ of Electronic Sci & Tech of China, China.* We report monolithically integrated magneto-optical isolators, circulators on SiN with 30 dB isolation ratio, -28 dB cross-talk, 54 nm 20 dB isolation bandwidth, and 2.7 dB insertion loss. Compact magneto-optical phase shifter arrays with $V_\pi L$=0.3 Vcm were also developed, allowing the development of MHz speed optical phased arrays on SiN.

Room 2

Tu2C • Quantum Components and Quantum PICs—Continued

Tu2C.6 • 15:30 Invited
Ultralow-Loss Silicon Nitride Integrated Circuits for Nonlinear and Quantum Photonics, Junqiu Liu[1]; [1]*Univ of Science and Technology of China, China.* Abstract not available.

Room 3

Tu2D • High Speed Transmitters—Continued

Tu2D.6 • 15:15
SOA-Integrated High-Power EML-CAN for 50G-PON Downstream, Satoshi Nishikawa[1], Ryoko Suzuki[1], Masahiro Matsuura[1], Yusuke Azuma[2], Kairi Atsugi[2], Yu Uwadoi[2], Hironori Nakahara[2], Yosuke Suzuki[1]; [1]*Advanced Technology R&D Center, Mitsubishi Electric Corporation, Japan;* [2]*High Frequency & Optical Device Works, Mitsubishi Electric Corporation, Japan.* A high-power SOA-integrated EML was demonstrated for a 50G-PON downstream (20 dBm output power). An EML-CAN was developed using this chip and it could effectively satisfy the ITU-T standard, thereby demonstrating its remarkable characteristics.

Tu2D.7 • 15:30 Invited
High Speed InP Modulator for Beyond 200 Gbaud, Yoshihiro Ogiso[1], Josuke Ozaki[1], Kenta Sugiura[1], Yusuke Saito[1], Mitsuteru Ishikawa[1]; [1]*NTT Device Innovation Center, Japan.* We developed a next-generation InP twin-IQ modulator PIC for beyond 200-Gbaud operations. A 3-dB electro-optic bandwidth of the modulator exceeds 100 GHz while maintaining a half-wave voltage of 1.5 V and total on-chip optical insertion loss of less than 3.5 dB.

Room 6C

Tu2E • Advanced Optical Fibers—Continued

Tu2E.5 • 15:15 Invited
Optofluidic Microstructured Fibers: a Nanoparticle Tracking Analysis Platform for Understanding Nanoscale Objects Such as SARS-CoV-2, Markus Schmidt[1]; [1]*Leibniz-Institut für Photonische Tech, Germany.* Understanding nanoscale processes at the single-species level is highly relevant for many areas. Here, we will present the details of fiber-assisted nanoparticle tracking analysis and show various experimental results relying on microstructured fibers.

Room 6D

Tu2F • Moore's Law: A Photonics Perspective for the Next Decade—Continued

Tu2F.5 • 15:20 Invited
The Path for Scaling Photonic Integrated Circuits, Anna Tauke-Pedretti[1]; [1]*DARPA, USA.* Computing, sensing and data transmission architectures all benefit from larger and more complex photonic circuits. A perspective on how these circuits could scale by overcoming unique technological challenges of photonics will be presented.

Room 6E

Tu2G • Panel: Beyond Two-Core Fibers: Single-Core vs Multi-Core Amplifiers in Long-Haul SDM Links—Continued

Room 6F

Tu2H • Transceiver and Transmission Impairments Mitigation—Continued

Tu2H.3 • 15:15
Transmitter Impairment Mitigation by 8×2 Widely Linear MIMO Equalizer with Improved Frequency Offset Tolerance, Xiang Li[1], Xuemeng Hu[1], Zenpeng Gong[1], Pengpeng Wei[1], Fan Shi[1], Xiao Xiao[2], Tianye Huang[1]; [1]*China Univ. of Geosciences, China;* [2]*Zhongrui Sulian (Wuhan) Science and Technology Co., Ltd, China.* Transmitter impairment mitigation for 45GBaud DP-64QAM with 8×2 WL MIMO equalizer embedding CW-DA-WL phase estimator is demonstrated. Q penalty less than 0.5-dB with 8-ps IQ skew and 2.5-dB power imbalance are achieved with improved tolerance to frequency offset.

Tu2H.4 • 15:30
Distortion Characterization and Performance Estimation of Time-Interleaved DAC and ADC Based on the Measurement of Nonlinear Noise Spectrum, Tong Ye[1], Ke Zhang[1], Xiaofei Su[1], Jingnan Li[1], Hisao Nakashima[2], Takeshi Hoshida[2], Zhenning Tao[1]; [1]*Fujitsu R&D Center, China;* [2]*Fujitsu Ltd., Japan.* Unlike many nonlinear devices, the time-interleaved DAC and ADC can be characterized by simple notch method accurately due to their unique nonlinear mechanism. By constructing equivalent model with measured noise spectrum, nonlinear system Q is estimated with 0.2-dB accuracy.

Room 7

Tu2I • Panel: Can New Access Technology and Architectures Support the Beyond 5G Network Vision—Continued

Room 8

Tu2J • Fiber Sensing Applications I—Continued

Tu2J.5 • 15:15
Local Wind Impact Sensing Using State of Polarization Measurement on a Live Short-Haul Aerial Fibre Cable, Kristina Shizuka Yamase Skarvang[1], Steinar Bjørnstad[2,4], Erik Sæthre[3], Dag Roar Hjelme[1]; [1]*NTNU, Norway;* [2]*Tampnet, Norway;* [3]*GlobalConnect, Norway;* [4]*Simula Research Laboratory, Norway.* A short aerial cable spun on a high-voltage line is used to monitor wind-induced stress on the cable infrastructure. Span-by-span localized early warnings may be issued based on the state of polarization transients.

Tu2J.6 • 15:30
Field Detection and Localization of Digging Excavator Events Using MIMO Digital Fiber Sensing Over a Deployed Optical Network for Proactive Fiber Break Prevention, Sterenn Guerrier[1], Haik Mardoyan[1], Christian Dorize[1], Henrique Pavani[1], Khalid Darwish[2], Mohammed Biyahi[3], Luigi Re[4], Amin Koubaa[5], Hassan Galal[5], Sylvain Chenard[6], Jeremie Renaudier[1]; [1]*Optical Transmission Dpt, Nokia Bell Labs, France;* [2]*IT Engineering Dept., Aramco, Saudi Arabia;* [3]*Area IT Dept., Aramco, Saudi Arabia;* [4]*Networks Infrastructure Division, Nokia, Italy;* [5]*Networks Infrastructure Division, Nokia, Saudi Arabia;* [6]*Networks Infrastructure Division, Nokia, Canada.* We demonstrate the detection and localization of the perturbations induced by a jackhammer and an excavator over a buried fiber cable from an operational optical network thanks to high sensitivity Multiple-Input-Multiple-Output digital fiber sensing.

Room 9

Tu2K • Indoor Optical Wireless Communication—Continued

Tu2K.6 • 15:15
40-Gbit/s Mobile FSO with High-Speed Beam Stabilizer and 2D-PDA-Based Diversity Receiver for Support Robots, Zu-Kai Weng[4], Yuki Yoshida[4], Toshimasa Umezawa[4], Abdelmoula Bekkali[1], Michikazu Hattori[1], Atsushi Matsumoto[4], Atsushi Kanno[2,4], Naokatsu Yamamoto[4], Tetsuya Kawanishi[3,4], Kouichi Akahane[4]; [1]*Toyo Electric Corporation, Japan;* [2]*Nagoya Inst. of Technology, Japan;* [3]*Waseda Univ., Japan;* [4]*National Inst. of Information and Communications Technology, Japan.* A mobile free-space optical system is experimentally demonstrated with high-speed beam stabilizer and 2D-photodetector array-based diversity receiver. In the 2.1-m line-of-sight link, the 400-mm/s zigzag-moving transmitter successfully transmits the 40-Gbit/s PAM-4 within 7% FEC criterion.

Tu2K.7 • 15:30
High-Bandwidth GaN Substrate Single-Pixel Blue Micro-LED Toward 10 Gbps Visible Light Communication, Zhiwei Rao[1], Xinyi Shan[1], Yue Liao[1], Zuxin Jin[1], Runze Lin[1], Xugao Cui[1], Pengfei Tian[1]; [1]*Fudan Univ., China.* A record data rate of 10.009 Gbps at a distance of 0.55 m based on a single c-plane freestanding GaN micro-LED was achieved by using OFDM modulation and a bit-loading algorithm.

Show Floor Programming

OFCnet Panel: Telecom Fiber Networks as the Core of the Next Generation TerraScope
13:45–14:15, *Theater III*

MW3 • MW Panel III: Coherent Technology Advancements to Address Next-Gen Networking Requirements
14:15–14:45, *Theater I*

DCS3 • Panel II: Lowering Power Consumption in Optical Solutions
14:15–15:45, *Theater II*

F5G Intelligent and Green Networks towards 2030
14:30–15:30, *Theater III*

Room 1A	Room 1B	Room 2	Room 3	Room 6C	Room 6D
Tu2A • Optical Transmission Techniques—Continued	**Tu2B • Nonlinear Photonic Devices and Material Platforms—Continued**	**Tu2C • Quantum Components and Quantum PICs—Continued**	**Tu2D • High Speed Transmitters—Continued**	**Tu2E • Advanced Optical Fibers—Continued**	**Tu2F • Moore's Law: A Photonics Perspective for the Next Decade—Continued**
Tu2A.4 • 15:45 **Spectrally Sliced Optical Arbitrary Waveform Measurement (OAWM) Using a Photonic Multi-Chip Receiver Assembly,** Dengyang Fang[1], Daniel Drayss[1], Yung Chen[1], Matthias Lauermann[2], Huanfa Peng[1], Grigory Lihachev[3], Alexander Quint[1], Luca Valenziano[1], Sebastian Randel[1], Thomas Zwick[1], Wolfgang Freude[1], Tobias J. Kippenberg[3], Christian Koos[1]; [1]*Karlsruhe Inst. of Technology (KIT), Germany;* [2]*Vanguard Automation GmbH, Germany;* [3]*Swiss Federal Inst. of Technology Lausanne (EPFL), Swaziland.* We demonstrate the first spectrally sliced OAWM receiver assembly that combines slicing filters and optical receivers in a hybrid multi-chip module. We prove the viability of the device by receiving a wavelength-division-multiplexed signal over a bandwidth of 320 GHz.				**Tu2E.6 • 15:45** **Power Resilient, Air-Gap Multi-Core Fiber with >20 W Fiber Fuse Propagation Threshold per Core,** Aditi Mehta[1], Kazunori Mukasa[2], Takeshi Takagi[2], Mujtaba Zahidy[1], Yaoxin Liu[1], Kjeld Dalgaard[1], Karsten Rottwitt[1], Michael Galili[1], Leif K. Oxenløwe[1], Toshio Morioka[1]; [1]*Danmarks Tekniske Universitet, Denmark;* [2]*Telecommunications & Energy Laboratories, Furukawa Elecrtric, Japan.* We measured fiber fuse properties of FMFs, coupled/uncoupled MCFs, and novel air-gap MCFs. We found that air-gap MCFs have fiber fuse propagation threshold of more than 20 W owing to efficient heat diffusion into air.	**Tu2F.6 • 15:40** Invited **Keeping up with and Enabling Moore's Law: Role of Photonics I/O,** Amit Nagra[1]; [1]*Intel, USA.* Intel presents its perspective on how photonic integration can enable similar performance scaling as Moore's Law for package I/O with higher data throughput and lower energy consumption, to support the emerging AI infrastructure needs.

16:00–16:30 Coffee Break, *Exhibit Hall*
Elevated Coffee Break, Sponsored by Infinera, *Booth 4217*

Room 6E

Tu2G • Panel: Beyond Two-Core Fibers: Single-Core vs Multi-Core Amplifiers in Long-Haul SDM Links—Continued

Room 6F

Tu2H • Transceiver and Transmission Impairments Mitigation—Continued

Tu2H.5 • 15:45
Frequency-Band Analysis of Equalization Enhanced Phase Noise Jointly with DSP Impact, Celestino S. Martins[1], Abel Lorences-Riesgo[1], Sami Mumtaz[1], Trung-Hien Nguyen[1], Abir Hraghi[1], Zhihang Wu[1], Yann Frignac[1], Gabriel Charlet[1], Yu Zhao[1]; [1]*Huawei Technologies France, France*. The fundamental of equalization-enhanced phase noise (EEPN) jointly with the DSP impact is investigated, using an approach based on frequency-band segmentation of the frequency-noise (FN) spectrum. This approach enables to study the EEPN penalty of different FN spectral regions and correlated with its bursty nature.

Room 7

Tu2I • Panel: Can New Access Technology and Architectures Support the Beyond 5G Network Vision—Continued

Room 8

Tu2J • Fiber Sensing Applications I—Continued

Tu2J.7 • 15:45
Field Test of Communication Cable for Environmental Monitoring, Chuanbiao Zhang[1], Xiongyan Tang[1], Guangquan Wang[1], Shikui Shen[1], He Zhang[1], Yanbiao Chang[1], Junzhong Cao[2]; [1]*China Unicom Research Inst., China;* [2]*China Unicom Tianjin Branch, China*. A routing section of the communication cable in the live network is used, combined with distributed optical fiber sensing equipment, for long-term monitoring, and through data recording, to achieve a variety of dynamic event response analysis.

Room 9

Tu2K • Indoor Optical Wireless Communication—Continued

Tu2K.8 • 15:45
Wavelength-Multiplexed Beam Steering in Fiber and Visible Light Communication Integrated Indoor Access Network, Wenqing Niu[1], Fujie Li[1], Zengyi Xu[1], Chao Shen[1], Ziwei Li[1], Jianyang Shi[1], Junwen Zhang[1], Nan Chi[1]; [1]*Fudan Univ., China*. We propose a wavelength-multiplexed fiber and VLC integrated access network. Neural networks with a generator-model structure are employed for single-hologram-based wavelength-multiplexed beam steering. A 2λ transmission with overall data rate of 4.02 Gbps is demonstrated.

16:00–16:30 Coffee Break, *Exhibit Hall*
Elevated Coffee Break, Sponsored by Infinera, *Booth 4217*

Show Floor Programming

OFCnet Panel: Quantum Key Distribution High-Speed Optical-Layer Encryption
15:45–16:30, *Theater III*

Room 1A

16:30–18:30
Tu3A • CPO and Ecosystem
Presider: Janet Chen; Meta, USA

Tu3A.1 • 16:30 Invited
Advancement in CPO and Ecosystem, Matthew Traverso[1]; [1]*Cisco Systems Inc, USA.* Abstract not available.

Room 1B

16:30–18:30
Tu3B • 6G and Emerging Applications
Presider: Daniel Kilper; Univ. of Dublin Trinity College, Ireland

Tu3B.1 • 16:30 Invited
The Role of Optical Networking in the 6G Era, Ioannis Tomkos[1], Dimitris Uzunidis[1], Konstantinos Moschopoulos[1], Christos Christofidis[1], Charalampos Papapavlou[1], Konstantinos Paximadis[1], Raul Muñoz[2], Dan M. Marom[3], Moshe Nazarathy[4]; [1]*Univ. of Patras, Greece;* [2]*Centre Tecnologic de Telecomunicacions de Catalunya, Spain;* [3]*Hebrew Univ. of Jerusalem, Israel;* [4]*Technion - Israel Inst. of Technology, Israel.* Sixth-generation (6G) networks will revolutionize the way we communicate and connect, with promises of higher data rate, lower latency and higher reliability. To efficiently support the 6G use cases and service requirements, the optical networking community needs to introduce a number of innovations at a component, system and control level. In this paper, we provide our view on these innovations and discuss their adaptation to the x-haul network.

Room 2

16:30–18:30
Tu3C • Quantum Information Generation, Distribution and Processing
Presider: Eleni Diamanti; CNRS, France

Tu3C.1 • 16:30
Highly Pure 4-Qubit States Fully Integrated in a Programmable Silicon-Photonic Chip, Jong-Moo Lee[1], Jiho Park[1], Jeongho Bang[1], Young-Ik Sohn[2], Alessio Baldazzi[3], Matteo Sanna[3], Stefano Azzini[3], Lorenzo Pavesi[3]; [1]*ETRI, Korea (the Republic of);* [2]*KAIST, Korea (the Republic of);* [3]*Univ. of Trento, Italy.* We demonstrate 98% Hong-Ou-Mandel (HOM) visibility, 82% Greenberger–Horne–Zeilinger (GHZ) fidelity, and Bell's inequality violations by 4-photon coincident measurements using a silicon-photonic chip including photon-pair sources, filters, and linear-optic gates.

Tu3C.2 • 16:45
A Gaussian Boson Sampling Based Ising Solver, Huihui Zhu[2], Haosen Chen[1], Hong Cai[2], Tian Chen[1], Lip Ket Chin[2], Xiangdong Zhang[1], Ai Qun Liu[2]; [1]*Beijing Inst. of Technology, China;* [2]*The Hong Kong Polytechnic Univ., China.* This paper presents an on-chip Gaussian Boson Sampling microprocessor, powered by photonic technology, proficiently solving graph combinatorial problems like max cut and vertex cover. It demonstrates photonic quantum computing's potential to accelerate traditionally insurmountable computations.

Room 3

16:30–18:30
Tu3D • High Speed Photodetectors
Presider: Patrick Runge; Fraunhofer HHI, Germany

Tu3D.1 • 16:30 Invited
Ultra-Fast Ge-on-Si Photodetectors, Stefan Lischke[1], Daniel Steckler[4], Anna Peczek[4], Jesse Morgan[2], Andreas Beling[2], Lars Zimmermann[4,3]; [1]*Technology / Process Integration, IHP - Leibniz Inst. for High Performance Microelectronics, Germany;* [2]*Department of Electrical and Computer Engineering, Univ. of Virginia, USA;* [3]*FG Silizium-Photonik, Technische Universität Berlin, Germany;* [4]*Technology / Si Photonics, IHP - Leibniz Inst. for High Performance Microelectronics, Germany.* A Ge-fin photodetector in which un-doped germanium is laterally sandwiched between complementary in situ-doped silicon is demonstrated, allowing for unprecedented 3-dB bandwidths up to 265 GHz. Here, we review our work on ultra-fast Ge photodiodes.

Room 6C

16:30–18:30
Tu3E • High Bit Rate High Capacity Transmission
Presider: Helmut Griesser; Adva Optical Networking GmbH, Germany

Tu3E.1 • 16:30
Real-Time Transmission of 34.9 Tb/s with 1-Tb/s Channels Over 4800 GHz-Wide C-Band Along 1000 km of G654E Fiber, Bruno Lavigne[1], Thierry Zami[1], Julien David[1], Stephan Weisser[2], Lutz Raddatz[2], Florian Pulka[2], Mael Lemonnier[1]; [1]*Alcatel Submarine Networks, France;* [2]*Nokia, Germany.* We transmit 34.9 Tb/s over the 4800 GHz-wide C-band through ten 100km-long G654E fiber spans. This is a record spectral efficiency with real-time 1-Tb/s 128-GBaud transponder and pure Erbium-doped-fiber-based amplification along 1000km core/regional distance.

Tu3E.2 • 16:45
150.27-Tb/s Capacity Over 150-km in S+C+L Band Using 156-Channel 115-GBaud Signals with Doped Fiber Amplification, Qingyu He[1], Dawei Ge[2], Ming Luo[1], Xu Zhang[1], Yan Wu[3], Liang Mei[3], Ping Du[3], Dong Wang[2], Hongguang Zhang[4], Han Li[2], Xi Xiao[4]; [1]*China Information Communication Technologies Group Corporation, China;* [2]*China Mobile Research Inst., China;* [3]*Fiberhome Telecommunication Technologies, China;* [4]*National Information Optoelectronics Innovation Center, China.* We demonstrate a 150.27-Tb/s S-, C- and L-band optical signal over 150-km G.654.E transmission in a 19.5-THz bandwidth with only DFAs. The average per-wavelength capacity is over 960-Gbit/s after entropy optimization in each band.

Room 6D

16:30–18:30
Tu3F • Optical Neural Networks
Presider: Mahdi Nikdast; Colorado State Univ., USA

Tu3F.1 • 16:30 Invited
Optics-Informed Neural Networks: Bridging Deep Learning with Photonic Accelerators, Miltiadis Moralis-Pegios[1], Apostolos Tsakyridis[1], Christos Pappas[1], Theodoros Moschos[1], George Giamougiannis[1], Stefanos Kovaios[1], Ioannis Roumpos[1], Manos Kirtas[1], Nikolaos Passalis[1], Anastastios Tefas[1], Nikos Pleros[1]; [1]*Aristoteleio Panepistimio Thessalonikis, Greece.* We discuss our work in optics informed photonic neural networks, an architectural framework bridging the idiosyncrasy of integrated photonic architectures with a set of Deep Learning algorithms, towards harnessing the full potential of light-based accelerators.

Room 6E

16:30–18:30
Tu3G • Panel: Cutting-Edge Technologies for Interconnecting AI/ML Clusters

Organizers
Brandon Buscaino, *Ciena, USA*
Norm Swenson, *Norman Swenson Consulting, USA*
Qiong Zhang, *Amazon, USA*

Speakers
Keren Bergman, *Columbia University, USA*
Jeff Hutchins, *Ranovus, USA*
Rob Kalman, *Avecina Tech, USA*
Near Margalit, *Broadcom Corporation, USA*
Sean Park, *Point2 Technology, USA*

The rapid evolution of artificial intelligence (AI) and machine learning (ML) has led to the development of increasingly complex and sophisticated AI/ML clusters. These clusters are composed of interconnected nodes working collaboratively to process vast amounts of data and perform intricate computations. This panel will explore the strategies and technologies that enable seamless communication and cooperation within these clusters, with an emphasis on low latency and power efficiency. Bringing together experts from academia and industry, the panel will delve into the challenges and solutions associated with creating robust, high-performance interconnections that optimize performance and efficiency of AI/ML systems.

Room 6F

16:30–18:30
Tu3H • Advanced Optical Subsystems
Presider: Hungchang (James) Chien; Marvell Semiconductor Inc., USA

Tu3H.1 • 16:30 ★ Top-Scored
50G Burst-Mode Receiver Using Monolithic SOA-UTC and Burst-Mode TIA, Laurens Breyne[1], Christophe Caillaud[2], Thibaut Gurne[1], Jean-François Paret[2], Michaël Straub[3], Gertjan Coudyzer[4], Karim Mekhazni[2], Michiel Verplaetse[1]; [1]*Nokia Bell Labs, Belgium;* [2]*III-V Lab, France;* [3]*Nokia Bell Labs, Germany;* [4]*Imec Ghent Univ., Belgium.* We demonstrate a 50G-PON upstream SOA-UTC based receiver integrated with a BM-TIA, without optical filtering. The OMA sensitivity is -24.3 dBm, the dynamic range exceeds 20 dB and the loud-soft penalty is 1 dB.

Tu3H.2 • 16:45
Semi-Analytical Methodology for Advanced Filter Design in Chirped-Managed Lasers, Reza Maram[2], Md Samiul Alam[1], Arif Shahriar[1], Pasquale Ricciardi[2], David V. Plant[1]; [1]*McGill Univ., Canada;* [2]*Fonex Data Systems, Canada.* We introduce a novel semi-analytical method for the deterministic design of advanced optical filters in chirped-managed lasers (CMLs), enhancing transmission reach for access networks. This approach can be applied to any baud rate of NRZ and PAM-4, overcoming previous trial-and-error methods.

Room 7

16:30–18:30
Tu3I • Disaggregated and Software Defined Access Networks
Presider: Marco Ruffini; Trinity College Dublin

Tu3I.1 • 16:30
Real-Time Demonstration of Softwarized Low-Complexity Timing Recovery by CMA Filter Interpolation for Baud-Rate Sampling DSP, Takahiro Suzuki[1], Sang-Yuep Kim[1], Jun-ichi Kani[1], Tomoaki Yoshida[1]; [1]*NTT Corporation, Japan.* This paper proposes a low-complexity timing recovery method and demonstrates the real-time softwarization of a baud-rate sampling DSP suite. It achieves a 38 % reduction in processing time with no penalty in sampling phase tolerance.

Tu3I.2 • 16:45 Tutorial
Disaggregation and Virtualization for Future Access and Metro Networks, Jun-ichi Kani[1]; [1]*NTT Access Service Systems Laboratories, NTT Corporation, Japan.* Future access and metro networks are expected to support advanced broadband services and evolving mobile x-haul in a flexible manner. This presentation reviews progress and challenges on disaggregation and virtualization technologies to meet this expectation.

Jun-ichi Kani has been with NTT Laboratories since 1996, where he has been mainly working on R&D and standardization of optical communication systems for access and metro applications. He is currently Senior Distinguished Researcher and Leader of Access Systems Technologies Group in NTT Access Network Service Systems Laboratories.

Room 8

16:30–18:30
Tu3J • Fiber Sensing Applications II
Presider: Sander Jansen; ADVA, Germany

Tu3J.1 • 16:30 ★ Top-Scored
Continuous Distributed Phase and Polarization Monitoring of Trans-Atlantic Submarine Fiber Optic Cable, Mikael Mazur[1], Nicolas K. Fontaine[1], Megan Kelleher[2,3], Valey Kamalov[4], Roland Ryf[1], Lauren Dallachiesa[1], Haoshuo Chen[1], David Neilson[1], Franklyn Quinlan[3]; [1]*Nokia Bell Labs, USA;* [2]*Physics, Univ. of Colorado Boulder, USA;* [3]*National Inst. of Standards and Technology, USA;* [4]*Valey Kamalov LLC, USA.* We perform submarine cable environmental sensing using an FPGA+GPU-based real-time polarization-resolved coherent OFDR prototype. Measurements of earthquake waves propagating across the Atlantic Ocean are recorded simultaneously at >70 evenly distributed points along the cable.

Tu3J.2 • 16:45
Earthquake Early Warning Through Terrestrial Optical Networks: a Bi-GRU Attention Model Approach on SOP Data, Fehmida Usmani[1,2], Hasan Awad[2], Emanuele Virgillito[2], Rudi Bratovich[3], Stefano Straullu[4], Francesco Aquilino[4], Roberto Proietti[2], Rosanna Pastorelli[3], Vittorio Curri[2]; [1]*SEECS, NUST, Islamabad, Pakistan;* [2]*Politecnico di Torino, Italy, Italy;* [3]*SM-Optics, Italy, Italy;* [4]*Links Foundation, Italy.* We propose a smart grid fiber sensing approach based on a Bi-GRU model with an attention mechanism for earthquake early warnings exploiting terrestrial optical networks. Model training and testing uses realistic synthetic earthquake waves.

Room 9

16:30–18:30
Tu3K • High Capacity Radio-over-Fiber Communication
Presider: Jhih-Heng Yan; Chunghwa Telecom Co Telecommuncation Lab, Taiwan

Tu3K.1 • 16:30
Is Ultra-High Order QAM Necessary for Delta-Sigma Modulator in Mobile Front-Haul?, Yin-He Jian[1], Jian-Wen Chen[1], Chih-Chun Wang[1], Tzu-Chieh Wei[1], Chi-Wai Chow[1], Chien-Hung Yeh[2]; [1]*National Yang Ming Chiao Tung Univ., Taiwan;* [2]*Feng Chia Univ., Taiwan.* We propose a delta-sigma-modulator (DSM) using multi-stage-noise-shaping (MASH) structure. Record high efficiencies of 1.016 (hard-decision forward-error-correction, FEC) and 1.166 (soft-decision-FEC) are achieved in the proposed MASH-DSM without the need of ultra-high-order quadrature-amplitude-modulation (QAM).

Tu3K.2 • 16:45
ASE Source Enabled 2 Tb/s CPRI-Equivalent Rate 1024-QAM DA-RoF Transmission, Jingjing Lin[1], Yixiao Zhu[2], Chenbo Zhang[1], Xu Liu[1], Zhangyuan Chen[1], Weiwei Hu[1], Xiaopeng Xie[1]; [1]*Peking Univ., China;* [2]*Shanghai Jiaotong Univ., China.* We demonstrate unprecedented 2nm broadband ASE source-enabled digital-analog radio-over-fiber mobile fronthaul system with joint force of SOAs for intensity noise suppression and multicore fiber for self-homodyne detection. We achieve 35GHz(=7core×5GHz) aggregated bandwidth with 2Tb/s CPRI-equivalent data rate supporting 1024-QAM signal.

Show Floor Programming

OFCnet Panel: Quantum Key Distribution High-Speed Optical-Layer Encryption
15:45–16:30, *Theater III*

CISCO: Who Controls the DCO's in Routers?
16:00–17:00, *Theater I*

Photonics in Current and Future Machine Learning Network Infrastructure
16:00–17:00, *Theater II*

Room 1A

Tu3A • CPO and Ecosystem—Continued

Tu3A.2 • 17:00 ★ Top-Scored

1.6 Tbps (224 Gbps/λ) Silicon Photonic Engine Fabricated with Advanced Electronic-Photonic FOWLP for Co-Packaged Optics and Linear Drive Applications, Xin Li[1], Sajay B. Gourikutty[2], Jiaqi Wu[2], Teck Guan Lim[2], Pengfei Guo[3], Jaye C. Davies[1], Edward Sing Chee Koh[1], Lau Boon Long[2], Ming Chinq Jong[2], Chao Li[3], Patrick Lo[3], Surya Bhattacharya[2], Tsung-Yang Liow[1]; [1]*Rain Tree Photonics Pte Ltd, Singapore;* [2]*Inst. of Microelectronics, A*STAR, Singapore;* [3]*Advanced Micro Foundry, Singapore.* A 1.6 Tbps (8-channel 224 Gbps/λ) Silicon Photonic Engine, fabricated using advanced electronic-photonic FOWLP, is successfully demonstrated for the first time, enabling low-cost, volume-manufacturable and highly scalable terabit photonic engines for CPO and LPO.

Tu3A.3 • 17:15 Invited

Optics Qualification in Data Centers: Navigating Reliability Challenges and Implementing Solutions, Vincent Zeng[1]; [1]*Meta Platforms Inc, USA.* Worldwide demands for faster, secure data transmittal including AI/ML have led to significant optical interconnect demands. The reliability and quality control in building block process remain increased challenges that engineering and manufacturing alike must address.

Room 1B

Tu3B • 6G and Emerging Applications—Continued

Tu3B.2 • 17:00

Hollow-Core-Fiber Placement in Latency-Constrained Metro Networks with EdgeDCs, Giovanni S. Sticca[1], Memedhe Ibrahimi[1], Nicola Di Cicco[1], Francesco Musumeci[1], Massimo Tornatore[1]; [1]*Politecnico di Milano, Italy.* We investigate the optimal placement of Hollow-Core Fibers (HCF) in latency-constrained metro networks with edgeDCs, performing physical-layer validation. Upgrading 24% of links to HCF reduces edgeDCs number by 29% compared to a network without HCFs.

Tu3B.3 • 17:15

Network for AI: Communication-Efficient Federated Learning with MST-Based Scheduling and Multi-Aggregation Over Optical Networks, Ruikun Wang[1,2], Jiawei Zhang[1], Memedhe Ibrahimi[2], Zhiqun Gu[1], Yuming Xiao[3], Francesco Musumeci[2], Massimo Tornatore[2], Yuefeng Ji[1]; [1]*Beijing Univ. of Posts and Telecomm, China;* [2]*Politecnico di Milano, Italy;* [3]*Purple Mountain Laboratories, China.* We propose a Minimum-Spanning-Tree-based scheduling and Multi-aggregation framework (MST-M) for communication-efficient Federated Learning. Simulation results show that MST-M saves over 10% in communication costs compared to existing heuristics.

Room 2

Tu3C • Quantum Information Generation, Distribution and Processing—Continued

Tu3C.3 • 17:00 Invited

A Roadmap Towards Entanglement Distribution Over Useful Telecom Distances, Vatshal Srivastav[1], Natalia Herrera Valencia[1], Will McCutcheon[1], Saroch Leedumrongwatthanakun[1], Sebastien Designolle[2], Roope Uola[2], Nicolas Brunner[2], Mehul Malik[1]; [1]*Heriot-Watt Univ., Edinburgh, UK;* [2]*Univ. of Geneva, Switzerland.* I review progress on the distribution of photonic entanglement under extreme conditions of noise and loss, enabled by high-dimensionally entangled quantum states of light.

Room 3

Tu3D • High Speed Photodetectors—Continued

Tu3D.2 • 17:00

DC–226 GHz Well-Impedance-Matched High-Speed Photoreceiver for Multi-Band Signal Detection, Toshimasa Umezawa[1], Pham T. Dat[1], Yuki Yoshida[1], Shinya Nakajima[1], Atsushi Matsumoto[1], Kouichi Akahane[1], Atsushi Kanno[2,1], Naokatsu Yamamoto[1]; [1]*National Inst of Information & Comm Tech, Japan;* [2]*Nagoya Inst. of Technology, Japan.* We designed and fabricated a well-impedance-matched ultrabroadband photoreceiver operating beyond 226 GHz and discussed its high data rate multiband performance from the baseband to the W-, D-, and G-bands.

Tu3D.3 • 17:15

Ultrafast 67 GHz Waveguide-Coupled Silicon-Germanium Avalanche Photodiode, Yang Shi[1], Mingjie Zou[1], Zuhang Li[1], Xinliang Zhang[1], Yu Yu[1]; [1]*Huazhong Univ of Science and Technology, China.* We demonstrate a silicon-germanium avalanche photodiode with record-high bandwidth of 67 GHz under a modest gain of 6.6, by levering the gain and bandwidth through comprehensively manipulating photocurrent density and electric field in multiplication region.

Room 6C

Tu3E • High Bit Rate High Capacity Transmission—Continued

Tu3E.3 • 17:00 Invited

S+C+L WDM Coherent Transmission with >1-Tb/s/λ Signals, Fukutaro Hamaoka[1], Masanori Nakamura[1], Takayuki Kobayashi[1], Yutaka Miyamoto[1], Etsushi Yamazaki[1], Yoshiaki Kisaka[1]; [1]*NTT Network Innovation Laboratories, Japan.* Ultra-wideband wavelength-division-multiplexed (WDM) transmission is an essential technology to achieve >100-Tb/s single-mode-fiber (SMF) capacity. This paper overviews the status of high-capacity SMF transmission and provides our research results using high-symbol-rate coherent channels under a triple-band WDM configuration.

Room 6D

Tu3F • Optical Neural Networks—Continued

Tu3F.2 • 17:00

Adaptive All-Optical Sigmoid Activation Functions for Photonic Neural Networks Using Fabry-Perot Laser Diodes Under Optical Injection, Petar Atanasijevic[1], Christos Pappas[2], Mladen Banović[1], Jasna Crnjanski[1], Apostolos Tsakyridis[2], Miltiadis Moralis-Pegios[2], Konstantinos Vyrsokinos[2], Marko Krstić[1], Pedja Mihailović[1], Slobodan Petričević[1], Nikos Pleros[2], Dejan M. Gvozdic[1]; [1]*School of Electrical Engineering, Univ. of Belgrade, Serbia;* [2]*Centre for Interdisciplinary Research and Innovation, Informatics Dept., Aristotle Univ. of Thessaloniki, Greece.* We experimentally validate the all-optical activation functions in Fabry-Perot lasers under optical injection for random and non-random inputs. Sigmoid-like activations for 100 ps pulses are reconfigured using injection parameters, consuming 1.4 pJ per nonlinear operation.

Tu3F.3 • 17:15

Plasmonically Enhanced Optical Accelerator for Nonlinear Signal Processing Based on Artificial Neural Networks, Tobias Blatter[1], Amane Zürrer[1], Yannik Horst[1], Christos Pappas[2], George Giamougiannis[2], Apostolos Tsakyridis[2], Manuel Kohli[1], Miltiadis Moralis-Pegios[2], Nikos Pleros[2], Juerg Leuthold[1]; [1]*ETH Zurich, Switzerland;* [2]*Aristotle Univ. of Thessaloniki, Greece.* We reconstructed a 48 Gbit/s nonlinearly distorted optical signal using an artificial neural network (ANN). The digital ANN execution exceeded traditional nonlinear equalizers, while its analog acceleration using plasmonic-organic-hybrid modulators surpassed conventional digital linear equalizers.

Room 6E

Tu3G • Panel: Cutting-Edge Technologies for Interconnecting AI/ML Clusters—Continued

Room 6F

16:30–18:30
Tu3H • Advanced Optical Subsystems—Continued

Tu3H.3 • 17:00
Multi-Channel Coherent Optical System Based on a High Power Fabry-Perot QW Laser Diode, Sharmila Raisa[1], Shalmoli Ghosh[1], Maurice O'Sullivan[2], Charles Laperle[2], Rongqing Hui[1]; *[1]Univ. of Kansas, USA; [2]Ciena Corporation, Canada.* We demonstrate 20-channel coherent transmission using a high-power single-section QW FP-laser diode over 78.3 km single mode fiber. The system capability can reach > 4Tb/s with a single laser in the transmitter using polarizations multiplexing.

Tu3H.4 • 17:15
EML-Based Coherent Receiver for Low CSPR Single-Sideband Transmission Enabled by Injection Locking, Siyu Luo[1], Zhengxuan Li[1], Yingxiong Song[1]; *[1]Shanghai Univ., China.* We propose a novel single-sideband self-coherent detection scheme employing an EML-based receiver and demonstrate a 6.5-dB sensitivity improvement compared with Kramers-Kronig receiver for the SSB 16-QAM signal transmission over 40-km SSMF.

Room 7

Tu3I • Disaggregated and Software Defined Access Networks—Continued

Room 8

Tu3J • Fiber Sensing Applications II—Continued

Tu3J.3 • 17:00
Field Implementation of Fiber Cable Monitoring for Mesh Networks with Optimized Multi-Channel Sensor Placement, Philip N. Ji[1], Zilong Ye[1,2], Glenn Wellbrock[3], Tiejun J. Xia[3], Ming-Fang Huang[1], Yoshiaki Aono[4], Ting Wang[1]; *[1]NEC Laboratories America Inc., USA; [2]California State Univ. Los Angeles, USA; [3]Verizon Corporation, USA; [4]Transport Network Department, NEC Corporation, Japan.* We develop a heuristic solution to effectively optimize the placement of multi-channel distributed fiber optic sensors in mesh optical fiber cable networks. The solution has been implemented in a field network to provide continuous monitoring.

Tu3J.4 • 17:15
Optical Fiber Sensing Network Control Plane Enabled by a Novel Sub µs Response Time Fiber Sensing Control Device, Mijail Szczerban[1], Mikael Mazur[1], Lauren Dallachiesa[1], Haik Mardoyan[1], Sarvesh S. Bidkar[1], Roland Ryf[1], Jesse E. Simsarian[1]; *[1]Nokia Bell Labs, USA.* We propose and implement a novel fiber sensing control device and sensing control plane that controls backscatter and polarization-based fiber sensing. We experimentally demonstrate in a fiber network that this device achieves sub-µs response time.

Room 9

Tu3K • High Capacity Radio-over-Fiber Communication—Continued

Tu3K.3 • 17:00
1.92-Tb/s CPRI-Equivalent Rate Direct Detection Transmission Based on ANN Pre-Equalization for Digital-Analog Radio-Over-Fiber Mobile Fronthaul, Junhao Zhao[1], An Yan[1], Guoqiang Li[1], Zhongya Li[1], Wangwei Shen[1], Yongzhu Hu[1], Nan Chi[1], Junwen Zhang[1]; *[1]Fudan Univ., China.* We experimentally demonstrate a 1.92-Tb/s CPRI-equivalent data-rate supporting 1024-QAM OFDM signal in a direct-detection-based digital-analog radio-over-fiber mobile-fronthaul link using ANN for signal pre-equalizations. Performances of pre-equalizers or post-equalizers based on different methods are also studied.

Tu3K.4 • 17:15
W-Band Photonics-Aided ISAC Wireless System Sharing OFDM Signal as Communication and Sensing, Jiaxuan Liu[1], Jianjun Yu[1,2], Xianming Zhao[3], Chengzhen Bian[1], Xiongwei Yang[1], Long Zhang[1], Wenzhong He[1], Jianyu Long[1], Yao Zhang[1], Yu Zhang[1], Zhou Ju[1], Xinyi Wang[1], Wen Zhou[1], Kaihui Wang[1], Feng Zhao[4]; *[1]Fudan Univ., China; [2]Purple Mountain Laboratories, China; [3]China Harbin Inst. of Technology, China; [4]School of Electronic Engineering, Xi'an Univ. of Posts and Telecommunications, China.* We experimentally demonstrate the dual functionality of OFDM signals for both communication and sensing. Photonics-aided ISAC system in W-band achieves range-Doppler imaging with 0.0102m resolution and data rate of 48.04 Gbit/s over wireless link.

Show Floor Programming

CISCO: Who Controls the DCO's in Routers?
16:00–17:00, *Theater I*

Photonics in Current and Future Machine Learning Network Infrastructure
16:00–17:00, *Theater II*

Room 1A

Tu3A • CPO and Ecosystem—Continued

Tu3A.4 • 17:45
Collective Die-to-Wafer Bonding Enabling Low-Loss Evanescent Coupling for Optically Interconnected System-on-Wafer, Pengfei Xu[1], Junwen He[1], Koen Kennes[1], Anton Dvoretskii[1], Arnita Podpod[1], Guy Lepage[1], Negin Golshani[1], Rafal Magdziak[1], Swetanshu Bipul[1], Dieter Bode[1], Peter Verheyen[1], Maumita Chakrabarti[1], Dimitrios Velenis[1], Andy Miller[1], Yoojin Ban[1], Filippo Ferraro[1], Joris Van Campenhout[1]; [1]*imec, Belgium*. We present a collective PIC die-to-wafer dielectric bonding process, enabling SiN waveguide-based die-to-wafer evanescent couplers with insertion losses of 0.36 ±0.18dB at 1310nm wavelengths, paving the way to optically interconnected 300mm wafer-scale multi-chip compute systems.

Room 1B

Tu3B • 6G and Emerging Applications—Continued

Tu3B.4 • 17:30 Invited
Programmable Packet-Optical Networks Using Data Processing Units (DPUs) with Embedded GPU, Piero Castoldi[1], Rana Abu Bakar[1], Andrea Sgambelluri[1], Juan José Vegas Olmos[2], Francesco Paolucci[3], Filippo Cugini[3]; [1]*Scuola Superiore Sant Anna di Pisa, Italy;* [2]*NVIDIA, Denmark;* [3]*CNIT, Italy.* Data Processing Units (DPUs) with embedded GPU have the potential to revolutionize optical networks functionalities at the edge. Use cases are presented for optical data monitoring with local AI processing, 5G acceleration, and embedded security.

Room 2

Tu3C • Quantum Information Generation, Distribution and Processing—Continued

Tu3C.4 • 17:30 ★ Top-Scored
Remote Entanglement of Quantum Memories Over a Metropolitan Network, Daniel R. Assumpcao[1], Can Knaut[1], Aziza Suleymanzade[1], Yan-Cheng Wei[1], Pieter-Jan Stas[1], Yan-Qi Huan[1], Bartholomeus Machielse[2,1], Erik Knall[1], Madison Sutula[1], Gefen Baranes[1,3], Neil Sinclair[1], Chawina De-Eknamkul[2], David Levonian[2,1], Mihir Bhaskar[2,1], Hongkun Park[1], Marko Loncar[1], Mikhail Lukin[1]; [1]*Harvard Univ., USA;* [2]*AWS Center for Quantum Networking, USA;* [3]*Massachusetts Inst. of Technology, USA.* We generate remote entanglement between spatially separate color-center based quantum nodes at rates up to 1 Hz. In addition, we demonstrate remote entanglement across a deployed 35km long fiber loop in the Boston urban area.

Tu3C.5 • 17:45 Invited
Photonic Integrated Circuits for Quantum Computing, Jörn P. Epping[2,1]; [1]*QuiX Quantum B.V., Netherlands;* [2]*Epiphany, Netherlands.* In this talk the requirements of integrated photonic circuits for quantum computing will be presented. Integrated photonic modules, e.g. for processors and source, have stringent demand for schemes such as photonic QC and ion traps.

Room 3

Tu3D • High Speed Photodetectors—Continued

Tu3D.4 • 17:30 Invited
Ultra-Wide Bandwidth and High Saturation Power Uni-Traveling Carrier Photodiodes, Bing Xiong[1], Yuxin Tian[1], Changzheng Sun[1], Zhibiao Hao[1], Jian Wang[1], Lai Wang[1], Yanjun Han[1,2], Hongtao Li[1], Lin Gan[1], Yi Luo[1,2]; [1]*Tsinghua Univ., China;* [2]*Inst. of Flexible Electronics Technology of THU, China.* In this talk, we present our recent work on ultra-wide bandwidth (>100 GHz) uni-traveling-carrier photodetectors with high saturation power, by optimizing the photogenerated carrier transport and taking advantage of the inductive gain peaking effect.

Room 6C

Tu3E • High Bit Rate High Capacity Transmission—Continued

Tu3E.4 • 17:30 Invited
High-Capacity and High-Spectral Efficiency Transmission Systems for 1.6 Tb/s and Beyond, Fabio Pittalà[1]; [1]*Keysight Technologies Deutschland GmbH, Germany.* Challenges and trends to achieve high-capacity and high-spectral efficiency transmissions for different fiber-optic applications are discussed focusing on 1.6 Tb/s/carrier. Recent research records, industry status and standardization progress of coherent optical interfaces are also reviewed.

Room 6D

Tu3F • Optical Neural Networks—Continued

Tu3F.4 • 17:30
Demonstration of Neural Heterogeneity with Programmable Brain-Inspired Optoelectronic Spiking Neurons, Yun-Jhu Lee[1], Mehmet Berkay On[1], Luis E. Srouji[1], Li Zhang[1], Mahmoud Abdelghany[1], S.J. Ben Yoo[1]; [1]*Univ. of California, Davis, USA.* Neural heterogeneity enables spiking neural networks to implement complex functions with fewer neurons. We designed, simulated, and demonstrated programmable optoelectronic spiking neurons that can achieve multiple neuron characteristics based on external tuning voltages.

Tu3F.5 • 17:45 Invited
Optical Neural Networks with Tensor Compression and Photonic Memory, Xian Xiao[1], Stanley Cheung[1], Bassem Tossoun[1], Thomas Van Vaerenbergh[1], Geza Kurczveil[1], Raymond Beausoleil[1]; [1]*Hewlett Packard Enterprise, USA.* This paper introduces our recent efforts on scalable, energy-efficient, and low-latency tensorized optical neural networks, including design considerations, options for wavelength-parallel photonic tensor cores, and photonic memory for non-volatile tuning.

Room 6E

Tu3G • Panel: Cutting-Edge Technologies for Interconnecting AI/ML Clusters—Continued

Room 6F

16:30–18:30
Tu3H • Advanced Optical Subsystems—Continued

Tu3H.5 • 17:30
Throughput Maximisation in Ultra-Wideband Hybrid-Amplified Links, Henrique Buglia[1], Eric Sillekens[1], Lidia Galdino[2], Robert Killey[1], Polina Bayvel[1]; [1]*Univ. College London, UK;* [2]*Corning, UK.* A semi-analytical, real-time nonlinear-interference model including ASE noise in hybrid-amplified links is introduced. Combined with particle-swarm optimisation, the capacity of a hybrid-amplified 10.5-THz 117x57-km link was maximised, increasing throughput by 12% versus an EDFAs-only configuration.

Tu3H.6 • 17:45
C-Band Net 1.8 Tb/s (240Gb/s/λ× 8λ) DWDM IM/DD Transmission Over 1.4km AR-HCF with Linear FFE Only, Chao Li[1], Zichen Liu[1], Yizhi Sun[2], Shoufei Gao[2], Qibing Wang[1], Hui Chen[1], Siyue Jin[1], Ming Luo[3], Xu Zhang[3], Chao Yang[3], Yingying Wang[2], Wei Ding[2], Lei Wang[1], Xi Xiao[3], Zhixue He[1], Shaohua Yu[1]; [1]*Peng Cheng Laboratory, China;* [2]*Jinan Univ., China;* [3]*China Information and Communication Technologies Group Corporation, China.* Record net 1.8Tb/s IM/DD optical interconnect supported by 8λ dense wavelength division multiplexing technique in C-band over wide-band low dispersion anti-resonant hollow-core fibre (AR-HCF) is experimentally demonstrated under 6.7% HD-FEC limit with linear FFE only.

Room 7

Tu3I • Disaggregated and Software Defined Access Networks—Continued

Tu3I.3 • 17:45
Low-Latency Upstream Scheduling in Multi-Tenant, SLA Compliant TWDM PON, Arijeet Ganguli[1], Marco Ruffini[1]; [1]*Trinity College Dublin, Ireland.* We present a multi-tenant multi-wavelength upstream transmission scheme for virtualised PONs, enabling compliance with latency-oriented Service Level Agreements (SLAs). Our analysis highlights an important trade-off between single-channel vs. multi-channel PONs, depending on ONUs tuning time.

Room 8

Tu3J • Fiber Sensing Applications II—Continued

Tu3J.5 • 17:30 Invited
Remote Sensing with High Spatial Resolution, André Sandmann[1], Florian Azendorf[1], Michael Eiselt[1]; [1]*Adtran Networks SE, Germany.* Distributed fiber sensing based on correlation-aided phase-sensitive optical time domain reflectometry is presented. The focus is on correlation as an enabler for high spatial resolution. Results from different applications are presented.

Room 9

Tu3K • High Capacity Radio-over-Fiber Communication—Continued

Tu3K.5 • 17:30 Invited
Sigma-Delta Radio Over Fiber, Guy Torfs[1], Achim Vandierendonck[1], Fatemeh Zardosht[1], Caro Meysmans[1], Xin Wang[1], Haolin Li[2], Piet Demeester[1]; [1]*IDLab, Ghent Univ. - imec, Belgium;* [2]*R&D, iCana, Belgium.* Sigma-delta modulation can encapsulate an analog radio signal in a digital bit stream enabling low-cost synchronous radio-over-fiber links. This paper covers both direct modulated links and links with external up-conversion for use in fronthaul connections.

Show Floor Programming

CISCO: Who Controls the DCO's in Routers?
16:00–17:00, *Theater I*

Photonics in Current and Future Machine Learning Network Infrastructure
16:00–17:00, *Theater II*

Room 1A	Room 1B	Room 2	Room 3	Room 6C	Room 6D
Tu3A • CPO and Ecosystem—Continued	**Tu3B • 6G and Emerging Applications—Continued**	**Tu3C • Quantum Information Generation, Distribution and Processing—Continued**	**Tu3D • High Speed Photodetectors—Continued**	**Tu3E • High Bit Rate High Capacity Transmission—Continued**	**Tu3F • Optical Neural Networks—Continued**
	Tu3B.5 • 18:00 **Availability-Guaranteed Differentiated Provisioning in Integrated Satellite-Terrestrial Optical Networks,** Lu Zhang[1,2], Xin Li[1], Massimo Tornatore[2], Jingjie Xin[1], Shanguo Huang[1]; *[1]Beijing Univ. of Post and Telecommu, China; [2]Department of Electronics Information and Bioengineering, Politecnico di Milano, Italy.* This paper investigates differentiated provisioning in integrated satellite-terrestrial optical networks. Two connection availability models are developed considering network dynamic nature. Two availability-guaranteed differentiated provisioning algorithms are proposed. Their effectiveness is verified by numerical results.		**Tu3D.5 • 18:00** **Type-II GaInAsSb/InP Modified Uni-Traveling Carrier Photodiodes Under Zero-Bias Operation,** Rimjhim Chaudhary[2,1], Akshay Arabhavi[2,1], Sara Hamzeloui[2,1], Martin Leich[2,1], Olivier Ostinelli[2,1], Colombo Bolognesi[2,1]; *[1]ETH Zurich, Switzerland; [2]Milimeterwave Electronics Laboratory, D-ITET, ETH Zurich, Switzerland.* We report the first bias-free performance of Type-II modified GaInAsSb/InP UTC-PD for high-bandwidth and high-power applications. The UTC-PD achieves zero-bias bandwidth of 60 GHz and high output power of -11 dBm at 100 GHz.	**Tu3E.5 • 18:00** **Single-Fiber Bidirectional Transmission Using 400G Coherent Digital Subcarrier Transceivers,** Pablo Torres-Ferrera[1], Jacqueline Sime[2], Thomas Duthel[2], Emanuele E. Virgillito[3], Vittorio Curri[3], Roberto Gaudino[3], Chris R. Fludger[2], Antonio Napoli[1]; *[1]Infinera, Germany; [2]Infinera, Germany; [3]Politecnico di Torino, Italy.* We experimentally evaluate the Rayleigh Back-Scattering power penalty in a single-fiber single-wavelength bidirectional link using coherent digital subcarrier-based transceivers and verify a theoretical model in this scenario. A negligible penalty is achieved by using subcarrier-interleaving.	
		Tu3C.6 • 18:15 **CMOS Photonic Integrated Circuit for Flex-Grid Polarization Entanglement,** Alexander Miloshevsky[1], Hsuan-Hao Lu[1], Lucas M. Cohen[2], Karthik V. Myilswamy[2], Saleha Fatema[2], Muneer Alshowkan[1], Andrew M. Weiner[2], Joseph M. Lukens[1,3]; *[1]Oak Ridge National Laboratory, USA; [2]Purdue Univ., USA; [3]Arizona State Univ., USA.* We showcase a CMOS-fabricated silicon photonic integrated circuit employing a bidirectionally pumped microring and polarization splitter-rotators for high-fidelity polarization entanglement. Spanning the optical C+L-band, this sources is ideal for wavelength-multiplexed entanglement distribution in multi-user networks.	**Tu3D.6 • 18:15** **Polarization-Independent Photodetector with Integrated Optical Preamplifier and 60 GHz 3 dB Bandwidth,** Hendrik Boerma[1], Tom Kieckhefel[1], Thanh T. Tran[1], Patrick Runge[1], Martin Schell[1,2]; *[1]Fraunhofer HHI, Germany; [2]Technical Univ. Berlin, Germany.* An InP-based photodetector monolithically integrated with a semiconductor optical amplifier is presented. The chip operates in the O-band and is polarization-independent. Eye pattern measurements at 56 GBaud confirm the lower detection limit of signals with -13 dB optical power compared to a photodetector without preamplification.	**Tu3E.6 • 18:15** ★ Top-Scored **110.7-Tb/s Single-Mode-Fiber Transmission Over 1040 km with High-Symbol-Rate 144-GBaud PDM-PCS-QAM Signals,** Fukutaro Hamaoka[1], Masanori Nakamura[1], Takeo Sasai[1], Shuto Sugawara[1], Takayuki Kobayashi[1], Yutaka Miyamoto[1], Etsushi Yamazaki[1]; *[1]NTT Network Innovation Laboratories, Japan.* We demonstrate a 110.7-Tb/s net bitrate over 13×80-km low-water-peak G.652.D fiber transmission using a hybrid backward Raman amplifier and TDFA/EDFA in 18.3-THz triple-band WDM with an average 907.6-Gb/s/λ channel rate for 122-channel 144-GBaud PDM-PCS-16/64QAM signals.	**Tu3F.6 • 18:15** **Inference and Training in Deep Learning Using a Symmetric Optical Crossbar Array,** Rui Tang[1], Shuhei Ohno[1], Ken Tanizawa[2], Kazuhiro Ikeda[3], Makoto Okano[3], Kasidit Toprasertpong[1], Shinichi Takagi[1], Mitsuru Takenaka[1]; *[1]The Univ. of Tokyo, Japan; [2]Tamagawa Univ., Japan; [3]National Inst. of Advanced Industrial Science and Technology, Japan.* We propose and demonstrate a symmetric optical crossbar array based on microring resonators (MRRs) to accelerate both the inference and training in deep learning, experimentally achieving a 93.3% classification accuracy in an inference task.

17:15–18:15 Exhibitor Reception, *Center Terrace*

18:30–20:00 Conference Reception, *Ballroom 20BCD*

19:30–21:00 Rump Session: How Much Optics Does AI Need?, *Room 6F*

Room 6E

Tu3G • Panel: Cutting-Edge Technologies for Interconnecting AI/ML Clusters—Continued

Room 6F

16:30–18:30 Tu3H • Advanced Optical Subsystems—Continued

Tu3H.7 • 18:00
Parameter Estimation of Semi-Conductor Optical Amplifier Booster Based on Digital Signal Processing, Tarek Eldahrawy[1], Abir Hraghi[1], Abel Lorences-Riesgo[1], Trung-Hien Nguyen[1], Iosif Demirtzioglou[1], Loig Godard[1], Hartmut Hafermann[1], Nayla El Dahdah[1], Yu Zhao[1], Yann Frignac[1], Gabriel Charlet[1]; [1]*Huawei technologies France, France*. We propose a method for SOA characterization using conventional coherent transmission signals, including dual-polarization signals. Using 16QAM signals, we demonstrate that this method can be applied for several baudrates and wavelengths.

Room 7

Tu3I • Disaggregated and Software Defined Access Networks—Continued

Tu3I.4 • 18:00
Low-Latency Physical-Layer Function Chaining Using Inter-Container Shared Memory for Fully Virtualized Access Networks, Takahiro Suzuki[1], Sang-Yuep Kim[1], Jun-ichi Kani[1], Tomoaki Yoshida[1]; [1]*NTT Corporation, Japan*. This paper proposes novel physical-layer function chaining utilizing inter-container shared memory for fully virtualized access systems. Our containerization of softwarized 10G-EPON physical coding sublayer functions reduces latency from 1.56 ms to 0.408 ms.

Tu3I.5 • 18:15
MAC-Assisted DSP Architecture for 50G TDM-PON Pstream Triple-Rate Reception, Nannan Zhang[1], Junwei Li[1], Lirong Bai[2], Xiangnan Zhao[3], Miao Yu[2], Leiya Hu[1], Gengchen Liu[3]; [1]*China Mobile Research Inst., China;* [2]*China Mobile Communications Corporation Group Co., Ltd, China;* [3]*Huawei Technologies Co., Ltd, China*. We propose and experimentally demonstrate a MAC-assisted DSP for tri-rate upstream reception of 50G PON, which greatly reduces preamble time and achieves requirements of power budget C+ class for BTB and 20km transmission.

Room 8

Tu3J • Fiber Sensing Applications II—Continued

Tu3J.6 • 18:00
Real-Time Monitoring of Cable Break in a Live Network Using a Coherent Transceiver Prototype, Mikael Mazur[1], Dennis Wallberg[2], Lauren Dallachiesa[1], Erik Börjeson[3], Roland Ryf[1], Magnus Bergroth[2], Börje Josefsson[2], Nicolas K. Fontaine[1], Haoshuo Chen[1], David Neilson[1], Jochen Schröder[4], Per Larsson-Edefors[3], Magnus Karlsson[4]; [1]*Nokia Bell Labs, USA;* [2]*Sunet, Sweden;* [3]*Computer Science and Engineering, Chalmers Univ. of Technology, Sweden;* [4]*Microtechnology and Nanoscience, Chalmers Univ. of Technology, Sweden*. We monitor a 524km live network link using an FPGA-based sensing-capable transceiver prototype during a human-caused cable break. Polarization data uncovers minute-level potential warning precursors directly preceding the break, offering real-time sensing-based outage mitigation prospects.

Tu3J.7 • 18:15
Highly Sensitive Co-Trench Detection of Optical Fibers by Correlation Analysis with Field Test, Jiachuan Lin[1], Zhiping Jiang[1], Tao Zhang[2], Qingpeng Liu[2], Haiming Qin[2], Hao Li[1]; [1]*Huawei Technologies Canada, Canada;* [2]*Huawei technologies, China*. A coherent OTDR and correlation analysis based method is proposed to detect co-trench fibers. High sensitivity and accuracy are demonstrated in a field test with two partially co-trenched fibers.

Room 9

Tu3K • High Capacity Radio-over-Fiber Communication—Continued

Tu3K.6 • 18:00 ★ Top-Scored
Analog RoF Fronthaul Carrying 27.6-Tb/s CPRI-Equivalent Rate and 512-QAM with Sideband Modulation for IQ Imbalance Separation and Bi-Directional Transmission, Yixiao Zhu[1], Xiansong Fang[2], Chenbo Zhang[2], Yicheng Xu[1], Qunbi Zhuge[1], Xiaopeng Xie[2], Weisheng Hu[1], Fan Zhang[2]; [1]*Shanghai Jiao Tong Univ., China;* [2]*Peking Univ., China*. We leverage sideband modulation-based bidirectional scheme to separate the transmitter-side IQ imbalance and boost the SNR to 30.8dB. We experimentally demonstrate high-capacity coherent analog RoF fronthaul achieving 27.6Tb/s(=12λ×2.089Tb/s) CPRI-equivalent rate and 512-QAM over 10-km SSMF.

Tu3K.7 • 18:15
Fading-Free Integrated Digital and Analog RoF Fronthaul Based on Dual-Drive MZM and Chirp Multiplexing, Yixiao Zhu[1], Xiansong Fang[2], Chenbo Zhang[2], Yicheng Xu[1], Guangying Yang[1], Qunbi Zhuge[1], Xiaopeng Xie[2], Fan Zhang[2], Weisheng Hu[1]; [1]*Shanghai Jiao Tong Univ., China;* [2]*Peking Univ., China*. We propose fiber dispersion fading-free integrated digital and analog radio-over-fiber fronthaul based on dual-drive MZM and chirp multiplexing. Single-wavelength co-transmission of 64-Gb/s PAM-4 and 6×1-GHz 64-QAM millimeter-wave signals is experimentally demonstrated over 10-km SSMF.

17:15–18:15 Exhibitor Reception, *Center Terrace*

18:30–20:00 Conference Reception, *Ballroom 20BCD*

19:30–21:00 Rump Session: How Much Optics Does AI Need?, *Room 6F*

06:00–07:00 OFC Fun Run, *Hilton Bayfront*

07:30–08:00 Coffee Break, *Upper Level Corridors*

08:00–10:00
W1A • Integrated Filters for Communication Systems

Presider: Milos Popovic; Boston Univ., USA

W1A.1 • 08:00 Invited

Band Aggregators for Band-Unaware Multi-Band CDC-ROADM, Kenya Suzuki[1], Mitsunori Fukutoku[2]; [1]*NTT Device Innovation Center, Japan;* [2]*NTT Innovative Devices Corporation, Japan.* We report on the concept of a multi-band CDC-ROADM network without network operators being aware of the differences between bands and its enabling devices, i.e., band aggregators.

08:00–10:00
W1B • Monitoring and Sensing

Presider: Ezra Ip; NEC Laboratories America Inc., USA

W1B.1 • 08:00

On the Accuracy of Power Profile Estimation Using MMSE or Deconvoluted Correlation-Based Profiles, Alix A. May[1], Fabien Boitier[1], Ana Ore Remigio[1], Patricia Layec[1]; [1]*Nokia Bell Labs France, France.* We evaluate the accuracy of the deconvolution of the longitudinal power profile computed using correlation-based method. We show that we obtain a similar accuracy to the MMSE approach in different cases.

W1B.2 • 08:15

Estimation and Localization of DGD Distributed Over Multi-Span Optical Link by Correlation Template Method, Choloong Hahn[1], Junho Chang[1], Zhiping Jiang[1]; [1]*Huawei Technologies Canada, Canada.* We propose a longitudinal DGD monitoring technique based on correlation template method at Rx-DSP. Estimation and localization of distributed DGD profile over 12×75 km-long SSMF span link are experimentally demonstrated with errors below 1 ps.

08:00–10:00
W1C • Network Control and Orchestration

Presider: Ricard Vilalta; CTTC, Spain

W1C.1 • 08:00 Tutorial

SDN Control of Multi-Band Over SDM Optical Networks with Physical Layer Impairments, Ramon Casellas[1], Ricardo Martínez[1], Raul Muñoz[1], Ricard Vilalta[1]; [1]*CTTC, Spain.* This tutorial aims at presenting key aspects in the design and development of a PLI-aware SDN control plane for Multi-Band over SDM disaggregated optical networks, including hierarchical arrangements with externalized path computation.

Ramon Casellas is serving as a Research Director at CTTC. His research interests include network control and management and has co-authored over 5 book chapters and over 300 papers, contributing to standardization and Open Source. He has been OFC program chair, general chair, short course instructor and IEEE/Optica JOCN editor.

08:00–10:00
W1D • Doped Fiber Amplifiers and High Power Laser

Presider: Victor Kopp; Chiral Photonics Inc, USA

W1D.1 • 08:00 Invited

Yb-Doped Fibers for kW-Class Fiber Lasers, Andrea Rosales-Garcia[1], Jeffrey Nicholson[1], Rasmus Vincentz Skougaard Jensen[2], Poul Kristensen[2], Jose Pincha[1], Simona Ovtar[2], Miranda Mitrovic[2], Kasper Ingerslev[2], Bent Edvold[2], Simon Christensen[2], David DiGiovanni[1], Bera Palsdottir[2]; [1]*OFS Fitel LLC, USA;* [2]*OFS Fitel Denmark ApS, Denmark.* We demonstrate a TMI-free 5.2 kW single-mode output from a fiber amplifier using Yb 20/400 fibers with reduced core thermo-optic coefficient. The TMI threshold is increased by 50% compared to that of commercial Yb-doped fibers.

08:00–10:00
W1E • Digital Subsystems for SDM and SCM Transmissions

Presider: John Downie; Corning Inc, USA

W1E.1 • 08:00 ★ Top-Scored

205.8Tb/s Weakly-Coupled 2-Mode 7-Core Transmission Over 1170-km FM-MCF Only Using 2×2 MIMO-DSP, Gang Qiao[1,2], Yu Yang[2], Honglin Ji[2], Shuailuo Huang[1], Chengbin Long[1], Yuyang Gao[1], Mingqing Zuo[1], Jiarui Zhang[1], Zhaopeng Xu[2], Qi Wu[2], Shangcheng Wang[2], Lulu Liu[2], Lei Shen[3], Jie Luo[3], Junpeng Liang[2], Zhixue He[2], Yongqi He[1], Weisheng Hu[2], Zhangyuan Chen[1], Juhao Li[1,2]; [1]*Peking Univ., China;* [2]*Peng Cheng Laboratory, China;* [3]*Yangtze Optical Fibre and Cable Joint Stock Limited Company (YOFC), China.* We demonstrate the first long-haul weakly-coupled FM-MCF transmission adopting non-degenerate LP_{01} and LP_{02} modes in a 6-LP-mode 7-core fiber. 205.8Tb/s throughput over 1170 km transmission with DP-QPSK modulation is achieved only utilizing 2×2 MIMO-DSP.

W1E.2 • 08:15 ★ Top-Scored

Low-Complexity 4D×D MIMO Equalizer Enabling 2.6-Tb/s/λ SDM Signal Reception Over Dynamic Four-Coupled-Core Cabled Transmission Line, Akira Kawai[1], Kohki Shibahara[1], Masanori Nakamura[1], Takayuki Kobayashi[1], Takayoshi Mori[2], Ryota Imada[2], Taiji Sakamoto[2], Yusuke Yamada[2], Kazuhide Nakajima[2], Yutaka Miyamoto[1]; [1]*NTT Network Innovation Laboratories, Japan;* [2]*NTT Access Network Service Systems Laboratories, Japan.* We propose a transceiver-impairment-tolerant 4D×D multiple-input/multiple-output equalizer with significantly reduced computational overhead and improved tracking performance for spatial-division-multiplexed receivers and demonstrated it in a 100-Gbaud transmission over a cabled four-coupled-core transmission line with MHz-class fluctuation.

08:00–10:00
W1F • Optical Computing and Memory

Presider: Tetsuya Kawanishi; Waseda Univ., Japan

W1F.1 • 08:00

Hyperspectral in-Memory Computing, Mostafa Honari-Latifpour[1], Byoung Jun Park[1], Yoshihisa Yamamoto[1], Myoung-Gyun Suh[1]; [1]*NTT Research Inc., USA.* We propose and demonstrate hyperspectral in-memory computing systems that harness both frequency and space dimensions, utilizing optical frequency combs and programmable optical memories. This approach offers the potential for energy-efficient optical information processing beyond PetaOPS-level performance.

W1F.2 • 08:15 Invited

Computation with Degenerate Optical Parametric Oscillator Networks, Hiroki Takesue[1], Takahiro Inagaki[1], Kensuke Inaba[1], Takuya Ikuta[1], Yasuhiro Yamada[1], Yuya Yonezu[1], Toshimori Honjo[1]; [1]*NTT Basic Research Laboratories, Japan.* We report the recent progress of a coherent Ising machine, which simulates the Ising model using a network of degenerate optical parametric oscillators (DOPO). We also describe a spiking neural network realized with DOPOs.

06:00–07:00 OFC Fun Run, *Hilton Bayfront*

07:30–08:00 Coffee Break, *Upper Level Corridors*

08:00–10:00 W1G • Panel: Next Generation Disaggregated Data Centers Using Future Chip to System Photonic Technologies

Organizers
Liam Barry, *Dublin City University, Ireland*
George Michelogiannakis, *Lawrence Berkeley National Laboratory, USA*

Speakers
Nicola Calabretta, *Eindhoven University of Technology, Netherlands*
Larry Dennison, *NVIDIA, USA*
Marco Fiorentino, *Hewlett Packard Enterprise, USA*
David Lazovsky, *Celestial AI, USA*
Chris Cole, *Quintessent, USA*
George Zervas, *University of College London, UK*

Emerging photonic technologies promise to revolutionize different aspects of future datacenters and HPC systems. However, new photonic components are best not treated as simple drop-in replacements of their electronic counterparts. Instead, we should consider new capabilities enabled by modern photonics, and how it can preserve performance scaling or reduce system costs, such as reconfigurable and modular systems or high-bandwidth connections between chiplets towards modular future systems. This panel brings together academic and industrial experts from multiple levels of systems from chip design to system architecture to discuss potential impact of emerging photonics as well as photonic experts to discuss how integration technologies are evolving and how they can be better tailored to maximize their future system-wide impact.

08:00–10:00 W1H • Short-Reach Transmission

Presider: Masanori Nakamura; NTT Network Innovation Laboratories, Japan

W1H.1 • 08:00
A Novel Machine Learning-Based Equalizer for a Downstream 100G PAM-4 PON, Chen Shao[1], Elias Giacoumidis[2], Shi Li[2], Jiali Lei[1], Tobias Käfer[1], Michael Faerber[1], Andre Richter[2]; [1]*Karlsruhe Inst. of Technology, Germany;* [2]*VPIphotonics GmbH, Germany.* A frequency-calibrated SCINet (FC-SCINet) equalizer is proposed for downstream 100G PON with 28.7 dB path loss. At 5 km, FC-SCINet improves the BER by 88.87% compared to FFE and a 3-layer DNN with 10.57% lower complexity.

W1H.2 • 08:15
Multiplication-Free Equalization Schemes for 244-Gbps PAM-4 Transmission, Fei Xie[1], Xiaoqian Huang[1], Shuangyue Liu[2], Du Tang[1], Zhengkang Wang[1], Yaojun Qiao[1]; [1]*Beijing Univ. of Posts and Telecomm, China;* [2]*Research Inst. of China Telecommunication, China.* We propose a multiplication-free equalization scheme using cluster-assisting lookup tables (CLUT). Results demonstrate an 11-order table size reduction compared to traditional LUTs, incurring only a 0.2-dB penalty.

08:00–10:00 W1I • Panel: Photonic Components for In-Physics Computing

Organizers
Joyce Poon, *Max Planck Institute of Microstructure Physics, Germany*
Patrick Runge, *Fraunhofer HHI, Germany*
Wei Shi, *Laval University, Canada*

Speakers
Jose Capmany, *Valencia Polytechnic University, Spain*
Chris Cole, *Parallax Group, USA*
Dirk Englund, *Massachusetts Institute of Technology, USA*
Patricia Lee, *Quantinuum, USA*
Hiro Onodera, *NTT Research & Cornell University, USA*
Maurice Steinman, *Lightelligence, USA*
Zach Vernon, *Xanadu Quantum Technologies, Canada*

The physical properties of light and matter can be exploited to realize novel computing paradigms that can have low latency, high energy efficiency, and capabilities beyond digital systems. These opportunities have spurred the recent interest in machine learning accelerators, neuromorphic computing, and quantum computing enabled by photonics. This panel will discuss the photonic devices and circuits needed for these new types of computing systems to be competitive with digital hardware. Both current and future technologies will be presented and explored. Some of the questions that we aim to answer include but are not limited to:

- How can we harness the advantages of photonics in practice to scale computing throughput?
- What are the applications that can truly benefit from photonics-enabled in-physics computing? And those cannot?
- What are the critical challenges in devices and integration (e.g., power consumption, size, loss etc.) the scientific community must overcome in order to realize the full potential of in-physics computing?

08:00–10:00 W1J • Access, Metro and Mobile Convergence

Presider: Chathurika Ranaweera; Deakin Univ., Australia

W1J.1 • 08:00 ★ Top-Scored
Experimental Demonstration of in-Field 400G Coherent Metro-Access Convergence, Giuseppe Rizzelli Martella[2], Mariacristina Casasco[1], Annachiara Pagano[3], Valter Ferrero[1], Roberto Gaudino[1]; [1]*Politecnico di Torino, Italy;* [2]*Fondazione LINKS, Italy;* [3]*TIM, Italy.* We present an experimental demonstration and analytical scaling of optically amplified metro combined with PON access transmission over installed fibers, using coherent 50GBaud PM-16QAM and discuss the technical feasibility of future 400G metro-access convergence.

W1J.2 • 08:15 Invited
Will a Metro-Access Optical Continuum Ever Fly? Deployment Challenges and Enabling Technologies, Fabio Cavaliere[1], Alessandro Percelsi[2]; [1]*Ericsson, Italy;* [2]*TIM, Italy.* We discuss optical continuum techniques to cut the total cost of ownership of telecom operators optical networks, and review enabling photonic technologies, particularly focusing on recent advances of silicon photonics-based reconfigurable optical add drop multiplexers.

08:00–10:00 W1K • Photonic Integration and Integrated Receivers

Presider: Patrick Lo; Advanced Micro Foundry Pte Ltd, Singapore

W1K.1 • 08:00
Breaking the Interconnection Limit by Integrating CMOS Electronics on PICs, Francesco Zanetto[1], Monica Crico[1], Andres I. Martinez[1], Fabio Toso[1], Francesco Morichetti[1], Andrea Melloni[1], Giorgio Ferrari[1], Marco Sampietro[1]; [1]*Politecnico di Milano, Italy.* We demonstrate the integration of electronic functionalities into state-of-the-art photonic platforms with zero changes to the technology. This enables time-multiplexed closed-loop control of programmable silicon photonic meshes with a reduced number of electrical interconnections.

W1K.2 • 08:15
Widely Tunable Laser Based on Thin-Film Lithium Niobate / III-v Hybrid Integration, Wang Shuxin[1], Qi Wang[1], Rui Ma[1], Zhongjin Lin[1], Xinlun Cai[1]; [1]*Sun Yat-sen Univ., China.* We demonstrated a tunable laser based on thin-film lithium niobate and III-V hybrid integration, showcasing a tuning range over 41 nm, a maximum output power of 13.8 mW, and a linewidth of 9.42 KHz.

Room 1A

W1A • Integrated Filters for Communication Systems—Continued

W1A.2 • 08:30
Highly Rectangular SCL-Band MUX/DEMUX Filter Using Compact Cascaded Arrayed Waveguide Gratings, Masashi Ota[1], Kenya Suzuki[1], Keita Yamaguchi[1], Takeshi Umeki[2], Satomi Katayose[2], Osamu Moriwaki[1]; *[1]NTT Device Innovation Center, Japan; [2]NTT Device Technology Laboratories, Japan.* We propose a small-footprint arrayed-waveguide grating (AWG) design method in which an arrayed waveguide area serves as an evaluation metric and report a 170-nm-wide and highly rectangular waveband MUX/DEMUX filter using compact cascaded AWGs.

W1A.3 • 08:45 ★ Top-Scored
32×100 GHz WDM Filter Based on Ultra-Compact Silicon Rings with a High Thermal Tuning Efficiency of 5.85 mW/π, Qingzhong Deng[1], Ahmed H. El-Saeed[1], Alaa Elshazly[1], Guy Lepage[1], Chiara Marchese[1], Hakim Kobbi[1], Rafal Magdziak[1], Jeroen De Coster[1], Neha Singh[1], Marko Ersek Filipcic[1], Kristof Croes[1], Dimitrios Velenis[1], Maumita Chakrabarti[1], Peter De Heyn[1], Peter Verheyen[1], Philippe Absil[1], Filippo Ferraro[1], Yoojin Ban[1], Joris Van Campenhout[1]; *[1]imec, Belgium.* To the best of our knowledge, this paper has achieved the lowest thermal tuning power (5.85 mW/π) for silicon rings with FSR≥3.2 THz, and the first silicon ring-based WDM-32×100 GHz filter.

W1A.4 • 09:00
Cost-Effective ROADM Using Wide-Bandwidth Silicon Tunable Ring Filter for Drop Operation, Ryosuke Matsumoto[1], Ryotaro Konoike[1], Hiroyuki Matsuura[1], Keijiro Suzuki[1], Takashi Inoue[1], Kazuhiro Ikeda[1], Shu Namiki[1], Ken-ichi Sato[1]; *[1]AIST, Japan.* We develop a ROADM using an 8-channel integrated polarization-insensitive, wide-bandwidth silicon tunable ring-filter for signal drop. A 75-GHz-spaced 60-channel 200-Gb/s DP-QPSK signal is transmitted over 640 km (8 span x 80 km) without any penalty.

Room 1B

W1B • Monitoring and Sensing—Continued

W1B.3 • 08:30 Invited
Recent Advances in Digital Longitudinal Monitoring of Fiber-Optic Link, Takeo Sasai[1], Minami Takahashi[1], Runa Kaneko[1], Yoshiaki Sone[1], Masanori Nakamura[1], Etsushi Yamazaki[1]; *[1]NTT Corporation, Japan.* We review fiber-longitudinal power profile estimation (PPE) methods, which estimate optical power along a fiber-optic link at a coherent receiver. We highlight key experiments demonstrating the extreme performance of PPE and its feasibility in operational use.

W1B.4 • 09:00
Fiber Longitudinal Monitoring of Inter-Band-SRS-Induced Power Transition in S+C+L WDM Transmission, Runa Kaneko[1], Takeo Sasai[1], Fukutaro Hamaoka[1], Masanori Nakamura[1], Etsushi Yamazaki[1]; *[1]NTT Network Innovation Laboratories, Japan.* We experimentally demonstrate the fiber-longitudinal power profile estimation (PPE) over the S+C+L band, which captures power transition in the propagation direction due to inter-band stimulated Raman scattering only using receiver-side signal processing.

Room 2

W1C • Network Control and Orchestration—Continued

W1C.2 • 09:00
Cost-Effective Capacity Enhancement of Survivable Optical Networks by Supplemental Band Expansion and Backup Resource Sharing, Daisuke Saito[1], Yojiro Mori[1], Kohei Hosokawa[2], Shigeyuki Yanagimachi[2], Hiroshi Hasegawa[1]; *[1]Nagoya Univ., Japan; [2]NEC Corporation, Japan.* A novel cost-effective capacity enhancement method for resilient optical networks is proposed that introduces supplemental multi-band transmission and sharing of extended bands by backup paths. Numerical simulations confirm 17.7-35.3% enhancement on three real topologies.

Room 3

W1D • Doped Fiber Amplifiers and High Power Laser—Continued

W1D.2 • 08:30
A 16 m High Bismuth-Doped Fiber Amplifier Provides 47.9 dB Gain in E+S-Band, Shaokun Liu[1], Xiaoke Yin[1], Le He[1], Zhimu Gu[1], Wenzhen Li[1], Yang Chen[2], Yingbin Xing[1], Yingbo Chu[1], Nengli Dai[1], Jinyan Li[1]; *[1]Huazhong Univ. of Science and Techn, China; [2]Wuhan CJphotonics Ltd., China.* We report a bismuth-doped fiber with high bismuth active center concentration and low unsaturable loss, demonstrating a record 16m E+S-band bismuth-doped fiber amplifier with 47.9dB gain and gain per unit length of 4.06dB/m at 1450nm.

W1D.3 • 08:45
Site Dependent Pumping Effect in Super L-Band EDFA, Lixian Wang[1], Saber Jalilpiran[2], Jacques Lefebvre[2], Sophie LaRochelle[2], Younès Messaddeq[2], Zhiping Jiang[1]; *[1]Huawei Technologies Canada, Canada; [2]Université Laval, Canada.* This work shows how pump wavelength would impact the static gain curve distortion of a super L-band EDFA under large input signal power variation. The theoretical model is explored to interpret the experimental observations.

W1D.4 • 09:00
E-Band Transmission of 30-Gbaud PM-16-QAM Supported by Neodymium-Doped Fiber Amplifier, Aleksandr I. Donodin[1], Leily Kiani[2], Shabnam Noor[1], Wladek Forysiak[1]; *[1]Aston Univ., UK; [2]Lawrence Livermore National Laboratory, USA.* We experimentally demonstrate the first E-band transmission through 50 km of G.652.D fiber using 30 Gbaud 16-QAM signals enabled by a neodymium doped fiber amplifier with 14 dB gain and 5 dB noise figure.

Room 6C

W1E • Digital Subsystems for SDM and SCM Transmissions—Continued

W1E.3 • 08:30
Demonstration of Point-to-Multipoint Diversity Gain in a 1.6-Tb/s-Class Sub-carrier-Multiplexed Coherent System, Di Che[1]; *[1]Nokia Bell Labs, USA.* We reveal a diversity gain in point-to-multipoint systems when the end points experience various channel conditions. We demonstrate rate improvement over the conventional time-division multiple access in an 18×10-GBaud subcarrier-multiplexed coherent system.

W1E.4 • 08:45
Circuit Implementation of Pilot-Based Dynamic MIMO Equalization for Coupled-Core Fibers, Erik Börjeson[1], Ekaterina Deriushkina[1], Mikael Mazur[2], Magnus Karlsson[1], Per Larsson-Edefors[1]; *[1]Chalmers Univ. of Technology, Sweden; [2]Nokia Bell Labs, USA.* We explore ASIC implementation for pilot-based MIMO equalizers for coupled-core transmission, considering chip area scaling trends and performance impact of time-dependent drift. For a system with 28-GBd subcarriers, an equalizer for 8×8 is 5.3 times larger than for 2×2.

W1E.5 • 09:00
On the Impact of Spatial Mode Dispersion for Mode-Dependent Loss Estimation and Mitigation in Coupled-Core MCF Links, Meng Mao[1], Bin Chen[2], Rendong Xu[3], Lin Sun[1], Junjie Xiong[4], Lin Ma[4], Gangxiang Shen[1], Gordon Ning Liu[1]; *[1]Soochow Univ., China; [2]Hefei Univ. of Technology, China; [3]Zhejiang Univ., China; [4]Shanghai Jiao Tong Univ., China.* Impact of SMD on MDL estimation and mitigation in CC-MCF links is theoretically investigated. SMD below 10 ps/km is mandatory to ensure the efficient MDL mitigation in 1000-km CC-MCF links.

Room 6D

W1F • Optical Computing and Memory—Continued

W1F.3 • 08:45
Integrated Photonic Computing Chip for Unary-Based Option Pricing, Hui Zhang[2,1], Sergi Ramos-Calderer[3], Yuancheng Zhan[1], Hong Cai[2], Patrick Lo[4], Leong Chuan Kwek[5], Jose Ignacio Latorre[5,3], Ai Qun Liu[2,1]; *[1]Nanyang Technological Univ., Singapore; [2]The Hong Kong Polytechnic Univ., Hong Kong; [3]Institut de Ciencies del Cosmos (ICCUB), Universitat de Barcelona, Spain; [4]Advanced Micro Foundry, Singapore; [5]Centre for Quantum Technologies, National Univ. of Singapore, Singapore.* A specialized photonic chip is demonstrated for unary European option pricing and quantum amplitude estimation is adopted to overcome classical computing bottlenecks. The chip achieves precise asset distribution modeling and prediction, significantly enhancing financial industry efficiency and services.

W1F.4 • 09:00 ★ Top-Scored
20 GHz Silicon Integrated Optical Ternary Content Addressable Memory (CAM) Cell, George Giamougiannis[1], Christos Pappas[1], Theodoros Moschos[1], Apostolos Tsakyridis[1], Miltiadis Moralis-Pegios[1], Chris Vagionas[1], Yanir London[2], Thomas Van Vaerenbergh[2], Bassem Tossoun[2], Nikos Pleros[1]; *[1]Aristoteleio Panepistimio Thessalonikis, Greece; [2]Hewlett Packard Enterprise, USA.* We propose and experimentally demonstrate an optical ternary content addressable memory cell operating at a record-high search speed of 20 Gb/s on a silicon photonic coherent Crossbar array with an energy efficiency of 0.2 pJ/bit.

Room 6E

W1G • Panel: Next Generation Disaggregated Data Centers Using Future Chip to System Photonic Technologies—Continued

Room 6F

W1H • Short-Reach Transmission—Continued

W1H.3 • 08:30
Single-Mode Coherent Transmission Over Universal Fiber for Data Center Interconnects, Fabio A. Barbosa[1], Mareli Rodigheri[1,2], Samuel Lennard[1], Ming-Jun Li[3], Filipe Ferreira[1]; *[1]Univ. College London, UK; [2]Univ. of Campinas, Brazil; [3]Corning Incorporated, USA.* We demonstrate DP-16-QAM up to 42 Gbaud over 50 km of universal fiber, meeting current DCI requirements while allowing SDM upgrades. Multipath interference is analyzed experimentally using mandrel wrapping and matched by split-step simulation.

W1H.4 • 08:45
Nonlinear Vector Autoregressor Equalization for PAM-4 Micro-Ring Modulator-Based Short-Reach Transmission, Yevhenii Osadchuk[1], Deming Kong[1], Darko Zibar[1], Francesco D. Ros[1]; *[1]Technical Univ. of Denmark, Denmark.* We experimentally demonstrate a nonlinear vector autoregressor equalizer for 40 and 50 GBaud PAM-4 transmission with microring modulators and show that it outperforms both Volterra and reservoir computing-based equalizers in B2B and 2 km scenarios.

W1H.5 • 09:00
CD-Aware OCT Precoding for C-Band 100-Gb/s IM/DD OFDM Transmission Over 50-km SSMF, Junwei Zhang[1], Liwang Lu[1], Heyun Tan[2], Xiaojian Hong[3], Chao Fei[3], Kangping Zhong[1], Alan P. Lau[1], Chao Lu[1]; *[1]The Hong Kong Polytechnic Univ., Hong Kong; [2]Sun Yat-sen Univ., China; [3]Zhejiang Univ., China.* A CD-aware orthogonal-circulant-matrix-transform (OCT) precoding is proposed for C-band 100-Gb/s IM/DD-OFDM transmission over 50-km SSMF. The proposed scheme outperforms conventional schemes and improves the capacity by >20% (>12%) compared to CD-aware subcarrier loading (DFT precoding).

Room 7

W1I • Panel: Photonic Components for In-Physics Computing—Continued

Room 8

W1J • Access, Metro and Mobile Convergence—Continued

W1J.3 • 08:45
Port-Agnostic Path Establishment with Point-to-Multipoint Control of Remote User Terminals for Metro/Access-Integrated All-Photonics Network, Ryo Igarashi[1], Shin Kaneko[1], Yasutaka Kimura[1], Naotaka Shibata[1], Takahiro Suzuki[1], Masamichi Fujiwara[1], Jun-ichi Kani[1], Tomoaki Yoshida[1]; *[1]NTT Corporation, Japan.* We propose a port-agnostic initial-connection sequence allowing simultaneous connection of multiple user terminals (UTs), and demonstrate end-to-end wavelength-path and fiber-path establishment for DWDM and non-DWDM UTs through point-to-multipoint-type remote UT control in Metro/Access-Integrated All-Photonics Network.

W1J.4 • 09:00
Wideband FTTR PON Integrating Optical Wireless Access, Bernhard Schrenk[1]; *[1]AIT Austrian Inst. of Technology, Austria.* Symmetric 10 Gb/s wired access is shown in co-existence with 15 Gb/s optical wireless and 1.9 Gb/s visible-light communication. Shortwave-blind FTTR operation and robust few-mode transmission over installed fiber loops are demonstrated.

Room 9

W1K • Photonic Integration and Integrated Receivers—Continued

W1K.3 • 08:30
Heterogeneously-Integrated Self-Injection Locked Lasers on Thin Film Lithium Niobate, Mingxiao Li[2], Chao Xiang[2], Jonathan Peters[2], Joel Guo[2], Theodore Morin[2], Shixin Xue[1], Mario Dumont[2], Jeremy Staffa[1], Qiang Lin[1], John Bowers[2]; *[1]Univ. of Rochester, USA; [2]Univ. of California, Santa Barbara, USA.* We demonstrate a heterogeneously integrated self-injection locked lithium niobate laser via direct bonding. The single mode lasing power is as high as 16 mW with a side mode suppression ratio over 50 dB.

W1K.4 • 08:45
A Cost-Efficient 1.28 Tb/s DWDM Receiver Using All-Si Double Microring Avalanche Photodiodes, Yiwei Peng[1], Yuan Yuan[1], Wayne Sorin[1], Stanley Cheung[1], Zhihong Huang[1], Di Liang[1], Marco Fiorentino[1], Raymond Beausoleil[1]; *[1]Hewlett Packard Enterprise, USA.* We demonstrate a novel 8-channel all-Si double-MRR RX with record-high 1.28 Tb/s aggregated data rate and ultra-low -50 dB crosstalk, which can compete with the commercial RXs and promises ~ 40% chip cost saving.

W1K.5 • 09:00
Integrated Photonic Resonant Modulator-Based Equalization and Optimization for DWDM, Asher S. Novick[2,1], Maarten Hattink[2,1], Anthony Rizzo[2], Yuyang Wang[2], Vignesh Gopal[2], Songli Wang[2], Robert Parsons[2], Keren Bergman[2]; *[1]Xscape Photonics, USA; [2]Electrical Engineering, Columbia Univ., USA.* We perform multi-wavelength signal equalization and optimization in a DWDM SiPh link by adjusting the operating regime of integrated resonant modulators. An effective increase in the optical link's dynamic range of >3 dB is measured.

Room 1A

W1A • Integrated Filters for Communication Systems—Continued

W1A.5 • 09:15
Monolithic Silicon Photonic Few-Mode Waveguide with Satellite Structures for Athermal Spectral Filtering, Ryotaro Konoike[1], Takayuki Kurosu[1], Guangwei Cong[1], Keijiro Suzuki[1], Kazuhiro Ikeda[1], Shu Namiki[1]; *[1]AIST, Japan.* We propose a fully CMOS-compatible few-mode waveguide with "satellite" structures that exhibits thermally anomalous modal phase difference, and demonstrate the condition for athermal operation of spectral filtering from 20 to 50 °C.

W1A.6 • 09:30
Inverse-Designed CWDM Demultiplexer Operated in O-Band, Alfred Cheung[2], Krishna Gadepalli[2], Jian Guan[2], Andreas Hoenselaar[2], Yang Meng[2], Anton Menshov[2], Jan Petykiewicz[1], Rhett Stucki[2], Lieven Verslegers[1], Jiahui Wang[2], Xavier Serey[2], Phil Watson[2], Ian Williamson[2], Yi-Kuei R. Wu[2]; *[1]Google, USA; [2]X the moonshot factory (formerly Google X), USA.* We introduce an inverse designed silicon 4-channel CWDM demux with mean worst insertion loss of 2-3.3 dB and mean worst crosstalk of 19-26 dB. Variability and predictability are demonstrated using a commercial CMOS process.

W1A.7 • 09:45 ★ Top-Scored
Dual-Polarization Phase Retrieval Receiver in Silicon Photonics, Brian Stern[1], Hanzi Huang[1,2], Haoshuo Chen[1], Kwangwoong Kim[1], Mohamad H. Idjadi[1]; *[1]Nokia Bell Labs, USA; [2]Shanghai Univ., China.* We demonstrate an integrated dual-polarization phase retrieval receiver. It uses silicon waveguides and resonators to recover phase from intensity-only measurements. We show retrieval of a polarization-division multiplexed 30-GBd QPSK signal over 80 km of SSMF.

Room 1B

W1B • Monitoring and Sensing—Continued

W1B.5 • 09:15
State-of-Polarization Monitoring Employing Optical Supervisory Channel Enabling Instantaneous Fluctuation Detection and Localization, Yusuke Sasaki[1], Masaki Sato[1], HIdemi Noguchi[1], Kohei Hosokawa[1]; *[1]Advanced Network Research Laboratories, NEC corporation, Japan.* We demonstrate a state of polarization monitoring system employing an optical supervisory channel can detect even short fluctuations of 10 µs with precise localization in the experiment over an FPGA.

W1B.6 • 09:30
Digital Vibration Detection and Localization Using Carrier Laser Phase Noise Retrieval in a Conventional Coherent Transponder, Yixiang Hu[1], Mohammad E. Mousa-Pasandi[2], Ramón Gutiérrez-Castrejón[1,3], Maurice O'Sullivan[2], Fanqi Kong[2], Brandon Buscaino[2], Jinsong Zhang[1], Santiago Bernal[1], Charles St-Arnault[1], David V. Plant[1]; *[1]McGill Univ., Canada; [2]Ciena, Canada; [3]Inst. of Engineering, Universidad Nacional Autónoma de México, Mexico.* We demonstrate digitally recovered carrier laser phase noise corrupted by vibration induced phase perturbations on signaling data without introducing ultranarrow linewidth lasers. We show >10 dB improvements in vibro-perturbation SNR versus bandpass filtering methods.

Room 2

W1C • Network Control and Orchestration—Continued

W1C.3 • 09:15
Privacy Preserving Digital Twin Knowledge Sharing for Multi-Domain Networks, Marc Ruiz[1], Luis Velasco[1]; *[1]Universitat Politecnica de Catalunya, Spain.* Knowledge sharing techniques among OCATA optical layer digital twin instances are proposed for multi-domain scenarios. Intra-domain model transformations are performed to guarantee privacy of intra-domain topology. Remarkable accuracy to estimate multi-domain lightpaths QoT is shown.

W1C.4 • 09:30
Open Software Development Kit (OpenSDK) for Optical Network Disaggregation, Filippo Cugini[1], Davide Scano[2], Andrea Sgambelluri[2], Francesco Paolucci[1], Alessio Giorgetti[3], Piero Castoldi[2]; *[1]CNIT, Italy; [2]Scuola Superiore Sant'Anna, Italy; [3]IEIIT, CNR, Italy.* OpenSDK is proposed to provide vendor-neutral, micro-service-based control of underlying optical hardware. Disaggregation is then achieved without requiring standard Southbound interfaces from the SDN Controller. Validation is performed enforcing smart operations on IPoWDM white box.

Room 3

W1D • Doped Fiber Amplifiers and High Power Laser—Continued

W1D.5 • 09:15
Gain Optimization of Er-Doped Fibers Doped with Er:BaF_2 Nanoparticles, Jennifer Campbell[1], Mary Ann Cahoon[2], Michael Gachich[1], Michael Norlander[1], Thomas Hawkins[2], John Ballato[2], Peter Dragic[1]; *[1]UIUC, USA; [2]Clemson Univ., USA.* An Er:BaF_2 nanoparticle doped silica fiber (EDF) heavily doped with erbium exhibits mitigated quenching effects and possesses a high quantum efficiency (976 nm pumping). Investigations herein suggest the erbium concentration is scalable to 1 wt%.

W1D.6 • 09:30
S+L Dual Band Silica Based EDFA Enabling Seamless Upgrade From C-Band to S+C+L Triple Band System, Youichi Akasaka[1], Paparao Palacharla[1]; *[1]Fujitsu Network Communications Inc, USA.* We propose S+L dual-band silica-based EDFA, enabling seamless upgrade from C-band to S+C+L triband transmission system. We achieve ~20dB gain, ~6dB NF with this 3-stage EDFA and 1500nm-1600nm gain bandwidth when combined with C-band EDFA.

W1D.7 • 09:45
21.9 THz-Wide Ytterbium Doped Fiber Amplifier for 1 µm Data Transmission, Xin Huang[1], Sijing Liang[1], Lin Xu[1], David J. Richardson[1,2], Yong-min Jung[1]; *[1]Univ. of Southampton, UK; [2]Microsoft (Lumenisity), UK.* We present an ultra-wideband ytterbium-doped fiber amplifier optimized for 1 µm data transmission, providing a remarkable 21.9 THz bandwidth (1025-1110 nm), with >20 dB average gain and <5.1 dB noise figure.

Room 6C

W1E • Digital Subsystems for SDM and SCM Transmissions—Continued

W1E.6 • 09:15
Low-Complexity Frequency Packing to Enable Filtering-Tolerant DSCM Transmission, Romil Patel[2], Sami Mumtaz[3], Marco A. Fernandes[1], Beatriz Oliveira[1], Gabriel Charlet[3], Yu Zhao[3], Paulo Monteiro[1], Abel Lorences-Riesgo[3], Fernando P. Guiomar[1]; *[1]Instituto de Telecomunicações, Portugal; [2]Photonics Systems Group, Tyndall National Inst. - Univ. College Cork, Ireland; [3]Optical Communication Technology Lab, Huawei Technologies France, France.* Employing optimized frequency packing over digital subcarrier multiplexing (DSCM), we exploit the mitigation of WSS filtering penalties. After transmitting a 60 Gbaud 8-DSCM with 0.2 roll-off over 5-10 WSSs, we experimentally demonstrate OSNR gains of >3 dB, without additional DSP complexity.

W1E.7 • 09:30
A Low Complexity Coherent 16×400 Gbit/s 4SC-16QAM DSCM System with Precise Transceiver IQ Skew Compensation and Simplified Equalization, Wei Wang[1], Dongdong Zou[1], Zhenpeng Wu[1], Xingwen Yi[1], Wei Sun[2], Fan Li[1], Zhaohui Li[1]; *[1]Sun Yat-Sen Univ., China; [2]R & D Department, Hengtong Optic-electric Co., Ltd., China.* A low complexity coherent 16×400 Gbit/s datacenter interconnect with 50Gbaud 4SC-16QAM DSCM signal is experimentally demonstrated, enabled by a novel low complexity transceiver IQ skew estimation method and simplified equalizer embedded phase tracking.

W1E.8 • 09:45
Enhanced Carrier Phase Recovery for Spectral-Efficient Digital Subcarrier Multiplexing Transmissions, Meng Xiang[1], Sailan Yan[1], Can Wei[1], Hong Lv[1], Li Jianping[1], Songnian Fu[1], Yuwen Qin[1]; *[1]Guangdong Univ. of Technology, China.* We demonstrate a performance enhanced carrier-phase-recovery (CPR) method for spectral-efficient digital-subcarrier-multiplexing transmissions with two-interleaved-pilot-tones. By reconstructing and compensating transmitter-side and receiver-side laser phase noises separately, equalization-enhance-phase-noise (EEPN) can be circumvented.

Room 6D

W1F • Optical Computing and Memory—Continued

W1F.5 • 09:15 Invited
Holographic Optical Storage for the Cloud?, Benn C. Thomsen[1], Grace Brennan[1], Nathanael Cheriere[1], Jiaqi Chu[1], Jannes Gladrow[1], Douglas Kelly[1], Giorgio Maltese[1], Dushyanth Narayanan[1], Greg O'Shea[1], Alan Sanders[1], Xingbo Wu[1], Mengyang Yang[1]; *[1]Microsoft, UK.* We assess the performance and energy efficiency of an end-to-end Holographic optical storage system to determine if this technology can cost effectively solve the access rate challenges in online cloud storage applications.

W1F.6 • 09:45
Frequency-Comb-Enabled Photonic RF Memory for Multi-False-Target Radar Compound Jamming, Kai Xu[1], Xinghan Li[1], Hongyu Li[1], Mengfan Cheng[1], Qi Yang[1], Ming Tang[1], Deming Liu[1], Lei Deng[1]; *[1]Wuhan National Laboratory for Optoelectronics and School of Optical and Electronic Information, Huazhong Univ. of Science and Technology, China.* We report the first all-optical multi-false-target radar jamming scheme using frequency-comb-enabled photonic RF memory. More than 10 false targets with range-velocity deception information are obtained, with storage time exceeding 840µs and signal frequency reaching 16GHz.

Room 6E

W1G • Panel: Next Generation Disaggregated Data Centers Using Future Chip to System Photonic Technologies—Continued

Room 6F

W1H • Short-Reach Transmission—Continued

W1H.6 • 09:15
Simultaneous IM/DD Data Transmission and High-Rate Secret Key Distribution Over a Single C-Band Channel, Michal Jachura[1], Jakub Szlachetka[2], Mateusz Kucharczyk[1], Marcin Jarzyna[1], Piotr Kolenderski[2], Jaroslaw P. Turkiewicz[3], Konrad Banaszek[1]; [1]*Univ. of Warsaw, Poland;* [2]*Nicolaus Copernicus Univ., Poland;* [3]*Warsaw Univ. of Technology, Poland*. We demonstrate hierarchical multiscale PAM-4 transmission combining 500 Mbps data transfer with optical-layer cryptographic key distribution at rates 23.76 Mbps and 8.20 Mbps secure against passive eavesdropper advantage 0 dB and 6 dB respectively.

Room 7

W1I • Panel: Photonic Components for In-Physics Computing—Continued

Room 8

W1J • Access, Metro and Mobile Convergence—Continued

W1J.5 • 09:15 **Invited**
Optical Transport Networks Converging Edge Compute and Central Cloud: an Enabler for 6G Services, Anna Tzanakaki[1], Markos Anastasopoulos[1]; [1]*National and Kapodistrian Univ. of Athens, Greece*. The paper positions the role of optical transport networks in converging edge and central cloud compute resources adopting an intent-based approach suitable for 6G systems. System level evaluations are performed over an experimental 5G testbed.

W1J.6 • 09:45
Large-Scale Network Field Trial Demonstrating the Evolution of 10G EPON to 50G PON Using Two-Generation Multi-PON Modules, Dezhi Zhang[1], Jialiang Jin[2], Jianglong Wang[3], Dekun Liu[4], Derek Nesset[5]; [1]*China Telecom Research Inst., State Key Laboratory of Optical Fiber and Cable Manufacture Technology, China;* [2]*China Telecom Research Inst., China;* [3]*China Telecom Corporation Limited, China;* [4]*Optical Research Department, Huawei Technologies Co., Ltd, China;* [5]*Ipswich Research Centre, Huawei Technologies, UK*. We report the first large-scale network field trial demonstrating the evolution of 10G EPON to 50G PON using a newly two-generation multi-PON module, which validates the sustainable evolution for mass 10G EPON networks.

Room 9

W1K • Photonic Integration and Integrated Receivers—Continued

W1K.6 • 09:15 **Invited**
InP-Based Optical Devices Integrated on Silicon Photonic Circuits, Takuya Okimoto[1,2], Naoki Fujiwara[1,2], Naoko Inoue[1,2], Takuo Hiratani[1,2], Takehiko Kikuchi[1,2], Takuya Mitarai[1,2], Munetaka Kurokawa[1,2], Hajime Tanaka[1,2], Hidenari Fujikata[1,2], Tohma Watanabe[1,2], Toshiyuki Nitta[1,2], Nobuhiko Nishiyama[1,3], Hideki Yagi[1,2]; [1]*Photonics Electronics Technology Research Association, Japan;* [2]*Sumitomo Electric Industries Ltd, Japan;* [3]*Tokyo Inst. of Technology, Japan*. We review our III-V/Si hybrid integration platform using chip-on-wafer direct bonding technique and the performance of hybrid lasers with InP-based gain regions on Si photonic circuits.

W1K.7 • 09:45
128 GBaud Coherent Receiver Engine with Flat Frequency Response, Jonas Gläsel[1], Alexander Schindler[2], Hendrik Boerma[1], Thanh T. Tran[1], Felix Ganzer[1], Duy P. Nguyen[3], Billy Allen[3], Patrick Runge[1], Martin Schell[1,2]; [1]*Fraunhofer HHI, Germany;* [2]*Technical Univ. Berlin, Germany;* [3]*MACOM Technology Solutions, USA*. We demonstrate a high responsivity intradyne coherent receiver engine with 80 GHz bandwidth. A co-design of the InP waveguide integrated coherent photodetector and the dual linear SiGe transimpedance amplifier results in a flat frequency response. A system evaluation at 128 GBaud shows the capability for QPSK and 16QAM.

10:00–17:00 Exhibition and Show Floor Programs, *Exhibit Hall, (coffee service 10:00–10:30)*

10:00–16:30 Career Zone, *Exhibit Hall B1*

10:30–12:30 W2A • Posters Session I, In-Person, *Exhibit Hall B1*
W2B • Posters Session II, Remote, *eGallery on OFC website*
Lunch Break *(on own; concessions available in Exhibit Hall)*

Show Floor Programming

NOS1 • Network Operator Summit: Keynote
10:15–10:45, *Theater I*

Open XR Optics
10:15–10:45, *Theater III*

Ethernet Interconnect Solutions: Will The Advancement in Coherent Signaling Leverage DataCom Connect
10:15–11:15, *Theater II*

OFCnet Panel: Quantum Entanglement and Quantum Memory for Next Generation Quantum Networks
11:00–11:45, *Theater III*

10:30–12:30
W2A • Posters Session I, In Person

W2A.1
Improving FFE Performance by an Error Decorrelation Algorithm, Nebojsa Stojanovic[1], Tom Jonas Wettlin[1], Lin Youxi[1], Maxim Kuschnerov[1], Talha Rahman[1], Stefano Calabro[1]; *[1]Huawei Technologies Co Ltd, Germany.* Two error decorrelation algorithms with negligible complexity and latency are developed to improve noise statistics after feed-forward equalizers. Performance improvement is demonstrated in simulations and experiments.

W2A.2
Wavelength-Stable Transmitter at ONU by Using Burst SOA for Coherent TDM-PON, Acai Tan[1], Zhengxuan Li[1], Siyu Luo[1], Zheng Xin[1], Qinyao Yang[1], Yingxiong Song[1]; *[1]Shanghai Univ., China.* We propose and experimentally demonstrate a wavelength-stable upstream transmission system for coherent TDM-PON by using a burst-mode SOA at the ONU, which is capable of supporting more than 512 ONUs with high performance and reliability.

W2A.3
Optical Single-Sideband (SSB) Conversion Technique Using Phase Modulator for High-Speed Short-Reach IM/DD PAM Signaling, Nobuhiko Kikuchi[1], Riu Hirai[1], Takahito Tanimura[1]; *[1]Hitachi Ltd, Japan.* We propose novel SSBI-free SSB conversion technique of high-speed PAM signals by phase modulation and show improvement of CD tolerance of MZ and EML transmitter by >6 and >7.6 times in 40-GB PAM4 transmission experiments.

W2A.4
Long-Distance Quantum Key Distribution Supported by a PIC-Based Interferometer, Giulia Guarda[2,3], Domenico Ribezzo[3,4], Tommaso Occhipinti[5], Alessandro Zavatta[3,5], Davide Bacco[1,5]; *[1]Department of Physics, Univ. of Florence, Italy; [2]Department of Physics, European Laboratory for Non Linear Spectroscopy, Italy; [3]National Inst. of Optics (CNR-INO), Italy; [4]Department of Physics, Univ. of Naples Federico II, Italy; [5]QTI S.r.l, Italy.* We demonstrate QKD with efficient-BB84 protocol employing a photonic integrated Mach-Zehnder interferometer in the receiver. Our solution outperforms fiber-based devices, covering a 45 dB link and achieving a 220% higher key rate at 10 dB.

W2A.5
3D Freeform Millimeter-Wave and THz Structures Based on Multi-Photon Lithography, Pascal Maier[1,2], Alexander Kotz[1], Joachim Hebeler[3], Qiaoshuang Zhang[4], Christian Benz[1,2], Alexander Quint[3], Marius Kretschmann[3], Tobias Harter[1], Sebastian Randel[1], Uli Lemmer[4], Wolfgang Freude[1], Thomas Zwick[3], Christian Koos[1,2]; *[1]Inst. of Photonics and Quantum Electronics (IPQ), Karlsruhe Inst. of Technology (KIT), Germany; [2]Inst. of Microstructure Technology (IMT), Karlsruhe Inst. of Technology (KIT), Germany; [3]Inst. of Radio Frequency Engineering and Electronics (IHE), Karlsruhe Inst. of Technology (KIT), Germany; [4]Light Technology Inst. (LTI), Karlsruhe Inst. of Technology (KIT), Germany.* We exploit high-resolution multi-photon lithography for fabricating 3D-freeform millimeter-wave and THz structures that overcome the limitations of conventional planar architectures. We demonstrate THz probes, suspended antennas, and ultra-broadband chip-chip interconnects offering bandwidths in excess of 0.3 THz.

W2A.6
100 Gbps PAM4 VCSEL-Based Transmission Over Meter-Scale Flexible Multimode Polymer Waveguides for Board-Level Optical Interconnects Application, Xu Liu[1], Lin Ma[1], Ying Shi[1], Qiancheng Yu[1], Motoya Kaneta[2], Zuyuan He[1]; *[1]Shanghai Jiao Tong Univ., China; [2]Sumitomo Bakelite Co., Ltd, Japan.* We demonstrate 100 Gbps PAM4 VCSEL-based transmission over 12-channel connectorized meter-scale flexible multimode polymer waveguides with a bandwidth-length product greater than 56 GHz●m at a wavelength of 850 nm for board-level optical interconnects application.

W2A.7
A Grating Coupler with High Coupling Efficiency and Large Bandwidth for Silicon-on-Insulator Technology, Christian Schweikert[1], Simon Nau[1], Niklas Hoppe[2], Wolfgang Vogel[1], Manfred Berroth[1], Georg Rademacher[1]; *[1]Univ. of Stuttgart, Germany; [2]Q.ANT GmbH, Germany.* Conventional grating couplers show a tradeoff between low-loss and broadband operation. By using the interference of counter-propagating waves, we demonstrate a grating coupler design with a simulated coupling efficiency-1dB-bandwidth product of 77 nm.

W2A.8
Low-Divergent 940-nm Photonic-Crystal Surface-Emitting Laser for Short-Reach Free-Space Data Link, Chih-Hsien Cheng[1], Po-Lun Chen[2,5], Pin-Wei Ho[2], Yu-Heng Hong[3], Shih-Chen Chen[3], Shu-Wei Chang[4,5], Chao-Hsin Wu[2], Hao-Chung Kuo[3,5], Atsushi Matsumoto[1], Kouichi Akahane[1], Gong-Ru Lin[2,6]; *[1]National Inst. of Information and Communications Technology, Japan; [2]National Taiwan Univ., Taiwan; [3]Semiconductor Research Center, Hon Hai Research Inst., Taiwan; [4]Research Center for Applied Sciences, Academia Sinica, Taiwan; [5]National Yang Ming Chiao Tung Univ., Taiwan; [6]NTU-Tektronix Joint Research Center, Tektronix Inc. and National Taiwan Univ., Taiwan.* The photonic-crystal-structured surface-emitting laser with a low-divergent-beam angle of 4.5 mrad can perform either 5.5-Gbit/s NRZ-OOK, or 16-Gbit/s broadband QAM DMT or 19.2-Gbit/s bit-loaded DMT formats for 30-cm short-reach point-to-point free-space-optical communication link.

W2A.9
Large-Scale Integrated Focal Plane Array for Two-Dimensional Scanning, Lei Yu[1,2], Yifan Xin[1,2], Pengfei Wang[1,2], Guangzhen Luo[1,2], Pengfei Ma[1,2], Zheng Wang[1,2], Licheng Chen[1,2], Yibo Yang[1,2], Yejin Zhang[1,2], Jiaoqing Pan[1,2]; *[1]Key Laboratory of Semiconductor Materials Science, CAS Inst. of Semiconductors, China; [2]Center of Materials Science and Optoelectronics Engineering, Univ. of Chinese Academy of Sciences, China.* The focal plane array is regarded as a promising solution for LiDAR. In this work, we present an ultra-large-scale focal plane array featuring 1024 antennas and 2113 micro-rings with a FoV of 85.7° × 29.5°.

W2A.10
A 7x4 Silicon Photonic Reconfigurable Optical Analog Processor with Algorithmic Calibration, Md Jubayer Shawon[1], Vishal Saxena[1]; *[1]Univ. of Delaware, USA.* This work presents a large-scale 7x4 square optical mesh-based programmable analog optical processor, or optical FPGA, fabricated in a standard CMOS-compatible foundry. The processor employs an electronic backend with optimized on-chip monitors and microheaters for algorithmic calibration for the automatic configuration of optical circuits.

W2A.11
Single Wavelength Laser to-CAN Integrated with One-Chip Wavelength Locker, Junichi Suzuki[1], Kiyotomo Hasegawa[1], Kei Masuyama[1], Nobuo Ohata[1]; *[1]Mitsubishi Electric, Japan.* A φ5.6-mm TO-CAN packaged light source module integrated with one-chip wavelength locker has been fabricated with a frequency shift <±1.1 GHz, small enough to achieve wavelength locking with a compact package for short-reach coherent communication.

W2A.12
Experimental Demonstration of Error Detection-Driven Nonlinearity Compensation for Optical Fiber Communication Systems, Metodi P. Yankov[1], Edson P. da Silva[2], Søren Forchhammer[1]; *[1]Department of Photonics and Electrical Engineering, Technical Univ. of Denmark, Denmark; [2]Department of Electrical Engineering, Federal Univ. of Campina Grande, Brazil.* We demonstrate how the error-detection capabilities of the inner code in an experimental rate-adaptive concatenated FEC scheme can be employed to reduce the computational complexity of the nonlinearity compensation block. Total complexity savings between 17% and 95% are reported depending on the target operating point.

W2A.13
Importance of the Contentionless OXC Property for WDM Networks Handling the Fastest Optical Channels, Thierry Zami[1]; *[1]Nokia Corporation, France.* This paper explains why the contentionless property becomes more than only "nice to have" in the add/drop stages of wavelength-routing OXCs with fewer channels in the C-band as channel symbol rate still significantly grows.

W2A.14
A Low-Cost Network Architecture Enabled by SOA-Based Filter-Less OADMs and Digital Subcarrier Multiplexing, Carlos Castro[1], Shiyi Xia[3], Antonio Napoli[1], João Pedro[4], Yesica Rumaldo[4], Nelson Costa[4], Nicola Calabretta[3], Bernhard Spinnler[1], Albert Rafel[2]; *[1]Infinera Germany, Germany; [2]BT Applied Research, UK; [3]Eindhoven Univ. of Technology, Netherlands; [4]Infinera Portugal, Portugal.* Enabled by digital subcarrier multiplexing and filter-less architectures based on semiconductor optical amplifiers, our point-to-multipoint scheme can cover distances of up to 350 km with OSNR margins > 9.3 dB in typical BT horseshoe networks

W2A.15
Energy-Efficient Spiking Neural Network Equalization for IM/DD Systems with Optimized Neural Encoding, Alexander von Bank[1], Eike-Manuel Edelmann[1], Laurent Schmalen[1]; *[1]KIT CEL, Germany.* We propose an energy-efficient equalizer for IM/DD systems based on spiking neural networks. We optimize a neural spike encoding that boosts the equalizer's performance while decreasing energy consumption.

W2A.16
Providing Anomalous Behaviour Profiling by Extending SmartNIC Transceiver Support in Packet-Optical Networks, Ricard Vilalta[1], Francisco Javier Vilchez[1], Lluis Gifre[1], Carlos Manso[1], Jose Luis Carcel Cervera[2], Rafael Leira Osuna[3], Javier Aracil Rico[3], Juan Fernández-Palacios[4], Ricardo Martínez[1], Ramon Casellas[1], Raul Muñoz[1]; *[1]CTTC, Spain; [2]Eviden, Spain; [3]Naudit, Spain; [4]Telefónica, Spain.* This paper presents the architectural and data model extensions necessary to provide support for SmartNICs from SDN controller perspective. It later presents a use case for providing anomalous behaviour profiling support using the proposed extensions.

W2A.17
Flexible Optical Metro-Access Networks Leveraging SOA-Based OADM Nodes and DSCM with Power Loading, Zhouyi Hu[1], Shiyi Xia[1], Hernrique F. Santana[1], Marijn Rombouts[1], Bin Shi[1], Nicola Calabretta[1]; *[1]Department of Electrical Engineering, Eindhoven Univ. of Technology, Netherlands.* We demonstrate a flexible metro-access network exploiting SOA-based OADM nodes and digital subcarrier multiplexing with power loading. Results show that at least 4 nodes can be supported for 40-Gb/s transmission with bandwidth allocation on demand.

W2A.18
Multi-Section Partially-Corrugated-Grating DFB Lasers for Achieving High Power, Low Noise, and Narrow Linewidth, Siti Sulikhah[1], Kryzchel Anne Malicsi Dela Cruz[1], San-Liang Lee[1], Charng G. Tu[2], Ing F. Jang[2], Hung P. Shiao[2], Chao-Hsin Wu[3], Hsiang-Chun Yen[3]; *[1]National Taiwan Univ. of Science and Technology, Taiwan; [2]WIN Semiconductors, Taiwan; [3]National Taiwan Univ., Taiwan.* A novel DFB laser structure with multi-section partially-corrugated-gratings (PCG) is demonstrated with enhanced output power, reduced noise, and reduced linewidth, resulting from the equalized photon density in the laser cavity by the partitioned partial gratings.

W2A.19
Machine Learning-Driven Low-Complexity Optical Power Optimization for Point-to-Point Links, Isaia Andrenacci[1,2], Matteo Lonardi[1], Petros Ramantanis[1], Élie Awwad[2], Ekhiñe Irurozki[2], Stephan Clémençon[2], Paolo Serena[3], Chiara Lasagni[3], Sébastien Bigo[1], Patricia Layec[1]; *[1]Nokia Bell Labs, France; [2]Télécom Paris, France; [3]Univ. of Parma, Italy.* We propose a strategy to dynamically adjust transmitted power solely based on the analysis of performance fluctuations due to polarization-dependent loss. We show that our method converges faster to optimum compared to a standard approach.

W2A • Posters Session I, In Person—Continued

W2A.20
Polarization-Insensitive, Silicon-Photonics Circuit, Four-Mode Spatial Multiplexer Matched to a Rectangular Core Fiber, David Halfon[1], Lior Rechtman[1], Aleksey Kukin[1], Jeffery S. Stone[2], Gaozhu Peng[2], Ming-Jun Li[2], Dan M. Marom[1]; *[1]Hebrew Univ. of Jerusalem, Israel; [2]Division of Science and Technology, Corning Inc., USA.* We design and test a SiPh mode multiplexer circuit, utilizing 3μm-thick ridge waveguides having low polarization dependence. The multiplexer achieves low loss (2-3dB) and low PDL (<0.8dB) across the C-band. Output modes are coupled to rectangular core fiber.

W2A.21
Ultra-Efficient Interleaved Vertical-Junction Microdisk Modulator with Integrated Heater, Asher S. Novick[2,1], Songli Wang[2], Anthony Rizzo[3], Vignesh Gopal[2], Keren Bergman[2]; *[1]Xscape Photonics, USA; [2]Electrical Engineering, Columbia Univ., USA; [3]Information Directorate, Air Force Research Laboratory, USA.* We demonstrate a vertical-junction microdisk modulator with interleaved RF contacts and doped-silicon heater. We measure a resonance ER=36.5 dB, FSR=27.15 nm, and open eye diagrams at 32 Gb/s NRZ with 800 mV peak-to-peak driving signal.

W2A.22
Photonic Physically Unclonable Functions Using Ring-Assisted Contra-Directional Couplers, MohammadAmin Mahdian[1], Ebadollah Taheri[1], Kaveh Hassan Rahbardar Mojaver[2], Mahdi Nikdast[1]; *[1]Electrical and Computer Engineering, Colorado State Univ., USA; [2]Electrical and Computer Engineering, McGill Univ., Canada.* We demonstrate a novel silicon-photonic-based Physically Unclonable Function (PUF) using grating-assisted contra-directional couplers integrated with perforated microring resonators. In the worst-case scenario, our device exhibits at least a 0.18 Hamming distance from the destined PUF.

W2A.23
Broadband Transmission Opto-Mechanical Switch Based on Cylindrical Ferrule Rotation Switching Using Fiber Bundle Inserted in Ferrule, Chisato Fukai[1], Takui Uematsu[1], Ryo Koyama[1], Ikutaro Ogushi[1], Kazunori Katayama[1]; *[1]NTT copropation, Japan.* We demonstrate an opto-mechanical switch based on rotation of a ferrule holding a fiber bundle. Excellent loss and reflection characteristics comparable with those of optical connectors are achieved in the telecommunication wavelength bands.

W2A.24
Verification of the Physical Modelling Approach of Spectral Hole Burning in EDFA Based on Erbium Ion Groups, Inga Rittner[1], Peter Krummrich[1]; *[1]Chair for High Frequency Technology, TU Dortmund Univ., Germany.* Our previously presented modelling approach for EDFA spectral hole burning has been extended to be valid at various operating points. It is successfully applied for three different input signals with strong local saturation.

W2A.25
High-Precision Frequency Difference Locking System for Up/Downstream Lasers with 30 nm Interval in Next Generation Coherent PON, Zifeng Chen[1], Jiajun Lou[1], Yuanhao Zhang[1], Quanan Chen[2], Can Liu[2], Juan Xia[1], Qiaoyin Lu[1], Weihua Guo[1,2]; *[1]Huazhong Univ. of Science and Technology, China; [2]Ori-Chip Optoelectronics Technology Co. Ltd, China.* We demonstrated a high-precision frequency locking system based on asymmetric Mach-Zehnder interferometer (AMZI). The 1526 nm upstream laser realized a frequency difference stability of about 30 nm ± 25 MHz with 1556 nm downstream laser.

W2A.26
Add-Drop Multiplexing for Spectrally Overlapped Nonlinear Frequency Division Multiplexed Transmission Systems, Olaf Schulz[1], Alvaro Moscoso-Mártir[2], Jeremy Witzens[2], Stephan Pachnicke[1]; *[1]Kiel Univ., Germany; [2]RWTH Aachen Univ., Germany.* We present an add-drop multiplexer for WDM nonlinear frequency division multiplexed transmission systems, capable of replacing channels in a modulated spectrum that uses spectral overlap to stitch the nonlinear spectrum to avoid guard bands.

W2A.27
Compact Hybrid-Integrated Multi-Wavelength O-Band Laser Source Using Photonic Wire Bonding, Victoria Rosborough[1], Juergen Musolf[1], Thomas Liu[1], Henry Garrett[1], Don Kebort[1], Steve Penniman[1], Devon Gavigan[2], Hannah Grant[1], Sabrina Wagner[1], Gordon Morrison[1], Leif Johansson[1], Milan Masanovic[1]; *[1]Freedom Photonics, USA; [2]Ciena, USA.* We present an O-band multi-wavelength source for wavelength division multiplexed optical transceivers. The source architecture comprises a monolithic DFB laser array hybrid-integrated with a Si_3N_4 star coupler via photonic wire bonds. The prototype source outputs an eight-wavelength comb into each of eight output fibers.

W2A.28
Experimental Analysis of Receiver Failure for 19-Core Randomly Coupled Core Fibre Transmission, Menno van den Hout[1], Ruby S. Ospina[2], Ruben S. Luis[3], Benjamin J. Puttnam[3], Giammarco Di Sciullo[4], Tetsuya Hayashi[5], Ayumi Inoue[5], Takuji Nagashima[5], Simon Gross[6], Andrew Ross-Adams[6], Michael Withford[6], Jun Sakaguchi[3], Darli A. A. Mello[3], Cristian Antonelli[4], Hideaki Furukawa[3], Chigo M. Okonkwo[1], Georg Rademacher[7]; *[1]High-Capacity Optical Transmission Laboratory, Technische Universiteit Eindhoven, Netherlands; [2]School of Electrical and Computer Engineering, State Univ. of Campinas, Brazil; [3]NICT, Japan; [4]Univ. of L'Aquila, Italy; [5]Sumitomo Electric Industries, Ltd., Japan; [6]MQ Photonics Research Centre, Macquarie Univversity, Australia; [7]Inst. of Electrical and Optical Communications, Univ. of Stuttgart, Germany.* We experimentally investigate the impact of the failures of spatial channel receivers on the transmission performance of a randomly coupled 19-core fiber system. Severe penalties are observed when a spatial channel receiver fails.

W2A.29
A Versatile Point-to-Point Network Architecture with Multi-Rate Adaptability From 100 Gbit/s to 10 Gbit/s, Georges Gaillard[1,2], Fabienne Saliou[1], Dylan Chevalier[1], Gael Simon[1], Philippe Chanclou[1], Luiz Anet Neto[2], Michel Morvan[2], Bruno Fracasso[2]; *[1]Orange, France; [2]IMT Atlantique, France.* PtP networks are optimized with optical switch and extended reach (25-50 km) to another CO to allow flexible bandwidth and power consumption. Different transmission capacities and scenarios are experimented with a DFB, from 100 Gbit/s to 10 Gbit/s with/without FEC and SOA.

W2A.30
Frequency Response Modeling and Saturation Power Improvement of Lateral-PIN Germanium Photodetectors, Hao Wu[1], Ning Cheng[1], Yanlong Yin[1], Min Teng[1], Xuezhe Zheng[1]; *[1]InnoLight Technology Ltd., China.* A frequency response model is developed for Germanium photodetector under large input optical powers. The model agrees well with measurement results. Furthermore, a high-speed lateral-PIN photodetector using parallel photodetection is demonstrated with ≥3-dBm saturation power.

W2A.31
Experimental Demonstration of Robust Spatial-Diversity Combining for Coherent Free-Space Optical Transmission, Abraham Johst[1,2], Markus Nölle[1], Lutz Molle[1], Nicolas Perlot[2], Michael Rohde[3], Ronald Freund[2,4]; *[1]Hochschule für Technik und Wirtschaft Berlin, Germany; [2]Fraunhofer Inst. for Telecommunications HHI, Germany; [3]Berliner Hochschule für Technik, Germany; [4]Technical Univ. of Berlin, Germany.* Spatial-diversity schemes are applied to improve signal quality of coherent free-space optical transmission systems with uncorrelated phase noise. We compare the performance of conventional schemes (MRC, SDC) and a newly proposed one (X-MRC).

W2A.32
Efficient Inter-Channel Interference Monitoring Using DSP in Standard Coherent Receivers, Leonardo Minelli[1], Gabriella Bosco[1], Antonello Nespola[2], Stefano Straullu[2], Stefano Piciaccia[3], Dario Pilori[1]; *[1]Dipartimento di Elettronica e Telecomunicazioni, Politecnico di Torino, Italy; [2]Links Foundation, Italy; [3]CISCO Photonics, Italy.* We experimentally demonstrate an efficient Optical Performance Monitoring algorithm, based on a Machine Learning-assisted Digital Signal Processing scheme suitable for standard coherent receivers, for estimating asymmetric cross-talk between adjacent WDM channels.

W2A.33
Comparison of FEC Design Concepts for Higher Error Correction Performance with Utilizing Turbo Product Code, Yohei Koganei[1], Kiichi Sugitani[1]; *[1]Fujitsu Ltd, Japan.* We investigate several FEC design concepts to enhance a turbo product code with higher overhead ratios. The result illustrates which concept would be effective to obtain higher performance according to the increase of the overhead.

W2A.34
Optimizing Key Consumption in Switched QKD Networks, Konstantinos (Kostas) Christodoulopoulos[1], Nikolaos Makris[1], George T. Kanellos[1], Dimitris Syvridis[1]; *[1]Univ. of Athens, Greece.* We consider a switched QKD network and develop a novel scheduling algorithm that periodically configures the QKD links to optimize the generation and buffering of keys so as to maximizes the key consumption rate across the network.

W2A.35
Impact of Symbol Rate Optimization and Laser Frequency Stability on Transmission Reach of Super-Channel Transceiver Configurations for Beyond 1.6 Tb/s, Olga Vassilieva[1], Inwoong Kim[1], Hiroyuki Irie[2], Hisao Nakashima[2], Takeshi Hoshida[2], Paparao Palacharla[1]; *[1]Fujitsu Network Communications Inc, USA; [2]Fujitsu Limited, Japan.* We show that subcarrier symbol rate optimization and better laser frequency stability can maximize transmission reach of super-channels. Configurations with 1.6Tb/s subcarriers achieve longer reach with benefits of smaller size/power and easier management.

W2A.36
Comparison of Feedback and Feedforward Clock Recoveries for Ultra-Fast Synchronization in Passive Optical Networks, Patrick A. Matalla[1], Christian Koos[1], Sebastian Randel[1]; *[1]KIT Inst. of Photonics & Quantum, Germany.* We compare digital non-data-aided feedback and feedforward clock recoveries for burst-mode operation in high-speed PONs. For 56 GBd NRZ, PAM2, and PAM4, we demonstrate that a clock frequency offset of 20 ppm can be synchronized within 40.96 ns.

W2A.37
Broadband, Efficient, and Low Dark Current SiN-on-SOI Waveguide-Coupled Photodetectors for Visible Light, Alperen Govdeli[1,2], Jared Mikkelsen[1], Abhishek Suriya[1], Hongyao Chua[3], Patrick Lo[3], Joyce K. Poon[1,2], Wesley Sacher[1]; *[1]Max Planck Inst. of Microstructure P, Germany; [2]Department of Electrical and Computer Engineering, Univ. of Toronto, Canada; [3]Advanced Micro Foundry Pte. Ltd., Singapore.* We demonstrate foundry-fabricated waveguide-coupled photodetectors wherein silicon nitride waveguides pass overtop doped silicon-on-insulator patches. At a 5V reverse bias, dark currents < 8pA, and red, green, and blue-wavelength external quantum efficiencies >70% were measured.

12:30–14:00
Exhibit-only Time, *Exhibit Hall*
The Journal Review Process: All You Need to Know!, *Room 6A*

Show Floor Programming

NOS1 • Network Operator Summit: Keynote
10:15–10:45, *Theater I*

Open XR Optics
10:15–10:45, *Theater III*

Ethernet Interconnect Solutions: Will The Advancement in Coherent Signaling Leverage DataCom Connect
10:15–11:15, *Theater II*

NOS2 • NOS Panel I: Optical Network Automation
10:45–12:15, *Theater I*

OFCnet Panel: Quantum Entanglement and Quantum Memory for Next Generation Quantum Networks
11:00–11:45, *Theater III*

CableLabs: Empowering Access Networks with Coherent Optics
11:30–12:30, *Theater II*

OFCnet Panel: Beyond Point-to-Point Quantum Key Distribution
12:00–12:45, *Theater III*

NOS3 • NOS Panel II: Optics for 5G/6G
12:30–14:00, *Theater I*

ITU-T SG15 - Standards Update on Higher Speed PON, Latest OTN Technologies and Interoperable Optical Interfaces
12:45–13:45, *Theater II*

OFCnet Panel: Software Define Infrastructures
13:00–13:30, *Theater III*

Open ROADM MSA Updates and Demonstration
13:45–14:45, *Theater III*

10:30–12:30
W2B • Posters Session II, Remote

W2B.1
Optimization of Channel Powers, Raman Pumps and EDFAs in the Wideband Fiber Optic Transmission Systems, Viacheslav V. Ivanov[1], Lidia Galdino[2], John D. Downie[3]; *[1]Corning SAS, Finland; [2]Corning Optical Communications, UK; [3]Corning Research and Development Corporation, USA.* A hybrid Raman/EDFA link design optimization method to maximize fiber capacity is proposed. The optimization method accounts for the interplay of signal power tilts due to channels ISRS, pump ISRS, and EDFA physics.

W2B.2
Topological Rotation Symmetry-Based Wavelength Allocation for Entanglement Distribution Networks, JiaLi Zhu[1], Yuan Cao[1], Jian Li[1], Xingyu Zhou[1], Zhang Chunhui[1], Xiaosong Yu[2], Zhao Yongli[2], Jie Zhang[2], Qin Wang[1]; *[1]Nanjing Univ. of Posts and Telecomm, China; [2]Beijing Univ. of Posts and Telecommunications, China.* We propose a wavelength allocation scheme based on topological rotation symmetry for entanglement distribution networks, reducing the number of wavelength channels required for N users from the order of $O(N)$ to $O(\sqrt{N})$.

W2B.3
Modeling and Experimental Evaluation of End-to-End Delay Jitter for Cross-Domain Interconnection in SD-TSN, Peter Zhang[1], Guochu Shou[1], Junli Xue[2]; *[1]Beijing Univ. of Posts and Telecommunications, China; [2]China Telecom Research Inst., China.* We establish a relationship model of end-to-end delay jitter with time synchronization for TSN cross-domain interconnection. Experiments in the testbed demonstrate that the delay jitter of 2000*km*/25hops with 0.3μs time error is less than 1μs.

W2B.4
Photon-Counting Single-Pixel 3D Imaging Using a Multimode-Fiber-Coupled Fractal SNSPD, Kai Zou[1], Yun Meng[1], Zifan Hao[1], Xiaolong Hu[1]; *[1]Tianjin Univ., China.* We demonstrate photon-counting single-pixel 3D imaging using a multimode-fiber-coupled fractal SNSPD and showcase 32×32-pixel imaging with reflectance and depth contrasts at the wavelength of 1560 nm.

W2B.5
Measurement of Optical Signal State of Polarization in OPGW Under Lightning Strike Condition, Fei Tong[1], Kaijing Hu[1], Wei Li[1], Shaohua Yu[2], Weihua Lian[1], HanQi Zhao[4], Bin Wu[4], Danke Hong[4], Ming Luo[3], Qianggao Hu[5], Jian Xu[5]; *[1]Huazhong Univ of Science and Technology, China; [2]Peng Cheng Laboratory (PCL), Shenzhen 518055, Guangdong, China; [3]The State Key Laboratory of Optical Communication Technologies and Networks, China Information Communication Technologies Group, China; [4]China Southern Power Grid Company, Ltd., Guangzhou 510530, China; [5]Accelink Technologies Co., Ltd Wuhan, China.* We monitored the polarization state of the power grid Optical Ground Wire (OPGW) cable for three months in 100G-OTN system and unprecedented detected the maximum state of polarization (SOP) rotation speed of 43Mrad/s.

W2B.6
A Low-Complexity 64QAM-Based Probabilistically Shaped OFDM for W-Band RoF System, Long Zhang[1], Kaihui Wang[1], Jiaxuan Liu[1], Xiongwei Yang[1], Ming Chen[2], Chen Wang[1], Bohan Sang[1], Yikai Wang[1], Li Zhao[3], Wen Zhou[1], Jianjun Yu[1]; *[1]Fudan Univ., China; [2]Hunan normal Univ., China; [3]Nanjing Univ. of Posts and Telecommunications, China.* We proposed and experimentally demonstrated a low-complexity probabilistic shaping (PS) 64QAM-OFDM in a W-band RoF system using envelope detection. After 45-km SSMF and 4-m wireless transmission, 28.13 Gb/s PS-64QAM-OFDM signals transmission is achieved.

W2B.7
CPRI-Equivalent Data Rate of 3.12 Tbps 16384QAM DSM 300GHz Terahertz Wave Signals Over Hollow-Core Fiber, Xiongwei Yang[1], Jianjun Yu[1], Weiping Li[1], Chen Wang[1], Wen Zhou[1], Kaihui Wang[1], Chengzhen Bian[1], Yi Wei[1], Mingxu Wang[1], Qiutong Zhang[1], Ying Wu[1], Bo Liu[3], Xianming Zhao[2], Junjie Ding[4], Jiao Zhang[4], Min Zhu[4], Jianguo Yu[5], Feng Zhao[6]; *[1]Fudan Univ., China; [2]Harbin Inst. of Technology, China; [3]Nanjing Univ. of Information Science & Technology, China; [4]Purple Mountain Laboratories, China; [5]Beijing Univ. of Posts and Telecommunications, China; [6]Xi'an Univ. of Posts and Telecommunications, China.* We experimentally demonstrate ultra-large-capacity hybrid fiber and THz-Wave wireless fronthaul over 2-km hollow-core fiber and 2-m wireless distance based on 80 channel WDM and DSM, achieving CPRI-equivalent data rate of 3.12 Tbit/s.

W2B.8
Data Labeling Using Unsupervised Cascaded Pre-Training with Fused Multi-Port Data for Optical Failure Management, Weijie Yang[1], Chunyu Zhang[1], Danshi Wang[1], Zhu Hong[2], Xinxing Xu[2], Degang Shi[3], Min Zhang[1]; *[1]Beijing Univ. of Posts and Telecommunications, China; [2]The Intelligent Network Innovation Center of Chinaunicom, China; [3]China United Network Communications Group Co., Ltd., China.* We propose an unsupervised cascaded pre-training data labeling method that considers the intrinsic correlation of multi-port data, and verifies the scheme validity in failure prediction using real multi-port data from optical networks.

W2B.9
Wide-Angle Vertical Coupling Gratings Enabled by Nano-Imprinted Microlens Array, Gan Xiao[1], XuanMing Zhang[2], Fei Lou[2], Lei Lei[1], Xin Cheng[2]; *[1]Shen Zhen Univ., China; [2]Southern Univ. of science and technology, China.* We experimentally show a vertical grating coupler featuring extended coupling angles through nano-imprinted lens array. This nanostructure exhibits a 2-3.4 dB increase in coupling efficiency within the ±15° angular range compared to the bare device.

W2B.10
Reconfigurable Photonic Integrated Reservoir for Different Baud-Rate PAM-4 Signal Recognition, Kailai Liu[1], Ying Zhu[1,2], Siyao Chang[2], Ming Lei[2], Chao Yang[1], Qiansheng Wang[2], Xi Xiao[1,2]; *[1]State Key Laboratory of Optical Communication Technologies and Networks, China Information and Communication Technologies Group Corporation (CICT), China; [2]National Information Optoelectronics Innovation Center, China Information and Communication Technologies Group Corporation (CICT), China.* A reconfigurable photonic integrated reservoir based on Mach-Zehnder Interferometer nodes is proposed. It can be programmed to adapt to different baud-rate IMDD systems for PAM-4 signal recognition. The photonic reservoir-based receivers can achieve a lower bit error rate and consume 0.5×power compared to their conventional electronic counterparts.

W2B.11
A Multi-Channel Chromatic Dispersion Compensation for 15-km Front-Haul Transmission, Yang Ren[1], Yangbo Wu[2], Zhengrui Tu[1]; *[1]B&P Laboratory, Huawei technologies, China; [2]Wireless BU, Huawei Technologies, China.* We report an integrated Bragg grating based multi-wavelength dispersion compensation. We achieve +20 ps/nm and -28 ps/nm at 1270 and 1335nm, with a on-chip loss of 4dB, showing a broadband dispersion compensation capability.

W2B.12
In-Service Simultaneous Monitoring of Transceiver and Channel Impairments in DSCM Systems Without Impairments Compensation, Linsheng Fan[1], Yanfu Yang[1], Qun Zhang[1], Siyu Gong[1], Jianwei Tang[1], Xueyang Li[2], Cheng Chen[1], Yongchao Jin[1], Yong Yao[1]; *[1]Harbin Inst. of Technology,Shenzhen, China; [2]Department of Circuits and System, Peng Cheng Laboratory (PCL), China.* In-service simultaneous transceiver and channel impairments monitoring scheme is proposed and experimentally verified in dual-polarization DSCM system. The monitoring scheme is based on frequency-domain pilot tones and involves no impairments compensation.

W2B.13
Denoising in Mode Conversion by Utilizing Diffractive Deep Neural Networks Optimized with Reinforcement Learning, Zheng Li[1], Wenbo Zhang[1], Yang Wang[1], Guanju Peng[1], Zongze Li[2], Xiaoyan Zhou[1,2], Lin Zhang[1,2]; *[1]Tianjin Univ., China; [2]Peng Cheng Laboratory, China.* We propose a reinforcement-learning-optimized nonlinear physical diffractive neural network, which can simultaneously perform OAM-mode and LP-mode conversion with Gaussian noise removal. The PSNR and SSIM of the converted modes reach 27.94 dB and 0.838, respectively.

W2B.14
High-Performance Chiral Mode Switching Device at 2 μm Waveband Using Photonic Crystal Waveguide, Kang Li[1], Hejie Peng[1], Siwei Wang[1], Lin Chen[1], Jian Wang[1]; *[1]Wuhan National Laboratory for Optoelectr, China.* We experimentally demonstrate a silicon chiral mode switching device by dynamically encircling exceptional point at 2 μm waveband, with high purities (> 95%) for both TE_0 and TE_1 modes in a broad bandwidth (85 nm).

W2B.15
Experimental Demonstration of 51.2 Tb/s Self-Homodyne Coherent Interconnects on a 3D Photonic Chip Inspiring Coherent Technology Transfer to Centimeter-Scale Ultra-Short-Reach Applications, Min Yang[1,2], Chengkun Cai[1,2], Kangrui Wang[1,2], Guofeng Yan[1,2], Shuo Zheng[1,2], Zhenyu Wan[1,2], Yanjun Zhu[3], Hua Zhang[4], Chaonan Yao[4], Yuchen Shao[4], Jian Wang[1,2]; *[1]Huazhong Univ. of Science and Techn, China; [2]Optics Valley Laboratory, China; [3]Hisense Broadband Inc, USA; [4]Hisense Broadband Multimedia Technologies Co., Ltd., China.* We demonstrated a record net 51.2 Tb/s (800Gb/s PDM-64QAM x 64 Channels) ultrafast laser inscribed 3D photonic chip interconnects based on self-homodyne coherent detection, showing the feasibility of coherent technology transfer to ultra-short-reach applications.

W2B.16
Direct Radio Frequency Modulation of Quantum Cascade Lasers for mid-IR Applications, Grzegorz Dudzik[1], Wojciech Fraczek[1], Piotr Jaworski[1], Karol Krzempek[1], Krzysztof Abramski[1]; *[1]Wroclaw Univ. of Science and Technology, Poland.* We present a QCL-based integrated laser module operating in the mid-IR range with direct modulation of RF signals up to 1.2 GHz and a miniaturized, fully functional electronic module for spectroscopic signal retrieval.

W2B.17
Cryogenic Ge-on-Si Avalanche Photodiodes Operating at 1550 nm Wavelength, Xiaofei Liu[1], Jingchuan Liu[1], Funan He[1], Ruyuan Ma[1], Xingyan Zhao[1], Qize Zhong[1], Yuan Dong[1], Ting Hu[1]; *[1]Shanghai Univ., China.* We report the first demonstration of Ge-on-Si APD for 1550 nm wavelength photodetection at the cryogenic temperature down to 11 K, with I_{dark}=0.369 μA, R=4.84 A/W and G=1840 at V_{bias} = −20.8 V.

W2B.18
Direct Measurement of Resonant Phonon Modes in Optical Fibers, Andrea Pertoldi[1,2], Rasmus D. Engelsholm[1], Ivan Galinskiy[2], Poul Varming[1], Patrick Bowen Montague[1]; *[1]NKT Photonics A/S, Denmark; [2]Niels Bohr Inst., Univ. of Copenhagen, Denmark.* We probe and model phonon modes in optical fibre by means of frequency noise measurements of distributed-feedback fibre lasers. Resonant acoustic waves with femtometer-scale amplitudes are fully characterised as they interact with the optical cavity.

W2B.19
Mode Division Multiplexed Coherent Optical Transmission in Time Domain by Using Higher-Order Hermite-Gaussian Pulses, Masataka Nakazawa[1], Masato Yoshida[1], Toshihiko Hirooka[1]; *[1]International Research Inst. for Disaster Science, Tohoku Univ., Japan.* We propose a new mode-division-multiplexing (MDM) technique in time-domain using higher-order Hermite-Gaussian pulses. 32-QAM, 450-km MDM transmission was successfully demonstrated with HG_0, HG_1, HG_2, and HG_3 pulses, where the time-domain orthogonality was used for demultiplexing.

W2B.20
Integrated Silicon Photonics Transmitter and Receiver Array Modules Enabling 1 Tb/s Interboard Optical Interconnect Over 8-Channel Polymer Optical Waveguide, Chao Yang[1], Chao Li[2], Daigao Chen[3], Ming Luo[1], Ying Zhu[1], Zhixue He[2], Xu Liu[4], Lin Ma[4], Xi Xiao[3,1]; *[1]China Information Communication Technologies Group Corporation, China; [2]Peng Cheng Laboratory, China; [3]National Information Optoelectronics Innovation Center, China; [4]Shanghai Jiaotong Univ., China.* 1-Tb/s PS-PAM-4 interboard optical interconnect using integrated SiPh transmitter and receiver array module over an 8-channel polymer optical waveguide is proposed and experimentally demonstrated, achieving a low-cost and high-speed solution for short-range optical interconnects.

W2B.21
High Sampling Rate Arbitrary Waveform Generation in the Polarimetric Synthetic Dimension, Yiran Guan[1], Guangying Wang[2], Jiejun Zhang[2], Jianping Yao[1]; *[1]Univ. of Ottawa, Canada; [2]Jinan Univ., China.* High sampling rate arbitrary waveforms generated in the polarimetric synthetic dimension based on a fiber-optic system is proposed. A triangular, rectangular, and sawtooth waveform at a sampling rate of 80 GSa/s are experimentally generated.

W2B.22
New GAWBS Noise Interacting with Longitudinally Propagating Acoustic Waves in Few-Mode Fibers, Masato Yoshida[1], Takaaki Hirai[1], Shohei Beppu[1,2], Keisuke Kasai[1], Toshihiko Hirooka[1], Masataka Nakazawa[1], Yuta Wakayama[2], Noboru Yoshikane[2]; *[1]Tohoku Univ., Japan; [2]KDDI Research Inc., Japan.* We describe the GAWBS noise characteristics in few-mode fibers (FMFs). We found that the GAWBS noise is newly generated due to an interaction between different LP modes through longitudinally propagating acoustic waves.

W2B • Posters Session II, RemoteContinued

W2B.23
Accelerate Distributed Deep Learning with a Fast Reconfigurable Optical Network, Wenzhe Li[1], Guojun Yuan[1], Zhan Wang[1], Guangming Tan[1], Peiheng Zhang[2,1], George N. Rouskas[3]; [1]*Inst. of Computing Technology, CAS, China;* [2]*Inst. of Intelligent Computing Technology, Suzhou, CAS, China;* [3]*Department of Computer Science, North Carolina State Univ., USA.* We propose a fast-reconfigurable and scalable optical network architecture, which employs a flow-based transmit scheduling scheme to accelerate data parallelism in distributed deep learning. Experimental results demonstrate that the 4-node prototype achieves training times comparable to those of ideal electrical switching.

W2B.24
Fast Online Optimization of Multi-Pump Raman Amplifiers for Field Deployment in Multi-Band Optical Networks, Xiaoxuan Gao[1], Rentao Gu[1], Yuejiao Liu[1], Lin Bai[1], Yuefeng Ji[1]; [1]*Beijing Univ. of Posts and Telecommunications, China.* We experimentally demonstrate Raman amplifier optimization with fast pump deviation inference in different scenarios. Using less than 3 new data, accurate gain generation is achieved with low root mean square error (< 0.1 dB).

W2B.25
Chirp-Dispersion Interaction-Enabled Uneven Optical PAM-4 Based on Dual-Drive MZM for 5.9-dB SNR Gain in Digital RoF Fronthaul with Quantizer Compatibility, Yimin Hu[1], Yixiao Zhu[1], Guangying Yang[1], Ziheng Zhang[1], Lina Man[1], Ziyu Cheng[1], Weisheng Hu[1]; [1]*Shanghai Jiao Tong Univ., China.* We theoretically model and explain the dispersion-induced eye closure/open in dual-drive MZM-based system and leverage the effect for uneven optical PAM-4 digital radio-over-fiber fronthaul. We evaluated two quantizers and 5.9-dB SNR gain is experimentally achieved.

W2B.26
Polarization-Insensitive Simplified Self-Heterodyne Detection Based on Optical Frequency Comb in MCF Transmission System, Jie Li[1], Ming Luo[1], Xiang Li[2], Xu Zhang[1], Qingyu He[1], Yuhan Gong[1], Zenpeng Gong[2], Xi Xiao[1]; [1]*China Information and Communication Technologies Group Corporation, China;* [2]*the School of Mechanical Engineering and Electronic Information, China Univ. of Geosciences, China.* We propose a polarization-insensitive space-division multiplexing scheme with self-heterodyne detection by simplified one balanced photodiode receiver based on optical frequency comb. A 17×200-Gb/s 16QAM transmission over 1-km 19-core fiber using low-cost DFB laser is demonstrated.

W2B.27
Super Wide-Flat Beam Transmission Over Scatter-Prone Underwater Channel Using Twin Parallel Flat-Narrow Beams Generated by Aspheric Lens Pair-Type Beam Shaper, Tomoya Ishikawaa[1], Ayumu Kariya[1], Fumiya Kobori[1], Keita Tanaka[1], Takahiro Kodama[1]; [1]*Kagawa Univ., Japan.* Our experiments demonstrate that the use of a twin flat-narrow beam system with time-domain hybrid PAM signals in underwater channels of up to 4 m significantly improves the elastic transmission capacity from 625-Mbps to 1.25-Gbps.

W2B.28
Near-Field Multi-Source Localization and Signal Enhancement for Fiber-Optic DAS, Junfeng Chen[1], Ke Ai[1], Hao Li[1], Cunzheng Fan[1], Zhijun Yan[1], Qizhen Sun[1]; [1]*Huazhong Univ. of Science and Technology, China.* The near-field multi-source localization and enhancement based on array signal processing (ASP) method are proposed for the distributed acoustic sensing (DAS), and it has been demonstrated with high positioning accuracy and great signal enhancement.

W2B.29
Large-Range and Seamless Rate-Adaptive Free-Space Optical System Based on Rate Compatible Modulation, Yang Zou[1], Tao Shu[2], Qirun Fan[1], Tianjin Mei[1], Xinyu Chang[1], Shenmao Zhang[1], Xiaoxiao Dai[1,3], Chen Liu[1,3], Mengfan Cheng[1,3], Lei Deng[1,3], Qi Yang[1,3], Deming Liu[1,3]; [1]*Wuhan National Lab for Optoelectronics (WNLO) & National Engineering Laboratory for Next Generation Internet Access System, School of Optical and Electronic Information, Huazhong Univ. of Science and Technology, China;* [2]*State Key Laboratory for Modern Optical Instrumentation, College of Optical Science and Engineering, International Research Center for Advanced Photonics, Zhejiang Univ., China;* [3]*Jinyinhu Laboratory, China.* A large-range and seamless rate-adaptive FSO scheme based on rate compatible modulation is proposed. Experimental results show that it can adaptively vary the rate from 6.7Gbps to 53.6Gbps within ~15 dB received optical power range.

W2B.30
60+60 km Weakly-Coupled MDM-WDM Transmission Enabled by 4-LP-Mode FM-EDFA, Shuailuo Huang[1], Gang Qiao[1], Yuyang Gao[1], Mingqing Zuo[2], Jinglong Zhu[2], Lei Shen[3], Yuanpeng Ding[3], Lei Zhang[3], Jie Luo[3], Yongqi He[1], Zhangyuan Chen[1,4], Juhao Li[1,4]; [1]*State Key Laboratory of Advanced Optical Communication Systems and Networks, Peking Univ., China;* [2]*Department of Fundamental Network Technology, China Mobile Research Inst., China;* [3]*State Key Laboratory of Optical Fiber and Cable Manufacture technology, YOFC, China;* [4]*Pengcheng National Laboratory, China.* A 4-LP-mode FM-EDFA utilizing multiple-ring-core FM-EDF is designed and fabricated to support weakly-coupled MDM transmission, based on which 60+60 km simultaneous $LP_{01}/LP_{11}/LP_{21}/LP_{02}$ MDM-WDM transmission is experimentally demonstrated only adopting 2×2 or 4×4 MIMO-DSP.

W2B.31
Si-SiN-SiN Tri-Layer Strictly Non-Blocking 8×8 Microring-Based Optical Switch, Bohao Sun[1], Ziyao Zhang[1], Minjia Chen[1], Chunhui Yao[1], Peng Bao[1], Zhitian Shi[1], Qixiang Cheng[1], Keren Bergman[2], Richard V. Penty[1]; [1]*Univ. of Cambridge, UK;* [2]*Columbia Univ., USA.* We report a Si-SiN-SiN tri-layer switch-and-select 8×8 optical switch with 128 thermally-driven microring-resonators. Crosstalk ratio and on-chip loss are measured in the range of -33.2 to -50.8dB and 2.1 to 10.5dB, respectively, with >70GHz passband.

W2B.32
High Bandwidth (>35GHz) 1060nm Single-Mode Transverse Coupled-Cavity VCSEL Array for Single-Mode Fiber Transmission, Hameeda R. Ibrahim[1,2], Chang Ge[1], Xiaodong Gu[1,3], Babu D. Padullaparthi[1], Fumio Koyama[1]; [1]*Tokyo Inst. of Technology, Japan;* [2]*Minia Univ., Egypt;* [3]*Ambition Photonics Inc., Japan.* We demonstrate 8ch-1060nm single-mode metal-aperture VCSEL array, exhibiting bandwidth >35GHz, single-mode power of 4mW and error-free 60Gbaud transmission through 2km-single-mode fiber(G.652). Also, uncooled operations up to 85deg with 50Gbps-NRZ and 100Gbps-PAM4 through 2km-SMF are demonstrated.

W2B.33
Security Enhancement of Quantum Noise Stream Cipher Based on Probabilistic Constellation Shaping, Sheng Liu[1], Shuang Wei[2], Wei Wang[2], Yajie Li[2], Dong Wang[1], Yongli Zhao[2], Dechao Zhang[1], Han Li[1], Jie Zhang[2]; [1]*China Mobile Research Inst., China;* [2]*BUPT, China.* We propose a QNSC pre-coding scheme based on probabilistic shaping of the basis, to reduce the probability of ciphertext bits that are easier to be intercepted. Experiment results show this scheme can improve the security performance by 100% in terms of Eve's cipher text BER.

W2B.34
Low-Complexity Multi-tap ET-DFE-PU for Soft-Input FEC in High-Speed IM/DD Systems, Xue Zhao[1], Jiahao Zhou[1], Jing Zhang[1], Rui Wang[1], Zhengyu Ma[1], Shaohua Hu[1], Bo Xu[1], Kun Qiu[1]; [1]*Univ of Electronic Science & Tech China, China.* We propose a low-complexity multi-tap LUT-based ET-DFE-PU algorithm to alleviate the degradation on LLR by error propagation. The experimental results show that the proposed algorithm can achieve 3.4-dB receiver sensitivity improvement compared with conventional DFE.

W2B.35
Air/Water Path Switching with Beam Steering for Water Distance/Turbidity Adaptive Underwater Optical Wireless Communication Network: Concept and Demonstration, Kiichiro Kuwahara[1], Hyuga Nagami[1], Keita Tanaka[1], Fumiya Kobori[1], Ayumu Kariya[1], Shogo Hayashida[2], Takahiro Kodama[1]; [1]*Faculty of Engineering, Kagawa Univ., Japan;* [2]*LED Backhaul Project, Sangikyo Corporation, Japan.* We conducted full-duplex class 1 eye-safe transmission experiments, including 4K video demonstrating robust connectivity to maximize transmission capacity under optimal paths by introducing aerial relay nodes within underwater optical wireless communication networks in shallow seas.

W2B.36
Pass-Through ELSFP with Optional Integrated Optical Mux and Demux for Colorless CPO Systems, Jingwei Liu[1], Zhan Su[1], Le Wu[1], Lei Shi[1], Lihua Chi[1], Xujun Pan[2], Sam Huang[2], Yu Ning[2], Zhigang Gong[2]; [1]*Ruijie Networks, China;* [2]*O-Net Technologies (Shenzhen) Group, China.* We demonstrate a novel type of Pass-Through ELSFP module configuration with (or without) integrated optical Mux and Demux, potentially enabling a WDM "colored" (or "colorless") system through a Colorless DR-type optical engine.

12:45–13:45 Challenges and Solutions for Realizing Quantum Fiber-Based Networks, *Room 3*

Show Floor Programming

NOS1 • Network Operator Summit: Keynote
10:15–10:45, *Theater I*

Open XR Optics
10:15–10:45, *Theater III*

Ethernet Interconnect Solutions: Will The Advancement in Coherent Signaling Leverage DataCom Connect
10:15–11:15, *Theater II*

NOS2 • NOS Panel I: Optical Network Automation
10:45–12:15, *Theater I*

OFCnet Panel: Quantum Entanglement and Quantum Memory for Next Generation Quantum Networks
11:00–11:45, *Theater III*

CableLabs: Empowering Access Networks with Coherent Optics
11:30–12:30, *Theater II*

OFCnet Panel: Beyond Point-to-Point Quantum Key Distribution
12:00–12:45, *Theater III*

NOS3 • NOS Panel II: Optics for 5G/6G
12:30–14:00, *Theater I*

ITU-T SG15 - Standards Update on Higher Speed PON, Latest OTN Technologies and Interoperable Optical Interfaces
12:45–13:45, *Theater II*

OFCnet Panel: Software Define Infrastructures
13:00–13:30, *Theater III*

Open ROADM MSA Updates and Demonstration
13:45–14:45, *Theater III*

Room 1A

14:00–16:00
W3A • Transmitters and Receivers
Presider: Frank Chang; Source Photonics, USA

W3A.1 • 14:00 ★ Top-Scored
Net-1.8 Tbps/λ Transmission Enabled by C+L-Band InP-Based Coherent Driver Modulator, Josuke Ozaki[1], Yoshihiro Ogiso[1], Hiroshi Yamazaki[2], Masanori Nakamura[2], Kenta Sugiura[1], Kazuya Nagashima[3], Yasuaki Hashizume[4], Nobuhiro Nunoya[1], Yutaka Miyamoto[2], Mitsuteru Ishikawa[1]; [1]*NTT Innovative Devices, Japan;* [2]*NTT Network Innovation Laboratories, Nippon Telegraph Telephone Corporation, Japan;* [3]*Furukawa Electric Co., Ltd, Japan;* [4]*NTT Device Innovation Center, Nippon Telegraph and Telephone Corporation, Japan*. Using a newly developed InP-based C+L-band supported coherent driver modulator with an electro-optic 3-dB bandwidth above 90 GHz, an 80km transmission with a net bit rate of 1.8Tbps/λ in the C+L band was successfully demonstrated.

W3A.2 • 14:15 ★ Top-Scored
Integrated Coherent Transmit-Receive Optical Sub-Assembly (IC-TROSA) for 140 GBd Applications, Efthymios Rouvalis[1], Patrick Domburg[1], Jörg Honecker[1], Jens Stephan[1], Christopher Harbs[1], Johann Henkel[1], Ulrich Technau[1], Andrés Varon[1], Sebastian Wissig[1], Georg Clarici[1], Matthias Berger[1]; [1]*Coherent, Germany.* We report on a high output power (>0 dBm), integrated coherent transmit-receive optical sub-assembly (IC-TROSA) integrating all electro-optical and control functions for single-carrier, coherent transmission up to 800 Gb/s.

Room 1B

14:00–16:00
W3B • Optical Signal Processing
Presider: Xiaoke Yi; Univ. of Sydney, Australia

W3B.1 • 14:00 Invited
Cascadability of PPLN-Based Inter-Band Wavelength Conversion for Band-Switchable Multi-Band Optical Cross-Connect, Haruka Minami[1], Takafumi Fukatani[1], Masahiro Nakagawa[1], Takeshi Seki[1], Shimpei Shimizu[1], Takayuki Kobayashi[1], Takushi Kazama[1], Koji Enbutsu[1], Takeshi Umeki[1], Rie Hayashi[1], Takeshi Kuwahara[1]; [1]*NTT Corporation, Japan*. A band-switchable multi-band optical cross-connect can contribute flexible operation of future multi-band networks. We review an experimental demonstration for cascadability of PPLN-based inter-band wavelength converters with a view to incorporating them into the optical cross-connect.

Room 2

14:00–16:00
W3C • Network Planning and Operation
Presider: Yvan Pointurier; Huawei, France

W3C.1 • 14:00
Is Channel Symbol Rate Faster Than 200 GBaud the Panacea for WDM Transparent Meshed Networks?, Thierry Zami[1], Nicola Rossi[1], Bruno Lavigne[1]; [1]*Nokia Corporation, France*. In the context of transparent meshed WDM networks, we illustrate and explain why very large channel symbol rate (288 GBd) can adversely reduce the achievable total network capacity, whilst still improving global expenditures per Gb/s.

W3C.2 • 14:15 Invited
Networking Benefits of Coherent Pluggable Optics, João Pedro[1,2]; [1]*Infinea Unipessoal Lda, Portugal;* [2]*Instituto de Telecomunicações, IST, Portugal*. This paper overviews the range of applications of coherent pluggable optics. Selected simulation results highlight how deploying devices that feature both high-performance and digital subcarrier multiplexing is a key enabler of cost-effective network solutions.

Room 3

14:00–16:00
W3D • Laser Stabilization and Comb Sources
Presider: Vladimir Gordienko, Aston University, UK

W3D.1 • 14:00 Invited
Environmentally Stable Ultra-Low Noise Self-Injection Locked Semiconductor Lasers, Andrey B. Matsko[1]; [1]*JPL, Caltech, USA.* Self-injection locking (SIL) of semiconductor lasers by means of monolithic optical cavities allows generation of high spectral purity and high stability optical signals under varying environmental conditions. We review recent advances in the field and focus at the SIL by means of monolithic Fabry-Perot resonators.

Room 6C

14:00–16:00
W3E • Embracing Fiber Sensing: What's the "Killer App" for Large-Scale Deployments? I
Presider: Sander Jansen; ADVA, Germany

W3E. • 14:00 Introduction

Room 6D

14:00–16:00
W3F • Submarine Long-Haul and Repaterless Transmission
Presider: Sergejs Makovejs; Corning Inc, UK

W3F.1 • 14:00
Subcarrier-Enabled Record Field Trial Demonstration in a Dispersion Uncompensated Ultra-Long Transpacific Cable, Sumudu G. Edirisinghe[1], Siddharth Varughese[1], Domanic Lavery[2], Pierre Mertz[1], Han Sun[2]; [1]*Advanced Optical Engineering, Infinera Corporation, USA;* [2]*Advanced Optical Engineering, Infinera Canada Inc, Canada*. A record real-time transmission is demonstrated over an 18,008 km dispersion uncompensated subsea cable, enabled by subcarrier-based EEPN mitigation and FEC. Numerical analysis supports the field trial's real-time measurements, quantifying the benefit of subcarrier modulation.

W3F.2 • 14:15
Low-Complexity Experimental Model for Submarine Link Performance Prediction, Juliana Tiburcio de Araujo[1], Alexis Carbo Meseguer[1], Jean-Christophe Antona[1]; [1]*Alcatel Submarine Networks (ASN), France.* We propose a low-complexity experimental model that predicts the OSNR of submarine links, considering both EDFA homogeneous and inhomogeneous responses. We tested it with random input pre-emphases, obtaining a mean RMSE of 0.29 dB after 24 spans when trained with simple single-span datasets.

Room 6E

14:00–16:00
W3G • Coherent DWDM Pluggables
Presider: Binbin Guan; Microsoft Corp, USA

W3G.1 • 14:00
Demonstration of 400G High Power ZR+ IP Over WDM in Key Network Scenarios with End-to-End 400GE Traffic, Yu Rong Zhou[1], John Keens[2], Martyn Allen[2]; [1]*BT Group plc, UK;* [2]*Cisco Systems Inc, USA.* We show successful demonstration of emerging 400G high power ZR+ optics in IP over WDM applications investigating its performance in key network scenarios with end-to-end 400GE traffic and streaming telemetry for performance monitoring.

W3G.2 • 14:15
QoT Estimation for Large-Scale Mixed-Rate Disaggregated Metro DCI Networks by Artificial Neural Networks, Yan He[1], Kausthubh Chandramouli[1], Zhai Z. Qun[3], Sai Chen[3], Liang Dou[2], Chongjin Xie[4], Chao Lu[1], Alan P. Lau[1]; [1]*The Hong Kong Polytechnic Univ., Hong Kong;* [2]*Alibaba Cloud, Alibaba Group, Beijing, China;* [3]*Alibaba Cloud, Alibaba Group, Hangzhou, China;* [4]*Alibaba Cloud, Alibaba Group, New York, USA.* We proposed an artificial neural network (ANN)-based QoT estimator for large-scale mixed-rate disaggregated metro DCI networks with an estimation error standard deviation of 0.3 dB, outperforming analytical-based methods with vendor-specific transponder SNR characterization.

Room 6F

14:00–16:00
W3H • Large Capacity Interconnect
Presider: Norman Swenson; Norman Swenson Consulting, USA

W3H.1 • 14:00 Invited
Reconfigurable Lightwave Fabrics for ML Supercomputers, Ryohei Urata[1]; [1]*Google LLC, USA.* We present the large-scale, production deployment of reconfigurable Lightwave Fabrics (LWF) for Machine Learning (ML) supercomputers. These fabrics consist of a custom developed optical circuit switch (OCS), circulators, and WDM transceiver technologies. The use of a LWF dramatically enhances the current generation 4096 tensor processing unit (TPU) system in both availability (up to 3x) as well as performance (up to 3.3x) with modest power and cost increases (1% and 6%, respectively).

Room 7

14:00–16:00
W3I • Panel: Role of Optics for Space Communication

Organizers
Chi-Wai Chow, *National Yang Ming Chiao Tung University, Taiwan*
Stephanie Ralph, *Georgia Tech, USA*
Katherine Newell, *Johns Hopkins University Applied Physics Lab, USA*
Yi Sun, *OFS Fitel LLC, USA*

Speakers
David DiGiovanni, *OFS Optics, USA*
Baris Erkmen, *Aalyria Technologies Inc., USA*
Tina Hsu, *SpaceX, USA*
Jim Lemieux, *Lockheed Martin, USA*
Alberto Carrasco-Casado, *NICT, Japan*
Todd Ulmer, *MIT Lincoln Labs, USA*

This joint panel session will outline the landscape of optics for space communications from device to subsystem to networks and applications. Panelists will discuss their work in devices and systems to bring together the broader picture on how current technology is driving applications in space optical communications today and in the future.

Room 8

14:00–16:00
W3J • Multi-Core Fiber Design and Transmission Characteristics
Presider: Jin-Xing Cai; SubCom LLC, USA

W3J.1 • 14:00 Invited
Field Transmission Performance of Few-Mode Fibers and Multicore Fibers, Cristian Antonelli[1]; [1]*Universita degli Studi dell'Aquila, Italy.* This presentation reviews accumulated knowledge on the performance of field-deployed fibers for spatially multiplexed transmission. These are multi-core and few-mode fibers deployed in the Italian city of L'Aquila as part of the INCIPICT testbed for space-division multiplexing.

Room 9

14:00–16:00
W3K • PICs for Quantum Communication and Quantum Computing: Challenges and Opportunities I
Presider: Eleni Diamanti; CNRS, France

W3K.1 • 14:00 Invited
Photonic Integrated Circuits for Quantum Communication, Davide Bacco[1], Giulia Guarda[1], Sebastiano Cocchi[1], Caterina Vigliar[2], Mujtaba Zahidy[2], Yunhong Ding[2], Leif K. Oxenløwe[2], Tommaso Occhipinti[3], Alessandro Zavatta[3]; [1]*Univ. of Florence, Italy;* [2]*Technical Univ. of Denmark, Denmark;* [3]*QTI s.r.l., Italy.* We report an overview of photonic integrated circuits for generating, manipulating, and measuring quantum states of light (qubit and qudit) in the context of quantum communications and quantum networks.

Show Floor Programming

IOWN GF's Open APN for the Evolution of Mobile Networks and Cloud-and-Edge Computing
14:00–15:00, *Theater II*

MW4 • MW Panel IV: Next Generation PON Technologies
14:15–15:45, *Theater I*

Amphenol Sponsored Session
15:15–16:15, *Theater II*

Coherent Optics Unleashed: From 400ZR Success to 800ZR/LR Advancements and 1600ZR Kick-off
16:00–17:00, *Theater I*

Room 1A

W3A • Transmitters and Receivers—Continued

W3A.3 • 14:30
Fully Integrated Silicon Photonic High-Speed Transmitter with Ring-Assisted Mach-Zehnder Modulator, Xinru Wu[1], Duanni Huang[1], Ranjeet Kumar[1], Guan-Lin Su[1], Junyi Gao[1], Songtao Liu[1], Xiaoxi Wang[1], Haisheng Rong[1]; [1]*Intel Corporation, USA.* We report a fully integrated transmitter which includes a DFB laser and a push-pull drive ring-assisted Mach-Zehnder modulator. We demonstrate 224Gb/s PAM-4 transmission with 1.8Vppd differential driving swing and transmitter penalty (TDECQ) of 1.25dB.

W3A.4 • 14:45 Invited
Monolithically Integrated Comb Lasers on Silicon for Optical I/O, Ting Wang[1]; [1]*Insitute of Physics, Chinese Academy of Sciences, China.* Significant HPC and AI development enable the rising demand of chip-to-chip optical I/O. Monolithically integrated multi-wavelength lasers on silicon integrated with micro-ring modulators are capable of increasing data transmission bandwidth among XPUs, FPGAs and ASICS. Multi-terabit optical data tranmission with on-board optics shall lead to next generation high-performance computing.

Room 1B

W3B • Optical Signal Processing—Continued

W3B.2 • 14:30
Over 3 THz Real-Time Optical Vector Oscilloscope, Lun Li[1], Yuchong Cai[1], Chi Zhang[1], Xi Xiao[2], Xinliang Zhang[1]; [1]*Huazhong Univ. of Science and Techn, China;* [2]*National Information Optoelectronics Innovation Center, China.* We propose a real-time optical vector oscilloscope to obtain full-field information with over 3-THz acquisition bandwidth. The experiments demonstrate 80 gigabit/s OOK and BPSK signals, and 2×160 gigabit/s QPSK wavelength-division multiplexed signals are simultaneously observed.

W3B.3 • 14:45
Universal Optical Logic Gates on a Programmable Silicon Photonic Platform, Farshid Ashtiani[1]; [1]*Nokia Bell Labs, USA.* We propose and demonstrate the implementation of NOT, OR/NOR, and AND/NAND logic gates compatible with integrated photonics. Using a programmable photonic platform consisting of a Mach-Zehnder interferometer mesh, universal logic gates are experimentally demonstrated.

W3B.4 • 15:00 ★ Top-Scored
Integrated Non-Sliced OAWM Engine Enabling 320 GHz Photonic-Electronic Analog-to-Digital Conversion, Daniel Drayss[1], Dengyang Fang[1], Alexander Quint[1], Luca Valenziano[1], Matthias Lauermann[3], Grigory Lihachev[2], Yung Chen[1], Huanfa Peng[1], Sebastian Randel[1], Thomas Zwick[1], Wolfgang Freude[1], Tobias J. Kippenberg[2], Christian Koos[1]; [1]*KIT, Germany;* [2]*EPFL, Switzerland;* [3]*Vanguard Automation, Germany.* We demonstrate an optically and electrically packaged silicon photonic receiver system for non-sliced optical arbitrary waveform measurement (OAWM). The OAWM engine is used for high-speed data transmission and for photonic-electronic analog-to-digital conversion at bandwidths of up to 320 GHz.

Room 2

W3C • Network Planning and Operation—Continued

W3C.3 • 14:45
Dynamic Asymmetric SC Allocation and Reconfiguration in Drop-and-Continue Optical Networks Based on P2MP-TRXs, Ruoxing Li[1], Sijia Li[1], Meihan Wu[1], Yuxiao Zhang[1], Qian Lv[1], Zuqing Zhu[1]; [1]*Univ of Science and Technology of China, China.* We study the dynamic service provisioning in drop-and-continue optical networks based on point-to-multipoint transceivers (P2MP-TRXs), and leverage asymmetric subcarrier (SC) allocation and SC-level reconfiguration to optimize resource utilization with low operational complexity.

W3C.4 • 15:00
Identification of Optical Links with Heterogenous Fiber Types in a Production Network, Emmanuel Seve[1], Sébastien Bigo[1], Patricia Layec[1]; [1]*Nokia Bell Labs France, France.* We develop a technique to identify fiber type within heterogeneous network links using correlation between lightpath accumulated dispersions. We successfully identified fiber types from real data issued from a continental-size production network running live.

Room 3

W3D • Laser Stabilization and Comb Sources—Continued

W3D.2 • 14:30
Frequency Modulated Integrated 780 nm Brillouin Laser with 24 Hz Fundamental and 1.4 kHz Integral Linewidths and 22 kHz Modulation Bandwidth, Andrei Isichenko[1], Nitesh Chauhan[1], Jiawei Wang[1], Mark W. Harrington[1], Kaikai Liu[1], Daniel Blumenthal[1]; [1]*UC Santa Barbara., USA.* We demonstrate a frequency modulated 780 nm Brillouin laser pumped by a semiconductor laser. We achieve a 1.4 kHz 1/π integral linewidth and 24 Hz fundamental linewidth and a 22 kHz modulation bandwidth.

W3D.3 • 14:45
Parametric Oscillators and Soliton Combs in Bandgap-Detuned Nanoresonators, Yan Jin[1,2], Jizhao Zang[1,2], Travis Briles[1], David Carlson[1,3], Scott Papp[1,2]; [1]*NIST Boulder, USA;* [2]*Univ. of Colorado Boulder, USA;* [3]*Octave Photonics, USA.* We report controllable generation of OPO lasers and soliton microcombs by manipulating nonlinear dynamics with nanophotonic bandgaps. By excitation detuned from bandgap modes, we realize wide-tunability, low-threshold-power and high-conversion-efficiency lasers.

W3D.4 • 15:00 ★ Top-Scored
Dark Soliton Microcomb with High Conversion Efficiency in a 400-nm-Thick Si3N4 Microring for WDM Light Sources, Hongyi Zhang[1], Liangjun Lu[1], Shuxiao Wang[2], Yan Cai[2], Yuyao Guo[1], Jianping Chen[1], Linjie Zhou[1]; [1]*Shanghai Jiao Tong Univ., China;* [2]*State Key Laboratory of Functional Materials for Informatics, Shanghai Inst. of Microsystem and Information Technology, Chinese Academy of Sciences, China.* We generate a dark soliton microcomb with a conversion efficiency of 49% and -10 dBm spectral bandwidth of 28 nm in a single 400-nm-thick Si_3N_4 microring fabricated by a commercial foundry, which supports high-performance WDM light sources.

Room 6C

W3E • Embracing Fiber Sensing: What's the "Killer App" for Large-Scale Deployments? I—Continued

W3E.1 • 14:30 Invited
Existing and Emerging Market Opportunities for Distributed Fiber Optic Sensing, Paul R. Dickinson[1,2]; [1]*Dura-Line, USA;* [2]*Fiber Optic Sensing Association, USA.* Through Broadcom and Datacom, optical fibers provide an ever-increasing mesh spanning the globe. In this presentation we'll discuss multi-use trends where distributed fiber optic sensing, using existing fibers, now provides novel capabilities for multiple market applications.

W3E.2 • 15:00 Invited
How can Sensing on Telecoms Fibres Bring Revenues to Operators?, Andrew Lord[1]; [1]*BT Applied Research, UK.* In this talk, we will assess the potential for fibre sensors to be integrated into operators' telecoms networks. What contributions might they make and with what associated use cases? How can they bring in revenue?

Room 6D

W3F • Submarine Long-Haul and Repaterless Transmission—Continued

W3F.3 • 14:30 Invited
Tailoring Transceiver Designs for Subsea, Siddharth Varughese[1], Domanic Lavery[1], Pierre Mertz[1]; [1]*Infinera Corporation, USA.* Unique challenges that subsea cables introduce which influence optical transceiver design are described. DSP algorithms that address these challenges are discussed and the use of subsea transceivers for seismic sensing is also introduced.

W3F.4 • 15:00
66.8 Tb/s Real-Time C+L Unrepeatered Transmission Over 301 km Using Forward and Backward Raman Amplification, Ivan Fernandez de Jauregui Ruiz[1], Nurmemet Abdukerim[1], John Van Weerdenburg[1], Thomas Gerard[1], Francisco J. Vaquero Caballero[1], Jonathan M. Buset[1], Lidia Galdino[2]; [1]*Infinera Corporation, France;* [2]*Corning Incorporated, UK.* We demonstrate record real-time 66.8 Tb/s over 301 km unrepeatered fiber transmission based on commercial 100.4 GBaud PCS-64QAM digital subcarrier-based transponders and commercial 9.6 THz multi-band C+L line system employing forward and backward Raman amplification.

Room 6E

W3G • Coherent DWDM Pluggables—Continued

W3G.3 • 14:30 Invited

Interoperable Coherent WDM Interfaces at 400G and 800G, Erwan Pincemin[1], Olivier Renais[1]; [1]*Orange Innovation, France*. 400G and 800G coherent WDM interfaces were recently standardized by MSA and standardization forums to enable interoperable operation across DCI, metro/regional and IPoWDM networks of transceivers from various vendors with DSP of different suppliers. OpenROADM is elaborating for the first time a probabilistic constellation shaping specification that addresses this need at 800G.

W3G.4 • 15:00 Tutorial

10 Years of Coherent DWDM Pluggables: Past, Present and Future, Christian Rasmussen[1]; [1]*Acacia Communications, Inc., USA*. Abstract not available.

Room 6F

W3H • Large Capacity Interconnect—Continued

W3H.2 • 14:30 Invited

High-Density Optical I/O for ML/AI Applications, Peter J. Winzer[1]; [1]*Nubis Communications, USA*. We discuss optical interconnect solutions optimized for machine-learning clusters. Key performance criteria include ultra-high I/O density, low-power, low-latency, and linear-drive operation to natively replace copper interconnects.

W3H.3 • 15:00

Real-Time 1.2Tb/s Large Capacity DCI Transmission, Hongbin Zhang[1], Benyuan Zhu[2], Shaoliang Zhang[1], Timo Pfau[1], Ahmed Awadalla[1], Mehmet Aydinlik[1], Jonas Geyer[1]; [1]*Cisco Systems Inc, USA;* [2]*OFS, USA*. We demonstrate real-time WDM transmissions of 39.6 Tb/s (33x1.2Tb/s) over a 172km fibre link. The transmission was accomplished without post-FEC error for >46-hours.

Room 7

W3I • Panel: Role of Optics for Space Communication—Continued

Room 8

W3J • Multi-Core Fiber Design and Transmission Characteristics—Continued

W3J.2 • 14:30

U-Band Transmission Characteristics Over Standard Cladding Step-Index 4-Core Fiber Span, 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., Japan;* [2]*Fujitsu Limited, Japan*. We evaluate the optical and transmission characteristics of a step-index four-core fiber with a standard cladding diameter in the U-band. Transmission over 57 km is demonstrated by applying a bidirectional architecture to suppress the crosstalk.

W3J.3 • 14:45

Design Guideline for Unrepeatered Counter-Propagating Multi-Core Fiber Link, Takashi Matsui[1], Taiji Sakamoto[1], Masaki Wada[1], Kazuhide Nakajima[1]; [1]*NTT Corporation, Japan*. We revealed that crosstalk influence in unrepeatered counter-propagating multi-core fiber link could be minimized at optimum gain and position of remote-optically pumped amplifier (ROPA). 1.5-times longer unrepeatered link was obtained by implementing isolators with ROPA.

W3J.4 • 15:00 Invited

Development of Four-Core MCFs with Standard Cladding Diameter From High-Core-Count MCFs, Kazuhiko Aikawa[1], Takuya Oda[1], Shota Kajikawa[1], Kohei Ozaki[1], Mayu Iizuka[1], Katsuhiro Takenaga[1], Akito Nishimura[1], Kentaro Ichii[1]; [1]*Fujikura Ltd., Japan*. We developed multiple-core filters (MCFs) with more than 30 cores and conducted transmission tests. Currently, we aim to commercialize four-core MCFs with a standard cladding diameter by conducting trials using MCF cables, and related technologies.

Room 9

W3K • PICs for Quantum Communication and Quantum Computing: Challenges and Opportunities I—Continued

W3K.2 • 14:20 Invited

Trapped-Ion Quantum Computing with Integrated Photonics, Bryan DeBono[1], Henry Semenenko[1], Lora Nugent[1], Molly Krogstad[1], Adam Ollanik[1], Duc Nguyen[1], Sara Campbell[1], Justin Schultz[1], Michael Plascak[1], Rezlind Bushati[1], Johanna Zultak[1], Mary Rowe[1]; [1]*Quantinuum, USA*. Quantinuum's trapped-ion quantum computer utilizes the QCCD architecture which exhibits high-fidelity operations, mid-circuit measurements, and full connectivity. This talk discusses how we can address scaling challenges with visible-light integrated photonics to facilitate large-scale quantum computing.

W3K.3 • 14:40 Invited

Fully Packaged Multichannel Cryogenic Quantum Memory Module, Ben Dixon[1]; [1]*MIT Lincoln Laboratory, USA*. Abstract not available.

W3K.4 • 15:00 Invited

Monolithic Integration of Silicon Quantum Photonics and Electronics in a 45nm SOI CMOS Foundry Platform, Danielius Kramnik[1], Imbert Wang[2], Josep Fargas Cabanillas[2], Anirudh Ramesh[3], Djordje Gluhovic[2], Sidney Buchbinder[1], Panagiotis Zarkos[1], Christos Adamopoulos[1], Prem Kumar[3], Milos Popovic[2], Vladimir Stojanovic[1]; [1]*Univ. of California Berkeley, USA;* [2]*Boston Univ., USA;* [3]*Northwestern Univ., USA*. Silicon photonics can enable useful quantum information processing, but scaling the interface to calibration and control circuits remains challenging. We monolithically integrate quantum photonics with electronics in a standard CMOS foundry to address this issue.

Show Floor Programming

IOWN GF's Open APN for the Evolution of Mobile Networks and Cloud-and-Edge Computing
14:00–15:00, *Theater II*

MW4 • MW Panel IV: Next Generation PON Technologies
14:15–15:45, *Theater I*

Amphenol Sponsored Session
15:15–16:15, *Theater II*

Coherent Optics Unleashed: From 400ZR Success to 800ZR/LR Advancements and 1600ZR Kick-off
16:00–17:00, *Theater I*

Room 1A

W3A • Transmitters and Receivers—Continued

W3A.5 • 15:15
Ultra-Thin Bottom-Emission VCSEL-Based Optoelectronic Flexible Printed Circuit Module for High-Speed Transmission, Zuhaib Khan[1], Chung-Yu Hong[2], Ming-Che Hsieh[2], Chun-I Wu[2], Long-Yi Lin[2], Chun-Chieh Chen[2], David Cheng[1]; *[1]Flexium Interconnect Inc., Taiwan; [2]QuantumZ Inc., Taiwan*. Innovative integration of back emission VCSEL-based optoelectronic module with optical waveguide achieves remarkable 50Gbps PAM4 optical and 25Gbps NRZ electrical transmission speeds. An ultrathin USB3.2 type C optoelectronic module with 0.2mm thickness has been realized.

W3A.6 • 15:30
A 4×112Gbps Compact Polarization-Insensitive Silicon Photonic WDM Receiver, Jintao Xue[1,2], Jinyi Wu[1,3], Chao Cheng[1,3], Wenfu Zhang[1,2], Binhao Wang[1,2]; *[1]State Key Laboratory of Transient Optics and Photonics, Xi'an Inst. of Optics and Precision Mechanics, China; [2]School of Future Technology, Univ. of Chinese Academy of Sciences, China; [3]School of Optoelectronics, Univ. of Chinese Academy of Sciences, China*. A 4×112Gbps polarization-insensitive silicon photonic WDM receiver with a two-dimensional grating coupler, cascaded dual-ring filters and bidirectional photodiodes is demonstrated. A polarization-dependent loss of 0.45dB is achieved.

Room 1B

W3B • Optical Signal Processing—Continued

W3B.5 • 15:15 ★ Top-Scored
Photonic 1K3D@60 FPS Surface Extraction with Hilbert Dimension Squeezing Approach, Jiang Yue[1], Wenjia Zhang[2], Jiayuan Guo[2], Han Wang[2], Zuyuan He[2]; *[1]Shanghai Jiao Tong Univ., China; [2]Shanghai Jiao Tong Univ., China*. We propose an integrated photonic 3D-surface information extractor leveraged by Hilbert dimension squeezing approach, achieving 3D-data surface information with 1K resolution @60 FPS and 93% data compression.

W3B.6 • 15:30
Heterogeneous Integrated Fiber-Chip System Enabling 192-Channel and 20-Tbit/s Multi-Dimensional Optical Signal Transmission and Processing, Kang Li[1], Guofeng Yan[1], Kangrui Wang[1], Chengkun Cai[1], Min Yang[1], Yuanjian Wan[1], Guangze Wu[1], Weike Zhao[2], Yingying Peng[2], Yaocheng Shi[2], Daoxin Dai[2], Jian Wang[1]; *[1]Wuhan National Laboratory for Optoelectr, China; [2]State Key Laboratory for Modern Optical Instrumentation, Center for Optical & Electromagnetic Research, College of Optical Science and Engineering, International Research Center for Advanced Photonics, China*. We demonstrate a heterogeneous integrated multi-dimensional fiber-chip system using few-mode fiber and 2D/3D integrated chips. By carrying a 56 Gbaud QPSK signal, the system with 192 mode/polarization/wavelength channels implements 20-Tb/s optical signal transmission and processing.

Room 2

W3C • Network Planning and Operation—Continued

W3C.5 • 15:15 ★ Top-Scored
Employing Fiber Loss Degradation Statistics in SLA Based Margin Calculation Method for Optical Networks, Zhai Z. Qun[1], Liang Dou[1], Sai Chen[1], Huan Zhang[1], Chongjin Xie[1]; *[1]Alibaba, China*. We present a statistical analysis of fiber loss degradation with data from a live production network. A proper model is proposed to investigate system margins under typical scenarios with different operation conditions.

W3C.6 • 15:30
Capacity-Bound Evaluation and Routing and Spectrum Assignment for Elastic Optical Path Networks with Distance-Adaptive Modulation, Kenji Cruzado[1], Yojiro Mori[1], Shih-Chun Lin[2], Motoharu Matsuura[3], Suresh Subramaniam[4], Hiroshi Hasegawa[1]; *[1]Nagoya Univ., Japan; [2]North Carolina State Univ., USA; [3]The Univ. of Electro Communications, Japan; [4]The George Washington Univ., USA*. A novel and effective network capacity estimation method and an RSA algorithm suitable for elastic optical path networks are presented. The proposed algorithm successfully achieves the utilization penalty of just 5-16% from the bound.

W3C.7 • 15:45
Using P2MP Transceivers as Regenerators in Disaggregated and Multi-Rate Regional Optical Networks, Ashwin Gumaste[1], Joao Pedro[1], Antonio Napoli[1], Sai Bhyri[1], Walid Wakim[1]; *[1]Infinera Corporation, USA*. We investigate the role of point-to-multipoint (P2MP) transceivers as regenerators in multi-rate regional optical networks. By smart placement of P2MP devices, we are able to reduce transceiver count by 29% and free up spectral resources.

Room 3

W3D • Laser Stabilization and Comb Sources—Continued

W3D.5 • 15:15 ★ Top-Scored
All-Fiber Raman and Parametric-Assisted Spectral Talbot Array Illuminator for Mode Spacing Multiplication, Zijian Li[1], Chen Ding[1], Qiarong Xiao[1], Qijie Xie[2], Yuanfei Zhang[1], Chaoran Huang[1], Chester Shu[1]; *[1]The Chinese Univ. of Hong Kong, Hong Kong; [2]PengCheng Lab, China*. An optical frequency comb with multiplied mode spacing of 94.5 GHz and up to 35 dB carrier-to-noise ratio is produced by a hybridly amplified spectral Talbot processor. The output supports frequency comb based coherent communications.

Room 6C

W3E • Embracing Fiber Sensing: What's the "Killer App" for Large-Scale Deployments? I—Continued

W3E.3 • 15:30 Invited
Environmental Monitoring Using Widely Deployed Telecommunication Optical Fiber Cables and Distributed Acoustic Sensing, Yoshifumi Wakisaka[1]; *[1]NTT Corp., Japan*. We present use cases in environmental monitoring by high-precision distributed acoustic sensing using widely deployed telecommunication optical fiber cables. We explain the progress and future prospects from the viewpoints of telecom carriers.

Room 6D

W3F • Submarine Long-Haul and Repaterless Transmission—Continued

W3F.5 • 15:15
Real-Time 100G and 200G Unrepeatered Transmission Over 691.8km and 655.9km Respectively, Quanying Wen[1], Jianping Li[1], Songsong Xu[1], Yanpu Wang[1], Jiang Lin[1], Jingying Yu[1], Bangtian Xu[1], Xuegang Lao[2], Gan Luo[3]; *[1]HMN Technologies Co., Ltd., China; [2]heng Tong Optical Material Co, Ltd, China; [3]Jiangsu Alpha Optic-Electric Technology Co., Ltd, China*. We present records of unrepeatered transmission 100Gb/s and 200Gb/s over 691.8km and 655.9km, respectively. This achievement involved the use of special modulation format, optimal Raman technology, and ultra-low loss & 130 um^2 A_{eff} fibers.

16:00–16:30 Coffee Beak, *Upper Level Corridors and Exhibit Hall*
Elevated Coffee Break, Sponsored by Infinera, *Booth 4217*

Room 6E

W3G • Coherent DWDM Pluggables—Continued

Room 6F

W3H • Large Capacity Interconnect—Continued

W3H.4 • 15:15
First Demonstration of Net-1.6-Tbps 4λ-WDM in 150-GHz-Grid IM/DD Transmission with a Single DAC/Channel and Advanced DSP for Intra-Datacenter-Interconnects, An Yan[1], Guoqiang Li[1], Sizhe Xing[1], Yongzhu Hu[1], Wangwei Shen[1], Ziwei Li[1], Chao Shen[1], Jianyang Shi[1], Xi Xiao[2], Zhixue He[3], Nan Chi[1], Junwen Zhang[1]; *[1]Fudan Univ., China; [2]National Information Optoelectronics Innovation Center, CICT, China; [3]Peng Cheng Laboratory, China.* For the first time, we experimentally demonstrate net-400-Gb/s/lane 150-GHz-spaced 4λ-WDM transmission over 0.5-km SSMF in C-band for intra-datacenter-interconnects based on 128-GBaud probabilistically shaped PAM-20, using a single DAC per channel and driver-free, high-bandwidth TFLN modulators.

W3H.5 • 15:30
Dispersion-Unmanaged Transmission of 144-Gb/s PAM-8 and 110-Gb/s PAM-6 Signals Over 10/20-km SSMF for DML-Based IM-DD Optics at C Band, Qi Wu[2,1], Zhaopeng Xu[2], Yixiao Zhu[1], Honglin Ji[2], Yu Yang[2], Junpeng Liang[2], Tonghui Ji[2], Gang Qiao[2], Shangcheng Wang[2], Lulu Liu[2], Zhixue He[2], Jinlong Wei[2], Qunbi Zhuge[1], Weisheng Hu[2]; *[1]Shanghai Jiao Tong Univ., China; [2]Peng Cheng Laboratory, China.* We experimentally demonstrate record net 134.6-Gb/s PAM-8 and 102.8-Gb/s PAM-6 signals transmission over 10/20-km SSMF using a 20-GHz commercial C-band DML without dispersion management, using joint sparse Volterra nonlinear equalization and noise whitening DSP techniques.

W3H.6 • 15:45
8λ×462Gb/s Transmission with Symmetric Carrier-Assisted Differential Detection Using Delay-Unknown Field Recovery, Yixiao Zhu[1], Xiansong Fang[2], Guangying Yang[1], Qunbi Zhuge[1], Weisheng Hu[1], Fan Zhang[2]; *[1]Shanghai Jiao Tong Univ., China; [2]Peking Univ., China.* We implement symmetric carrier-assisted differential detection receiver as an LO-free alternative to single-polarization coherent receiver. Using 2×1 MIMO equalizer-based optical field recovery and SSBI cancellation, 3.7Tb/s(=8λ×462Gb/s) PS-64-QAM signals are transmitted over 25-km SSMF for data-center-interconnects.

Room 7

W3I • Panel: Role of Optics for Space Communication—Continued

Room 8

W3J • Multi-Core Fiber Design and Transmission Characteristics—Continued

W3J.5 • 15:30
High-Density Weakly-Coupled 4-Core MCF with 160-μm Coating for O-Band Application, Shota Kajikawa[1], Mayu Iizuka[1], Takuya Oda[1], Katsuhiro Takenaga[1], Kentaro Ichii[1]; *[1]Fujikura Ltd., Japan.* We developed weakly coupled 4-core multi-core fiber with 100-μm cladding and 160-μm coating suitable for O-band applications, which achieves an impressive core density of 9.8 times higher than that of conventional single-core fiber.

W3J.6 • 15:45
Standard Coating Diameter Uncoupled 19-Core Multicore Fiber with Highest Core Density for Optical Wiring, Yusuke Matsuno[1], Ryuichi Sugizaki[1], Masanori Takahashi[1]; *[1]Furukawa Electric Co., Ltd., Japan.* 19-core MCF with standard coating diameter was fabricated. Highest core density was achieved compared with that of reported uncoupled MCFs using homogeneous cores. r=7.5mm bending can be applied to the MCF with certain mechanical reliability.

Room 9

W3K • PICs for Quantum Communication and Quantum Computing: Challenges and Opportunities I—Continued

W3K.5 • 15:20 Invited
Integrated Quantum Photonics/Foundry Talk, Segolene Olivier[1]; *[1]CEA-Leti, France.* Abstract not available.

16:00–16:30 Coffee Beak, *Upper Level Corridors and Exhibit Hall*
Elevated Coffee Break, Sponsored by Infinera, *Booth 4217*

Show Floor Programming

IOWN GF's Open APN for the Evolution of Mobile Networks and Cloud-and-Edge Computing
14:00–15:00, *Theater II*

MW4 • MW Panel IV: Next Generation PON Technologies
14:15–15:45, *Theater I*

Amphenol Sponsored Session
15:15–16:15, *Theater II*

Coherent Optics Unleashed: From 400ZR Success to 800ZR/LR Advancements and 1600ZR Kick-off
16:00–17:00, *Theater I*

Room 1A

16:30–18:30
W4A • THz Processing and Communications
Presider: Lalitha Ponnampalam; Univ. College London, UK

W4A.1 • 16:30
616-Gbit/s Single Line Rate Fiber-THz-Fiber Seamless Transmission Utilizing Cascaded MIMO Equalization, Junjie Ding[1], Zhigang Xin[2], Weidong Tong[2], Jiao Zhang[1,2], Yuancheng Cai[1], Mingzheng Lei[1], Bingchang Hua[1], Yucong Zou[1], Xingyu Chen[1], Jianjun Yu[1,3], Min Zhu[1,2]; [1]*Purple Mountain Laboratories, China;* [2]*Southeast Univ., China;* [3]*Fudan Univ., China*. We experimentally demonstrate 56-GBaud PS-64QAM signal fiber-THz-fiber seamless communication by employing photonic up-/down-conversion technique and cascaded MIMO equalization algorithms, achieving a record-breaking single-carrier line rate of 616 Gbit/s.

W4A.2 • 16:45
Flexible Capacity Wireless Communication in THz-Band with Michelson Interferometer-Based THz-Wave Filter, Koichi Takiguchi[1]; [1]*Department of Electrical and Electronic Engineering, Ritsumeikan Univ., Japan*. We report wireless communication in the 300 GHz-band, which uses variable channel number and symbol rate signals. We demultiplexed densely allocated 8 to 32 Gbit/s signals directly in the THz-domain using a Michelson interferometer-based filter.

W4A.3 • 17:00
Photonic Frequency Hopping Driven by High-Speed Wavelength Tunable Laser for Secure Terahertz-Wave Communication, Shenghong Ye[1], Naoto Masutomi[1], Bo Li[1], Ryo Matsumoto[1], Ryota Kaide[1], Haolan Tang[1], Yoshiki Kamimura[1], Ming Che[1], Yuya Mikami[1], Yuta Ueda[2], Kazutoshi Kato[1]; [1]*Kyushu Univ., Japan;* [2]*NTT Corporation, Japan*. We proposed a photonic frequency-hopping physical-secure Terahertz-wave communication system driven by a high-speed wavelength tunable laser and a photomixer, and experimentally demonstrated a frequency-hopping time of less than 25 ns at 300-GHz band.

Room 1B

16:30–18:30
W4B • FSO for Turbulent and Underwater Channels
Presider: Boon Ooi; King Abdullah Univ of Sci & Technology, Saudi Arabia

W4B.1 • 16:30
Water-to-Air PAM4 Optical Camera Communication Using Long Short Term Memory Neural Network (LSTM-NN), Yun-Han Chang[1], Shang-Yen Tsai[1], Ming-Chieh Tsai[1], Jia-Fu Li[1], Yin-He Jian[1], Chi-Wai Chow[1], Chien-Hung Yeh[2]; [1]*National Yang Ming Chiao Tung Univ., Taiwan;* [2]*Feng Chia Univ., Taiwan*. We demonstrate a wide field-of-view (FOV) water-to-air transmission using rolling-shutter-based optical-camera-communication (OCC). Long-short-term-memory-neural-network (LSTM-NN) is utilized to mitigate the wavy water-surface induced link outage and to decode 4-level pulse-amplitude-modulation (PAM4) rolling-shutter pattern.

W4B.2 • 16:45
Seeing Through Wave—Real-Time Beam Tracking via a ResNet-Based Model in Water-air OWC Systems, Anzi Xu[1], Yujie Di[1], Xiangyu Yue[1], Lian-Kuan Chen[1]; [1]*The Chinese Univ. of Hong Kong, Hong Kong.* A ResNet-based model using one wave-distorted image input is demonstrated for real-time beam tracking. Packet loss rates reduce from 18% to 4% under a wave's ASCR of 0.614 rad/s, realizing a robust water-air OWC system.

W4B.3 • 17:00
Experimental Demonstration of 14.5 Gbps Turbulence-Resilient Visible Laser Communication with Vector Beams Based on $LiNbO_3$ External Modulation, Jifan Cai[1], Zhilan Lu[1], Shuqi Zhang[1], Wenqing Niu[1], Jianyang Shi[1], Ziwei Li[1], Chao Shen[1], Junwen Zhang[1], Nan Chi[1]; [1]*Fudan Univ., China*. The paper experimentally demonstrates the turbulence-resistant effects of vector optics in free-space communication, achieving a transmission rate of 14.5Gbps using a visible light $LiNbO_3$ external modulator.

Room 2

16:30–18:30
W4C • Coding and Modulation
Presider: David Millar; Infinera Corporation, USA

W4C.1 • 16:30
FPGA Prototyping of CCDM with on-Line Configurable Probabilistic Distribution Based on Parallel Arithmetic Coding, Jingwei Song[1], Yan Li[1], Xiaoshuo Jia[1], Zulin Liu[1], Kejia Xu[1], Jifang Qiu[1], Hongxiang Guo[1], Xiaobin Hong[1], Zhisheng Yang[1], Jian Wu[1]; [1]*Beijing Univ of Posts & Telecom, China*. The real-time CCDM and inverse CCDM were realized in an FPGA. The DM and inverse DM achieved a throughput of 16.8GBaud and supported on-line reconfiguration to realize different entropies with fine granularity.

W4C.2 • 16:45
Generalized Staircase Codes with Arbitrary Bit Degree, Mohannad Shehadeh[1], Frank R. Kschischang[1], Alvin Y. Sukmadji[1]; [1]*Univ. of Toronto, Canada*. We introduce a natural generalization of staircase codes in which each bit is protected by arbitrarily many component codewords rather than two. This enables powerful energy-efficient FEC based on iterative decoding of Hamming components.

W4C.3 • 17:00
Low-Complexity SD-FEC Based on Channel-Polarized Multistage Codes for Data Center Networks, Takeshi Kakizaki[1], Masanori Nakamura[1], Fukutaro Hamaoka[1], Seiji Okamoto[1], Etsushi Yamazaki[1]; [1]*NTT Corporation, Japan*. We propose channel-polarized multistage codes (CP-MSC) using multiple SD-FEC codes with different overheads. 0.08-dB net coding gain improvement is obtained by 21% total-overhead CP-MSC over conventional low-complexity SD-FEC code at the same overhead and complexity.

Room 3

16:30–18:30
W4D • Amplifier Architecture for Data Transmission
Presider: Masanori Nakamura; NTT Network Innovation Laboratories, Japan

W4D.1 • 16:30
C+L Band Transmission Under Bidirectionally Pumped Distributed Raman Amplification Using Semiconductor Incoherent Pumps, Shigehiro Takasaka[1], Daichi Ogata[1], Ayato Shirai[1], Satoru Ichihara[1], Junji Yoshida[1], Norihiro Ohishi[1]; [1]*Furukawa Electric, Japan*. We demonstrate a 100Gbaud DP-16QAM signal transmission over either 150/200 km SSMF/CSF under bidirectionally pumped Raman amplification using semiconductor incoherent sources as forward pumps. We confirm effectiveness of the incoherent sources for high signal quality.

W4D.2 • 16:45
1200km Coherent O-Band Transmission Using in-Line BDFAs and Standard Single-Mode Fibre, Kyle Bottrill[1], Natsupa Taengnoi[1,2], Yu Wang[1], Jayanta Sahu[1], Periklis Petropoulos[1]; [1]*Univ. of Southampton, UK;* [2]*Kasetsart Univ., Thailand*. We demonstrate a record 1200km reach O-band transmission of a 22.5GBd dual-pol QPSK signal using a recirculating loop with in-line BDFA amplification and 50km spans of standard single-mode fibre.

W4D.3 • 17:00
U-Band WDM Transmission Over 90-km Deployed Fiber-Optic Cable Leveraged by S+C+L-Band WDM Channels, Tomoyuki Kato[1], Shohei Beppu[2], Daiki Soma[2], Hidenobu Muranaka[1], Shun Okada[1], Hiroyuki Irie[1], Yuta Wakayama[2], Noboru Yoshikane[2], Takehiro Tsuritani[2], Yu Tanaka[1], Takeshi Hoshida[1]; [1]*Fujitsu Limited, Japan;* [2]*KDDI Research, Inc., Japan*. We present SRS-assisted reach extension of U-band WDM transmission in deployed fiber-optic cable. It is verified that U-band channels benefit from the reduction of span loss in 90-km transmission co-propagating with S+C+L-band WDM channels.

Room 6C

16:30–18:30
W4E • Embracing Fiber Sensing: What's the "Killer App" for Large-Scale Deployments? II
Presider: Jeremie Renaudier; Nokia Bell Labs, France

W4E.1 • 16:30 Invited
The "Killer App" is That the Fiber Already Exists!, Glenn Wellbrock[1], Tiejun J. Xia[1]; [1]*Verizon, USA*. We wouldn't even be talking about fiber sensing if it required the placement of new specialty fibers, but the fact that we can leverage our existing cables enables countless applications! We will explore many in this paper.

W4E.2 • 17:00 Invited
Progression from Discrete Fiber Bragg Grating Sensors to Distributed Optical Fibre Sensing in the Railway Industry, Kang-Kuen Lee[1]; [1]*Hong Kong Polytechnic Univ., Hong Kong*. Electromagnetic interference is abundant in railways and conventional sensors would require lots of filtering. with FBG sensors no filtering is required and ideal for the monitoring of mission critical systems in the railways. Will report on the successful applications of FBG sensors for CBM in the railways.

Room 6D

16:30–18:30
W4F • Optical Architectures and Subsystems for Accelerating ML/AI Applications
Presider: Nicola Calabretta; Technische Universiteit Eindhoven, Netherlands

W4F.1 • 16:30 Tutorial
Optical Architecture and Interconnection for Datacenter Networking and Machine Learning, Hong Liu[1]; [1]*Google LLC, USA*. The optical layer has evolved rapidly to shape and differentiate compute infrastructure. This tutorial presents an overview and trend of optical architecture and interconnection technologies for datacenter networks and machine learning supercomputers.

Hong Liu is an Engineering Fellow at Google's Machine Learning, Systems, and Cloud AI team, where she is involved in the roadmap, architecture, and photonic innovation for Google's datacenter networks and machine learning. She received her Ph.D. in electrical engineering from Stanford University, and is an Optica Fellow.

Room 6E

16:30–18:30
W4G • Space Communication
Presider: Katherine Newell; Johns Hopkins Applied Physics Lab, USA

W4G.1 • 16:30 Invited
Photonic Integrated Circuits for Space Communications, Chris Roeloffzen[1], Peter Maat[1], Ilka Visscher[1], Marcel Hoekman[1], Lennart Wevers[1], Edwin Klein[1], Paul van Dijk[1], Roelof Bernardus Timens[1], Robert Grootjans[1], Furkan Sahin[1], Rick Heuvink[1], Ronald Dekker[1]; [1]*LioniX International, Netherlands*. We present a hybrid integrated microwave photonic (iMWP) chip platform where Si_3N_4-based-TriPleX and InP optical waveguides are combined to enable broadband and high frequency radio signal processing. An iMWP beamformer for phased array antenna systems will be presented.

W4G.2 • 17:00 ★ Top-Scored
A 100 W Output Power Coherent Transmission Link for Future High Data Rate Earth-to-Satellite Communication, Yannik Horst[1], Laurenz Kulmer[1], Tobias Blatter[1], Joel Winiger[1], Vincent Billault[2], Guénolé Dandé[2], Jérome Bourderionnet[2], Arnaud Brignon[2], Anaelle Maho[4], Matthew Welch[3], Stefan M. Koepfli[1], Juerg Leuthold[1]; [1]*IEF ETHZ, Switzerland;* [2]*Thales Research and Technology, France;* [3]*Gooch and Housego, UK;* [4]*Thales Alenia Space, France*. An optical coherent transmission link with 100Watt output power is tested for satellite communications. Modulation formats are tested for transmission of the highest data-rates despite of nonlinear amplifier impairments across a linear, low-SNR free-space link.

Room 6F

16:30–18:30
W4H • Datacom Modulation and Linear Transceivers
Presider: Brandon Buscaino; Ciena Corporation, USA

W4H.1 • 16:30 Invited
Advances in Thin-Film Lithium Niobate Photonics for Datacom Applications, Mengyue Xu[1]; [1]*Purdue Univ., USA*. We review recent developments in thin-film lithium niobate photonics to enable high-capacity and energy-efficient optical integration solutions for next-generation datacom.

W4H.2 • 17:00 Invited
Connecting the Switch to the Fiber: the Energy Efficiency Challenge, Davide Tonietto[1]; [1]*Huawei Technologies Canada, Canada*. The pressure for energy efficiency in AI and distributed computing systems has put in sharp focus ASIC to fiber efficiency as an area needing improvement. What is the origin of the problem and the possible solutions?

Room 7

16:30–18:30
W4I • AI-Based Automation
Presider: Konstantinos (Kostas) Christodoulopoulos; Univ. of Athens, Greece

W4I.1 • 16:30 ★ Top-Scored
Experimental Demonstration of Automated ML Service Provisioning for VNT Configuration in SDM Networks, Hanyu Gao[1], Xiaokang Chen[1], Wenbang Zheng[1], Aoxue Wang[1], Jingshun Pan[1], Xiaoliang Chen[1], Zhaohui Li[1]; [1]*Sun Yat-sen Univ., China*. We demonstrate automated ML service provisioning for VNT configuration over a 7-core fiber SDM testbed. Results show below 3-second VNT configuration time and provisioning of QoT estimators with >90% accuracy using <100 samples.

W4I.2 • 16:45 Invited
AI-Based Automation of Multi-Layer Multi-Domain Transport Networks, Oscar González de Dios[1], Pablo Armingol Robles[1], Liesbeth Roelens[1], Juan Fernández-Palacios[1]; [1]*Telefonica, Spain.* with increasing demand for customized connectivity, transport networks must evolve towards an autonomous and customer-driven network management. In this paper we describe a AI-based data-driven control architecture to support end-to-end automated slicing in multi-layer networks.

Room 8

16:30–18:30
W4J • Multi-Core Fiber Characterization and Connection
Presider: Tristan Kremp; OFS Fitel LLC, USA

W4J.1 • 16:30 Invited
Advancements in Key Technological Building Blocks for Enabling MCF Implementation, Tetsuya Nakanishi[1], Tetsuya Hayashi[1], Shintaro Mouri[1], Takemi Hasegawa[1]; [1]*Sumitomo Electric Industries Ltd, Japan.* Multi-core fiber (MCF) technology has made significant progress since the capacity limitations of single-mode fiber had been posed. This presentation will review the advancements and readiness of MCF and its key components, showcasing the technical feasibility of MCF technology in real-world applications.

W4J.2 • 17:00
Multi-Core Fiber Backscattered Crosstalk Statistical Distribution Model, Aramais Zakharian[1], Ming-Jun Li[1]; [1]*Corning Inc, USA.* Inter-core crosstalk statistical distribution due to Rayleigh backscattering is analyzed for bi-directional transmission in multi-core fibers. The counter-propagating crosstalk distribution is shown to be consistent with a chi-squared statistics with eight degrees of freedom.

Room 9

16:30–18:30
W4K • PICs for Quantum Communication and Quantum Computing: Challenges and Opportunities II
Presider: Cheryl Sorace-Agaskar; MIT Lincoln Lab, USA

W4K.1 • 16:30 Invited
Universal and Fault-Tolerant Photonic Quantum Computing, Blair Morrison[1]; [1]*Xanadu, Canada*. Xanadu is developing a universal and fault-tolerant quantum computer using photonic GKP qubits. We will discuss this hardware architecture and the current state of progress towards reaching this goal.

W4K.2 • 16:55 Invited
Scalable Microwave-to-Optical Transducers for Quantum Computing and Network, Chi Xiong[1]; [1]*IBM TJ Watson Research Center, USA*. Microwave-to-optics quantum transducers are an essential component for scaling superconducting quantum processors and building heterogeneous quantum network. This talk reviews the challenges and progresses in making quantum transducers and discusses IBM's electro-optic transducer approach.

Show Floor Programming

Coherent Optics Unleashed: From 400ZR Success to 800ZR/LR Advancements and 1600ZR Kick-off
16:00–17:00, *Theater I*

Room 1A

W4A • THz Processing and Communications—Continued

W4A.4 • 17:15 Invited

Digital Coherent Receiver Based Optical Performance Monitoring Technology and its Application to Photonics Tomography, Shoichiro Oda[1], Ryu Shinzaki[1], Motohiko Eto[1], Kazuyuki Tajima[1], Kyousuke Sone[1], Setsuo Yoshida[1], Inwoong Kim[2], Olga Vassilieva[2], Paparao Palacharla[2], Takeshi Hoshida[1]; [1]*Fujitsu Ltd, Japan;* [2]*Fujitsu Network Communications, Inc, USA.* Digital-coherent-receiver-based fiber-longitudinal power profile estimation (PPE) over multiple spans is presented. We then review three specific examples of applications of photonics tomography based on PPE and discuss the comparison between hardware and software implementation.

Room 1B

W4B • FSO for Turbulent and Underwater Channels—Continued

W4B.4 • 17:15

Experimental Demonstration of an 8-Gbit/s QPSK Coherent Underwater Wireless Optical Communication Link Under Scattering Conditions, Yuxiang Duan[1], Huibin Zhou[1], Zile Jiang[1], Muralekrishnan Ramakrishnan[1], Xinzhou Su[1], Wing Ko[1], Yue Zuo[1], Hongkun Lian[1], Zixun Zhao[1], Ruoyu Zeng[1], Yingning Wang[1], Moshe Tur[2], Alan E. Willner[1]; [1]*Univ. of Southern California, USA;* [2]*School of Electrical Engineering, Tel Aviv Univ., Israel.* We experimentally demonstrate an 8-Gbit/s QPSK coherent underwater wireless optical communication link under scattering conditions at 532 nm. We achieve BER below 20% FEC limit under attenuation length up to 6.5, and the corresponding receiver sensitivity is -29.8 dBm.

W4B.5 • 17:30

Broadband Single Flat Narrow Beam Shaped Time-Domain Adaptive Modulation for Underwater Transmission with Wavelength Characteristics in Blue-Green WDM System, Takahiro Kodama[1], Fumiya Kobori[1], Ayumu Kariya[1], Keita Tanaka[1], Kiichiro Kuwahara[1]; [1]*Kagawa Univ., Japan.* We experimentally demonstrated that time-domain adaptive modulation per wavelength optimizes the underwater transmission capacity of a broad-spectrum WDM-TDHP comprising 450 nm and 520 nm wavelengths, shaped into a flat-narrow beam using a Galileoscope-type beam shaper.

Room 2

W4C • Coding and Modulation—Continued

W4C.4 • 17:15

High-Speed Multilevel Coded Modulation and Soft Performance Monitoring in Optical Communications, Tsuyoshi Yoshida[1], Isamu Kudo[1], Kenji Ishii[1], Hideo Yoshida[1], Hidenori Shimizu[1], Susumu Hirano[1], Yoshiaki Konishi[1], Magnus Karlsson[2], Erik Agrell[2]; [1]*Mitsubishi Electric Corporation, Japan;* [2]*Chalmers Univ. of Technology, Sweden.* We implemented and evaluated probabilistically-shaped multilevel coded modulation and soft-information based performance monitoring at throughputs from 200 Gb/s to 1.2 Tb/s for multi-haul fiber-optic communications. Error-free operations were observed in 5- to 128-ary modulation formats.

W4C.5 • 17:30

Compensation of FEC Induced Distribution Distortion Based on Distribution Detuning in a 36-Tb/s (45×800-Gb/s) 2100-km Polar Coded PS-64QAM System, Xiaoshuo Jia[1], Yan Li[1], Jingwei Song[1], Ming Luo[2], Chao Yang[2], Qingyu He[2], Xu Zhang[2], Daigao Chen[3], Hongguang Zhang[3], Xi Xiao[2,3], Xiaobin Hong[1], Hongxiang Guo[1], Zhisheng Yang[1], Jifang Qiu[1], Jian Wu[1]; [1]*State Key Laboratory of Information Photonics and Optical Communications, Beijing Univ of Posts & Telecom, China;* [2]*State Key Laboratory of Optical Communication Technologies and Network, China Information and Communication Technologies Group Corporation, China;* [3]*National Information Optoelectronics Innovation Centre, China Information and Communication Technologies Group Corporation, China.* In this paper, a detuned distribution enabled polar coded probabilistic shaped 64-QAM is proposed and experimentally investigated over a 36-Tb/s (45×800-Gb/s) 2100-km transmission system at the spectral efficiency of 8-bit/s/Hz.

Room 3

W4D • Amplifier Architecture for Data Transmission—Continued

W4D.4 • 17:15

Transmission Capacity Expansion Using Bidirectional Multicore EDFA Under Bidirectional Signal Assignment, Hitoshi Takeshita[1], Yusuke Shimomura[1], Kohei Hosokawa[1]; [1]*NEC Corporation, Japan.* Bidirectionally cladding pumped multicore EDFA was found to have 13 and 7 points advantages in optical reachability and transmission capacity expansion, respectively, compared with unidirectional one under bidirectional signal assignment condition.

W4D.5 • 17:30 ★ Top-Scored

122.6 Tb/s S+C+L Band Unrepeated Transmission Over 223 km Link with Optimised Bidirectional Raman Amplification, Jiaqian Yang[1], Romulo Aparecido de Paula Junior[1], Henrique Buglia[1], Pratim Hazarika[2], Eric Sillekens[1], Ronit Sohanpal[1], Mingming Tan[2], Dini Pratiwi[2], Ruben S. Luis[3], Benjamin J. Puttnam[3], Yuta Wakayama[4], Wladek Forysiak[2], Polina Bayvel[1], Robert Killey[1]; [1]*Univ. College London, UK;* [2]*Aston Univ., UK;* [3]*NICT, Japan;* [4]*KDDI Research, Japan.* A 223 km unrepeated transmission link is experimentally demonstrated using 121 nm optical bandwidth. Optimised bidirectional Raman amplification as well as Thulium- and Erbium-doped fibre amplifiers enable a record throughput of 122.62 Tb/s.

Room 6C

W4E • Embracing Fiber Sensing: What's the "Killer App" for Large-Scale Deployments? II—Continued

W4E.3 • 17:30 Invited

Monitoring and Sensing Applications Enabled by Enhanced Scattering Fibers in Future Telecom Networks, Paul Westbrook[1]; [1]*OFS Laboratories, USA.* We describe how enhanced scattering fibers can greatly increase the sensitivity of distributed acoustic sensing in future networks with minimal effects on their use for telecommunications, thereby enabling a new generation of sensing applications.

Room 6D

W4F • Optical Architectures and Subsystems for Accelerating ML/AI Applications—Continued

W4F.2 • 17:30

Wavelength Reconfigurable Transceiver for Multi-Interface Compute Accelerator Networks, Zhenguo Wu[1], Robert Parsons[1], Songli Wang[1], Yuyang Wang[1], Keren Bergman[1]; [1]*Columbia Univ., USA.* We present a multi-port reconfigurable silicon photonic transceiver for flexible bandwidth reallocation in multi-interface architectures. We demonstrate on-chip wavelength reconfiguration on a optical testbed and show 94% job completion time improvement in large-scale network simulations.

W4G • Space Communication—Continued

W4G.3 • 17:15
Range and Velocity Measurement with a Bi-Static LiDAR System Based on Optical Phased Array, Weihan Xu[1], Xianyi Cao[1], Qiqi Yuan[1], Chuxin Liu[1], Yuyao Guo[1,2], Liangjun Lu[1,2], Kan Wu[1], Jianping Chen[1,2], Linjie Zhou[1,2]; [1]*Shanghai Jiao Tong Univeristy (SJTU), China;* [2]*SJTU-Pinghu Inst. of Intelligent Optoelectronics, China.* Based on a linearly-chirped DFB laser and two multi-layered Si_3N_4-On-Si optical phased arrays, bi-static frequency-modulated-continuous-wave (FMCW) ranging and velocimetry are demonstrated at a ranging resolution of 8 mm and a velocity resolution of 1.6 mm/s.

W4G.4 • 17:30
Common Path Beam Angle Measurement for Free Space Optical Communication System, Qirun Fan[1], Yansheng Zou[1], Haoze Du[1], Xueyuan Ao[1], Qirui Xu[1], Xiaoxiao Dai[1], Qi Yang[1], Ming Tang[1], Chen Liu[1]; [1]*Huazhong Univ. of Science and Technology, China.* We experimentally demonstrate a common path design for the pointing angle measurement and communication signal receiving. The angle measurement ability is characterized and the concurrent angle measurement and communication is verified for free-space optical communication.

W4H • Datacom Modulation and Linear Transceivers—Continued

W4H.3 • 17:30
100G and 200G per Lane Linear Drive Optics for Data Center Applications, Elaine Chou[1], Yishen Huang[1], Siamak Amiralizadeh[1], Jeffrey Rahn[1], Jonathan K. Doylend[1], Qing Wang[1], Janet C. Chen[1], Darron Young[1]; [1]*Meta, USA.* 100G/lane linear-drive pluggable optics demonstrate interoperability with over 3 dB link margin. Simulations suggest that 200G/lane linear drive requires bump-to-bump losses below 22 dB, but transmit-side retimers increase loss tolerance beyond 34 dB.

W4I • AI-Based Automation—Continued

W4I.3 • 17:15
Extending the OCATA Digital Twin for Optical Connections Based on Digital Subcarrier Multiplexing, Mariano Devigili[1], Diogo Goncalo Sequeira[2], Marc Ruiz[1], Nelson Costa[2], Carlos Castro[3], Antonio Napoli[3], João Pedro[2,4], Luis Velasco[1]; [1]*Universitat Politecnica de Catalunya, Spain;* [2]*Infinera Unipessoal Lda., Portugal;* [3]*Infinera, Germany;* [4]*Instituto de Telecomunicações, Portugal.* Time-domain digital twin models for single carrier and DSCM signals are developed that propagate features to estimate the impact of filter penalties on the BER. Results show remarkable accuracy, which is used for lightpath provisioning.

W4I.4 • 17:30
Digital Twin-Based Insertion Loss Estimator for Anomalous Loss Localization and Network Equalization Enhancement, Xin Yang[1,2], Chenyu Sun[2,3], Gabriel Charlet[2], Massimo Tornatore[1], Yvan Pointurier[2]; [1]*DEIB, Politecnico di Milano, Italy;* [2]*Huawei Paris Research Center, France;* [3]*Communication Systems Department, EURECOM, France.* We propose and experimentally validate a novel accurate digital-twin-based span-level insertion losses estimator. This enables detection and localization of anomalous insertion losses; when combined with equalization, 1.3dB SNR margin improvement is demonstrated despite inaccurate physical layer knowledge.

W4J • Multi-Core Fiber Characterization and Connection—Continued

W4J.3 • 17:15
Single-End Crosstalk Measurement Method for Multi-Core Fibers Using Continuous Light Source, Yuto Yamaguchi[1], Ayumi Inoue[1], Takahiro Kikuchi[1], Takuji Nagashima[1], Hidehisa Tazawa[1], Tetsuya Hayashi[1]; [1]*Optical Communications Laboratory, Sumitomo Electric Industries Ltd, Japan.* We propose multi-core fiber (MCF) crosstalk measurement method which requires only one fan-in/fan-out at a single end of MCF, and is applicable to short MCFs whose crosstalk is difficult to be measured using OTDR method.

W4J.4 • 17:30
Measurement-End Dependence of Counter-Propagating Crosstalk in Spooled Multi-Core Fiber, Yuto Kobayashi[1], Shin Sato[1], Yuki Kawaguchi[1], Takemi Hasegawa[1]; [1]*Sumitomo Electric Industries, Ltd., Japan.* We clarified theoretically and experimentally that the counter-propagating crosstalk in spooled multi-core fiber changes depending on the end for measurement, which indicates the need for management of conditions in measuring the counter-propagating crosstalk.

W4K • PICs for Quantum Communication and Quantum Computing: Challenges and Opportunities II—Continued

W4K.3 • 17:20 Invited
Commercialising Qrngs - From Lab to Product, Wenmiao Yu[1]; [1]*Quantum Dice, UK.* Quantum Random Number Generators are commonly researched in academia. Given their benefits for applications from encryption to simulations, why are QRNGs not more widely used? This talk discusses the challenges and potential within QRNG commercialisation.

Room 1A

W4A • THz Processing and Communications—Continued

W4A.5 • 17:45 Invited

Broadband InGaAs MHEMT THz Transmitters and Receivers, John Laurenz[1], Fabian Thome[1], Arnulf Leuther[1], Axel Tessmann[1]; [1]*Fraunhofer IAF, Germany.* We describe THz amplifier and front-end modules that have been developed based on an InGaAs metamorphic HEMT (mHEMT) technology for THz-wireless communication applications around 300 GHz, covering the frequency range between 270 and 330 GHz and enabling record output-power levels above 10 dBm. Furthermore, we report on the development of state-of-the-art distributed mHEMT circuits with absolute bandwidths in excess of 300 GHz as building block of next-generation ultra-broadband THz front ends.

Room 1B

W4B • FSO for Turbulent and Underwater Channels—Continued

W4B.6 • 17:45

Experimental Demonstration of Underwater Optical Ranging with Enhanced Accuracy Under Scattering Conditions Using Multiple Bessel Modes, Zile Jiang[1], Muralekrishnan Ramakrishnan[1], Huibin Zhou[1], Xinzhou Su[1], Yuxiang Duan[1], Hao Song[1], Ruoyu Zeng[1], Yingning Wang[1], Robert Bock[2], Moshe Tur[3], Alan E. Willner[1,4]; [1]*Department of Electrical Engineering, Univ. of Southern California, USA;* [2]*R-Dex Systems, Inc., USA;* [3]*School of Electrical Engineering, Tel Aviv Univ., Israel;* [4]*Dornsife Dept. of Physics & Astronomy, Univ. of Southern California, USA.* We demonstrate a structured beam-based underwater optical ranging system through scattering, and we utilize multiple (>2) Bessel modes for accuracy enhancement. The average error decreases from ~16 mm to ~3 mm when the number of modes increases from 2 to 8.

W4B.7 • 18:00 Invited

Underwater Wireless Optical Communications: From the Lab Tank to the Real Sea, Jing Xu[1,2], Yufan Zhang[1], Chengye Cai[1]; [1]*Ocean College, Zhejiang Univ., China;* [2]*Hainan Inst. of Zhejiang Univ., China.* This paper introduces the recent progress of underwater wireless optical communications (UWOC). Studies in channel dynamics and link alignment issues contribute to the mature applications of UWOC in real sea environments.

Room 2

W4C • Coding and Modulation—Continued

W4C.6 • 17:45

Low-Complexity Non-Binary Forward Error Correction for Lattice-Based 4D Constellations, Sebastian Stern[1], Mahmoud Sallam[1], Robert F. Fischer[1]; [1]*Inst. of Communications Engineering, Ulm Univ., Germany.* Low-complexity non-binary LDPC decoding is studied for a 512-ary lattice-based 4D Welti constellation. In an 800ZR scenario, more than 1 dB SNR gain is obtained over DP-16QAM and binary FEC at fixed symbol rate.

W4C.7 • 18:00

Optimization of Iterative Chase Soft Decoder Based on Cross Entropy Minimization, Etsushi Yamazaki[1,2], Shinya Sugiura[2]; [1]*NTT, Japan;* [2]*Univ. of Tokyo, Japan.* We propose a scheme to optimize the parameters of iterative Chase decoder. Minimizing the cross entropy loss of the final stage Chase decoder output in the form of log-likelihood ratio improves turbo product code performance.

W4C.8 • 18:15

Iteration-Dependent Scaled Min-Sum Decoding for Low-Complexity Key Reconciliation in CV-QKD, Erdem E. Cil[1], Laurent Schmalen[1]; [1]*Karlsruher Institut für Technologie, Germany.* We introduce an iteration-dependent scaled min-sum decoding for low-rate LDPC codes in CV-QKD, achieving near-sum product algorithm performance with reduced complexity, and facilitating CV-QKD hardware implementation.

Room 3

W4D • Amplifier Architecture for Data Transmission—Continued

Room 6C

W4E • Embracing Fiber Sensing: What's the "Killer App" for Large-Scale Deployments? II—Continued

W4E.4 • 18:00 Invited

Fiber Sensing Use Cases and Applications for an Electric Utility, Michael Morgan[1]; [1]*Exelon, USA.* Abstract not available.

Room 6D

W4F • Optical Architectures and Subsystems for Accelerating ML/AI Applications—Continued

W4F.3 • 17:45

A Tale for Many: Integrated Control Mechanism of Optical Circuit Switching for Data Center and Distributed Deep Learning System, Cen Wang[1], Yuta Wakayama[1], Noboru Yoshikane[1], Takehiro Tsuritani[1]; [1]*KDDI Research, Japan.* We propose an integrated control mechanism of optical circuit switching for both general data center traffics and deep distributed learning applications. Semi-physical evaluations show a relative throughput of 1.27 and a 6.18× speedup in a 256-block network constructed by MEMS-based optical switches.

W4F.4 • 18:00

Assessment of an O-Band 4x4 InP Monolithic Photonic Switch at 100 Gbit/s PAM-4, Marijn Rombouts[1], Aref Rasoulzadeh Zali[1], Stefanos Andreou[2], Luc Augustin[2], Nicola Calabretta[1]; [1]*Technische Universiteit Eindhoven, Netherlands;* [2]*Smart Photonics, Netherlands.* We assess the performance of an O-band integrated optical 4x4 switch using the broadcast and select architecture with 100 Gbit/s PAM-4 signals. We measured a power penalty of <1 dB at the FEC-limit for multiple optical paths.

17:00–19:00 Photonics Society of Chinese (PSC) Heritage Workshop and Networking Social, *Room 15*

Room 6E

W4G • Space Communication—Continued

W4G.5 • 17:45
Reconfigurable Silicon Photonic Transmitter for Space Based Communications Nodes, Vignesh Gopal[1], Xinzhou Su[2], Asher Novick[1,3], Hao Song[2,4], Zile Jiang[2], Muralekrishnan Ramakrishnan[2], James Venditto[1], Anthony Rizzo[1,5], Xiang Meng[1], Ricard Menchon-Enrich[6], Alan E. Willner[2], Keren Bergman[1]; [1]*Columbia Univ., USA;* [2]*Univ. of Southern California, USA;* [3]*Xscape Photonics, USA;* [4]*Acacia Communications Inc., USA;* [5]*Air Force Research Laboratory, USA;* [6]*Intel, USA.* We present the first reconfigurable silicon-photonic link capable of both coherent and intensity modulation/direct detection (IM-DD). We experimentally demonstrate error free OOK, BPSK, and QPSK modulated signals all on a single transmitter.

W4G.6 • 18:00
Circularly-Polarized Self-Homodyne Free-Space Optical Communication Using Partial Stokes-Vector Receiver, Shota Ishimura[1], Hidenori Takahashi[1], Go Soma[2], Kento Komatsu[2], Takuo Tanemura[2], Takehiro Tsuritani[1], Masatoshi Suzuki[1]; [1]*KDDI Research Inc., Japan;* [2]*The Univ. of Tokyo, Japan.* We propose a circularly-polarized self-homodyne free-space optical (FSO) system using a partial Stokes-vector receiver (SVR) that enables polarization rotation-independent coherent signal reception. The advantage over the standard SVR is verified through a 100-Gbps FSO experiment.

W4G.7 • 18:15
Rate-Flexible Hybrid Constellation Shaping for Polar-Coded 32QAM in FSO Systems, Xiaoyu Liu[1], Zhiyang Liu[1], Shilin Xiao[1], Weiying Yang[1], Weisheng Hu[1]; [1]*Shanghai Jiaotong Univ., China.* We experimentally demonstrate a rate-flexible hybrid constellation shaping for polar-coded 32QAM in FSO systems, which can improve the Q factor by 0.72~1.53dB at different data rates over weak turbulence channels.

Room 6F

W4H • Datacom Modulation and Linear Transceivers—Continued

W4H.4 • 17:45
300-Gbit/s/λ PAM8 Modulation with a Silicon Microring Modulator Using Long Short Term Memory Regression and Deep Neural Network Classification, Tun-Yao Hung[1], David W. U. Chan[2], Ching-Wei Peng[1], Chi-Wai Chow[1], Chien-Hung Yeh[3], Hon Ki Tsang[2]; [1]*National Yang Ming Chiao Tung Univ., Taiwan;* [2]*Chinese Univ. of Hong Kong, Hong Kong;* [3]*Feng Chia Univ., Taiwan.* We demonstrate a 300-Gbit/s PAM8 modulation using a 55-GHz bandwidth silicon-microring-modulator (SiMRM) with a driving voltage of 1.8-Vpp. To achieve high-order PAM8 modulation, long-short-term-memory (LSTM) and deep-neural-network (DNN) are used for regression and classification respectively.

W4H.5 • 18:00
Single Carrier net 400 Gbit/s IM/DD Over 400 m Fiber Enabled by Plasmonic Mach-Zehnder Modulator, Laurenz Kulmer[1], Tobias Blatter[1], Manuel Kohli[1], Yannik Horst[1], Stefan M. Koepfli[1], Juerg Leuthold[1]; [1]*ETH Zurich, Switzerland.* We demonstrate a 437.1Gbit/s IM/DD link by employing a 178GBd PAM8 signal encoded by a plasmonic MZM. Symbol rates of up to 256GBd and transmission over 400m while maintaining net-rates of >400Gbit/s are successfully demonstrated.

Room 7

W4I • AI-Based Automation—Continued

W4I.5 • 17:45
Digital Twin-Enabled Optical Network Automation: Power Re-Optimization, Chenyu Sun[1,2], Xin Yang[3,1], Gabriel Charlet[1], Photios A. Stavrou[2], Yvan Pointurier[1]; [1]*Optical Communication Technology Lab, Paris Research Center, Huawei Technologies France, France;* [2]*Communication Systems Department, EURECOM, France;* [3]*Department of Electronics, Information and Bioengineering, Politecnico di Milano, Italy.* A digital twin-enabled network automated power optimization method is proposed and experimentally validated in a ring network. Proposed algorithms prevent SNR degradation during re-optimization, while closed-loop operation further improves SNR estimation accuracy.

W4I.6 • 18:00
Towards Explainable Reinforcement Learning in Optical Networks: the RMSA Use Case, Omran Ayoub[1], Carlos Natalino[2], Paolo Monti[2]; [1]*Department of Innovative Technologies, Univ. of Applied Sciences of Southern Switzerland, Switzerland;* [2]*Department of Electrical Engineering, Chalmers Univ. of Technology, Sweden.* We propose an approach to extract explanations from a trained reinforcement learning agent. Our analysis over three RMSA environment variations shows how the agent uses the input information, increasing our understanding of its learned policy.

W4I.7 • 18:15
Resource Re-Allocation for Pre-Planned Power Outages in Optical Networks, Qiaolun Zhang[1], Patricia Layec[2], Achille Pattavina[1], Massimo Tornatore[1]; [1]*Politecnico di Milano, Italy;* [2]*Nokia Bell Labs France, France.* We quantitatively evaluate disruption of services under pre-planned power outages in optical networks. Considering batteries for bypassing and re-routing, the rejection rate is reduced by 33% with less than 1% service degradation.

Room 8

W4J • Multi-Core Fiber Characterization and Connection—Continued

W4J.5 • 17:45
Stress Distribution Effects on Polarization-Mode Dispersion in Multi-Core Fibers, Gustavo Ocampo[1], Yoshimichi Amma[2], Kunimasa Saitoh[1]; [1]*Graduate School of Information Science and Technology, Hokkaido Univ., Japan;* [2]*Optical Technologies R&D Center, Fujikura Ltd., Japan.* We investigate the origin of large PMD measurements in a 30-core heterogeneous MCF based on stress distribution analysis. We show proximity between cores and their refractive index profiles as main stressors, resulting in large PMD.

W4J.6 • 18:00
96-Core MPO-APC Connector Using 4-Core Fiber with SMF Standard Insertion Loss Grade, Kohei Haji[1], Yuki Saito[1], Shuhei Toyokawa[1], Shintaro Mouri[1], Tetsu Morishima[1]; [1]*Sumitomo Electric Industries, Ltd., Japan.* We developed 96-core MCF-MPO connector with 8-degree angled endface. Fabricated connectors achieved 0.12 dB average insertion loss and all core PC, and passed Telcordia GR 1435-CORE Durability and Humidity Condensation Cycling Test.

W4J.7 • 18:15
Self-Written Waveguide Approach for Optical Interconnects in Multi-Core Fiber Systems, Liangjun He[1], Hau Ping Chan[1]; [1]*City Univ. of Hong Kong, Hong Kong.* We present a self-written waveguide approach for efficient optical interconnects in multi-core fiber systems. This cost-effective and flexible method enables enhanced coupling between two four-core fibers, achieving 0.47 dB coupling loss and -29.61dB crosstalk.

Room 9

W4K • PICs for Quantum Communication and Quantum Computing: Challenges and Opportunities II—Continued

W4K.4 • 17:45 Invited
Title to be Announced, Philip Sibson[1]; [1]*KETS Quantum, UK.* Abstract not available.

17:00–19:00 Photonics Society of Chinese (PSC) Heritage Workshop and Networking Social, *Room 15*

07:30–08:00 Coffee Break, *Upper Level Corridors*

08:00–10:00 Th1A • Programmable Circuits/Switches and Control Technologies

Presider: Keita Yamaguchi; NTT Corporation, Japan

Th1A.1 • 08:00 Invited

NEO-PGA: Nonvolatile Electro-Optically Programmable Gate Array, Arka Majumdar[1]; [1]*Univ. of Washington, USA.* In this talk, I will discuss different phase change materials that can be used in conjunction with silicon and silicon nitride photonics, to create reconfigurable optical switches for visible and infrared wavelengths.

08:00–10:00 Th1B • Datacom: VCSELs, Multi-Lambda Sources, Spatial Multiplexing

Presider: Thomas Greer; NVIDIA, USA

Th1B.1 • 08:00 Invited

Multi-Wavelength Sources for in Package Optics, Matthew N. Sysak[1], Radek Roucka[1], Raval Manan[1], Nandita Aggarwal[1], Chen Li[1], Fernando Luna[1], Sally El-Henawy[1], Frey John[1], Ken Wang[1], Li-fan Yang[1], Mark Wade[1], Chen Sun[1]; [1]*Ayar Labs, USA.* Ayar Labs 8 wavelength, 64 carrier, CW-WDM MSA compliant SuperNova optical source is reviewed. A new 16 wavelength, 256 carrier, CW-WDM MSA compliant optical source is presented supporing >8 Tbps from a CMOS die.

08:00–10:00 Th1C • Wireless and Access Quantum Networks

Presider: Rui Wang; University of Bristol, UK

Th1C.1 • 08:00

High-Rate Quantum Access Network Using Coherent States, Yan Pan[1], Yiming Bian[2], Li Ma[1], Heng Wang[1], Jiayi Dou[2], Yun Shao[1], Yaodi Pi[1], Ting Ye[1], Jie Yang[1,2], Yang Li[1], Wei Huang[1], Song Yu[2], Yicheng Zhang[2], Bingjie Xu[1]; [1]*Science and Technology on Communication Security Laboratory, Inst. of Southwestern Communication, China;* [2]*State Key Laboratory of Information Photonics and Optical Communications, School of Electronic Engineering, China.* A quantum access network with Mbps level key rate and simple structure compatible with classical network facilities is reported, where the average secret key rate per user can reach 4.24 Mbps at 30 km.

Th1C.2 • 08:15 Invited

The Opportunities and Challenges of Euro-QCI, Felix Wissel[1]; [1]*Deutsche Telekom AG Laboratories, Germany.* EuroQCI, the European Quantum Communication Infrastructure, is one of the most ambitious security initiatives in Europe. We will present the current status and discuss challenges and opportunities.

08:00–10:00 Th1D • Integrated Nonlinear-Optical Devices and Amplifiers

Presider: Vladimir Gordienko; Aston Univ., UK

Th1D.1 • 08:00 Invited

Erbium-Doped Si_3N_4 Photonic Integrated Circuits and Wafer-Scale Fabrication to Include our Recent Progress, Yang Liu[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland.* We present the recent progress on Erbium-doped Si_3N_4 photonic integrated circuits-based devices including high-power amplifiers and hertz-linewidth lasers, and the fabrication via wafer-scale processes.

08:00–10:00 Th1E • Advanced PON Technology

Presider: Jim Zou; Adtran, Germany

Th1E.1 • 08:00

400 Gbit/s Dual-Wavelength and Dual-Polarization IM-DD TDM-PON with 34 dB Power Budget, Dora van Veen[1], Robert Borkowski[1], Kovendhan Vijayan[1], Amitkumar Mahadevan[1], Vincent Houtsma[1]; [1]*Nokia Corporation, USA.* We demonstrate a 400G dual-wavelength dual-polarization IM-DD TDM-PON based on optical duobinary modulation with 34 dB back-to-back optical power budget. After 20 km of SSMF we find an optical path penalty below 1 dB.

Th1E.2 • 08:15

A 92% Complexity Reduction of Low-Latency Multi-Group Precoding Scheme Based on Björck Sequences, Geyang Wang[1], David W. U. Chan[1], Hon Ki Tsang[1], Wai Ho Mow[2], Lian-Kuan Chen[1]; [1]*The Chinese Univ. of Hong Kong, Hong Kong;* [2]*The Hong Kong Univ. of Science and Technology, Hong Kong.* We present a multi-group precoding scheme based on Björck sequences, achieving a tradeoff between complexity and BER performance. Experiments at ~200 Gb/s demonstrate that the proposed approach outperforms OCT while reducing complexity by 92%.

08:00–10:00 Th1F • Optical Methods and Sensing

Presider: Bill Corcoran; Monash University, Australia

Th1F.1 • 08:00 ★ Top-Scored

Free-Space Optical Receiver with Real-Time Self-Configuration Using a Fully Integrated CMOS Controller, Emanuele Sacchi[1], Alexandru Andronie[1], SeyedMohammad SeyedinNavadeh[1], Francesco Zanetto[1], Francesco Morichetti[1], Andrea Melloni[1], Marco Sampietro[1], Giorgio Ferrari[1]; [1]*Politecnico di Milano, Italy.* We present a CMOS chip for closed-loop control of integrated photonic processors, able to configure 8 interferometers in 20ms while consuming 80mW. The chip autonomously mitigates the effect of atmospheric turbulence in free-space receivers.

Th1F.2 • 08:15 Invited

Photon-Counting Technologies for Efficient High-Capacity Space-to-Ground Laser Communications, David O. Caplan[1], Zachary Darling[1], Matthew Grein[1], Matt Guyton[1], David Russo[1], Brian Tyrrell[1], Andrew Wagner[1]; [1]*MIT Lincoln Lab, USA.* Photon-counting optical receivers have the best sensitivity but are practically limited to relatively low data rates < ~1 Gbit/s. Here, we present technologies that can extend sensitive photon-counting-performance into the 100 Gbit/s regime and beyond.

07:30–08:00 Coffee Break, *Upper Level Corridors*

08:00–10:00
Th1G • Open Line Systems and Digital Twins
Presider: Shikui Shen; China Unicom, China

Th1G.1 • 08:00
Characterizing Fiber Nonlinearity with Deployed Equipment in Optical Line Systems, Yinqing Pei[1], Alex W. MacKay[1], Mehrnoosh Boroojerdi[1], Jean-Luc Archambault[1], David W. Boertjes[1]; [1]*Ciena, Canada.* We introduce the first measurement procedure to characterize fiber nonlinear parameters of all fibers in an optical network using widely deployed network equipment which does not rely on modem measurements or external instrumentation.

Th1G.2 • 08:15
All-Optical GOSNR Estimation on an Open Line System Using Polarization-Resolved Optical Spectrum Analysis, Gang He[1], Steven Searcy[2], Sorin Tibuleac[2]; [1]*EXFO Inc, Canada;* [2]*Adtran, USA.* We introduce an all-optical method for estimating linear and nonlinear noise using an unmodulated laser source and varied state of polarization optical spectrum analyzer, then experimentally validate the technique against the conventional transceiver-based GOSNR approach.

08:00–10:00
Th1H • MMF Based Transmission
Presider: Lidia Galdino; Corning Inc., UK

Th1H.1 • 08:00
5.27 Peta-bit/s Weakly-Coupled SDM-WDM Transmission Over 55-km 10-Mode 7-Core Fiber for SDM-Priority Scheme, Gang Qiao[1,2], Yu Yang[1], Honglin Ji[1], Yuyang Gao[2], Mingqing Zuo[2], Chengbin Long[2], Jiarui Zhang[2], Jinyi Yu[2], Zhaopeng Xu[1], Shangcheng Wang[1], Lulu Liu[1], Qi Wu[1], Lei Shen[3], Jie Luo[3], Zhixue He[1], Hongbin Li[1], Weisheng Hu[1], Shaohua Yu[1], Juhao Li[1,2]; [1]*Peng Cheng Laboratory, China;* [2]*Peking Univ., China;* [3]*YOFC, China.* We propose an SDM-priority SDM-WDM transmission scheme with simplified optical transceiver structure, for which a record throughput of 5.27 peta-bit/s transmission over 55-km weakly-coupled 10-mode 7-core fiber is experimentally demonstrated with up to 4×4 MIMO-DSP.

Th1H.2 • 08:15
102-Tbit/s C-Band WDM-MDM-PDM Transmission Over 1000-km FMF Enabled by Advanced Block-Wise MIMO-FD-DFE, Chen Wang[1], Bohan Sang[1], Kaihui Wang[1], Junjie Ding[1], Wen Zhou[1], Xianming Zhao[2], Bing Ye[3], Weizhang Chen[3], Xiangjun Xin[5], Bo Liu[5], Lei Shen[4], Jianjun Yu[1]; [1]*Fudan Univ., China;* [2]*Harbin Inst. of Technology, China;* [3]*ZTE corporation, China;* [4]*Yangtze Optical Fiber and Cable, China;* [5]*Beijing Univ. of Posts and Telecommunications, China.* A high-performance block-wise MIMO-FD-DFE is proposed and experimentally verified in an 80-channel MDM system at the C-band for ISI compensation, which extends the transmission distance by over 33.33% at 20% SD-FEC threshold.

08:00–10:00
Th1I • Next Generation ROADMs, Multiband and SDM Networking
Presider: Jesse Simsarian; Nokia Bell Labs, USA

Th1I.1 • 08:00 Invited
Enabling Technologies for Scalable ROADMs, Peter Roorda[1], Brian Smith[1], Paul Colbourne[1], Sheldon McLaughlin[1], Martin Matthews[1]; [1]*Lumentum Operations LLC, Canada.* Continued ROADM capacity scaling will require WSS devices in quad and octal configurations, with higher port counts, that operate across wider bands (C and L). Introduction of hybrid fiber/wavelength switching architectures for multi-rail will follow.

08:00–10:00
Th1J • Short-Reach Transmission Systems
Presider: Ming-Fang Huang; NEC Laboratories America Inc., USA

Th1J.1 • 08:00 Invited
O-Band Coherent Links for Intra-Data Center Applications, Aaron Maharry[1]; [1]*Lucidean, Inc., USA.* We present recent advances in O-band coherent links for intra-data center applications. Offloading functions traditionally performed by coherent digital signal processing (DSP) into the optical domain is the path to low-power and low-cost coherent links.

Th1A • Programmable Circuits/Switches and Control Technologies—Continued

Th1A.2 • 08:30
Programmable Integrated Photonic Circuit for Matrix Inversion, Gabriele Cavicchioli[1], David B. Miller[2], Nader Engheta[3], Andrea Melloni[1], Francesco Morichetti[1]; *[1]Dipartimento di elettronica informazione e bioingegneria, Politecnico di Milano, Italy; [2]Ginzton Laboratory, Stanford Univ., USA; [3]Department of Electrical and Systems Engineering, Univ. of Pennsylvania, USA.* We propose and demonstrate the optical inversion of a programmable matrix by using a silicon photonic interferometer mesh in a feedback loop, without any optical-to-electronic conversions inside the inversion process.

Th1A.3 • 08:45
Automated Tuning of Ring-Assisted MZI–Based Interleaver for DWDM Systems, Songli Wang[1], Yuyang Wang[1], Xiang Meng[1], Kaveh Hosseini[2], Tim Tri Hoang[2], Keren Bergman[1]; *[1]Columbia Univ., USA; [2]Intel Corporation, USA.* We present an RAMZI auto-tuning structure for DWDM systems, rectifying phase errors and optimizing passband alignment. Experimental results validate improved performance and operational efficiency, facilitating scalable communication infrastructures in high-performance computing systems and data centers.

Th1B • Datacom: VCSELs, Multi-Lambda Sources, Spatial Multiplexing—Continued

Th1B.2 • 08:30 ★ Top-Scored
Self-Locking of Free-Running DFB Lasers to a Single Microring Resonator for Dense WDM, Yonghang Sun[1,2], James Salamy[1,2], Caitlin E. Murray[1,2], Brent E. Little[5], Tak S. Chu[6], Roberto Morandotti[3], Arnan Mitchell[2], David J. Moss[4], Bill P. Corcoran[1]; *[1]Optical Communications Lab, ECSE, Monash Univ., Australia; [2]InPAC, School of Engineering, RMIT Univ., Australia; [3]INRS-EMT, Canada; [4]Optical Sciences Centre, Swinburne Univ. of Technology, Australia; [5]QXP Inc., Chile; [6]Dept. of Physics, City Univ. of Hong Kong, Hong Kong.* We self-injection lock two DFB lasers to a microring resonator, to enhance frequency-spacing stability, and use these to carry channels with <1 GHz guard-band.

Th1B.3 • 08:45
56G VCSEL Transmission at 980 nm Across 500 m Multimode Fiber, Jochen Hellmig[2], Xin Chen[3], Rashid Safaisini[1], Adrian Juarez[3], Jeroen Dragt[2], Jason E. Hurley[3], Philip Moser[1], Bedouin Sassiya[1], Roger King[1], Gunter Larisch[1], Ming-Jun Li[3], Roman Koerner[1]; *[1]TRUMPF Photonic Components GmbH, Germany; [2]TRUMPF Photonic Components GmbH, Netherlands; [3]Corning Incorporated, USA.* Transmission of 56-Gbps signals across a 500-meter 980 nm optimized multimode fiber with 14.2 GHz.km bandwidth using 980 nm multimode VCSEL is demonstrated. The results show promising performance within IEEE standards for short reach applications.

Th1C • Wireless and Access Quantum Networks—Continued

Th1C.3 • 08:45
Continuous-Variable Quantum Passive Optical Network, Adnan A. Hajomer[1], Ivan Derkach[2,1], Vladyslav C. Usenko[2], Radim Filip[2], Ulrik L. Andersen[1], Tobias Gehring[1]; *[1]Technical Univ. of Denmark, Denmark; [2]Palacky Univ., Czechia.* We report the first continuous-variable quantum passive optical network (CVQPON), that supports secure key generation for 5 users simultaneously. This is achieved considering practical PON topology with an 11 km span of access links.

Th1D • Integrated Nonlinear-Optical Devices and Amplifiers—Continued

Th1D.2 • 08:30
Broadband Mid-Infrared Continuous-Wave Wavelength Conversion in a Germanium-on-Silicon Waveguide, Zhiwei Yan[1], Qiyuan Yi[1], Qiyuan Li[1], Guanglian Cheng[1], Yuhan Sun[2], Lipeng Xia[2], Yuheng Liu[2], Xinzhe Xiong[1], Zengfan Shen[1], Fanglu Xu[1], Meng He[1], Yi Zou[2], Li Shen[1]; *[1]Huazhong Univ. of Sci. and Tech., China; [2]ShanghaiTech Univ., China.* We experimentally demonstrate broadband mid-infrared wavelength conversion using a germanium-on-silicon waveguide with conversion efficiency up to -28.72 dB under a continuous-wave pump at 3.56 μm. The measured conversion bandwidth is about 390 nm.

Th1D.3 • 08:45
An Integrated Gallium Phosphide Travelling-Wave Optical Parametric Amplifier, Nikolai Kuznetsov[1,2], Alberto Nardi[1,3], Alisa Davydova[1,2], Mikhail Churaev[1,2], Johann Riemensberger[1,2], Paul Seidler[3], Tobias J. Kippenberg[1,2]; *[1]Ecole Polytechnique Federale de Lausanne, Switzerland; [2]Center of Quantum Science and Engineering, EPFL, Switzerland; [3]IBM Research Europe, Switzerland.* We demonstrate optical continuous-travelling-wave parametric amplification in a 5.55-cm-long integrated gallium phosphide waveguide, achieving up to 35 dB of gain and significantly surpassing the bandwidth of erbium-doped fiber amplifiers.

Th1E • Advanced PON Technology—Continued

Th1E.3 • 08:30 Invited
New Applications and Technologies of Optical Access, Frank Effenberger[1]; *[1]FutureWei Technologies Inc, USA.* Fiber optic access networks are the defacto solution for broadband service. This paper explores the current work on new applications of passive optical networks and new technologies that may play a role in its future.

Th1F • Optical Methods and Sensing—Continued

Th1F.3 • 08:45
PPLN-Based Polarization-Diverse Phase-Sensitive Amplification of 96-Gbaud PDM-PCS-64QAM Signal with Carrier-Phase-Locked Phase-Conjugated Twin Waves, Shimpei Shimizu[1], Takushi Kazama[1,2], Takeshi Umeki[1,2], Koji Enbutsu[2], Masanori Nakamura[1], Masashi Abe[2], Takayuki Kobayashi[1], Yutaka Miyamoto[1]; *[1]NTT Network Innovation Laboratories, NTT Corporation, Japan; [2]NTT Device Technology Laboratories, NTT Corporation, Japan.* We demonstrated non-degenerate phase-sensitive amplification (PSA) of a 96-Gbaud PDM-PCS-64QAM signal. Phase-conjugated twin waves (PCTWs) with a polarization-independent carrier phase provided low-noise PSA of a 2.5-dB black-box noise figure without polarization tracking of the PCTWs.

Th1G • Open Line Systems and Digital Twins—Continued

Th1G.3 • 08:30 Invited

Optical Spectrum as a Service in Multi-Operator Environments: Challenges and Enabling Technologies for Transparent Optical Overlay Networks, Kaida Kaeval[1], Klaus Grobe[2], Jörg-Peter Elbers[2]; *[1]Tallinn Univ. of Technology, Estonia; [2]Adtran, Germany.* This work reflects the challenges, intermediate solutions, and outlooks on the wide-scale implementation of Optical Spectrum as a Service in live multi-operator network environments.

Th1H • MMF Based Transmission—Continued

Th1H.3 • 08:30

A Joint Mode Permutation Architecture for 10-Mode-Multiplexed Long-Haul Transmissions, Xiaochuan Liu[5], Wang Yanze[5], Qiushi Huang[1], Dechao Zhang[2], Xutao Wang[5], Qiang Guo[3], Zhiqun Yang[5], Yaping Liu[5], Rui Zhou[3], Wei Sun[1], Mingqing Zuo[2], Min Yan[1], Zhenhua Liu[1], Xianyu Zhang[1], Zhanhua Huang[5], Dong Wang[2], Xinhua Xiao[3], Lin Zhang[5,4]; *[1]Jiangsu Alpha Optic-electric Technology Co., Ltd., China; [2]Department of Fundamental Network Technology, China Mobile Research Inst., China; [3]B&P Laboratory, Huawei Technologies Co., Ltd., China; [4]Peng Cheng Laboratory, China; [5]Key Laboratory of Opto-electronic Information Technology of Ministry of Education and Tianjin Key Laboratory of Integrated Opto-electronics Technologies and Devices, School of Precision Instruments and Opto-electronics Engineering, Tianjin Univ., China.* We propose a joint mode permutation architecture for 10-mode transmission. Compared with cyclic mode-group permutation, the required equalizer window is further reduced by 30.7%, while the transmission reach is extended to 2000 km.

Th1H.4 • 08:45

147.4 Tb/s DP-64QAM MDM-WDM Transmission Over 500-km FMF Utilizing MIMO Equalization Based on Multi-Label Neural Network, Bohan Sang[1], Chen Wang[1], Yao Zhang[1], Bowen Zhu[1], Jianyu Long[1], Tianqi Zheng[1], Kaihui Wang[1], Wen Zhou[1], Bo Liu[2], Lei Shen[3], Bing Ye[4], Jianjun Yu[1]; *[1]Fudan Univ., China; [2]Nanjing Univ. of Information Science and Technology, China; [3]Yangtze Optical fibre and Cable, China; [4]Zhongxing Telecommunication Equipment, China.* We experimentally demonstrated MDM-WDM transmission of 4-mode 80-channel 48-GBd PDM-64-QAM signals over 500 km SC-FMF utilizing multi-label MIMO NN equalization. The net rate reached 147.4 Tb/s. MIMO-NNE achieved 25% reach improvement comparing to traditional MIMO-LMS.

Th1I • Next Generation ROADMs, Multiband and SDM Networking—Continued

Th1I.2 • 08:30

Double-Decker CDC-ROADM Node for Multi-Band Network with Wavelength Band Granularity, Kenya Suzuki[1], Masashi Ota[1], Yoshie Morimoto[1], Keita Yamaguchi[1], Fukutaro Hamaoka[2], Shuto Sugawara[2], Takeo Sasai[2], Takayuki Kobayashi[2], Masanori Nakamura[2], Satomi Katayose[3], Takeshi Umeki[3], Daisuke Ogawa[4], Yiran Ma[5], Stefano Camatel[5], Mitsunori Fukutoku[4], Yutaka Miyamoto[2], Osamu Moriwaki[1]; *[1]NTT Device Innovation Center, Japan; [2]NTT Network Innovation Laboratories, Japan; [3]NTT Device Technology Laboratories, Japan; [4]NTT Innovative Devices Corporation, Japan; [5]Finisar Australia Pty Ltd, Australia.* We propose double-decker ROADM node by introducing a band cross-connect in addition to the conventional wavelength cross-connect, which is suitable for a multi-band network. This configuration provides improved transmission characteristics compared with a conventional CDC-ROADM.

Th1I.3 • 08:45

Throughput Increase in Multi-Fiber Networks Using Partial Lane-Change Capabilities, Oleg Karandin[1], Francesco Musumeci[1], Yvan Pointurier[2], Massimo Tornatore[1]; *[1]Politecnico di Milano, Italy; [2]Huawei Technologies, Paris Research Center, France.* Effective application of lane change in multi-fiber (MF) networks is hindered by limitations in WSS-size in ROADMs. We show that introducing lane-change only at degree-2 nodes leads to significant throughput increase, for a commensurate additional equipment cost.

Th1J • Short-Reach Transmission Systems—Continued

Th1J.2 • 08:30

Optical Multipath Interference Reduction Using Adaptive DC-Removal in High-Speed IM/DD Systems, Silas Oettinghaus[1], Annika Dochhan[1], Tom Wettlin[2], Talha Rahman[2], Stefano Calabro[2], Nebojsa Stojanovic[2], Stephan Pachnicke[1]; *[1]Kiel Univ., Germany; [2]Munich Research Centre, Huawei Technologies Duesseldorf GmbH, Germany.* We present an experimental study of multipath-interference reduction techniques for 56GBd and 92GBd PAM-4. By extending the equalizer with an adaptive removal of intensity fluctuations, MPI tolerance is increased by 2 and 10 dB, respectively.

Th1J.3 • 08:45

Advanced MLSE with Simple Soft Output Achieving High NGMI for SD-FEC in IM-DD Transmission with Severe Bandwidth Limitation, Shuto Yamamoto[1], Hiroki Taniguchi[1], Masanori Nakamura[1], Akira Masuda[1], Etsushi Yamazaki[1]; *[1]NTT Corporation, Japan.* We propose a simple LLR-calculation method which modifies the LLR distribution using hard-decision information for IM-DD systems with MLSE and SD-FEC. The proposed method achieves high NGMI in 128-Gbaud PAM4 transmission with 40-GHz bandwidth limitation.

Room 1A

Th1A • Programmable Circuits/Switches and Control Technologies—Continued

Th1A.4 • 09:00
Reinforced Q-Learning Enabled Automatic Blind Working Wavelength Alignment Against Wide Input-Wavelength Shifts and Temperature Variations for Silicon Photonic Vernier Ring Filters, Guangwei Cong[1], Ryotaro Konoike[1], Keijiro Suzuki[1], Noritsugu Yamamoto[1], Rai Kou[1], Yuriko Maegami[1], Morifumi Ohno[1], Kazuhiro Ikeda[1], Shu Namiki[1], Koji Yamada[1]; [1]*AIST (Natl Inst of Adv Indust Sci&Tech), Japan.* We experimentally demonstrate long-time (~10 hours) continuous full-C-band automatic working wavelength alignment for silicon photonic cascaded-ring vernier filters against wide input-wavelength and temperature changes using reinforced Q-learning method, without pre-building look-up table and temperature monitor.

Th1A.5 • 09:15
A Scalable, High-Speed Optical Rotor Switch, Max Mellette[1], Ilya Agurok[2], Alex Forencich[2], Spencer Chang[2], George Papen[2], Joseph Ford[1,2]; [1]*inFocus Networks, USA;* [2]*UC San Diego, USA.* Rotary optical switching enables low-loss microsecond-scale reconfiguration between pre-programmed interconnects with thousands of ports, supporting high-bandwidth and low-latency Rotornet datacenter architectures. We describe a 7 µs 128 × 128 port rotor switch with 4 dB fiber-to-fiber insertion loss and a 1-dB spectral bandwidth of 120 nm.

Room 1B

Th1B • Datacom: VCSELs, Multi-Lambda Sources, Spatial Multiplexing—Continued

Th1B.4 • 09:00 Invited
Multimode Links Based on High-Speed VCSELs for Cost-Effective Data Center Connectivity, Vipul Bhatt[1]; [1]*Coherent Corp, USA.* Low cost and low power consumption of multimode links are the result of a design effort to optimize specifications for short reach applications. We will review 800G link budget, 3.2T MCPO, and 1:1 sparing.

Room 2

Th1C • Wireless and Access Quantum Networks—Continued

Th1C.4 • 09:00
Adaptive Reconciliation for Experimental Continuous-Variable Quantum Key Distribution Over a Turbulent Free-Space Optical Channel, Kadir Gumus[1], João R. Frazão[1], Vincent van Vliet[1], Sjoerd v. Heide[1], Menno van den Hout[1], Aaron Mejía[1,2], Tom Bradley[1], Chigo M. Okonkwo[1,2]; [1]*High-capacity Optical Transmission Laboratory, Univ. of Technology Eindhoven, Netherlands;* [2]*CUbIQ Technologies, Netherlands.* We experimentally demonstrate adaptive reconciliation for continuous-variable quantum key distribution over a turbulent free-space optical channel. Additionally, we propose a method for optimising the reconciliation efficiency, increasing secret key rates by up to 8.1%.

Th1C.5 • 09:15
Co-Propagation of Classical and Continuous-Variable QKD Signals Over a Turbulent Optical Channel\\With a Real-Time QKD Receiver, João R. Frazão[1], Vincent van Vliet[1], Sjoerd v. Heide[1], Menno v. Hout[1], Kadir Gumus[1], Aaron Mejía[1], Boris Skoric[1], Chigo Okonkwo[1]; [1]*TU/e, Netherlands.* We demonstrate classical and quantum signal co-propagation over a turbulent free-space channel with 3~Tbit/s throughput and record 2.7 Mbit/s secret-key rate. Our real-time GPU-based receiver assessed quantum signal integrity under different turbulence scenarios for the first time.

Room 3

Th1D • Integrated Nonlinear-Optical Devices and Amplifiers—Continued

Th1D.4 • 09:00 ★ Top-Scored
Integrated Optical Parametric Amplifier with Record Gain, Junjie Xiao[1], Di Xia[1], Liyang Luo[1], Bin Zhang[1], Zhaohui Li[1]; [1]*Sun Yat-Sen Univ., China.* We report an innovative phase-sensitive optical amplification using GeSbS microresonators, obtaining 31.5 dB gain with 8.5 mW CW-pump power in phase-insensitive mode, a 4.95 dB additional gain and 18.9 dB extinction ratio in phase-sensitive mode.

Th1D.5 • 09:15
Efficient Two Photon Absorption for 400-nm Remote Optical Control at 2-µm Waveband in a Low-Loss Multimode Silicon Waveguide, Zhaonian Wang[1], Jiangbing Du[1,2], Ke Xu[3], Zuyuan He[1,2]; [1]*Shanghai Jiao Tong Univ., China;* [2]*Peng Cheng Laboratory, China;* [3]*Department of Electronic and Information Engineering, Harbin Inst. of Technology (Shenzhen), China.* Efficient TPA for 400-nm range remote control at 2-µm waveband is experimentally realized with 8.9-dB ER by C-band pump using a low-loss multimode silicon waveguide, indicating fully utilized advantages at both C and 2-µm wavebands.

Room 6C

Th1E • Advanced PON Technology—Continued

Th1E.4 • 09:00
1.024-Tbit/s CDM-SDM Coherent PON Over 10-km Weakly-Coupled MCF, Luxiao Zhang[1], Lin Sun[1], Rendong Xu[2], Junjie Xiong[3], Lin Ma[3], Bin Chen[4], Jun Li[1], Yi Cai[1], Gangxiang Shen[1], Gordon Ning Liu[1]; [1]*Soochow Univ., China;* [2]*Zhejiang Univ., China;* [3]*Shanghai Jiao Tong Univ., China;* [4]*Hefei Univ. of Technology, China.* 1.024-Tbit/s CDM-SDM coherent PON is experimentally demonstrated based on weakly-coupled MCFs and Walsh code assignment. Space-time coding is utilized for balancing the inconsistency of the reception performances of CDM-assigned ONUs.

Th1E.5 • 09:15
200G IM/DD Time-and-Polarization-Division-Multiplexed PON with >29dB Power Budget Using Boosted EML and APDs, Robert Borkowski[1], Kovendhan Vijayan[1], Vincent Houtsma[1], Qian Hu[1], Amitkumar Mahadevan[1], Pat Iannone[1], Dora van Veen[1]; [1]*Nokia Bell Labs, USA.* We experimentally show feasibility of downstream 200 Gbit/s IM/DD TPDM PON system with >4 dB margin to 29 dB optical power budget based on two 100 Gbit/s polarization channels in a single wavelength window. The system uses SBS suppression to mitigate nonlinear fiber loss and duoternary modulation to overcome bandwidth limitation.

Room 6D

Th1F • Optical Methods and Sensing—Continued

Th1F.4 • 09:00
Cryptographic Key Generation Using Conventional Single-Mode Fiber and an Optical Time Domain Reflectometer, Yuto Sagae[1], Atsushi Nakamura[1], Takayoshi Mori[1], Yusuke Koshikiya[1], Kazuhide Nakajima[1]; [1]*NTT, Japan.* Generation of cryptographic key is demonstrated by conventional equipment for an optical network. Random bit sequences obtained from an optical time domain reflectometry of a single-mode fiber satisfies a quality of randomness as cryptographic keys.

Th1F.5 • 09:15
Demonstration of on-Chip Optical Frequency Comb Generation and Optical Injection Locking, Efstathios Andrianopoulos[1], Nikolaos K. Lyras[1], Tianwen Qian[2], Milan Deumer[2], Georgios Megas[1], Garrit Schwanke[2], Durvasa Gupta[2], Panos Groumas[3], Zerihun Tegegne[4], Ben Schuler[2], Muhsin Ali[5], Bradley Snyder[4], Simon Nellen[2], Christos Tsokos[1], David De Felipe[2], Maria Massaouti[1], Guillermo Carpintero[5], Robert B. Kohlhaas[2], Joost van Kerkhof[4], Norbert Keil[2], Christos Kouloumentas[3], Hercules Avramopoulos[1]; [1]*Photonics Communications Research Laboratory, National Technical Univ. of Athens, Greece;* [2]*Fraunhofer Inst. for Telecommunications, Heinrich-Hertz-Institut, Germany;* [3]*Optagon Photonics, Greece;* [4]*PHIX BV, Netherlands;* [5]*Universidad Carlos III de Madrid, Spain.* We experimentally demonstrate for the first time a photonic integrated circuit comprising an optical frequency comb generation unit and an optical injection locking unit, as part of a fully packaged photonic wireless sub-THz receiver module.

Th1G • Open Line Systems and Digital Twins—Continued

Th1G.4 • 09:00
GPT-Enabled Digital Twin Assistant for Multi-Task Cooperative Management in Autonomous Optical Network, Yao Zhang[1], Min Zhang[1], Yuchen Song[1], Xiaotian Jiang[1], Yidi Wang[1], Shikui Shen[2], Danshi Wang[1]; [1]*Beijing Univ. of Posts and Telecommunications, China;* [2]*China Unicom Research Inst., China.* A GPT-enabled digital twin (DT) assistant is implemented with the capabilities of intention understanding, analysis, reasoning, and complex multi-task collaboration, which integrate DT technologies to enhance the automated operation, monitoring, control, and upgrade of optical networks.

Th1G.5 • 09:15
Auto-DTWave: Digital Twin-Aided Autonomous Optical Network Operation with Continuous Wavelength Loading, Xiaomin Liu[1], Qizhi Qiu[1], Yihao Zhang[1], Meng Cai[1], Yichen Liu[1], Lilin Yi[1], Weisheng Hu[1], Qunbi Zhuge[1]; [1]*Shanghai Jiao Tong Univ., China.* We develop joint online digital twin (DT) construction and amplifier configuration with continuous wavelength loading in a commercial testbed. The DT achieves an RMSE of 0.37dB, assisting near-optimal amplifier configuration with <0.1dB average Q-factor deviation.

Th1H • MMF Based Transmission—Continued

Th1H.5 • 09:00
Mechanism and First Experimental Demonstration of ILMD-Induced Reduction of Intramodal Cross-Phase Modulation in Weakly-Coupled FMF Transmission, Mingqing Zuo[1], Gang Qiao[2,3], Yu Yang[3], Chengbin Long[2], Dawei Ge[1], Dong Wang[1], Yunbo Li[1], Zhangyuan Chen[2], Dechao Zhang[1], Han Li[1], Juhao Li[2,3]; [1]*China Mobile Research Inst., China;* [2]*Peking Univ., China;* [3]*Peng Cheng Laboratory, China.* We for the first time experimentally analyze the interaction between intramodal XPM and ILMD effects in weakly-coupled FMF, and prove that the ILMD could be a major factor for effectively reducing the intramodal XPM impairments.

Th1H.6 • 09:15 Invited
Effect of Modal Dispersion on the Nonlinear Interference Noise in SDM Transmissions, Chiara Lasagni[1], Paolo Serena[1], Alberto Bononi[1], Antonio Mecozzi[2], Cristian Antonelli[2]; [1]*Università degli studi di Parma, Italy;* [2]*Università degli studi dell'Aquila, Italy.* We review the effects of spatial mode dispersion and differential mode group delay on the nonlinear interference noise in space-division multiplexed systems based on few-mode fibers with weak linear coupling between mode groups.

Th1I • Next Generation ROADMs, Multiband and SDM Networking—Continued

Th1I.4 • 09:00 Invited
Control of Packet Over Multi-Granular Optical Networks Combining Wavelength, Waveband and Spatial Switching for 6G Transport, Raul Muñoz[1], Varsha Lohani[1], Ramon Casellas[1], Ricardo Martínez[1], Ricard Vilalta[1]; [1]*CTTC, Spain.* This paper presents an end-to-end transport SDN control system for packet (IP) and multi-granular (WDM/WBDM/SDM) optical networks for 6G transport. The dynamic routing and resource assignment combining wavelength, waveband, and spatial resources is also addressed.

Th1J • Short-Reach Transmission Systems—Continued

Th1J.4 • 09:00
Adaptive and DSP-Compatible Optical Multipath Interference Mitigation Scheme for 60Gbps PAM8-CRAN, Rui Xue[1], Chuanming Huang[1], Mengfan Cheng[1], Qi Yang[1], Deming Liu[1], Lei Deng[1]; [1]*Huazhong Univ. of Science and Techn, China.* We proposed an adaptive DSP-compatible time-varying multipath interference noise mitigation algorithm based on probability distribution over 15.5km SSMF at 56/60Gbps PAM4/8. The signal-to-interference ratio tolerance improvement of 3dB PAM8 shows its potentiality for high-order PAM.

Th1J.5 • 09:15
An Optimization Method for Probabilistic Constellation Shaping in Peak-Power Constraint Systems in the Presence of Peak Enhancement Effects, Basak Ozaydin[1], Di Che[1], Xi Chen[1]; [1]*Nokia Bell Labs, USA.* We propose a generic method to optimize the probabilistic distributions for a peak-power constraint system with arbitrary peak enhancement effects. The technique is useful for developing flexible-rate optical transceivers in links without optical amplifiers.

Room 1A	Room 1B	Room 2	Room 3	Room 6C	Room 6D
Th1A • Programmable Circuits/Switches and Control Technologies—Continued	**Th1B • Datacom: VCSELs, Multi-Lambda Sources, Spatial Multiplexing—Continued**	**Th1C • Wireless and Access Quantum Networks—Continued**	**Th1D • Integrated Nonlinear-Optical Devices and Amplifiers—Continued**	**Th1E • Advanced PON Technology—Continued**	**Th1F • Optical Methods and Sensing—Continued**
Th1A.6 • 09:30 **Low-Crosstalk 8×8 Silicon Photonic Switch Fabric with Dual-Stage MZI Cells,** Peng Bao[1], Chunhui Yao[1], Giuseppe Talli[2], Maxim Kuschnerov[2], Richard V. Penty[1], Qixiang Cheng[1]; *[1]Univ. of Cambridge, UK; [2]Huawei Technologies Duesseldolf GmbH, Germany.* We demonstrate a strictly non-blocking 8×8 silicon photonic switch fabric with centrally placed dual-stage MZI cells that effectively suppress first-order crosstalk. This thermally actuated device exhibits on-chip loss of <5dB and low-crosstalk of <-40dB.	**Th1B.5 • 09:30** **C Band Single Wavelength 1.68Tb/s Optical Interconnect Over 12.18-km 7-Core Multicore Fiber,** Qibing Wang[1], Chao Li[1], Yuanyuan Zhao[1], Zichen Liu[1], Hui Chen[1], Siyue Jin[1], Xi Xiao[1], Lei Wang[1], Zhixue He[1], Shaohua Yu[1]; *[1]PengCheng Lab, China.* We demonstrate a single-wavelength 112GBaud PAM4 signal transmission over 12.18-km 7-core MCF at C band using FFE, under 7% HD-FEC threshold. Furthermore, a maximum data rate of 1.68-Tb/s is achieved with PAM8 and simplified VNLE.	**Th1C.6 • 09:30** **O-Band QKD Link Over a Multiple ONT Loaded Carrier-Grade GPON for FTTH Applications,** Nikolaos Makris[1], Argiris Ntanos[2], Alkinoos Papageorgopoulos[1], Aristeidis Stathis[2], Persefoni Konteli[1], Iliana Tsoni[1], Giannis Giannoulis[2], Foteini Setaki[3], Theofanis Stathopoulos[3], George Lyberopoulos[3], Hercules Avramopoulos[2], George T. Kanellos[1], Dimitris Syvridis[1]; *[1]Department of Informatics and Telecommunications, National and Kapodistrian Univ. of Athens, Greece; [2]School of Electrical and Computer Engineering, National Technical Univ. of Athens, Greece; [3]COSMOTE S.A, Greece.* We have successfully integrated an O-band commercial Quantum-Key-Distribution (QKD) system over a lit GPON testbed that replicates a carrier-grade Fiber-to-the-Home (FTTH) optical access network with multiple ONTs to emulate real-life FTTH operational deployments.	**Th1D.6 • 09:30** **Over 100nm Wavelength Conversion Bandwidth with High Efficiency on AlGaAsOI Nonlinear Waveguides,** Zhengshun Lei[1], Weiqiang Xie[1], Wenqi Wei[2], Zihao Wang[2], Ting Wang[2], Jianjun Zhang[2], Yikai Su[1]; *[1]Shanghai Jiao Tong Univ., China; [2]Beijing National Laboratory for Condensed Matter Physics, Inst. of Physics, Chinese Academy of Sciences, China.* A nonlinear wavelength conversion with over 100nm bandwidth and >–10dB conversion efficiency on AlGaAsOI waveguides is demonstrated, using a low-power and single continuous-wave pump. Theoretical simulations are in excellent agreement with the experimental results.	**Th1E.6 • 09:30** **Hybrid TFDM Coherent PON Featuring Adaptable Capacity and Out-of-Band Communication Channels,** Haipeng Zhang[1], Zhensheng Jia[1], Luis Alberto Campos[1], Karthik Choutagunta[1], Curtis Knittle[1]; *[1]CableLabs, USA.* We present a novel TFDM coherent PON architecture supporting adaptable modulation across subcarriers. Experimental validation highlights its flexibility in various link distance/splitting configurations, featuring out-of-band communication subcarriers. Downstream broadcasting and upstream burst transmission were demonstrated.	**Th1F.6 • 09:30** **Nonlinear SNR Estimation Based on Power Profile Estimation in Hybrid Raman-EDFA Link,** Inwoong Kim[1], Kyousuke Sone[2], Olga Vassilieva[1], Shoichiro Oda[2], Paparao Palacharla[1], Takeshi Hoshida[2]; *[1]Fujitsu Network Communications, Inc., USA; [2]Fujitsu Limited, Japan.* We demonstrate the nonlinear SNR estimation based on longitudinal power profile obtained with coherent receiver. The estimation error is less than 0.6 dB in WDM transmission over hybrid Raman-EDFA link.
Th1A.7 • 09:45 **1 × 5 MEMS Mode Selective Switch with an Inverse-Designed Silicon Nitride MDM,** Julian L. Pita[1], Almur Rabih[1], Seyedfakhreddin Nabavi[1], Frederic Nabki[1], Michaël Ménard[1]; *[1]École de technologie supérieure, Canada.* We present the first experimental demonstration of an inverse-designed 5-mode division multiplexer (MDM) in silicon nitride for MEMS-based inter-chip switches. The MDM exhibits high efficiency, wide bandwidth, compactness, robust fabrication, and compatibility with commercial foundry production.	**Th1B.6 • 09:45** **130.6-Tb/s Self-Homodyne Coherent Transmission Over Weakly-Coupled FMF for Data Center Applications,** Gang Qiao[1,2], Yu Yang[1], Zhaopeng Xu[1], Mingqing Zuo[2], Chengbin Long[2], Jiarui Zhang[2], Shangcheng Wang[1], Lulu Liu[1], Qi Wu[1], Junpeng Liang[1], Lei Shen[3], Jie Luo[3], Honglin Ji[1], Zhixue He[1], Yongqi He[2], Zhangyuan Chen[2], Weisheng Hu[1], Juhao Li[1,2]; *[1]Peng Cheng Laboratory, China; [2]Peking Univ., China; [3]Yangtze Optical Fibre and Cable Joint Stock Limited Company (YOFC), China.* We experimentally demonstrate high-capacity MDM self-homodyne coherent transmission over 30-km weakly-coupled 10-mode fiber with specially designed multiple-ring-core profile, achieving a total throughput of 130.6 Tb/s with 9 information-bearing modes carrying 16-λ 120-GBaud PCS 64-QAM signals.	**Th1C.7 • 09:45** **Datacom-Agnostic Shortwave QKD for Short-Reach Links,** Mariana F. Ramos[1], Marie-Christine Slater[1], Michael Hentschel[1], Martin Achleitner[1], Hannes Hübel[1], Bernhard Schrenk[1]; *[1]AIT Austrian Inst. of Technology, Austria.* We investigate the co-existence of 852-nm and 1550-nm QKD with carrier-grade 4×25-Gb/s/λ LAN-WDM over a short-reach interconnect. Shortwave QKD yields a higher key rate and is insensitive to Raman noise, as opposed to 1550-nm QKD.	**Th1D.7 • 09:45** **Highly Efficient Second-Harmonic Generation in a Double-Layer Thin-Film Lithium Niobate Waveguide,** Yuan Li[1], Lutong Cai[1], Lin Zhang[1]; *[1]Tianjin Univ., China.* We demonstrate unprecedentedly efficient second-harmonic generation in a thin-film lithium niobate waveguide, with conversion efficiency as high as 9300% $W^{-1}cm^{-2}$ achieved, which is enabled by greatly enhancing the modal overlap of the higher-order mode in polarization-reversed dual-layer lithium niobate.	**Th1E.7 • 09:45** **Analysis of SBS-Induced Performance Penalties and Their Mitigation in 50G TDM-PON Downstream,** Christoph Füllner[1], Ning Wang[2], Fathima Shabana M. A[1], Dora van Veen[3], René Bonk[1]; *[1]Nokia Bell Labs, Germany; [2]Department of Fundamental Network Technology, China Mobile Research Inst., China; [3]Nokia Bell Labs, USA.* We study SBS for 50G TDM-PON downstream showing that considerable performance penalties can occur depending on the specific operating conditions of the transmitter. Frequency dithering can mitigate SBS without impact on other performance metrics.	**Th1F.7 • 09:45** **Reflective Microresonator Based Microwave Photonic Sensor Assisted by Sparse Transformer,** Xiaoyi Tian[1,2], Yeming Chen[1,2], Joel A. Sved[1,2], Yiming Yan[1,2], Luping Zhou[1], Liwei Li[1,2], Linh Nguyen[1], Xiaoke Yi[1,2]; *[1]School of Electrical and Computer Engineering, The Univ. of Sydney, Australia; [2]Sydney Nano Inst., Australia.* We demonstrate a sparse transformer assisted microwave photonic sensor using a microring cascaded with an inverse designed reflector. Even with a small dataset, the root-mean-square-error of a temperature estimation model is achieved as 0.0074 °C.

10:00–16:00 Exhibition and Show Floor Programs, *Exhibit Hall*

10:00–15:45 Career Zone, *Exhibit Hall B1*

10:30–12:30 Th2A • Posters Session III, In-Person, *Exhibit Hall B1*
Lunch Break *(on own; concessions available in Exhibit Hall)*

Room 6E

Th1G • Open Line Systems and Digital Twins—Continued

Th1G.6 • 09:30 Invited

The Evolution of Open and Disaggregated Optical Networks: From Open Line System to Open Box System, Sai Chen[1], Weitang Zheng[1], Liang Dou[1], Huan Zhang[1], Zhao Sun[1], Lei Wang[1], Fan Gao[1], Boyuan Yan[1], Zhai Z. Qun[1], Chongjin Xie[1]; [1]*Alibaba Cloud, China.* Optical networks have been evolving from proprietary and close systems to open line systems, and further to open box systems. Technologies that enabled the evolution are reviewed and discussed.

Room 6F

Th1H • MMF Based Transmission—Continued

Th1H.7 • 09:45

10-Mode PM-QPSK Transmission Over 2320 km Enabled by Optimized Mode Permutation Strategies, Wang Yanze[1], Xiaochuan Liu[1], Qiushi Huang[2], Dechao Zhang[3], Xutao Wang[1], Qiang Guo[4], Tianyu Gao[1], Zhiqun Yang[1], Yaping Liu[1], Haofeng Hu[1], Rui Zhou[4], Wei Sun[2], Mingqing Zuo[3], Min Yan[2], Zhenhua Liu[2], Xianyu Zhang[2], Zhanhua Huang[1], Dong Wang[3], Xinhua Xiao[4], Lin Zhang[1,5]; [1]*Key Laboratory of Opto-electronic Information Technology of Ministry of Education and Tianjin Key Laboratory of Integrated Opto-electronics Technologies and Devices, School of Precision Instruments and Opto-electronics Engineering, Tianjin Univ., China;* [2]*Jiangsu Alpha Optic-electric Technology Co., Ltd., China;* [3]*Department of Fundamental Network Technology, China Mobile Research Inst., China;* [4]*B&P Laboratory, Huawei Technologies Co., Ltd., China;* [5]*Peng Cheng Laboratory, China.* For the first time, we demonstrate a 10-mode transmission over 2320 km at 15-Gbaud, greatly extending the record reach by 1000 km. We develop and experimentally verify the rules for identifying superior mode-permutation strategies.

Room 7

Th1I • Next Generation ROADMs, Multiband and SDM Networking—Continued

Th1I.5 • 09:30 ★ Top-Scored

Comparative Assessment of S+C+L-Band and E+C+L-Band Systems with Hybrid Amplification, Andre Souza[1,2], Nelson Costa[1], João Pedro[1,2], João Pires[2]; [1]*Infinera, Unipessoal Lda, Portugal;* [2]*Instituto de Telecomunicações, Instituto Superio Técnico, Portugal.* We compare the potential of four multi-band transmission systems leveraging optimized Raman amplification. Simulation results highlight that complementing a SuperC+L-band system with the S-band outperforms using the E-band or interleaving data-channels and Raman pumps.

Th1I.6 • 09:45

Hyperaccelerated Power Optimization in Multi-Band Elastic Optical Networks, Farhad Arpanaei[1], Kimia Ghodsifar[2], Hamzeh Beyranvand[2], José Alberto Hernández[1], Jose R. Moscoso[3], Carlos Natalino[4], Mahdi Ranjbar Zefreh[5], Antonio Napoli[6], Juan Fernández-Palacios[3], David Larrabeiti[1]; [1]*Universidad Carlos III de Madrid, Spain;* [2]*Department of Electrical Engineering, Amirkabir Univ. of Technology (Tehran Polytechnic), Iran (the Islamic Republic of);* [3]*Research and Development, Telefonica, Spain;* [4]*Department of Electrical Engineering, Chalmers Univ. of Technology, Sweden;* [5]*CISCO Systems, CISCO, Italy;* [6]*Infinera, Germany.* We show that solving interrelated inverse differential equations can address pre-tilt power optimization, resulting in a few-second-computed optimal power for each span and boosting average channel generalized signal-to-the-noise ratio (GSNR) by up to 0.5 dB.

Room 8

Th1J • Short-Reach Transmission Systems—Continued

Th1J.6 • 09:30

Role of Frequency-Resolved SNR in Entropy-Loading DMT Systems: Rate Comparison and Simplified Options, Peiji Song[1], Di Che[2]; [1]*The Chinese Univ. of Hong Kong, Hong Kong;* [2]*Nokia Bell Labs, USA.* We verify that frequency-resolved SNR is crucial to approach the capacity of a discrete-multitone system with entropy loading (EL), and propose several methods to reduce the complexity of EL while keeping the SNR information to minimize the rate penalty.

Show Floor Programming

MW5 • MW Panel V: Disaggregation Inside the DC
10:15–11:45, *Theater I*

10:00–16:00 Exhibition and Show Floor Programs, *Exhibit Hall*

10:00–15:45 Career Zone, *Exhibit Hall B1*

10:30–12:30 Th2A • Posters Session III, In-Person, *Exhibit Hall B1*
Lunch Break *(on own; concessions available in Exhibit Hall)*

10:30–12:30
Th2A • Posters Session III, In Person

Th2A.1
Optical Fiber Bendable at 3-mm Diameter for Optical Transceivers and Silicon Photonic Packaging, Xin Chen[1], Jason E. Hurley[1], Yin Shu[1], Ming-Jun Li[1]; [1]*Corning Inc, USA*. A 3-mm diameter bendable and mechanically reliable fiber for both O- and C-band wavelength windows is designed and fabricated. Bending losses of 0.036 dB/turn at 1310 nm and 0.39 dB/turn at 1550 nm are demonstrated.

Th2A.2
TeraFlowSDN Controlling SDM and Wideband Optical Networks, Andrea Sgambelluri[1], Nicola Sambo[1,2], Muhammad Ismaeel[2], Lluis Gifre[3], Carlos Manso[3], Michael Enrico[4], Josep M. Fàbrega[3], Ricard Vilalta[3], Raul Muñoz[3]; [1]*Scuola Superiore Sant'Anna, Italy;* [2]*CNIT, Italy;* [3]*CTTC, Spain;* [4]*HUBER+SUHNER Polatis Ltd, UK*. A SDN controller based on TeraFlow is designed and implemented to control optical networks including parallel fibers and optical-band switching. An experimental validation is carried out with OpenConfig transponders and OpenConfig augmented multi-granular nodes.

Th2A.3
Crosstalk-Compensated Optical Phased Arrays for Wide-Angle Beam-Steering, Ankita Sharma[1,2], John Straguzzi[1], Tianyuan Xue[1,2], Alperen Govdeli[1,2], Fu-Der Chen[1,2], Andrei Stalmashonak[1], Wesley Sacher[1], Joyce K. Poon[1,2]; [1]*MPI for Microstructure Physics, Germany;* [2]*Univ. of Toronto, Canada*. We demonstrate beam-steering over ~115° using independent amplitude and phase control to compensate for optical crosstalk in an optical phased array with 1mm-long waveguide grating emitters spaced at a ~λ/2 (775 nm) pitch.

Th2A.4
Span Order Dependency for Nonlinear Interference Noise Over in-Homogeneous Multispan O-Band Coherent Transmission, Daniel J. Elson[1], Mindaugas Jarmolovičius[2], Noboru Yoshikane[1], Takehiro Tsuritani[1], Eric Sillekens[2], Polina Bayvel[2], Robert Killey[2], Yuta Wakayama[1]; [1]*KDDI R&D Laboratories, Japan;* [2]*Optical Networks Group, UCL (Univ. College London), UK*. Coherent O-band transmission was conducted in the nonlinear regime. For spans with an in-homogeneous zero dispersion wavelength, the amount and spectral content of nonlinear interference noise was found to be dependent on span order.

Th2A.5
Hierarchical Energy-Aware Monitoring Framework for Sustainability of Packet-Optical Networks, Waleed Akbar[1], Francisco Javier Vilchez[1], Raul Muñoz[1], Ricard Vilalta[1], Lluis Gifre[1]; [1]*CTTC, Spain*. We present a hierarchical energy monitoring framework to systematically analyze energy consumption in computing, IP, and Optical networks. We demonstrated the framework on the laboratory testbed to validate the practicality and scalability.

Th2A.6
100 Gbps PAM4 Transmissions Over 50 km with 40 dB Power Budget for PON Using a High-Gain Quantum Dot SOA, Lakshmi Narayanan Venkatasubramani[1], Ahmed Galib Reza[1], Vladimir S. Mikhrin[2], Alexey E. Gubenko[2], Alexey Kovsh[3], Liam P. Barry[1]; [1]*Dublin City Univ., Ireland;* [2]*Innolume GmbH, Germany;* [3]*Alfalume Inc., USA*. We experimentally demonstrate a 106 Gbps PON downstream signal transmission using a high-gain InAs/InGaAs quantum dot-based SOA as a preamplifier. We achieved a record-high power budget of 40 dB considering an HD-LDPC BER limit of 1×10^{-2}.

Th2A.7
A Novel Low Complexity and Precise Transceiver IQ Skew Calibration Method for Single Carrier Coherent System, Wei Wang[1], Zhenpeng Wu[1], Dongdong Zou[1], Fan Li[1], Zhaohui Li[1]; [1]*Sun Yat-Sen Univ., China*. We propose a novel precise transceiver IQ skew calibration method utilizing the specially designed training signal for single carrier coherent system. The results show that the estimation error can be within ±0.2ps.

Th2A.8
Joint Network and Computing Resource Optimisation in Distributed Quantum Computing, Sima Bahrani[1], Rui Wang[1], Juan Parra-Ullauri[1], Romerson Oliveira[1], Reza Nejabati[1], Dimitra E. Simeonidou[1]; [1]*Univ. of Bristol, UK*. We propose an orchestration framework to optimize network and computing resources and minimize degradation from quantum and classical communication in distributed quantum computing interconnect networks.

Th2A.9
A Silicon Photonic Chip-Based System for 2.5-GHz Quantum Key Distribution (QKD), Wei Luo[1], Lin Cao[2], Hong Cai[1], Muhammad Faeyz Karim[2], Leong Chuan Kwek[3,2], Ai Qun Liu[1,2]; [1]*The Hong Kong Polytechnic Univ., Hong Kong;* [2]*Nanyang Technological Univ., Singapore;* [3]*National Univ. of Singapore, Singapore*. We have demonstrated a compact, chip-based system for high-speed polarization-encoded QKD, which utilizes advanced silicon photonics technology and operates at a clock rate of 2.5 GHz. Our design enables secure key rates up to 1.018 Mbps at equivalent fiber distance of 100 km in the finite-size regime.

Th2A.10
Optimal Nonlinear Spectral Back-Rotation for Discrete Eigenvalue NFT Transmission Systems, Chuang Xu[1], Alan P. Lau[1]; [1]*The Hong Kong Polytechnic Univ., China*. We propose back rotating the nonlinear spectral phase by half of the transmission distance as a computationally simple impairment compensation algorithm for discrete eigenvalue NFT transmission systems.

Th2A.11
High-Speed and Low-Power Optical DAC Transmitter Using All-Silicon Lumped Segmented Modulator Directly Driven by CMOS Inverter Driver, Yohei Sobu[2,1], Yukito Tsunoda[2,1], Toshihiko Mori[2,1], Guoxiu Huang[1], Takuji Yamamoto[2,1], Shinsuke Tanaka[2,1], Takeshi Hoshida[1]; [1]*Fujitsu Limited, Japan;* [2]*Photonics Electronics Technology Research Association, Japan*. We fabricated a 2×2-bit optical DAC transmitter using silicon segmented modulators and CMOS drivers. Highest symbol rates of 56Gbaud PAM4 and 50Gbaud 16QAM were achieved with transmitter density higher than 300Gbps/mm^2 among optical DAC transmitters.

Th2A.12
100 Gbps WDM OWC Link Performance Using IMOS Surface Grating Coupler and Commercial Fiber Receivers, Mikolaj Wolny[1], Jiangrui Deng[1], Sander Reniers[1], Ton Koonen[1], Eduward Tangdiongga[1]; [1]*Eindhoven Univ. of Technology, Netherlands*. We propose the use of an IMOS surface grating coupler for light collection and commercial pigtailed receivers for light detection in short-link OWC system. We demonstrate error-free OOK transmission of four 25 Gbps WDM channels.

Th2A.13
Activation Stretching for Tackling Noise in Photonic Aware Neural Networks, Emilio Paolini[1,2], Lorenzo De Marinis[1], Luca Valcarenghi[1], Luca Maggiani[3], Nicola Andriolli[2]; [1]*Scuola Superiore Sant'Anna, Italy;* [2]*IEIIT, Consiglio Nazionale delle Ricerche, Italy;* [3]*Sma-RTy, Italy.* This paper introduces a stretching strategy for nonlinear activation functions aimed to enhance noise resilience in photonic-aware neural networks. Its effectiveness is numerically demonstrated in counteracting different noise levels in low-resolution operations.

Th2A.14
Learning to Extract Distributed Polarization Sensing Data from Noisy Jones Matrices, Mohammad Farsi[1], Christian Häger[1], Magnus Karlsson[2], Erik Agrell[1]; [1]*Electrical Engineering, Chalmers Univ. of Technology, Sweden;* [2]*Microtechnology and Nanoscience, Chalmers Univ. of Technology, Sweden*. We consider the problem of recovering spatially resolved polarization information from receiver Jones matrices. We introduce a physics-based learning approach, improving noise resilience compared to previous inverse scattering methods, while highlighting challenges related to model overparameterization.

Th2A.15
Over 1-Watt Analog RoF Signal Transmission Using a 1-km Hollow-Core Photonic Bandgap Fiber, Kai Murakami[1], Souya Sugiura[1], Hironori Yamaji[1], Motoharu Matsuura[1], Takeshi Takagi[2], Kazunori Mukasa[2]; [1]*Univ. of Electro-Communications, Japan;* [2]*Furukawa Electric Co. Ltd., Japan*. We demonstrate analog RoF transmission with signal power exceeding 1-Watt using a hollow-core photonic bandgap fiber. Due to the low nonlinearity, superior transmission performance was obtained in single- and four-channel transmission compared to silica-core fibers.

Th2A.16
End-to-end QoT Predictions Enhanced by GNPy-Based Digital Twin with Network Telemetry, Sen Shen[1], Haiyuan Li[1], Andreas Tyrovolas[1], Yiran Teng[1], Reza Nejabati[1], Shuangyi Yan[1], Dimitra E. Simeonidou[1]; [1]*HPN, UK*. Digital twin for dynamic optical networks is implemented using GNPy, network telemetry and databases. It enhances ML-based End-to-End QoT predictions in field trials by supporting model pre-training and minimizing data requirements through the AI engine.

Th2A.17
400G Cost-Effective EML for B5G/6G Fronthaul Network, Seungchul Lee[1], Namje Kim[1], Miran Park[1], Kihong Yoon[2], Mihee Hwang[2], Joonsang Yu[2], Sangho Lee[2], O-Kyun Kwon[1]; [1]*ETRI, Korea (the Republic of);* [2]*OE solutions, Korea (the Republic of)*. We demonstrate a cost-effective 400G EML operating within O-band CWDM. This device, designed with an identical active layer, maintains a TDECQ value below 2 dB under 100G PAM4 modulation at 50 °C.

Th2A.18
Interleaved Dielectric-Metal Plasmonic Grating Polarizer, Yao Cui[1,2], Yipeng Ji[2], Jonas Kapraun[2], Chih-Chiang Shen[2], Jiaxing Wang[2], Connie J. Chang-Hasnain[2]; [1]*Tsinghua Berkeley Shenzhen Inst., China;* [2]*Berxel Photonics Co. Ltd, China*. We demonstrate novel metasurface optics leveraging the interaction of interleaved dielectric and metal plasmonic subwavelength gratings. A flat polarizer with high extinction ratio and high transmission for a wide angle of incidence is reported.

Th2A.19
0.08 fF, 0.72 nA Dark Current, 91% Quantum Efficiency, 38 Gb/s Nano-Photodetector on a 45 nm CMOS Silicon-Photonic Platform, Mingye Fu[1], S. J. Ben Yoo[1]; [1]*Univ. of California, Davis, USA*. We demonstrated a Germanium-on-Silicon photodetector utilizing an asymmetric-Fabry-Perot resonator with 0.08 fF capacitance. The measurements at 1315.5 nm show 0.72 nA (3.40 nA) dark current, 0.93 A/W (0.96 A/W) responsivity, 36 Gb/s (38 Gb/s) operation at -1V (-2V) bias.

Th2A.20
Automated Control Plane for Reconfigurable Optical Crosshaul in Next Generation RAN, Yijie Tao[1], Chathurika Ranaweera[2], Sampath Edirisinghe[3], Christina Lim[1], Ampalavanapillai Nirmalathas[1], Lena Wosinska[4], Tingting Song[1]; [1]*Univ. of Melbourne, Australia;* [2]*Deakin Univ., Australia;* [3]*Univ. of Sri Jayewardenepura, Sri Lanka;* [4]*Chalmers Univ. of Technology, Sweden*. The paper proposes a unified automated control plane of an SDN-enabled densely deployed reconfigurable optical crosshaul for future radio access networks, with tested ability to perform sub-second automated reconfiguration on low-cost and low-bandwidth control plane.

Th2A.21
XLRON: Accelerated Reinforcement Learning Environments for Optical Networks, Michael D. Doherty[1], Alejandra Beghelli[1]; [1]*Univ. College London, UK*. We present XLRON: an open source project enabling, for the first time, GPU-accelerated reinforcement learning on optical network problems. We demonstrate 100-1000x speed-up in training time over similar tools, thereby opening new research possibilities.

Th2A • Posters Session III, In Person—Continued

Th2A.22
Filter-Less Synthesis of 50-GHz Double-Spaced Flat Optical Comb by in-Phase/Quadrature Electro-Optic Modulator for High Bandwidth Transmission, Shun Harada[1], Takahide Sakamoto[1], Tatsuki Ishijima[1]; [1]*Tokyo metropolitan Univ., Japan.* 50-GHz spaced flat optical comb is experimentally generated in the electro-optic modulation process by using an IQM driven with 25 GHz signals. We demonstrate that the double-frequency spaced comb effectively carries multi-channel 5x28 Gbaud signals.

Th2A.23
Experimental Disaggregation of Propagation Effects in Optical Links, Joana Girard-Jollet[1,3], Jean-Christophe Antona[1], Alexis Carbo Meseguer[1], Fabien Boitier[2], Petros Ramantanis[2], Ghaya Rekaya[3]; [1]*Alcatel Submarine Networks, France;* [2]*Nokia Bell Labs, France;* [3]*Telecom Paris, France.* We introduce a protocol to evaluate experimentally the fiber nonlinear coefficients for intra- and inter-channel effects. We characterized a three-span transmission using highly dispersed QPSK signals, observing good agreement with the eGN model.

Th2A.24
Sub-Terahertz Interconnection Based on Ge-Si Photodetector, Wei Chen[1], Yilun Wang[1], Liao Chen[1], Zhibin Jiang[1], Zhibo Hou[1], Yu Yu[1], Xinliang Zhang[1]; [1]*Wuhan National Laboratory for Optoelectronics and School of Optical and Electronic Information, Huazhong Univ. of Science and Technology, China.* The sub-THz inter-chip interconnections are first demonstrated with terahertz photomixers based on standard-process fabricated germanium-silicon photodetectors and bow-tie antennas, featuring a frequency range over 200 GHz.

Th2A.25
16.9 Gb/s Single-Channel LWIR FSO Data Transmission with Directly Modulated QCL and MCT Detector, Mahdieh Joharifar[1], Hamza Dely[2], Laureline Durupt[3], Armands Ostrovskis[4], Richard Schatz[1], Rafael Puerta[5], Thomas Bonazzi[2], Gregory Maisons[3], Djamal Gacemi[2], Lu Zhang[6], Sandis Spolitis[4], Yan-ting Sun[1], Vjaceslavs Bobrovs[4], Xianbin Yu[6], Angela Vasanelli[2], Oskars Ozolins[1,7], Carlo Sirtori[2], Xiaodan Pang[1,7]; [1]*Kungliga Tekniska Hogskolan, Sweden;* [2]*Physics, École normale supérieure, France;* [3]*Mirsense, France;* [4]*Riga Technical Univ., Latvia;* [5]*Ericsson, Sweden;* [6]*Zhejiang Univ., China;* [7]*RISE, Sweden.* We experimentally demonstrate a room-temperature LWIR FSO link with a 9.1-um directly modulated QCL and an MCT detector. Net bitrate of up to 16.9 Gb/s is achieved at both 15C and 20C over a 1-meter distance.

Th2A.26
Accurate Beyond-400G Transmitter Quality Metric Based on Transmitter Constellation Closure Measurement, Qirui Fan[1], Xiang Liu[1]; [1]*Huawei, Hong Kong.* We demonstrate the use of transmitter constellation closure (TCC) for accurate quality assessment of beyond-400G coherent transmitters, and show its tolerance to inter-symbol interference and phase noise with and without probability constellation shaping (PCS).

Th2A.27
Sub-1 dB Loss SiN-to-Polymer Waveguide Coupling: an Enabler for Co-Packaged Optics, Jef Van Asch[1,2], Jeroen Missinne[1], Junwen He[2], Pengfei Xu[2], Arnita Podpod[2], Guy Lepage[2], Negin Golshani[2], Rafal Magdziak[2], Huseyin Sar[2], Hakim Kobbi[2], Swetanshu Bipul[2], Dieter Bode[2], Yoojin Ban[2], Filippo Ferraro[2], Joris Van Campenhout[2], Geert Van Steenberge[1]; [1]*CMST, Ghent Univ., Belgium;* [2]*Optical I/O, imec, Belgium.* We report the design, fabrication and characterization of a broadband silicon nitride to polymer waveguide adiabatic coupling interface with sub-1 dB loss around 1310 nm, enabling a sub-2 dB chip-to-chip and chip-to-fiber coupling loss.

Th2A.28
Performance Evaluation and Optimization of LDPC FEC for 100 Gbps Coherent Passive Optical Networks, Qun Zhang[1], Haipeng Zhang[2], Zhensheng Jia[2]; [1]*ZK Ascend Inc., USA;* [2]*CableLabs, USA.* Using both simulation and experimental data, we investigate performance of the LDPC FEC code used in current 25G/50G PONs through clipping optimization for coherent PONs, demonstrating its feasibility for future PON's applications.

Th2A.29
Capacity Optimization Strategies in an Unrepeatered System, Hans Bissessur[1], Alexis Busson[1], Daryna Kravchenko[1], Farana Hedaraly[1]; [1]*Alcatel Submarine Networks, France.* We show 11% capacity improvement in an unrepeatered link at a constant baud-rate, by adjusting the bit-rate of a real-time transponder on a channel-per-channel basis, compared to a fixed bit-rate transponder.

Th2A.30
Reduced-Complexity Frequency Interleaved DAC for High-Speed Optical Communications, Juan I. Bonetti[1], Mario Hueda[1,2]; [1]*Fundación Fulgor, Argentina;* [2]*Digital Communications Research Laboratory, FCEFyN, UNC, Argentina.* We propose a new architecture of frequency-interleaved DACs for the all-electronic generation of high-bandwidth signals. We demonstrate significant reduction in both DSP complexity and PAPR, along with a simplified analog circuit design.

Th2A.31
Beam-Steering Based on Dispersive Optical Phased Array for FMCW LiDAR Application, Xingyi Jiang[1], Zhaoyang Zhang[1], Qikai Huang[1], Qiang Zhang[2], Jianyi Yang[1], Hui Yu[2]; [1]*College of Information Science and Electronic Engineering, Zhejiang Univ., China;* [2]*Zhejiang Lab, China.* We demonstrate dispersive optical phased arrays based on the Si_3N_4-on-Si platform. Two-dimensional beam steering across a 45.6° × 10° FOV with a beam width of 1.45° × 0.032° is achieved by wavelength tuning alone. Besides, FMCW ranging operation at a target distance of 10 m are experimentally performed.

Th2A.32
Integrated Coherent Optical Fiber Communication System with Discrete-Time Analog Transmission, Hongyu Huang[1], Yu Zhenming[1], Liming Cheng[1], Wei Zhang[1], Yueqiu Mu[1], Kun Xu[1]; [1]*Beijing Univ of Posts & Telecom, China.* We propose and experimentally demonstrate an integrated coherent optical fiber communication system based on discrete-time analog transmission (DTAT-IOFC). The experimental results indicate that DTAT-IOFC exhibits better performance and achieves 6 dB optical signal-to-noise ratio gain.

Th2A.33
A Compact Silicon-Based Photonic Phase-Tunable Microwave Frequency Downconverter, Xingyi Jiang[1], Qiang Zhang[2], Shengyu Fang[1], Shuyue Zhang[1], Hui Yu[2]; [1]*College of Information Science and Electronic Engineering, Zhejiang Univ., China;* [2]*Zhejiang Lab, China.* We experimentally demonstrate a compact silicon-based photonic frequency downconverter with tunable phase shift. It can be operated at 20/40 GHz while supporting a 137° phase shift of 0.04 GHz IF signal.

Th2A.34
QoT-Aware Adaptive Multi-Band Networking Over Hybrid Fibers Enabled by Wavelength-Selective Band Switching, Masahiro Nakagawa[1], Takafumi Fukatani[1], Takeshi Seki[1], Rie Hayashi[1], Takeshi Kuwahara[1]; [1]*NTT Corporation, Japan.* We investigate highly adaptive multi-band networking for diverse physical-layer conditions. Using our wavelength-selective band-switchable OXC prototype, we demonstrate adaptive C+L-band spectrum utilization over hybrid SMF/DSF links as link-by-link band selection can suppress nonlinear interference accumulation.

Th2A.35
Estimation of Energy Storage Status in Power Supply System Using Power Over Fiber for Outdoor Environment, Tomohiro Kawano[1], Ryo Koyama[1], Akihiro Kuroda[1], Takui Uematsu[1], Chisato Fukai[1], Hiroshi Watanabe[1], Ikutaro Ogushi[1]; [1]*NTT Corporation, Japan.* We demonstrate that our model for estimating power charging regimes of the power supply system combining Power over Fiber and an energy storage is very accurate as it accounts for the temperature dependence.

Th2A.36
Neural Network Model of a Second Stage L-Band Amplifier Using Experimental Training Sets, Hamed Rabbani[1], Kaboko Jean-Jacques Monga[1], Sophie LaRochelle[1], Leslie Rusch[1]; [1]*Laval Univ., Canada.* Using experimental measurements with high-power input signals, we train a neural network model of the second stage of an L-band amplifier. with the model, we jointly optimize amplifier gain and noise figure (alternately gain flatness).

Th2A.37
PtMP Multi-if-Over-Fiber Systems Using Remotely Shared Local Oscillators for Plural Antenna Sites, Kazuki Tanaka[1], Shinji Nimura[1], Ryo Inohara[1]; [1]*KDDI Research, Inc., Japan.* A multi-channel intermediate frequency-over-Fiber (IFoF) system with remotely shared local oscillators (LO) is proposed. IF-to-RF conversion by a shared LO is experimentally verified meeting the 3GPP error vector magnitude (EVM) criterion for 64-QAM OFDM signal.

12:30–14:00 Exhibit-only Time, *Exhibit Hall*

Show Floor Programming

MW5 • MW Panel V: Disaggregation Inside the DC
10:15–11:45, *Theater I*

OFCnet Panel: Optical Benchmarks
11:00–11:30, *Theater III*

Low-Latency High-Speed Optical Interconnection Technologies for AI Compute Era
11:30–12:30, *Theater II*

OFCnet Panel: Optical Infrastructures and Services
11:45–12:15, *Theater III*

MW6 • MW Panel VI: Disaggregation for Network Operators
12:00–13:30, *Theater I*

AIM Photonics Presents PICs, Heterogeneous Integration, and Packaging for Next-Generation Silicon Photonic Applications
12:45–13:45, *Theater II*

Energy Efficient Interfaces - Reining in Power Consumption Trends for Next-Generation Optical Networking
13:45–14:45, *Theater I*

Room 1B

14:00–16:00
Th3B • Practical Security Demonstration
Presider: Andrew Lord; BT, UK

Th3B.1 • 14:00
Secure FSO Transmission with Quantum Deliberate Signal Randomization on the Y-00 Protocol Under Fog Conditions, Fumio Futami[1], Ken Tanizawa[1], Kentaro Kato[1], Yuichiro Hara[2], Michikazu Hattori[2], Abdelmoula Bekkali[2], Yukihiko Suga[2]; [1]*Tamagawa Univ., Japan;* [2]*TOYO Electric Corporation, Japan.* Security-enhanced 10Gbit/s DP PSK Y-00 cipher transmission is demonstrated with deliberate signal randomization driven by quantum random number generator in free space in dense fog. High security and transmission performance are achieved over the entire transmission system.

Th3B.2 • 14:15
Experimental Demonstration of an Efficient Correlation Attack Method in 300km QAM/QNSC Transmission, Mingrui Zhang[1], Yajie Li[1], Kongni Zhu[1], Shuang Wei[1], Yuang Li[1], Zhao Yongli[1], Jie Zhang[1]; [1]*Beijing Univ. of Posts and Telecom., China.* We propose an efficient correlation attack based on low-order demodulation to recover the seed keys in QNSC. Experiment results prove its high success possibility and low computational complexity in 300km QAM/QNSC transmission.

Th3B.3 • 14:30
Integrating Quantum Key Distribution into TLS 1.3: A Transport Layer Approach to Quantum-Resistant Communications in Optical Networks, Carlos Rubio Garcia[1], Abraham Cano Aguilera[1], Juan José Vegas Olmos[2], Simon Rommel[1], Idelfonso Tafur Monroy[1]; [1]*Eindhoven Univ. of Technology, Netherlands;* [2]*Software architecture, NVIDIA corporation, Israel.* We present an experimental quantum-resistant OpenSSL-based TLS 1.3 implementation using classical cryptography and QKD. This solution is ideal for high-performance scenarios with optical fiber communication where QKD potential can be leveraged.

Room 2

14:00–16:00
Th3C • Free Space Optical Communication
Presider: Oskars Ozolins; RISE Research Inst.s of Sweden AB, Sweden

Th3C.1 • 14:00 Invited
Free Space Communication Enabled by Directly Modulated Quantum Cascade Laser, Xiaodan Pang[1,2], Richard Schatz[1], Mahdieh Joharifar[1], Hamza Dely[3], Laureline Durupt[4], Gregory Maisons[4], Djamal Gacemi[3], Rafael Puerta[5], Thomas Bonazzi[3], Lu Zhang[6], Sandis Spolitis[2], Yan-ting Sun[1], Vjaceslavs Bobrovs[2], Xianbin Yu[7,6], Angela Vasanelli[3], Carlo Sirtori[3], Oskars Ozolins[2,8]; [1]*Kungliga Tekniska Hogskolan, Sweden;* [2]*Inst. of Telecommunications, Riga Technical Univ., Latvia;* [3]*Laboratoire de Physique de l'ENS, Département de Physique, École Normale Supérieure, Université PSL, Sorbonne Université, Université Paris Cité, CNRS, France;* [4]*mirSense, France;* [5]*Ericsson Research, Ericsson, Sweden;* [6]*College of Information Science and Electrical Engineering, Zhejiang Univ., China;* [7]*Zhejiang Lab, China;* [8]*RISE Research Inst.s of Sweden, Sweden.* We summarize our recent experimental studies of free-space communications enabled by directly modulated quantum cascade lasers at both MWIR and LWIR regions. Different detector types with different characteristics are compared.

Th3C.2 • 14:30
Large-Core Optics for Simplified Short-Range FSO Links, Florian Honz[1], Bernhard Schrenk[1]; [1]*AIT, Austria.* We evaluate large-core FSO links where excellent coupling pairs with bandwidth fading due to multi-mode propagation. The 10-Gb/s/λ limit for 105-µm double-clad fibers is mitigated by spectral launch tuning, restoring 84% of single-clad 25-Gb/s/λ capacity.

Room 3

14:00–16:00
Th3D • Photonic Integration for Novel Applications
Presider: Wei Shi; Université Laval, Canada

Th3D.1 • 14:00 Invited
Enhanced Recurrent Neural Network Equalization Based on Hidden Feature Extraction Learning for Optical Interconnect, Chuanchuan Yang[1], Yunfeng Gao[1], Jiaxing Wang[2], Hongbin Li[1], Connie J. Chang-Hasnain[2]; [1]*Peking Univ., China;* [2]*Shenzhen Berxel Photonics Co. Ltd., China.* We propose a hidden feature extraction learning method for RNN equalization to improve training efficiency without increasing computational burden. Superior BER is demonstrated in 288 Gb/s 100 m VCSEL-MMF interconnect compared with black-box training strategy.

Th3D.2 • 14:30 Invited
Hybrid Photonic Integrated Circuits for Quantum Communications, Moritz Kleinert[1], Martin Kresse[1], Sarah Simon[1], Maximilian Ott[1], Jakob Reck[1], Csongor Keuer[1], Klara Mihov[1], Madeleine Weigel[1], Tianwen Qian[1], Philipp Winklhofer[1], David De Felipe[1], Crispin Zawadzki[1], Norbert Keil[1], Martin Schell[1]; [1]*Photonic Components, Fraunhofer Henrich Hertz Inst., Germany.* Hybrid photonic integration is promising for the miniaturization of quantum communications setups. We discuss current integration approaches and present hybrid PICs for the generation of polarization-based quantum states and photon pairs in the PolyBoard platform.

Room 6C

14:00–16:00
Th3E • MCF Based Transmission
Presider: Yuta Wakayama; KDDI Research, Japan

Th3E.1 • 14:00 ★ Top-Scored
Transoceanic-Class WDM/SDM Transmission of PDM-QPSK Signals Over Coupled 12-Core Fiber, Manabu Arikawa[1], Kohki Shibahara[2], Taiji Sakamoto[3], Ryota Imada[3], Kazuhide Nakajima[3], Yutaka Miyamoto[2], Emmanuel Le Taillandier de Gabory[1]; [1]*Advanced Network Research Laboratories, NEC Corporation, Japan;* [2]*NTT Network Innovation Laboratories, NTT Corporation, Japan;* [3]*NTT Access Network Service Systems Laboratories, NTT Corporation, Japan.* We demonstrated long-haul transmission of 32-Gbaud PDM-QPSK over coupled 12-core fiber with standard cladding diameter. Error-free transmission after FEC was achieved up to 7280 km. The estimated rms MDL per 52-km span was 0.3 dB.

Th3E.2 • 14:15
45.7 Tb/s Over 12 053 km Transmission with an All-Multi-Core Recirculating-Loop 4-Core-Fiber System, Giammarco Di Sciullo[1,2], Benjamin J. Puttnam[2], Menno v. Hout[2,3], Ruben S. Luis[2], Divya Ann Shaji[1], Georg Rademacher[4], Chigo M. Okonkwo[3], Antonio Mecozzi[1], Cristian Antonelli[1], Hideaki Furukawa[2]; [1]*Univ. of L'Aquila, Italy;* [2]*National Inst. of Information and Communications Technology (NICT), Japan;* [3]*Eindhoven Univ. of Technology (TU/e), Netherlands;* [4]*Univ. of Stuttgart, Germany.* We demonstrate 45.7 Tb/s transmission of 4×175×24.5 GBd DP-QPSK signals over 12 053 km of four-core fiber using multi-core C-band EDFAs and Raman amplification. This is the first all-multi-core component recirculating-loop-based long-haul transmission system.

Th3E.3 • 14:30
Long-Haul Transmission Over Ultra-Low Attenuation and Crosstalk 4-Core Multicore Fiber, John D. Downie[1], Jason E. Hurley[1], Mark Gray[1], Stephen Johnson[1]; [1]*Corning Inc, USA.* We report long-haul transmission up to 9000 km with conventional 75 km spans over 4-core multicore fiber with ultra-low attenuation (0.155-0.156 dB/km) and crosstalk supporting co-propagating and bi-directional transmission configurations with equal performance.

Room 6D

14:00–16:00
Th3F • Sub-THz and mm-wave Signal Processing
Presider: Tomoyuki Kato; Fujitsu Ltd, Japan

Th3F.1 • 14:00
151.5-GHz Sub-THz Signal Reception and Downconversion Using All-Optical Technology, Pham Tien Dat[1], Yuya Yamaguchi[1], Shingo Takano[2], Shotaro Hirata[2], Junichiro Ichikawa[2], Ryo Shimizu[2], Keizo Inagaki[1], Isao Morohashi[1], Yuki Yoshida[1], Atsushi Kanno[1], Naokatsu Yamamoto[1], Kouichi Akahane[1]; [1]*NICT Network System Research Inst., Japan;* [2]*Sumitomo Osaka Cement Co., Ltd., Japan.* A direct reception of a sub-THz signal and its conversion to the microwave band is demonstrated using an all-optical receiver and photonic downconversion technology. An 80-Gb/s OFDM signal was transmitted over a converged fiber–sub-THz–fiber system at 151.5-GHz.

Th3F.2 • 14:15
40-GHz Bandwidth Envelope Detector Used in 0.3-THz IM/DD System for 4096-QAM DSM Signal Transmission, Jianyu Long[1], Jingwen Tan[1], Jianjun Yu[1,2], Jiaxuan Liu[1], Xiongwei Yang[1], Yi Wei[1], Kaihui Wang[1], Wen Zhou[1], Xianming Zhao[5], Junjie Ding[2], Jiao Zhang[2], Min Zhu[2], Jianguo Yu[4], Feng Zhao[3]; [1]*Fudan Univ., China;* [2]*Purple Mountain Laboratories, China;* [3]*Xi'an Univ. of Posts and Telecommunications, China;* [4]*Beijing Univ. of Posts and Telecommunications, China;* [5]*China Harbin Inst. of Technology, China.* We experimentally demonstrate a photonics-aided THz IM/DD transmission system using a large-bandwidth envelope detector and delta-sigma modulation. The proposed system can support 4096-QAM DSM modulation and simple and low-cost receiver architecture.

Th3F.3 • 14:30
Optical Frequency Division on SiN-Based Platform for Low-Noise MmWave Generation, Shuman Sun[1], Beichen Wang[1], Kaikai Liu[2], Jiawei Wang[2], Ruxuan Liu[1], Mandana Jahanbozorgi[1], Zijiao Yang[3], Paul Morton[4], Karl Nelson[5], Daniel Blumenthal[2], Xu Yi[1,3]; [1]*Department of Electrical and Computer Engineering, Univ. of Virginia, USA;* [2]*Department of Electrical and Computer Engineering, Univ. of California Santa Barbara, USA;* [3]*Department of Physics, Univ. of Virginia, USA;* [4]*Morton Photonics, USA;* [5]*Honeywell International, USA.* We demonstrate integrated optical frequency division using SiN-based reference cavity and microcomb, achieving a 36 dB phase noise reduction. with 100 GHz carrier frequency, phase noise reaches -115 dBc/Hz at 10 kHz offset.

Room 6E

14:00–16:00
Th3G • Optical Computing and Accelerators
Presider: Nikos Pleros; Aristoteleio Panepistimio Thessalonikis, Greece

Th3G.1 • 14:00
A TeraFLOP Photonic Matrix Multiplier Using Time-Space-Wavelength Multiplexed AWGR-Based Architectures, Christos Pappas[1], Theodoros Moschos[1], Miltiadis Moralis-Pegios[1], George Giamougiannis[1], Apostolos Tsakyridis[1], Manos Kirtas[1], Nikolaos Passalis[1], Anastastios Tefas[1], Nikos Pleros[1]; [1]*Aristotle Univ. of Thessaloniki, Greece*. We demonstrate experimentally a novel 8×8 AWGR-based photonic matrix multiplier that enables simultaneously time-, wavelength- and space- division multiplexed computing with a computational power of 1.28 TeraFLOP.

Th3G.2 • 14:15
Multi-Transverse Mode Multiply-and-Accumulate Operation Toward Advancement of Photonic Accelerators, Seyed Mohammad Reza Safaee Ardestani[1], Kaveh Hassan Rahbardar Mojaver[1], Odile Liboiron-Ladouceur[1]; [1]*McGill Univ., Canada*. We demonstrate a novel mode-division-multiplexing subsystem achieving four output power levels using two single-bit rings on two TE modes for photonic accelerators. The photodetector combines the energy of two TE modes without requiring coherent summation.

Th3G.3 • 14:30 **Tutorial**
Optical Computing and Linear Optics, Dirk R. Englund[1]; [1]*Massachusetts Inst. of Technology, USA*. Abstract not available.

Room 6F

14:00–16:00
Th3H • Photonics Manufacturing Technologies
Presider: Sagi Mathai; Hewlett Packard Labs, USA

Th3H.1 • 14:00 **Invited**
Progress Towards Low Loss Waveguides in Si/SiN Integrated Photonics Platforms, Nicholas Fahrenkopf[1,2], Siti K. Binti[1,2], Cung Tran[1,2], Yukta Timalsina[1,2], Lewis G. Carpenter[1,2], Michael Zylstra[3], Hao Yang[3], Christopher Baiocco[1,2], Gerald Leake Jr[1,2], Christopher V. Poulton[3], David Harame[1,2]; [1]*Research Foundation for The State Univ. of New York, USA;* [2]*AIM Photonics, USA;* [3]*Analog Photonics, USA*. We present low-loss waveguide development on an active silicon photonics platform. Supported by AIM Photonics, the APSUNY component library provides seamless access to a full suite of devices compatible with this new process technology.

Th3H.2 • 14:30 **Invited**
Latest Progress and Challenges in 300mm Monolithic Silicon Photonics Manufacturing, Takako Hirokawa[1], Yusheng Bian[1], Ken Giewont[1], Abdelsalam Aboketaf[1], Sujith Chandran[1], Jae-Kyu Cho[1], Zahidur Chowdhury[1], Won Suk Lee[1], Qidi Liu[1], Prateek Sharma[1], Massimo Sorbara[1]; [1]*Globalfoundries Inc, USA*. In this paper we discuss the latest developments in the GlobalFoundries Fotonix™ program, including enhancements in device performance, packaging, PDK compact models, and in-house test capabilities.

Room 7

14:00–16:00
Th3I • Survivability and Fault Management
Presider: Zuqing Zhu; Univ of Science and Technology of China, China

Th3I.1 • 14:00
Unavailability Analyses of Hyperscale Data Center Interconnect Optical Networks with Optical Layer Protection, Lingling Wang[1], Lei Wang[1], Chunxiao Wang[1], Chongjin Xie[1]; [1]*Alibaba Cloud, Alibaba Group, China*. with massive field operation data collected from our production optical networks, we analyze the network unavailability of metro data center interconnect networks where optical layer protection is used, and the main factors affecting network unavailability are quantified.

Th3I.2 • 14:15
Scaling Optical Network Fault Management with Decentralized Graph Learning, Qunzhi Lin[1], Xiaokang Chen[1], Zhenlin Ouyang[1], Hanyu Gao[1], Xiaoliang Chen[1], Zhaohui Li[1]; [1]*Sun Yat-sen Univ., China*. We propose a decentralized graph learning framework for scaling cognitive fault management in optical networks. Results show the proposed design achieves >96% fault identification and localization accuracy.

Th3I.3 • 14:30
Optical Network Anomaly Detection and Localization Based on Forward Transmission Sensing and Route Optimization, Philip N. Ji[1], Zilong Ye[1,2], Yue-Kai Huang[1], Thomas Ferreira de Lima[1], Yoshiaki Aono[3], Koji Asahi[3], Ting Wang[1]; [1]*NEC Laboratories America Inc., USA;* [2]*California State Univ. Los Angeles, USA;* [3]*Transport Network Department, NEC Corporation, Japan*. We introduce a novel scheme to detect and localize optical network anomaly using forward transmission sensing, and develop a heuristic algorithm to optimize the route selection. The performance is verified via simulations and network experiments.

Room 8

14:00–16:00
Th3J • Machine Learning DSP
Presider: Gabriele Liga; Eindhoven Univ. of Technology (TUe), Netherlands

Th3J.1 • 14:00 **Invited**
Real-Time Implementation of Machine-Learning DSP, Erik Börjeson[1], Christian Häger[1], Per Larsson-Edefors[1], Keren Liu[1]; [1]*Chalmers Univ. of Technology, Sweden*. While ML algorithms can learn and adapt to channel characteristics, implementation of ML-based DSP hardware is challenging. We demonstrate a real-time implementation of a model-based ML equalizer that compensates a non-linear and time-varying channel.

Th3J.2 • 14:30
Non-Uniform Quantization and RUM for Optimizing Implementation of Real-Time FIR Equalization in Short-Reach Optical Links, Bohan Sang[1], Kaihui Wang[1], Luhan Jiang[1], Chen Wang[1], Yikai Wang[1], Jiaxuan Liu[1], Long Zhang[1], Jingtao Ge[1], Wen Zhou[1], Jianjun Yu[1]; [1]*Fudan Univ., China*. We propose non-uniform quantization and rotational-update mechanism for low-complexity equalization. It's verified in DDLMS for 92-Gbaud 10-km offline and 14.7456-Gbaud 25-km FPGA-based real-time PAM4 IM/DD experimental transmission, results show up to 99.5% multiplications are reduced.

Show Floor Programming

Meeting Rural Broadband Needs with High Capacity PON
14:00–15:00, *Theater II*

Current State and Future of Thin-Film Lithium Niobate Photonics
14:45–15:45, *Theater III*

An Ecosystem Perspective on Scaling Integrated Photonics for the AI Revolution
15:00–16:00, *Theater I*

Th3B • Practical Security Demonstration—Continued

Th3B.4 • 14:45
Field Trial of Quantum-Secured IPSec Tunnels with Chip-Based QKD, Philip Sibson[2], Jake Kennard[2], Thomas Crabtree[2], Paul Wright[1], Catherine White[1], Emilio Hugues-Salas[1], Andrew Lord[1], Gert Grammel[3], William Mead[3], Melchior Aelmans[3], Radko Radev[3], Steven Jacques[3]; *[1]BT, UK; [2]KETS Quantum, UK; [3]Juniper Networks, USA.* We report a field trial of chip-based QKD over 28.5km of deployed G.652 fibre, integrated using RFC 8784 with Juniper routers, with concurrent IPsec tunnels consuming independent keys. This illustrates practical quantum-resilient transport layer communication.

Th3B.5 • 15:00
Quantum-Safe 10 Gbps Site-to-Site IPsec VPN Tunnel Over 46 km Deployed Fibre, Obada Alia[1], Albert Huang[1], Huan Luo[1], Omar Amer[2], Marco Pistoia[2], Charles Lim[1]; *[1]Global Technology Applied Research, JP Morgan Chase, Singapore; [2]Global Technology Applied Research, JPMorgan Chase, USA.* We successfully demonstrated a 10 Gbps QKD-secured IPsec VPN tunnel between two JPMorgan Chase datacenters in a metro network over 46 km of deployed telecom fiber with over 168 hours of continuous operation.

Th3B.6 • 15:15
Solar-Blind QKD Over Simplified Short-Range FSO Link, Florian Honz[1], Michael Hentschel[1], Philip Walther[2], Hannes Hübel[1], Bernhard Schrenk[1]; *[1]AIT, Austria; [2]Faculty of Physics, Vienna Center for Quantum Science and Technology (VCQ), Univ. of Vienna, Austria.* We demonstrate QKD and data communication over an out-door free-space link where large-core fiber substitutes active alignment. We further prove E-band QKD as stable and robust under full daylight, despite the loss of spatial filtering.

Th3C • Free Space Optical Communication—Continued

Th3C.3 • 14:45
Experimental Demonstration of Fidelity Enhancement for Chaotic Signals in Free-Space Turbulent Channels Utilizing Vector Optical Field Manipulation, Xiangang Luo[1], Yiqun Zhang[2], Mingfeng Xu[1], Zheng Song[2], Mengjie Zhou[3], Jiazheng Ding[3], Mingbo Pu[1], Kun Qiu[2], Ning Jiang[2]; *[1]CAS Inst. of Optics and Electronics, China; [2]School of Information and Communication Engineering, Univ. of Electronic Science and Technology of China, China; [3]Tianfu Xinglong Lake Laboratory, China.* We experimentally demonstrate fidelity enhancement in transmitting chaotic signals through an indoor simulated kilometer-scale turbulence channel using vector optical field manipulation, which results in a 30% fidelity improvement relative to Gaussian beams under stronger turbulence.

Th3C.4 • 15:00
100m Free-Space Over 10Gbps Visible Light Laser Communication Using Gallium-Nitride Blue LD and Huffman-Coded Dyadic Probabilistic Shaping, Zengyi Xu[1,2], Yuning Zhou[1], Zhilan Lu[1], Jifan Cai[1], Nan Chi[1]; *[1]Fudan Univ., China; [2]Pengcheng Laboratory, China.* In this experiment, we achieved over 10Gbps transmission rate in a 100m free-space visible light laser communication system. Huffman-coded QAM provides probabilistic shaping effects and improves the system's working range and robustness against turbulence.

Th3C.5 • 15:15
Tailoring Rate and Latency of Free Space Optical Systems to Turbulence Conditions with Probabilistic Constellation Shaping and Data Interleaving, Rajiv Boddeda[1], Amirhossein Ghazisaeidi[1], Sébastien Bigo[1], Samar Rabeh[1], Guillaume Dovillaire[2], Sylvain Almonacil[1], Haik Mardoyan[1], Jeremie Renaudier[1]; *[1]Nokia Bell Labs France, France; [2]Imagine Optics, France.* We show up to 250 Gbps per carrier transmission is achievable with digital coherent technologies at 65dB link-loss. We jointly optimize symbol-rate, probabilistic shaping and interleaving while replicating strong turbulence conditions.

Th3D • Photonic Integration for Novel Applications—Continued

Th3D.3 • 15:00
Plasmonic on-Chip Antenna Enabling Fully Passive sub-THz-to-Optical Receiver for Future RoF Systems, Hande Ibili[1], Tobias Blatter[1], Laurenz Kulmer[1], Michael Baumann[1], Salim Turki[1], Yannik Horst[1], Stefan M. Koepfli[1], Boris Vukovic[1], Jasmin Smajic[1], Juerg Leuthold[1]; *[1]ETH Zurich, Switzerland.* We demonstrate a fully-passive on-chip antenna integrated plasmonic modulator receiver with a built-in field enhancement of 10'000 around 235GHz making RF electronics redundant. Transmission of up to 80Gbit/s in a wireless sub-THz link is shown.

Th3D.4 • 15:15
Space Qualifying Silicon Photonic Modulators and Circuits, Tingyi Gu[1], Dun Mao[1,2], Lorry Chang[1], Hwaseob Lee[1], Anthony Yu[3], Michael Krainak[4], Po Dong[2]; *[1]Department of Electrical and Computer Engineering, Univ. of Delaware, USA; [2]Coherent, USA; [3]Lasers and Electro-Optics Branch, NASA Goddard Space Flight Center, USA; [4]Relative Dynamics, USA.* Here we performed space experiments of photonic integrated circuits, revealing the critical roles of energetic charged particles. The year-long cosmic radiation does not change carrier mobility but reduces free carrier lifetime, resulting in unchanged electro-optic modulation efficiency and well-expanded optoelectronic bandwidth.

Th3E • MCF Based Transmission—Continued

Th3E.4 • 14:45
Experimental Demonstration of Single-Wavelength net 16.1Tb/s Self-Homodyne Coherent Transmission Over a 24-Core Fiber, Guofeng Yan[1], Min Yang[1], Kangrui Wang[1], Chengkun Cai[1], Bing Han[1], Zhenyu Wan[1], Yanjun Zhu[2], Hua Zhang[3], Chaonan Yao[3], Yuchen Shao[3], Jian Wang[1]; *[1]HUST, China; [2]Hisense Broadband Inc, 2580 North First Street, USA; [3]Hisense Broadband Multimedia Technologies Co, China.* We demonstrate the transmission of 102-Gbaud DP-16QAM signals over a 2.7km 24-core fiber in the SDM-SHD system, employing MHz-linewidth DFB laser and FIFO devices based on femtosecond laser direct writing technique.

Th3E.5 • 15:00 Invited
Tailoring Large Scale Manufacturing of MCF to High-Capacity Subsea Systems, Kevin W. Bennett[1]; *[1]Corning Research & Development Corp, USA.* Multicore fiber (MCF) targeted for use in subsea systems is under active development. There are many variables and constraints which must be considered in the design, fabrication, and deployment of this new type of fiber to enable its success. This talk will expand upon the details and performance achieved to date by subsea fiber manufacturers through the lens of manufacturing suitability.

Th3F • Sub-THz and mm-wave Signal Processing—Continued

Th3F.4 • 14:45
Integrated Photonic Microring Resonators for FSR Dependent Microwave Bandpass Filters, Ashitosh V. Velamuri[1], Bijoy K. Das[1]; *[1]Indian Inst. of Technology Madras, India.* We have proposed a uniquely designed silicon photonic microring resonator for microwave bandpass filters; FSR of the microring is key to define the centre frequency. A bandwidth tunable (1.4-4.5GHz) Ku-band filter has been demonstrated experimentally.

Th3F.5 • 15:00
Integrated Twisted Bilayer Graphene Photonic Upconverter for D-Band Wireless Links, Alberto Montanaro[1,2], Alex Boschi[3], Guillaume Ducournau[4], Vaidotas Mišeikis[3], Stefano Soresi[5], Mario Frecassetti[6], Paola Galli[6], Henri Happy[7], Sergio Pezzini[8], Camilla Coletti[3], Marco Romagnoli[1], Vito Sorianello[1]; *[1]CNIT, Italy; [2]Scuola Uperiore Sant'Anna, Italy; [3]IIT, Italy; [4]CNRS, France; [5]Inphotec, CamGraPhIC srl, Italy; [6]NOKIA, Italy; [7]IEMN, France; [8]CNR, Italy.* We report a compact D-band graphene photonics-based upconverter at 140 GHz for next generation 6G networks. We show 10Gb/s QPSK and 4Gb/s 16QAM transmission exploiting ultra-broadband (> 180GHz) operation of CVD-grown large-angle twisted-bilayer-graphene.

Th3F.6 • 15:15
Applications of Multicore-Fiber Nonuniformly-Spaced Delay Lines in Microwave Photonics, Mario A. González Pérez[1], Elham Nazemosadat[1], Ivana Gasulla Mestre[1]; *[1]ITEAM Research Inst., Universitat Politècnica de València, Spain.* We experimentally demonstrate a flat-top bandpass microwave filter and a fractional Hilbert transformer in a multicore fiber. Both applications operate based on nonuniformly-spaced delay lines, providing equivalent negative tap coefficients by adjusting their time delays.

Room 6E

Th3G • Optical Computing and Accelerators—Continued

Room 6F

Th3H • Photonics Manufacturing Technologies—Continued

Th3H.3 • 15:00
Mitigating Substrate Leakage Loss on a Monolithic SiPh Platform: Experimental Demonstration of Hybrid Si-SiN Waveguides for O-Band Datacom, Yusheng Bian[1]; [1]*GlobalFoundries, USA*. We introduce the concept of hybrid Si-SiN waveguides to mitigate substrate leakage on a monolithic-SiPh platform. Experimental data indicates an ~80% reduction in TM-waveguide loss (resulting in ~0.3 dB/cm-attenuation) and a 9-fold TM-bend loss reduction.

Th3H.4 • 15:15
High Performance Silicon Nitride Passive Optical Components on Monolithic Silicon Photonics Platform, Sujith Chandran[1], Yusheng Bian[1]; [1]*GlobalFoundries, USA*. We demonstrate low-loss silicon nitride passive optical components including straight and bend waveguides, 1×2MMI, 2×2MMI, directional-coupler and waveguide crossings on a monolithic silicon photonics platform. Hardware performance statistics substantiate the mass manufacturability of the building-blocks.

Room 7

Th3I • Survivability and Fault Management—Continued

Th3I.4 • 14:45
Detecting Anomalies in the Optical Layer Using Unsupervised Machine Learning, Sandra Aladin[1,2], Lena Wosinska[2], Christine Tremblay[1]; [1]*École de technologie supérieure, Canada;* [2]*Chalmers Univ. of Technology, Sweden*. We propose an unsupervised machine learning (ML) approach using field data for the detection of optical layer anomalies. We show how multivariate ML models can forecast hard failures by detecting soft failures.

Th3I.5 • 15:00
Expertise-Embedded Machine Learning for Enhanced Failure Management of Optical Modules in OTN, Zhiming Sun[1], Chunyu Zhang[1], Min Zhang[1], Bing Ye[2], Danshi Wang[1]; [1]*State Key Laboratory of Information Photonics and Optical Communications, Beijing Univ. of Posts and Telecommunications, China;* [2]*State Key Laboratory of Mobile Network and Mobile Multimedia Technology, China*. We propose an expertise-embedded approach for failure management of optical modules in OTN that incorporates expert decision-making logic into data-driven ML models, thereby enhancing inference capabilities. Empirical assessments reveal a marked performance enhancement in models post-embedding, particularly in few-shot failure scenarios.

Th3I.6 • 15:15
Spatio-Temporal Failure Prediction Using LSTGM for Optical Networks, Cheng Xing[1], Chunyu Zhang[1], Yu Wang[2], Zhiyan Duan[2], Wenjie Song[2], Min Zhang[1], Danshi Wang[1]; [1]*Beijing Univ of Posts & Telecom, China;* [2]*The Intelligent Network Innovation Center of Chinaunicom of China United Network Communications Group Co., Ltd., China*. A Latent Spatio-Temporal Graph Model is proposed for failure prediction in optical networks, which can effectively learn both spatial and temporal distribution of real equipment performance data and achieve F1-score up to 0.9745.

Room 8

Th3J • Machine Learning DSP—Continued

Th3J.3 • 14:45
Transmitter Nonlinearity Mitigation Using Direct Learning Architecture Based Digital Predistortion Coefficients Identification, Zepeng Gong[2,1], Fan Shi[1], Ming Luo[2], Xu Zhang[2], Yuhan Gong[2], Xiang Li[1], Tianye Huang[1], Xi Xiao[3]; [1]*China Univ. of Geosciences, China;* [2]*China Information and Communication Technologies Group Corporation (CICT), China;* [3]*National Information Optoelectronics Innovation Centre, China*. We propose to identify the coefficients of digital predistortion equalizer based on direct learning architecture (DLA) for 100 GBaud 16QAM and 80 GBaud 64QAM transmission. Effective SNR improvement of 0.54dB and 0.66dB were experimentally verified.

Th3J.4 • 15:00
Machine Learning-Aided Nonlinearity-Tailored Carrier Phase Recovery for Subcarrier Multiplexing Systems, Manuel Neves[1], Abel Lorences-Riesgo[2], Paulo Monteiro[1], Fernando P. Guiomar[1]; [1]*Instituto De Telecomunicacoes, Portugal;* [2]*Optical Communication Technology Lab, Huawei Technologies France, France*. Nonlinear phase noise (NLPN) hampers the benefits of digital subcarrier multiplexing (DSCM) systems. Our paper introduces a low-complexity carrier phase recovery (CPR) method for countering NLPN in DSCM systems, achieving 0.5 dB improvement over conventional CPR.

Th3J.5 • 15:15
Fully-Blind Neural Network Based Equalization for Severe Nonlinear Distortions in 112 Gbit/s Passive Optical Networks, Vincent Lauinger[1], Patrick Matalla[2], Jonas Ney[3], Norbert Wehn[3], Sebastian Randel[2], Laurent Schmalen[1]; [1]*CEL, Karlsruhe Inst. of Technology, Germany;* [2]*IPQ, Karlsruhe Inst. of Technology, Germany;* [3]*RPTU Kaiserslautern-Landau, Germany*. We demonstrate and evaluate a fully-blind digital signal processing (DSP) chain for 100G passive optical networks (PONs), and analyze different equalizer topologies based on neural networks with low hardware complexity.

Show Floor Programming

Meeting Rural Broadband Needs with High Capacity PON
14:00–15:00, *Theater II*

Current State and Future of Thin-Film Lithium Niobate Photonics
14:45–15:45, *Theater III*

An Ecosystem Perspective on Scaling Integrated Photonics for the AI Revolution
15:00–16:00, *Theater I*

Room 1B

Th3B • Practical Security Demonstration—Continued

Room 2

Th3C • Free Space Optical Communication—Continued

Th3C.6 • 15:30
Reliability Enhancement in FSO Communications Using FMF Assisted by Subcarrier Multiplexing, Manuel José M. de Freitas[2,1], Marco A. Fernandes[2,1], Vitor Correia[2,1], Paulo Monteiro[2,1], Fernando P. Guiomar[2,1], Gil Fernandes[2,1]; *[1]Universidade de Aveiro, Portugal; [2]Instituto de Telecomunicações, Portugal.* We exploit the frequency diversity offered by digital subcarrier-multiplexing to overcome the coherent combining challenge associated with the use of FMF in FSO systems. Experimental validation at 200 Gbps in an atmospheric chamber reveals reliability gains of >20% compared with an equivalent single-mode coupling system.

Th3C.7 • 15:45
Eye-Safe Terabit-Class WDM Optical Wireless: How Many Channels are Enough?, Marco A. Fernandes[1], Gil Fernandes[1], Bruno T. Brandão[1], Manuel José M. de Freitas[1], Nourdin Kaai[2], Alina Tomeeva[2], Bas v. Wielen[2], John Reid[2], Daniele Raiteri[2], Paulo Monteiro[1], Fernando P. Guiomar[1]; *[1]Instituto De Telecomunicacoes, Portugal; [2]Aircision, Netherlands.* On the path towards Terabit-class optical wireless, the use of WDM technology poses many practical questions. Supported by a 1.8 km field-trial, and multiplexing up to 16×200G channels, we expose the tradeoffs between capacity and reliability depending on the channel count, optical pre-amplification architecture and coding requirements.

Room 3

Th3D • Photonic Integration for Novel Applications—Continued

Th3D.5 • 15:30
Sub-1V Near-Infrared Thin-Film Lithium Niobate Modulator for High-Speed Visible Communication, Daniel R. Assumpcao[1], Dylan Renaud[1], Amirhassan Shams-Ansari[1], Marko Loncar[1]; *[1]Harvard, USA.* We demonstrate state-of-the-art ultra-low voltage (0.7V), high-bandwidth modulators in thin-film lithium niobate operating at near-infrared wavelengths (850nm) and show the ability to transmit 60 GBd signals with direct electrical driving (400 mV_{pp}).

Th3D.6 • 15:45
High Temperature and Large Bandwidth Blue InGaN/GaN Micro-LEDs, Daniel Rogers[1], Haotian Xue[1], Fred Kish[1], Bardia Pezeshki[2], Alex Tselikov[2], Jonathan Wierer[1]; *[1]North Carolina State Univ., USA; [2]Avicena Tech, USA.* InGaN/GaN micro-light-emitting diodes with the highest bandwidths at very high temperatures (3.2 GHz at 290C) are demonstrated. Differential carrier lifetime analysis is undertaken to understand recombination-related effects on the modulation response.

Room 6C

Th3E • MCF Based Transmission—Continued

Room 6D

Th3F • Sub-THz and mm-wave Signal Processing—Continued

Th3F.7 • 15:30
Narrowband Noise Filtering of Arbitrary Waveforms by Reversible in-Fiber Temporal Talbot Sampling, Majid Goodarzi[1], Manuel P. Fernandez[1,2], Xinyi Zhu[1], José Azaña[1]; *[1]Institut National de la Recherche Scientifique (INRS), Canada; [2]Instituto Balseiro (UNCuyo-CNEA) & CONICET, Argentina.* We effectively employ temporal Talbot effects to filter narrowband optical noise beyond optical bandpass filter capabilities in MHz-bandwidth temporal waveforms and random data signals, recovering buried optical signals and enhancing optical signal-to-noise ratio.

Th3F.8 • 15:45
Ultra-Large Key Space Multi-Dimensional Masking Encryption System for DSM-Based D-Band Wireless Fronthaul, Tianqi Zheng[1], Kaihui Wang[1], Xiongwei Yang[1], Qiutong Zhang[1], Weiping Li[1], Yi Wei[1], Feng Wang[1], Xianming Zhao[2], Feng Zhao[3], Jianjun Yu[1]; *[1]Fudan Univ., China; [2]The Inst. of Future Information Technology, Harbin Inst. of Technology, China; [3]School of Automation Xi'an Univ. of Posts and Telecommunications, School of Automation Xi'an Univ. of Posts and Telecommunications, China.* We implement a multi-dimensional masking encryption scheme with an ultra-large key space of 10^{143} in a photonics-aided millimeter radio-over-fiber (ROF) system. The equivalent 1.67GBaud encrypted-4096QAM signal is successfully transmitted and decrypted over a 4.6-km wireless link in the DSM-based D-band wireless fronthaul system.

16:00–16:30 Coffee Break, *Upper Level Corridors*

16:30–18:30 Postdeadline Paper Sessions, *Room 6C, 6D, 6E, 6F*

Room 6E

Th3G • Optical Computing and Accelerators—Continued

Room 6F

Th3H • Photonics Manufacturing Technologies—Continued

Th3H.5 • 15:30
Low-Temperature and Hydrogen-Free Silicon Dioxide Cladding for Next-Generation Integrated Photonics, Zihan Li[1,2], Zheru Qiu[1,2], Rui N. Wang[3], Xinru Ji[1,2], Marta Divall[1,2], Anat Siddharth[1,2], Tobias J. Kippenberg[1,2]; *[1]École Polytechnique Fédérale de Lausanne, Switzerland; [2]Center for Quantum Science and Engineering, EPFL, Switzerland; [3]Luxtelligence SA, Switzerland.* We demonstrate a process for hydrogen-free low-loss silicon oxide films deposited using $SiCl_4$ and O_2 as precursors. A wide low-loss window from 1260 nm to 1625 nm is achieved at deposition temperature of 300 °C.

Th3H.6 • 15:45
Arbitrary Mode Size Conversion with 3D-Nano-printed Couplers: a Generic Coupling Strategy, Huiyu Huang[1], Zhitian Shi[1], Giuseppe Talli[2], Maxim Kuschnerov[2], Richard V. Penty[1], Qixiang Cheng[1]; *[1]Univ. of Cambridge, UK; [2]Huawei Technologies Duesseldolf GmbH, European Research Center, Germany.* We present a solution for efficient off-chip coupling with no requirement of on-chip mode engineering and additional manufacturing processes. A 10.4μm to 4μm fiber-to-chip mode-field-dimension conversion is demonstrated with ~2dB loss across >100nm wavelength range.

Room 7

Th3I • Survivability and Fault Management—Continued

Th3I.7 • 15:30
DC-Carrier Cooperation for Rapid Restoration Against PNE-Node Failure in Optical Networks, Subhadeep Sahoo[1], Sifat Ferdousi[1], Sugang Xu[2], Yusuke Hirota[2], Massimo Tornatore[1,3], Yoshinari Awaji[2], Biswanath Mukherjee[1,4]; *[1]Univ. of California Davis, USA; [2]National Inst. of Information and Communications Technology, Japan; [3]Politecnico di Milano, Italy; [4]Soochow Univ., China.* We propose a rapid restoration strategy against PNE-node failure during post-disaster cooperation among DC providers and optical-network carriers. Our strategy reduces disruption and improves DC-service restoration by 35% in 20% less time compared to baseline.

Th3I.8 • 15:45
Disaggregated Confidentiality-Preserving Scheme for Fault Detection in Optical Networks, Rafael F. Sales[1], Andrei N. Ribeiro[1], Moises F. Silva[2], Fabricio R. Lobato[1], Andrea Sgambelluri[3], Luca Valcarenghi[3], João w. Costa[1]; *[1]Universidade Federal do Pará, Brazil; [2]Los Alamos National Laboratory, USA; [3]Scuola Superiore Sant'Anna, Italy.* We propose a confidentiality-preserving approach based on distributed principal component analysis (PCA) and telemetry data scrambling to detect hard-failures in optical networks. Experiments in a real optical testbed show the suitability of the proposed disaggregated solution.

Room 8

Th3J • Machine Learning DSP—Continued

16:00–16:30 Coffee Break, *Upper Level Corridors*

16:30–18:30 Postdeadline Paper Sessions, *Room 6C, 6D, 6E, 6F*

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Key to Authors and Presiders

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