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The information in this program is as of 18 January 2023.

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.

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Conference Schedule at a Glance

All times reflect Pacific Time Zone	Sunday 05 March	Monday 06 March	Tuesday 07 March	Wednesday 08 March	Thursday 09 March
Registration	07:30–19:00	07:30–17:30	07:00–18:00	07:30–17:00	07:30–15:00
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	08:00–16:00
Symposium: Quantum Information and Optical Communication Networks: Emerging Research Areas, Challenges and Opportunities		14:00–18:30			
Symposium: The Crucial Role of Photonics in Achieving the UN Sustainability Development Goals: Learnings and Opportunities			14:00–18:30		
Symposium: Beyond the Hype of Network Analytics: Use Cases, Feasibility and Barriers				14:00-18:30	
Special Session: Ultra-Stable Frequency Sources and their Future Applications in Telecom		08:00–10:00			
Special Session: High Performance Networks for Future Data Center and Computing Applications		10:30–12:30			
Special Session: Photonics for Visible Wavelengths				08:00–16:00	
Open Networking Summit: Top to Bottom: Practical Approaches to Openness, Disaggregation, and Reaggregation in Optical Communication				16:30–18:30	
Demo Zone		14:00–16:15			
Rump Session: Is the Silicon Photonics Platform about to be Standardized, Diversified or Supplanted?			19:30–21:30		
Poster Sessions				10:30–12:30	10:30–12:30
Postdeadline Papers					16:30–18:30
Exhibition and Show Floor Activities					
Exhibition and Show Floor (includes Expo Theater I, II, III, Career Zone and Suzanne R. Nagel Lounge) Unopposed 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)
Market Watch - Expo Theater I *Sponsored by Cisco*			10:30–15:30	14:45–16:15	10:30–13:45
Network Operator Summit - Expo Theater I				10:15–14:30	
Data Center Summit – Expo Theater II *Sponsored by Amphenol*			12:00–15:45		
Special Events					
Optical Transmission Systems – Design and Simulation Workshop (Presented by the Optica Foundation & VPIphotonics)	13:00–18:00				
OFC Mentor/Mentee Meet-Up		12:00–13:00			
The Journal Review Process: All You Need to Know!		14:00–15:30			
Birds of a Feather: Designing and Operating the Next Generation Optical Photonic Networks		16:30–18:30			
Photonics Society of Chinese Heritage Workshop & Networking Social		17:00–19:30			
Student Party		19:00–21:00			
Plenary Session			08:00–10:00		
Conversation with the Plenary Speakers			10:15–10:45		
Optical Communications Technical Group Poster Pitch Competition			11:00–12:00		
Awards Ceremony and Luncheon *Supported by Corning*			12:00–14:00		
Conference Reception			18:30–20:00		
International Women's Day Breakfast				07:00–08:30	
The Art of Writing the Perfect OFC Paper				10:30–12:00	
Rise and Shine Fun Run/Walk					06:00–07:00

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- Parking
- Coat and Baggage Check
- Restaurant Information
- General Conference Information
- Lost and Found (for after-hours Lost and Found, please go to the OFC Security Office located in Show Office D. Look for the security sign).

Exhibition

Exhibit Halls B-G

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, 07 March Unopposed Exhibit-Only Time	10:00–17:00 10:00–14:00
Wednesday, 08 March Unopposed Exhibit-Only Time	10:00 -17:00 12:30–14:00
Thursday, 09 March Unopposed Exhibit-Only Time	10:00–16:00 12:30–14:00

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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, 05 March	08:00–17:00
Monday, 06 March	08:00–17:00
Tuesday, 07 March	08:00–17:00
Wednesday, 08 March	08:00–17:00
Thursday, 09 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. The media room is restricted to registered media/analysts holding a Media badge.

Media Center Hours

Sunday, 05 March	12:00–16:00
Monday, 06 March	07:30–18:00
Tuesday, 07 March	07:30–18:00
Wednesday, 08 March	07:30–18:00
Thursday, 09 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, 07 March	10:00–16:45
Wednesday, 08 March	10:00–16:30
Thursday, 09 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.

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2. Go to ofcconference.org/app
3. Scan the QR code

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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 in alphabetical order and set bookmark reminders to stop by booths. Tap on the map icon within a description, and you'll find locations on the Exhibit Hall map. View a daily schedule of all activities occurring on the show floor.

Technical Digest Papers
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Registration

Lobby D

Sponsored by ACACIA COMMUNICATIONS, INC. now part of Cisco

Hours:

Sunday, 05 March	07:30–19:00
Monday, 06 March	07:30–17:30
Tuesday, 07 March	07:00–18:00
Wednesday, 08 March	07:30–17:00
Thursday, 09 March	07:30–15:00

Speaker Ready Room

Room 11

All speakers and presiders are required to report to the Speaker Ready Room at least 1 hour before their sessions begin. Computers will be available to review uploaded slides.

Speaker Ready Room Hours*

Sunday, 05 March	13:00–17:00
Monday, 06 March	07:00–18:00
Tuesday, 07 March	10:00–18:00
Wednesday, 08 March	07:00–18:00
Thursday, 09 March	07:00–15:30

*Market Watch and Network Operator Summit speakers should go directly to Exhibit Hall C in Expo Theater I (#5335) to upload their presentations.

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Short Course Schedule

Sunday, 05 March 2023

08:30–12:30 (UTC - 08:00)

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

SC203: 400 Gb/s and Beyond Optical Communication 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*

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*; Howard Wang, *Nokia, USA*

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

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

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, *Google, 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 (UTC - 08:00)

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

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

SC444: Optical Communication Technologies for 5G and F5G
Dr. Xiang Liu, *Huawei Technologies, China*

13:00–16:00 (UTC - 08:00)

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

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

13:00–17:00 (UTC - 08:00)

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

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

SC514: FEC Techniques for Optical Communications NEW
Georg Böcherer, *Huawei Technologies, Germany;* Alex Graell i Amat, *Chalmers University, Sweden*

Monday, 06 March 2023

08:30–12:30 (UTC - 08:00)

SC102: WDM in Long-haul Transmission Systems
Neal S. Bergano, *Retired, USA*

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

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

SC448: Evolving Software Defined Optical Network: Architecture and Design Principles
Ramon Casellas, *CTTC, Spain*

SC452: FPGA Prototyping for Optical Subsystems
Noriaki Kaneda, *nEye systems Inc, USA*; Robert Elschner, *Fraunhofer HHI, Germany*

SC453A: Hands-on: Fiber Optic Handling, Measurements, and Component Testing
Steve Baldo, *Seikoh Giken, USA*; Chris Heisler, *OptoTest Corporation, USA*; Steve Lane and Julien Maille, *Data-Pixel, France*

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

SC472: Hands-on: Controlling and Monitoring Optical Network Equipment
Ricard Vilalta, *CTTC, Spain*

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 NEW
Petar Pepeljugoski, *IBM Research, USA*;
Greg D. Le Cheminant, *Keysight Technologies, USA*

09:00–12:00 (UTC - 08:00)

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

SC450: Design, Manufacturing, and Packaging of Opto-electronic Modules
Peter O'Brien, *Tyndall National Institute, Ireland;*
Yoichi Taira, *Keio University, Japan*

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

13:30–16:30 (UTC - 08:00)

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*

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

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

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

13:30–17:30 (UTC - 08:00)

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

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

SC327: Modeling and Design of Long-haul Fiber-optic 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*

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

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, *OptoTest Corporation, USA*, Steve Lane and Julien Maille, *Data-Pixel, France*

Special Programming

Workshops

Sunday, 05 March, 13:00–15:30

S1A: Smart Pluggable Coherent Optics: Is it the End of Layered IP Over DWDM?

Room: 6C

Organizers: Fatima Gunning, *Tyndall National Institute, Ireland;* Alejandra Beghelli, *University College London, United Kingdom;* Norman Swenson, *Norman Swenson Consulting, USA;* Dirk Van den Borne, *Juniper, Germany*

The traditional layered IP/DWDM network architecture – where the IP layer is housed in a separate infrastructure and operated/managed independently from the optical layer - has successfully accommodated the exponential growth of traffic for the past two decades. Coherent technology innovation has enabled network capacity growth while reducing the cost per bit in the optical layer. Network Processing Units (NPUs) in IP routers can today process many Terabits per ASIC. However, with Shannon's capacity limit and the end of Moore's law in sight, how will networks continue to evolve?

Smart pluggable optics may enable future growth while eliminating the redundant hardware, control plane and management layers, leading to increased efficiency in cost and energy, enabling true integrated IP over DWDM. However, will power and space constraints limit their optical performance and hence limit the use cases that smart pluggable modules can address? How can we effectively manage such smart pluggable modules? Traditionally, personnel responsible for Layer 3 operations have been unfamiliar with the network planning required for complex Layer 0/1 network configuration. Automation and software-defined network functionality can help with this, but are they enough? Is it possible to decouple advances in module transport capabilities from the development cycles of the host routers such that management software does not need to be rewritten or upgraded with every improvement in smart optics capabilities?

This workshop will explore the various aspects of introducing smart pluggable optics to new network architectures. In Part I, we will focus on use cases for integrated IP over DWDM versus traditional layered IP and transport solutions. In Part II, we will discuss the control and management challenges of an integrated IP over DWDM network architecture.

Speakers:
Heidi Adams, *Nokia, Canada*
Ian Alderdice, *Ciena, USA*
Oscar Gonzalez de Dios, *Telefonica, Spain*
Steven Hand, *Infinera, USA*
Tad Hofmeister, *Google, USA*
Maxim Kuschnerov, *Huawei, Germany*
Qingyun (Wendell) Liu, *Verizon, USA*
Tim Pennell, *Juniper Networks, USA*
Glenn Wellbrock, *Verizon, USA*

S1B: Quantum Dots – The Resurrection?

Room: 6D

Organizers: Hai-Feng Liu, *HG Genuine Optics Tech Co.,Ltd, China;* Martin Schell, *Fraunhofer HHI, Germany;* Tomoyuki Akiyama, *Fujitsu, Japan*

After more than 30 years of research and more than ten years since the first field deployments, quantum dot (QD) based lasers and semiconductor optical amplifiers (SOAs) have recently begun generating strong interest. QDs offer unique properties and additional degrees of freedom in design compared to traditional quantum wells. They are being explored for use in various applications and monolithic integration into silicon photonics manufacturing platforms. Is this resurgence based on the improved quality of the quantum dots or fundamentally new properties? Is isolator-free on-chip silicon integration the "killer app"? Is this success transferable back to III/V substrates like InP or GaAs? Where further can quantum dots go in performance? Will CdSe, ZSe, or other colloidal quantum dots play a role?

Speakers:
Namyoung Anh, *Los Alamos National Laboratory, USA*
Yasuhiko Arakawa, *Tokyo University, Japan*
Alexey Kovsh, *Alfalume, USA*
Alan Y Liu, *Quintessent, USA*
Huiyun Liu, *University College London, UK*
Martin Moehrle, *Fraunhofer HHI, Germany*
Johann Peter Reithmaier, *University of Kassel, Germany*
Stephan Reitzenstein, *Technical University of Berlin, Germany*
Mitsuru Sugawara, *QD Laser, Japan*
Maksym Sych, *Aegiq, UK*

S1C: Is Optical Access in Good Shape for the Future?

Room: 6E

Organizers: Dora Van Veen, *Nokia Corporation, USA;* Mu Xu, *CabelLabs, USA;* Naveena Genay, *Orange Labs Network, France;* Tetsuya Kawanishi, *Waseda University, USA*

Recently the remote work/entertainment situation enforced by the outbreak of COVID-19 pandemic has shown the importance of upgrading the access network to enable needed services.

In this workshop, we will discuss the status of optical access, how optical access will look in the future, and if we are in good shape.

Copper access is being upgraded to optical access because of increasing demand for more data rate for super-broadband services with minimum latency for fixed networks' applications for residential and business users that have evolved, like gaming, holograms, AR/VR, Industry 4.0, live sport/music viewing, etc.

In addition to the residential and business use cases, another use case that will shape future optical access is mobile backhauling. This use case requires optical links that are capable of high data rates. Mobile users' high data rates and applications have evolved, meaning convergence of fixed and mobile services, the use of small cells, sensors, IoT, more flexibility, and strict

requirements for latency are needed. But what data rate do we need for 5G, 20 Gb/s per user? Do we need a peak rate over 100 Gb/s by 2030 for 6G?

We will consider energy efficiency, low carbon emission networks, and resilient networks (lifeline, battery, etc.) for future access. Optical networks are also expected to assist with societal requirements (fire assistance, sensors for agriculture, water level monitoring, climate, etc.) to support the Sustainable Development Goals (SDGs) by the United Nations.

To enable all the emerging use cases for optical access, a cost-effective symmetrical data rate of 100 Gb/s and beyond will be needed. In addition, new optical access standards, and what comes after the 25G and 50G-PON standards? Topics for discussion include IM/DD versus coherent, introduction of flexibility, and point-to-point versus point-to multipoint architectures. Will optical access standards move forward for all types of architectures? Will cost-effective coherent access be feasible?

Speakers:
Pham Tien Dat, *NICT, Japan*
Saifuddin Faruk, *University of Cambridge, UK*
Roberto Gaudino, *Politecnico di Torino, Italy*
Ed Harstead, *Nokia, Germany*
Paulo Monteiro, *University of Averio, Portugal*
Derek Nesset, *Huawei, Germany*
Kazuki Tanaka, *KDDI Labs, Japan*
JunShan Wey, *Verison, USA*

S1D: Will Optics Have a Role to Play in Scaling Out Future Quantum Computing Architectures? (Part 1)

Room: 6F

Organizers: Mekena Metcalf, *Lawrence Berkley, USA;* Eleni Diamanti, *Universite Pierre et Marie Curie, France;* Daniel Kilper, *Trinity College Dublin, Ireland;* Fotini Karinou, *Microsoft Research Ltd, UK*

Scaling quantum computing architectures is trending towards interconnected quantum processing units. For several platforms that require increasingly larger dilution refrigerators, communication between the modular quantum chips based on electrical/RF connections is a limitation due to the limited thermal load capacity the refrigerator can support. Other platforms expected to operate at higher temperatures would eventually face similar challenges. Optical interconnects are a potential answer to this scaling challenge to enable multi-chip communication. Such topologies would require thr conversion of qubits to optical wavelengths for some platforms and, more generally, transmission over a networked quantum computing architecture, i.e., notionally a "quantum data center."

Further, control of quantum computers necessitates a hybrid computing framework with both classical and quantum resources. In the first session, this workshop will encapsulate industry strategies for scaling quantum computing for various qubit technologies with classical control frameworks. The secondary session will cover the technologies and challenges facing quantum interconnects.

Session 1: This session will give an overview of different technologies/platforms the industry is pursuing to build a scalable quantum computing architecture. The Speakers will present their chosen technology, their vision toward a scalable computing platform, the challenges and the role of optics in their roadmap.

Session 2: This session will focus on different material platforms and devices as building blocks to enable various essential quantum system functionalities and their integration and packaging aspects to address system challenges induced by cryogenic environments.

Speakers:
Mercedes Gimeon-Segovia, *VP System Architecture, PsiQuantum, USA*
Jungsang Kim, *Co-Founder and Chief Technology Officer, IonQ Inc., USA*
Jason Orcutt, Principal Research Scientist, *IBM Quantum, USA*
Richard Rouse, *Microsoft, USA*

S1E: Is It Really Game Over for the Quest to Approach Fiber Capacity Limits?

Room: 7AB

Organizers: Gabriele Liga, *Eindoven University of Technology, Netherlands;* David Millar, *Infinera, USA;* Sergejs Makovejs, *Corning, USA*

After a decade of intense research and animated discussions around new approaches to increase the spectral efficiency (SE) of single-mode optical fiber transmission systems, we now see a significant slowdown in achievable SE gains as improvements become more challenging and costly. Therefore, the question of improving system SE appears to be beyond the scope of just modem improvements for the first time in many years. As a result, the balance between optical transmission power, SE gains, and investment cost needed to develop more advanced solutions is ever so harder to strike. Yet, no one knows with absolute certainty how much fiber capacity gain can be achieved in the coming years and with what level of implementation complexity.

This workshop will address a fundamental question: is it still worth trying to squeeze more SE out of optical fiber transmission systems? And if not, what are the most attractive alternative options to keep up with the current network capacity demand? Other questions to discuss in this workshop will include the following:

- Increasing number of spatial paths (more fibers per cables, new fiber designs, etc.) is promising, but is it the only way forward?
- Is it worth realizing the remaining SE gains, and which tools should we use? Are ultra-wide bandwidth solutions also valid contenders?
- What is the practical limit on bit-rate per wavelength (1.6Tb/s, 3.2Tb/s, etc.)? Are there any options to overcome this limit?
- Pluggable transceivers have somewhat reduced performance with significantly reduced power and size. Will they enable the next wave of capacity growth throughout the network?

- How much network capacity growth do we need in different parts of the networks (today and in the future)? Should we think about network capacity vs. p-t-p route capacity?

Speakers:
Cristian Antonelli, *UnivAQ, Italy*
Vahid Aref, *Nokia, Canada*
John Downie, *Corning, USA*
Takemi Hasegawa, *Sumitomo Electric, Japan*
Kishore Kota, *Marvell, USA*
Rob Maher, *Infinera, USA*
Eduardco Mateo, *NEC, Japan*
Jeff Rahn, *Meta, USA*
Massimilliano Salsi, *SSSUP, Italy*
Marco Secondini, *Scuola Superiore Sant'Anna, Italy*
Glenn Wellbrock, *Verison, USA*
Metodi Yankov, *DTU, Denmark*

S1F: Where are the Boundaries Between IM-DD and Coherent?
Room: 8

Organizers: Clint Schow, *Univ. of California, Santa Barbara, USA;* Di Che, *Nokia Bell Labs, USA;* Sam Palermo, *Texas A&M University, USA;* Paola Parolari, *Politecnico di Milano, Italy*

Despite the continuous debate between IM-DD and Coherent, it is an irresistible trend that Coherent has gradually encroached the market share of IM-DD. The extensive deployment of 400ZR over the past few years has marked a big success of Coherent to single-span transmissions like metro/datacenter inter-connects. Currently, academia and industry are actively developing next-generation coherent solutions targeting even shorter distances such as <10km data-center intra-connects and optical access networks. Besides the advances of DSP/Photonic integration, a hotly pursued pathway to accelerate the expansion of Coherent is Coherent Lite, aiming to simplify or even remove the power-hungry DSP by using lower symbol rate, simpler modulation format, and specially designed analog electronic or optical subsystems.

Though the coherent camp has the ambition to rule the world, the IM-DD camp believes they'll hold their last stand where the parallel optics solve all the problems and Coherent makes no sense. The question is whether such a stand exists, and if so, where is the eventual boundary between IM-DD and Coherent? The boundary can be characterized by various metrics like data rate, distance, power consumption and transceiver cost, and may be closely related to the application drivers. This workshop will discuss such boundaries and address typical questions like:

- Will Coherent Lite find its position in the competition between IM-DD and Coherent?
- Is there a practical technique for an all-analog coherent system to avoid the ADC and DSP?
- Will there be a common and interoperable implementation for Coherent like 400ZR for shorter-distance applications, or will the solutions be diversified?
- Will the local oscillator wavelength management kill the application of Coherent to ultra-short-reach uncooled applications?
- Is it worth sending a remote light through a separate link for self-homodyne coherent detection?
- Can coherent access really meet the end users' stringent power/cost limit, and if so, how far we're away from that?

This workshop will invite speakers from academia, system and module vendors, datacenter and access operators to provide a diversity of perspectives.

Speakers:

Hector Andrade, *Univ. of California, Santa Barbara, USA*
Matt Sysak, Ayar Labs, USA
Tao Gui, *Huawei, China*
Zhensheng Jia, *Cable Labs, USA*
Hong Liu, *Google, USA*
Radha Nagarajan, *Marvell, USA*
Fabienne Saliou, *Orange Labs, France*
Seb J. Savory, *University of Cambridge, UK*
Yawei Yin, *Microsoft, USA*
Hongbin Zhang, *Cisco, USA*

Sunday, 06 March, 16:00–18:30

S2A: Revolutionary vs. Evolutionary SDM Fibers: Extra Gain at Extra Complexity
Room: 6C

Organizers: Tetsuya Hayashi, *Sumitomo Electric Industries Ltd , Japan;* Inna Kozmina, *Corning, USA;* Pierre Sillard, *Prysmian Group, France;* Benyuan Zhu, *OFS Laboratories, USA*

Rising network traffic, driven by consumer bandwidth demand, creates a capacity challenge for networks of all types. The search for scalable capacity has become a driving force in network systems. Space Division Multiplexing (SDM) is a viable approach as it increases the relative core density in a given system. In data center applications, it could solve practical installation problems of very large fiber counts in data center interconnect (DCI) links. In a submarine, it offers a path towards 1-5 Pb/s subsea cable capacity. The latter presents the ultimate challenge due to high-reliability requirements and power-limited cable designs on top of the high-capacity transmission. The debate will therefore focus on which technology will emerge to meet challenging 5 Pbps cable capacity targets in a submarine. Scalability, ecosystem readiness, compatibility with incumbent systems, and mechanical robustness are among the factors to be addressed for two leading solutions: multicore (MCF) and reduced geometry (Cladding or Coating) fibers

Speakers:
Mattia Cantono, *Google, USA*
Olivier Courtois, *Alcatel Submarine Networks, France*
Hans Damdgaard, *OFS, Denmark*
Lidia Galdino, *Corning, UK*
Stephen Grubb, *Meta, USA*
Takemi Hasegawa, *Sumitomo Electric, Japan*
Takanori Inoue, *NEC, Japan*
Victor Kopp, *Chiral Photonics, USA*
Alexei Pilipetskii, *Subcom, USA*
Shigehiro Takasaka, *Furukawa, Japan*

S2B: Will Machine Learning be the Killer Application for Optical Networks in Data Centres

Room: 6D

Organizers: Georgios Zervas, *University College London, UK;* Hitesh Ballani, *Microsoft, USA;* Manya Ghobhadi, *MIT, USA*

Machine learning models increase x10 every 18 months. Custom processors (TPUs, NPUs, xPUs) used for ML tasks support significantly higher I/O bandwidth compared to CPUs. However, the scalability and training time significantly depends on network performance. Current electronic multi-layer networks, due to over-subscription and large network diameter, lead to significant overheads and could limit the scale and efficiency of the system and ML applications. This workshop will explore methods used to scale models (data/model/hybrid parallelism) across hundreds and thousands of processing units, discuss existing network solutions and explore the potential and challenges of optical networks. 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 include:

- Can electronic packet switching and traditional pluggable transceivers sustain the performance and power consumption demanded by the rapid growth of ML models?
- What are the requirements for broad adoption of fast all-optical switching and networking?
- Will optical networks change how we design distributed deep learning training systems and processes?

Part 1. Session on methods and current systems to support large-scale ML models.

Part 2. Potential and challenges of optical networks for ML systems.

Speakers:
Larry Dennison, *NVIDIA, USA*
Alessandro Ottino, *University College London, UK*
Josh Shalf, *Lawrence Berkley National Laboratory, USA*
Sergey Shumarayev, *Intel Corporation, USA*

S2C: Perennial Bandwidth at Home: LiFi or FiWi?

Room: 6E

Organizers: Bernhard Schrenk, *Austrian Institute of Technology, Austria;* Eduward Tangdiongga, *Eindhoven University of Technology, Netherlands;* Chi-Wai Chow, *National Chiao Tung University, Taiwan*

With access to fiber broadband, the user experience is strongly linked to home network performance. Towards this direction, Fiber-to-the-Room (FTTR) is now being investigated as a perennial deep-fiber infrastructure within ITU-T SG15 and ETSI F5G. FTTR poses a lot of questions concerning its opportunities. It also positions wireless in-house access in a new context: FTTR as an extender for WiFi6 promises Gbps connectivity in a quasi-interference-free environment, with considerable potential for wireless bandwidth upgrades when moving to (sub-)mm-wave technology readily maturing through Beyond-5G efforts. Will FiWi deployment within the premises cannibalize efforts to make LiFi a commodity? Are there still unmet requirements that can only be addressed through LiFi? Will LiFi co-exist or rather cease to exist? The workshop aims to address these pressing questions by bringing together speakers from academia and industry to discuss the deployment aspects of future home networks backed by FTTR technology and the roles of light- and radio-based wireless access.

Speakers:
Benjamin Azoulay, *Oledcomm, France*
Rene Bonk, *Nokia Bell Labs, Germany*
Philippe Chanclou, *Orange Labs, France*
Steve Hranilovic, *McMaster University, Canada*
Anthony Ng'oma, *Corning, USA*
Nikola Serafimovski, *pureLiFi, UK*

S2D: Will Optics Have a Role to Play in Scaling Out Future Quantum Computing Architectures? (Part 2)

Room: 6F

Organizers: Mekena Metcalf, *Lawrence Berkley, USA;* Eleni Diamanti, *Universite Pierre et Marie Curie, France;* Daniel Kilper, *Trinity College Dublin, Ireland;* Fotini Karinou, *Microsoft Research Ltd, UK*

Scaling quantum computing architectures is trending towards interconnected quantum processing units. For several platforms that require increasingly larger dilution refrigerators, communication between the modular quantum chips based on electrical/RF connections is a limitation due to the limited thermal load capacity the refrigerator can support. Other platforms expected to operate at higher temperatures would eventually face similar challenges. Optical interconnects are a potential answer to this scaling challenge to enable multi-chip communication. Such topologies would require thr conversion of qubits to optical wavelengths for some platforms and, more generally, transmission over a networked quantum computing architecture, i.e., notionally a "quantum data center."

Further, control of quantum computers necessitates a hybrid computing framework with both classical and quantum resources. In the first session, this workshop will encapsulate industry strategies for scaling quantum computing for various qubit technologies with classical control frameworks. The secondary session will cover the technologies and challenges facing quantum interconnects.

Session 1: This session will give an overview of different technologies/platforms the industry is pursuing to build a scalable quantum computing architecture. The Speakers will present their chosen technology, their vision toward a scalable computing platform, the challenges and the role of optics in their roadmap.

Session 2: This session will focus on different material platforms and devices as building blocks to enable various essential quantum system functionalities and their integration and packaging aspects to address system challenges induced by cryogenic environments.

Speakers:

Peter O'Brien, *Tyndall National Institute, Ireland*
John Bowers, *University of California, Santa Barbara, USA*
Simon Gröblacher, *QPhoX, Netherlands*
Pri Narang, *University of California, Los Angeles, USA*
Jelena Vuckovic, *Stanford University, USA*

S2E: Does Optics Have a Role in Space?

Room: 7AB

Organizers: Morio Toyoshima, *National Institute of Information & Comm Tech, Japan;* Murat Yuksel, *University of Central Florida, USA;* Eleni Diamanti, *Universite Pierre et Marie Curie, France*

Optical Wireless Communication (OWC), also called free-space optical communication, has recently evolved in many significant ways and is now employed in a wide range of applications extending to space. Long-distance, high-data-rate communication in space is becoming increasingly important to support science data transfer, telemetry, remote monitoring, and Internet connectivity. As a result, there is a trend in space communication to transition from radio frequency-based links to links using optical beams. Key motivations are an unregulated spectrum, smaller size/weight, lower power consumption per bit, larger bandwidth, and significantly smaller beam diffraction, resulting in much smaller link loss and, thus, higher capacity. The promising OWC applications in space will include Low Earth Orbit satellite constellations and High-Altitude Platform Stations with Optical Inter-Satellite Links (OISLs), inter-satellite mesh networks, low latency networking, and integration of satellites and 5G-and-beyond. In addition, quantum technologies attract great interest for their potential applications in computing, sensing, and communications. Satellite-based quantum communications are interesting in this context for linking securely quantum devices to provide groundbreaking services leveraging space networks at a global scale. Several challenges need to be overcome to make future applications based on space optical links a reality. The workshop will discuss the gigabit-per-second speed communication, the pointing-and-acquisition-tuning of OISLs at extremely high orbital speeds, the dynamic network routing, and the economic viability for OWC in space as well as the novel and secure space network concept based on optical technologies for satellite quantum information networks.

Speakers:

Guray Acar, *European Space Agency, Netherlands*
Mohammed-Slim Alouini, *KAUST, Saudi Arabia*
Baris Erkmen, *Hedron, USA*
Bryan S. Robinson, *MIT Lincoln Lab, USA*
Mathias van den Bossche, *Thales Alenia Space, France*
Juan Yin, *University of Science and Technology of China, China*

S2F: Slow and Wide Versus Fast and Narrow: How Do We Make our Datacenters Green?

Room: 8

Organizers: Trey Greer, *NVIDIA, USA;* Norm Swenson, *Norman Swenson Consulting, USA;* Xian Zhou, *University of Science & Technology Beijing, China*

There are different approaches to improving energy efficiency in and between data centers. We can continue to press toward higher baud rates and higher bits per symbol or use multiplexing techniques over optical wavelength, subcarrier frequency, and spatial/fiber cores at lower baud rates. Which approach results in the best efficiency in terms of overall power consumption for the end-to-end system? It should include the power consumption of electrical interconnect, light generation, detection, amplification, signal processing, SERDES, and FEC. This workshop will address this topic in two sessions, within the data center (chip to chip) and between data centers.

Short Reach, <100 meters

The first session will deal with short-reach interconnect within a rack or between racks. Energy per bit is vital in these short optical interconnects.

- In the context of the bandwidth needed for 100 Tbps switches, where is the sweet spot in the battle between high channel bit rates vs. high fiber counts and channels per fiber?
- In lieu of higher channel data rates, what's the best way to increase the number of channels per fiber core or fiber cores around the host ASIC?
- On the host ASIC side, can we save power with the wider and slower electrical interfaces made possible with co-packaged optics?

Long Reach, up to 10km

The second session will look at communications between data centers.

- Which technologies and multiplexing techniques promise the most energy efficiency to achieve these distances? Is it intensity modulation/direct detection on multiple lanes, coherent subcarrier multiplexing, simplified coherent, or something else?
- What's the role of DSP in a power-efficient transponder? Does DSP actually result in net power savings?
- What key technologies must be demonstrated to realize these energy-efficient techniques in practical product offerings?

Speakers:
Keren Bergmen, *Columbia University, USA*
Arash Farhood, *Marvell, USA*
Joe Kahn, *Stanford University, USA*
Dan Kuchta, *IBM, USA*
Di Liang, *Alibaba, USA*
Karl Muth, *Broadcom, USA*
Sunil Priyadarshi, *Intel, USA*
Dave Welch, *Infinera, USA*

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

Sunday, 05 March, 19:00–21:00
Room: 17

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*

Come and 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 we concentrate 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 mostly 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 alike. 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 2023. Please refer to the abstract section or Conference App for full details.

Quantum Information and Optical Communication Networks: Emerging Research Areas, Challenges and Opportunities

Monday, 06 March, 14:00–18:30
Room: 1AB

Organizers: Eleni Diamanti, *CNRS, France*; Fotini Karinou, *Microsoft Research, UK*; Dan Kilper, *University of Dublin Trinity College, Ireland*; Fabian Laudenbach, *Xanadu Quantum Computing, Canada*; Rui Lin, *Chalmers, Sweden*; Michael Vasilyev, *University of Texas, USA*; Rui Wang, *University of Bristol, UK*

Recent advances in quantum technologies are enabling new functionality in communication networks. Quantum key management system support is available as a feature on commercial optical transmission systems and quantum random number generators are attracting attention for use in a variety of applications. At the same time, research is accelerating on the development of networked quantum computing to both scale existing platforms and to provide internet-like capabilities, perhaps to form a quantum internet. In addition to QKD-related applications, a new body of activity is developing around entanglement distribution and routing. A race is on to develop a scalable and commercially viable quantum repeater for distributing entanglement and performing teleportation over long distances. Quantum sensor networks promise nonclassical sensitivity enhancements. All these developments open up a wide range of potential new research areas in optical devices, communications and networks, spanning both the near and long term.

Key questions that this symposium will address include:

- What are other applications of quantum networking beyond QKD?
- Is optical quantum networking considered broadly just another version of classical optical networking, i.e., same methods, just different constraints? What are the new research areas created by bringing quantum technologies into optical networking?
- What is the "quantum internet"? Are there bottlenecks to achieving quantum internet that are related to networking performance?
- How far are prepare-and-measure/trusted QKD networks from the quantum internet/quantum network needed for (distributed) quantum computing?
- What are the main quantum computing platforms and what role does photonics play?
- What scale can we expect the quantum networks to reach in the short/medium/long term?
- Are optical networks the best match for connecting distributed quantum computers?
- What changes are necessary for the optical infrastructure to support a quantum internet in terms of hardware and software?

This symposium will explore these questions and others in regard to emerging research areas with a focus on optical communication technologies. The first session will provide high level overviews of broad areas with introductory or survey level talks followed by a panel discussion. The second session will breakdown specific areas in shorter talks, concluded with a panel discussion.

Session I: Emerging Research Areas in Quantum for Optical Communications

This session will provide broad overviews of key emerging research areas, including topics such as quantum enhanced security technologies in optical transmission systems, wavelength conversion and quantum computer/memory interfaces, quantum repeater network architectures for multi-partite entanglement distribution and teleportation, and quantum sensor networks and distributed quantum applications. The panel will discuss the current state of the art and the key research challenges.

Session II: Examples of Photonic Research within Emerging Areas

This session will go into greater depth on specific research problems within the broad areas discussed in Session I. Talks will include areas such as measurement device independent quantum key distribution and novel security architectures, specific quantum memory technologies and architectures for quantum repeaters, quantum network routing algorithms, long baseline interferometry or similar quantum enhanced sensor networks, and error correction coding for quantum optical communications. The panel will discuss recent research advances in these areas and existing challenges.

Speakers

Prem Kumar, *Northwestern University, USA*
Reza Nejabati, *University of Bristol, UK*
Sophia Economou, *Virginia Tech, USA*
Ulrik Andersen, *Danmarks Tekniske Universitet, Denmark*
Matt Eichenfield, *University of Arizona, USA*
Vladyslav Usenko, *Palacký University Olomouc, Czech Republic*
Saikat Guha, *University of Arizona, USA*

The Crucial Role of Photonics in Achieving the UN Sustainability Development Goals: Learnings and Opportunities

Tuesday, 07 March, 14:00–18:30
Room: 1AB

Organizers: Fotini Karinou, *Microsoft, UK;* Yuanqiu Luo, *Futurewei Technologies;* Albert Rafel, *British Telecommunications, UK;* Luca Valcarenghi, *Scuola Superiore Sant Anna de Pisa, Italy;* Elaine Wong, *University of Melbourne, Australia*

The United Nation's 2030 Agenda for Sustainable Development is a shared blueprint for global peace and prosperity, for the planet and its people, now and into the future. Core to this agenda are 17 Sustainable Development Goals (SDGs) that form an urgent call for action by all countries. Ending poverty and other deprivations must go hand-in-hand with strategies that close the digital divide, improve health and education, reduce inequality, and eliminate greenhouse gas emissions. The role of photonics, e.g., when deployed around a smart city framework and in rural underserved communities, is crucial to meeting the UN SDGs in a timely manner. However, even with its critical role as the digital backbone of society, the infrastructure itself can become a significant sustainability burden. It is thus imperative that future optical communication systems and networks are integrated in the society ensuring environmental sustainability as they evolve.

This OFC 2023 symposium, as the first in a series of OFC symposia on this topic, will specifically aim to:(a) reflect on the smartcity predictions made by OFCity 2015 competition teams towards sustainability, and (b) discuss related recent R&D efforts and future opportunities towards achieving SDGs from data center network operators, telecom network operators, system and technology providers, and academia. Through the discussions, we aim to highlight crucial next steps for the OFC Community to focus on the next years.

Speakers

Kasandra Pilay, *Council for Scientific and Industrial Research (CSIR), South Africa*
Marco Ruffini; *University of Dublin Trinity College, Ireland*
Yosuke Aragane, *NTT, Japan*
Marcus Brunner, *Huawei Technologies, China*
Naveena Genay, *Orange Labs, France*
Thomas Karagiannis, *Microsoft Research Cambridge, UK*
James (Dezhi) Zhang, *China Telecom Corp Ltd, China*

Beyond the Hype of Network Analytics: Use Cases, Feasibility, and Barriers

Wednesday, 08 March,14:00–18:30
Room: 1AB

Organizers: Paolo Monti, *Chalmers University of Technology, Sweden*; Loukas Paraschis, *IIEEE Communication Society, and Alphawave Semi, USA*; Christine Tremblay, *École de Technologie Supérieure, Canada*; Elaine Wong, *Melbourne School of Engineering, Australia*

Network Analytics has become an increasingly important new area of innovation, most often led by the explosive demands in data center networks. There are many exciting use cases which collectively promise to catalyze the paradigm shift from event (and human) driven networking to machine-driven and eventually autonomous networking based on self-adjusting or self-healing frameworks. There are also many equally exciting recent innovations in the related enabling technologies, most notably leveraging advancements in software automation, telemetry and provisioning with model driven abstractions combined with machine-learning and AI data analytics, towards network (often multilayer) optimization or proactive (even predictive) protection or restoration. For example, in a notable such network optimization, Google announced in August 2022 the use of SDN analytics and control and optical switches to replace its packet switching clos fabric spine and enable a much more scalable data center fabric. The OFC 2023 symposium, as the first in a series of OFC symposia on this topic, will specifically aim to identify, beyond the hype, the main optical network analytics use cases, their feasibility, barriers, and related R&D efforts. Invited speakers from data center operators, telecom network, system and technology providers, and academia will review the advancements and debate the important next steps.

Speakers

Vipul Deokar, *Meta Platforms, USA*
Jian Kong, *Microsoft Corp., USA*
Chongjin Xie, *Alibaba Group, USA*
Anny Xijia Zheng, *Google LLC, USA*
Andrew Lord, *BT Exact, UK*
Darli Mello, *UNICAMP, Brazil*
Jelena Pesic, *Nokia Bell Labs, France*
Luis Velasco, *Universitat Politecnica de Catalunya, Spain*
Bob Shine, *Telescent Inc., USA*
Achim Autenrieth, *ADVA, Germany*
Gauravdeep Shami, *Ciena, USA*

Panels

Ten panels are scheduled for OFC 2023. Please refer to the abstract section for full descriptions.

Towards Standardized PIC Testing: Challenges & Roadmaps
Date: Monday, 06 March, 08:00–10:00
Room: 7AB

Organizers: Patrick Lo, *Advanced Micro Foundry, Singapore*; Ashkan Seyedi, *NVIDIA, USA*; Wei Shi, *Université Laval, Canada*

Virtualization in Optical Networks: A Reality Check
Date: Monday, 06 March, 08:00–10:00
Room: 6C

Organizers: Ricardo Martinez, *CTTC, Spain*; Jamie Gaudette, *Microsoft, USA*; Annachiara Pagano, *Telecom Italia, Italy*

Connectivity for Beyond 5G: How Can Wireline and Wireless Optical Access Live Up to the Mobile Expectations?
Date: Monday, 06 March, 10:30–12:30
Room: 7AB

Organizers: Jim Zou, *ADVA, Germany*; Albert Rafel, *BT, UK*; Baris Erkmen, *HEDRON, USA*; Frank Chang, *Source Photonics, USA*; Ke Wang, *RMIT, Australia*

Optical Fiber Sensing: Technology and Emerging Applications
Date: Monday, 06 March, 14:00–18:30
Room: 7AB

Organizers: Raja Ahmad, *Cisco Systems, USA*; Ting Wang, *NEC, USA*; Georg Rademacher, *NICT, Japan*; Mikael Mazur, *Nokia Bell Labs, USA*

1.6Tb/s+ Intra-DC Networks
Date: Monday, 06 March, 16:30–18:30
Room: 6C

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

LiDAR Systems and Technologies with Integrated Photonics
Date: Tuesday, 07 March, 14:00–16:00
Room: 7AB

Organizers: Long Chen, *Cisco, USA*; Sylvie Menezo, *SCINTIL Photonics, France*; Milos Popovic, *Boston University, USA*; Shilong Pan, *Nanjing Univ Aeronautics & Astronautics, China*

Advanced Packaging Technologies for Optical Modules
Date: Wednesday, 08 March, 08:00–10:00
Room: 6C

Organizers: Omer Khayam, *Google, USA*; Joris Van Campenhout, *IMEC, Belgium*; Juthika Basak, *Nokia, USA*; Molly Piels, *Juniper Networks, USA*

How Can We Start to Consistently and Quantitively Account for End-to End Power Consumption, Beginning with a Focus on 100 Meter Datacenter Links?
Date: Thursday, 09 March, 08:00–10:00
Room: 7AB

Organizers: Trey Greer, *NVIDIA, USA*; Clint Schow, *Univ. of California, Santa Barbara, USA*

Promises, Prospects and Challenges of VCSELs for Data Center Interconnects, Free-Space Communications, and Sensing
Date: Thursday, 09 March, 08:00–10:00
Room: 6C

Organizers: Connie Chang-Hasnain, *Berxel Photonics, China*; Hai-Feng Liu, *HG Genuine, China*; Jim Lott, *Technical University Berlin, Germany*; Fotini Karinou, *Microsoft Research Ltd, UK*

Roadmap for Photonic AI Accelerators
Date: Thursday, 09 March, 14:00–16:00
Room: 7AB

Organizers: Volker Sorger, *George Washington University, USA*; Nikos Pleros, *Aristotle University of Thessaloniki, Greece*; Xian Xiao, *Hewlett Packard Labs, USA*; Glenn Bartolini, *Coherent Corp, USA*

Special Sessions

Ultra-Stable Frequency Sources and their Future Applications in Telecom
Monday, 06 March, 08:00–10:00
Room: 1AB

Organizers: Dan Blumenthal, *University of Calfornia, Santa Barbara, USA;* Nick Fontaine, *Nokia Bell Labs, USA;* Radan Slavik, *University of Southampton, UK*

Optical fiber communications have resulted in commodity technologies benefiting other disciplines, including optical fiber and other components. Now, the outcomes of these other disciplines, in turn, can benefit fiber communications. An important example is time and frequency metrology and the development of the Optical Frequency Combs used to transfer signals over optical fibers (e.g., to compare national clocks at different National Metrology Institutes). Other examples include self-referenced ultra-stable optical and microwave signals for atomic clocks, ultra-narrow-linewidth frequency stabilized lasers, and quantum computing and sensing technologies. These technologies are now finding importance and application that feedback to fiber communications with optical networks needing more accurate time and frequency (e.g., for emerging 5G, distributed database synchronization), and using the existing telecom data carrying fiber base as a distributed precision sensor providing additional services such as Earthquake detection.

The Objective of the Special Session is to bring together researchers from the distinct disciplines of fiber communications, environmental sensing, precision metrology and spectroscopy, atomic clocks and stabilized lasers, and quantum sensing to bridge communications between these different areas and explore common research grounds and solutions. For example, measurement sensitivity using undersea cables is greatly improved using sources with high frequency and phase stability developed by the metrology community. We aim to promote an understanding of the requirements of ultrastable frequency sources in telecom, including portability and the benefits of photonic integration, and to discuss the current state-of-the-art performance. Further, we hope to develop connections in the telecom community that has access to terrestrial and transoceanic fibers with

those who develop state-of-the-art photonic sources and precision optical techniques with those who have expertise in environmental sensing and precision frequency and phase transfer. Finally, we aim to understand how emerging telecom fields, such as quantum systems, could benefit from precision frequency metrology and atomic timing developments. The session will also touch upon frequency references in applications such as space communications, wireless communications, atmospheric sensing, time transfer, geodetic sensing, and synchronization of large-scale experiments.

Speakers

Christopher Hilweg, *Universitat Wien, Austria*
Giuseppe Marra, *National Physical Laboratory, UK*
Frank Quinlan, *National Inst. of Standards & Technology, USA*
Mark Saffman, *University of Wisconsin, USA*

High Performance Networks for Future Data Center and Computing Applications

Monday, 06 March, 10:30–12:30
Room: 1AB

Organizers: Fotini Karinou, *Microsoft, UK;* Laurent Schares, *IBM TJ Watson Research Center, USA;* Chongjin Xie, *Alibaba, USA*

Data center workloads are continuously growing due to various emerging applications calling for higher bandwidth, lower latency, and more power-efficient networks. Machine Learning (ML) workloads, in particular, grow exponentially in size every year, and training them requires clusters of thousands of interconnected accelerators with Tbps-scale I/O bandwidth per node today. This new hardware needed to serve emerging applications will require innovation in designing and building networks that can scale AI supercomputers without exploding the overall power consumption and cost. This session will discuss emerging trends, including, for example, (1) *composable systems* with disaggregated resources (GPUs, CPUs, storage/memory) being co-located as a pool that is accessed via a local network and (2) *reconfigurable network topologies* to provision bandwidth on demand. It will focus on the challenges and opportunities for photonics and will try to address some of the following questions:

- Will optics penetrate composable systems or the accelerator-to-accelerator space?
- Reconfigurable network topologies - what role will they play?
- Ethernet: will it continue to be the driving design paradigm in the AI era?
- CXL or proprietary interconnects: what protocol will dominate the chip-scale fabrics?

Speakers

Rui Wang, Google LLC, USA
Manya Ghobadi, *Massachusetts Institute of Technology, USA*
Larry Dennison, *NVIDIA, USA*
Binzhang Fu, *Alibaba Cloud, China*
Ram Huggahalli, *Microsoft Azure, USA*

Photonics for Visible Wavelengths

Wednesday, 08 March, 08:00–16:00
Room: 2

Organizers: Cheryl Agaskar, *MIT Lincoln Lab, USA;* Chi-Wai Chow, *National Yang Ming Chiao Tung University, Taiwan;* Fotini Karinou, *Microsoft Research Ltd, UK*
David Marpaung, *University of Twente, Netherlands*

Visible wavelengths are getting increasing attention due to their usefulness for communication, quantum, and sensing applications. In communication, blue-green wavelengths can be used for underwater comm, while LiFi systems can work across the visible spectrum. Visible wavelengths are often necessary when probing physical systems, such as the neutral atoms or ions used in quantum computing, optical clocks, color centers used in quantum sensors, or biological systems such as medical or chemical sensors. Visible light can also be useful for lidar and atmospheric sensing. Finally, nonlinear photonics and frequency combs often involve visible wavelengths.

This special session will begin by covering mature and emerging applications of visible light photonics. It will address why visible light is needed and the benefits of working in the more traditional telecommunication range. It will also explain how mature the current applications are and what systems, if any, are used in the field. It will then cover the state of the art of visible light devices such as lasers, detectors, and fibers, as well as foundry processes and packaging needs. This session will address the maturity of the available technologies and whether current or anticipated future performance is acceptable for application needs. And lastly, the session will also attempt to highlight the most significant outstanding needs in this emerging field.

Session I is scheduled from 08:00–10:00
Session II is scheduled from 14:00–16:00

Speakers

Brian Corbett, *Tyndall National Institute, Ireland*
Michael Geiselmann, *LIGENTEC, Switzerland*
Douwe Geuzebroek, *LioniX, Netherlands*
Harald Haas, *University of Strathclyde, UK*
Hao-Chung Kuo, *National Yang Ming Chiao Tung University, Taiwan*
William Loh, *MIT Lincoln Lab, USA*
Boon Ooi, *King Abdullah Univ. of Science & Technology, Saudi Arabia*
Joyce Poon, *Max-Planck-IInstitut für Mikrostrukturphysik, Germany*
Todd Stievater, *U.S. Naval Research Laboratory, USA*
Jeremy Witzens, *RWTH Aachen University, Germany*

Demo Zone

Monday, 06 March, 14:00–16:15
Room: 6A

Organizers: Ben Puttnam, *National Institute of Information and Communications Technology (NICT), Japan*; Marco Ruffini, *University of Dublin Trinity College, Ireland*

Committee: Fatima Gunning, *Tyndall National Institute, Ireland*; Ezra Ip, *NEC Laboratories America Inc., USA*; Jelena Pesic, *Nokia Bell Labs, France*; Raul Muñoz, *CTTC, Spain*; Dora Van Veen, *Nokia Bell Labs, USA*

The Demo Zone features live demonstrations of research projects and proof-of-concept implementations in the space of optical communication devices, systems, and networks.

Please refer to the abstract section for full descriptions.

Rump Session: Is the Silicon Photonics Platform about to be Standardized, Diversified or Supplanted?

Tuesday, 07 March, 19:30–21:30
Room: 6F

Moderator: Daniel Kuchta, *IBM TJ Watson Research Center, USA;* Co-Moderator: Michael Hochberg, *Luminous Computing, USA*

As the required raw single wavelength data transmission rates now exceed 200 Gbps, the use of the all-Silicon transmitter is threatened by a coven of materials: Thin Film Lithium Niobate, Organic Polymers, Barium Titanate, Plasmonic metals, and of course, InP. Will Silicon Photonics follow the course of integrated circuits and bifurcate into the equivalent of CMOS (pure Si) and Bipolar (Si, SiGe, and everything else) variants? Can pure Si Silicon Photonics maintain commercial dominance? Or will InP finally take over? This year's rump session will bring together industry provocateurs representing these three competing views and pit them against each other and the audience in an arena containing beer and live lions (the VCSEL community)!

Open Networking Summit: Top to Bottom: Practical Approaches to Openness, Disaggregation, and Reaggregation in Optical Communication

Wednesday, 08 March, 16:30–18:30
Room: 8

Organizers: Yawei Yin, *Microsoft, USA;* Jim Zou, *ADVA, Germany;* Dan Pitt, *Palo Alto Innovation Advisors, USA*

As we look at the success of the "Open" and "Disaggregated" systems in data centers, it is not difficult to draw a few fundamental conclusions: #1, servers came easiest because of standardized processing units, whether it's x86-based CPU, GPU, or Arm processors, running in Linux-based white-box servers, which have become the norm for even the branded server vendors; #2, the standard interfaces that can connect servers together, i.e., the Ethernet-based NIC card and the BGP/TCP/IP protocol stack that enable the communication, and the appearance of Linux-based white-box switches have not yet resulted in their proliferation beyond the hyperscale realm because of the strength of incumbent brands and the challenges of integrating and supporting disaggregated components, and #3, the optical links, while disaggregated to the pluggable level with standardized interfaces, cannot match the density and scale of the computing world. Moreover, DSP algorithms are still being treated as "secret sauce," and advanced modulation schema is not connecting different light sources together. Finally, silicon photonics and III-V semiconductors remain silos not amenable to the integration density required for a wide-open market in co-packaged optics and the eye-popping applications in consumer, health, and civic technologies. In this session, we will paint a "coherent" portrait of advancing openness, manageable disaggregation, and heterogeneous integration and reaggregation in optical communication. We will look at the progress in open-source network operating systems, open-source coherent optical light sources, industry standards in DSP algorithms, and manufacturable heterogeneous-integration technologies. Join us to hear from and debate with the experts leading these innovations.

Speakers

Óscar González de Dios, *Telefónica I+D, Spain*
Stephan Neidlinger, *ADVA, Germany*
Guohan Lu, *Microsoft, USA*
David Gomez, *X-Celeprint, USA*
Tino Jaeger, *X-FAB. Germany*

Postdeadline Paper Presentations

Thursday, 09 March, 16:30–18:30
Rooms: 6C, 6D, 6E, 6F

Discover the best and most cutting-edge research in optical communications. The OFC 2023 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, 07 March.

The 2023 Program Chairs are proud to introduce several new events at OFC 2023 to enhance attendee experience and create more opportunities for learning and networking.

Through these events, we aim to welcome new attendees to the conference, help students integrate and grow within the OFC community, Optica and the IEEE societies and to promote and celebrate inclusion and diversity throughout the conference.

We are grateful to the OFC Steering and Long-Range Planning Committees, Optica, IEEE Communications Society, and IEEE Photonics Society staff and the organizers of the various events for their support in bringing our vision to life.

Nick Fontaine, Fotini Karinou, Elaine Wong

Special Events

Optical Transmission Systems – Design and Simulation Workshop (Presented by the Optica Foundation & VPIphotonics)

Sunday, 05 March, 13:00–18:00
Room: 31A (Limited Registration. RSVP required to trooney@optica.org)

This workshop will show you how to conceptualize and evaluate optical transmission systems from a communication engineer's perspective by using professional simulation software. You will learn how to efficiently simulate optical transmission systems and automate the design and analysis of new technologies using VPIphotonics Design Suite. We will investigate transmission systems scenarios for applications ranging from data center interconnects to high-capacity core network links to optical satellite communication links. We will explore general system design concepts, demonstrate how to investigate the impact of performance-limiting effects, and assess how to mitigate or compensate for them.

Topics include:

- Professional simulation software design environment
- Intensity-modulated direct detection systems
- Digital coherent systems
- Free-space optical systems

This workshop targets students and early-career professionals who want to learn how to utilize a professional simulation and design environment for their engineering and research tasks in optical transmission systems. Basic knowledge of technologies, concepts, and methodologies of the various transmission systems is helpful.

This workshop 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 own private laptops.

Registration is limited to 35 seats to provide attendees with direct access to our team of experts, so reserve your seat today by contacting trooney@optica.org.

OFC Mentor/Mentee Meet-Up

Monday, 06 March, 12:00–13:00
Room: 17 (Separate registration required. See ofcconference.org/special-events/ for details.)

Are you new to OFC, perhaps a student, a young professional, or even an experienced researcher, but have never been to OFC? Or are you looking for some advice in navigating through your research goals and ambition?

Join us at our mentor match event, where you can meet photonics experts and mentors who may advise you on how to steer through the conference, introduce you to people in the field, share some of their experiences, and find someone who shares a unique talent with you.

The Journal Review Process: All You Need to Know!

Monday, 06 March, 14:00–15:30
Room: 14B

Journal publications are critical for our industry. They are where new results, ideas and demonstrations are reported, after which they are permanently stored and made available for others to use in their own research and design work. This body of knowledge has been built up for the optical industry over many decades. This event will provide a behind-the-scenes look into the journal publications process and allow attendees with the opportunity to ask questions and interact with Editors and Reviewers of some of the highest impact factor Journals in the field of optical communications and networking. It will follow the trail of what happens once a new research paper is submitted to an IEEE or Optica journal.

The event will consist of informative presentations followed by roundtable discussions, hosted by people involved in the review and publication process, willing to answer questions and engage with you. Most importantly, for those interested to learn more, this event will provide guidance on how to get involved in the review process of the most prestigious journal publications in the field of optical telecommunications.

Welcome Address
Andrew Lord, *Editor-in-Chief, Journal of Optical Communications and Networking, Sr. Manager of Optical Networks Research, BT, UK;* Gabriella Bosco, *Editor-in-Chief at IEEE/Optica Journal of Lightwave Technology, Full Professor at Politecnico di Torino, Italy*

Overview of the Review Process
Kelly Cohen, *Sr. Publisher, Optica Publishing Group, USA*

Why be a Reviewer?
Peter Winzer, *Former Editor-in-Chief Journal of Lightwave Technology, Founder, Nubis Communications, USA*

Are Journals Really Just for Academia?
Sorin Tibuleac, *JLT Associate Editor, Director, ADVA Optical Networking, USA*

Birds of a Feather: Designing and Operating the Next Generation Optical Photonic Networks

Monday, 06 March, 16:30–18:30
Room: 14B

Starting in 2023, OFCnet brings a new opportunity to the exhibition to demonstrate products, concepts, solutions, research, and architectures in a live high-speed optical network connected to the leading research and education networks worldwide. This increased focus on designing and building the next generations of Optical Networks will expand exposure to connectivity, emerging technologies, Quantum Computer networks, programmability, and network software applications for big data applications.

In this BOF, we propose a workshop series that solicits papers and demonstrator reports on all aspects of building networks out of components and using those networks for the whole range of commodities to extreme applications. Furthermore, we will solicit input on possible challenges for demonstrating novel new architectures, technologies, and implementations.

Student Party

Monday, 06 March, 19:00–21:00
Location: The Loft, Petco Park

New to OFC, the Student Party is an opportunity for students to meet and network in a fun and relaxed environment. Please be sure to bring a form of ID with you to the event.

Conversation with the Plenary Speakers

Tuesday, 07 March, 10:15–10:45
Theater III, Exhibit Hall

Join OFC General Chairs Ramon Castelles, Chris Cole and Ming-Jun Li for a conversation with Plenary Speakers, Patricia Obo-Nai, Jayshree Ullal and Wendell Weeks.

Optical Communications Technical Group Poster Pitch Competition

Tuesday, 07 March, 11:00–12:00
Room 3

You are invited to join the Optica Technical Group on Optical Communications for this fun and interactive session. Students and early career professionals will be sharing their latest research with us through short talks and videos. You will then have the chance to vote for the best poster pitch and network with colleagues over refreshments. Please RSVP at https://forms.gle/ngK4UCFK7729QqU1A to let us know you will be attending.

Conference Reception

Tuesday, 07 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.

International Women's Day Breakfast

Wednesday, 08 March, 07:00–08:30
Room: 20A (Limited registration. See ofcconference.org/special-events/ for details.)

The 2023 United Nation International Women's Day theme is "DigitALL: Innovation and Technology for Gender Equity." In support of this, Program Chairs Fotini Karinou, *Microsoft Research Ltd, United Kingdom* & Elaine Wong, *Univ. of Melbourne, Australia,* invite you to join them Wednesday, 08 March at 07:00 for breakfast followed by a panel discussion to recognize and celebrate the contributions of women in optical fiber communications.

Panelists will discuss their personal career path and the women who have inspired them and explore the role women have played in innovation and in driving positive transformation in science, technology and engineering. Our panel will comprise thought leaders and innovators in science, engineering and technology.

The Art of Writing the Perfect OFC Paper

Wednesday, 08 March, 10:30–12:00
Room: 14B

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.

IEEE/Optica Publishing Group Journal of Lightwave Technology 40th Anniversary Luncheon

Wednesday, 08 March,
Room: 20A (Invitation Only)

The Journal of Lightwave Technology celebrates its 40th anniversary with a special luncheon at OFC 2023, recognizing the hard work and dedication of all the volunteers who have contributed to the success of the journal since its inception.

Since its founding in 1983, the Journal of Lightwave Technology has published leading research in optical waveguide technologies and their applications, from integrated photonics to optical networks. The journal's collection includes seventeen special issues featuring the most relevant work presented at the OFC conference.

Photonics Society of Chinese Heritage Workshop & Networking Social

Wednesday, 08 March, 17:00–19:30
Room: 15AB

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

Data Center Technology at the Crossroads

Data center technology is entering a time of great change. After many years of headlong growth, the impetus for continued rapid progress is even stronger, but there are now also unprecedented new options for direction. This workshop will explore a few of the most impactful roadmap choices the industry will have to make in the next three to five years, such as data center coherent, direct-drive optics, CPO/NPO/Chiplet, and Thin-film Lithium Niobate.

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.

Rise and Shine Morning Run/Walk

Thursday, 09 March, 06:00–07:00
Hilton Bayfront, (Bottom of San Diego Convention Center stairs, front entrance)

Meet up for an early morning three-mile run or walk with fellow colleagues.

OFC Plenary Session

Tuesday, 07 March, 08:00–10:00
Ballroom 20

Harnessing Digitalization for Effective Social Change

Patricia Obo-Nai, *Chief Executive Officer, Vodafone, Ghana*

Digitalization is a potent driver of progress in the modern world, particularly in Africa. The increased use of mobile phones has given it the momentum it needs across Africa. However, much more work is required. This talk will touch on what needs to be done to ensure that everyone, especially the most vulnerable, reaps the benefits of the global digital movement.

Patricia Obo-Nai is an experienced leader in Ghana's telecommunications industry. She was named CEO of Vodafone Ghana in April 2019, making her the first Ghanaian to hold that position in the country's 10 years of business.

Obo-Nai has a Bachelor of Science in Electrical and Electronic Engineering from Kwame Nkrumah University of Science and Technology (KNUST), an Executive MBA in Project Management from the University of Ghana Business School, and executive education from the Kellogg School of Management, London Business School, and INSEAD in France.

She is passionate about the future of young people and women in the digital age and is a vigorous advocate for STEM. She has advocated for youth and women on a variety of local and international platforms, including the UN General Assembly panel sessions.

The Road to Petascale Cloud Networking

Jayshree V. Ullal, *President and Chief Executive Officer, Arista Networks, USA*

As the future application demands and compute performance evolve, the network needs to adapt for exponential growth in traffic, connecting tens of thousands of processors with Petabits of bandwidth. As a pioneer in cloud networking, Arista has become synonymous with elastic scaling and programmable provisioning delivering modern data-driven platforms.

Arista believes Moore's law is alive and will enable next-generation 100-Terabit switching and multi-terabit optics. A networking and Silicon Valley veteran, Jayshree Ullal will discuss the trends, evolution, and impact of petascale and AI-driven networking technologies ahead.

Jayshree V. Ullal As President and CEO of Arista for over a decade, Ullal is responsible for Arista's business and thought leadership in cloud networking. She led the company to historic and successful IPO in June 2014 from zero to a multibillion-dollard business. Formerly Ullal was Senior Vice President at Cisco, responsible for a $10B business in datacenter, switching and services. With more than 30 years of networking experience, she is the recipient of numerous awards including E&Y's "Entrepreneur of the Year" in 2015, Barron's "World's Best CEOs" in 2018 and one of Fortune's "Top 20 Business persons" in 2019.

Ullal holds a B.S. in Engineering (Electrical) and an M.S. degree in engineering management. She is a recipient of the SFSU and SCU Distinguished Alumni Awards in 2013 and 2016.

Capacity to Transform

Wendell P. Weeks, *Chairman and Chief Executive Officer, Corning Incorporated, USA*

Corning's Chairman and CEO, Wendell Weeks, will highlight the industry's growth drivers and breakthrough innovations in product and process, and the importance of connecting the unconnected with glass thinner than a human hair. Mr. Weeks will also share how optical fiber, invented more than 50 years ago, is contributing to greener solutions – benefiting our shared and more sustainable future.

Wendell P. Weeks has served as Corning's chief executive officer since 2005 and as chairman of its board since 2007. He has been a member of the company's board of directors since 2000.

Weeks joined Corning in 1983, working in finance, before holding roles in business development, commercial, and general management.

In 1996, he became vice president and general manager of Corning's optical fiber business. In 2001, he was named president of the company's Optical Communications division, leading through dynamic market growth and the subsequent challenges of the telecommunications crash. Weeks became Corning's president and chief operating officer in 2002, helping oversee Corning's restructuring and return to profitability.

As CEO, he has played an instrumental role in several life-changing innovations, including the development of Corning® Gorilla® Glass. He has earned 33 U.S. patents.

Weeks is a graduate of Lehigh University and earned a Master of Business Administration from Harvard University as a Baker Scholar. He serves on the board of directors at Amazon.com Inc. and on the board of trustees for the Corning Museum of Glass and the Institute for Advanced Study. He is a member of the Liveris Academy Honorary Board.

OFC and Co-Sponsor Awards and Honors

Awards Ceremony and Luncheon

Tuesday, 07 March, 12:00–14:00
Ballroom 20A

Supported by CORNING

Join conference co-sponsors Optica (formerly OSA), IEEE Photonics Society, and IEEE Communications Society for a special luncheon to recognize award and honor recipients from each society. The event is open to all ticket-holders, but seating is limited. Tickets can be purchased for USD 45 at registration.

The following awards and recognitions will be presented at the Awards Ceremony and Luncheon.

2023 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 Optica and the IEEE Photonics Society and is funded by Corning, Incorporated.

Congratulations to this year's recipient, Ming-Jun Li, *Corning Incorporated, USA*

Optica 2023 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.

Congratulations to the following Fellows:

Kazi Abedin, *CACI International, Inc., USA*
Anjali Agarwal, *CACI | Technology Innovation and Labs, USA*
Antonella Bogoni, *Sant'Anna School/CNIT, Italy*
Xi (Vivian) Chen, *Nokia Bell Labs, USA*
John D. Downie, *Corning Incorporated, USA*
Masayuki Fujita, *Osaka University, Japan*
Gordon Keeler, *Defense Advanced Research Projects Agency, USA*
Guixin Li, *Southern University of Science and Technology, China*
Yoshiaki Nakano, *The University of Tokyo, Japan*
Hideyuki Nasu, *Furukawa Electric Co., Ltd., Japan*
Jin-Wei Shi, *National Central Univ, Taiwan*
Perry Ping Shum, *Southern University of Science and Technology Shenzhen Guangdong, China*
Vijay Vusirikala, *Google LLC, USA*
Jingyi Yu, *ShanghaiTech University, China*

IEEE Photonics Society 2023 Fellows

A distinction reserved for select IEEE members who have achieved extraordinary accomplishments. Fellows have contributed importantly to the advancement or application of engineering, science, and technology, bringing the realization of significant value to society.

Congratulations to the following Fellows:

Fabrizio Forghieri, *Cisco Photonics, Italy*
Magnus Karlsson, *Chalmers University of Technology, Sweden*
Christina M Lim, *University of Melbourne, Australia*
Yoshiaki Nakano, *The University of Tokyo, Japan*
Boon S Ooi, *King Abdullah University of Science and Technology, Saudi Arabia*
Ping Shum, *Southern University of Science and Technology Shenzhen Guangdong, China*

IEEE Communications Society 2023 Fellows

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

Congratulations to the following Fellows:

Andrew Lord, *BT Group, UK*
Perry Ping Shum, *Southern University of Science and Technology Shenzhen Guangdong, China*
Massimo Tornatore, *Politecnico di Milano, Italy*

IEEE/Optica Journal of Lightwave Technology Best Paper Award

Recognizes the top cited original papers published in JLT in 2020, as determined by a variety of citation metrics and databases. It is presented by the JLT Coordinating and Steering Committees.

Copies of the winning papers will be available at OFC and will be made open access in the IEEE Xplore Digital Library.

Congratulations to the authors of the following paper:

800G DSP ASIC Design Using Probabilistic Shaping and Digital Sub-Carrier Multiplexing by Han Sun[1], Mehdi Torbatian[1], Mehdi Karimi[1], Robert Maher[2], Sandy Thomson[1], Mohsen Tehrani[1], Yuliang Gao[1], Ales Kumpera[1], George Soliman[1], Aditya Kakkar[1], Mohammad Osman[1], Ziad A. El-Sahn[1], Clayton Doggart[1], Weikun Hou[1], Shailesh Sutarwala[1], Yuejian Wu[1], Mohammad Reza Chitgarha[2], Vikrant Lal[2], Huan-Shang Tsai[2], Scott Corzine[2], Jiaming Zhang[2], John Osenbach[3], Sanketh Buggaveeti[3], Zulfikar Morbi[2], Miguel Iglesias Olmedo[2], Irene Leung[2], Xian Xu[2], Parmijit Samra[2], Vince Dominic[2], Steve Sanders[2], Mehrdad Ziari[2], Antonio Napoli[4], Bernhard Spinnler[4], Kuang-Tsan Wu[1], Parthiban Kandappan[2], *[1]Infinera Canada Inc., Ottawa, Canada; [2]Infinera Corp., Sunnyvale, USA; [3]Infinera Corp., Allentown, USA; [4]Infinera Corp., Munich, Germany*

IEEE Photonics Award

Established in 2002, the award is presented for, but not limited to: light-generation, transmission, deflection, amplification and detection, and the optical/electro-optical componentry and instrumentation used to accomplish these functions. Recipients are selected by the Technical Field Awards Council of the IEEE Awards Board.

Congratulations to this year's recipient,
Roel Baets, *Ghent University - IMEC, Belgium*

Wiley-IEEE Press Professional Book Award

Recognizes the authors of an outstanding monograph or professional book published by Wiley-IEEE Press during a three-year window prior to the year of the nomination. Books must cover a field relevant to the IEEE.

Congratulations to this year's recipients,

VCSEL Industry: Communication and Sensing by Babu Dayal Padullaparthi, *VQuanta Private Limited, India;*
Jim Tatum, *Dallas Quantum Devices, USA;*
Kenichi Iga, *Tokyo Institute of Technology, Japan*

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.

Congratulations to this year's recipient,
Hong Liu, *Google, USA*

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.

Congratulations to this year's finalists:

Leonard Budd, *ORC, UK*
Benjamin Crockett, *INRS, Canada*
Keren Liu, *Chalmers University of Technology, Sweden*
George Giamougiannis, *Aristoteleio Panepistimio Thessalonikis, Greece*
Kyousuke Nakada, *Kagawa University, Japan*
Christos Pappas, *Aristotle University of Thessaloniki, Greece*
Apostolos Tsakyridis, *Aristotle University of Thessaloniki, Greece*

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.

Congratulations to this year's recipients:

Hannah Tomio, *Massachusetts Institute of Technology, USA*
Xiaohui Xu, *Purdue University, USA*
Wenting Yi, *University College London, UK*

The Tingye Li Innovation Prize

Presented to an early career professional who has demonstrated innovative research, the prize honors the global impact Tingye Li had on 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.

Congratulations to this year's recipient, Benjamin Crockett, *Institut National de la Recherche Scientifique (INRS), Canada*

Activities on the Show Floor

The OFC 2023 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 continuum of the supply chain – 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 and 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

Exhibit Halls B-G

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 2023 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 12 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, 07 March	10:00–17:00	10:00–10:30 16:00–16:30
Wednesday, 08 March	10:00–17:00	10:00–10:30 16:00–16:30
Thursday, 09 March	10:00–16:00	10:00–10:30

Elevated Coffee Break Station Infinera
Booth 4717

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 Formerly OSA

Suzanne R. Nagel Lounge

Booth 2839

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.

Lounge Hours

Tuesday, 07 March	10:00–17:00
Wednesday, 08 March	10:00–17:00
Thursday, 09 March	10:00–16:00

Please refer to your OFC 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 OFC Conference App for regular updates to show floor programming.

Expo Theater I, Exhibit Hall C

Sponsored by cisco

Market Watch

This three-day series of panel discussions engages the latest application topics and business issues in the field of 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, 07 March	
10:30–12:00	Panel I: State of the Industry
12:15–13:45	Panel II: PAM vs. Coherent for Data Center Connectivity
14:00–15:30	Panel III: 800G / 128GBaud Pluggable Coherent - Key Technologies and Applications
15:45–16:45	**COBO:** Design Considerations of Optical Connectivity in a Co-Packaged or On-Board Optics Switch
Wednesday, 08 March	
14:45–16:15	Panel IV: Performance-Centric Long Haul
Thursday, 09 March	
10:30–12:00	Panel V: Perspectives on the Future of ROADM Technologies and Architectures for Next-Gen Networks
12:15–13:45	Panel VI: Satellite Communications – Coherent Optics in Free Space
14:00–14:30	Cisco Sponsored Session
14:45–15:45	3D Sensing in High Volume Consumer and Automotive Applications

Network Operator Summit

This dynamic program presents the inside perspective from service providers and network operators–their issues, drivers, and how their requirements may impact the future of the industry. 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, 08 March	
10:15–10:45	Network Operator Summit:  Keynote Andreas Gladisch, *Vice-President, Deutsche Telekom AG, Germany*
11:00–12:30	Panel I: What's the Value of Optical Network Automation and How Can Optics Help
13:00–14:30	Panel II: Brownfield Application in Legacy Networks

2023 Show Floor Program Chair

Scott Wilkinson, *Cignal AI, USA*

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, 07 March	
10:45–11:45	**OCP:** Optics in Future AI Systems: Interconnects, Switching and Processing
12:00–12:30	**Data Center Summit:**  Keynote Chongjin Xi, *Senior Director, Chief Communication Scientist, Alibaba Group, USA*
12:30–14:00	**Data Center Summit Panel I:** More than a Clos: Future Datacenter Network Architectures and the Role of Optics
14:15–15:45	**Data Center Summit Panel II**: Open Line Systems – Can We Shape "Disaggregation" in One Direction?
16:00–17:00	Amphenol Sponsored Session

Please refer to your OFC 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 OFC Conference App for regular updates to show floor programming.

Wednesday, 08 March	
10:30–11:30	**Ethernet Alliance:** Ethernet in Telecom: The Rise of ZR and ZR+ for Metro (and Beyond?)
11:45–12:45	**OpenZR+:** OpenZR+MSA - New Developments and Next Steps
13:00–14:00	**OIF:** Defining 800ZR and 800L; An OIF Update
14:15–15:15	**FBA:** The State of Fiber in America
15:30–16:30	**Broadband Forum:** Technologies and Focus to Add Value to the Goal of a Single Multi-Access Optical PON Network
Thursday, 09 March	
11:00–12:00	**AIM Photonics** and the Next PIC Generation
12:15–13:15	**OIF:** Enabling Next Generation Co-Packaging Solutions
13:30–14:30	**IPEC:** IPEC Overview of Optoelectronic Technology and Industry Standards in the Cloud Era
14:45–15:45	**F5G Update:** The Second Release of Use Cases and Demonstrations

Expo Theater III Programming, *Exhibit Hall F*

Schedule

Tuesday, 07 March	
10:15–10:45	Conversation with the Plenary Speakers
11:00–12:00	**ITU-T SG15:** Standards Update with the Latest on 5G Transport, Higher Speed PON, SDM, OTN Technologies and Interoperable Optical Interfaces
12:15–12:45	How Innovations in Coherent Optical Engines Can Deliver Substantial Value to Telecom Networks Presented by Infinera
13:15–13:45	OFCnet
14:15–14:45	OFCnet Optical Engineering and Maintenance
15:00–16:00	**IEEE Future Directions:** Space-Based Optical, Communications and Networking
16:15–16:45	OFCnet Quantum Key Distribution
Wednesday, 08 March	
10:15–10:45	SWK Series: Next Generation Connectivity Presented by Sumitomo Electric Lightwave
11:00–11:30	OFCnet Quantum Network - Coexistence, Transporting Entanglements
11:40–12:10	OFCnet High Performing Networks Demonstrations
12:20–12:50	With Growing Bandwidth Demand Driving Innovative Optical Technologies, What Is the Impact on Network Architectures Today and Tomorrow? Presented by Infinera
13:00–13:30	OFCnet Backstage Pass: Highlighting the Unsung Heroes of Optical Connectivity
13:45–14:45	**OpenROADM:** Open ROADM MSA Updates and Demonstration
15:00–15:30	Bringing Order to Chaos – OIF – Part 1 Presented by OIF
15:30–16:00	Bringing Order to Chaos – OIF – Part 2 Presented by OIF
Thursday, 09 March	
10:15–10:45	QXP Innovative Silicon-based Midex Materials for Photonic Integration Presented by QXP Technologies Inc.
11:00–11:30	OFCnet Emerging Technologies
13:30—15:00	**MOPA:** Mobile Optics (MOPA) for the 6G Era

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OFCnet, Booth 5917

Starting in 2023, OFCnet brings a new opportunity to the exhibition to demonstrate products, concepts, solutions, research, and architectures in a live high-speed optical network connected to leading research and education networks worldwide. This increased focus on designing and building the next generation of Optical Networks will enable OFCnet to bring emerging technologies, Quantum Computer networks, programmability, and network software applications for big data applications to the forefront of the industry.

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Carl Williams, *CJW Quantum Consulting, USA*
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Live demonstrations from the following organizations and companies will be connected through OFCnet. Please refer to the Buyers' Guide for more details.

ADVA
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ESnet
Ethernet Alliance
ID Quantique
NuCrypt
Qunnect
Qubitekk
Northwestern University - ICAIR
NTT Labs
Nokia
NEC
OIF
SDSC
University of Amsterdam
University of Bristol
UCSD
UTD
Verizon

OFCnet is supported by:

Poster Presentations

Exhibit Hall B1

Wednesday, 08 March 10:30–12:30	W2A • Posters Session I, In-Person
Thursday, 09 March 10:30–12:30	Th2A • Posters Session III, In-Person

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

Beverages and light snacks are served during poster sessions. More information about the posters can be found in the abstract section of this program book.

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Program Chairs

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Fotini Karinou, *Microsoft Research Ltd, UK*
Elaine Wong, *University of Melbourne, Australia*

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Track D: Devices, Components, and Fibers

D1: Advanced Prototyping, Packaging and Integration

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Fred Kish, *North Carolina State Univ., USA*
Sylvie Menezo, *SCINTIL Photonics, France*
Sam Palermo, *Texas A&M Univ., USA*
Joris Van Campenhout, *IMEC, Belgium*
Xi Xiao, *Wuhan Research Inst. of Post & Telecom, China*
Molly Piels, *Juniper, USA*

D2: Passive Components

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Qixang Cheng, *Cambridge Research Inst., UK*
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Christi Madsen, *Texas A&M Univ., USA*
Sagi Mathai, *Hewlette Packard Labs, USA*
Miloš Popović, *Boston Univ., USA*
Mengjie Yu, *Univ. of Southern California, USA*

D3: Active Components

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Omer Khayam, *Google LLC, USA*
Martin Schell, *Fraunhofer Institut, Germany*
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Mitsuru Takenaka, *Univ. of Tokyo, Japan*
Connie Chang-Hasnain, *Berxel, China*
Askhan Seyedi, *NVIDIA, USA*
Patrick Lo, *AMF, Singapore*
Joyce Poon, *Max Planck Institute of Microstructure Physics, Germany*
Wei Shi, *Univ. of Laval, Canada*

D4: Fiber and Propagation Physics

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Sophie Camille Bres, *EPFL, Switzerland*
Ivana Gasulla, *Universitat Politecnica de Valencia, Spain*
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Luca Palmieri, *Univ. of Padova, Italy*
Georg Rademacher, *NICT, Japan*
Pierre Sillard, *Prismian Group, France*
Toshiki Taru, *Sumitomo Electric Industries Ltd., Japan*
Natalie Wheeler, *Univ. of Southampton, UK*
Aramias Zakharian, *Corning, USA*
Benyuan Zhu, *OFS Laboratories, USA*

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

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John Ballato, *Clemson Univ., USA*
Xiaoyi Bao, *Univ. of Ottawa, Canada*
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Yosuke Mizuno, *Yokohama National Univ., Japan*
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Yi Sun, *OFS Optics, USA*
Hidehisa Tazawa, *USumitomo Electric Industries Ltd., Japan*
Changyuan Yu, *The Hong Kong Polytechnic Univ., Hong Kong*

Track S: Subsystems and Systems

S1: Datacom Subsystems and Systems

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S2: Transmission Subsystems

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John Downie, *Corning Inc., USA*
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S3: Transmission Systems

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S4: Optical Processing, Microwave and Fiber-Sensing

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

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Track N: Networks and Services

N1: Advances in Development of Systems, Networks and Services

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N2: Optical Networking for Data Center and Computing Applications

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

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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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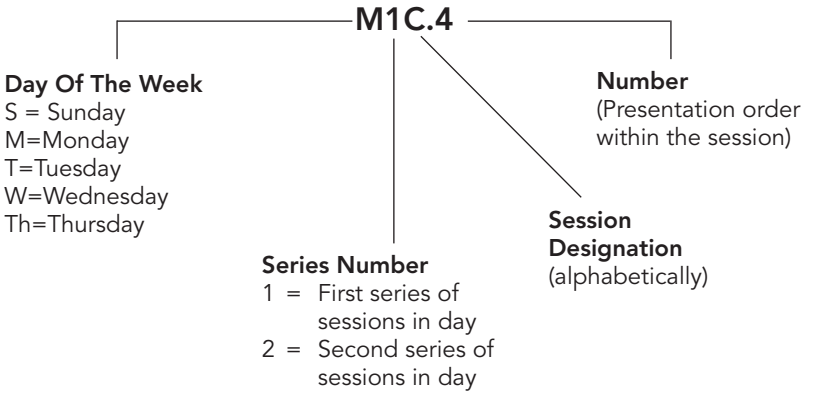
Explanation of Session Codes



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

Record Presentation

Top-Scored Top Scored Paper

Agenda of Sessions — Sunday, 05 March

	Room 6C	Room 6D	Room 6E	Room 6F	Room 7AB	Room 8
08:30–12:30	**SC105, SC203, SC208, SC328, SC395, SC432, SC443, SC461, SC463, SC469, SC470**					
09:00–12:00	**SC177, SC216, SC444**					
12:00–13:00	**Lunch Break** *(on own)*					
13:00–15:30	**S1A • Workshop: Smart Pluggable Coherent Optics: Is it the End of Layered IP Over DWDM?**	**S1B • Workshop: Quantum Dots - The Resurrection?**	**S1C • Workshop: Is Optical Access in Good Shape for the Future?**	**S1D • Workshop: Will Optics Have a Role to Play in Scaling Out Future Quantum Computing Architectures? I**	**S1E • Workshop: Is It Really Game Over for the Quest to Approach Fiber Capacity Limits?**	**S1F • Workshop: Where are the Boundaries Between IM-DD and Coherent?**
13:00–16:00	**SC447, SC512**					
13:00–17:00	**SC267, SC384, SC514**					
13:00–18:00	**Optical Transmission Systems - Design and Simulation Workshop,** *Room 31A*					
15:30–16:00	**Coffee Break,** *Upper Level Corridors*					
16:00–18:30	**S2A • Workshop: Revolutionary vs. Evolutionary SDM Fibers: Extra Gain at Extra Complexity?**	**S2B • Workshop: Will Machine Learning be the Killer Application for Optical Networks in Data Centres?**	**S2C • Workshop: Perennial Bandwidth at Home: LiFi or FiWi?**	**S2D • Workshop: Will Optics Have a Role to Play in Scaling Out Future Quantum Computing Architectures? II**	**S2E • Workshop: Does Optics have a Role in Space?**	**S2F • Workshop: Slow and Wide Versus Fast and Narrow: How Do We Make our Datacenters Green?**
19:00–21:00	**Hack Your Research! Tools and Tricks for Today's Telecommunications Techies,** *Room 17*					

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, 06 March

	Room 1AB	Room 2	Room 3	Room 6C	Room 6D
07:30–08:00	**Coffee Break,** *Upper Level Corridors*				
08:00–10:00	**M1A • Special Session: Ultra-Stable Frequency Sources and their Future Applications in Telecom I**	**M1B • SDM Devices and Amplifiers**	**M1C • Circulators, Mode Multiplexers, Dispersion Compensators, Ultrasound and Wavemeters**	**M1D • Panel: Virtualization in Optical Networks: A Reality Check**	**M1E • Coherent Technologies for Data Centers**
08:30–12:30	**SC102, SC160, SC341, SC369, SC433, SC448, SC452, SC453A, SC454, SC472, SC473, SC483, SC487,SC513**				
09:00–12:00	**SC359, SC450, SC465**				
10:00–10:30	**Coffee Break,** *Upper Level Corridors*				
10:30–12:30	**M2A • Special Session: High Performance Networks of Future Data Center and Computing Applications**	**M2B • SDM Devices and Systems**	**M2C • Fiber- and Waveguide-Based Sensors**	**M2D • High Speed EMLs and DMLs**	**M2E • Optical Fiber and Device Modelling**
12:00–13:00	**OFC Mentor/Mentee Meet-up,** *Room 17*				
12:30–14:00	**Lunch Break** *(on own)*				
13:30–16:30	**SC114, SC217, SC408, SC459, SC485**				
13:30–17:30	**SC261, SC325, SC327, SC347, SC357, SC393, SC431, SC451, SC453B**				
14:00–15:30	**The Journal Review Process: All You Need to Know!,** *Room 14B*				
14:00–16:00	**M3A • Symposium: Quantum Information and Optical Communication Networks: Emerging Research Areas, Challenges and Opportunities I**	**M3B • Multi-Core Fiber**	**M3C • Free Space and Coupling Devices**	**M3D • RF and THz Signal Generation**	**M3E • Enabling Technologies for Data Center and HPC**
14:00–16:15	**M3Z • OFC Demo Zone,** *Room 6A*				
16:00–16:30	**Coffee Break,** *Upper Level Corridors*				
16:30–18:30	**Birds of a Feather: Designing and Operating the Next Generation Optical Photonic Networks,** *Room 14B*				
16:30–18:30	**M4A • Symposium: Quantum Information and Optical Communication Networks: Emerging Research Areas, Challenges and Opportunities II**	**M4B • Multi-Mode Fiber**	**M4C • High Power and Comb Laser Sources**	**M4D • Panel: 1.6Tb/s+ Intra-DC Networks**	**M4E • High Bandwidth Density Interconnects for Computing**
19:00–21:00	**Student Party,** *Petco Park*				

Key to Shading

Short Courses

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Room 6E	Room 6F	Room 7AB	Room 8	Room 9
Coffee Break, *Upper Level Corridors*				
M1F • Complexity Optimized Coding and DSP for Optical Communications	**M1G • Survivability and Security**	**M1H • Panel: Towards Standardized PIC Testing: Challenges and Roadmaps**	**M1I • Photonic Integrated QKD** (ends at 09:30)	**M1J • Optical Signal Processing**
SC102, SC160, SC341, SC369, SC433, SC448, SC452, SC453A, SC454, SC472, SC473, SC483, SC487,SC513				
SC359, SC450, SC465				
Coffee Break, *Upper Level Corridors*				
M2F • Machine Learning for System Modeling and Channel Equalization	**M2G • Data Center Networking and PON Security** (ends at 12:15)	**M2H • Panel: Connectivity for Beyond 5G: How Can Wireline and Wireless Optical Access Live Up to the Mobile Expectations?**	**M2I • Innovative QKD Systems** (ends at 12:15)	**M2J • Optical Computing**
OFC Mentor/Mentee Meet-up, *Room 17*				
Lunch Break *(on own)*				
SC114, SC217, SC408, SC459, SC485				
SC261, SC325, SC327, SC347, SC357, SC393, SC431, SC451, SC453B				
The Journal Review Process: All You Need to Know!, *Room 14B*				
M3F • LIDAR, RADAR and Ranging Systems	**M3G • Telemetry and Synchronisation**	**M3H • Panel: Optical Fiber Sensing: Technology and Emerging Applications Part I**	**M3I • Monolithic or 3D Electro-Optical Integration**	**M3J • Accurate Frequency/ Time Distribution and Optical Computing**
M3Z • OFC Demo Zone, *Room 6A*				
Coffee Break, *Upper Level Corridors*				
Birds of a Feather: Designing and Operating the Next Generation Optical Photonic Networks, *Room 14B*				
M4F • Visible Light Communications and Positioning (ends at 18:15)	**M4G • Multi-X Networks**	**M4H • Panel: Optical Fiber Sensing: Technology and Emerging Applications Part II**	**M4I • Passive Silicon Photonic Devices**	**M4J • Photonic Switching Devices**
Student Party, *Petco Park*				

Agenda of Sessions — Tuesday, 07 March

	Room 1AB	Room 2	Room 3	Room 6C	Room 6D	Room 6E	Room 6F
07:30–08:00	**Plenary Session Coffee Break,** *Upper Level, Ballroom 20 Lobby*						
08:00–10:00	**Tu1A • Plenary Session,** *Ballroom 20BCD*						
10:00–17:00	**Exhibition and Show Floor,** *Exhibit Hall (concessions available)*						
10:00–14:00	**Unopposed Exhibit-only Time,** *Exhibit Hall (coffee service 10:00–10:30)*						
10:00–16:45	**OFC Career Zone,** *Exhibit Hall, B2* **OFC Career Zone Job Fair | Resume Critique Workshop | Mock Interviews**						
11:00–12:00	**Optical Communications Technical Group Poster Pitch Competition,** *Room 3*						
12:00–14:00	**OFC and Co-Sponsors Awards Ceremony and Luncheon,** *Upper Level, Ballroom 20A*						
14:00–16:00	**Tu2A • Symposium: The Crucial Role of Photonics in Achieving the UN Sustainability Development Goals: Learnings and Opportunities I**	**Tu2B • Photonic Devices for Novel Applications**	**Tu2C • Deployment and Field Trials**	**Tu2D • Network Planning and Operation**	**Tu2E • Co-Packaged and PIC for Data Center Applications**	**Tu2F • AI and Optimization in (Disaggregated) Networks**	**Tu2G • Subsea and Long-Haul Transmission**
16:00–16:30	**Coffee Break,** *Upper Level Corridors and Exhibit Hall*						
16:30–18:30	**Tu3A • Symposium: The Crucial Role of Photonics in Achieving the UN Sustainability Development Goals: Learnings and Opportunities II**	**Tu3B • Photonic Integrated Circuits**	**Tu3C • New Materials and Technologies**	**Tu3D • Network Orchestration**	**Tu3E • SDM - For Short Reach and Long-Haul Transmission Systems**	**Tu3F • Coexistence and Emerging Use-Cases of PON**	**Tu3G • Subsea and Sensing Networks**
17:15–18:15	**Exhibitor Reception,** *Center Terrace*						
18:30–20:00	**Conference Reception,** *Upper Level, Ballroom 20BCD*						
19:30–21:30	**Rump Session: Is the Silicon Photonics Platform about to be Standardized, Diversified or Supplanted?,** *Room 6F*						

<table>
<tr><th>Room 7AB</th><th>Room 8</th><th>Room 9</th><th>Exhibit Hall
Theater I</th><th>Exhibit Hall
Theater II</th><th>Exhibit Hall
Theater III</th></tr>
<tr><td colspan="3">Plenary Session Coffee Break, Upper Level, Ballroom 20 Lobby</td><td colspan="3">Exhibit Hall Opens 10:00</td></tr>
<tr><td colspan="3">Tu1A • Plenary Session, Ballroom 20BCD</td><td rowspan="11">MW1 • MW Panel I: State of the Industry
10:30–12:00

MW2 • MW Panel II: PAM vs. Coherent for Data Center Connectivity
12:15–13:45

MW3 • MW Panel III: 800G / 128GBaud Pluggable Coherent - Key Technologies and Applications
14:00–15:30

SF1 • COBO: Design Considerations of Optical Connectivity in a Co-Packaged or On-Board Optics Switch
15:45–16:45</td><td rowspan="11">SF2 • OCP: Optics in Future AI Systems: Interconnects, Switching and Processing
10:45–11:45

DCSK • Data Center Summit Keynote: Past Experiences and Future Prospects of Data Center Interconnect Optical Networks
12:00–12:30

DCS1 • DCS Panel I: More than a Clos: Future Datacenter Network Architectures and the Role of Optics
12:30–14:00

DCS2 • DCS Panel II: Open Line Systems - Can We Shape "Disaggregation" in One Direction?
14:15–15:45

Amphenol Sponsored Session
15:00-16:00</td><td rowspan="11">Conversation with the Plenary Speakers
10:15–10:45
SF3 • ITU-T SG15: Standards Update with the Latest on 5G Transport, Higher Speed PON, SDM, OTN Technologies, and Interoperable Optical Interfaces
11:00–12:00
How Innovations in Coherent Optical Engines Can Deliver Substantial Value to Telecom Networks Presented by Infinera
12:15–12:45
OFCnet Panel
13:15–13:45
OFCnet Optical Engineering and Maintenance
14:15–14:45
SF4 • IEEE Future Directions: Space-Based Optical Communications and Networking
15:00–16:00
OFCnet Quantum Key Distribution
16:15–16:45</td></tr>
<tr><td colspan="3">Exhibition and Show Floor, Exhibit Hall (concessions available)</td></tr>
<tr><td colspan="3">Unopposed Exhibit-only Time, Exhibit Hall (coffee service 10:00–10:30)</td></tr>
<tr><td colspan="3">OFC Career Zone, Exhibit Hall, B2
OFC Career Zone Job Fair | Resume Critique Workshop | Mock Interviews</td></tr>
<tr><td colspan="3">Optical Communications Technical Group Poster Pitch Competition, Room 3</td></tr>
<tr><td colspan="3">OFC and Co-Sponsors Awards Ceremony and Luncheon, Upper Level, Ballroom 20A</td></tr>
<tr><td>Tu2I • Panel: LiDAR Systems and Technologies with Integrated Photonics</td><td>Tu2H • Quantum Computing
(ends at 15:45)</td><td>Tu2J • Radio-Over-Fiber for 5G and Beyond Systems</td></tr>
<tr><td colspan="3">Coffee Break, Upper Level Corridors and Exhibit Hall</td></tr>
<tr><td>Tu3H • Quantum Interconnect and Hybrid Classical/Quantum Systems</td><td>Tu3I • High-Baud Rate Data Center Technologies</td><td>Tu3J • W-Band Fiber-Wireless Links</td></tr>
<tr><td colspan="3">Exhibitor Reception, Center Terrace</td></tr>
<tr><td colspan="3">Conference Reception, Upper Level, Ballroom 20BCD</td></tr>
<tr><td colspan="3">Rump Session: Is the Silicon Photonics Platform about to be Standardized, Diversified or Supplanted?, Room 6F</td><td colspan="3">Exhibit Hall Closes 17:00</td></tr>
</table>

Agenda of Sessions — Wednesday, 08 March

	Room 1AB	Room 2	Room 3	Room 6C	Room 6D	Room 6E	Room 6F
07:30–08:00	**Coffee Break,** *Upper Level Corridors*						
07:00–08:30	**International Women's Day Breakfast,** *Upper Level, Ballroom 20A*						
08:00–10:00	**W1A • Advanced Photodetectors**	**W1B • Special Session: Photonics for Visible Wavelengths I**	**W1C • Fiber Characterization and Fiber Sensing**	**W1D • Panel: Advanced Packaging Technologies for Optical Modules**	**W1E • DSP Design and System Modeling**	**W1F • 5G and Beyond**	**W1G • Optical Networks for Machine Learning Systems**
10:00–17:00	**Exhibition and Show Floor,** *Exhibit Hall, (coffee service 10:00–10:30)*						
10:00–16:30	**OFC Career Zone,** *Exhibit Hall* **OFC Career Zone Job Fair | Resume Critique | Mock Interviews**						
10:30–12:00	**The Art of Writing the Perfect OFC Paper,** *Room 14B*						
10:30–12:30	**W2A • Posters Session I, In-Person,** *Exhibit Hall B1* **W2B • Posters Session II, Remote,** *ePoster Gallery on OFC website* **Lunch Break** *(on own; concessions available in Exhibit Hall)*						
12:00–14:00	**IEEE/Optica Publishing Group Journal of Lightwave Technology 40th Anniversary Luncheon,** *Upper Level, Ballroom 20A*						
12:30–14:00	**Unopposed Exhibit-only Time,** *Exhibit Hall*						
14:00–16:00	**W3A • Symposium: Beyond the Hype of Network Analytics: Use Cases, Feasibility and Barriers I**	**W3B • Special Session: Photonics for Visible Wavelengths II**	**W3C • Devices for Quantum Technologies (Joint D5/SCQ)**	**W3D • Modulators and Transceivers**	**W3E • Transmission Impairment Mitigation and Compensation Techniques**	**W3F • Convergent Optical Access for Mobile Connectivity**	**W3G • Photonic Processing for Computing and ML**
16:00–16:30	**Coffee Beak,** *Upper Level Corridors and Exhibit Hall*						
16:30–18:30	**W4A • Symposium: Beyond the Hype of Network Analytics: Use Cases, Feasibility and Barriers II**	**W4B • Lasers and CPO**	**W4C • Advanced Optical Technologies**	**W4D • Hollow Core Fiber** (ends at 18:15)	**W4E • Direct Detection and Short Reach Transmission Systems**	**W4F • Converged Fixed and Mobile Networks**	**W4G • Machine Learning for Estimation and Forecasting**

Room 7AB	Room 8	Room 9	Room 4	Exhibit Hall Theater I	Exhibit Hall Theater II	Exhibit Hall Theater III
Coffee Break, *Upper Level Corridors*				Exhibit Hall Opens at 10:00		
International Women's Day Breakfast, *Upper Level, Ballroom 20A*				**NOSK • Network Operator Summit: Keynote** 10:15–10:45 **NOS1 • NOS Panel I: What's the Value of Optical Network Automation and How Can Optics Help** 11:00–12:30 **NOS2 • NOS II: Brownfield Applications in Legacy Networks** 13:00–14:30 **MW4 • MW Panel IV: Performance-Centric Long Haul** 14:45–16:15	**SF5 • Ethernet Alliance: Ethernet in Telecom: The Rise of ZR and ZR+ for Metro (and Beyond?)** 10:30–11:30 **SF6 • OpenZR+: OpenZR+MSA - New Developments and Next Steps** 11:45–12:45 **SF7 • OIF: Defining 800ZR and 800LR; an OIF Update** 13:00–14:00 **SF9 • FBA: The State of Fiber in America** 14:15–15:15 **SF10 • Broadband Forum: Technologies and Focus to Add Value to the Goal of a Single Multi-Access Optical PON Network** 15:30–16:30	**SWK Series: Next Generation Connectivity Presented by Sumitomo Electric Lightwave** 10:15–10:45 **OFCnet Quantum Network - Coexistence, Transporting Entanglements** 11:00–11:30 **OFCnet High Performing Networks Demonstrations** 11:40–12:10 **With Growing Bandwidth Demand Driving Innovative Optical Technologies, What Is the Impact on Network Architectures Today and Tomorrow? Presented by Infinera** 12:20–12:50 **OFCnet Backstage Pass: Highlighting the Unsung Heroes of Optical Connectivity** 13:00–13:30 **SF8 • OpenROADM: Open ROADM MSA Updates and Demonstration** 13:45–14:45 **Bringing Order to Chaos – OIF – Part 1 Presented by OIF** 15:00–15:30 **Bringing Order to Chaos – OIF – Part 2 Presented by OIF** 15:30–16:00
W1H • Optical Performance Monitoring	**W1I • Flexible Coherent PON**	**W1J • Fiber Sensing**				
Exhibition and Show Floor, *Exhibit Hall, (coffee service 10:00–10:30)*						
OFC Career Zone, *Exhibit Hall* **OFC Career Zone Job Fair | Resume Critique | Mock Interviews**						
The Art of Writing the Perfect OFC Paper, *Room 14B*						
W2A • Posters Session I, In-Person, *Exhibit Hall B1* **W2B • Posters Session II, Remote,** *ePoster Gallery on OFC website* **Lunch Break** *(on own; concessions available in Exhibit Hall)*						
IEEE/Optica Publishing Group Journal of Lightwave Technology 40th Anniversary Luncheon, *Upper Level, Ballroom 20A*						
Unopposed Exhibit-only Time, *Exhibit Hall*						
W3H • Coherent Pluggables and Field Trials	**W3I • Enabling Technology for Free Space Optical Communications** (ends at 15:45)	**W3J • Sensing, Devices and OTDR**				
Coffee Beak, *Upper Level Corridors and Exhibit Hall*						
W4H • Transmission Systems and Modelling	**W4I • Open Networking Summit: Top to Bottom: Practical Approaches to Openness, Disaggregation, and Reaggregation in Optical Communication**	**W4J • Hybrid Communication/ Sensing Systems**	**W4K • Quantum Networks** (ends at 18:15)			
				Exhibit Hall Closes at 17:00		

Agenda of Sessions — Thursday, 09 March

	Room 1AB	Room 2	Room 3	Room 6C	Room 6D	Room 6E	Room 6F
06:00–07:00	**Rise and Shine Morning Run/Walk,** *Hilton Bayfront*						
07:30–08:00	**Coffee Break,** *Upper Level Corridors*						
08:00–10:00	**Th1A • Novel Photonic Devices and Applications**	**Th1B • Nonlinear-Optical Amplifiers and Oscillators**	**Th1D • Data Center Networks and Control**	**Th1C • Panel: Promises, Prospects and Challenges of VCSELs for Data Center Interconnects, Free-Space Communications, and Sensing**	**Th1E • Beyond 400G Transmission**	**Th1F • Machine Learning and Advanced Digital Signal Processing**	**Th1G • Signal Processing in Next-Generation PON**
10:00–15:45	**OFC Career Zone,** *Exhibit Hall* **OFC Career Zone Job Fair | Resume Critique Workshop | Mock Interviews**						
10:00–16:00	**Exhibition and Show Floor,** *Exhibit Hall, (coffee service 10:00–10:30)*						
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	**Unopposed Exhibit-only Time,** *Exhibit Hall*						
13:00–14:00	**Personal Branding for Social Media Workshop, OFC Career Zone,** *Exhibit Hall*						
14:00–16:00	**Th3A • Novel Enabling Devices**	**Th3B • Silicon Photonics Devices and Integrated Circuits**	**Th3C • Doped Fiber Amplifiers**	**Th3D • Advances in Data Center Switching and Interconnects**	**Th3E • Modulation Formats**	**Th3F • Wideband Transmission Systems**	**Th3G • High Data-Rate Direct Detection in Access** (ends at 15:45)
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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<tr><th>Room 7AB</th><th>Room 8</th><th>Room 9</th><th>Exhibit Hall
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Theater II</th><th>Exhibit Hall
Theater III</th></tr>
<tr><td colspan="3">Rise and Shine Morning Run/Walk, Hilton Bayfront</td><td colspan="3">Exhibit Hall Opens at 10:00</td></tr>
<tr><td colspan="3">Coffee Break, Upper Level Corridors</td><td rowspan="9">MW5 • MW Panel V: Perspectives on the Future of ROADM Technologies and Architectures for Next-Gen Networks
10:30–12:00

MW6 • MW Panel VI: Satellite Communications - Coherent Optics in Free Space
12:15–13:45

Cisco Sponsored Session
14:00–14:30

SF15 • 3D Sensing in High Volume Consumer and Automotive Applications
14:45–15:45</td><td rowspan="9">SF11 • AIM Photonics and the Next PIC Generation
11:00–12:00

SF12 • OIF: Enabling Next Generation Co-Packaging Solutions
12:15–13:15

SF13 • IPEC: IPEC Overview of Optoelectronic Technology and Industry Standards in the Cloud Era
13:30–14:30

SF16 • F5G Update: The Second Release of Use Cases and Demonstrations
14:45–15:45</td><td rowspan="9">QXP Innovative Silicon-based Midex Materials for Photonic Integration Presented by QXP Technologies Inc.
10:15–10:45

OFCnet Emerging Technologies
11:00–11:30

SF14 • MOPA: Mobile Optics (MOPA) for the 6G Era
13:30–15:00</td></tr>
<tr><td>Th1J • Panel: How Can We Start to Consistently and Quantitatively Account for End-to-End Power Consumption, Beginning with a Focus on 100 Meter Datacenter Links?</td><td>Th1I • THz Optical Communications</td><td>Th1H • Satellite Communications and UV, LWIR Free Space Optical Communications</td></tr>
<tr><td colspan="3">OFC Career Zone, Exhibit Hall
OFC Career Zone Job Fair | Resume Critique Workshop | Mock Interviews</td></tr>
<tr><td colspan="3">Exhibition and Show Floor, Exhibit Hall, (coffee service 10:00–10:30)</td></tr>
<tr><td colspan="3">Th2A • Posters Session III, In-Person, Exhibit Hall B1
Lunch Break (on own; concessions available in Exhibit Hall)</td></tr>
<tr><td colspan="3">Unopposed Exhibit-only Time, Exhibit Hall</td></tr>
<tr><td colspan="3">Personal Branding for Social Media Workshop, OFC Career Zone, Exhibit Hall</td></tr>
<tr><td>Th3I • Panel: Roadmap for Photonic AI Accelerators</td><td>Th3H • Free Space and Optical Camera Communications
(ends at 15:45)</td><td>Th3J • Advanced Control in Quantum Systems</td></tr>
<tr><td colspan="3">Coffee Break, Upper Level Corridors</td></tr>
<tr><td colspan="3">Postdeadline Paper Sessions, Room 6C, 6D, 6E, 6F</td><td colspan="3">Exhibit Hall Closes at 16:00</td></tr>
</table>

Room 1AB	Room 2	Room 3	Room 6C	Room 6D

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

08:00–10:00
M1A • Special Session: Ultra-Stable Frequency Sources and their Future Applications in Telecom I

Presider: Daniel Blumenthal and Nicolas Fontaine; Nokia Bell Labs, USA and Radan Slavik; Univ. of Southampton, UK

M1A.1 • 08:00 Invited

Title to be Announced, Christopher Hilweg[1]; [1]*Universitat Wien, Austria.* Abstract not available.

M1A.2 • 08:30 Invited

Title to be Announced, Giuseppe Marra[1]; [1]*National Physical Laboratory (UK), UK.* Abstract not available.

08:00–10:00
M1B • SDM Devices and Amplifiers

Presider: Yi Sun; OFS Fitel LLC, USA

M1B.1 • 08:00 Invited

Scaling Modal Capacity of Fibers by Exploiting Topological Properties of Light, Siddharth Ramachandran[1]; [1]*Boston Univ., USA.* We describe the phenomenon and applications of topological confinement, a lighttransport mechanism distinct from total-internal reflection that has yielded up to 60 modes over a km with in-fiber intermodal crosstalk as low as -45 dB/km.

M1B.2 • 08:30 Invited

Structured Light Generation in Multicore or Multimode Fiber Amplifiers, Di Lin[1]; [1]*Univ. of Southampton, UK.* Abstract not available.

08:00–10:00
M1C • Circulators, Mode Multiplexers, Dispersion Compensators, Ultrasound and Wavemeters

Presider: Glenn Bartolini; Coherent Inc, USA

M1C.1 • 08:00 Invited

Polarization-Insensitive Isolators and Circulators on InP Photonics, Yuqing Jiao[1]; [1]*Technische Universiteit Eindhoven, Netherlands.* On-chip isolators and circulators are regarded as the last piece of puzzel for photonic integrated circuits. In this talk recent successful demonstration of a polarization insensitive design, compatible with the InP laser process, is presented.

M1C.2 • 08:30

Fully Passive Integrated-Optic Chromatic Dispersion Compensator and its Use to PAM4 Signal Compensation, Koichi Takiguchi[1]; [1]*Ritsumeikan Univ., Japan.* We report an integrated-optic chromatic dispersion compensator without any adjustment parts. The compensator comprises two arrayed-waveguide gratings and 100 fixed delay lines and was used to compensate for 80 Gbit/s pulse amplitude modulation signal distortion.

08:00–10:00
M1D • Panel: Virtualization in Optical Networks: A Reality Check

Organizers: Jamie Gaudette, *Microsoft, USA;* Ricardo Martinez, *CTTC, Spain;* Annachiara Pagano, *Telecom Italia, Italy*

Speakers: Filippo Cugini, *CNIT, Italy;* Oscar González de Dios, *Telefonica, Spain;* Darren Loher, *Google, USA;* Priyanth Mehta, *Ciena, USA;* Emilio Riccardi, *Telecom Italia, Italy*

Description: Over the last few years, telecom operators have consolidated the strategy for achieving cost-effective and flexible vendor-neutral open solutions by disaggregating the optical transport infrastructures. This will permit telecom operators to face the continuous growth of traffic while keeping a similar network cost (e.g., eliminating vendor lock-in). A key enabler to that is the virtualization concept applied in a broad sense to embrace both the control/management and data plane.

The complexity for managing and controlling open and disaggregated networks notably increases since multiple providers at the system and component level will come into play. Thus, it is needed to rely on vendor-neutral control solutions (e.g., ONF Open disaggregated transport networks -ODTN) where open and standard APIs enables the SDN controllers configuring multi-vendor network nodes. With respect to the SDN control architectures, an emerging solution revolves around the cloud-native (microservices) technology with the aim to overcome the classic monolithic implementations towards a more agile, flexible, and scalable controllers (e.g., µONOS).

At the data plane, the disaggregation helps eliminating the vendor lock-in where an interesting step on this strategy is the evolution towards open packet and optical white boxes (e.g., Open Optical & Packet Transport -OOPT- project within the Telecom Infra Project, TIP). White boxes decouple the providers of both hardware, based on COTS and open components, from the software, i.e., Network Operating System (e.g., SONiC, Stratum, …). This is enabled by open interfaces with the aim to accelerate the innovation, reduce cost, and increase the flexibility within disaggregated transport networks.

The panel is expected to last 2 h (5-6 speakers are expected with 10-15 minute). Speakers from academia, system vendors, telecom operators, and service providers will share their views on the current challenges faced by deploying and operating virtualized optical network infrastructure. In addition, they will address the tradeoffs at play, identify the sweet spots of the

08:00–10:00
M1E • Coherent Technologies for Data Centers

Presider: Norman Swenson; Norman Swenson Consulting, USA

M1E.1 • 08:00 Invited

Power Efficient Coherent Detection for Short-Reach System, Hongbin Zhang[1]; [1]*Cisco Systems Inc, USA.* Faster-than-Nyquist QPSK based on symbol-rate DSP can maximize the link loss budget and enable a single laser solution and low-power driver design in 1.6 Tb/s DR4 short-reach systems.

M1E.2 • 08:30

Self-Coherent Transmission Using Metasurface-Based Stokes-Vector Receiver, Go Soma[1], Yoshiro Nomoto[2], Toshimasa Umezawa[3], Yuki Yoshida[3], Yoshiaki Nakano[1], Takuo Tanemura[1]; [1]*School of Engineering, The Univ. of Tokyo, Japan;* [2]*Central Research Laboratory, Hamamatsu Photonics K.K., Japan;* [3]*National Inst. of Information and Communications Technologies, Japan.* Stokes-vector receiver with compact metasurface and two-dimensional photodetector array is developed to demonstrate 15-Gbaud 16QAM self-coherent transmission over 25-km single-mode fiber. Surface-normal configuration enables direct coupling to multi-core fibers in the future highly parallelized systems.

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

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

Room 6E

08:00–10:00
M1F • Complexity Optimized Coding and DSP for Optical Communications
Presider: Gabriele Liga; Eindhoven Univ. of Technology (TUe), Netherlands

M1F.1 • 08:00 Tutorial
Complexity-Optimized FEC for Optical Communications, Frank R. Kschischang[1]; [1]*Univ. of Toronto, Canada.* Abstract not available.

Room 6F

08:00–10:00
M1G • Survivability and Security
Presider: Paolo Monti; Chalmers Univ. of Technology, Sweden

M1G.1 • 08:00 Invited
Flexible Survivability in Multi-Band Next-Generation Optical Transport Networks, António Eira[1], Andre Souza[1,2], João Pedro[1,2]; [1]*Infinera Corporation, Portugal;* [2]*Instituto de Telecomunicações, Portugal.* We evaluate survivable network design options in the scope of C+L long-haul systems with high baud-rate channels. The analysis shows how design margins required for different failure response levels significantly affect resource and cost efficiency.

M1G.2 • 08:30
P4-Based Telemetry Processing for Fast Soft Failure Recovery in Packet-Optical Networks, Filippo Cugini[1], Carlos Natalino da Silva[2], Davide Scano[3], Francesco Paolucci[1], Paolo Monti[2]; [1]*CNIT, Italy;* [2]*Electrical Engineering, Chalmers Univ. of Technology, Sweden;* [3]*Scuola Superiore Sant'Anna, Italy.* A novel framework for in-network P4 processing of distributed telemetry data is presented, enabling effective soft failure detection and recovery strategies enforced in just few microseconds.

Room 7AB

08:00–10:00
M1H • Panel: Towards Standardized PIC Testing: Challenges and Roadmaps

Organizers: Patrick Lo, *Advanced Micro Foundry, Singapore;* Ashkan Seyedi, *NVIDIA, USA;* Wei Shi, *Université Laval, Canada*

Speakers: Li Chao, *Advanced Micro Foundry Pte Ltd, Singapore;* Raphael Dube-Demers, *EXFO, Canada;* James Pond, *Ansys, Canada;* Ed Preisler, *Tower-Jazz, USA;* Anand Ramaswamy, *OpenLight, USA;* Ryan Scott, *Keysight Laboratories, USA;* Eric Snow, *Intel Corporation, USA*

Description: This panel brings together industry leaders to discuss standardization of the PIC at the wafer-level, directly from the foundry. We propose a vision for defining standard test methodologies, data formats, test structures and associated figures of merit to allow for direct comparison of various silicon photonics processes. We also propose a simulation-based design approach based on validated models & process margins for new devices, which intends to accelerate design cycles and reduce spending. As the need for silicon photonics becomes critically important, these capabilities are paramount for the industry to achieve critical mass. Join the leaders from foundries, test & measurement vendors, EPDA companies and silicon photonics vendors to hear the vision, to ask questions and to voice your opinion on how we as a community can move towards standardized PIC testing.

Room 8

08:00–09:30
M1I • Photonic Integrated QKD
Presider: Cheryl Sorace-Agaskar; MIT Lincoln Laboratory, USA

M1I.1 • 08:00 Invited
A Chip-Based Quantum Access Network Without Trusted Relays, Feihu Xu[1]; [1]*Univ of Science and Technology of China, China.* I will report our recent efforts towards the construction of a chip-based quantum access network using the measurement-device-independent protocols. This includes the recent experiments on Si chip-based QKD, high-rate QKD, twin-field QKD and all-photonic quantum repeater.

M1I.2 • 08:30
CV-QKD Receiver Platform Based on a Silicon Photonic Integrated Circuit, Yoann Piétri[1], Luis Trigo Vidarte[2], Matteo Schiavon[1], Philippe Grangier[3], A. Rhouni[1], Eleni Diamanti[1]; [1]*LIP6 - CNRS - Sorbonne Université, France;* [2]*ICFO - Institut de Ciències Fotòniques, The Barcelona Inst. of Science and Technology, Spain;* [3]*Université Paris-Saclay, Institut d'Optique Graduate School, CNRS, Laboratoire Charles Fabry, France.* We report on the characterization of a SiGe PIC-based receiver along with its usage in a Gaussian-modulated coherent state CV-QKD setup. Excess noise measurements lead to secret key rate estimations of 280 kbit/s at 6.9km.

Room 9

08:00–10:00
M1J • Optical Signal Processing
Presider: Bill Corcoran; Monash Univ., Australia

M1J.1 • 08:00
Ultra-Wideband Pulse Generation Based on Dispersion-Diversity Multicore Fiber, Mario Ureña Gisbert[1], Sergi García Cortijo[1], Ivana Gasulla Mestre[1]; [1]*Universitat Politècnica de València, Spain.* We experimentally demonstrate, for the first time, reconfigurable arbitrary waveform generation using a dispersion-diversity heterogeneous multicore fiber by synthesizing a variety of tunable high-order ultra-wideband pulses (up to 7 samples).

M1J.2 • 08:15
Power Dissipation Bounds for Photonic Analog to Digital Converters, Callum Deakin[1], Zhixin Liu[1]; [1]*Univ. College London, UK.* We present the first power dissipation bounds for a generalised class of photonic analog to digital converters, and estimate their achievable power efficiency compared to conventional electronic designs.

M1J.3 • 08:30
Wide-Bandwidth, Enhanced-Quality Wireless Signal Detection With Low-Bandwidth Devices, Mohammed I. Elsayed[1], Janosch Meier[1], Younus Mandalawi[1], Karanveer Singh[1], Paulomi Mandal[1], Evans Baidoo[1], Ayman M. Mokhtar[2], Thomas Schneider[1]; [1]*Technische Universität Braunschweig, Germany;* [2]*Optoelectronics, Military Technical college, Egypt.* We discuss a new method for detecting high-bandwidth wireless signals with low-bandwidth electronics. We experimentally demonstrate the detection of 24 GBd-QPSK Nyquist data with 4 GHz electronics and a Q-factor enhancement of 2.2 dB.

Room 1AB

M1A • Special Session: Ultra-Stable Frequency Sources and their Future Applications in Telecom I—Continued

M1A.3 • 09:00 Invited

Title to be Announced, Franklyn Quinlan[1]; [1]*National Inst of Standards & Technology, USA*. Abstract not available.

Room 2

M1B • SDM Devices and Amplifiers—Continued

M1B.3 • 09:00

Modal Gain Equalization of Few-Mode Erbium-Doped Fiber Amplifiers Enabled by Mirrored Mode Exchanges, Tao Xu[1], Zhiqun Yang[1], Yaping Liu[1], Qiang Guo[2], Rui Zhou[2], Xinhua Xiao[2], Wenhao Li[3], Wei Li[3], Cheng Du[3], Zhanhua Huang[1], Lin Zhang[1,4]; [1]*Tianjin Univ., China;* [2]*Huawei Technologies Co., Ltd., China;* [3]*FiberHome Telecommunication Technologies Co., Ltd, China;* [4]*Peng Cheng Laboratory, China*. We propose a six-mode erbium-doped fiber amplifier with significantly reduced differential modal gain (DMG) by mirrored exchanging of the spatial modes for the first time. A DMG of <1.8 dB across the whole C-band is experimentally achieved.

M1B.4 • 09:15

Power Efficient Core Pumped Multicore Erbium Doped Optical Fiber Amplifier, Takafumi Ohtsuka[1], Takahiro Kikuchi[1], Takahiro Suganuma[1], Takemi Hasegawa[1], Hidehisa Tazawa[1]; [1]*Optical Communications Laboratory, Sumitomo Electric Industries, LTD., Japan*. A core pumped 4-core erbium doped optical fiber amplifier with a pump fan-in integrated combiner achieved the highest optical power conversion efficiency of 32.2% among reported C-band multicore erbium doped optical fiber amplifiers.

Room 3

M1C • Circulators, Mode Multiplexers, Dispersion Compensators, Ultrasound and Wavemeters—Continued

M1C.3 • 08:45

Free-Standing, Microscale, Mode-Selective Photonic Lantern Supported by a Truss Structure, Yoav Dana[1], Dan Marom[1]; [1]*hebrew Univ. of jerusalem, Israel*. We design, fabricate and characterize a three-mode selective photonic lantern using 3D waveguides made of photopolymer core and air cladding. Although the waveguides exhibit high index contrast, crosstalk between mode groups measures below -10dB.

M1C.4 • 09:00

Fabrication-Tolerant, 2-Mode, 4λ Multiplexer Based on Si Waveguides for Beyond Tbit/s Optical Ethernet, Takeshi Fujisawa[1], Kunimasa Saitoh[1]; [1]*Hokkaido Univ., Japan*. A fabrication-tolerant, 2-mode, 4l multiplexer is proposed for beyond Tbit/s optical Ethernet system. Various techniques for strengthening fabrication tolerance are introduced, and a proof-of-concept device is fabricated for Si-photonics platform.

M1C.5 • 09:15

Athermal Silicon Photonic Wavemeter With Wide Temperature Range, Brian Stern[1], Kwangwoong Kim[1], Harry Gariah[2], David Bitauld[2]; [1]*Nokia Bell Labs, USA;* [2]*III-V Lab (a joint lab of Nokia Bell Labs, Thales & CEA-LETI), France*. We demonstrate a silicon photonic wavemeter with high accuracy for broadband measurements over a large temperature range of 20-60 C. The integrated wavemeter reaches a mean error of 11 pm over an 80 nm span.

Room 6C

M1D • Panel: Virtualization in Optical Networks: A Reality Check—Continued

virtualization vision, and describe the best practices that should be in place.

The panel will consist of two parts, one more related to the disaggregated / white box data plane aspects and one targeting more service and network control aspects. Finally, the panel will end with a panel discussion where the invited speakers and the audience will discuss the issues highlighted during the various talks.

Room 6D

M1E • Coherent Technologies for Data Centers—Continued

M1E.3 • 08:45

DSP-Free Frequency Stabilized DCI Coherent Fiber Links Operating at 5.4Tbps 15λx90G-16QAM, 330G 72G-32QAM, and 336G 56G-64QAM, Mark W. Harrington[1], Grant Brodnik[1], Andrei Isichenko[1], Kaikai Liu[1], Travis Briles[2], Scott Papp[2,3], Daniel J. Blumenthal[1]; [1]*UCSB, USA;* [2]*Time and Frequency division 688, NIST, USA;* [3]*Physics, Univ. of Colorado, USA*. We demonstrate a 5.4 Tbps (90G-16QAMx15λ) DSP-free WDM coherent link and compare performance to single-λ 360G 72G-32QAM and 56G-64QAM coherent links over 100m using an integrated coil-resonator-stabilized Brillouin-laser-pumped integrated Kerr-comb.

M1E.4 • 09:00 Invited

Self-Homodyne Coherent Systems for Short-Reach Optical Interconnects, Ming Tang[1]; [1]*Huazhong Univ of Science and Technology, China*. Self-homodyne coherent detection scheme is promising for short-reach optical interconnect for its significantly reduced complexity and compatibility with legacy coherent infrastructure without sacrificing spectral efficiency. Solutions towards practical use are presented here with future perspectives.

Room 6E

M1F • Complexity Optimized Coding and DSP for Optical Communications—Continued

M1F.2 • 09:00 Top-Scored

Beyond 200-GBd QAM Signal Detection Based on Trellis-Path-Limited Sequence Estimation Supporting Soft-Decision Forward Error Correction, Masanori Nakamura[1], Hiroki Taniguchi[1], Shuto Yamamoto[1], Fukutaro Hamaoka[1], Munehiko Nagatani[2,1], Teruo Jyo[2], Miwa Mutou[2], Yuta Shiratori[2], Hitoshi Wakita[2], Takayuki Kobayashi[2,1], Yutaka Miyamoto[1]; [1]*NTT Network Innovation Laboratories, Japan;* [2]*NTT Device Technology Laboratories, Japan.* We proposed and experimentally demonstrated a trellis-path-limited sequence estimation method combining the log-likelihood ratio from minimum-mean-square-error equalizer-enabled signal detection with soft-decision -FEC decoding under severe bandwidth limitations, achieving 1.35-Tb/s 256-GBd 16QAM and 1.65-Tb/s 208-GBd 64QAM.

M1F.3 • 09:15

Implementation of a Robust and Power-Efficient Nonlinear 64-QAM Demapper Using in-Memory Computing, Amro I. Eldebiky[1], Georg Böcherer[2], Maximilian Schaedler[2], Stefano Calabrò[2], Bing Li[1], Ulf Schlichtmann[1]; [1]*Electronic Design Automation chair, Technical Univ. of Munich (TUM), Germany;* [2]*Huawei Munich Research Center, Germany.* Analog in-memory computing reduces power consumption sacrificing computational accuracy. We implement multiplication-accumulation in resistive RAM accounting for non-idealities (variations, quantization, ADC noise). The floating-point performance is recovered while minimizing power consumption in offline 64-QAM experiments.

Room 6F

M1G • Survivability and Security—Continued

M1G.3 • 08:45

Packet-Optical Differentiated Survivability Implemented by P4 Slices and GNMI Telemetry, Rossano P. Pinto[1], Kayol S. Mayer[1], Dalton S. Arantes[1], Darli Mello[1], Christian E. Rothenberg[1]; [1]*UNICAMP, Brazil.* We demonstrate a packet-optical differentiated survivability mechanism implemented in P4 switches using gNMI telemetry. The controller detects the premium slice interruption and switches it to an alternative path reducing the throughput of the regular slice.

M1G.4 • 09:00 Invited

Enhancement of Network-Cloud Ecosystem Resilience With Openness Disaggregation and Cooperation, Sugang Xu[1], Kiyo Ishii[2], Noboru Yoshikane[3], Subhadeep Sahoo[4], Sifat Ferdousi[4], Masaki Shiraiwa[1], Yusuke Hirota[1], Takehiro Tsuritani[3], Massimo Tornatore[5], Yoshinari Awaji[1], Shu Namiki[2], Biswanath Mukherjee[4,6]; [1]*National Inst. of Information and Communications Technology (NICT), Japan;* [2]*National Inst. of Advanced Industrial Science and Technology (AIST), Japan;* [3]*KDDI Research, Inc., Japan;* [4]*Univ. of California, Davis, USA;* [5]*Politecnico di Milano, Italy;* [6]*Soochow Univ., China.* We investigate the problem of enhancing the resilience of future optical network-cloud ecosystems. We introduce new solutions to build disaster-resilient single- and multi-entity network-cloud ecosystems with openness, disaggregation, and cooperation between networks and clouds.

Room 7AB

M1H • Panel: Towards Standardized PIC Testing: Challenges and Roadmaps—Continued

Room 8

M1I • Photonic Integrated QKD—Continued

M1I.3 • 08:45

InP-Based CV-QKD PIC Transmitter, Jennifer D. Aldama[1], Samael Sarmiento-Hernández[1], Sebastian Etcheverry[1], Ignacio López Grande[1], Luis Trigo Vidarte[1], Lorenzo Castelvero[1], Alberto Hinojosa[2], Tobias Beckerwerth[3], Yoann Piétri[4], A. Rhouni[4], Eleni Diamanti[4], Valerio Pruneri[1]; [1]*ICFO-Institut de Ciencies Fotoniques, Spain;* [2]*VLC, Spain;* [3]*Fraunhofer HHI, Germany;* [4]*Sorbonne Université, CNRS, France.* An InP-based photonic integrated circuit (PIC) transmitter for pulsed Gaussian-modulated coherent-state (GMCS) CV-QKD protocol is presented and characterized. Results show potential asymptotic secret key rates of 0.4 Mbps at 11 km, and up to 2.3 Mbps in back-to-back configuration.

M1I.4 • 09:00

Demonstration of Reference Frame Independent Quantum Key Distribution With Integrated Optical Circuits, Kyongchun Lim[1], Byung-seok Choi[1], Joong-Seon Choe[1], Ju Hee Baek[1], Minchul Kim[1], Kap-Joong Kim[1], Chun Ju Youn[1]; [1]*ETRI, Korea (the Republic of).* Free-space quantum key distribution usually requires limited space and weight. We implement reference frame independent quantum key distribution protocol with chip-scale integrated optical circuits such as laser diode, variable optical attenuator, and polarization beam combiner.

M1I.5 • 09:15

Polarization-Encoded BB84 QKD Transmitter Sourced by a SiGe Light Emitter, Florian Honz[1], Nemanja Vokic[1], Philip Walther[2], Hannes Hübel[1], Bernhard Schrenk[1]; [1]*AIT Austrian Inst. of Technology, Austria;* [2]*Faculty of Physics, Univ. of Vienna, Universitat Wien, Wien, Wien, AT, academic, Austria.* We demonstrate a polarization-encoded BB84 transmitter sourced by a SiGe light source and show that such a potentially "all-silicon" QKD scheme can operate well below the QBER threshold at which secret keys can be established.

Room 9

M1J • Optical Signal Processing—Continued

M1J.4 • 08:45 Invited

Automatic Turbulence Resilience in Self-Coherent Free-Space Optical Communications, Runzhou Zhang[1], Xinzhou Su[1], Hao Song[1], Huibin Zhou[1], Moshe Tur[2], Alan Willner[1]; [1]*Univ. of Southern California, USA;* [2]*Tel Aviv Univ., Israel.* We review the recently reported self-coherent approaches that can enable resilient free- space optical communications using automatic optoelectronic multi-mode mixing.

M1J.5 • 09:15

Photonics-Enabled Nanosecond Scale Real-Time Spectral Analysis With 92-GHz Bandwidth and MHz Resolution, Xinyi Zhu[1], Benjamin Crockett[1], Connor M. Rowe[1], Jose Azaña[1]; [1]*INRS-EMT, Canada.* We demonstrate gapless and real-time spectral analysis of broadband waveforms with >250 analysis points per spectrum. The concept is based on a discretization of an electro-optic time-lens to implement a phase modulation equivalent to 206.25p.

Room 1AB

M1A • Special Session: Ultra-Stable Frequency Sources and their Future Applications in Telecom I—Continued

M1A.4 • 09:30 Invited

Title to be Announced, Mark Saffman[1]; [1]*Univ. of Wisconsin-Madison, USA.* Abstract not available.

Room 2

M1B • SDM Devices and Amplifiers—Continued

M1B.5 • 09:30 Invited

Photonic-Lantern-Based MDM Devices, Lars E. Grüner-Nielsen[1,2], Neethu M. Mathew[1], Michael Galili[1], Lars S. Rishøj[1], Karsten Rottwitt[1]; [1]*DTU Electro, Tech. Univ. of Denmark, Denmark;* [2]*Danish Optical Fiber Innovation, Denmark.* Results for air clad photonic lanterns are presented including new results for a 6-mode photonic lantern. Results for cross talk dynamics in a 1.6 km link versus both time and wavelengths are presented.

Room 3

M1C • Circulators, Mode Multiplexers, Dispersion Compensators, Ultrasound and Wavemeters—Continued

M1C.6 • 09:30

64-Channel Fiber-Optic Ultrasound Detector Array With High Sensitivity for Photoacoustic Imaging, Anqi Wang[1], Liuyang Yang[1], Dongchen Xu[1], Geng Chen[1], Chenhao Dai[1], Qizhen Sun[1]; [1]*Huazhong Univ. of Science and Technology, China.* We present a 64-channel fiber-optic ultrasound detector array with high sensitivity. The sensor can exhibit a NEP of 0.64kPa and a wide bandwidth about 47MHz, which gives a favorable resolution of photoacoustic imaging.

M1C.7 • 09:45

Photonic Micro-Ring Tensor Core for Parallel and Shared Batch Processing, Jiang Yue[1], Wenjia Zhang[1], Xuying Liu[1], Zuyuan He[1]; [1]*State Key Laboratory of Advanced Optical Communication Systems and Networks, Shanghai Jiao Tong Univ., China.* We propose and experimentally demonstrate a batch dimension processing scheme based on the micro-ring weighting bank, which can at least quadruple the computing capability of the photonic tensor core without extra weighting units and power consumption.

Room 6C

M1D • Panel: Virtualization in Optical Networks: A Reality Check—Continued

Room 6D

M1E • Coherent Technologies for Data Centers—Continued

M1E.5 • 09:30 ★ Top-Scored

A 224 Gbps/λ O-Band Coherent Link for Intra-Data Center Applications, Aaron Maharry[1], Stephen Misak[1], Hector Andrade[1], Junqian Liu[1], Giovanni Gilardi[2], Sean Liao[2], Ansheng Liu[2], Yuliya A. Akulova[2], Larry Coldren[1], James Buckwalter[1], Clint Schow[1]; [1]*UC Santa Barbara, USA;* [2]*Intel Corporation, USA.* We present the first >200 Gbps/λ O-band optical link with integrated transmitter and receiver photonic and electronic ICs. 224 Gbps/λ DP-QPSK transmission is demonstrated below the 3.8×10^{-3} HD-FEC threshold with 6.8 pJ/bit power consumption.

M1E.6 • 09:45

A 200Gb/s QAM-16 Silicon Photonic Transmitter With 4 Binary-Driven EAMs in an MZI Structure, Arian Hashemi Talkhooncheh[1], Aaron Zilkie[2], Guomin Yu[2], Roshanak Shafiiha[2], Azita Emami[1]; [1]*California Inst. of Technology, USA;* [2]*Rockley Photonics Inc., USA.* A DAC-less 200Gb/s QAM-16 transmitter in a multi-micron silicon-photonics platform using 4 binary-driven SiGe EAMs in an unbalanced MZI is presented. The transmitter exhibits bit-error rates of 3×10^{-4} and 2.8×10^{-4} for square and hexagonal constellations.

08:30–12:30 SC102, SC160, SC341, SC369, SC433, SC448, SC452, SC453A, SC454, SC472, SC473, SC483, SC487,SC513

09:00–12:00 SC359, SC450, SC465

10:00–10:30 Coffee Break, *Upper Level Corridors*

Room 6E

M1F • Complexity Optimized Coding and DSP for Optical Communications—Continued

M1F.4 • 09:30 ★ Top-Scored
FPGA Implementation of Multi-Layer Machine Learning Equalizer With on-Chip Training, Keren Liu[1], Christian Häger[2], Erik Börjeson[1], Per Larsson-Edefors[1]; [1]*Department of Computer Science and Engineering, Chalmers Univ. of Technology, Sweden;* [2]*Department of Electrical Engineering, Chalmers Univ. of Technology, Sweden.* We design and implement an adaptive machine learning equalizer that alternates multiple linear and nonlinear computational layers on an FPGA. On-chip training via gradient backpropagation is shown to allow for real-time adaptation to time-varying channel impairments.

M1F.5 • 09:45
Area-Efficient Neural Network CD Equalizer for 4x200Gb/s PAM4 CWDM4 Systems, Bo Liu[1], Christian Bluemm[2], Stefano Calabrò[2], Bing Li[1], Ulf Schlichtmann[1]; [1]*Technical Univ. of Munich, Germany;* [2]*Huawei Technologies Duesseldorf GmbH, Germany.* We use multi-task learning to train a neural network on datasets of multiple wavelengths to mitigate chromatic dispersion. Shared weights allow logic simplification of multipliers. Flexible biases allow a low BER. Results show the neural network equalizer achieves a similar BER compared with a Volterra equalizer with 71% reduction in hardware area.

Room 6F

M1G • Survivability and Security—Continued

M1G.5 • 09:30
An Open Line System With Ultra-Fast Protection Switching for Data Center Interconnect, Juan Wang[1], Yu Jin[1], Chen Zhu[1], Feng Gao[1], Yongxin Cui[1], Gang Cheng[1], Xu Zhou[1]; [1]*Baidu, China.* We present a DCI OLS with 5ms ultra-fast protection switching. By optimizing the DSP traffic rebuild time with a magneto-optic switch, we are able to improve the current ITU standard by an order of magnitude.

M1G.6 • 09:45
Man-in-the-Middle Attacks Through Re-Shaping I-Q Optical Constellations, Marc Ruiz[1], Jaume Comellas[1], Luis Velasco[1]; [1]*Universitat Politecnica de Catalunya, Spain.* A module to re-shape optical constellations making the optical signal resembles as it has traversed some distance is presented. Armed with this module, Main-in-the-Middle attacks can be performed, which could be undetectable by security systems.

Room 7AB

M1H • Panel: Towards Standardized PIC Testing: Challenges and Roadmaps—Continued

Room 8

M1I • Photonic Integrated QKD—Continued

Room 9

M1J • Optical Signal Processing—Continued

M1J.6 • 09:30
Photonic Max-Pooling for Deep Neural Networks Using a Programmable Photonic Platform, Farshid Ashtiani[1], Mehmet Berkay On[1,2], David Sanchez-Jacome[3], Daniel Pérez-López[3], S. J. Ben Yoo[2], Andrea Blanco-Redondo[1]; [1]*Nokia Bell Labs, USA;* [2]*Univ. of California Davis, USA;* [3]*iPronics, Spain.* We propose a photonic max-pooling architecture for photonic neural networks which is compatible with integrated photonic platforms. As a proof of concept, we have experimentally demonstrated the max-pooling function on a programmable photonic platform consisting of a hexagonal mesh of Mach-Zehnder interferometers.

M1J.7 • 09:45
Combined Parametric and Denoising Passive Amplification by FWM-Based Oversampling and Talbot-Based Decimation, Manuel P. Fernández[1,2], Saket Kaushal[1], Benjamin Crockett[1], Laureano A. Bulus Rossini[2], Pablo A. Costanzo Caso[2], Jose Azaña[1]; [1]*Institut national de la recherche scientifique (INRS), Canada;* [2]*Instituto Balseiro (UnCuyo-CNEA) & Conicet, Argentina.* We present an optical waveform amplification methodology combining parametric and denoising passive amplification through all-fiber oversampling and dispersion-induced decimation. We demonstrate peak-to-peak gains up to 17 dB and effective denoising of MHz-bandwidth optical signals.

08:30–12:30 SC102, SC160, SC341, SC369, SC433, SC448, SC452, SC453A, SC454, SC472, SC473, SC483, SC487,SC513

09:00–12:00 SC359, SC450, SC465

10:00–10:30 Coffee Break, *Upper Level Corridors*

Room 1AB

10:30–12:30
M2A • Special Session: High Performance Networks of Future Data Center and Computing Applications
Presider: Laurent Schares; IBM, USA

M2A.1 • 10:30 Invited
Title to be Announced, Rui Wang[1]; [1]*Google LLC, USA*. Abstract not available.

M2A.2 • 10:50 Invited
Title to be Announced, Manya Ghobadi[1]; [1]*Massachusetts Inst. of Technology, USA*. Abstract not available.

Room 2

10:30–12:30
M2B • SDM Devices and Systems
Presider: Yuta Wakayama; KDDI R&D Laboratories, Japan

M2B.1 • 10:30 Invited
Performance Requirements for FIFO-Less Multicore Fibre Repeaters in Transatlantic-Class Transmission, Daniel J. Elson[1], Yuta Wakayama[1], Noboru Yoshikane[1], Takehiro Tsuritani[1]; [1]*KDDI R&D Laboratories, Japan*. We use the extended droop model to evaluate the performance requirements for SDM repeaters in transatlantic systems. The impact of repeater crosstalk on cable capacity is evaluated separately from fibre effects.

M2B.2 • 11:00 ★ Top-Scored
10-Spatial-Mode 1300-km Transmission Over 6-LP Graded Index Few-Mode Fiber With 36-ns Modal Dispersion, Kohki Shibahara[1], Megumi Hoshi[1], Yutaka Miyamoto[1]; [1]*NTT Network Innovation Laboratories, Japan*. We demonstrate record-long 10-mode-multiplexed transmission over 1300 km with 6-LP few-mode-fiber with modal dispersion coefficient of 157 ps/km. Modal-dispersion-unmanaged link was built by cyclic mode-group permutation, achieving reduction in modal dispersion accumulation by 82 %.

Room 3

10:30–12:30
M2C • Fiber- and Waveguide-Based Sensors
Presider: Xiaoyi Bao; Univ. of Ottawa, Canada

M2C.1 • 10:30 Invited
Transforming Subsea Optical Cables Into a Giant Network of Environmental Sensors, Giuseppe Marra[1]; [1]*National Physical Laboratory (UK), UK*. 70% of the Earth's surface is water-covered, yet the ocean floor remains mostly unmonitored. We show how ultra-stable interferometry can change this by enabling seafloor cables to be used as arrays of enviromental sensors.

M2C.2 • 11:00
High-Sensitivity Acoustic Impedance Sensing Using Forward Stimulated Brillouin Scattering in Highly Nonlinear Fiber, Keyan Zeng[1], Liang Wang[1], Ming Tang[1], Deming Liu[1]; [1]*Huazhong Univ. of Sci. & Tech., China*. High-sensitivity acoustic impedance sensing has been demonstrated for the first time by using radial acoustic modes induced forward Brillouin scattering in highly nonlinear fiber. The measurement sensitivity has been improved to be 3.83MHz/[kg/(s•mm^2)].

Room 6C

10:30–12:30
M2D • High Speed EMLs and DMLs
Presider: Wei Shi; Université Laval, Canada

M2D.1 • 10:30 Invited
Ultrahigh Speed EA-DFB Lasers Beyond 200 Gbps per Lane, Kazuhiko Naoe[1]; [1]*Lumentum Japan, Inc., Japan*. We describe 224 Gbps-PAM4 uncooled operation by EA-DFB. Moreover, 330.8-Gbps PAM6 (128-Gbaud PAM6), 384 Gbps PAM8 (128-Gbaud PAM8) and 420 Gbps PAM8 (140-Gbaud PAM8) operations by ultrahigh speed EA-DFB are reviewed.

M2D.2 • 11:00 ★ Top-Scored
225 Gb/s PAM4 2 km and 10 km Transmission of EMLs With Hybrid Waveguide Structure for 800GbE and 1.6TbE Transceivers, Asami Uchiyama[1], Shinya Okuda[1], Yohei Hokama[1], Mizuki Shirao[2], Kenichi Abe[3], Takeshi Yamatoya[1]; [1]*High Frequency & Optical Device Works, Mitsubishi Electric Corporation, Japan;* [2]*Information Technology R&D Center, Mitsubishi Electric Corporation, Japan;* [3]*Advanced Technology R&D Center, Mitsubishi Electric Corporation, Japan*. We experimentally demonstrated 10 km transmission of 225 Gb/s PAM4 modulation signal using our developed high-speed EMLs with a hybrid waveguide structure. Clear eye patterns were observed with 5 taps of TDECQ reference equalizer.

Room 6D

10:30–12:30
M2E • Optical Fiber and Device Modelling
Presider: Sergejs Makovejs; Corning Inc, UK

M2E.1 • 10:30
Experimental Model of EDFA Spectral Hole Burning for WDM Transmissions Systems, Juliana Tiburcio de Araujo[1], Alexis Carbo Meseguer[1], Jean-Christophe Antona[1]; [1]*Alcatel Submarine Networks (ASN), France*. We propose an empirical model to characterize the Spectral Hole Burning (SHB) of a chain of 200 EDFA in WDM transmission systems. Then we test it with 300 random input pre-emphases obtaining an average of root-mean-square error down to 0.5 dB.

M2E.2 • 10:45
Auxiliary Neural Network Assisted Machine Learning EDFA Gain Model, Jiachuan Lin[1], Xiang Lin[1], Zhiping Jiang[1]; [1]*Huawei Technologies Canada, Canada*. An enhanced EDFA model employing auxiliary neural networks is proposed. Adaptive to different devices, the model reduces the root mean square error from 0.04 to 0.02 dB with significantly less amount of training data.

M2E.3 • 11:00
Experimental Demonstration of Optical Modulation Format Identification Using SOI-Based Photonic Reservoir, Guillermo von Hünefeld[1,2], Gregor Ronniger[1], Enes Seker[3,4], Rijil Thomas[3], Pooyan Safari[1], Isaac Sackey[1], Md Mahasin Khan[1], Stephan Suckow[3], Max Lemme[4,3], David Stahl[5], Colja Schubert[1], Johannes Karl Fischer[1], Ronald Freund[1,2]; [1]*Fraunhofer HHI, Germany;* [2]*Technische Universität Berlin, Technische Universitat Berlin, Berlin, Berlin, DE, academic, Germany;* [3]*AMO GmbH, AMO GmbH, Aachen, Nordrhein-Westfalen, DE, other/research, Germany;* [4]*RWTH, Rheinisch-Westfalische Technische Hochschule Aachen, Aachen, Nordrhein-Westfalen, DE, academic, Germany;* [5]*ID Photonics GmbH, Germany*. We experimentally show modulation format identification of optical signals using silicon-on-insulator (SOI) photonic-integrated-circuit-based reservoir. After 100-km SSMF transmission, we achieve identification of 32 GBd 4QAM, 16QAM, 32QAM and 64QAM signals with up to ~97% accuracy.

Room 6E

10:30–12:30
M2F • Machine Learning for System Modeling and Channel Equalization
Presider: Jianqiang Li; Kuaishou Technology, USA

M2F.1 • 10:30 Tutorial
Digital Twins and Measurement Informed Physical Layer Models, Seb J. Savory[1]; [1]*Univ. of Cambridge, UK.* Digital coherent transceivers can monitor the state of an optical network, enabling measurement informed physical layer models. After reviewing the measurement capabilities, we cover physics-based and data-driven models, concluding with the requirements for digital twins.

Room 6F

10:30–12:15
M2G • Data Center Networking and PON Security
Presider: Albert Rafel; British Telecommunications, UK

M2G.1 • 10:30 Invited
Apollo: Large-Scale Deployment of Optical Circuit Switching for Datacenter Networking, Hong Liu[1]; [1]*Google LLC, USA. We describe Apollo, the world's first large-scale production deployment of optical circuit switches (OCSes) for datacenter networking. We review the underlying hardware technologies including the design of our internally developed OCS and WDM transceivers.*

M2G.2 • 11:00
Field Demonstration of Disaggregated Optical Network Consisting of ZR+ and Coherent Channels Using Power Equalization by Switched Gain Equalization Controlled Amplifiers, Sumit Chatterjee[2], Deepak Sanghi[2], Praveen Maheshwari[2], Abhishek Anchal[1], Eyal Lichtman[1]; [1]*Ribbon Communications, Israel;* [2]*Airtel, India.* We report a field trial of 400G-ZR+ QSFP-DD-DCO and ten coherent channels, interoperating with oFEC between two different vendors. We equalize the power by switched gain equalization controlled amplifers. Field trial is verified by simulations.

Room 7AB

10:30–12:30
M2H • Panel: Connectivity for Beyond 5G: How Can Wireline and Wireless Optical Access Live Up to the Mobile Expectations?

Organizers: Frank Chang, *Source Photonics, USA;* Baris Erkmen, *HERDON, USA;* Albert Rafel, *BT, UK;* Ke Wang, *RMIT, Australia;* Jim Zou, *ADVA, Germany*

Speakers: Devin Brinkley, *X the Moonshot Factory, USA;* Hanne-Stine Hallingby, *Telenor, Norway;* Xiang Liu, *Huawei Technologies, Hong Kong;* Junwen Zhang, *Fudan University, China*

Description: With 5G being commercially deployed and ramped up and witnessing its revolution from 4G, optical access technologies are playing an intrinsic role more than ever before to enable the connectivity between the central office and remote radio units. Looking ahead, both academia and industry have already started investigating the next generation, 6G, in terms of requirements, use cases, enabling technologies, architectures, etc.

Amongst the early research focusing on new radio technologies, it can be foreseen that more wireline and wireless optical access will be adopted, to sustain the even higher throughput and performance demand, less energy consumption, more diverse networking scenarios, just to name a few.

This panel will reveal and discuss new technology trends in the optical domain, ranging from key components to end-to-end system applications, including for instance 50G/100G BiDi optics, free-space optical transmission, microwave photonics, WDM-PON, and more. Some of them were already envisioned at the dawn of 5G but too early to be ready, while some of them are purely driven by the solid scaling factor.

The panelists from both academia and industry will share their thoughts and visions.

Room 8

10:30–12:15
M2I • Innovative QKD Systems
Presider: Eleni Diamanti; CNRS, France

M2I.1 • 10:30 Invited
Atomic Clocks Technologies for Twin-Field QKD in Real World, Cecilia Clivati[1], Alice Meda[1], Simone Donadello[1], Marco Genovese[1], Filippo Levi[1], Salvatore Virzì[1], Alberto Mura[1], Mirko Pittaluga[2], Zhiliang Yuan[4], Andrew Shields[2], Marco Lucamarini[3], Ivo Degiovanni[1], Davide Calonico[1]; [1]*INRIM, Italy;* [2]*Toshiba Europe Ltd, UK;* [3]*Univ. of York, UK;* [4]*Beijing Academy of Quantum Information Sciences, China.* We integrate atomic clocks technologies, namely narrow-linewidth lasers and phase-coherent distribution of optical signals over fiber, in a Twin-Field Quantum Key Distribution system in a real world fiber network, and discuss possible improvements in key distribution.

M2I.2 • 11:00 ★ Top-Scored
High-Rate Continuous-Variable Measurement-Device-Independent Quantum key Distribution, Adnan Hajomer[1], Huy Q. Nguyen[1], Tobias Gehring[1]; [1]*Technical Univ. of Denmark, Denmark.* We report the first continuous-variable measurement-device-independent QKD system generating secret keys at 5 MBaud without frequency and phase locking. We achieve this using a relay structure based on a polarization 90-degree optical hybrid and well-designed DSP.

Room 9

10:30–12:30
M2J • Optical Computing
Presider: Darko Zibar; Technical Univ. of Denmark, Denmark

M2J.1 • 10:30 Invited
Optical RAM and Optical Cache Memories for Computing, Theonitsa Alexoudi[1], Chris Vagionas[1], Christos Pappas[1], Theodoros Moschos[1], Nikos Pleros[1]; [1]*Aristoteleio Panepistimio Thessalonikis, Greece.* In this paper, we present the recent progress and achievements of optical RAM technologies expanding from single RAM cells up to fully functional optical cache memory implementations for future Computing architectures

M2J.2 • 11:00
An Optoelectronic Analog Ising Machine Enabling 2048-Spin and Low-Latency Calculations, Zihao Chen[1], Zhenhua Li[1], Zhaoang Deng[1], Jie Liu[1], Siyuan Yu[1]; [1]*Sun Yat-sen Univ., China.* An optoelectronic analog Ising machine employing FPGA with DAC and ADC modules is experimentally demonstrated. The SpMV algorithm is applied to accomplish two MAX-CUT tasks mapped into 2048-spin Ising networks, taking only 1.68us per iteration.

Room 1AB

M2A • Special Session: High Performance Networks of Future Data Center and Computing Applications—Continued

M2A.3 • 11:10 Invited

Title to be Announced, Larry Dennison[1]; [1]*NVIDIA Corporation, USA.* Abstract not available.

M2A.4 • 11:30 Invited

High-Performance Networks for Disaggregated Systems, Binzhang Fu[1]; [1]*Alibaba Cloud, China.* Abstract not available.

M2A.5 • 11:50 Invited

Disaggregated Resources/CXL, Ram Huggahalli[1]; [1]*Microsoft Azure, USA.* Abstract not available.

Room 2

M2B • SDM Devices and Systems—Continued

M2B.3 • 11:15

Partial MIMO-Based Mode Division Multiplexing Transmission Over the First Field-Deployed 15-Mode Fiber in Metro Scenario, Alberto Gatto[1], Paola Parolari[1], Ruben S. Luis[2], Georg Rademacher[2], Benjamin J. Puttnam[2], Robert Emmerich[3], Colja Schubert[3], Giuseppe Ferri[4], Frank Achten[4], Pierre Sillard[4], Paolo Martelli[1], Giammarco Di Sciullo[5], Fabio Graziosi[5], Andrea Marotta[5], Antonio Mecozzi[5], Cristian Antonelli[5], Pierpaolo Boffi[1]; [1]*Politecnico di Milano - DEIB, Italy;* [2]*National Inst. of Information and Comm. Technology (NICT), Japan;* [3]*Fraunhofer Inst. for Telecommunications (HHI), Germany;* [4]*Prysmian Group, France;* [5]*Univ. of L'Aquila and CNIT, Italy.* We assess mode division multiplexing transmission based on partial MIMO equalization over 6.1 km of the first deployed 15-mode fiber in L'Aquila, Italy. We demonstrate more than 13- Tb/s throughput with reduced receiver DSP resources.

M2B.4 • 11:30

Mode-Group-Division Multiplexing Over a Deployed 15-Mode-Fiber Cable, Lauren Dallachiesa[1], Roland Ryf[1], Nicolas K. Fontaine[1], Mikael Mazur[1], Haoshuo Chen[1], Pierre Sillard[2], Giuseppe Ferri[3], Frank Achten[4], Andrea Carena[5], Antonino Nespola[6], Andrea Marotta[7], Antonio Mecozzi[7], Cristian Antonelli[7]; [1]*Nokia Bell Labs, USA;* [2]*Prysmian Group, France;* [3]*Prysmian Group, Italy;* [4]*Prysmian Group, Netherlands;* [5]*Politecnico di Torino, Italy;* [6]*Fondazione LINKS-Leading Innovation & Knowledge for Society, Italy;* [7]*Univ. of L'Aquila, Italy.* We experimentally demonstrate transmission over a subset of up to 4 spatial modes of a deployed 15-mode Graded-index Fiber Cable.

M2B.5 • 11:45

Long-Haul Unidirectional Transmission Over Weakly-Coupled MCF With Distance-Insensitive Inter-Core Skew Spread, Kohki Shibahara[1], Megumi Hoshi[1], Takashi Matsui[2], Takayoshi Mori[2], Kazuhide Nakajima[2], Yutaka Miyamoto[1]; [1]*NTT Network Innovation Laboratories, Japan;* [2]*NTT Access Network Service Systems Laboratories, Japan.* We demonstrate unidirectional 3000-km transmission over homogeneous step-index weakly-coupled multi-core fiber. Distance-insensitive pulse broadening is obtained by inline core-permutation without any fan-in/fan-out device, enabling inter-core-crosstalk cancellation at 3000 km only with 3-ns-processing window in MIMO-DSP.

Room 3

M2C • Fiber- and Waveguide-Based Sensors—Continued

M2C.3 • 11:15

Sweep-Free Brillouin Optical Correlation Domain Analysis Utilizing Digital Optical Frequency Comb, Huan He[1], Shuyan Chen[1], Can Zhao[1], Zhiyong Zhao[1], Songnian Fu[2], Ming Tang[1]; [1]*Huazhong Univ. of Science and Technology, China;* [2]*Guangdong Univ. of Technology, China.* We propose and demonstrate a probe sweep-free Brillouin optical correlation domain analysis sensor based on digital optical frequency comb, where acquisitions of Brillouin gain spectrum reach 20 kSa/s at arbitrary position with 10-cm spatial resolution.

M2C.4 • 11:30 Tutorial

Solid State LIDAR, Toshihiko Baba[1]; [1]*Yokohama National Univ., Japan.* Fully nonmechanical solid-state LiDARs are being developed, in particular, on Si photonics platform with OPA, FPA and SLG. They are in the stage of demonstrating real-time LiDAR action. This presentation discusses their perspective.

Room 6C

M2D • High Speed EMLs and DMLs—Continued

M2D.3 • 11:15 ★ Top-Scored

200G per Lane Uncooled CWDM Hybrid CMBH-Ridge Electroabsorption Modulated Lasers for 2-km Transmission, Prashanth Bhasker[1], Sumeeta Arora[1], Alex Robertson[1], Tom McCaully[1], Adrian Ni[1], John Johnson[1]; [1]*Broadcom Inc, USA.* We report uncooled (20-70C) hybrid CMBH-Ridge O-band CWDM EMLs with60 GHz bandwidth (BW). At 112.5GBd PAM4 and 1.1Vpp, 4 dB extinction ratio (ER) and greater than 7 dBm output power is demonstrated over temperature

M2D.4 • 11:30 ★ Top-Scored

225-Gb/s PAM4 Operation Using Lumped-Electrode-Type EA-DFB Laser for 5- and 10-km Transmission With Low TDECQ, Kazuki Nishimura[1], Hideaki Asakura[1], Syunya Yamauchi[1], Takanori Suzuki[1], Yoshihiro Nakai[1], Yoriyoshi Yamaguchi[1], Takeo Kageyama[1], Masatoshi Mitaki[1], Yuma Endo[1], Kazuhiko Naoe[1]; [1]*Lumentum Japan, Inc., Japan.* Both 5-km and 10-km transmission was demonstrated under 225-Gb/s PAM4 operation using EA-DFB lasers. We confirmed low TDECQ values of 2.0~3.2 dB for 5 km in the CWDM range and 10 km at 1293.5 nm.

M2D.5 • 11:45

4 x 200 Gb/s EML-Array With a Single MQW Layer Stack, Michael A. Theurer[1], Christoph Kottke[1], Ronald Freund[1,2], Felix Ganzer[1], Patrick Runge[1], Martin Moehrle[1], Ute Troppenz[1], Ariane Sigmund[1], Martin Schell[1,2]; [1]*Fraunhofer Heinrich Hertz Inst., Germany;* [2]*Technical Univ. Berlin, Germany.* We demonstrate an EML-array for up to 4x200 Gb/s PAM4 modulation at 45°C. Its single MQW layer stack design allows for low-cost fabrication. The device is optimized for equal performance over four LAN-WDM wavelength channels.

Room 6D

M2E • Optical Fiber and Device Modelling—Continued

M2E.4 • 11:15

KerrNet: Machine Learning to Speed up Exact Nonlinear Variance Computation of Arbitrary Links, Xiaoyan Ye[1,2], Amirhossein Ghazisaeidi[1]; [1]*Nokia bell labs France, France;* [2]*Télécom Paris, France.* We introduce a new QoT tool handling arbitrary transmission configurations based on neural networks, accelerating exact models for nonlinear variance: the computation time is reduced by six orders of magnitude while accuracy is not compromised

M2E.5 • 11:30 Tutorial

Modeling of Nonlinear Distortion in Space-Division Multiplexing, Paolo Serena[1]; [1]*Universita degli Studi di Parma, Italy.* We discuss the modeling of nonlinear effects in space-division multiplexing links. We will cover aspects like perturbation theory, the interaction between mode dispersion and the Kerr effect, and Gaussian noise model-based performance predictions.

Room 6E

M2F • Machine Learning for System Modeling and Channel Equalization—Continued

M2F.2 • 11:30
Deep-Learning-Enabled High Electrical-Spectral-Efficiency Direct Detection With Reduced Computation Complexity, Xingfeng Li[1], Jingchi Li[1], Shaohua An[1], Hudi Liu[1], William Shieh[2], Yikai Su[1]; [1]*Shanghai Jiao Tong Univ., China;* [2]*Westlake Univ., China.* We demonstrate a 50-GBaud complex-valued double-sideband 16-QAM signal transmission over 80-km single-mode fiber with ~64% computational-budget reduction in field reconstruction. This is achieved by using 1×1 convolutions for dimensionality sparsification.

M2F.3 • 11:45
Edge-Carrier-Assisted Phase-Retrieval Based on Deep Learning Enabling low CSPR and low Applied Dispersion Values, Daniele Orsuti[1], Martina Cappelletti[1], Marco Santagiustina[1], Andrea Galtarossa[1], Luca Palmieri[1]; [1]*Department of Information Engineering, Univ. of Padova, Italy.* We explore the use of deep learning to loosen the constraints and enhance the performance of weak-carrier-assisted phase-retrieval receivers. The applied-dispersion-value can be reduced by 4-times and the complexity by 50% with low sensitivity penalties.

Room 6F

M2G • Data Center Networking and PON Security—Continued

M2G.3 • 11:15 Invited
Hybrid Classical and Quantum Data Centers Using Optical Networks, Richard Murray[1]; [1]*ORCA Computing, UK.* Abstract not available.

M2G.4 • 11:45
Branch Identification in Passive Optical Networks Using Machine Learning, Khouloud Abdelli[1], Carsten Tropschug[2], Helmut Griesser[2], Sander Jansen[2], Stephan Pachnicke[3]; [1]*ADVA, Kiel Univ., Germany;* [2]*ADVA, Germany;* [3]*Kiel Univ., Germany.* A machine learning approach for improving monitoring in passive optical networks with almost equidistant branches is proposed and experimentally validated. It achieves a high diagnostic accuracy of 98.7% and an event localization error of 0.5m

Room 7AB

M2H • Panel: Connectivity for Beyond 5G: How Can Wireline and Wireless Optical Access Live Up to the Mobile Expectations?—Continued

Room 8

M2I • Innovative QKD Systems—Continued

M2I.3 • 11:15
Practical High-Speed Gaussian Coherent State Continuous Variable Quantum Key Distribution With Real-Time Parameter Monitoring and Post-Processed Key Distillation, Amanda Weerasinghe[1], Muataz Alhussein[1], He Li[1], Adrian Wonfor[1], Richard Penty[1]; [1]*Univ. of Cambridge, UK.* We demonstrate Gaussian modulated continuous variable quantum key distribution at 50MHz symbol rate. Unlike most demonstrations, we record received signals in real-time and distil keys, producing a record 3Mb/s key rate after 25km transmission.

M2I.4 • 11:30
QKD Protocol Over 100 km Long Submarine Optical Fiber Assisted by a System-in-Package Fast-Gated InGaAs Single Photon Detector, Domenico Ribezzo[1], Mujtaba Zahidy[2], Antoine Petitjean[1], Gianmarco Lemmi[1], Claudia De Lazzari[3], Ilaria Vagniluca[3], Enrico Conca[4], Alberto Tosi[4], Tommaso Occhipinti[3], Francesco Saverio Cataliotti[4], Leif Katsuo Oxenløwe[2], André Xuereb[5], Davide Bacco[6], Alessandro Zavatta[6]; [1]*National Inst. of Optics INO-CNR, Italy;* [2]*Centre for Silicon Photonics for Optical Communications (SPOC), Department of Electrical and Photonics Engineering, Technical Univ. of Denmark, Denmark;* [3]*QTI SRL, Italy;* [4]*Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, Italy;* [5]*Department of Physics, Univ. of Malta, Malta;* [6]*Dipartimento di Fisica, Università degli studi di Firenze, Italy.* A QKD link established between Sicily (Italy) and Malta has been utilized to test the performances of a fast-gated InGaAs single photon detector, achieving a fourteen times higher key rate than using a commercial detector.

M2I.5 • 11:45
Improvement of Satellite-to-Ground QKD Secret key Rate With Adaptive Optics, Valentina Marulanda Acosta[1,2], Daniele Dequal[4], Matteo Schiavon[2], Aurélie Bonnefois[1], Caroline Lim[3], Jean-Marc Conan[1], Eleni Diamanti[2]; [1]*ONERA, France;* [2]*LIP6, France;* [3]*SYRTE, France;* [4]*Italian Space Agency, Italy.* We demonstrate the gain brought by adaptive optics for space-ground QKD links. Refined modeling of turbulence, adaptive optics and QKD ,including finite-size effects, shows improvement by several orders of magnitude of the secret key rate.

Room 9

M2J • Optical Computing—Continued

M2J.3 • 11:15 ★ Top-Scored
Programmable Tanh- and ReLU-Like Optoelectronic Activation Functions for Neuromorphic Photonic Circuits, Christos Pappas[1], Stefanos Kovaios[1], Miltiadis Moralis-Pegios[1], Apostolos Tsakyridis[1], George Giamougiannis[1], Joris V. Kerrebrouck[2], Gertjan Coudyzer[2], Xin Yin[2], Nikos Pleros[1]; [1]*Aristotle Univ. of Thessaloniki, Greece;* [2]*Ghent Univ., Belgium.* We demonstrate reconfigurable tanh- and ReLU-like nonlinear activation functions for incoherent neuromorphic photonics using a balanced photodiode assembled with a programmable electronic TIA chip. Experimental results up to 10 Gb/s line-rates are presented.

M2J.4 • 11:30
Optoelectronic Neuromorphic Accelerator at 523.27 GOPS Based on Coherent Optical Devices, Ying Zhu[1], Xu Zhang[1], Xin Hua[2], Lu Xu[2], Xiao Hu[2], Ming Luo[1], Xi Xiao[1], Shaohua Yu[1]; [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.* An integratable and scalable optoelectronic neuromorphic accelerator based on coherent optical devices is proposed and demonstrated. It can achieve the computing speed for convolutions of 523.27 GOPS and accuracy up to 96.67% for handwritten digit recognition as a neural network.

M2J.5 • 11:45 Invited
Artificial Intelligence Using Complex Photonics: Decision Making and Reservoir Computing, Atsushi Uchida[1]; [1]*Saitama Univ., Japan.* We overview recent development on photonic decision making and reservoir computing for artificial intelligence using complex photonics. Parallel implementations of photonic devices can accelerate information processing in decision making and reservoir computing.

Room 1AB	Room 2	Room 3	Room 6C	Room 6D
M2A • Special Session: High Performance Networks of Future Data Center and Computing Applications—Continued	**M2B • SDM Devices and Systems—Continued**	**M2C • Fiber- and Waveguide-Based Sensors—Continued**	**M2D • High Speed EMLs and DMLs—Continued**	**M2E • Optical Fiber and Device Modelling—Continued**
	M2B.6 • 12:00 Invited **Impact and Mitigation of Mode-Dependent Gain in Ultra-Long-Haul SDM Systems,** Darli Mello[1], Ruby Ospina[1], Hrishikesh Srinivas[2], Karthik Choutagunta[2], Elaine Chou[2], Joseph Kahn[2]; [1]*Univ. of Campinas, Brazil;* [2]*Stanford Univ., USA.* The effect of mode-dependent gain in ultra-long-haul optical SDM systems with coupled channels is reviewed. Simulation results indicate stringent MDG requirements for future SDM amplifiers. Challenges in MDG estimation are also addressed.		**M2D.6 • 12:00** **106-Gbps PAM4 Operation at an Extinction Ratio Above 3.5 dB Using a Conventional Buried-Heterostructure Directly Modulated Laser,** Kosuke Shinohara[1], Ryosuke Miyagoshi[1], Yosuke Suzuki[1], Ryoko Suzuki[1], Go Sakaino[1], Masaaki Shimada[1], Keisuke Matsumoto[1]; [1]*Mitsubishi Electric Corporation, Japan.* A 106-Gbps PAM4 operation with an extinction ratio above 3.5 dB and TDECQ values of 1.85 and 3.04 dB was demonstrated using a conventional buried-heterostructure directly modulated laser at temperatures of 25 and 55 °C. **M2D.7 • 12:15** **10-km Transmission of 106-Gb/s PAM4 With Directly Modulated DFB Lasers in the CWDM Range,** Shuhei Ohno[1], Masaru Onga[1], Takayuki Nakajima[1], Akira Nakanishi[1], Noriko Sasada[1], Shinichi Tanaka[1], Ryosuke Nakajima[1], Kazuhiko Naoe[1]; [1]*Lumentum Japan, Inc., Japan.* The 106-Gb/s PAM4 operation of four DMLs in the 1.3-μm CWDM range demonstrated < 2.0 dB TDECQ after 5-km transmission. Clear eye openings and BER below KP4-FEC limit (2.2×10^{-4}) were achieved even after 10-km transmission.	

12:00–13:00 OFC Mentor/Mentee Meet-up, *Room 17*

12:30–14:00 Lunch Break *(on own)*

13:30–16:30 SC114, SC217, SC408, SC459, SC485

13:30–17:30 SC261, SC325, SC327, SC347, SC357, SC393, SC431, SC451, SC453B

14:00–15:30 The Journal Review Process: All You Need to Know!, *Room 14B*

Room 6E

M2F • Machine Learning for System Modeling and Channel Equalization—Continued

M2F.4 • 12:00
Improving the Bootstrap of Blind Equalizers With Variational Autoencoders, Vincent Lauinger[1], Fred Buchali[2], Laurent Schmalen[1]; [1]*Karlsruher Inst. of Technology (KIT), Germany;* [2]*Nokia, Germany.* We evaluate the start-up of blind equalizers at critical working points, analyze the advantages and obstacles of commonly-used algorithms, and demonstrate how the recently-proposed variational autoencoder(VAE) based equalizers can improve bootstrapping.

M2F.5 • 12:15
Physics-Informed Neural Operator-Based Full Wavefield Back-Propagation for Multi-Span Optical Transmission, Yuchen Song[1], Xiaotian Jiang[1], Xiao Luo[1], XiMeng Zhang[1], Min Zhang[1], Danshi Wang[1]; [1]*Beijing Univ. of Post and Telecommu, China*. An unsupervised physics-informed neural operator-based wavefield back-propagation scheme is proposed and used for the full wavefield information reconstruction along the link, nonlinearity compensation (0.46 dB Q-factor gain over 1StPS DBP), and fiber parameter identification.

Room 6F

M2G • Data Center Networking and PON Security—Continued

M2G.5 • 12:00
Towards Costless Temperature Monitoring Through PLOAM Information in TDMA PON Networks, Christian Salgado-Cazorla[1], Borja Vidal[1]; [1]*Universitat Politècnica de València, Spain*. Derivation of environmental temperature from FTTH networks is investigated. Ranging grants in G.984 allows estimation of average temperatures without additional hardware. This information can be valuable in smart cities and early fire warning systems

Room 7AB

M2H • Panel: Connectivity for Beyond 5G: How Can Wireline and Wireless Optical Access Live Up to the Mobile Expectations?—Continued

Room 8

M2I • Innovative QKD Systems—Continued

M2I.6 • 12:00
Secure Unrepeated Fiber Transmission With Quantum Deliberate Signal Randomization on Y-00 Protocol, Fumio Futami[1], Ken Tanizawa[1], Kentaro Kato[1], Yuki Kawaguchi[2], Shin Sato[2]; [1]*Tamagawa Univ., Japan;* [2]*Sumitomo Electric Industries, Ltd., Japan*. We demonstrate security-enhanced 10-Gbit/s PSK Y-00 cipher transmission with deliberate signal randomization driven by a quantum random number generator in a 362 km ultra-low-loss fiber link without optical amplifiers. High security is achieved at high optical powers.

Room 9

M2J • Optical Computing—Continued

M2J.6 • 12:15
Incoherent Fiber-Based Optical Neuromorphic Computing Circuit, Maya Yevnin[2], Alon Harel[2], Or Arbel-Arenfrid[2], Zeev Zalevsky[1], Eyal Cohen[2]; [1]*Bar-Ilan Univ., Israel;* [2]*CogniFiber LTD,, Israel*. We present novel photonic neuromorphic computing scheme working with incoherent light while capable implementing negative weighting for the neural network and obtaining reliable/accurate computing of the linear multiply-accumulate function necessary for neural networks applications.

12:00–13:00 OFC Mentor/Mentee Meet-up, *Room 17*

12:30–14:00 Lunch Break *(on own)*

13:30–16:30 SC114, SC217, SC408, SC459, SC485

13:30–17:30 SC261, SC325, SC327, SC347, SC357, SC393, SC431, SC451, SC453B

14:00–15:30 The Journal Review Process: All You Need to Know!, *Room 14B*

Room 1AB

14:00–16:00
M3A • Symposium: Quantum Information and Optical Communication Networks: Emerging Research Areas, Challenges and Opportunities I
Presider: Fotini Karinou; Microsoft Research Ltd, UK and Daniel Kilper; Univ. of Dublin Trinity College, USA

M3A.1 • 14:00 Invited
Engineering Challenges for the Emerging Quantum Networks, Prem Kumar[1]; [1]*Northwestern Univ., USA.* Abstract not available.

Room 2

14:00–16:00
M3B • Multi-Core Fiber
Presider: Takashi Matsui; NTT Corporation, Japan

M3B.1 • 14:00
Unique Bending Loss Properties and Design Consideration for Coupled Multi-Core Fiber, Ryota Imada[1], Taiji Sakamoto[1], Takayoshi Mori[1], Yusuke Yamada[1], Kazuhide Nakajima[1]; [1]*NTT Corporation, Japan.* We reveal the unique bending angle and coupled core count dependence of bending loss in a coupled multi-core fiber and demonstrate adequate core design conditions can be derived by considering the average bending loss property.

M3B.2 • 14:15
Uncoupled 6-Core Fibers With a Standard 125-um Cladding,ITU-T G.652 Optical Properties, and Low XT, Kazunori Mukasa[1], Takeshi Takagi[2], Takaaki Shishikura[2], Katsuhisa Maruyma[2], Hajime Oshio[2], Aditi Mehta[3], Karsten Rottwitt[3], Toshio Morioka[3]; [1]*Furukawa Electric Co., Ltd., Japan;* [2]*Furukawa Electric Co., Ltd., Japan;* [3]*Technical Univ. of Denmark, Denmark.* We developed ultra-high-density uncoupled 6-core fibers with a standard 125-um cladding, G.652 properties, and low crosstalk at 100 km of -55~-39 dB by utilizing a novel air-gap structure, which would potentially give the ultimate high-density.

Room 3

14:00–16:00
M3C • Free Space and Coupling Devices
Presider: Stefano Camatel; Finisar Corporation, Australia

M3C.1 • 14:00
Low-Loss, High Extinction Ratio Fiber to Chip Connection via Laser Fusion for Polarization Maintaining Fibers, Sushant Kumar[1], Juniyali Nauriyal[1], Jaime Cardenas[1]; [1]*Univ. of Rochester, USA.* We present a new method for PM-fiber to photonic chip connection via laser fusion. This enables low cost and robust coupling with -1.1dB loss per facet while maintaining 20dB or greater polarization extinction ratio.

M3C.2 • 14:15 ★ Top-Scored
Automatic Setting of Multiple FSO Orthogonal Communication Channels Between Photonic Chips, Seyedmohammad Seyedinnavadeh[1], Maziyar Milanizadeh[2], Francesco Zanetto[1], Vittorio Grimaldi[1], Christian De Vita[1], Giorgio Ferrari[1], David A. Miller[3], Andrea Melloni[1], Francesco Morichetti[1]; [1]*Politecnico di Milano, Italy;* [2]*National Research Council Canada, Canada;* [3]*Stanford Univ., USA.* Multiple orthogonal free-space optical (FSO) communication channels are automatically established between photonic chips hosting programmable integrated processors. All-optical channel demultiplexing is achieved with a crosstalk < -30 dB even after co-propagation though arbitrary mode mixers.

Room 6C

14:00–16:00
M3D • RF and THz Signal Generation
Presider: Tetsuya Kawanishi; Waseda Univ., Japan

M3D.1 • 14:00 ★ Top-Scored
Sub-THz Wireless Transmission Based on Graphene on Silicon Nitride Integrated Photonics, Alberto Montanaro[1,2], Giulia Piccinini[3,4], Vaidotas Miseikis[4,5], Vito Sorianello[1], Marco Angelo Giambra[6], Stefano Soresi[6], Luca Giorgi[7], Antonio D'Errico[7], Kenji Watanabe[8], Takashi Taniguchi[9], Sergio Pezzini[10], Camilla Coletti[4,5], Marco Romagnoli[1]; [1]*CNIT, Italy;* [2]*Scuola Superiore Sant'Anna, Italy;* [3]*3) NEST, Scuola Normale Superiore, Italy;* [4]*4) Center for Nanotechnology Innovation @NEST, Istituto Italiano di Tecnologia, Italy;* [5]*Graphene Labs, Istituto Italiano di Tecnologia, Italy;* [6]*Inphotec, CamGraPhIC srl, Italy;* [7]*Ericsson Research, Italy;* [8]*Research Center for Functional Materials, National Inst. for Materials Science, 1-1 Namiki, Tsukuba, 305-0044, Japan, Japan;* [9]*International Center for Materials Nanoarchitectonics, Japan;* [10]*NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, Italy.* We demonstrate the first wireless transmission based on graphene, using an integrated photonic device enabling up-conversion in the sub-THz range. Our approach opens the perspective to the realization of antenna arrays based on integrated photonics.

M3D.2 • 14:15
Silicon-Based on-Chip Phase-Coded Linearly-Chirped Microwave Waveform Generation, Xu Hong[1], Bin Wang[1], Yihao Cheng[1], Weifeng Zhang[1]; [1]*Beijing Inst. of Technology, China.* We propose and design a silicon photonic chip for phase-coded linearly-chirped microwave waveform generation based on opto-electronic oscillator. Using the chip, a phase-coded linearly-chirped microwave waveform with an ultra-large time-bandwidth product of 1.96×10^6 is experimentally demonstrated.

Room 6D

14:00–16:00
M3E • Enabling Technologies for Data Center and HPC
Presider: Robert Borkowski; Nokia Bell Labs, USA

M3E.1 • 14:00 Tutorial
Machine Learning Methods for Integrated Photonics, Stephen E. Ralph[1]; [1]*Georgia Tech, USA.* This tutorial will review recent advances in machine learning techniques, including inverse design and performance monitoring, that address practical high-capacity photonics design challenges, incorporating manufacturing constraints, user defined performance goals while ensuring end-to-end performance.

Room 6E

14:00–16:00
M3F • LIDAR, RADAR and Ranging Systems
Presider: Baris Erkmen; Google LLC, USA

M3F.1 • 14:00
A Hybrid Solid-State Beam Scanner for FMCW LiDAR Application, Zhaoyang Zhang[1], Xufeng Du[2], Zhiyan Zhou[1], Qikai Huang[1], Qiang Zhang[3], Tingge Dai[1], Hui Yu[1], Yuehai Wang[1], Jianyi Yang[1]; [1]*Zhejiang Univ., China;* [2]*Guofeng Electronics, China;* [3]*Zhejiang Lab, China*. We demonstrate a hybrid solid-state beam scanner based on a Si_3N_4 switching array. Two-dimensional beam steering with a 14.3°×9.9° field of view and FMCW ranging operation at a distance of 7.4 m are achieved.

M3F.2 • 14:15
Enhanced Velocity Sensitivity in 4-D FMCW LiDAR by Use of Avalanche Photodiode With Cascaded Multiplication Layer, Zohauddin Ahmad[1], Sung-Yi Ou[1,4], Wei-Chih Su[2], Po-Shun Wang[1], None Naseem[1], Jyehong Chen[3], Yung-Jr Hung[4], You-Chia Chang[3], Chia-Chien Wei[4], Tzyy-Sheng Horng[2], Jin-Wei Shi[1]; [1]*National Central Univ., Taiwan;* [2]*Department of Electrical Engineering, National Sun Yat-sen Univ., Taiwan;* [3]*Department of Photonics, National Yang Ming Chiao Tung Univ., Taiwan;* [4]*Department of Photonics, National Sun Yat-Sen Univ., Taiwan.* A 4-D FMCW LiDAR is demonstrated. In comparison to the traditional p-i-n PD in its receiver-side, the cascaded M-layers APDs provide a better quality of 4-D images with unprecedented high velocity-sensitivity (5μm/sec) for slow-moving objects.

Room 6F

14:00–16:00
M3G • Telemetry and Synchronisation
Presider: Konstantinos (Kostas) Christodoulopoulos; Univ. of Athens, Greece

M3G.1 • 14:00
An Intelligent Optical Telemetry Architecture, Luis Velasco[1], Pol Gonzalez[1], Marc Ruiz[1]; [1]*Universitat Politecnica de Catalunya, Spain.* A distributed telemetry system is proposed with agents receiving and analyzing data before sending to a centralized manager. Intelligent data aggregation on optical constellations telemetry largely reduces data rate without introducing significant error.

M3G.2 • 14:15 Invited
Telemetry Framework With Data Sovereignty Features, Behnam Shariati[1], Haydar Qarawlus[2], Steffen Biehs[2], José-Juan Pedreño-Manresa[3], Pooyan Safari[1], Mihail Balanici[1], Ayoub Bouchedoub[2], Hendrik Haße[2], Achim Autenrieth[3], Johannes Karl Fischer[1], Ronald Freund[1]; [1]*Fraunhofer Inst Nachricht Henrich-Hertz, Germany;* [2]*Fraunhofer ISST, Germany;* [3]*ADVA Optical Networking, Germany.* We propose a novel framework that enables data ecosystem and regulated telemetry streaming in open and disaggregated optical networks. We review its requirements, present its architecture, and discuss two demonstrated use-cases in our testbeds.

Room 7AB

14:00–16:00
M3H • Panel: Optical Fiber Sensing: Technology and Emerging Applications Part I

Organizers: Raja Ahmad, *Cisco Systems, USA;* Mikael Mazur, *Nokia Bell Labs, USA;* Georg Rademacher, *NICT, Japan;* Ting Wang, *NEC Laboratories America, USA*

Speakers: Dan Bluhmental, *University of California, Santa Barbara, USA;* Pierepaolo Boffi, *Politecnico di Milano, Italy;* Lea Bouffant, *Cornell University, USA;* Miguel Gonzalez-Herraez, *Universidad de Alcala, Spain;* Leo Hollberg, *Stanford University, USA;* Paul Ohodnicki, *University of Pittsburgh, USA;* Charlotte Rowe, *Los Alamos National Laboratory, USA;* Hiroshi Takahashi, *Nippon Telegraph and Telephone Corporation, Japan;* Paul Westbrook, *OFS Labs, USA*

Description: This session focuses on broadening the perspective of fiber sensing using telecom components and networks to advance fields outside telecom. The panel consists of speakers representing different scientific areas and aims at creating a discussion forum for how telecom networks can further be utilized.

Room 8

14:00–16:00
M3I • Monolithic or 3D Electro-Optical Integration
Presider: Long Chen; Cisco Systems Inc, USA

M3I.1 • 14:00
Ultra-Dense 3D Integrated 5.3 Tb/s/mm² 80 Micro-Disk Modulator Transmitter, Stuart R. Daudlin[1], Sunwoo Lee[2], Devesh Khilwani[2], Christine Ou[2], Anthony Rizzo[1], Songli Wang[1], Michael Cullen[1], Alyosha Molnar[2], Keren Bergman[1]; [1]*Columbia Univ., USA;* [2]*Cornell Univ., USA.*A large-scale array of 80 micro-disk modulators is densely bonded to an electronic chip and driven at 10 Gb/s/modulator for an unprecedented 5.3 Tb/s/mm² bandwidth density and 50 fJ/bit energy consumption.

M3I.2 • 14:15
Monolithically Integrated Autonomous Demultiplexers With Near Zero Power Consumption for Beyond Tb/s Links, Ali Pirmoradi[1], Firooz Aflatouni[1]; [1]*Univ. of Pennsylvania, USA.*Integrated multiplexer/de-multiplexer systems based on capacitively tuned MZI and adiabatic ring resonators with sequential tuning and wavelength locking are presented.

Room 9

14:00–16:00
M3J • Accurate Frequency/Time Distribution and Optical Computing
Presider: Radan Slavik; Univ. of Southampton, UK

M3J.1 • 14:00 Invited
Frequency Combs Outside the Metrology Lab: Time Transfer Over Long Distance Terrestrial Links, Laura C. Sinclair[1], Emily D. Caldwell[1,2], Benjamin K. Stuhl[3], William C. Swann[1], Nathan R. Newbury[1], Jean-Daniel Deschenes[4]; [1]*National Inst of Standards & Technology, USA;* [2]*Department of Electrical, Energy and Computer Engineering, Univ. of Colorado Boulder, USA;* [3]*Space Dynamics Laboratory, USA;* [4]*OctoSig Consulting, Canada.* Future clock networks will require femtosecond-level time distribution for applications ranging from fundamental physics tests to distributed coherent sensing. We present a quantum-limited comb-based time transfer approach and results on clock synchronization over ultra-long distances.

Room 1AB

M3A • Symposium: Quantum Information and Optical Communication Networks: Emerging Research Areas, Challenges and Opportunities I—Continued

M3A.2 • 14:30 Invited

Building a Dynamic Quantum Network: Use Cases and Challenges From Security to Scalable Quantum Computing, Reza Nejabati[1]; [1]*Univ. of Bristol, UK.* Abstract not available.

M3A.3 • 15:00 Invited

Multi-Photon Entanglement in Quantum Networks; Sophia Economou, *Virginia Tech, USA.* This talk will give a background on entangled photonic states for quantum repeaters. We will focus on logical encoding of photonic states that protects against loss and on protocols for the generation of such states.

Room 2

M3B • Multi-Core Fiber—Continued

M3B.3 • 14:30 Invited

MCF Manufacturing, Kazunori Mukasa[1]; [1]*Furukawa Electric Co., Ltd., Japan.* To actually apply MCFs in the real systems, we still have several challenges to overcome. One of them is the MCF manufacturing technology including measurements and we will describe the current situations and future prospective.

M3B.4 • 15:00

Relationship Between Polarization Mode Dispersion and Crosstalk in Heterogeneous Multi-Core Fibers With Different Cladding Diameters, Gustavo Ocampo[1], Takanori Sato[1], Takeshi Fujisawa[1], Mayu Nakagawa[2], Kunimasa Saitoh[1]; [1]*Hokkaido Univ., Japan;* [2]*Fujikura Ltd., Japan.* We experimentally investigate the relationship between crosstalk and polarization mode dispersion (PMD) in two heterogeneous multi-core fibers with different cladding diameters. We observed that increasing the cladding diameter improves the crosstalk, but deteriorates the PMD.

Room 3

M3C • Free Space and Coupling Devices—Continued

M3C.3 • 14:30

Monolithically Integrated Self-Aligned SiN Edge Coupler With <0.6/0.8 dB TE/TM Insertion Loss, <-39 dB Back Reflection and >520 mW High-Power Handling Capability, Yusheng Bian[1]; [1]*GLOBALFOUNDRIES, USA.* We experimentally demonstrated V-groove-based self-aligned SiN edge coupler (EC) on a monolithic CMOS-SiPh platform. <0.6/0.8 dB TE/TM SMF-EC transmission efficiency, in conjunction with <-39 dB back reflection and >520 mW power handling capability were achieved.

M3C.4 • 14:45 ★ Top-Scored

Free-Space Signal Transmission Using Optical Beam Scanning Device Incorporating Broadband Silicon Surface Optical Couplers, Yuki Atsumi[1], Tomoya Yoshida[1], Ryosuke Matsumoto[1], Ryotaro Konoike[1], Youichi Sakakibara[1], Takashi Inoue[1], Keijiro Suzuki[1]; [1]*Natl Inst of Adv Industrial Sci & Tech, Japan.* Characteristics of beam scanning device based on a broadband silicon vertically-curved-waveguide surface optical couplers are evaluated. We then demonstrate free-space transmission of 10-Gbps NRZ-OOK signals in the wide wavelength range from 1530 to 1590 nm.

M3C.5 • 15:00

LCOS Based Flexible Spatial Channel Switch for Heterogeneous SDM Fiber Network, Yuta Goto[1], Satoshi Shinada[1], Yusuke Hirota[1], Hideaki Furukawa[1]; [1]*NICT, Japan.* We propose an LCOS based flexible spatial channel switch for a heterogeneous SDM fiber network which can easily connect different types of SDM fibers without FIFO. The switching operation was confirmed by measuring OSNR and BER characteristics.

Room 6C

M3D • RF and THz Signal Generation—Continued

M3D.3 • 14:30 Invited

Piezo-Optomechanical Technologies for RF and Optical Communications, Matt Eichenfield[1]; [1]*Sandia National Laboratories Albuquerque, USA.* Abstract not available.

M3D.4 • 15:00 ★ Top-Scored

Demonstration of Optoelectronic-Phased-Array Driven THz-Wave Power Combination and Beam Steering, Ming Che[1], Kazuya Kondo[1], Ryo Doi[1], Kazutoshi Kato[1]; [1]*Kyushu Univ., Japan.* We developed an 8-channel photonic phased array for phases tuning of THz waves generated from 8 arrayed InP/InGaAs UTC-PDs. 300-GHz-waves are combined with 16-dB gain and steered continuously in a range of ±50°.

Room 6D

M3E • Enabling Technologies for Data Center and HPC—Continued

M3E.2 • 15:00

Nonlinearity Free Operation of SOA for Use in High-Capacity Co-Packaged Optics, Takayuki Kurosu[1], Satoshi Suda[1], Shu Namiki[1], Takeru Amano[1]; [1]*Natl Inst of Adv Industrial Sci & Tech, Japan.* We propose a novel concept to generate high-capacity WDM signals from single source of non-mode-locked multi-wavelength light using SOAs. Using micro-ring modulators in a way to suppress SOA nonlinearity, high-quality PAM4 signals can be generated.

Room 6E

M3F • LIDAR, RADAR and Ranging Systems—Continued

M3F.3 • 14:30
Impact of Laser Phase Noise on Ranging Precision Within and Beyond Laser Coherence Length in FMCW LiDAR, Wenting Yi[1], Zichuan Zhou[1], Zhixin Liu[1], Polina Bayvel[1], Robert I. Killey[1]; [1]*Univ. College London, UK.* We study the impact of laser phase noise on ranging precision in a frequency-modulated continuous-wave (FMCW) LiDAR system, demonstrating ranging of 384.72 m with ~15 cm precision at 7× intrinsic laser coherence length.

M3F.4 • 14:45
Experimental Demonstration of 0.4-Meter Ranging Through Underwater Scattering With 20-mm Resolution Using z-Dependent Angular Rotation of a Spatially Structured Beam, Hao Song[1], Huibin Zhou[1], Yuxiang Duan[1], Zile Jiang[1], Murale Ramakrishnan[1], Wing Ko[1], Yingning Wang[1], Xinzhou Su[1], Kaiheng Zou[1], Abdulrahman Alhaddad[1], Ruoyu Zeng[1], Robert Bock[2], Moshe Tur[3], Alan Willner[1]; [1]*Univ. of Southern California, USA;* [2]*R-DEX System, Inc., USA;* [3]*Tel Aviv Univ., Israel.* We experimentally demonstrate a 0.4-meter underwater optical ranging with a 20-mm resolution through underwater scattering (extinction coefficient γ up to 9.4 m-1) utilizing the z-dependent angular rotation of a spatially structured beam.

M3F.5 • 15:00 Invited
Coherent LIDAR Technology: Practical Deployment and Challenges, Shuren Hu[1]; [1]*Vanderbilt Univ., USA.* Abstract not available.

Room 6F

M3G • Telemetry and Synchronisation—Continued

M3G.3 • 14:45
Data Augmentation to Reduce Computational Complexity of Neural-Network-Based Soft-Failure Cause Identifier, Lareb Zar Khan[1], Pedro J. Freire[2], João Pedro[3], Nelson Costa[3], Antonio Napoli[4], Nicola Sambo[1]; [1]*Scuola Superiore SantAnna, Italy;* [2]*Aston Univ., UK;* [3]*Infinera, Portugal;* [4]*Infinera, Germany.* We investigated data augmentation to train neural networks (NNs) for soft-failure cause identification, demonstrating its impacts on NN complexity. Results indicate up to 68% reduction in the computational complexity of NN for each inference.

M3G.4 • 15:00
Failure Data Augmentation for Optical Network Equipment Using Time-Series Generative Adversarial Networks, Cheng Xing[1], Chunyu Zhang[1], Bing Ye[2], Danshi Wang[1], Yinqiu Jia[3], Jin Li[1], Min Zhang[1]; [1]*Beijing Univ. of Posts and Telecommunications, China;* [2]*State Key Laboratory of Mobile Network and Mobile Multimedia Technology, Shenzhen, 518055, China, China;* [3]*State Key Laboratory of Mobile Network and Mobile Multimedia Technology, Shenzhen, 518055, China, China.* We propose a failure data augmentation scheme based on time-series generation adversarial networks with real equipment performance data of optical networks and verify that the augmented failure sample data is similar to real failure data.

Room 7AB

M3H • Panel: Optical Fiber Sensing: Technology and Emerging Applications Part I—Continued

Room 8

M3I • Monolithic or 3D Electro-Optical Integration—Continued

M3I.3 • 14:30
First 100 Gb/s Monolithically Integrated Electronic-Photonic Coherent Receiver With Direct Edge Coupling to Standard Single Mode Fiber Array, Ahmed Osman[1], Georg Winzer[2], Christian Mai[2], Anna Peczek[2], Karsten Voigt[2], William Dorward[3], Stefan Lischke[2], Mesut Inac[2], Andrea Malignaggi[2], Lars Zimmermann[2], Ilias Sourikopoulos[1], Leontios Stampoulidis[1]; [1]*LEO Space Photonics, Greece;* [2]*IHP GmbH, Germany;* [3]*ALTER Technology UK, UK.* We report fabrication, assembly and testing of the first >100 Gb/s monolithic electronic-photonic coherent receiver chip and sub-assembly, edge coupled to standard single mode fiber array.

M3I.4 • 14:45
A Direct Bond Interconnect 3D Co-Integrated Silicon-Photonic Transceiver in 12nm FinFET With -20.3dBm OMA Sensitivity and 691fJ/bit, Anirban Samanta[1], Po-Hsuan Chang[2], Peng Yan[2], Mingye Fu[1], Mehmet Berkay On[1], Ankur Kumar[2], Hyungryul Kang[2], Il-Min Yi[2], Dedeepya Annabattuni[2], Yu Zhang[1], David Scott[3], Robert Patti[4], Yang-Hang Fan[2], Yuanming Zhu[2], Samuel Palermo[2], S. J. Ben Yoo[1]; [1]*Department of Electrical and Computer Engineering, Univ. of California, Davis, USA;* [2]*Analog & Mixed-Signal Center, Texas A&M Univ., USA;* [3]*Optelligent, USA;* [4]*Nhanced Semiconductors, USA.* We present the first experimental demonstration of an electronic-photonic co-designed transceiver circuit heterogeneously 3D co-integrated with high-density, low-parasitic Direct Bond Interconnect (DBI®) featuring full SerDes that achieves -20.3dBm OMA sensitivity and 691fJ/bit link energy efficiency.

M3I.5 • 15:00 Tutorial
Tradeoffs in the Paths Forward for Advanced Packaging in Photonics, Jon Aday[1]; [1]*Amkor Technology, USA.* Advanced semiconductor packaging is currently being used to support products that utilize photonics connections, but as we migrate from a wire bonded solution to flip chip the complexity increases dramatically. The fiber coupling methods will also impact the process flows and package structures that can be implemented. The tradeoffs will be reviewed between the coupling methods and semiconductor packaging options as we migrate from pluggables to co-packaged optics.

Room 9

M3J • Accurate Frequency/ Time Distribution and Optical Computing—Continued

M3J.2 • 14:30 Invited
Optical Clock Distribution Over Stable Fiber Links in Noisy Environments, Tomoya Akatsuka[1], Hiromitsu Imai[1], Masao Takamoto[2], Ichiro Ushijima[2,3], Takashi Goh[4], Toshikazu Hashimoto[5], Hidetoshi Katori[2,3], Katsuya Oguri[1], Tetsuomi Sogawa[6]; [1]*NTT Basic Research Laboratories, Japan;* [2]*RIKEN, Japan;* [3]*The Univ. of Tokyo, Japan;* [4]*NTT Device Innovation Center, Japan;* [5]*NTT Device Technology Laboratories, Japan;* [6]*NTT Science and Core Technology Laboratory Group, Japan.* We demonstrate a 190-km-long optical fiber link that achieves high-stability frequency transfer in noisy environments. A four-stage cascaded link with ultralow-noise laser repeater stations connects distant optical lattice clocks without deteriorating their stabilities.

M3J.3 • 15:00
Optical Frequency Transfer Stability of 1E-15 at 1 Second Over Correlated Core Pairs in a 40 km 7-Core Fiber Link, Mark W. Harrington[1], Nicolas K. Fontaine[2], Mikael Mazur[2], Daniel J. Blumenthal[1]; [1]*UCSB, USA;* [2]*Nokia Bell Labs, USA.* We demonstrate a 40km stabilized optical frequency transfer system with fractional frequency stability of 1e-15 at 1s without single-core bidirectional propagation. Highly correlated cores of a 7-core fiber are used for signal transmission and return, mitigating uncorrelated phase fluctuations found in duplex approaches.

Room 1AB

M3A • Symposium: Quantum Information and Optical Communication Networks: Emerging Research Areas, Challenges and Opportunities I—Continued

M3A.4 • 15:30 Invited

Photonic Quantum Computing; Ulrik Andersen, *Danmarks Tekniske Universitet, Denmark*. Abstract not available.

Room 2

M3B • Multi-Core Fiber—Continued

M3B.5 • 15:15

Characteristics of Over 600-km-Long 4-Core MCF Drawn From a Single Preform, Shota Kajikawa[1], Tsubasa Saito[1], Katsuhiro Takenaga[1], Kentaro Ichii[1]; [1]*Fujikura Ltd., Japan*. This report presents details of the successful production of a 4-core MCF, with 125-µm cladding and a length greater than 600 km. This is the champion data for MCF length drawn from a single preform.

M3B.6 • 15:30 Invited

Optical Link Characteristics and Long-Term Stability of High-Density Multi-Core Fiber Cables Deployed in the Terrestrial Field, Yusuke Yamada[1], Takayoshi Mori[1], Takashi Matsui[1], Masashi Kikuchi[1], Kazuhide Nakajima[1]; [1]*NTT Corporation, Japan*. The feasibility of a standard 125-µm-cladding multi-core-fiber-based high-density terrestrial cable is described including long-term stability in an underground facility. The impact of a core-rotating splice on the link loss is also investigated.

Room 3

M3C • Free Space and Coupling Devices—Continued

M3C.6 • 15:15

Automated Assembly of 500-Count, Laser-Welded, Fiber- Optic Arrays at Density Limit, John R. Marciante[1], Per Adamson[1], Robert Balonek[1], Mike Cinquino[1], Joey Lawson[1], Jordan Leidner[1]; [1]*RAM Photonics Industrial, LLC, USA*. We have developed a new technique for high-count fiber array connector production. Fully automated manufacturing was demonstrated for 500-count arrays with 250µm center-to- center spacing and sub-micron placement for arbitrary fiber type in any 2D configuration.

M3C.7 • 15:30

Fan-in/Fan-out for Heterogeneous 19-Core Fibers Based on Metasurfaces With Nonuniform Phase Plates, Yang Wang[1], Xutao Wang[1], Zhiqun Yang[1], Yaping Liu[1], Lin Zhang[1,2], Zhanhua Huang[1]; [1]*Tianjin Univ., China;* [2]*Peng Cheng Laboratory, China*. We propose a metasurface-based fan-in/fan-out device for heterogeneous 19-core fibers. Our results indicate that an average insertion loss of 0.9 dB and maximum crosstalk of -25.5 dB can be achieved at 1550 nm.

M3C.8 • 15:45

High-Resolution Radiation Characterization for an Uniformly Emitted SiNx Nanophotonic Phased Array, Caiming Sun[1], Binghui Li[1], Ning Ding[1], Aidong Zhang[1]; [1]*CUHK Shenzhen, China*. With a high-resolution characterization setup, waveguide modes are clearly observed in near-field radiation patterns of SiNx nano-antennas. This phased array has uniform emission throughout the antenna within 3dB bandwidth of 120 nm from 785-905 nm.

Room 6C

M3D • RF and THz Signal Generation—Continued

M3D.5 • 15:15

All-Optical sub-THz Signal Generation Using Two Mutually Coupled Semiconductor Lasers, Chin-Hao Tseng[1], Bin-Kai Liao[1], Sheng-Kwang Hwang[1,2]; [1]*Department of Photonics, National Cheng Kung Univ., Taiwan;* [2]*Advanced Optoelectronic Technology Center, National Cheng Kung Univ., Taiwan*. This study proposes a novel all-optical approach for sub-THz signal generation. Sub-THz signals ranging from 100 to 300 GHz with a 3-dB linewidth below 2 kHz and a SPSR of about 47 dB are generated.

M3D.6 • 15:30 ★ Top-Scored

Optical Synchronization of a Photonic Crystal Resonator to a 10 GHz Chip-Scale Mode-Locked Laser PIC, Chinmay D. Shirpurkar[1], Jizhao Zang[2], David Carlson[2], Travis Briles[2], Scott Papp[2], Peter Delfyett[1]; [1]*CREOL, The College of Optics & Photonics, USA;* [2]*Time and Frequency Division, National Inst. of Standards and Technology, USA*. We present an optical frequency division technique to transfer the timing stability of a stabilized Photonic Crystal Resonator Comb (~200 GHz repetition rate) to a chip-scaled mode-locked laser (~10 GHz repetition rate).

M3D.7 • 15:45

Conversion Gain Enhancement of a UTC-PD-Integrated HEMT Photonic Double-Mixer by High-Intensity Optical Subcarrier Signal, Dai Nakajima[1], Kazuki Nishimura[1], Mitsuki Watanabe[1], Tsung-Tse Lin[1], Keisuke Kasai[1], Masato Yoshida[1], Tetsuya Suemitsu[2], Taiichi Otsuji[1], Akira Satou[1]; [1]*RIEC, Tohoku Univ., Japan;* [2]*NICHe, Tohoku Unversity, Japan*. We investigate the effectiveness of high-intensity subcarrier signal input to the UTC-PD-integrated HEMT for optical-to-wireless carrier frequency down-conversion and report that the conversion gain increased linearly from -51 dB to -44 dB.

Room 6D

M3E • Enabling Technologies for Data Center and HPC—Continued

M3E.3 • 15:15 ★ Top-Scored

Self-Homodyne Coherent Transmission With All-Optical Clock Synchronization for DSP-Free Co-Packaged Optics, Ming-Ming Zhang[1], Weihao Li[1], Yizhao Chen[2], Zihe Hu[1], Ming Tang[1]; [1]*OEI, HUST, China;* [2]*CSE, HUST, China*. Utilizing the all-optical clock delivery and synchronization, we successfully achieved baud-rate sampled 40-Gbaud DP-16QAM self-homodyne transmission with 1.92 Tbps aggregated capacity over 3.5-km MCF, yielding a promising solution for the DSP-free coherent co-packaged optics.

M3E.4 • 15:30

Sub-ms Data Recovery at 1,000-Port Scale Optical Switch Developed With Customized Practical Devices, Osamu Moriwaki[1], Kazushige Yonenaga[1], Satoshi Ide[1], Noboru Takachio[1], Hiroshi Onaka[1], Kenya Suzuki[1]; [1]*Photonics Electronics Technology Research Association, Japan*. We have successfully demonstrated a large optical switching system with short switching times. Our transient time optimized digital coherent DSP, wavelength tunable laser, and silica-based PLC switch are the key components of the system.

M3E.5 • 15:45

Optical Clock Synchronization for O-Band Directly Modulated Laser Based Data Center Interconnection, Zichuan Zhou[1], Kari Clark[1], Ashish Verma[2], Yasuhiro Matsui[2], Zhixin Liu[1]; [1]*Univ. College London, UK;* [2]*Coherent Incorporated, USA*. We show that clock synchronized transmission has reduced receiver-side jitter that limits DMLs' performance compared to conventional clock and data recovery. We access transmission quality using 35-GHz-bandwidth DMLs at 1271 and 1373 nm.

Room 6E

M3F • LIDAR, RADAR and Ranging Systems—Continued

M3F.6 • 15:30
Coherent LiDAR Prototype Based on 2D MEMS Mirror Scanning, Sarah Cwalina[1], Christoph Kottke[1], Norman Laske[2], Volker Jungnickel[1], Ronald Freund[1]; [1]*Fraunhofer Heinrich Hertz Inst., Germany;* [2]*Fraunhofer Inst. for Silicon Technology, Germany.* We present a new coherent LiDAR prototype with two-dimensional micro-electro-mechanical-system scanning and walk-off mitigation capability. We address the linearization challenge of the FMCW transmitter, the scan-capture-synchronization and provide point-clouds of two distinct objects.

M3F.7 • 15:45
Electro-Optical Phase-Locked Loop for Hybrid Integrated External Cavity Laser, Chuxin Liu[1], Yuyao Guo[1], Ruiyang Xu[1], Liangjun Lu[1], Linjie Zhou[1], Jianping Chen[1]; [1]*Shanghai Jiao Tong Univ., China.* We implement an analog EO-PLL for a III/V-Si_3N_4 hybrid integrated ECL to generate a highly-linear FMCW signal over multiple wavelengths. The ranging resolution is improved from 5 m to 22 cm for a 100-m target.

Room 6F

M3G • Telemetry and Synchronisation—Continued

M3G.5 • 15:15
Optical Network Diagnostics Using Graph Neural Networks and Natural Language Processing, Xiaonan Xu[1], Haoshuo Chen[1], Jesse Simsarian[1], Roland Ryf[1], Mikael Mazur[1], Lauren Dallachiesa[1], Nicolas K. Fontaine[1], David Neilson[1]; [1]*Nokia Bell Labs, USA.* We propose an AI-powered network diagnostic strategy including alarm clustering and fault localization with >98% accuracy for up-to 16-degree ROADMs and demonstrate the advantages of using NLP in encoding.

M3G.6 • 15:30 ★ **Top-Scored**
Automation of Fast Configuration Error Diagnosis in Optical Transport Networks - Natural Language Processing is All You Need, Cen Wang[1], Noboru Yoshikane[1], Daniel J. Elson[1], Takehiro Tsuritani[1]; [1]*Photonic Transport Network Laboratory, KDDI Research, Inc., Japan.* We train language models to automate the diagnosis of OTN configuration errors, and the diagnostic accuracy is up to 97.56%. We additionally demonstrate the effectiveness of the models on a real OTN system.

M3G.7 • 15:45
Experimental Demonstration of Integrated Low-Cost High-Precision Timing Solution for Optical Transport Networks Supporting 5G, Ekin Arabul[1], Romerson Oliveira[1], Rui Wang[1], Reza Nejabati[1], Dimitra E. Simeonidou[1]; [1]*Univ. of Bristol, UK.* We successfully integrated FPGA-based low-cost high-precision timing scheme into an optical transport network solution. 16.2 ps synchronisation precision has been achieved across two devices while network-wise setup can sustain up to 21.2 ps precision.

Room 7AB

M3H • Panel: Optical Fiber Sensing: Technology and Emerging Applications Part I—Continued

Room 8

M3I • Monolithic or 3D Electro-Optical Integration—Continued

M3I.5 • 15:00 **Tutorial**
Tradeoffs in the Paths Forward for Advanced Packaging in Photonics, Jon Aday[1]; [1]*Amkor Technology, USA.* Advanced semiconductor packaging is currently being used to support products that utilize photonics connections, but as we migrate from a wire bonded solution to flip chip the complexity increases dramatically. The fiber coupling methods will also impact the process flows and package structures that can be implemented. The tradeoffs will be reviewed between the coupling methods and semiconductor packaging options as we migrate from pluggables to co-packaged optics.

Room 9

M3J • Accurate Frequency/ Time Distribution and Optical Computing—Continued

M3J.4 • 15:15
Calculating With Phase Opens up the High-Precision and High-Reconfigurability Integrated Photonic Computing, Yuepeng Wu[1], Hongxiang Guo[1], Bowen Zhang[1], Ran Tao[1], Yi Guo[1], Tian Zhang[1], Jifang Qiu[1], Jian Wu[1]; [1]*School of Electronic Engineering, Beijing Univ. of Posts and Telecommunications, China.* We propose and experimentally demonstrate a novel phase-based optical computing system integrated with photonic AD/DA converters. Further simulation shows that our system can perform 15-bit arithmetic operations when the SNR is around 34 dB.

M3J.5 • 15:30
Fully Integrated Silicon Photonic Tensor Core for Next-Generation Applications, Nicola Peserico[1], Xiaoxuan Ma[1], Ahmed Khaled[2], Zhimu Gou[2], Bhavin J. Shastri[2], Volker J. Sorger[1]; [1]*George Washington Univ., USA;* [2]*Queens Univ., Canada.* Here we present our architecture for Silicon Photonic Tensor Core, capable of responding to the needs of Neural Networks, Augmented and Virtual Reality applications. We present a novel version fully integrated, from lasers to photodetectors.

M3J.6 • 15:45 ★ **Top-Scored**
WDM-Compatible Integrated Photonic Computing Core for Implementing a Neural Network, Zhenyu Zhao[1], Shuang Zheng[1], Weifeng Zhang[1]; [1]*Beijing Inst. of Technology, China.* We propose and design an energy-efficient integrated photonic computing core by using a microdisk resonator-assisted Mach-Zehnder interferometer. With the use of the fabricated silicon photonic chip, an optical convolutional neural network for image classification is experimentally demonstrated.

Room 6A

14:00–16:15
M3Z • OFC Demo Zone

Presider: Benjamin Puttnam; National Inst Info & Comm Tech (NICT), Japan and Marco Ruffini; Univ. of Dublin Trinity College, Ireland

M3Z.1
Adaptive Geometric Constellation Shaping in a Transmission System With a Real-Time Optimisation Loop, Mindaugas Jarmolovicius[1], Anastasiia Vasylchenkova[1], Eric Sillekens[1]; [1]*Univ. College London, UK*. We demonstrate the real-time performance of an adaptive intelligent transceiver, tailoring the constellation shape to the transmission system by iteratively maximising the information throughput, quantified by the GMI.

M3Z.2
Optical Network Tomography: Demonstration of Anomaly Loss Monitoring and Fiber-Type Identification, Ryu Shinzaki[1], Motohiko Eto[1], Kazuyuki Tajima[1], Kyosuke Sone[1], Setsuo Yoshida[1], Shoichiro Oda[1], Inwoong Kim[2], Olga Vassilieva[2], Paparao Palacharla[2], Takeshi Hoshida[1]; [1]*Fujitsu Limited, Japan;* [2]*Fujitsu Network Communications, Inc., USA*. We demonstrate optical network tomography software prototype for localization of anomaly loss and fiber-type identification based on the estimated optical power profile using experimentally measured waveform data in a multi-span transmission testbed.

M3Z.3
Demonstration of Data-Sovereign Telemetry Broker for Open and Disaggregated Optical Networks, Haydar Qarawlus[1], Steffen Biehs[1], Behnam Shariati[2], José-Juan Pedreño-Manresa[3], Ayoub Bouchedoub[1], Hendrik Haße[1], Pooyan Safari[2], Achim Autenrieth[3], Johannes Karl Fischer[2]; [1]*Fraunhofer ISST, Germany;* [2]*Fraunhofer HHI, Germany;* [3]*ADVA Optical Networking, Germany*. We demonstrate a novel and modular telemetry broker that allows remote collection and exchange of telemetry data. Our proposal enforces data sovereignty principles powered by International Data Spaces components and enables unprecedented data ownership control.

M3Z.4
Distributed Architecture Supporting Intelligent Optical Measurement Aggregation and Streaming Event Telemetry, Pol Gonzalez[1], Ramon Casellas[2], José-Juan Pedreño-Manresa[3], Achim Autenrieth[3], Fabien Boitier[4], Behnam Shariati[5], Johannes Karl Fischer[5], Marc Ruiz[1], Jaume Comellas[1], Luis Velasco[1]; [1]*Universitat Politecnica de Catalunya, Spain;* [2]*CTTC, Spain;* [3]*ADVA, Germany;* [4]*Nokia, France;* [5]*HHI, Germany*. A distributed telemetry system integrating optical measurement and event data collection is demonstrated. Measurements of optical spectra from Nokia Bell Labs, of optical transponders from ADVA and SDN controller events from CTTC will be showcased.

M3Z.5
Distribution of Quantum Entanglement Through Fiber With co-Propagating Classical Data, Daniel Reilly[1], Kim Lee[1], Paul Moraw[1], Tim Rambo[2], Aaron Miller[2], Joe Mambretti[3], Prem Kumar[3], Gregory S. Kanter[1]; [1]*NuCrypt, USA;* [2]*Quantum Opus, USA;* [3]*Northwestern Univ., USA*. A complete system for distributing quantum entangled signals over fiber based on commercially available equipment will be demonstrated. Measurements are collected and controlled from a single location using an embedded optical data link.

M3Z.6
Detection of Abnormal Activities on a SM or MM Fiber, Stefan Karlsson[1], Mikael Andersson[3], Rui Lin[2], Lena Wosinska[2], Paolo Monti[2]; [1]*FMV, Sweden;* [2]*Electrical Engineering, Chalmers Univ. of Technology, Sweden;* [3]*Micropol Fiberoptics AB, Sweden*. We demonstrate eavesdrop detection based on polarization signatures by analyzing polarization state changes at the receiver. We identify changes related to the normal operation and the ones caused by eavesdropping.

M3Z.7
Live Demonstration of ML-Based PON Characterization and Monitoring, Maximilian Brügge[1], Jasper Müller[1], Sai Kireet Patri[1], Sander Jansen[1], Jim Zou[1], Stephanie Althoff[2], Klaus-Tycho Förster[2]; [1]*ADVA Optical Networking SE, Germany;* [2]*Technical Univ. of Dortmund, Germany*. We demonstrate a machine learning-based solution for optical time-domain reflectometry devices which can assist in the classification and monitoring of reflective events in a passive optical network.

M3Z.8
Open Disaggregated Optical Network Control With Network Management as Code, Javier Errea[1], Huy Q. Tran[1], Dominique Verchere[1], Trung H. Thieu[2], Andrea Mazzini[3], Lahcen Abnaou[4], Jelena Pesic[4], Marina Curtol[4], Abdelali El Imadi[4], Adlen Ksentini[5], Djamal Zeghlache[6]; [1]*Nokia Bell Labs, France;* [2]*Nokia Bell Labs, USA;* [3]*Nokia, Italy;* [4]*Nokia, France;* [5]*Communication Systems, EURECOM, France;* [6]*Telecom SudParis, France*. Network Management as Code is presented to manage the infrastructure and deployment of control functions in a declarative manner by adopting GitOps in open disaggregated optical networks. We introduce an Automation Engine that analyzes topology changes to trigger the Continuous Delivery procedure of SDN applications on a micro-service architecture.

M3Z.9
Slice Grouping for Transport Network Slices Using Hierarchical Multi-Domain SDN Controllers, Lluis Gifre[1], Ricard Vilalta[1], Juan Carlos Caja-Diaz[2], Oscar Gonzalez de Dios[2], Juan Pedro Fernandez-Palacios[2], José-Juan Pedreño-Manresa[3], Achim Autenrieth[3], Mika Silvola[4], Nicola Carapellese[5], Michele Milano[5], Adrian Farrel[6], Daniel King[6], Ricardo Martínez[1], Ramon Casellas[1], Raul Muñoz[1]; [1]*CTTC, Spain;* [2]*Telefónica I+D, Spain;* [3]*ADVA Optical Networking, Germany;* [4]*Infinera, Finland;* [5]*Siae Microelettronica, Italy;* [6]*Old Dog Consulting, UK*. This demonstration showcases how TeraFlowSDN provides support for hierarchical control of multiple heterogeneous SDN domains (through IP, microwave and optical technologies). Different transport slices are offered with multiple SLAs and grouped to optimize resources.

M3Z.10
Demonstration of Packet-Optical Intent-Based Survivability Using Mininet-Optical, Rossano P. Pinto[1], Celso H. Cesila[1], Kayol S. Mayer[1], Andres F. Portilla[1], Dalton S. Arantes[1], Darli Mello[1], Christian E. Rothenberg[1]; [1]*UNICAMP, Brazil*. We demonstrate packet-optical intent-based networking with survivability intents in a Mininet-Optical testbed. The intent agent negotiates intents with users based on path availability and allocates end-to-end connectivity services.

M3Z.11
Demonstration of Voice User Interface for Intelligent Network Orchestration, Xiaonan Xu[1], Haoshuo Chen[1], Jesse E. Simsarian[1], Roland Ryf[1], Mikael Mazur[1], Lauren Dallachiesa[1], Nicolas K. Fontaine[1], David Neilson[1]; [1]*Nokia Bell Labs, USA*. We demonstrate a voice user interface for ONOS, where natural language processing (NLP) is applied to translate human-spoken language into ONOS northbound API requests and to answer network-related questions with numerical reasoning.

M3Z.12
Demonstration of a Scalable and Efficient Pipeline for ML-Based Optical Monitoring, Carlos Natalino da Silva[2], Lluis Gifre[1], Raul Muñoz[1], Ricard Vilalta[1], Marija Furdek[2], Paolo Monti[2]; [1]*Centre Tecnologic de Telecomunicacions de Catalunya (CTTC/CERCA), Spain;* [2]*Electrical Engineering, Chalmers Univ. of Technology, Sweden*. We demonstrate a scalable processing of OPM data using ML to detect anomalies in optical services at run time. A dashboard will show operational SDN controller metrics, raw OPM data, and the ML assessment results.

M3Z.13
Hybrid SDN Orchestration in Multi-Layer Network With SONiC Packet-Optical Nodes and Coherent Pluggables, Davide Scano[1], Jordi Ortiz[2], Alessio Giorgetti[3], José Manuel Martínez[4], Andrea Sgambelluri[1], Emilio Riccardi[5], Filippo Cugini[6], Pablo Pavon[7]; [1]*Scuola Superiore Sant'Anna, Italy;* [2]*Univ. Center of Defense at the Spanish Air Force Academy, Spain;* [3]*IEIIT CNR, Italy;* [4]*E-lighthouse Network Solutions, Spain;* [5]*TIM, Italy;* [6]*CNIT, Italy;* [7]*Technical Univ. of Cartagena, Spain*. This demo presents a comprehensive framework exploiting effective cooperation of packet-optical nodes, at the edge of packet and optical domains, managed by the BGP and OSPF protocols and a Hierarchical Control Architecture. The framework enables orchestrated provisioning and soft failure recovery across a multi-layer metro network.

M3Z.14
Enhancing Cross Layer Monitoring on Open Optical Transport Networks, Nathan A. Ellsworth[1], Andrea Fumagalli[1], Tianliang Zhang[1], Sebastian Troia[2], Guido Maier[2]; [1]*The Univ. of Texas at Dallas, USA;* [2]*Politecnico di Milano, Italy*. Continuous monitoring of key network elements is instrumental in intelligent control and predictive analysis. This demonstration illustrates implementation challenges that are encountered in cross-layer monitoring of optical transport networks in an open-source network operations platform.

M3Z.15
Self-Calibrating Transponder Using Intelligent DSP Metrics for Efficient Optical Networks, Bernhard Spinnler[1], Juraj Slovak[1], Hao Su[1], Sharfuddin Syed[1], Ashwin Gumaste[1], Harald Bock[1]; [1]*Infinera Corporation, USA*. We demonstrate a self-aware automated transponder system for disaggregated open ROADM-based networks with automation using real-time inputs from a PS-capable 800Gb/s DSP that facilitates in situ measurement of signal performance, for optimal line-rate selection.

M3Z.16
Simultaneous 1080-Channel Control and Measurement for Photonic IC, Muhammad R. Afif[2,1], Ali F. Hadi[2,1], Muhammad I. Hadi[2,1], Muhammad I. Rafi[2,1], Muhamad R. Abdullah[2,1], Andri Mahendra[2,1]; [1]*PT Nicslab Global Industri, Indonesia;* [2]*Nicslab Ops, Inc., USA*. An integrated source-measurement unit (SMU) system that can be scaled up to 1080 channels is developed. This platform can drive and measure current and voltage for many use cases including photonic integrated circuits (PICs).

M3Z.17
Direct-Detection Receiver for QPSK-Modulated Signals, Dagmawi A. Bekele[1]; [1]*Danmarks Tekniske Universitet, Denmark*. We demonstrate a novel optical receiver for direct-detection of QPSK signals using microring-based photonic integrated circuit. The QPSK signal is converted into a PAM7 electrical signal, and demodulated without the need for a local oscillator.

M3Z.18
Optoelectronic Frequency Synthesizer With World-Record Phase Noise, Meysam Bahmanian[1], Christoph Scheytt[1], Saeed Fard[1]; [1]*Univ. of Paderborn, Germany*. We demonstrate an ultra-low phase noise PLL based on MLL. The OEPLL has a phase noise (-150 dBc/Hz 100kHz) for 10GHz carrier frequency. This phase noise is 10–20 dB better than state-of-the-art frequency synthesizers.

16:00–16:30 Coffee Break, *Upper Level Corridors*

16:30–18:30 Birds of a Feather: Designing and Operating the Next Generation Optical Photonic Networks, *Room 14B*

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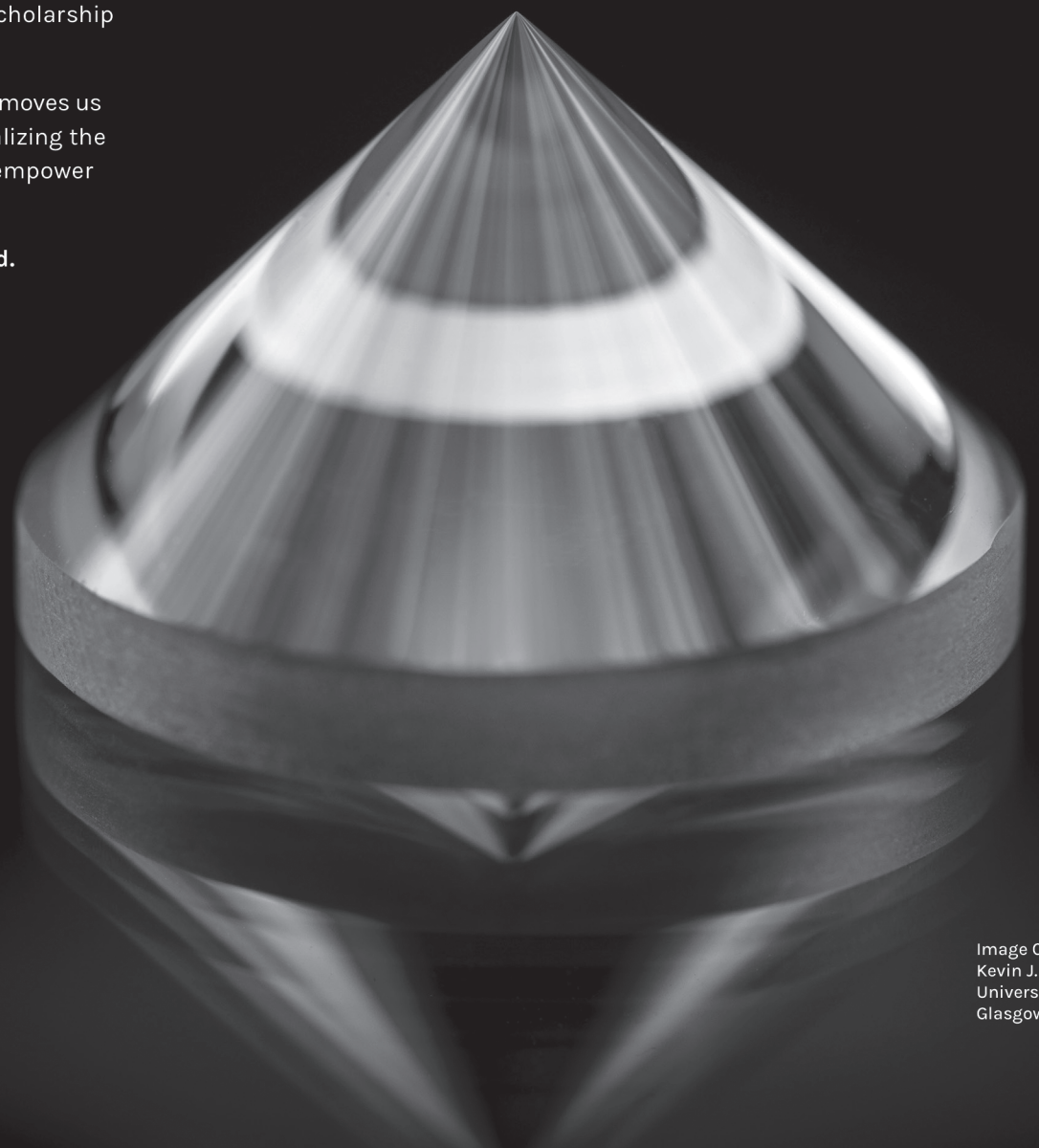

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Room 1AB

16:30–18:30
M4A • Symposium: Quantum Information and Optical Communication Networks: Emerging Research Areas, Challenges and Opportunities II
Presider: Eleni Diamanti; CNRS, France and Rui Lin; Chalmers Tekniska Högskola, Sweden

M4A.1 • 16:30 Invited
Communication Interfaces to Quantum Memories, Matt Eichenfield[1]; [1]*Univ. of Arizona, USA.* Abstract not available.

Room 2

16:30–18:30
M4B • Multi-Mode Fiber
Presider: Ivana Gasulla Mestre; Universitat Politècnica de València, Spain

M4B.1 • 16:30
A Method for Differential Modal Delay Reduction by Using Curvature of few-Mode Optical Fiber in High-Density Cable, Masashi Kikuchi[1], Takayoshi Mori[1], Yusuke Yamada[1]; [1]*NTT Corporation, Japan.* We propose a method of controlling the differential modal delay of 2LP-mode graded-index fiber by using the curvature of fiber in high-density cable. The method achieved a 50% reduction in the C-L band.

M4B.2 • 16:45
Definition of Mode Field Diameter for Few-Mode Fibers Based on Stationary Expression of Propagation Constant, Atsushi Nakamura[1], Masaharu Ohashi[2], Yusuke Koshikiya[1]; [1]*NTT Corporation, Japan;* [2]*Osaka Metropolitan Univ. College of Technology, Japan.* We derive a novel definition of mode field diameters (MFDs) for few-mode fibers (FMFs) from the wave equation. The MFDs obtained with our definition are useful in evaluating splice losses of each mode in FMFs.

Room 3

16:30–18:30
M4C • High Power and Comb Laser Sources
Presider: Matthew Sysak; Ayar Labs, USA

M4C.1 • 16:30
Record High Efficiency High-Power Uncooled 1.31 µm CW-DFB Lasers, Milind Gokhale[1], Mark A. Emanuel[1], Benjamin Li[1]; [1]*Casela Technologies, USA, USA.* We demonstrate record high 75°C power conversion efficiencies of 25% at 100 mW (1mm cavity) and 20% at 200 mW (2mm cavity) for CW-DFB lasers with reliable, kink-free, single-mode operation at 1.31 µm.

M4C.2 • 16:45
High Power Uncooled CW-DFB Lasers With High Reliability, Yuanfeng Mao[1], Yuanbing Cheng[1], Yanbo Li[1], Tianhai Chang[1]; [1]*Huawei Technologies Co., Ltd., China.* We demonstrate L-band and O-band CW-DFB lasers with kink-free and stable single mode lasing over 600 mW at 55°C and 200 mW at 85°C, respectively. More than 2000 hours reliable operation at 90°C is achieved.

Room 6C

16:30–18:30
M4D • Panel: 1.6Tb/s+ Intra-DC Networks

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

Speakers: Andreas Bechtolsheim, *Arista Networks, USA;* Mark Heimbuch, *Cisco, USA;* Maxim Kuschnerov, *Huawei Technologies, Germany;* Thomas Liljeberg, *Intel Corporation, USA;* Radha Nagarijan, *Marvell Technology, USA;* Chongjin Xie, *Alibaba Group, USA;* Xiong Zhou, *Google, USA*

Description: The bandwidth demands of hyperscale data center operators have been increasing tremendously over the last years. Consequently, an MSA for 800 Gb/s pluggables has been formed and the IEEE P802.3df task force for the development of 1.6 Tb/s Ethernet has been launched recently. This panel aims to highlight the requirements for next generation 1.6 Tb/s+ systems from the data center operator's perspective and the expected timelines for deployment. Also, it shall provide clarity on the desired module specifications by discussing recent advances in electronic and photonic integration.

Topics will include the following questions:

- What are the needs of hyperscale data center operators?
- 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, system 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.

Room 6D

16:30–18:30
M4E • High Bandwidth Density Interconnects for Computing
Presider: Xiaodan Pang; Kungliga Tekniska Hogskolan, Sweden

M4E.1 • 16:30
A 0.4 pJ/bit NRZ Voltage Mode VCSEL Driver for up to 224 Gbit/s SWDM Links, Urs Hecht[1], Helia Ordouei[1], Nikolay Ledenstov Jr.[2], Philipp Scholz[1], Patrick Kurth[1], Ilya E. Titkov[2], Nikolay Ledentsov[2], Friedel Gerfers[1]; [1]*TU Berlin, Germany;* [2]*Vertically Integrated Systems GmbH (VIS), Germany.* We present the first true voltage-mode VCSEL driver achieving 60Gbit/s at peak efficiency of 0.36pJ/bit with BER<1e-12 improving the state-of-the-art by a factor of 2. Transmission experiments showcase error-free 56Gbit/s transmission up to 100m fiber. Advanced demonstration enables even 224Gbit/s when using SWDM at a total efficiency of 0.4pJ/bit.

M4E.2 • 16:45
30-Gbps/ch x 4 ch Simultaneous Error-Free Transmission With a Low-Power Transmitter Flip-Chip-Bonded 1.3-µm LD-Array-on-Si, Toshiki Kishi[1], Munehiko Nagatani[1], Shigeru Kanazawa[2], Kota Shikama[1], Takuro Fujii[1], Hidetaka Nishi[1], Tadashi Minotani[1], Norio Sato[1], Toru Segawa[1], Shinji Matsuo[1]; [1]*NTT Device Technology Labs., Japan;* [2]*NTT Device Innovation Center, Japan.* 30-Gbps/ch NRZ PRBS-31 x 4 ch simultaneous error-free 1.6-km transmission was achieved with a low-power 4-ch transmitter consisting of 65-nm CMOS cascode shunt LD drivers and flip-chip-bonded LD-array-on-Si, resulting in power efficiency of 1.2 mW/Gbps.

Room 6E

16:30–18:15
M4F • Visible Light Communications and Positioning
Presider: James Lott; Technical Univ. Berlin, Germany

M4F.1 • 16:30
25G+ Distance-Adaptive Visible Light Communications Enabled by Entropy Loading, Pedro Loureiro[1], Fernando Guiomar[1], Paulo Monteiro[1]; [1]*Instituto de Telecomunicações, Portugal*. Using probabilistic shaping together with multi-carrier modulation and entropy loading, we experimentally demonstrate a distance-adaptive RGB-VLC system operating with diffuse white light and supporting record-high bit rates of 26–46 Gbit/s over 50-200 cm.

M4F.2 • 16:45
Capacity Enhancement of VLC by Blue-Green Wavelength Division Multiplexing Using Optical Phased Array, Yujie Di[1,2], Caiming Sun[2,3], Shuyan Chen[1], Weiwei Liu[2], Yizhan Dai[1], Binghui Li[3], Wu Shi[2], Jing Lin[2], Yingjie Shao[4], Jing Xu[5], Lian-Kuan Chen[1]; [1]*Department of Information Engineering, The Chinese Univ. of Hong Kong, Hong Kong;* [2]*Peng Cheng Laboratory, China;* [3]*Shenzhen Inst. of Artificial Intelligence and Robotics for Society (AIRS), The Chinese Univ. of Hong Kong (CUHK), China;* [4]*Centre for Applied Photonics Fraunhofer UK Research Ltd, UK;* [5]*Optical Communications Laboratory, Ocean College, Zhejiang Univ., China*. We proposed and experimentally demonstrated the first blue-green OPA-based WDM-VLC systems with narrow channel spacing. A 4.5-Gbit/s transmission with 50% capacity enhancement was achieved by OCT-precoding and simplified third-order Volterra equalization.

Room 6F

16:30–18:30
M4G • Multi-X Networks
Presider: Yojiro Mori; Nagoya Univ., Japan

M4G.1 • 16:30 ★ Top-Scored
Experimental Demonstration of Cascadable PPLN-Based Inter-Band Wavelength Converters for Band-Switchable Multi-Band Optical Cross-Connect, Haruka Minami[1], Kenta Hirose[1], Takafumi Fukatani[1], Masahiro Nakagawa[1], Takeshi Seki[1], Shimpei Shimizu[2], Takayuki Kobayashi[2], Takushi Kazama[2,3], Koji Enbutsu[3], Kei Watanabe[2,3], Takeshi Umeki[2,3], Takashi Miyamura[1], Takeshi Kuwahara[1]; [1]*NTT Network Service Systems Laboratories, Japan;* [2]*NTT Network Innovation Laboratories, Japan;* [3]*NTT Device Technology Laboratories, Japan*. We experimentally demonstrate the cascadability of PPLN-based inter-band wavelength converters to realize band-switchable multi-band optical cross-connect. Experimental results show that input power optimization can reduce the degradation in transmission quality even when traversing >20 converters.

M4G.2 • 16:45
Enabling Multiband Transmission and Programmability in Disaggregated Optical Metro Networks, Laia Nadal Reixats[1], Ramon Casellas[1], Josep Maria Fabrega[1], F. Javier Vilchez[1], Michela Svaluto Moreolo[1]; [1]*Ctr Tecnològic de Telecom de Catalunya, Spain*. A multi band (MB) sliceable bandwidth/bit rate variable (S-BVT) architecture is experimentally assessed over a disaggregated optical metro network. The programmability of the MB S-BVT is demonstrated by the implementation of an OpenConfig SDN agent.

Room 7AB

16:30–18:30
M4H • Panel: Optical Fiber Sensing: Technology and Emerging Applications Part II

Organizers: Raja Ahmad, *Cisco Systems, USA;* Mikael Mazur, *Nokia Bell Labs, USA;* Georg Rademacher, *NICT, Japan;* Ting Wang, *NEC Laboratories America, USA*

Speakers: Dan Bluhmental, *University of California, Santa Barbara, USA;* Pierepaolo Boffi, *Politecnico di Milano, Italy;* Lea Bouffant, *Cornell University, USA;* Miguel Gonzalez-Herraez, *Universidad de Alcala, Spain;* Leo Hollberg, *Stanford University, USA;* Paul Ohodnicki, *University of Pittsburgh, USA;* Charlotte Rowe, *Los Alamos National Laboratory, USA;* Hiroshi Takahashi, *Nippon Telegraph and Telephone Corporation, Japan;* Paul Westbrook, *OFS Labs, USA*

Description: This session focuses on the telecom/network operator perspective of fiber sensing to improve future optical communication systems. The panel, which consists of academia, equipment manufacturers and network operators, aims to further discuss the aspect of how, why and when to implement and use fiber sensing in optical networks.

Room 8

16:30–18:30
M4I • Passive Silicon Photonic Devices
Presider: Glenn Bartolini; Coherent Inc, USA

M4I.1 • 16:30
CMOS-Foundry Compatible, Broadband, and Compact Routing of Multimode SOI Waveguides, Asher S. Novick[1], Kaylx Jang[1], Anthony Rizzo[1], Aneek E. James[1], Utsav Dave[1], Michal Lipson[1], Keren Bergman[1]; [1]*Columbia Univ., USA*. We demonstrate a CMOS-foundry compatible, broadband, and compact platform for routing multimode wavguides. Insertion loss of <0.5dB and modal cross-talk of <-15dB are measured for 90° and 180° R_{eff}<3μm bends supporting over 200nm of bandwidth.

M4I.2 • 16:45
Passive Integrated Athermal (De)Multiplexers on 300 mm Silicon Photonics Wafers, Yun Gao[1], Noah Pestana[1], Skylar Deckoff-Jones[1], Jiajiu Zheng[1], Jordan Goldstein[1], Andrew Netherton[2], Ren-Jye Shiue[1], Michael Watts[1], Chris Poulton[1]; [1]*Analog Photonics LLC, USA;* [2]*Department of Electrical and Computer Engineering, Univ. of California Santa Barbara, USA*. We demonstrate passive integrated athermal (de) multiplexers showing near 0 pm/°C wavelength shift from 20 to 80 °C on 300 mm silicon photonics wafers. Wafer-scale data shows its high fabrication tolerance for next-generation optical transceiver systems.

Room 9

16:30–18:30
M4J • Photonic Switching Devices
Presider: Sagi Mathai; Hewlett Packard Labs, USA

M4J.1 • 16:30 Invited
All-Optical Switching Past, Present, and Future, Richard A. Jensen[1], Rohit Kunjappa[1], Nick Parsons[1]; [1]*Huber+Suhner Polatis, USA*. This paper covers developments in all-optical switching applications over time, along with current and emerging trends. Large all-optical switching deployments have been growing steadily and are now poised for wide-scale deployment in networks and datacenters.

Room 1AB

M4A • Symposium: Quantum Information and Optical Communication Networks: Emerging Research Areas, Challenges and Opportunities II—Continued

M4A.2 • 17:00 Invited

Multi-User Quantum Communication With Linear Optical Networks, Vladyslav Usenko[1]; [1]*Palacký Univ. Olomouc, Czechia*. Multi-user quantum communication enables distribution of secret keys or quantum resources between multiple users. We will discuss possible realizations using continuous-variable states and linear optical networks, considering realistic channels and devices, and optimizing network topology.

M4A.3 • 17:30 Invited

Quantum Sensor Networks, Saikat Guha[1], [1]*University of Arizona, USA*. Abstract not available.

Room 2

M4B • Multi-Mode Fiber—Continued

M4B.3 • 17:00 Invited

Few-Mode Fibers: Characterizations and Applications, Marianne Bigot[1], Maroun Bsaibes[2], Laurent Bigot[2], Yves Quiquempois[2], Pierre Sillard[1]; [1]*Prysmian Group, France;* [2]*PhLAM, Université de Lille, France*. We report design guidelines and modal loss characterizations (light scattering and extra-loss phenomena) of few-mode fibers that allow optimizing their crosstalk, differential mode group delay and differential mode attenuation for practical applications.

M4B.4 • 17:30

Remote Digital Holographic Characterization of a 75.2 km Few-Mode Fiber Without Reference Wave Transfer, Akira Kawai[1], Shimpei Shimizu[1], Kohki Shibahara[1], Takayuki Kobayashi[1], Yutaka Miyamoto[1]; [1]*NTT Network Innovation Laboratories, Japan*. We characterized inter-mode-group crosstalk of 75.2-km-long three-mode fiber transmission lines with a digital holography system in which a reference wave is "remotely" generated at the output side by utilizing optical injection locking.

Room 3

M4C • High Power and Comb Laser Sources—Continued

M4C.3 • 17:00

Demonstration of a High-Power and High-Reflection-Tolerance Semiconductor Laser for Co-Packaged Optics, Ning Cheng[1], Dechao Ban[1], Xuezhe Zheng[1]; [1]*Innolight, China*. A high-power (>100mW) semiconductor laser is demonstrated with a small far-field divergence of 9.3°x17.6°. Under a -19.8dB back-reflection, this laser exhibits little changes in relative intensity noise and almost no power penalty for 53Gbd/s PAM4 transmission.

M4C.4 • 17:15

A High-Power, Power-Efficient 1.3-µm SOA-Integrated DFB Laser for CPO Applications, Daisuke Inoue[1], Konosuke Aoyama[2], Naoki Fujiwara[1], Daisei Shoji[2], Harold Kamisugi[1,2]; [1]*Sumitomo Electric Industries, LTD., Japan;* [2]*Sumitomo Electric Device Innovations, Inc., Japan*. We present a high power 1.3-µm SOA-integrated DFB laser which exhibits a power conversion efficiency of more than 25% with output power of 350 mW up to 45°C. This device also shows an averaged RIN of below -155 dB/Hz.

M4C.5 • 17:30

Fully Integrated III-v-on-Silicon Multi-Port DFB Laser Comb Source for 100 GHz DWDM, Torrey Thiessen[1], Jason Mak[1], Florian Denis-Le Coarer[1], Zheng Yong[1], Kevin Froberger[1], Marylise Marchenay[1], Martin Peyrou[1], Laurent Milord[1], Joyce Poon[2,3], Christophe Jany[4], Sylvie Menezo[1]; [1]*SCINTIL Photonics, Canada;* [2]*Electrical and Computer Engineering, Univ. of Toronto, Canada;* [3]*Max Planck Inst. of Microstructure Physics, Germany;* [4]*CEA Leti, France*. We demonstrate a 4λx8 output DFB laser comb source with 94GHz channel spacing. The comb source produces approximately 1mW of fiber-coupled power per wavelength per fiber with 2dB power variability across all 32 output channels.

Room 6C

M4D • Panel: 1.6Tb/s+ Intra-DC Networks—Continued

Room 6D

M4E • High Bandwidth Density Interconnects for Computing—Continued

M4E.3 • 17:00 Invited

Optical Communication for Data Centers and HPC, Bill Dally[1,2]; [1]*NVIDIA Corporation, USA;* [2]*Stanford Univ., USA*. This talk will discuss the needs of data centers and high-performance computers for optical communication. Issues of bandwidth, bandwidth density, cost, and energy efficiency will be discussed. We will also look at the tradeoff between the number of carriers and bit rate per carrier.

M4E.4 • 17:30

Simultaneous Error-Free Data Modulation With Silicon Microdisks in the Multi-FSR Regime for Scalable DWDM Links, Vignesh Gopal[1], Anthony Rizzo[1], Maarten Hattink[1], Asher S. Novick[1], James Robinson[1], Kaveh Hosseini[2], Tim T. Hoang[2], Keren Bergman[1]; [1]*Columbia Univ., USA;* [2]*Intel Corporation, USA*. We demonstrate simultaneous error-free modulation of wavelength channels with spectral separation exceeding the individual microdisk FSR. The channels, re-interleaved onto a single optical output, are demultiplexed using ring filters validating the scalable transceiver architecture.

Room 6E

M4F • Visible Light Communications and Positioning—Continued

M4F.3 • 17:00
Optical Beam Steerable and Flexible Data Rate Orthogonal Frequency Division Multiplexing Non-Orthogonal Multiple Access (OFDM-NOMA) Visible Light Communication, Yin-He Jian[1], Chih-Chun Wang[1], Tzu-Chieh Wei[1], Ying-Kai Hong[1], Huang-Ming Chen[1], Chi-Wai Chow[1], Yang Liu[2], Chien-Hung Yeh[3]; [1]*National Yang Ming Chiao Tung Univ., Taiwan;* [2]*Philips, Hong Kong;* [3]*Feng Chia Univ., Taiwan*. We propose and demonstrate visible-light-communication (VLC) system using spatial-light-modulator (SLM) and orthogonal-frequency-division-multiplexing non-orthogonal-multiple access (OFDM-NOMA), illustrating the flexibilities of optical-beam steering and data-rate allocation for multiple users.

M4F.4 • 17:15
Optical Beam Steering Using Mode-Coupling Control in Plastic Optical Fibre, Carina Ribeiro Barbio Corrêa[1], A.M.J. Koonen[1], Eduward Tangdiongga[1]; [1]*Eindhoven Univ. of Technology, Netherlands*. An all-fibre beam steering solution, based on mode coupling in 240-µm core size POF, is presented. Using DMT modulation over 90-cm wireless link and steering full angle of 9°, a throughput of 1.6 Gbps is achieved for visible light.

M4F.5 • 17:30
Free-Space Visible Light Communication With Downstream and Upstream Transmissions Supporting Multiple Moveable Receivers Using Light-Diffusing Fiber, Yun-Han Chang[1], Chi-Wai Chow[1], Chih-Chun Wang[1], Yin-He Jian[1], Wahyu Hendra Gunawan[1], Yang Liu[2], Chien-Hung Yeh[3]; [1]*National Yang Ming Chiao Tung Univ., Taiwan;* [2]*Philips, Hong Kong;* [3]*Feng Chia Univ., Taiwan*. We demonstrate a free-space bi-directional visible-light-communication (VLC) system using a light-diffusion-fiber (LDF) optical antenna. It allows 360° field-of-view (FOV) non-contact and moveable VLC detection, achieving 210-Mbit/s downlink and 850-Mbit/s uplink transmissions.

Room 6F

M4G • Multi-X Networks—Continued

M4G.3 • 17:00
Demonstration of Multi-Hop Mode-Group Routing in a Field-Deployed Multi-Mode Fiber Network, Paola Parolari[1], Alberto Gatto[1], Ruben S. Luis[2], Georg Rademacher[2], Benjamin J. Puttnam[2], Robert Emmerich[3], Colja Schubert[3], Giuseppe Ferri[4], Frank Achten[4], Pierre Sillard[4], Paolo Martelli[1], Giammarco Di Sciullo[5], Fabio Graziosi[5], Andrea Marotta[5], Antonio Mecozzi[5], Cristian Antonelli[5], Pierpaolo Boffi[1]; [1]*Politecnico di Milano, Italy;* [2]*National Inst. of Information and Comm. Technology, Japan;* [3]*Fraunhofer Heinrich Hertz Inst., Germany;* [4]*Prysmian Group, France;* [5]*Univ. of L'Aquila and CNIT, Italy*. Space-division multiplexing can enhance node flexibility in urban networks by exploiting routing of weakly coupled mode groups. We demonstrate multi-hop Tb/s group routing in different switching scenarios in the deployed 15-mode fiber-ring in L'Aquila, Italy

M4G.4 • 17:15
Cost-Effective Network Capacity Enhancement With Multi-Band Virtual Bypass Links, Daisuke Saito[1], Yojiro Mori[1], Kohei Hosokawa[2], Shigeyuki Yanagimachi[2], Hiroshi Hasegawa[1]; [1]*Nagoya Univ., Japan;* [2]*NEC corporation, Japan*. A cost-effective network expansion method through the use of virtual links in which multi-band transmission is introduced. Network capacity enhancement reaches over 10% just with the introduction of a few virtual links on each topology.

M4G.5 • 17:30
Modular Optical Nodes With Anylane Add-Drop for Spatial Division Multiplexed Networks, Che-Yu Liu[2], David Neilson[1], Roland Ryf[1], S. J. Ben Yoo[3], Jesse E. Simsarian[1]; [1]*Nokia Bell Labs, USA;* [2]*Department of Computer Science, Univ. of California, Davis, USA;* [3]*Department of Electrical and Computer Engineering, Univ. of California, Davis, USA*. We compare anylane add-drop optical nodes with modular architectures for spatial-division multiplexed (SDM) networks. By modifying open-source GNPy for SDM, we present simulations that show lower blocking probability for networks that utilize anylane add-drop architectures.

Room 7AB

M4H • Panel: Optical Fiber Sensing: Technology and Emerging Applications Part II—Continued

Room 8

M4I • Passive Silicon Photonic Devices—Continued

M4I.3 • 17:00
Wafer Scale Ge-on-Si Metalens for the mid-Infrared, Yanyan Zhou[1], Qize Zhong[1], Zhihao Ren[2], Landobasa Y. Tobing[1], Yuan Hsing Fu[1], Rachel Ang[1], Bo Li[1], Hong Zhou[2], Chengkuo Lee[2], Lennon Y. Lee[1]; [1]*Inst. of Microelectronics, Singapore;* [2]*National Univ. of Singapore, Singapore*. We report the first demonstration of metalens devices fabricated on an 8-inch Ge-on-Si wafer for the mid-infrared regime. Experimental observations of beam focusing show good match with the design.

M4I.4 • 17:15
Low-Reflection Ultrahigh-Extinction-Ratio All-Silicon TM-Pass Polarizer Covering E to U Optical Communication Bands, Guanglian Cheng[1], Qiyuan Yi[1], Zhiwei Yan[1], Qiyuan Li[1], Chaotan Sima[1], Li Shen[1], Fanglu Xu[1]; [1]*Huazhong Univ. of Science and Techn, China*. We design and demonstrate a low-reflection TM-pass polarizer with high polarization extinction ratio > 30 dB over a 260 nm bandwidth. The fabricated polarizer exhibits excess loss < 0.9 dB for 1410-1700 nm wavelength range.

M4I.5 • 17:30 **Tutorial**
Tutorial on Silicon Photonics Applications, Tomoyuki Akiyama[1]; [1]*Fujitsu Limited, Japan*. This tutorial reviews history of silicon photonics from early-stage proof of concept to recent diverging applications based on large-scale integration, covering breakthrough technologies and key future prospects.

Room 9

M4J • Photonic Switching Devices—Continued

M4J.2 • 17:00
Core-to-Core Switching Module for 4-Core MCFs Using Silicon Photonics Matrix Switch Incorporating Silicon Vertically Curved Optical Coupler, Tomoya Yoshida[1], Yuki Atsumi[1], Emiko Omoda[1], Katsuya Kito[2], Katsuhiro Iwasaki[2], Yusuke Kinoshita[2], Tomoaki Kiriyama[2], Ryotaro Konoike[1], Keijiro Suzuki[1], Ryosuke Matsumoto[1], Takashi Inoue[1], Kazuhiro Ikeda[1], Takashi Kato[2], Youichi Sakakibara[1]; [1]*AIST, Japan;* [2]*Kohoku Kogyo Co. Ltd., Japan*. We developed MCF core-to-core path-switching module using vertically curved silicon couplers. MCFs were directly mounted using passive pre-alignment with transmission camera observation. 32-Gbaud DP-QPSK signal transmission over the switch module was possible without significant penalty.

M4J.3 • 17:15
C- and L-Band low Polarization Sensitive Nanosecond 1×2 Electro-Optic MZI Switch on 3-µm Thick Silicon Platform, Yu Wang[1], Srivathsa Bhat[2], Bin Shi[1], Timo Aalto[2], Nicola Calabretta[1]; [1]*Eindhoven Univ. of Technology, Netherlands;* [2]*VTT Technical Research Centre of Finland, Finland*. We fabricated and assessed a wideband (C-/L- band) nanosecond 1×2 electro-optic switch in 3-µm thick silicon. Results show 2.5dB lowest insertion loss, 16dB averaged extinction ration, 2.5dB polarization dependent loss and 6-ns switching time.

M4J.4 • 17:30
Core-Selective Switch for SDM Network Based on LCPG and MEMS Technology, Yuki Kuno[1], Masahiro Kawasugi[1], Yuji Hotta[1], Ryohei Otowa[1], Makoto Mizoguchi[1], Yasuki Sakurai[1]; [1]*SANTEC CORPORATION, Japan*. We propose a core selective switch (CSS) with VOA function utilizing liquid crystal polarization grating and MEMS technology. The prototype of 19-core 1×8 CSS showed an attenuation of 19.5 dB with more than 35 dB optical crosstalk.

Room 1AB

M4A • Symposium: Quantum Information and Optical Communication Networks: Emerging Research Areas, Challenges and Opportunities II—Continued

Room 2

M4B • Multi-Mode Fiber—Continued

M4B.5 • 17:45
55-Spatial-Mode Fiber for Space Division Multiplexing, Pierre Sillard[1], Marianne Bigot[1], Frank Achten[1], Georg Rademacher[2], Ruben S. Luis[2], Benjamin J. Puttnam[2]; *[1]Prysmian Group, France; [2]NICT, Japan*. We report the design and the fabrication of a trench-assisted graded-index-core fiber that supports 55 spatial modes. The fiber is optimized to ensure low macro-bend losses for all the modes, while minimizing the differential-mode-group delays.

M4B.6 • 18:00 Invited
Processing and Applications of Semiconductor Core Fibers, Ursula J. Gibson[1]; *[1]Norwegian Univ. of Science and Tech, USA*. Optical fibers with semiconducting cores permit transmission of signals from the visible to THz wavelengths, and devices can utilize the large nonlinear coefficients of the core materials. Fabrication, post-processing, properties and devices are reviewed.

Room 3

M4C • High Power and Comb Laser Sources—Continued

M4C.6 • 17:45
100 Gbps/λ Transmission With Quantum Dot O-Band Comb Source Using 50 GBd PAM4/16QAM-OFDM Signals, Lakshmi Narayanan Venkatasubramani[1], Haixuan Xu[2], Mikhail Buyalo[3], Alexey Gubenko[3], Yonglin Yu[2], Liam Barry[1]; *[1]Dublin City Univ., Ireland; [2]Wuhan National Laboratory for Optoelectronics, Huazhong Univ. of Science and Technology, China; [3]Innolume, Germany.*We demonstrate a record high transmission rate of 100 Gbps/λ with 50 GBd PAM4 and 16QAM-OFDM signals using a packaged wavelength-tunable InAs/InGaAs quantum dot-based laser comb source for short-reach application. We successfully show the performance is within the standard FEC limits.

M4C.7 • 18:00
Highly Reliable Quantum dot Laser Directly Grown on CMOS Compatible Si (001) Substrate, Xiangjie Zhao[1], Xiang Li[1], Guanlin Lou[1], Ling Sun[1], Shiyong Zhang[1], Haihua Qi[1]; *[1]Hisilicon Optoelectronics Co. Ltd., China*. Highly reliable InAs/GaAs quantum dot laser directly grown on CMOS compatible Si (001) substrate without any predefined pattern or intermediate material. Aging at 85°C 100mA, the laser shows optical power degradation less than 5% after 3000 hours.

M4C.8 • 18:15
Multi Aperture High Power 100G Single Mode 850nm VCSEL for Extended Reach 800G Ethernet, Lukasz Chorchos[1,2], Nikolay Ledenstov Jr.[2], Oleg Makarov[2], Vitaly Shchukin[2], Vladimir Kalosha[2], Jaroslaw P. Turkiewicz[1], Nikolay Ledentsov[2]; *[1]Warsaw Univ. of Technology, Poland; [2]VI Systems GmbH, Germany.* The paper presents multi-aperture single mode 850nm VCSEL with optical modulation bandwidth exceeding 30GHz and narrow optical spectrum width enabling long distance high-speed data transmission exceeding 800m over OM4 multi-mode fiber.

Room 6C

M4D • Panel: 1.6Tb/s+ Intra-DC Networks—Continued

Room 6D

M4E • High Bandwidth Density Interconnects for Computing—Continued

M4E.5 • 17:45
A Kind of Low-Modal-Crosstalk Mode DEMUX for Stable DSP-Free IM/DD MDM Transmission, Jian Cui[1], Yuyang Gao[1], Shuailuo Huang[1], Jinyi Yu[1], Lei Shen[2], Lei Zhang[2], Changkun Yan[2], Liubo Yang[2], Ruichun Wang[2], Yongqi He[1], Zhangyuan Chen[1,3], Juhao Li[1,3]; *[1]Peking Univ., China; [2]YOFC, China; [3]Pengcheng Laboratory, China.* A low-modal-crosstalk 4-LP-mode demultiplexer with orthogonal combiner for degenerate mode reception is designed and fabricated by side-polishing processing, based on which DSP-free IM/DD MDM-WDM transmission over 20-km weakly-coupled FMF are experimentally demonstrated.

M4E.6 • 18:00 Invited
Developments of VCSEL-Based CPO Transceivers Beyond 1Tbps, Daniel Kuchta[1]; *[1]IBM TJ Watson Research Center, USA*. This paper covers recent industry developments in VCSEL-based transceivers that are designed for co-packaging on a first level package with ASICs, such as CPUs, GPUs, and data center switches.

19:00–21:00 Student Party, *Petco Park*

Room 6E

M4F • Visible Light Communications and Positioning—Continued

M4F.6 • 17:45 Invited

Inbuilding Optical Wireless Positioning Using Time of Flight, Christoph Kottke[1], Ziyan Ma[1], Sepideh Mohammadi Kouhini[1], Volker Jungnickel[1]; *[1]Fraunhofer Inst Nachricht Henrich-Hertz, Germany.* We present a LiFi positioning and communication system based on the ITU-T G.9991 standard. Accuracies as low as 3 cm in x,y,z direction have been achieved, utilizing an optimization approach for the LED behavior.

Room 6F

M4G • Multi-X Networks—Continued

M4G.6 • 17:45

On the Impact of Fault-Induced Power Transients in Wideband Optical Networks, Andre Souza[1,3], António Eira[1], Nelson Costa[1], João Pedro[1,2], João Pires[2]; *[1]INFINERA UNIPESSOAL LDA, NIF 510553079, Portugal; [2]Instituto de Telecomunicações, Instituto Superior Técnico, Portugal; [3]Instituto Superior Técnico, Portugal.* We study the consequences of power transients caused by link failures and stimulated Raman scattering in multi-band networks. Results show that carefully optimizing transient margins should avoid high capacity reduction and excessive costs.

M4G.7 • 18:00 ★ Top-Scored

Single Multicore-Fiber Bidirectional Spatial Channel Network Based on Spatial Cross-Connect and Multicore EDFA Efficiently Accommodating Asymmetric Traffic, Kyousuke Nakada[1], Hitoshi Takeshita[2], Yuki Kuno[3], Yusuke Matsuno[4], Itsuki Urashima[1], Yuusuke Shimomura[2], Yuji Hotta[3], Tsubasa Sasaki[4], Yudai Uchida[1], Kohei Hosokawa[2], Ryohei Otowa[3], Rika Tahara[1], Emmanuel Le Taillandier de Gabory[2], Yasuki Sakurai[3], Ryuichi Sugizaki[4], Masahiko Jinno[1]; *[1]Kagawa Univ., Japan; [2]NEC Corporation, Japan; [3]santec corporation, Japan; [4]Furukawa Electric Co., Ltd., Japan.* A single multicore-fiber bidirectional spatial channel network that efficiently accommodates asymmetric traffic is proposed and demonstrated using a core-selective-switch-based spatial cross-connect with an *M*×*N* wavelength-selective switch and a bidirectional multicore EDFA with reversible optical isolators.

M4G.8 • 18:15

Architecture and Performance Evaluation of Bundled-Path-Routing Multi-Band Optical Networks, Ryuji Munakata[1], Takuma Kuno[1], Yojiro Mori[1], Shih-Chun Lin[2], Motoharu Matsuura[4], Suresh Subramaniam[3], Hiroshi Hasegawa[1]; *[1]Nagoya Univ., Japan; [2]North Carolina State Univ., USA; [3]George Washington Univ., USA; [4]Univ. of Electro-communications, Japan.* We propose a novel bundled-path-routing node architecture for multi-band optical networks and a network design algorithm based on graph degeneration. Feasibility is demonstrated through experiments on a prototype with 300.8 Tbps throughput.

Room 7AB

M4H • Panel: Optical Fiber Sensing: Technology and Emerging Applications Part II—Continued

Room 8

M4I • Passive Silicon Photonic Devices—Continued

Room 9

M4J • Photonic Switching Devices—Continued

M4J.5 • 17:45

Performance Verification of 7,424 × 7,424 Optical Switch Offering 1.4 µs Switching Time, 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]National Inst. of Advanced Industria, Japan.* We experimentally verify performance of 7,424×7,424 optical switches that offer 1.4-µs switching time. Two key enablers are reported; newly developed polarization-insensitive 64×1 silicon-photonic switches integrated with wavelength-tunable filters, and a fast burst-mode coherent receiver.

M4J.6 • 18:00 Invited

Large-Scale High-Speed Photonic Switches Fabricated on Silicon-Based Photonic Platforms, Tao Chu[1,2], Nuo Chen[1], Weijie Tang[2], Yating Wu[1]; *[1]Zhejiang Univ., China; [2]Zhejiang Laboratory, China.* Large-scale high-speed photonic switches were demonstrated on silicon-on-insulator and thin-film Lithium Niobate platforms, respectively. Ultra-low-loss spot-size-converter, grating coupler, waveguide crossing, and high-speed switch unit are developed, as well as an integrated 128 × 128 switch.

19:00–21:00 Student Party, *Petco Park*

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

Ballroom 20BCD

08:00–10:00
Tu1A • Plenary Session
Presider: Ramon Casellas; CTTC, Spain; Christopher Cole; Coherent Corp., USA; Ming-Jun Li; Corning Inc, USA

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

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

10:00–16:45 OFC Career Zone, *Exhibit Hall, B2*
OFC Career Zone Job Fair | Resume Critique Workshop | Mock Interviews

11:00–12:00 Optical Communications Technical Group Poster Pitch Competition, *Room 3*

12:00–14:00 OFC and Co-Sponsors Awards Ceremony and Luncheon, *Upper Level, Ballroom 20A*

Room 1AB

14:00–16:00
Tu2A • Symposium: The Crucial Role of Photonics in Achieving the UN Sustainability Development Goals: Learnings and Opportunities I
Presider: To be announced.

Tu2A.1 • 14:00 Invited
Innovative Optical and Wireless Network (IOWN) for a Sustainable World, Yosuke Aragane[1]; [1]*NTT Communications Corporation, Japan*. IOWN is a next generation communication and computing infrastructure which enables both high-performance and low-power consumption for the Sustainable Development Goals by IOWN's capabilities of an all-photonics network and a data-centric infrastructure.

Room 2

14:00–16:00
Tu2B • Photonic Devices for Novel Applications
Presider: Connie Chang-Hasnain; Berxel Photonics, USA

Tu2B.1 • 14:00 Invited
Optoelectronic Components for Communications and Sensing, Julie Eng[1]; [1]*II-VI Incorporated, USA*. Abstract not available.

Room 3

14:00–16:00
Tu2C • Deployment and Field Trials
Presider: Aramais Zakharian; Corning Inc, USA

Tu2C.1 • 14:00
Polarity and Twist Rate Detection for Accurate and Reliable Low Loss Multicore Fiber Fusion Splicing, Tristan Kremp[1], Yue Liang[2], Alan H. McCurdy[2]; [1]*OFS Laboratories, USA;* [2]*OFS Fitel LLC, USA*. Using a novel azimuthal alignment algorithm and side-view images, we reliably determine the polarity and twist rate of multicore fiber and achieve average losses as low as 0.03 dB using a 3-electrode arc-discharging fusion splicer.

Room 6C

14:00–16:00
Tu2D • Network Planning and Operation
Presider: Hidenori Takahashi; KDDI Research, Inc., Japan

Tu2D.1 • 14:00
Optimal Line-Rates for IP-Over-DWDM in Metro and Core Networks: Comparison of ZR+ and Xponder Architectures, Ashwin Gumaste[1], João Pedro[1], Paul Momtahan[1], Harald Bock[1]; [1]*Infinera Corporation, USA. With the advent of pluggable ZR/ZR+ and embedded optics at 400Gb/s and beyond, we consider optimal network architectures and line-rates in access, metro and core networks. Simulations across a US-core network are demonstrated.*

Room 6D

14:00–16:00
Tu2E • Co-Packaged and PIC for Data Center Applications
Presider: Fumio Koyama; Tokyo Inst. of Technology, Japan

Tu2E.1 • 14:00 Invited
Silicon-Photonic Integrated Circuits With Enhanced Optical Functionality for Data-Center Applications, Christopher R. Doerr[1]; [1]*Doerr Consulting, LLC, USA*. Abstract not available.

Room 6E

14:00–16:00
Tu2F • AI and Optimization in (Disaggregated) Networks
Presider: Stephan Pachnicke; Christian-Albrechts Universität zu Kiel, Germany

Tu2F.1 • 14:00 Invited
CTC Experiences on Building Computing Power Network, Gefan Zhou[1]; [1]*China Telecom Corp Ltd, Beijing Res Inst, China.* For the optimum leveraging of distributed computing and network resources in the network for various services, we proposed an advanced architecture of Computing Power Network (CPN) with the development of CPN gateway and transaction platform.

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

Ballroom 20BCD

08:00–10:00
Tu1A • Plenary Session
Presider: Ramon Casellas; CTTC, Spain; Christopher Cole; Coherent Corp., USA; Ming-Jun Li; Corning Inc, USA

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

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

10:00–16:45 OFC Career Zone, *Exhibit Hall, B2*
OFC Career Zone Job Fair | Resume Critique Workshop | Mock Interviews

11:00–12:00 Optical Communications Technical Group Poster Pitch Competition, *Room 3*

12:00–14:00 OFC and Co-Sponsors Awards Ceremony and Luncheon, *Upper Level, Ballroom 20A*

Room 6F

14:00–16:00
Tu2G • Subsea and Long-Haul Transmission
Presider: Alexei Pilipetskii; SubCom LLC, USA

Tu2G.1 • 14:00 Invited
Promising DSP Techniques to Increase Long Haul Transmission Capacity, Domanic Lavery[1], Siddharth Varughese[2], Carlo Condo[1], Mohamed Osman[1], Mehdi Torbatian[1], Sandy Thomson[1], Yuejian Wu[1], Robert Maher[3], Han Sun[1]; [1]*Infinera Canada Inc., Canada;* [2]*Infinera Corporation, USA;* [3]*Infinera Corporation, USA.* The state-of-the-art in realtime DSP for long haul coherent optical communication systems is described. We discuss how emerging applications for coherent transceivers may influence DSP design choices.

Room 7AB

14:00–16:00
Tu2I • Panel: LiDAR Systems and Technologies with Integrated Photonics

Organizers: Long Chen, *Cisco, USA;* Sylvie Menezo, *SCINTIL Photonics, France;* Shilong Pan, *Nanjing University Aeronautics & Astronautics, China;* Milos Popovic, *Boston University, USA*

Speakers: Philippe Absil, *IMEC, Belgium;* Hyunil Byun, *Samsung Electronics, Republic of Korea;* Sen Lin, *Aurora, USA;* Clement Nouvel, *Valeo, Germany;* Chris Poulton, *Analog Photonics, USA*

Description: LIDAR, i.e., "laser imaging, detection, and ranging", is a 3D scanning technology using optical signals. Soon after the invention of lasers, LIDAR was put in use in areas such as meteorology, geography, and military applications. For example, in 1971 during the Apollo 15 mission, astronauts used a laser altimeter to map the surface of the moon. Such LIDAR instruments for remote sensing are widely used

Room 8

14:00–15:45
Tu2H • Quantum Computing
Presider: Rui Lin; Chalmers Tekniska Högskola, Sweden

Tu2H.1 • 14:00 Tutorial
On-Chip Engineering Entanglement for Photonic Quantum Computing, Jianwei Wang[1]; [1]*Peking Univ., China.* Abstract not available.

Room 9

14:00–16:00
Tu2J • Radio-Over-Fiber for 5G and Beyond Systems
Presider: Thomas Clark; JHU/APL, USA

Tu2J.1 • 14:00
Transparent Radio–Fiber–Radio–Fiber System in 100-GHz Band for Indoor Uplink Signal Transmission in Beyond 5G, Pham Tien Dat[1], Yuya Yamaguchi[1], Atsushi Kanno[1,2], Naokatsu Yamamoto[1], Tetsuya Kawanishi[3,1], Kouichi Akahane[1]; [1]*NICT Network System Research Inst., Japan;* [2]*Nagoya Inst. of Technology, Japan;* [3]*Waseda Univ., Japan.* We demonstrate the first radio–fiber–radio–fiber system for delivery of 100-GHz radio signals from indoor to central offices. We transmitted single-carrier and OFDM signals with line rates of 30 and 40 Gb/s over the system.

Show Floor Programming

Conversation with the Plenary Speakers
10:15–10:45, *Theater III*

MW1 • MW Panel I: State of the Industry
10:30–12:00, *Theater I*

SF2 • OCP: Optics in Future AI Systems: Interconnects, Switching and Processing
10:45–11:45, *Theater II*

SF3 • ITU-T SG15: Standards Update with the Latest on 5G Transport, Higher Speed PON, SDM, OTN Technologies, and Interoperable Optical Interfaces
11:00–12:00, *Theater III*

DCSK • Data Center Summit Keynote: Past Experiences and Future Prospects of Data Center Interconnect Optical Networks
12:00–12:30, *Theater II*

How Innovations in Coherent Optical Engines Can Deliver Substantial Value to Telecom Networks
Presented by Infinera
12:15–12:45, *Theater III*

MW2 • MW Panel II: PAM vs. Coherent for Data Center Connectivity
12:15–13:45, *Theater I*

DCS1 • DCS Panel I: More than a Clos: Future Datacenter Network Architectures and the Role of Optics
12:30–14:00, *Theater II*

OFCnet Panel
13:15-13:45, *Theater III*

OFCnet Optical Engineering and Maintenance
14:15-14:45, *Theater III*

MW3 • MW Panel III: 800G / 128GBaud Pluggable Coherent - Key Technologies and Applications
14:00–15:30, *Theater I*

Room 1AB

Tu2A • Symposium: The Crucial Role of Photonics in Achieving the UN Sustainability Development Goals: Learnings and Opportunities I—Continued

Tu2A.2 • 14:30 Invited

How Optical Technology in F5G Support Fulfilling the UN Sustainability Goals, Marcus Brunner[1]; [1]*Huawei Technologies, Switzerland.* Abstract not available.

Room 2

Tu2B • Photonic Devices for Novel Applications—Continued

Tu2B.2 • 14:30 Invited

Silicon Photonics for High-Speed 5G and Optical Networks, Leslie Rusch[1], Xun Guan[2]; [1]*Université Laval, Canada;* [2]*Tsinghua Shenzhen International Graduate School, China.* Optical fronthaul for radio access networks will enable the promise of 5G and beyond. We describe how centralized sources and diminutive microring modulators can meet these goals while also reducing footprint and power consumption.

Room 3

Tu2C • Deployment and Field Trials—Continued

Tu2C.2 • 14:15 ★ Top-Scored

Ultra-High-Density Microduct Cable With Uncoupled 12-Core Fibers With Standard 250-µm Coating, Tetsuya Hayashi[1], Ayumi Inoue[1], Yohei Suzuki[2], Yuji Norisugi[2], Keiji Kawamoto[2], Junya Takano[1], Takuji Nagashima[1], Takao Hirama[2], Kentaro Takeda[2], Yuki Shimoda[2], Fumiaki Sato[2]; [1]*Optical Communications Laboratory, Sumitomo Electric Industries, Ltd., Japan;* [2]*Optical Fiber & Cable Division, Sumitomo Electric Industries, Ltd., Japan.* We developed 12-core fibers suitable for short/medium-reach applications and fabricated a 144-fiber 8-mm-outer-diameter cable using the 12-core fibers, which demonstrates the feasibility of ultra-high-core-count optical cables that can be blown into widely-deployed small-diameter microducts.

Tu2C.3 • 14:30 Invited

Development and Perspectives of Next Generation Optical Fiber Cable Standardization, Peter L. Pondillo[1]; [1]*Corning Inc, USA.* Provides an overview of recent standardization activities addressing new technological trends and advancements in optical fiber and cable performance specifications and/or test methods.

Room 6C

Tu2D • Network Planning and Operation—Continued

Tu2D.2 • 14:15

Optimal Transponder Technology for Transporting 800 GbE Services in IP-Over-WDM Backbone Networks, Serge Melle[1], Thierry Zami[1], Nicola Rossi[1], Bruno Lavigne[1]; [1]*Nokia Corporation, France.* This network study compares the benefit of Elastic Optical Transponders enabling 130GBaud WDM channels for transporting 800GE services, showing ability to minimize number of required EOTs per Gb/s in regional and long-haul networks.

Tu2D.3 • 14:30

Optimal Channel Spacing for Next-Gen WDM Networking With 800ZR+ Elastic Optical Transponders, Thierry Zami[1], Nicola Rossi[1], Bruno Lavigne[1]; [1]*Nokia Corporation, France.* By foreseeing an evolution from 800ZR to 800ZR+, like 400ZR+ just after 400ZR, we evaluate how WDM networks benefit from these 800ZR+ interfaces depending on their traffic and on their quality of wavelength routing equipment

Tu2D.4 • 14:45

On Real-Time Optical Subcarrier Management in P2MP Networks With Mixed-Strategy Gaming, Qian Wang[1], Hailey Shakespear-Miles[2], Xiaoliang Chen[1], Marc Ruiz[2], Zhaohui Li[1], Luis Velasco[2]; [1]*Sun Yat-sen Univ., China;* [2]*Universitat Politècnica de Catalunya (UPC), Spain.* We developed a mixed-strategy gaming approach for distributed and real-time optical subscarrier management in point-to-multipoint networks, achieving traffic loss rates close to those by ILP-based centralized optimization.

Room 6D

Tu2E • Co-Packaged and PIC for Data Center Applications—Continued

Tu2E.2 • 14:30

Polarization Insensitive Photonic Integrated 1x4 WDM Wavelength Selective Switch for Optical Networks, Aref Rasoulzadehzali[1], Ripalta Stabile[1], Nicola Calabretta[1]; [1]*TUe, Netherlands.* We experimentally demonstrate a 1x4 WDM polarization-insensitive wavelength selective switch based on bulk SOAs co-integrated with AWGs. Results show a net gain, broadband, and error-free operation with 0.6 dB power penalty up to 25Gbps NRZ-OOK.

Tu2E.3 • 14:45

Fully Integrated Dual-Polarization Silicon Photonic Transceiver With Automated Polarization Control, Xinru Wu[1], Duanni Huang[1], Taehwan Kim[1], Ranjeet Kumar[1], Guan-Lin Su[1], Chaoxuan Ma[1], Songtao Liu[1], Ganesh Balamurugan[1], Haisheng Rong[1]; [1]*Intel Corporation, USA.* We demonstrate a dual-polarization, single-wavelength transceiver with BER below soft-decision FEC (<2.0e-2) at 320Gb/s (PAM-4) aggregate rate. The silicon photonic chip includes integrated laser, ring modulators, Si/Ge detectors, and polarization demux with automatic polarization control.

Room 6E

Tu2F • AI and Optimization in (Disaggregated) Networks—Continued

Tu2F.2 • 14:30

Experimental Demonstration of ML-Based DWDM System Margin Estimation, Jasper Müller[1,2], Frank Slyne[3], Kaida Kaeval[1], Sebastian Troia[4], Tobias Fehenberger[1], Jörg-Peter Elbers[1], Daniel C. Kilper[3], Marco Ruffini[3], Carmen Mas Machuca[2]; [1]*ADVA, Germany;* [2]*Chair of Communication Networks, Technical Univ. of Munich, Germany;* [3]*Connect Research Centre, , School of Computer Science and Statistic, Trinity College Dublin, Ireland;* [4]*Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, Italy.* SNR margins between partially and fully loaded DWDM systems are estimated without detailed knowledge of the network. The ML model, trained on simulation data, achieves accurate predictions on experimental data with an RMSE of 0.16 dB.

Tu2F.3 • 14:45

Explainable Machine Learning-Enabled Just-Enough Margin Configurations in Dynamic S+C+L-Band Optical Networks, Zeyuan Yang[1], Rentao Gu[1], Yuefeng Ji[1]; [1]*Beijing Univ. of Posts and Telecommunications, China.* We configure an explainable machine learning-enabled just-enough margin for each lightpath in dynamic S+C+L-band optical networks. Explainable decisions improve blocking ratio and spectral efficiency performances by 35.9% and 17.2% compared with the benchmarks.

Tu2G • Subsea and Long-Haul Transmission—Continued

Tu2G.2 • 14:30
128GBd Record QPSK Transmission Over 20 631 km and PCS16QAM Transmission Over 12 558 km Using InP Technology Platform, Juan Esparza[1], Henrique Pavani[1], Andrea Quintana Zambrano[1], Richard Garuz[1], Sebastien Dupont[1], Stephane Ruggeri[1]; [1]*ASN, France*. We experimentally demonstrate the generation, transmission, and detection of 128GBd QPSK and PCS16QAM signals in optical submarine systems. We have validated the transmission of 33 channels PCS16QAM along the C-band over 12 558 km with an average of 0.74 dB margin from 25% soft FEC threshold.

Tu2G.3 • 14:45
Longitudinal Power Monitoring Over a Deployed 10,000-km Link for Submarine Systems, Alix A. May[1], Fabien Boitier[1], Alexis Carbo Meseguer[2], Juan Esparza[2], Philippe Plantady[2], Alain Calsat[2], Patricia Layec[1]; [1]*Nokia Bell Labs France, France;* [2]*Alcatel Submarine Networks, France*. We demonstrate the power profile estimation over a deployed 10,000-km submarine link using digital processing at the receiver. We experimentally show that we estimate span lengths with 0.49km uncertainty and locate multiple power losses.

Tu2I • Panel: LiDAR Systems and Technologies with Integrated Photonics—Continued

today. In addition, over the last decade, with the rapid advancements in 3D face recognition, autonomous vehicles, and industrial automation, low-cost, compact, and reliable LIDAR systems are seen as a key technology for precision sensing in many consumer and industrial applications.

This panel aims to provide a glimpse of LIDAR systems in different applications and different technology directions, and how integrated photonics can help drive down the size, cost, and improve reliabilities of LIDAR systems. In particular, the panel will discuss the pros and cons of direct detection in time-of-flight LIDAR and coherent detection in frequency-modulated continuous wave LIDAR, and their suitability in different sensing applications, and discuss the 2D scanning mechanisms, comparing mechanical beam steering with integrated photonics based solutions such as optical phase array and switched beam array.

Tu2H • Quantum Computing—Continued

Tu2J • Radio-Over-Fiber for 5G and Beyond Systems—Continued

Tu2J.2 • 14:15 ★ Top-Scored
14.1Tb/s CPRI-Equivalent Rate 1024-QAM Transmission via Combs-Cloned Self-Homodyne WDM Digital-Analog Radio-Over-Fiber System, Chenbo Zhang[1], Yixiao Zhu[2], Bibo He[1], Rongwei Liu[1], Yicheng Xu[2], Qunbi Zhuge[2], Weiwei Hu[1], Weisheng Hu[2], Zhangyuan Chen[1], Xiaopeng Xie[1]; [1]*Peking Univ., China;* [2]*Shanghai Jiao Tong Univ., China*. We leverage cutting-edge photonic approaches to demonstrate a clone-combs-based self-homodyne WDM digital-analog RoF system for mobile fronthaul. We achieve a 240GHz(=12λ×20GHz) aggregated bandwidth with an unprecedented 14.1Tb/s CPRI-equivalent data rate supporting the 1024-QAM signal.

Tu2J.3 • 14:30 Tutorial
Towards Mobile Fronthaul for 6G Networks, Nathan J. Gomes[1]; [1]*Univ. College London, UK*. In less than a decade, rapid developments have taken place in mobile fronthaul technology. As research and development for 6G commences, the future possible directions for fronthaul technology will be outlined in this tutorial.

Show Floor Programming

MW3 • MW Panel III: 800G / 128GBaud Pluggable Coherent - Key Technologies and Applications
14:00–15:30, *Theater I*

OFCnet Optical Engineering and Maintenance
14:15–14:45, *Theater III*

DCS2 • DCS Panel II: Open Line Systems - Can We Shape "Disaggregation" in One Direction?
14:15–15:45, *Theater II*

OFCnet Quantum Key Distribution
16:15-16:45, *Theater III*

Room 1AB

Tu2A • Symposium: The Crucial Role of Photonics in Achieving the UN Sustainability Development Goals: Learnings and Opportunities I—Continued

Tu2A.3 • 15:00 Invited

Standards and Optical Technologies to Decrease Power Consumption: What is Being Done and Remains to be Done, Naveena Genay[1]; [1]*Orange Labs, France.* Abstract not available.

Room 2

Tu2B • Photonic Devices for Novel Applications—Continued

Tu2B.3 • 15:00 Invited

Integration of Amplifiers in Silicon Nitride Photonic Circuit, Sonia Garcia-Blanco[1]; [1]*Universiteit Twente, Netherlands.* Abstract not available.

Room 3

Tu2C • Deployment and Field Trials—Continued

Tu2C.4 • 15:00

Loss Performance of Field-Deployed High-Density 1152-Channel Link Constructed With 4-Core Multicore Fiber Cable, Takuya Oda[1], Shota Kajikawa[1], Katsuhiro Takenaga[1], Okimi Mukai[1], Daiki Takeda[1], Nikhil Angra[2], Usman Nasir[2], Jongchul Park[3], Jing Zhang[3], Victor Kopp[3], Daniel Neugroschl[3], Kentaro Ichii[1]; [1]*Fujikura Ltd., Japan;* [2]*AFL Hyperscale, USA;* [3]*Chiral Photonics Inc., USA.* A cable link with 288 four-core multicore fibers and 288 pairs of fanout devices was deployed in the field and its losses were evaluated. No excess losses were observed from MCF-related components in field installation.

Tu2C.5 • 15:15 ★ Top-Scored

114 Pbit/s·km Transmission Using Three Vendor-Installed 60-km Standard Cladding Multi-Core Fiber Spans With Multiple Fusion Splicing, Daiki Soma[1], Shohei Beppu[1], Yuichi Miyagawa[2], Noboru Yoshikane[1], Takehiro Tsuritani[1]; [1]*KDDI Research, Inc., Japan;* [2]*KDDI Corporation, Japan.* 63.58 Tbit/s transmission has been experimentally demonstrated over 1,800-km standard cladding trench-assisted profile 4-core fiber (TA-4CF) with multiple connections using installed multivendor TA-4CF optical cables in aerial areas and underground ducts for practical deployment.

Room 6C

Tu2D • Network Planning and Operation—Continued

Tu2D.5 • 15:00

Clustering-Based Dynamic Bandwidth Allocation for Point-to-Multipoint Coherent Optics, José Alberto Hernández Gutiérrez[1], Farhad Arpanaei[1], Gonzalo Martinez[1], Oscar Gonzalez de Dios[2], Juan Pedro Fernandez-Palacios[2], Antonio Napoli[3]; [1]*Universidad Carlos III de Madrid, Spain;* [2]*Telefonica I+D, Spain;* [3]*Infinera, Germany.* This article introduces a modified version of clustering techniques that can be applied in traffic aggregation for point-to-multipoint optical network architectures employ- ing digital subcarrier multiplexing. The algorithm dynamically assigns individual subcarri- ers to nodes with uncorrelated traffic profiles

Tu2D.6 • 15:15 Invited

Adaptive Traffic Grooming Using Reinforcement Learning in Multilayer Elastic Optical Networks, Takafumi Tanaka[1]; [1]*NTT Network Innovation Laboratories, Japan.* We introduce a traffic grooming technique using reinforcement learning in multilayer networks. We confirm that superior performance over heuristic methods is obtained in adaptability to several requirements such as blocking probability and energy consumption.

Room 6D

Tu2E • Co-Packaged and PIC for Data Center Applications—Continued

Tu2E.4 • 15:00 Invited

Advancements in Heterogeneously Integrated Silicon Photonics for IMDD and Coherent Data Transmission, Yuliya A. Akulova[1], Richard Jones[1], Kimchau Nguyen[1], Ranju Venables[1], Pierre Doussiere[1], Ansheng Liu[1], Giovanni Gilardi[1], Mengyuan Huang[1], David Patel[1], Haijiang Yu[1], Saeed Fathololoumi[1], Daniel Zhu[1], Hari Mahalingam[1], Tiehui Su[1], Pegah Seddighian[1], Christian Malouin[1], Wenhua Lin[1], Ye Wang[1], Kadhair Al-hemyari[1], Eric Snow[1]; [1]*Intel Corporation, USA.* Explosive growth of datacenter traffic drives rapid scaling of optical interconnects architectures and technologies. We summarize the advancements in Intel's heterogeneously integrated silicon photonics manufacturing platform enabling throughput scaling for IMDD and high-efficiency coherent links.

Room 6E

Tu2F • AI and Optimization in (Disaggregated) Networks—Continued

Tu2F.4 • 15:00

Deep Neural Network-Enabled Fast and Large-Scale QoT Estimation for Dynamic C+L-Band Mesh Networks, Yao Zhang[1], Yuchen Song[1], Shi Yan[2], Jin Li[1], Chuanbiao Zhang[3], Yu Tang[3], Min Zhang[1], Danshi Wang[1]; [1]*Beijing Univ. of Posts and Telecommunications, China;* [2]*China Unicom Research Inst., China;* [3]*China United Network Communications Group Company Limited, China.* A fast and accurate QoT estimation scheme using deep neural network is proposed for dynamic C+L-band large-scale mesh networks. The calculation time is decreased dramatically and it is applied to measure the fiber broken case.

Tu2F.5 • 15:15

Improved QoT Estimations Through Refined Signal Power Measurements in a Disaggregated and Partially-Loaded Live Production Network, Yan He[1], Zhiqun Zhai[2], Lingling Wang[3], Yaxi Yan[1], Dou Liang[3], Chongjin Xie[4], Chao Lu[5], Alan Pak Tao Lau[1]; [1]*Photonics Research Inst., Department of Electrical Engineering, The Hong Kong Polytechnic Univ., Hong Kong;* [2]*Alibaba Cloud, Alibaba Group, Hangzhou, China, China;* [3]*Alibaba Cloud, Alibaba Group, Beijing, China, China;* [4]*Alibaba Cloud, Alibaba Group, New York, USA, USA;* [5]*Photonics Research Inst., Department of Electronic and Information Engineering, The Hong Kong Polytechnic Univ., Hong Kong.* We proposed to combine signal power measurements from optical amplifiers and channel monitors in a disaggregated and partially-loaded live production network to reduce the standard deviation of GSNR estimation error from 0.6347dB to 0.4387dB.

Room 6F

Tu2G • Subsea and Long-Haul Transmission—Continued

Tu2G.4 • 15:00
Unrepeatered C-Band Transmission of 35.5 Tb/s Capacity Over 291 km Using 128 GBd DP-16-QAM, Alexis Busson[1], Hans Bissessur[1], Daryna Kravchenko[1], Farana Hedaraly[1], Juan Uriel Esparza[1]; [1]*Alcatel Submarine Networks, France*. We present a 128 GBd high baud rate record unrepeatered experiment with 39 channels carrying DP-16-QAM with offline post-processing over 291 km of low-loss high effective-area optical fiber, applying co-Raman propagation and third-order counter-Raman amplification.

Tu2G.5 • 15:15
On the Road to 1-Pbps Systems: Experimental Demonstration of an Energy Efficient 500-Tbps Transatlantic Cable With 200-µm Outer Diameter Fibers, Alexis Carbo Meseguer[1], Andrea Quintana Zambrano[1], Jean-Christophe Antona[1], Juan uriel Esparza[1], Juliana Tiburcio de Araujo[1], Olivier Courtois[1], Vincent Letellier[1]; [1]*Alcatel Submarine Networks, France*. We experimentally emulate an energy efficient 500-Tbps subsea cable with 24 fiber pairs of 200-µm outer diameter Pure Silica Core Fiber and then we draw projections to assess how to achieve a 1-Pbps submarine cable for distances from 3000 to 12000 km.

Room 7AB

Tu2I • Panel: LiDAR Systems and Technologies with Integrated Photonics—Continued

Room 8

Tu2H • Quantum Computing—Continued

Tu2H.2 • 15:00
Analysing the Effect of Quantum Network Interconnect on the Performance of Distributed Quantum Computing, Sima Bahrani[1], Rui Wang[1], Romerson Oliveira[1], Reza Nejabati[1], Dimitra E. Simeonidou[1]; [1]*Univ. of Bristol, UK*. We investigate how a dynamically reconfigurable network supports short-range distributed quantum computing in a data center scenario by analysing the penalties and benefits of adopting such architecture in the NetSquid platform utilising two use cases.

Tu2H.3 • 15:15 Invited
Fault-Tolerant Photonic Quantum Computing, Zachary Vernon[1]; [1]*Xanadu Quantum Computing, Canada*. A hardware and architectural progress report on our efforts to build a large-scale, fault-tolerant quantum computer using photonics. Relevant aspects of both component development and manufacturing requirements will be discussed.

Room 9

Tu2J • Radio-Over-Fiber for 5G and Beyond Systems—Continued

Show Floor Programming

MW3 • MW Panel III: 800G / 128GBaud Pluggable Coherent - Key Technologies and Applications
14:00–15:30, *Theater I*

OFCnet Optical Engineering and Maintenance
14:15–14:45, *Theater III*

DCS2 • DCS Panel II: Open Line Systems - Can We Shape "Disaggregation" in One Direction?
14:15–15:45, *Theater II*

Amphenol Sponsored Session
15:00-16:00, *Theater II*

SF4 • IEEE Future Directions: Space-Based Optical Communications and Networking
15:00–16:00, *Theater III*

OFCnet Quantum Key Distribution
16:15-16:45, *Theater III*

Room 1AB

Tu2A • Symposium: The Crucial Role of Photonics in Achieving the UN Sustainability Development Goals: Learnings and Opportunities I—Continued

Tu2A.4 • 15:30 Invited

The Role of Photonics in Sustainability and in Quantifying Greenhouse Gas Emissions, Thomas Karagiannis[1]; [1]*Microsoft Research Ltd, UK*. Abstract not available.

Room 2

Tu2B • Photonic Devices for Novel Applications—Continued

Tu2B.4 • 15:30

EAM-Integrated DBR-LD With 16-Channel and 100-Gbps/λ PAM-4 Modulation, Su Ik Park[1,4], Oh Kee Kwon[2], Chul Wook Lee[2], Ki Soo Kim[2], Kyung Su Park[3], Jae Hyun Jin[1], Jung Hoon Kim[1], Jong In Shim[4]; [1]*Essence photonics Inc., Korea (the Republic of);* [2]*Electronics and Telecommunications Research Inst., Korea (the Republic of);* [3]*Kangwon National Univ., Korea (the Republic of);* [4]*Hanyang Univ. ERICA, Korea (the Republic of).* An EAM-integrated DBR-LD is reported using a novel waveguide structure for efficient wavelength tuning, and a 16-channel 100-Gbps/λ PAM-4 operation with a grid of 150 GHz near 1290 nm are achieved successfully.

Tu2B.5 • 15:45

Uncooled Operation of Si Mach-Zehnder Modulator Integrated With Membrane Semiconductor Optical Amplifiers Inside Interferometer Arms, Takuma Aihara[1], Tatsurou Hiraki[1], Takuro Fujii[1], Koji Takeda[1], Hiroshi Fukuda[1], Takaaki Kakitsuka[1], Tai Tsuchizawa[1], Shinji Matsuo[1]; [1]*NTT Corporation, Japan*. Membrane SOAs are integrated inside the interferometer arms of Si-MZM, in which the SOAs have on-chip gain of 11-5.3 dB at 25-80°C. In this configuration, SOAs can be used in saturated region suppressing pattern effect.

Room 3

Tu2C • Deployment and Field Trials—Continued

Tu2C.6 • 15:30 Invited

Advances in Fiber Technologies and Undersea Systems, Marsha A. Spalding[1]; [1]*SubCom LLC, USA*. Abstract not available.

Room 6C

Tu2D • Network Planning and Operation—Continued

Tu2D.7 • 15:45

Resource Allocation in Optical Networks With Mode Group Division Multiplexing and Light Trail, Qiaolun Zhang[1], Yizhou Yang[1], Alberto Gatto[1], Massimo Tornatore[1]; [1]*Politecnico di Milano, Italy.* We quantitatively evaluate resource efficiency enabled by mode-group-division multiplexing (MGDM) and light-trail (LT) in optical metro networks. Combining MGDM with LT reduces 95% of MIMO complexity of Full-MIMO with only 11% additional spectrum occupation.

Room 6D

Tu2E • Co-Packaged and PIC for Data Center Applications—Continued

Tu2E.5 • 15:30 Invited

System-on-Chip Photonic Integrated Circuits in Silicon Photonics and the Role of Plasmonics, Claudia Hoessbacher[1], Benedikt Baeuerle[1], Eva De Leo[1], Wolfgang Heni[1], Stephan Koch[1], Juerg Leuthold[2]; [1]*Polariton Technologies AG, Switzerland;* [2]*Inst. of Electromagnetic Fields (IEF), ETH Zurich, Switzerland.* This paper reviews photonic integrated circuits on silicon photonics. We focus on system on chips in applications for optical communications, sensing, and quantum technologies, and outline the role of plasmonics in silicon photonics.

Room 6E

Tu2F • AI and Optimization in (Disaggregated) Networks—Continued

Tu2F.6 • 15:30 Invited

Dynamic Optical Networks as Arcade Games: Lessons Learnt and Next Steps, Alejandra L. Beghelli[1], Moshe Simon[1]; [1]*Univ. College London, UK*. We transformed the dynamic routing and spectrum allocation problem into an Arcade-like game and trained a reinforcement learning agent to play it. Preliminary results show the agent outperforms the K-SP-FF heuristic.

16:00–16:30 Coffee Break, *Upper Level Corridors and Exhibit Hall*

Room 6F

Tu2G • Subsea and Long-Haul Transmission—Continued

Tu2G.6 • 15:30
420-Gb/s/Channel WDM PS-64QAM Transmission Over 4,000-km ULAF Using Ring-Wise Neural Network Equalization, Bohan Sang[1], Miao Kong[1], Wen Zhou[1], Jianyu Long[1], Li Zhao[1], Bing Ye[2], Weizhang Chen[2], Xiangjun Xin[3], Bo Liu[3], Jianjun Yu[1]; [1]*Fudan Univ., China;* [2]*ZTE Corp., China;* [3]*Beijing Univ. of Posts and Telecommunications, China.* We realized 420-Gbit/s/channel WDM coherent transmission over 4,000-km ULAF utilizing a novel well-expandable Ring-Wise Neural Network equalizer (RW-NNE) targeted to PS-64QAM signals. Results show that our RW-NNE with 25.3%-lower complexity outperforms normal NNE by 25% reach improvement.

Tu2G.7 • 15:45
Real-Time 33.6 Tb/s (42 × 800 Gb/s) Unrepeatered Transmission Over 302 km Using ROPA System, JianJun Wu[1], Jiekui Yu[1], Jiasheng Liu[1], Qianggao Hu[1], MingXiong Duan[1], WenZhong Wang[1], Chao Huang[1], Han Long[1], Shujuan Sun[1], Man Tan[1], Liyan Huang[1], Jian Xu[1]; [1]*Wuhan Guangxun Technology Co., Ltd, China.* This paper demonstrates a record unrepeatered transmission with the capacity of 33.6 Tb/s (42 × 800 Gb/s) over 302.7 km (47.52 dB) with a single fiber configuration, using forward Raman pump, backward ROPA, and ultra-low loss & large effective area fiber.

Room 7AB

Tu2I • Panel: LiDAR Systems and Technologies with Integrated Photonics—Continued

Room 8

Tu2H • Quantum Computing—Continued

Room 9

Tu2J • Radio-Over-Fiber for 5G and Beyond Systems—Continued

Tu2J.4 • 15:30
Enhancing NOMA Performance in Uplink MMW-RoF Mobile Fronthaul Systems by Using Index Modulation, Shen-Chen Tsai[1], Jhih-Heng Yan[2], Kai-Ming Feng[1]; [1]*National Tsing Hua Univ., Taiwan;* [2]*Chunghwa Telecom Co. Ltd, Taiwan.* A novel OFDM-based index modulation (IM) assisted multi-users NOMA wireless uplink system is demonstrated in MMW-RoF mobile fronthaul. With IM, the proposed scheme achieves higher flexibility on spectral efficiency and power ratio than conventional NOMA.

Tu2J.5 • 15:45
Constellation Independent Look-up Table Enabled Digital Predistortion for Digital-Analog Radio-Over-Fiber System, Xiaobo Zeng[1], Yixiao Zhu[1], Yicheng Xu[1], Mengfan Fu[1], Hexun Jiang[1], Lilin Yi[1], Weisheng Hu[1], Qunbi Zhuge[1]; [1]*Shanghai Jiao Tong Univ., China.* A constellation independent look-up table (LUT) method for transceiver nonlinearity predistortion in digital-analog radio-over-fiber system is proposed and experimentally demonstrated, achieving a SNR gain of 1.04dB. The table size can be reduced to 0.3% of the conventional LUT.

16:00–16:30 Coffee Break, *Upper Level Corridors and Exhibit Hall*

Show Floor Programming

MW3 • MW Panel III: 800G / 128GBaud Pluggable Coherent - Key Technologies and Applications
14:00–15:30, *Theater I*

OFCnet Optical Engineering and Maintenance
14:15–14:45, *Theater III*

DCS2 • DCS Panel II: Open Line Systems - Can We Shape "Disaggregation" in One Direction?
14:15–15:45, *Theater II*

Amphenol Sponsored Session
15:00-16:00, *Theater II*

SF4 • IEEE Future Directions: Space-Based Optical Communications and Networking
15:00–16:00, *Theater III*

SF1 • Design Considerations of Optical Connectivity in a Co-Packaged or On-Board Optics Switch
15:45–16:45, *Theater I*

OFCnet Quantum Key Distribution
16:15-16:45, *Theater III*

Room 1AB

16:30–18:30
Tu3A • Symposium: The Crucial Role of Photonics in Achieving the UN Sustainability Development Goals: Learnings and Opportunities II
Presider: To be announced.

Tu3A.1 • 16:30 Invited
Standards and Optical Technologies to Decrease Power Consumption: What is Being Done and Remains to be Done, Naveena Genay[1], *Orange Labs, France.* Abstract not available.

Room 2

16:30–18:30
Tu3B • Photonic Integrated Circuits
Presider: Milos Popovic; Boston Univ., USA

Tu3B.1 • 16:30 Tutorial
Thin Film Lithium Niobate Integrated Circuits - a Tutorial Introduction and Overview, Arnan Mitchell[1]; [1]*Royal Melbourne Inst. of Technology, Australia.* This tutorial will present a introduction and overview of integrated photonic circuits using the thin-film lithium niobate platform, starting with the fundamentals and history and leading to a speculative outlook for future technologies and applications.

Room 3

16:30–18:30
Tu3C • New Materials and Technologies
Presider: Mitsuru Takenaka; The Univ. of Tokyo, Japan

Tu3C .1 • 16:30 Invited
Advances in Ultra-Wideband LiNbO3 Thin-Film Modulators, Xinlun Cai[1]; [1]*Sun Yat-Sen Univ., China.* We review recent advances and design considerations for thin-film lithium niobate (TFLN) modulators with ultra-wide bandwidth and CMOS-compatible voltage, and we discuss how to approach the limits of the electro-optic bandwidth of the TFLN-based modulators.

Room 6C

16:30–18:30
Tu3D • Network Orchestration
Presider: To be announced.

Tu3D.1 • 16:30
Heuristic-Assisted Deep Reinforcement Learning for Resource-Efficient and QoS-Guaranteed 5G RAN Slice Migration in Elastic Metro Aggregation Optical Networks, Jiahua Gu[1,2], Min Zhu[1,2], Yunwu Wang[1,2], Xiaofeng Cai[1,2], Yuancheng Cai[1,2], Jiao Zhang[1,2]; [1]*Southeast Univ., China;* [2]*Purple Mountain Laboratory, China.* We propose a heuristic-assisted deep reinforcement learning framework for resource-efficient and QoS-guaranteed 5G RAN slice migration in EONs, which can optimize the spectrum resource consumption, traffic migration, and power consumption, simultaneously.

Tu3D.2 • 16:45
End-to-end Orchestration in Support of IIoT Applications Over Optically Interconnected TSN Domains, Albert Pagès[1], Fernando Agraz[1], Salvatore Spadaro[1]; [1]*Universitat Politècnica de Catalunya, Spain.* We demonstrate that joint orchestration of TSN and optical network domains in support of IIoT applications reduces the TSN blocking by four orders of magnitude and the usage of high priority queues by a 28-100%.

Room 6D

16:30–18:30
Tu3E • SDM - For Short Reach and Long-Haul Transmission Systems
Presider: John Downie; Corning Inc, USA

Tu3E.1 • 16:30 Invited
SDM and Parallelism in Submarine Cable Systems, Jin-Xing Cai[1]; [1]*SubCom LLC, USA.* We review the most recent achievements in undersea transmission with high optical power efficiency and the associated enabling technologies and discuss the economics of SDM and the corresponding reduction in cost per bit for submarine cable systems.

Room 6E

16:30–18:30
Tu3F • Coexistence and Emerging Use-Cases of PON
Presider: Annachiara Pagano; Telecom Italia, Italy

Tu3F.1 • 16:30 Invited
An Operator's Approach on the Co-existence in Future Optical Access Networks, Fabienne Saliou[1], Philippe Chanclou[1], Gael Simon[1], Jeremy Potet[1], Georges Gaillard[1], Stephane Le Huérou[1]; [1]*Orange, France.* Main challenges of coexistence of future access transmissions are detailed. Important tradeoffs are identified: wavelength plan for triple PON coexistence, optics for high optical budget, considering OOB and SRS penalties. Multiplicity of technical implementations for PtP and PON transceivers are against future interoperability.

Room 6F

16:30–18:30
Tu3G • Subsea and Sensing Networks
Presider: Ting Wang; NEC Laboratories America Inc., USA

Tu3G.1 • 16:30 Tutorial
High-Capacity Submarine Cables: Past, Present and Future, Georg Mohs[1]; [1]*SubCom LLC, USA.* Abstract not available.

Room 7AB

16:30–18:30
Tu3H • Quantum Interconnect and Hybrid Classical/Quantum Systems
Presider: Rui Wang; Univ. of Bristol, UK

Tu3H.1 • 16:30 Tutorial
Quantum Interconnects, Galan Moody[1]; [1]*Electrical and Computer Engineering, Univ. of California Santa Barbara, USA.* Quantum interconnects—devices that can transfer quantum states across different physical systems—are a vital component for quantum information technologies. In this tutorial, I will discuss recent advances and the challenges going forward.

Room 8

16:30–18:30
Tu3I • High-Baud Rate Data Center Technologies
Presider: Xiaodan Pang; Kungliga Tekniska Hogskolan, Sweden

Tu3I.1 • 16:30 ★ Top-Scored
106.25 Gbaud 4-Level Pulse Amplitude Modulation Links Supporting (2x)100Gigabit Ethernet on Single Lambda, Oskars Ozolins[1,2], Armands Ostrovskis[3,10], Toms Salgals[3,10], Benjamin Krüger[4], Fabio Pittala[4], Mahdieh Joharifar[2], Richard Schatz[2], Di Che[5], Yasuhiro Matsui[6], Thomas Dippon[4], Yuchuan Fan[1], Aleksejs Udalcovs[1], Marek Chacinski[7], Urban Westergren[2], Lu Zhang[8], Haik Mardoyan[9], Xianbin Yu[8], Sandis Spolitis[3,10], Sergei Popov[2], Markus Gruen[4], Vjačeslavs Bobrovs[3], Hadrien Louchet[4], Xiaodan Pang[2,1]; [1]*RISE Research Inst.s of Sweden AB, Sweden;* [2]*KTH Royal Inst. of Technology, Sweden;* [3]*Riga Technical Univ., Latvia;* [4]*Keysight Technologies, Germany;* [5]*Nokia Bell Labs, USA;* [6]*Coherent, USA;* [7]*Coherent, Sweden;* [8]*Zhejiang Univ., China;* [9]*Nokia Bell Labs, France;* [10]*Communication Technologies Research Center, Riga Tecnical Univ., Latvia.* We experimentally demonstrate and compare EML- and DML-based optical interconnects with 106.25 Gbaud NRZ-OOK and PAM4 for computing applications. The results show that both transmitters can be used to enable optical-amplification-free transmissions with low-complexity DSP.

Tu3I.2 • 16:45
56 GBaud PAM-4 Direct Detection With High-Speed Avalanche Photodiodes, Tobias Beckerwerth[1], Christoph Kottke[1], Volker Jungnickel[1], Ute Troppenz[1], Martin Moehrle[1], Patrick Runge[1], Martin Schell[1,2]; [1]*Fraunhofer Heinrich Hertz Inst., Germany;* [2]*Technical Univ. Berlin, Germany.* We demonstrate 56 GBaud PAM-4 transmission by using a high-speed waveguide avalanche photodiode (WG APD) and an electro absorption modulated laser (EML). Compared to a PIN photodiode, the WG APD reduces the power budget in a B2B setup by 6 dB.

Room 9

16:30–18:30
Tu3J • W-Band Fiber-Wireless Links
Presider: Anthony Ng'oma; Corning Inc, USA

Tu3J.1 • 16:30
Real-Time 125-Gb/s DP-QPSK Signal Delivery Over 150 m Based on a Dual-Polarized Single-Channel W-Band Wireless Link Enabled by Photonics, Yuancheng Cai[1,2], Min Zhu[1,2], Jiao Zhang[1,2], Mingzheng Lei[2], Bingchang Hua[2], Yucong Zou[2], Wei Luo[1], Shitong Xiang[1], Liang Tian[2], Junjie Ding[3], Like Ma[4], Yongming Huang[1,2], Jianjun Yu[2,3], Xiaohu You[1,2]; [1]*National Mobile Communications Research Laboratory, Southeast Univ., China;* [2]*Purple Mountain Laboratories, China;* [3]*Fudan Univ., China;* [4]*China Mobile Research Inst., China.* In a photonics-enabled fiber-wireless-fiber system, we successfully demonstrate the first real-time 125-Gb/s DP-QPSK signal delivery over a 150-m dual-polarized single-channel wireless link with a record of real-time transmission capacity and wireless distance at W band.

Tu3J.2 • 16:45
Bi-Directional 5G NR Fiber-Wireless Systems With Single-Carrier Optical Modulation and Phase Modulation Scheme, Yu-Sheng Lin[1], Wei-Cheng Fan[1], Cheng-Jun Lin[1], Chung-Yi Li[2], Hai-Han Lu[1]; [1]*National Taipei Univ. of Technology, Taiwan;* [2]*National Taipei Univ., Taiwan.* 5G MMW/sub-THz signals through a bi-directional fiber-wireless system with single-carrier optical modulation for downstream and PM scheme for upstream are implemented. It shows promise for performing 5G NR communication towards MMW and sub-THz bands.

Show Floor Programming

SF1 • Design Considerations of Optical Connectivity in a Co-Packaged or On-Board Optics Switch
15:45–16:45, *Theater I*

OFCnet Quantum Key Distribution
16:15-16:45, *Theater III*

Room 1AB

Tu3A • Symposium: The Crucial Role of Photonics in Achieving the UN Sustainability Development Goals: Learnings and Opportunities II—Continued

Tu3A.2 • 17:00 Invited

The Role of Photonics in Sustainability and in Quantifying Greenhouse Gas Emissions, Thomas Karagiannis[1], *Microsoft Research Ltd, UK.* Abstract not available.

Room 2

Tu3B • Photonic Integrated Circuits—Continued

Room 3

Tu3C • New Materials and Technologies—Continued

Tu3C .2 • 17:00

200 Gbit/s Transmitter Based on a Spin-on Ferroelectric Waveguide Modulator, Shiyoshi Yokoyama[1], Jiawei Mao[1], Futa Uemura[1], Hiromu Sato[1], Guo-Wei Lu[2]; [1]*Kyushu Univ., Japan;* [2]*The Univ. of Aizu, Japan.* We demonstrate a 200 Gbit/s PAM4 transmitter using a ferroelectric waveguide Mach-Zehnder modulator. It has BER below FEC threshold, drive voltage of 1.3 V_{pp}, and possible reliable operation.

Tu3C .3 • 17:15

200 Gbit/s Barium Titanate Modulator Using Weakly Guided Plasmonic Modes, Daniel Chelladurai[1], Manuel Kohli[1], Bertold Ian Bitachon[1], Laurenz Kulmer[1], Tobias Blatter[1], David Moor[1], Joel Winiger[1], Andreas Messner[1], Clarissa Convertino[2], Felix Eltes[2], Yuriy Fedoryshyn[1], Juerg Leuthold[1]; [1]*ETH Zurich, Switzerland;* [2]*Lumiphase AG, Switzerland.* A plasmonic Mach-Zehnder modulator based on thin-film barium titanate is introduced demonstrating line rates up to 200 Gbit/s. The structure enables low insertion loss and high optical power stability without a DC bias during operation.

Room 6C

Tu3D • Network Orchestration—Continued

Tu3D.3 • 17:00 Invited

End-to-End Interdomain Transport Network Slice Management Using DLT-Enabled Cloud-Based SDN Controllers, Ricard Vilalta[1], Pol Alemany[1], Lluis Gifre[1], Ricardo Martínez[1], Ramon Casellas[1], Raul Muñoz[1]; [1]*CTTC, Spain.* This paper discusses the advantages and challenges of multiple architectures that consider the negotiation of inter-domain transport network slices using blockchain technologies. To this end, we presents results obtained using cloud-native ETSI TeraFlowSDN controller.

Room 6D

Tu3E • SDM - For Short Reach and Long-Haul Transmission Systems—Continued

Tu3E.2 • 17:00

108-Ch (12-Core×9-WDM) Self-Homodyne Transmission Using Only a Single Laser for 8.64-Tb/s Short-Reach Optical Links, Shota Ishimura[1], Takashi Kan[1], Shuntaro Maeda[2], Takuo Tanemura[2], Yoshiaki Nakano[2], Hidenori Takahashi[1], Takehiro Tsuritani[1]; [1]*KDDI Research, Inc., Japan;* [2]*The Univ. of Tokyo, Japan.* We demonstrate 108-ch (12-core×9-WDM) frequency comb-based self-homodyne multi-core transmission with a net bit rate of 8.64-Tb/s. This demonstration shows the feasibility of high-capacity short-reach SDM/WDM systems using only a single laser.

Tu3E.3 • 17:15

Experimental Investigation of Reduced Complexity MIMO Equalization in a 55-Mode Fiber SDM Transmission System, Ruby S. Bravo Ospina[2,1], Georg Rademacher[2], Ruben S. Luis[2], Benjamin J. Puttnam[2], Nicolas K. Fontaine[3], Mikael Mazur[3], Haoshuo Chen[3], Roland Ryf[3], David Neilson[3], Daniel Dahl[6], Joel Carpenter[6], Pierre Sillard[4], Frank Achten[5], Marianne Bigot[4], Darli Mello[1], Hideaki Furukawa[2]; [1]*FEEC, Univ. of Campinas, Brazil;* [2]*Photonic Network Laboratory, National Inst. of Information and Communications Technology, Japan;* [3]*Nokia Bell Labs, USA;* [4]*Prysmian Group, France;* [5]*Prysmian Group, Netherlands;* [6]*Univ. of Queensland, Australia.* We investigate the MIMO equalizer complexity reduction by selective filter deactivation in a 25.9 km 55-mode SDM transmission system. We demonstrate a 21.5% equalizer complexity reduction at the cost of a 4.9% decrease in data rate.

Room 6E

Tu3F • Coexistence and Emerging Use-Cases of PON—Continued

Tu3F.2 • 17:00

Real-Time, low Latency Virtual DBA Hypervisor for SLA-Compliant Multi-Service Operations Over Shared Passive Optical Networks., Arijeet Ganguli[1], Frank Slyne[1], Marco Ruffini[1]; [1]*Univ. of Dublin Trinity College, Ireland.* We present a heuristic algorithm for a PON upstream scheduling hypervisor, supporting low latency services with strict service-level agreement. The algorithm achieves near-optimal performance while running in only 3.5 us, thus operating in real-time.

Tu3F.3 • 17:15

Experimental Assessment of Stimulated Raman Scattering Impairments Between XGS-PON and 50G-PON, Fabienne Saliou[1], Gael Simon[1], Jeremy Potet[1], Philippe Chanclou[1]; [1]*Orange, France.* Critical 0.67dB of power depletion due to SRS on the upstream signals of 50G-(E)PON US and XGS-PON US is measured experimentally when contra-propagating in 20km SMF with 50G-(E)PON Downstream

Tu3G • Subsea and Sensing Networks—Continued

Tu3H • Quantum Interconnect and Hybrid Classical/Quantum Systems—Continued

Tu3I • High-Baud Rate Data Center Technologies—Continued

Tu3I.3 • 17:00 Invited

The Future of Multi-Terabit Datacenter Interconnects Based on Tight Co-Integration of Photonics and Electronics Technologies, Maria Spyropoulou[1], Giannis Kanakis[1], Giorgos Brestas[1], Yuqing Jiao[2], Salim Abdi[2], Zhaowei Chen[2], Desalegn Feyisa Wolde[2], Ripalta Stabile[2], Nicola Calabretta[2], K.A. Williams[2], Virginie Nodjiadjim[3], Romain Hersent[3], Agnieszka Konczykowska[3], Muriel Riet[3], Richard Schatz[4], Oskars Ozolins[4,5], Xiaodan Pang[4,5], Mahdieh Joharifar[4], Jakub Zvěrina[6], Martin Zoldák[6], Boaz Atias[7], Paraskevas Bakopoulos[7], Elad Mentovich[7], Hercules Avramopoulos[1]; [1]*Photonics Research Communications Laboratory, School of Electrical and Computer Engineering, National Technical Univ. of Athens, Greece;* [2]*Eindhoven Hendrik Casimir Inst. (EHCI), Eindhoven Univ. of Technology, Netherlands;* [3]*III-V Lab, France;* [4]*School of SCI, KTH Royal Inst. of Technology, Sweden;* [5]*RISE Research Inst.s of Sweden AB, Sweden;* [6]*Argotech A.S., Czechia;* [7]*NVIDIA, Israel.* We propose a novel co-packaged optical transceiver architecture capable of operating at 112 Gbaud per lane and scalable to 1.6 Tb/s capacity and beyond for next generation 51.2T and 102.4T digital switches.

Tu3J • W-Band Fiber-Wireless Links—Continued

Tu3J.3 • 17:00 Invited

Prospects and Technologies for Mobile Terahertz 6G Communications, Jonas Tebart[1], Peng Lu[1], Thomas Haddad[1], Shuya Iwamatsu[1], Andreas Stohr[1]; [1]*Universität Duisburg-Essen, Germany.* Prospects and challenges for mobile 6G communications using terahertz frequencies are discussed. For the first time, THz wireless communications with 15 Gbps to multiple mobile users employing a photonic-assisted beam steering antennas is experimentally demonstrated.

Room 1AB

Tu3A • Symposium: The Crucial Role of Photonics in Achieving the UN Sustainability Development Goals: Learnings and Opportunities II—Continued

Tu3A.3 • 17:30 Invited

Energy Saving of Optical Access Systems, Dezhi Zhang[1], Zhe Du[2]; *[1]China Telecom Corp Ltd, Beijing Res Inst, China; [2]China Telecom Research Inst., China.* This work reviews the standardization work of optical access networks in the field of energy saving, and introduces the development and application of energy saving technologies for optical access networks.

Room 2

Tu3B • Photonic Integrated Circuits—Continued

Tu3B.2 • 17:30 ★ Top-Scored

Integrated Microlens Coupler for Photonic Integrated Circuits, Jianheng Luo[1], Johannes Henriksson[1], Myung-Ki Kim[2], Daniel Klawson[1], Chun-Yuan Fan[1], Ming C. Wu[1]; *[1]Univ. of California Berkeley, USA; [2]KU-KIST Graduate School of Converging Science and Technology, Korea Univ., Korea (the Republic of).* We design and experimentally demonstrate a new silicon photonic fiber coupling method using integrated microlens couplers. Efficient and broadband coupling to a single mode fiber with the best coupling loss of 0.9 dB is achieved

Tu3B.3 • 17:45

On-Chip Universal Linear Optics Using a 4x4 Silicon Photonic Coherent Crossbar, George Giamougiannis[1], Miltiadis Moralis-Pegios[1], Apostolos Tsakyridis[1], Nikos Bamiedakis[2], David Lazovsky[2], Nikos Pleros[1]; *[1]Aristoteleio Panepistimio Thessalonikis, Greece; [2]Celestial AI, USA.* We demonstrate the first on-chip and fidelity-restorable universal linear optical circuit that relies on a novel 4×4 silicon photonic coherent crossbar architecture. Its experimental characterization yields a fidelity of 99.93±0.06%, calculated over 10,000 arbitrary matrices

Tu3B.4 • 18:00 Invited

Large Scale Opto-Electro-Mechanical Integrated Circuits, Ming C. Wu[1]; *[1]Univ. of California Berkeley, USA.* Abstract not available.

Room 3

Tu3C • New Materials and Technologies—Continued

Tu3C .4 • 17:30

High-Performance EO Polymer/Si and InP Nano-Hybrid Optical Modulators in O-Band and C-Band Wavelengths, Junichi Fujikata[1], Hiromu Sato[2], Alisa Bannaron[2], Guo-Wei Lu[3], Shiyoshi Yokoyama[2]; *[1]Tokushima Univ., Japan; [2]Inst. for Materials Chemistry and Engineering, Kyushu Univ., Japan; [3]Division of Computer Engineering, Aizu Univ., Japan.* We present high-efficiency of 0.18Vcm and 252Gbps of PAM-4 high-speed operation for EO polymer/Si and InP hybrid optical modulators in C-band wavelengths. We also demonstrate record high-efficiency of 0.35Vcm and high-speed operation in O-band wavelengths.

Tu3C .5 • 17:45 Invited

An Active Visible-Light Integrated Photonics Platform on 200-mm Si, Wesley D. Sacher[1], Yiding Lin[1], Hong Chen[1], Saeed S. Azadeh[1], Zheng Yong[1,2], Xianshu Luo[3], Hongyao Chua[3], Jason C. C. Mak[2], Alperen Govdeli[1,2], Ankita Sharma[1,2], Jared C. Mikkelsen[1], Xin Mu[1,2], Andrei Stalmashonak[1], Guo-Qiang Lo[3], Joyce Poon[1,2]; *[1]Max Planck Inst. of Microstructure Physics, Germany; [2]Department of Electrical and Computer Engineering, Univ. of Toronto, Canada; [3]Advanced Micro Foundry Pte. Ltd., Singapore.* We present a foundry-fabricated monolithically integrated photonics platform for the visible spectrum (λ=445–640nm) with two layers of silicon nitride waveguides, silicon photodiodes, efficient undercut thermo-optic phase shifters, in situ trimming, and electro-thermal MEMS devices.

Room 6C

Tu3D • Network Orchestration—Continued

Tu3D.4 • 17:30

Disaggregated Optical Network Orchestration Based on the Physical Layer Digital Twin, Giacomo Borraccini[1], Renato Ambrosone[1,2], Alessio Giorgetti[3], Stefano Straullo[4], Francesco Aquilino[4], Emanuele Virgillito[1], Andrea D'Amico[1], Rocco DIngillo[1], Nicola Sambo[5], Filippo Cugini[6]; *[1]Politecnico di Torino, Italy; [2]Consortium GARR, Italy; [3]IEIIT-CNR, Italy; [4]LINKS Foundation, Italy; [5]Scuola Superiore Sant'Anna, Italy; [6]CNIT, Italy.* The architecture and functionality of an open and disaggregated optical network is presented, focusing on the orchestration of the physical layer digital twin and the optical network controller, implemented on an experimental multi-vendor triangular-topology setup.

Tu3D.5 • 17:45

Dynamic Bypass of Wavelength Switching in SDN-Enabled WDM VNTs Over SDM Networks With High bit-Rate Optical Channels, Raul Muñoz[1], Carlos Manso[1], Filippos Balasis[2], Daiki Soma[2], Shohei Beppu[2], Ramon Casellas[1], Lluis Gifre[1], Ricard Vilalta[1], Ricardo Martínez[1], Noboru Yoshikane[2], Takaehiro Tsuritani[2]; *[1]CTTC, Spain; [2]KDDI Research, Japan.* We experimentally demonstrate an SDN architecture for WDM VNTs to offload pass-through high bit-rate optical channels from overloaded ROADMs by provisioning spatial channels between the source and destination ROADM's add-drop stages, and rerouting the optical channels

Tu3D.6 • 18:00

A Programmable Ethernet Transport *Packetponder* Using Common Compact Form Factor Pluggable Tunable Transceivers to Support Novel DWDM Architectures, Julie Raulin[3,1], Gawen Davey[2], Yuliya Verbishchuk[3,1], Alexander Jeffries[2], Cormac J. Sreenan[1], Fatima C. Garcia Gunning[3]; *[1]School of Computer Science and Information Technology, Univ. College Cork, Ireland; [2]APS-Networks, Netherlands; [3]Photonics Systems Group, Tyndall National Inst., Ireland.* We introduce a *packetponder* comprising a programmable packet switch with P4 ASIC containing a mixture of "grey" and tunable DWDM pluggable transceivers that, combined with ROADMs, introduces novel possibilities for Ethernet transport architectures.

Room 6D

Tu3E • SDM - For Short Reach and Long-Haul Transmission Systems—Continued

Tu3E.4 • 17:30 Invited

Technologies for Optical Submarine Cables, Past Present and Future, Yuichi Nakamura[1], Hitoshi Takeshita[1]; *[1]NEC Corporation, Japan.* Optical submarine cables are critical infrastructures that carry more than 80% of theInternet traffic between continents. An overview of the technology used in past and present opticalsubmarine cables is presented.

Tu3E.5 • 18:00 ★ Top-Scored

Real-Time 6-Mode 19-Core Fiber Transmission, Shohei Beppu[1], Masahiro Kikuta[2], Daiki Soma[1], Yoichi Yaegashi[2], Koji Igarashi[3], Masahiro Shigihara[2], Kazuhiko Aizawa[2], Noboru Yoshikane[1], Takehiro Tsuritani[1]; *[1]KDDI Research, Inc., Japan; [2]NEC Platforms, Ltd., Japan; [3]Osaka Univ., Japan.* We demonstrate the real-time few-mode multicore fiber transmission for the first time. The C- and L-band WDM DP-QPSK signals transmitted over an 11-km 6-mode 19-core fiber were demodulated in real-time by an FPGA-based MIMO DSP.

Room 6E

Tu3F • Coexistence and Emerging Use-Cases of PON—Continued

Tu3F.4 • 17:30

Demonstration of Industrial Network Applications by PHY Softwarization for Fully Virtualized Access Networks, Takahiro Suzuki[1], Yushi Koyasako[1], Sang-Yuep Kim[1], Jun-ichi Kani[1], Tomoaki Yoshida[1]; *[1]NTT Corporation, Japan.* This paper demonstrates that PHY processing for industrial network applications and PON can be realized on a common general-purpose server for flexible service creations; it realizes the level of latency performance required by IRT communication.

Tu3F.5 • 17:45

Deterministically Scheduled PON for Industrial Applications, Konstantinos (Kostas) Christodoulopoulos[1], Sarvesh Bidkar[2], Thomas Pfeiffer[2], Rene Bonk[2]; *[1]Informatics and Telecommunications, Univ. of Athens, Greece; [2]Nokia Bell Labs, Germany.* We propose a deterministic scheduling scheme for TDM-PON upstream bursts to achieve low latency and jitter with high throughput efficiency. We demonstrate co-scheduling of TDM-PON with an Ethernet Time Sensitive Network to serve industrial applications.

Tu3F.6 • 18:00 Invited

Fiber to the Room (FTTR): Standards and Deployments, Xuming Wu[1], Yan Zeng[2], Xiaoshu Si[1], Xiang Wang[2], Xiang Liu[3]; *[1]Huawei Technologies Co., Ltd, China; [2]Huawei Technologies Co., Ltd., China; [3]Huawei Hong Kong Research Center, China.* We review recent advances in the field deployment of fiber-to-the-room (FTTR) systems for Gigabit/s home networking and in the global standardization of the FTTR solution. A novel centralized Wi-Fi access network (C-WAN) architecture is described.

Room 6F

Tu3G • Subsea and Sensing Networks—Continued

Tu3G.2 • 17:30 Invited

Cost/Bit Scaling Opportunities in Submarine Cables, Eduardo F. Mateo[1]; [1]*NEC Corporation, Japan.* The cost/bit of submarine networks has experienced enormous reductions in the past three decades. This decline starts to show signs of fatigue. This paper analyzes the causes and discusses opportunities to address this saturation.

Tu3G.3 • 18:00

Surface and Underwater Surveillance Based on Highly Sensitive Distributed Fiber-Optic Hydrophone, Junfeng Chen[1], Ke Ai[1], Hao Li[1], Xiangpeng Xiao[1], Cunzheng Fan[1], Zhijun Yan[1], Qizhen Sun[1]; [1]*Huazhong Univ of Science and Technology, China.* We report field test results of surface and underwater surveillance based on fiber-optic distributed acoustic sensing (DAS) and highly sensitive distributed fiber-optic hydrophone (DFOH). Various intrusive targets like boat, frogman and etc. are detected.

Room 7AB

Tu3H • Quantum Interconnect and Hybrid Classical/Quantum Systems—Continued

Tu3H.2 • 17:30 ★ Top-Scored

Co-Propagation of 6 Tb/s (60*100Gb/s) DWDM & QKD Channels With ~17 dBm Aggregated WDM Power Over 50 km Standard Single Mode Fiber, Paulette Gavignet[1], François Mondain[1], Erwan Pincemin[1], Andy Grant[2], Lee Johnson[2], Robert Woodward[2], James Dynes[2], Andrew Shields[2]; [1]*Orange Innovation, France;* [2]*(2) Toshiba Europe Ltd, UK.* We report the co-propagation, over 50km of SSMF, of the quantum channel (1310nm) of a QKD system with ~17dBm total power of DWDM data channels (1550nm range). A metric to evaluate Co-propagation Efficiency is proposed.

Tu3H.3 • 17:45

Optimization of Classical Light Wavelengths Coexisting With C-Band Quantum Networks for Minimal Noise Impact, Jordan M. Thomas[1], Gregory S. Kanter[1], Si Xie[2], Joaquin Chung[3], Raju Valivarthi[4], Cristián Peña[2], Rajkumar Kettimuthu[3], Panagiotis Spentzouris[2], Maria Spiropulu[4], Prem Kumar[1]; [1]*Northwestern Univ., USA;* [2]*Fermi National Accelerator Laboratory, USA;* [3]*Argonne National Laboratory, USA;* [4]*California Inst. of Technology, USA.* We investigate the optimal coexisting classical light wavelengths to use alongside C-band quantum networks to minimize noise from spontaneous Raman scattering and discuss techniques for optimizing coexisting time synchronization systems for teleportation and entanglement swapping.

Tu3H.4 • 18:00

Demonstration of Quantum Channel Monitoring via Quantum Wrappers, Mehmet Berkay On[1], Sandeep Kumar Singh[1], Gamze Gul[2], Gregory S. Kanter[2], Roberto Proietti[3], Prem Kumar[2], S. J. Ben Yoo[1]; [1]*Univ. of California, Davis, USA;* [2]*Northwestern Univ., USA;* [3]*Politecnico di Torino, Italy.* We experimentally demonstrate quantum channel monitoring by wavelength-time multiplexing of classical wrapper bits with quantum payloads. Bit-error-rate measurements of 5 Gb/s classical bits infer the coincidence-to-accidental ratio of the quantum channel up to 13.3 dB.

Room 8

Tu3I • High-Baud Rate Data Center Technologies—Continued

Tu3I.4 • 17:30

Net 100 Gb/s/λ VCSEL+MMF Nonlinear Digital Pre-Distortion Using Convolutional Neural Networks, Leonardo Minelli[1], Fabrizio Forghieri[2], Tong Shao[3], Roberto Gaudino[1]; [1]*Politecnico di Torino, Italy;* [2]*Cisco Photonics, Italy;* [3]*Cisco Optical GmbH, Germany.* We experimentally demonstrate VCSEL+MMF nonlinear Digital Pre-Distorters, optimized using Convolutional Neural Networks, for fulfilling the IEEE P802.3db™/D3.2 TDECQ requirements for net 100 Gb/s/λ optical transmitters.

Tu3I.5 • 17:45

128-Gbaud PAM4 O-Band Transmission Using Advanced MLSE With Simple LLR Calculation for SD-FEC Scheme, Shuto Yamamoto[1], Hiroki Taniguchi[1], Akira Masuda[1], Masanori Nakamura[1], Yoshiaki Kisaka[1]; [1]*NTT Corporation, Japan.* We propose simple methods to calculate LLR for IM-DD system with MLSE and SD-FEC and show that an advanced MLSE with the LLR calculation methods makes NGMI higher in 128-Gbaud PAM4 in 20-GHz bandwidth limitation.

Tu3I.6 • 18:00

8×250 Gbit/s PAM4 Transmission Over 1 km Single Mode Fiber With an all-Silicon LAN WDM Transmitter, Penghui Xia[2,1], Zhongya Li[3], Nannan Ning[1], Qiang Zhang[2], Xiaoqing Jiang[1], Jianyi Yang[1], Junwen Zhang[3], Hui Yu[2,1]; [1]*Zhejiang Univ., China;* [2]*Zhejiang Lab, China;* [3]*Fudan Univ., China.* We demonstrate 2 Tbit/s (8×250 Gbit/s) and 1.6 Tbit/s (8×200 Gbit/s) 4-level pulse amplitude modulation (PAM4) transmissions over 1 km and 10 km single mode fibers (SMF) with an all-silicon wavelength division multiplexing transmitter chip.

Room 9

Tu3J • W-Band Fiber-Wireless Links—Continued

Tu3J.4 • 17:30

Bidirectional Full-Duplex Delivery of 103Gbps PS-256QAM Signals Over 20-km SMF and 4600-m Wireless, Weiping Li[1], Jianjun Yu[1,2], Feng Wang[1], Xiaoxue Ji[1], Xiongwei Yang[1], Wen Zhou[1], Tangyao Xie[3], Jianguo Yu[3], Jiao Zhang[2], Min Zhu[2], Feng Zhao[4], Huajiong Lin[5]; [1]*Fudan Univ., China;* [2]*Purple Mountain Laboratories, China;* [3]*Beijing Univ. of Posts and Telecommunications, China;* [4]*Xi'an Univ. of Posts and Telecommunications, China;* [5]*Harbin Inst. of Technology, China.* We have experimentally demonstrated photonics-aided bidirectional full-duplex delivery of 103Gbps PS-256QAM signals over 20-km single-mode fiber (SMF) wireline link and 4600 m wireless link based on the polarization-division-multiplexing scheme and advanced DSPs.

Tu3J.5 • 17:45

8192QAM Signal Transmission Over 20-m Wireless Distance at W-Band Using Delta-Sigma Modulation, Jiaxuan Liu[1], Jianjun Yu[1], Jianyu Long[1], Mingxu Wang[1], Chengzhen Bian[1], Kaihui Wang[1], Weiping Li[1], Jiao Zhang[2], Min Zhu[2], Tangyao Xie[3], Jianguo Yu[3,2], Feng Zhao[4]; [1]*Fudan Univ., China;* [2]*Purple Mountain Laboratories, China;* [3]*Beijing Univ. of Posts and Telecommunications, China;* [4]*School of Electronic Engineering, Xi'an Univ. of Posts and Telecommunications, China.* We experimentally demonstrate a W-band photon-assisted millimeter-wave transmission system using delta-sigma modulation and envelope detection. The proposed IM/DD-MMW-RoF system can support 8192 QAM signaling over a 20-meter wireless link using DSM while meeting the SD-FEC threshold of 4.2×10^{-2}.

Tu3J.6 • 18:00

Integrated W-Band Photonic-Wireless Transmitter Enabled by Silicon Microring Modulator and on-Chip Dual-Mode DFB Laser, Xuying Liu[1], Wenjia Zhang[1], Jiang Yue[1], Dan Lu[2], Fan Yang[3], Zuyuan He[1]; [1]*State Key Laboratory of Advanced Optical Communication Systems and Networks, Shanghai Jiaotong Univ., China;* [2]*Key Laboratory of Semiconductor Material Science, Inst. of Semiconductors, Chinese Academy of Sciences, China;* [3]*School of Electronic Science and Engineering, Univ. of Electronic Science and Technology of China, China.* We propose an integrated W-band transmitter enabled by dual-mode DFB laser and silicon microring modulator for next generation wireless communication. Error free transmission of 10 Gb/s communication at 85 GHz have been experimentally demonstratedby utilizing off-chip free-running and on-chip DFB laser.

Room 1AB	Room 2	Room 3	Room 6C	Room 6D	Room 6E
Tu3A • Symposium: The Crucial Role of Photonics in Achieving the UN Sustainability Development Goals: Learnings and Opportunities II—Continued	**Tu3B • Photonic Integrated Circuits—Continued**	**Tu3C • New Materials and Technologies—Continued**	**Tu3D • Network Orchestration—Continued**	**Tu3E • SDM - For Short Reach and Long-Haul Transmission Systems—Continued**	**Tu3F • Coexistence and Emerging Use-Cases of PON—Continued**
		Tu3C .6 • 18:15 **Heterogeneously Integrated Near-Infrared DFB Laser on Tantalum Pentoxide,** Ali Eshaghian Dorche[2,1], Nima Nader[1], Eric J. Stanton[2,1], Sae Woo Nam[1], Richard P. Mirin[1]; [1]*National Inst of Standards & Technology, USA;* [2]*Physics, Univ. of Colorado Boulder, USA.* We present a diode laser heterogeneously integrated with tantalum pentoxide waveguides on a silicon substrate emitting 5 mW continuous-wave power per facet at 1020 nm wavelength with a 14 mA threshold and a 22 dB side-mode-suppression ratio.		**Tu3E.6 • 18:15** **Real-Time 179.2Tb/s Transmission Using Commercial 400Gb/s Transceivers Over 350 km Multicore Fiber,** Lipeng Feng[1], Anxu Zhang[1], Hao Guo[2], Dongxiang Wang[2], Chuyu Peng[2], Yuyang Liu[1], Kai Lv[1], Hao Liu[1], Xiaoli Huo[1], Junjie Li[1]; [1]*China Telecom Research Inst., China;* [2]*FiberHome Fujikura Optic Technology Co.,Ltd, China.* We firstly demonstrate the feasibility of 179.2 Tb/s transmissions over a 350 km 7-core fiber link while considering the splicing loss and link budget reservation for field deployment, using real-time 400Gb/s/carrier commercial transceivers.	

17:15–18:15 Exhibitor Reception, *Center Terrace*

18:30–20:00 Conference Reception, *Upper Level, Ballroom 20BCD*

19:30–21:30 Rump Session: Is the Silicon Photonics Platform about to be Standardized, Diversified or Supplanted?, *Room 6F*

Room 6F

Tu3G • Subsea and Sensing Networks—Continued

Tu3G.4 • 18:15 ★ Top-Scored

Field Trial of FPGA-Based Real-Time Sensing Transceiver Over 524km of Live Aerial Fiber, Mikael Mazur[1], Dennis Wallberg[2], Lauren Dallachiesa[1], Erik Börjeson[3], Roland Ryf[1], Magnus Bergroth[2], Borje Josefsson[2], Nicolas K. Fontaine[1], Haoshuo Chen[1], David Neilson[1], Jochen Schröder[3], Per Larsson-Edefors[3], Magnus Karlsson[3]; [1]*Nokia Bell Labs, USA;* [2]*Sunet, Sweden;* [3]*Chalmers Univ. of Technology, Sweden.* We perform fiber sensing over a 524km live network using a real-time coherent transceiver prototype. Polarization and length changes from the link consisting exclusively of aerial fiber wound around high-voltage power cables are continuously monitored.

Room 7AB

Tu3H • Quantum Interconnect and Hybrid Classical/Quantum Systems—Continued

Tu3H.5 • 18:15

Programmable, Latency-Aware and Dynamic Quantum-Secured Optical Network With Key Refresh Rate Negotiation and QKD Sharing, Romerson Oliveira[1], Ekin Arabul[1], Rui Wang[1], Constantinos Vrontos[1], Reza Nejabati[1], Dimitra E. Simeonidou[1]; [1]*Univ. of Bristol, UK.* We have demonstrated a dynamic QKD network with a latency-aware and QKD-capacity sensitive algorithm. This scheme negotiates the optimal key refresh period and assigns priorities for preferred channels. Network reconfiguration time is within 49ms.

Room 8

Tu3I • High-Baud Rate Data Center Technologies—Continued

Tu3I.7 • 18:15

19-Core SDM Self-Homodyne Coherent Transmission Using Fan-in/Fan-Out Photonic Lantern, Min Yang[1], Chengkun Cai[1], Yize Liang[1], Lei Shen[3], Yanjun Zhu[2], Hua Zhang[4], Chaonan Yao[4], Yuchen Shao[4], Lei Zhang[3], Changkun Yan[3], Liubo Yang[3], Ruichun Wang[3], Jun Chu[3], Jian Wang[1]; [1]*Huazhong Univ. of Science and Techn, China;* [2]*Hisence Broadband Inc,, USA;* [3]*State Key Laboratory of Optical Fiber and Cable Manufacture Technology, China;* [4]*Hisence Broadband Multimedia Technologies Co., Ltd,, China.* We experimentally demonstrate space-division multiplexing (SDM) self-homodyne coherent transmission in 19-core fiber with low-cost, MHz-linewidth distributed feedback (DFB) laser, using fan-in/fan-out (FIFO) photonic lantern based on femtosecond laser direct writing technique.

Room 9

Tu3J • W-Band Fiber-Wireless Links—Continued

Tu3J.7 • 18:15

Autoencoder Learning of Nonlinear Constellation Shape for Fiber-Wireless Convergence System, Xiang Liu[1,2], Jiao Zhang[1,2], Min Zhu[1,2], Weidong Tong[1,2], Zhigang Xin[1], Yunwu Wang[1,2], Mingzheng Lei[2], Bingchang Hua[2], Yuancheng Cai[1,2], Yucong Zou[2], Jianjun Yu[2,3]; [1]*Southeast Univ., China;* [2]*Purple Mountain Laboratories, China;* [3]*Fudan Univ., China.* We propose and experimentally demonstrate a novel nonlinear constellation shape auto-optimization method with a complex-valued 2D-ANN equalizer. Up to 70% lower BER compared with the conventional format is achieved at 50 Gbps in fiber-MMW system.

17:15–18:15 Exhibitor Reception, *Center Terrace*

18:30–20:00 Conference Reception, *Upper Level, Ballroom 20BCD*

19:30–21:30 Rump Session: Is the Silicon Photonics Platform about to be Standardized, Diversified or Supplanted?, *Room 6F*

Room 1AB	Room 2	Room 3	Room 6C	Room 6D	Room 6E

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

07:00–08:30 International Women's Day Breakfast, *Upper Level, Ballroom 20A*

08:00–10:00
W1A • Advanced Photodetectors

Presider: Martin Schell; Fraunhofer HHI, Germany

W1A.1 • 08:00 Invited

High-Speed Photodetectors, Patrick Runge[1]; [1]*Fraunhofer HHI, Germany.* The paper highlights recent developments of high-speed photodetectors for 200 Gb/s and beyond communication applications. Designs for standard photodiode types as well as avalanche photodiode types with internal amplification are reviewed in terms of their high-speed performance.

W1A.2 • 08:30 Top-Scored

Demonstration of an Ultra-High-Responsivity All-Silicon Avalanche Photodetectors, Yiwei Peng[1], Yuan Yuan[1], Wayne Sorin[1], Stanley Cheung[1], Zhihong Huang[1], Marco Fiorentino[1], Raymond Beausoleil[1]; [1]*Hewlett Packard Enterprise, USA.* We demonstrate an all-Si 20 Gb/s microring avalanche photodiodes with a responsivity of more than 65 A/W. This is the first all-Si APD that can compete with current commercial Ge and III-V photodetectors.

08:00–10:00
W1B • Special Session: Photonics for Visible Wavelengths I

Presider: Cheryl Sorace-Agaskar; MIT Lincoln Laboratory, USA

W1B.1 • 08:00 Invited

Visible Wavelength PICs for Fluorescent Microscopy and Flow Cytometry, Jeremy Witzens[1], Alireza Tabatabaei[2], Martin Büscher[3], Thomas Klos[4], Marc Spehr[2], Douwe Geuzebroek[5], Florian Merget[2]; [1]*Inst. of Integrated Photonics, Germany;* [2]*RWTH Aachen Univ., Germany;* [3]*Miltenyi Biotec, Germany;* [4]*TOPTICA Photonics, Germany;* [5]*LioniX International, Netherlands.* Abstract not available.

W1B.2 • 08:20 Invited

Underwater Visible Light Communication, Boon S. Ooi[1]; [1]*King Abdullah Univ of Sci & Technology, Saudi Arabia.* Recent development and advances in underwater wireless optical communication (UWOC) will be presented. We will focus our discussion on device and system challenges facing multiple-Gbit/s laser-based UWOC, and its future perspective.

08:00–10:00
W1C • Fiber Characterization and Fiber Sensing

Presider: Lara Garrett; SubCom LLC, USA

W1C.1 • 08:00

Bending Radius Dependence of Power Coupling Coefficient and Spatial Mode Dispersion in Coupled Multi-Core Fibers, Masaki Nakamori[1], Atsushi Nakamura[1], Masaharu Ohashi[2], Yusuke Koshikiya[1]; [1]*NTT Corporation, Japan;* [2]*Osaka Metropolitan Univ. College of Technology, Japan.* We experimentally investigated the dependence of the power coupling coefficient (PCC) on the bending radius in coupled multi-core fibers for the first time. We also discuss the relationship between the PCC and spatial mode dispersion.

W1C.2 • 08:15

Characterization of Coupled Multi-Core Fiber Nonlinearity Using Modified CW-SPM Method, Taiji Sakamoto[1], Ryota Imada[1], Kazuhide Nakajima[1]; [1]*NTT Access Service Systems Laboratories, Japan.* Narrow bandwidth continuous-wave-based SPM method is proposed for measuring the effective nonlinear coefficient γ_{eff} of coupled multi-core fibers. We confirmed that the measured γ_{eff} with 2- or 4-core fibers agreed well with the theoretical model.

W1C.3 • 08:30

Distributed Polarization and Coupling Analysis of a 3-Coupled-Core Fiber, Martina Cappelletti[1], Daniele Orsuti[1], Riccardo Veronese[2], Nicolas K. Fontaine[3], Roland Ryf[3], Mikael Mazur[3], Haoshuo Chen[3], Marco Santagiustina[1], Andrea Galtarossa[1], Luca Palmieri[1]; [1]*Univ. of Padua, Italy;* [2]*Prysmian Group, Italy;* [3]*Nokia Bell Labs, USA.* OFDR-based, distributed characterization of polarization and coupling properties of a 3-coupled-core fiber is reported. Results highlight the beating among the supermodes of the fiber, enabling the evaluation of their polarization and modal birefringence.

08:00–10:00
W1D • Panel: Advanced Packaging Technologies for Optical Modules

Organizers: Molly Piels, *Juniper Networks, USA;* Juthika Basak, *Nokia, USA;* Omer Khayam, *Google, USA;* Joris Van Campenhout, *IMEC, Belgium*

Speakers: David Gomez, *X-Celeprint Inc., Ireland;* Alexander Janta-Polczynski, *IBM-Bromont, Canada;* John Martinho, *Ranovus, Canada;* Edward Preisler, *Tower Semiconductor, USA;* Sandeep Razdan, *Cisco, USA;* Sebastian Skacel, *Vanguard Automation, Germany;* Hasham Taha, *Teramount, Israel*

Description: As the baud rate, channel density, power and cost efficiency continue to scale up in optical modules, more advanced packaging technologies are being introduced to optical modules. Such packaging technologies include electronic and photonic ICs integration schemes, laser packaging/integration techniques, optical fibers or other optical connections, etc. packaging schemes that are developed at wafer foundries, outsourced semiconductor assembly and test (OSAT) companies, and component and module suppliers. This panel aims to highlight various technologies and stimulate discussions on how advanced packaging can help/shape the future optical module development.

08:00–10:00
W1E • DSP Design and System Modeling

Presider: Di Che; Nokia Bell Labs, USA

W1E.1 • 08:00 Invited

DSP Design for Point-to-Multipoint Transmission, Thomas Duthel[1], Chris Fludger[1], Bo Liu[1], Antonio Napoli[1], Amir Rashidinejad[2], Stenio Ranzini[1], Sezer Erkilinc[3], Aditya Kakkar[2], Atul Mathur[4], Vince Dominic[4], Parmijit Samra[4], Han Sun[2], Azmina Somani[2], Dave Welch[4]; [1]*Infinera GmbH, Germany;* [2]*Infinera Canada Inc., Canada;* [3]*Infinera AB, Sweden;* [4]*Infinera Corporation, USA.* Coherent optical transmission systems using digital sub-carriers are ideal for point-to-multi-point applications. Many functional blocks are similar to the ones of single-channel processors. But, several aspects, specific to digital sub-carriers and point-to-multi-point, need consideration in the DSP implementation. lable.

W1E.2 • 08:30

Parallel Extension of High-Speed Analog-Circuit FIR Equalizer for Low-Latency Optical Transceiver/Receiver, Shuhei Otsuka[1], Ryo Koguchi[1], Takahide Sakamoto[1]; [1]*Tokyo Metropolitan Univ., Japan.* We experimentally demonstrate parallel extension of analog FIR equalizer. By a dual parallel extended configuration, an 18-tap FIR filter with an 18-ps tap delay is constructed, which adaptively equalizes real-time 11.1-Gbaud NRZ signals.

08:00–10:00
W1F • 5G and Beyond

Presider: Daniel Kilper; Univ. of Dublin Trinity College, USA

W1F.1 • 08:00 Tutorial

Optical Satellite Networks, Vincent W. Chan[1]; [1]*Massachusetts Inst. of Technology, USA.* Abstract not available.

Room 6F	Room 7AB	Room 8	Room 9

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

07:00–08:30 International Women's Day Breakfast, *Upper Level, Ballroom 20A*

08:00–10:00
W1G • Optical Networks for Machine Learning Systems

Presider: To be announced.

W1G.1 • 08:00 ★ Top-Scored

SiP Architecture for Accelerating Collective Communication in Distributed Deep Learning, Zhenguo Wu[1], Liang Yuan Dai[1], Ziyi Zhu[1], Asher S. Novick[1], Madeleine Glick[1], Keren Bergman[1]; [1]*Columbia Univ., USA.* We present a silicon photonic architecture for accelerating collective communications in distributed deep learning. We demonstrate a 22% job completion time improvement in a small-scale testbed and 1.4 to 5.9x improvement in large-scale simulations.

W1G.2 • 08:15

MAESTRO: MAke-BEfore-Break StraTegy for Reconfiguration in Optical Datacenters, Sandeep Kumar Singh[1], Che-Yu Liu[1], Roberto Proietti[2], S. J. Ben Yoo[1]; [1]*Univ. of California Davis, USA;* [2]*Politenico de Torino, Italy.* We present a MAke-bEfore-break StraTegy for Reconfiguration in Optical datacenters (MAESTRO). The simulation results show a reduction in packet loss by up to 98% compared to a baseline reconfiguration method.

W1G.3 • 08:30

On the Performance of a Fast Optically Switched Network for Machine-Learning Accelerator Clusters, Marijn Rombouts[1], Nicola Calabretta[1]; [1]*Eindhoven Univ. of Technology, Netherlands.* We investigate the viability of optically switched network for ML accelerator clusters and compare it to a leaf-spine network with 256/1024 GPUs. Results show almost ideal throughput, sub-µs latency and zero packet-loss for <0.6 traffic-load.

08:00–10:00
W1H • Optical Performance Monitoring

Presider: Ezra Ip; NEC Laboratories America Inc., USA

W1H.1 • 08:00 Tutorial

Methods for Geophysical Sensing on Submarine Cables, Valey Kamalov[1]; [1]*Google LLC, USA.* We will review basic physics to establish five methods to use subsea optical fiber networks for network resiliency improvements, earthquake and tsunami early warning, and climate change: i) Optical interferometry–based, ii) Optical polarization–based, iii) Coherent Rayleigh backscattering; iv) Microwave frequency fiber interferometry, v) Faraday's law of induction to explain correlation of voltage disturbance and the strength of the geomagnetic perturbation

08:00–10:00
W1I • Flexible Coherent PON

Presider: Dora van Veen; Nokia Corporation, USA

W1I.1 • 08:00 Invited

Reusing Data Center Optics and Solutions for Beyond 25Gb/S PON: Is the Gap Really Bridged?, Vincent Houtsma[1], Dora van Veen[1]; [1]*Nokia Bell Labs, USA.* In this paper we will review the benefits as well as challenges to overcome in adoption of data center technologies for next-generation TDM-PONs.

W1I.2 • 08:30 ★ Top-Scored

Rate-Flexible Coherent PON Up to 300 Gb/s Demonstrations With Low Complexity TDM Burst Design, Haipeng Zhang[1], Zhensheng Jia[1], Luis A. Campos[2], Curtis Knittle[1]; [1]*R&D, CableLabs, USA;* [2]*Next-Gen Systems, CableLabs, USA.* Two flexible-rate coherent PON architectures have been demonstrated, featuring a low complexity TDM burst DSP. A peak data rate of up to 300-Gb/s and transmission over 50-km link and 1×32 split ratio has been achieved.

08:00–10:00
W1J • Fiber Sensing

Presider: Mikael Mazur, Nokia Bell Labs, USA

W1J.1 • 08:00 Invited

Geophysical Studies Using DAS, Nate Lindsey[1]; [1]*Fiber Sense Pty Ltd, USA.* φ-OTDR/DAS enables dense, long-range (1 - 200 km), array recordings of strain fields with exceptional sensitivity (< 1×10−9 strain) wherever optical fiber exists. The measurement is conventionally based on interferometrically extracting dynamic phase information of the Rayleigh backscattered light from one end of a single-mode fiber. Recently, φ-OTDR/DAS has expanded into telecommunications networking, seismology and geophysics, water infrastructure monitoring, and civil engineering.

W1J.2 • 08:30

Observation of Local Small Magnitude Earthquakes Using State of Polarization Monitoring in a 250km Passive Arctic Submarine Communication Cable, Kristina Shizuka Yamase Skarvang[1], Steinar Bjørnstad[2], Robin André Rørstadbotnen[1], Kurosh Bozorgebrahimi[3], Dag Roar Hjelme[1]; [1]*NTNU, Norway;* [2]*Tampnet, Norway;* [3]*SIKT, Norway.* We demonstrate local small-magnitude earthquake observation using State of Polarization sensing on an alien wavelength in a live single-span passive submarine cable communication system. Distributed Acoustic Sensing verifies seismic waves propagating along the cable.

Room 1AB

W1A • Advanced Photodetectors—Continued

W1A.3 • 08:45
80-GHz Bandwidth and High Responsivity of InP Coherent Receiver PIC With Butt-Joint Waveguide PDs, Takuya Okimoto[2,1], Hideki Yagi[2,1], Ken Ashizawa[3], Kouichiro Yamazaki[3], Koji Ebihara[3], Satoru Okamoto[3], Kazuhiko Horino[3], Munetaka Kurokawa[2,1], Yoshiyuki Sugimoto[1], Seiji Kumagai[1], Keiji Tanaka[1], Masaru Takechi[2,1], Mitsuru Ekawa[2,1], Yoshihiro Yoneda[1,3]; [1]*Sumitomo Electric Industries, Ltd., Japan;* [2]*Photonics Electronics Technology Research Association, Japan;* [3]*Sumitomo Electric Device Innovations, Inc., Japan.* An InP-based coherent receiver PIC with waveguide PDs demonstrates 80-GHz bandwidth and high responsivity of 0.156 A/W at a wavelength of 1.55 μm. A coherent receiver module with PICs and a TIA performs sufficient characteristics for 128-GBaud transmission.

W1A.4 • 09:00
190 GHz Bandwidth Modified Uni-Traveling Carrier Photodiodes With High Saturation Power, Yuxin Tian[1], Bing Xiong[1], Changzheng Sun[1], Zhibiao Hao[1], Jian Wang[1], Lai Wang[1], Yanjun Han[1], Hongtao Li[1], Yi Luo[1]; [1]*Tsinghua Univ., China.* Back-illuminated modified uni-traveling carrier photodiodes with improved saturation performance at ultra-high frequencies are developed. The 4-μm-diameter PD exhibits a 3-dB bandwidth of 190 GHz with a saturation power of -1.21 dBm@190 GHz.

Room 2

W1B • Special Session: Photonics for Visible Wavelengths I—Continued

W1B.3 • 08:40 Invited
Indoor Visible Light Communication (LiFi), Harald Haas[1]; [1]*Univ. of Strathclyde, UK.* Abstract not available.

W1B.4 • 09:00 Invited
Micro-LEDs and Quantum Based-Full Color Devices for Display and Visible Light Communications, Hao-Chung Kuo[1], Wei-Ta Huang[1], Konthoujam James Singh[1], Chi-Wai Chow[1], Gong-Ru Lin[1], Gary Chen[1]; [1]*National Yang Ming Chiao Tung Univ., Taiwan.* Red-green-blue (RGB) full-color micro light-emitting diodes (μ-LEDs) fabricated from semipolar (20-21) wafers, with a quantum-dot photoresist color-conversion layer, were demonstrated. We also demonstrated high-stability quantum dot-converted 3-in-1 full-color mini-light-emitting diodes passivated with low-temperature atomic layer deposition.

Room 3

W1C • Fiber Characterization and Fiber Sensing—Continued

W1C.4 • 08:45
Distributed Characterization of Low-Loss Hollow Core Fibers Using EDFA-Assisted Low-Cost OTDR Instrument, Xuhao Wei[1], Bo Shi[1], David J. Richardson[1], Francesco Poletti[1], Radan Slavik[1]; [1]*Univ. of Southampton, UK.* We use a low-cost commercially-available Optical Time Domain Reflectometer (OTDR). Sensitivity is boosted by 28 dB using two EDFAs, enabling characterization with spatial resolution of 1.5 m, which is 10 times better than previously reported.

W1C.5 • 09:00 Tutorial
Optical Sensing With Specialty Fibers, Joel Villatoro[1,2]; [1]*Univ. of the Basque Country UPV/EHU, Spain;* [2]*IKERBASQUE, Spain.* Specialty fibers allow the development of new platforms that considerably widen the optical fiber sensing field. In this tutorial, recent cutting-edge applications of such fibers to monitor physical, gas, and (bio) chemical parameters will be discussed.

Room 6C

W1D • Panel: Advanced Packaging Technologies for Optical Modules—Continued

Room 6D

W1E • DSP Design and System Modeling—Continued

W1E.3 • 08:45
Simultaneous Frequency-Dependent Impairments Calibration for 96GBaud Coherent Optical Transceiver, Longquan Dai[1], Shuchang Yao[2], Ziheng Zhang[1], Jing Dai[2], Ming Luo[3], Xi Xiao[3,4], Yaqin Wang[2], Qi Yang[1], Ming Tang[1], Deming Liu[1], Lei Deng[1]; [1]*Huazhong Univ of Science and Technology, China;* [2]*Fiberhome Telecommunication Technologies Co., LTD,, China;* [3]*China Information and Communication Technologies Group Corporation (CICT), China;* [4]*National Information Optoelectronics Innovation Center, China.* We report a calibration method to simultaneously characterize all the frequency-dependent impairments of coherent optical transceivers. With calibration operation, dual-polarization 96GBaud Nyquist-16QAM signal transmission is achieved by using a silicon photonics-based 64GBaud-class coherent optical transceiver.

W1E.4 • 09:00
Calibration of High-Speed Time-Interleaving DAC, Ke Zhang[1], Xiaofei Su[1], Hisao Nakashima[2], Takeshi Hoshida[2], Zhenning Tao[1]; [1]*Fujitsu R&D, China;* [2]*Fujitsu Limited, Japan.* Distortion in high-speed time-interleaving DAC caused by the mismatch among subDACs is experimentally calibrated by the enhanced error backpropagation scheme. Undesired spur is reduced by 20 dB, and the ENOB is improved by 0.72 bit.

Room 6E

W1F • 5G and Beyond—Continued

W1F.2 • 09:00
Access Point Selection Based on Regular Coding in Walker-Delta Optical Satellite Networks, Yuanjian Zhang[1], Wei Wang[1], Yongli Zhao[1], Hua Wang[1], Yinji Jing[1], Jie Zhang[1]; [1]*Beijing Univ. of Post and telecommu, China.* In this paper, a mobile-side access satellite selection algorithm based on regular coding is proposed. Simulation results show it can effectively reduce the connection latency and blocking ratio in walker-delta satellite optical networks.

Room 6F

W1G • Optical Networks for Machine Learning Systems—Continued

W1G.4 • 08:45
A Vectorised Packing Algorithm for Efficient Generation of Custom Traffic Matrices, Christopher W. Parsonson[1], Joshua Benjamin[1], Georgios S. Zervas[1]; [1]*Univ. College London, UK*. We propose a new algorithm for generating custom network traffic matrices which achieves 13x, 38x, and 70x faster generation times than prior work on networks with 64, 256, and 1024 nodes respectively.

W1G.5 • 09:00 Tutorial
Optical Switching Will Innovate Intra Data Center Networks, Ken-ichi Sato[1,2]; [1]*National Inst. of AIST, Japan;* [2]*Information and Communication Engineerint, Nagoya Univ., Japan*. This tutorial will discuss how optical switching technologies can innovate future data center networks. The two core technologies, large-port-count optical switches that have pay-as-you-grow scalability, and simple and fast optical switch network control are reviewed.

Room 7AB

W1H • Optical Performance Monitoring—Continued

W1H.2 • 09:00
On the Spatial Resolution of Location-Resolved Performance Monitoring by Correlation Method, Choloong Hahn[1], Zhiping Jiang[1]; [1]*Huawei Technologies Canada, Canada*. We show that the spatial resolution of correlation method for location-resolved performance monitoring is as good as the MMSE by applying deconvolution. Also, we propose a digital block filtering method to improve the spatial resolution under given signal and link condition.

Room 8

W1I • Flexible Coherent PON—Continued

W1I.3 • 08:45 ★ Top-Scored
Pilot-Aided Continuous Digital Signal Processing for Multi-Format Flexible Coherent TDM-PON in Downstream, Guoqiang Li[1], An Yan[1], Sizhe Xing[1], Zhongya Li[1], Wangwei Shen[1], Jiaye Wang[1], Junwen Zhang[1], Nan Chi[1]; [1]*Fudan Univ., China*. To avoid burst-signal processing in downstream transmission during modulation-format switching, we propose and experimentally demonstrate a pilot-aided DSP scheme with continuous SOP tracking, carrier-phase recovery, and channel estimation in the 300G flexible CPON based on 4/16/64-QAMs.

W1I.4 • 09:00
Low-Cost 100G Coherent PON Enabled by TFDM Digital Subchannels and Optical Injection Locking, Haipeng Zhang[1], Zhensheng Jia[1], Luis A. Campos[2], Curtis Knittle[1]; [1]*R&D, CableLabs, USA;* [2]*Next-Gen Systems, CableLabs, USA*. We demonstrate a novel 100G TFDM coherent PON architecture featuring low-cost ECL-free ONU enabled by remote optical carrier delivery through injection locking. System performance shows no degradation compared to a regular ECL based system.

Room 9

W1J • Fiber Sensing—Continued

W1J.3 • 08:45
Optical Fiber Artificial Neuromast for Versatile Underwater Safe Navigation, Liangye Li[1], Xuhao Fan[1], Shunfeng Sheng[1], Yunfei Liu[1], Wangyang Xu[1], Wei Xiong[1], Qizhen Sun[1]; [1]*Huazhong Univ of Science and Technology, China*. We present an optical fiber artificial neuromast inspired by fish lateral lines for versatile underwater safe navigation, exhibiting an ultra-high flow sensitivity of 62.02 nm s/mL (0-0.05mL/s) and a resolution of 0.32 μL/s.

W1J.4 • 09:00
Simultaneous Communications and Vibration Sensing Over a Single 100-km Deployed Fiber Link by Fiber Interferometry, Yaxi Yan[1,2], Liwang Lu[3], Xiong Wu[3], Jingchuan Wang[3], Yan He[1], Daru Chen[2], Chao Lu[3], Alan Pak Tao Lau[1]; [1]*Department of Electrical Engineering, The Hong Kong Polytechnic Univ., Hong Kong;* [2]*Hangzhou Inst. of Advanced Studies, Zhejiang Normal Univ., China;* [3]*Department of Electronic and Information Engineering, The Hong Kong Polytechnic Univ., Hong Kong*. We demonstrate simultaneous 60 GBaud 16-QAM transmissions and vibration sensing over a single 100-km deployed fiber link. Vibration localization is realized by extracting the phases of a co-propagating pilot and a counter-propagating tone.

Room 1AB

W1A • Advanced Photodetectors—Continued

W1A.5 • 09:15
A 4 × 100 Gbps DWDM Receiver Using All-Si Microring Avalanche Photodiodes, Yuan Yuan[1], Yiwei Peng[1], Zhihong Huang[1], Jared Hulme[1], Stanley Cheung[1], Wayne Sorin[1], Di Liang[1], Marco Fiorentino[1], Raymond Beausoleil[1]; [1]*Hewlett Packard Labs, Hewlett Packard Enterprise, USA.* We demonstrate an O-band 4-channel DWDM receiver using all-Si microring APDs. Each all-Si APD exhibits a low dark current at nA level before the breakdown, a responsivity of ~ 0.5 A/W, and a 3-dB bandwidth of ~ 44 GHz. All 4 channels are capable of open eye diagrams at 50 Gbps NRZ and 100 Gbps PAM4 operations.

W1A.6 • 09:30
Low Dark Current Backside-Illuminated Photodiode for 200 Gb/s Operation With 40 μm Wide Alignment Tolerance, Ryota Takemura[1], Daiki Tsubouchi[1], Akihito Ohno[1], Yasuhiro Yamauchi[1]; [1]*Mitsubishi Electric Corporation, Japan.* A backside-illuminated photodiode employing a semiconductor-buried structure is demonstrated at 200 Gb/s. The photodiode exhibited a 3dB bandwidth of 65 GHz, an effective aperture of 40 μm, and a dark current of 1 pA.

W1A.7 • 09:45
$In_{0.52}Al_{0.48}as$ Based Single Photon Avalanche Diodes With Multiple M-Layers for High-Efficiency and Fast Temporal Responses, Po-Shun Wang[1], Yu-Ying Hung[1], Tzu-Yuan Fang[1], Chin-He Kuo[1], Yuan-Hung Huang[1], Yan-Chieh Chang[1], Yi-Shan Lee[1,2], Jin-Wei Shi[1]; [1]*National Central Univ., Taiwan;* [2]*Graduate Institite of Optoelectronics, National Tsing Hua Univ., Taiwan.* Multiple multiplication-layers SPADs with excellent performances in terms of high-efficiency (>74%), neat impulse response time (101ps), and short hold-off time (83ns@<1% afterpulsing) can be achieved simultaneously with a simple passive quenching circuit under gated-mode operations.

Room 2

W1B • Special Session: Photonics for Visible Wavelengths I—Continued

W1B.5 • 09:20 Invited
Visible Light Photonics for SBS and Quantum Sensing, William Loh[1], John Chiaverini[1], Dave Kharas[1], Thomas Mahony[1], Ryan Maxson[1], Robert McConnell[1], Alex Medeiros[1], Rachel Morgan[1], Cheryl M. Sorace-Agaskar[1], Alkesh Sumant[1], Reuel Swint[1], Gavin West[2]; [1]*MIT Lincoln Laboratory, USA;* [2]*MIT, USA.* Integrated photonics at visible wavelengths offer exciting possibilities for miniaturizing and scaling the capabilities of quantum sensors. Here we discuss the techniques and challenges with bringing visible wavelengths to a chip platform.

Room 3

W1C • Fiber Characterization and Fiber Sensing—Continued

Room 6C

W1D • Panel: Advanced Packaging Technologies for Optical Modules—Continued

Room 6D

W1E • DSP Design and System Modeling—Continued

W1E.5 • 09:15
Distortion Analysis and Equivalent Multiplicative and Additive Noise Model for High-Speed DAC and ADC, Xiaofei Su[1], Tong Ye[1], Ke Zhang[1], Chengwu Yang[1], Hisao Nakashima[2], Takeshi Hoshida[2], Zhenning Tao[1]; [1]*Fujitsu R&D Center, China;* [2]*Fujitsu Limited, Japan.* By analyzing the distortions of time-interleaving convertors, equivalent model with both multiplicative and additive noises is proposed and constructed by tone-based measurements. Experiments show that the proposed model estimates system performance with 0.2 dB accuracy.

W1E.6 • 09:30
Experimental Probing and Modeling of the PDL Impact on the Optical Signal-to-Noise Ratio, Andrea D Amico[1], Giacomo Borraccini[1], Stefano Straullu[2], Francesco Aquilino[2], Stefano Piciaccia[3], Alberto Tanzi[3], Gabriele Galimberti[3], Vittorio Curri[1]; [1]*Politecnico di Torino, Italy;* [2]*Links Foundation, Italy;* [3]*Cisco Photonics, Italy.* The PDL impact on the OSNR is systematically probed on an experimental setup using coherent optical technology for the first time. Extending the observation through a Monte Carlo analysis, the PDL-induced OSNR penalty is modeled.

W1E.7 • 09:45
Preemphasis-Aware Semiconductor Optical Amplifier Model, Hartmut Hafermann[1], Xiaohui Zhao[1], Shuqi Yu[1], Yann Frignac[1]; [1]*Huawei Technologies, France.* A preemphasis-aware model for SOAs with non-flat WDM inputs yielding a root-mean-square error of less than 0.05 dB is presented. It outperforms generic neural-network models while using a fraction of the training data.

Room 6E

W1F • 5G and Beyond—Continued

W1F.3 • 09:15 Invited
Human-Centric Networking and the Road to 6G, Dimitra E. Simeonidou[1]; [1]*Univ. of Bristol, UK.* Abstract not available.

W1F.4 • 09:45
Field Trial of End-to-end Management and Control of Semi-Active WDM System for 5G Centralized Front-Haul Network, Yang Zhao[1], Jiang Sun[1], Haomian Zheng[2], Chaode Yu[2], Dong Wang[1], Qian Cai[1], Yunbo Li[1], Liuyan Han[1], Dechao Zhang[1], Han Li[1]; [1]*China Mobile Research Inst., China;* [2]*Huawei Technologies Co., Ltd., China.* A novel management and control architecture and abstract model of semi-active WDM system for 5G front-haul network are proposed. The functions of device information acquisition, alarm monitoring and fault location is demonstrated in field trial.

10:00–17:00 Exhibition and Show Floor, *Exhibit Hall, (coffee service 10:00–10:30)*

10:00–16:30 OFC Career Zone, *Exhibit Hall*
OFC Career Zone Job Fair | Resume Critique | Mock Interviews

10:30–12:00 The Art of Writing the Perfect OFC Paper, *Room 14B*

10:30–12:30 W2A • Posters Session I, In-Person, *Exhibit Hall B1*
W2B • Posters Session II, Remote, *ePoster Gallery on OFC website*
Lunch Break *(on own; concessions available in Exhibit Hall)*

W1G • Optical Networks for Machine Learning Systems—Continued

W1H • Optical Performance Monitoring—Continued

W1H.3 • 09:15
Locating Fiber Loss Anomalies With a Receiver-Side Monitoring Algorithm Exploiting Cross-Phase Modulation, Paolo Serena[1], Chiara Lasagni[2], Alberto Bononi[1], Fabien Boitier[3], Alix May[3], Petros Ramantanis[3], Matteo Lonardi[3,4]; *[1]Universita degli Studi di Parma, Italy; [2]Università dell'Aquila, Italy; [3]Nokia Bell Labs, France; [4]Nokia, Italy.* We propose and experimentally test a cross-phase modulation based algorithm to monitor network loss anomalies from detected data. The idea does not need service interruption, special signals, nor an exhaustive search of the anomaly coordinate.

W1H.4 • 09:30
0.77-dB Anomaly Loss Localization Based on DSP-Based Fiber-Longitudinal Power Estimation Using Linear Least Squares, Takeo Sasai[1], Masanori Nakamura[1], Etushi Yamazaki[1], Hideki Nshizawa[1], Yoshiaki Kisaka[1]; *[1]NTT Corporation, Japan.* We experimentally demonstrate that DSP-based fiber-longitudinal power estimation achieves good agreement with OTDR with a root-mean-square error of 0.18 dB and thus localizes a 0.77-dB anomaly loss, which may occur as a connector loss.

W1H.5 • 09:45
Distributed Span Degradation Self-Aware Detection and Compensation for C+L-Band Transmission Systems, Shengnan Li[1], Chen Zhu[1], Shuo Wang[1], Feng Gao[1], Yongxin Cui[1], Gang Cheng[1], Xu Zhou[1]; *[1]Beijing Baidu Netcom Science Technology, China.* We propose a distributed approach that enables OLAs to instantaneously self-aware its preceding span's degradation and apply the gain/tilt adjustments, this ultra-fast method is experimentally demonstrated in both C96+L96 and C120+L100 systems with near-optimal performance.

W1I • Flexible Coherent PON—Continued

W1I.5 • 09:15
Demonstration of Beyond 100G Three-Dimensional Flexible Coherent PON in Downstream With Time, Frequency and Power Resource Allocation Capability, Wangwei Shen[1], Sizhe Xing[1], Guoqiang Li[1], Zhongya Li[1], An Yan[1], Jiaye Wang[1], Junwen Zhang[1], Nan Chi[1]; *[1]Fudan Univ., China.* We propose and demonstrate a novel three-dimensional flexible coherent PON with the resource-allocation capability in time, frequency and power domain. High flexibility is demonstrated with >100G over 20-km fiber for coherent PON in downstream.

W1I.6 • 09:30 Invited
High-Performance and Robust Burst Reception in Coherent PON, Junwen Zhang[1]; *[1]Fudan Univ., China.* Abstract not available.

W1J • Fiber Sensing—Continued

W1J.5 • 09:15
Field Trial of High-Resolution Distributed Fiber Sensing Over Multicore Fiber in Metropolitan Area With Construction Work Detection Using Advanced MIMO-DAS, Sterenn Guerrier[1], Antonio Mecozzi[3], Christian Dorize[1], Cristian Antonelli[3], Lauren Dallachiesa[4], Haik Mardoyan[1], Elie Awwad[5], Daniele Orsuti[6], Luca Palmieri[6], Mikael Mazur[4], Tetsuya Hayashi[2], Roland Ryf[4], Jérémie Renaudier[1]; *[1]Nokia Bell Labs, France; [2]Sumitomo Electric Industries, Ltd., Japan; [3]Universita degli Studi dell'Aquila, Italy; [4]Nokia Bell Labs, Nokia Bell Labs, Murray Hill, NJ, US, USA; [5]Télécom Paris Département Communications et Électronique, Telecom Paris Departement Communications et Electronique, Paris, Île-de-France, FR, academic/tech, France; [6]Universita degli Studi di Padova, Universita degli Studi di Padova, Padova, Veneto, IT, academic, Italy.* We demonstrate a successful field trial of MIMO-DAS over multicore fiber (MCF) allowing for accurate localization of acoustic events in the city of L'Aquila, Italy. We show a 2m spatial resolution and 1mHz-380Hz acoustic bandwidth.

W1J.6 • 09:30
Full Link SNR Equalization DAS System Over 80km Based on Gradient Discrete Scattering Enhanced Fiber, Cunzheng Fan[1], Xiangpeng Xiao[1], Hao Li[1], Weiliang Zhao[1], Zhijun Yan[1], Qizhen Sun[1]; *[1]Huazhong Univ of Science and Technology, China.* We proposed a full-link SNR-equalization DAS based on gradient discrete scattering enhanced fiber with backscattering rates increase gradually according to optical loss. The experimental results show a 15pε/√Hz strain resolution over 80km.

W1J.7 • 09:45
Polarization Sensing Using Polarization Rotation Matrix Eigenvalue Method, Fatih Yaman[1], Yang Li[1,2], Shaobo Han[1], Takanori Inoue[3], Eduardo F. Mateo[3], Yoshihisa Inada[3]; *[1]NEC Laboratories America Inc., USA; [2]Computer Science, Georgia State Univ., USA; [3]Submarine Network Division, NEC Corporation, Japan.* Polarization-based, multi-span sensing over a link with reflection-back circuits is demonstrated experimentally. By measuring rotation matrices instead of just monitoring polarization, a 35 dB extinction in localization is achieved regardless of the disturbance magnitude.

10:30–12:30
W2A • Posters Session I (In-Person)

W2A.1
An Apparatus for Fast Inspecting and Cleaning MPO Connector, Yu Huang[1], Jose Castro[1], Thomas Sedor[1], Rick Pimpinella[1], Bulent Kose[1], Brett Lane[1]; [1]*Panduit, USA*. In this paper, we present an apparatus that can inspect and clean the end face of the fiber-optic connector without the need to switch the connector from one tool to another.

W2A.2
A 200Gb/s Low Power DSP-Based Optical Receiver and Transmitter With Integrated TIA and Laser Drivers, Arik Zafrany[1], Daniel Burgos[1], Li Cai[1], Sau Siong Chong[1], Colin Cramm[1], Sadegh Dadash[1], Vishal Giridharan[1], Vivek Gurumoorthy[1], Belal Helal[1], Cheng-Ru Ho[1], Amrutha Iyer[1], Steve Jantzi[1], Chang-Feng Loi[1], The Linh Nguyen[1], Kevin Parker[1], Ed Pillai[1], Karthik Raviprakash[1], Sagar Ray[1], Paolo Rossi[1], Zhuochao Sun[1], Amber Tan[1], Lawrence Tse[1], Brian Wall[1], Luke Wang[1], Jeffrey Wang[1], Tzu-Fan Wu[1]; [1]*Marvell Semiconductors, USA*. Fully integrated low power 200Gb/s DSP based optical transmitter and receiver ICs with transmitter chip incorporating fully integrated laser drivers and receiver chip with fully integrated Transimpedance amplifier (TIA) in 16nm FinFet using wirebond technology.

W2A.3
Error-Tolerant Integrated Optical Unitary Processor Based on Multi-Plane Light Conversion, Ryota Tanomura[1], Rui Tang[1], Takuo Tanemura[1], Yoshiaki Nakano[1]; [1]*The Univ. of Tokyo, Japan*. We experimentally demonstrate error-tolerant optical unitary processors with multiport directional couplers. Thanks to the inherent redundancy of the multi-plane light conversion scheme, equivalent performance is obtained in the presence of large fabrication errors.

W2A.4
Silicon Photonic Tunable Flat-top Filters Based on CROW Structures at 2-mm Spectral Range, You Wu[1], Xi Wang[1], Xiaoyuan Guo[1], Jiangbing Du[2], Qinghai Song[3], Ke Xu[1]; [1]*Department of Electronic and Information Engineering, Harbin Inst. of Technology, Shenzhen, China;* [2]*State Key Laboratory of Advanced Optical Communication Systems and Networks, Shanghai Jiao Tong Univ., China;* [3]*Department of Science, Harbin Inst. of Technology, Shenzhen, China*. Silicon photonic tunable flat-top filters are demonstrated via the 5th-order and the 10th-order CROW structure at 2-mm waveband. Box-like transmission spectra are measured with 3-dB bandwidth of 3.34 nm and 5.34 nm, respectively.

W2A.5
Inverse-Designed Grating Arrays for High-Sensitivity Plenoptic Time-of-Flight Pixels, John Rollinson[1], Robert Karlicek[1], Mona Hella[1]; [1]*Rensselaer Polytechnic Inst., USA*. We present a plenoptic time-of-flight pixel design using grating arrays with inverse-designed passive photonic power combining to achieve scalable signal-to-noise ratio. Experimental results are presented as a proof-of-principle demonstration of the pixel architecture.

W2A.6
Tuner-Free Lumped-Element Resonantly Enhanced Mach-Zehnder Modulator With Ultra-Wide Operating Wavelength Range, Manuel Ackermann[1], Alvaro Moscoso-Mártir[1], Florian Merget[1], Jeremy Witzens[1]; [1]*Inst. of Integrated Photonics RWTH, Germany*. We demonstrate a resonantly enhanced Mach-Zehnder modulator utilizing highly overcoupled ring resonators with staggered resonances to achieve a 7-nm 1-dB-penalty operating range. It can be operated lumped element without tuning any of the resonators.

W2A.7
On-Chip Tunable Mode-Locked Comb Laser in Generic Foundry Platform, Mu-Chieh Lo[1], Alex Bennett[1], Zichuan Zhou[1], Alfonso Ruocco[1], Zhixin Liu[1]; [1]*Univ. College London, UK*. An integrated, passive, harmonically mode-locked laser fabricated utilizing a generic integration technology is reported. The device features both emission wavelength and comb spacing variability by using a colliding-pulse cavity composed of two tunable gratings.

W2A.8
Enhancement of Bandwidth-Responsivity Product in High-Speed Avalanche Photodiodes With Optimized Flip-Chip Bonding Package for Coherent Detection, None Naseem[1], Nan-Wei Chen[2], Syed Hasan Parvez[1], Zohauddin Ahmad[1], Sean Yang[3], H.-S. Chen[3], Hsiang-Szu Chang[3], Jack J. Huang[3], Jin-Wei Shi[1]; [1]*Department of Electrical Engineering, National Central Univ., Taiwan;* [2]*Department of Electrical Engineering, Yuan Ze Univ., Taiwan;* [3]*Source Photonics, Taiwan*. Flip-chip bonding APDs with 14μm window diameters are demonstrated. Wide-bandwidth (36GHz), high-responsivity (3.4A/W), low dark current (175nA) and high MMW output power (-1dBm at 40GHz) can be achieved simultaneously with 12.5mA I_{sat} under 0.9V_{br}.

W2A.9
Aging Effects on the Attenuation Coefficient and Splice Losses in Installed Submarine Optical Cables., Roque A. Ciufo Poeys[1], Jean-Pierre Von Der Weid[1]; [1]*Pontificia Univ Catolica Rio de Janeiro, Brazil*. Aging effects in submarine optical cables were evaluated with OTDR measurements along 12 years. Penalties from splice losses were twofold higher than those from fiber attenuation. Cables are expected to last more than 25 years.

W2A.10
Bundle-Type fan-in/fan-out Device for 4-Core Multi-Core Fiber With High Return Loss, Kohei Ozaki[1], Yoshifumi Koike[1], Akito Nishimura[1]; [1]*Fujikura Ltd., Japan*. We have developed a bundle-type fan-in/fan-out device that can achieve a high return loss by using a multi-core fiber/single-core fiber conversion component comprising a high-precision molded plastic ferrule.

W2A.11
Quasi-Constant Signal Power Transmission With Low Signal RIN by DRA With Incoherent-Forward and Coherent-Backward Pumps, Shigehiro Takasaka[1], Norihiro Ohishi[1], Satoru Ichihara[1], Nitidet Thudsalingkarnsakul[2], Naoya Hojo[3], Yasuto Tatamida[1], Junji Yoshida[1], Sanguan Anantathanasarn[2], Toshio Kimura[1]; [1]*Furukawa Electric, Japan;* [2]*Furukawa FITEL (Thailand), Japan;* [3]*Furukawa FITEL Optical Device, Japan*. We measure characteristics of a transmitted WDM signal in an 80 km-long SMF under bi-directionally pumped DRA with incoherent-forward and coherent-backward pumps. The signal shows OSNR of 50.0 dB and RIN less than -140 dB/Hz.

W2A.12
4-Core Fiber Narrow Pitch Fanout Comprised of Tapered High-Δ MCF, Masanori Takahashi[1], Tsubasa Sasaki[1], Ryuichi Sugizaki[1], Yoshihiro Arashitani[1]; [1]*Furukawa Electric, Japan*. Narrow pitch all fiber base fanout comprised of fiber bundle fanout and high-Δ 4-core fiber is developed. Core pitch and insertion loss of the fanout are reduced to 19.4 μm and 0.6 dB, respectively.

W2A.13
First Field Trial of FTTR Based on Native Management and Control Architecture for 5G Small Cell Backhaul, Jinglong Zhu[1], Junwei Li[1], Nannan Zhang[1], Ning Wang[1], Dechao Zhang[1], Han Li[1], Xiaodong Duan[1], Xuming Wu[2], Lirong Bai[3]; [1]*Department of Fundamental Network Technology, China Mobile Research Inst., China;* [2]*Optical Research Dept, Huawei Technologies Co., Ltd., China;* [3]*China Mobile Communications Corporation Group Co., Ltd., China*. We firstly propose a native management and control architecture of FTTR, based on which a field trial for 5G small cell backhaul is demonstrated. The download speed of each user equipment reaches nearly 800 Mbps

W2A.14
Supporting Bandwidth Guarantee for a Fast Optical Switching Network With Micro Buffer Switching Fabric, Fulong Yan[1], Chongjin Xie[1], Nicola Calabretta[2]; [1]*Alibaba Cloud, China;* [2]*TU/e, Netherlands*. We propose a micro buffer fast optical switch (MFOS) fabric for a data center network. MFOS highly improves the network performance and achieves 6.7 us latency and 99.9% throughput at a load of 0.8.

W2A.15
Speedy and Cost-Efficient Optical Network Modernization Through Quantum-Inspired Computing, Masahiko Sugimura[4], Mohammad Javad-Kalbasi[1], Hidetoshi Matsumura[2], Xi Wang[3], Paparao Palacharla[3], Shahrokh Valaee[1]; [1]*The Univ. of Toronto, Canada;* [2]*Fujitsu Consulting (Canada) Inc., Canada;* [3]*Fujitsu Network Communications Inc., USA;* [4]*Fujitsu Limited, Japan*. We present a migration plan optimization solution to accelerate the removal of legacy devices and minimize travel costs in network modernization utilizing Fujitsu Digital Annealer. Our method found more cost-efficient plans by up to 70%.

W2A.16
Optimal Design of Filterless Horseshoe Networks Supporting Point-to-Multipoint Transceivers, Mohammad Mohammad Hosseini[1], João Pedro[2,4], Nelson Costa[2], Antonio Napoli[3], Jaroslaw E. Prilepsky[1], Sergei K. Turitsyn[1]; [1]*Aston Univ., UK;* [2]*Infinera, Portugal;* [3]*Infinera, Germany;* [4]*Instituto de Telecomunicações, Portugal*. This paper proposes an ILP framework to optimize metro-aggregation filterless horseshoe networks for digital subcarrier multiplexing point-to-multipoint (P2MP) transceiver deployment. The results show that this significantly reduces amplifier requirements while ensuring end-to-end performance.

W2A.17
Soft-Failure Identification and Localization Method Based on Received Optical Signal Quality and Repeater Nodes' Performance, Hiroshi Yamamoto[1], Kouhei Watanabe[1], Hiroki Date[1], Daisaku Shimazaki[1], Yutaka Fukuchi[2], Hideki Maeda[2]; [1]*NTT Corporation, Japan;* [2]*Tokyo Univ. of Science, Japan*. We propose novel methodology to identify and localize soft-failures using performance metrics monitored at repeater nodes in addition to signal quality monitored at transponders and show feasibility in experiments using commercial equipment and field-deployed fibers.

W2A.18
Degradation Detection and Severity Estimation by Exploiting an Optical Time and Frequency Digital Twin, Mariano Devigili[1], Marc Ruiz[1], Sima Barzegar[1], Nelson Costa[2], 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, IST, Portugal*. We exploit the intrinsic advantages of a time and frequency domain digital twin to detect degradations and to estimate their severity. Noticeable performance shown for filter failures confirms the usefulness of this approach.

W2A.19
Towards an Analytical Tool to Support Planning of 400ZR+-Enabled IPoWDM Networks, Nicolás A. Jara[1], Gerardo Rubino[2], Hermann Pempelfort[1], Patricia Morales[1], Alejandra L. Beghelli[3]; [1]*Department of Electronics Engineering, Universidad Tecnica Federico Santa Maria, Chile;* [2]*INRIA Rennes - Bretagne Atlantique, INRIA, France;* [3]*Optical Network Group (ONG), Electronic and Electric Engineering Department, Univ. College London, UK*. A highly accurate analytical procedure to support emerging ZR+-enabled IPoWDM network planning tools is presented. The procedure is four orders of magnitude faster than simulation, allowing extensive and fast network analysis and design.

W2A.20
Demonstration of Real-Time 4×125.516 Gbit/s MMW-Over-Fiber Passive Optical Network Transmission at W-Band Based on Optical Wavelength Routing Scheme, Bingchang Hua[1], Min Zhu[1,2], Jiao Zhang[1,2], Mingzheng Lei[1], Yuancheng Cai[1,2], Yucong Zou[1], Liang Tian[1], Jian Chen[2], Weidong Tong[2], Xiang Liu[2], Guo Zhao[3], Jianjun Yu[4]; [1]*Purple Mountain Laboratories, China;* [2]*Southeast Univ., China;* [3]*Nanjing Wasin Fujikura Optical Communication Ltd, China;* [4]*Fudan Univ., China*. We proposed and experimentally demonstrate the first real-time transparent point-to-multipoint photonics-assisted MMW-over-fiber passive optical network transmission scheme with a record line rate of 4×125.516 Gbit/s at W-band based on optical wavelength routing scheme.

W2A.21
On the Rate Monitoring Performance of Active Learning-Based Classifier for PCS-Based Rate-Flexible TWDM-CPON, Zixian Wei[1], Jinsong Zhang[1], Weijia Li[1], David Plant[1]; [1]*McGill Univ., Canada*. We firstly demonstrated active learning (AL)-based classifier for monitoring the entropy/rate of the PCS-based rate-flexible TWDM-CPON. For an 80-km 350-Gb/s/**λ**~450-Gb/s/**λ** downstream, the AL-based scheme achieves 100%/95% entropy/rate identification accuracies corresponding to 25/5 Gbps tuning steps.

W2A.22
600-Gbit/s/λ Mode-Multiplexed Bit-Loading DMT Signal Transmission for Short-Reach Optical Interconnect, Xinkuo Yu[1,2], Jianping Li[1,2], Yuwen Qin[1,2], Ou Xu[1,2], Meng Xiang[1,2], Songnian Fu[1,2]; [1]*Inst. of Advanced Photonics Technology, School of Information Engineering, Guangdong Univ. of Technology, China;* [2]*Guangdong Provincial Key Laboratory of Information Photonics Technology, Guangdong Univ. of Technology, China*. Single wavelength 600-Gbit/s bit-loading MDM-DMT signal transmission over 20m OM2 fiber with BER below SD-FEC threshold (2.7×10-2) is demonstrated without MIMO-DSP for mode demultiplexing. This report shows the potential for future large-capacity short-reach optical interconnects.

W2A • Posters Session I (In-Person)—Continued

W2A.23
DFE and BCJR Performance With SD FEC in 112 GBd PAM4 IMDD Systems, Nebojsa Stojanovic[1], Lin Youxi[1], Talha Rahman[1], Stefano Calabrò[1]; [1]*Huawei Technologies Co Ltd, Germany.* Soft information quality of different DSP schemes followed by hybrid soft/hard decision FEC is investigated. We demonstrate in simulations and experiments that BCJR achieves a significant gain over DFE by providing better soft information.

W2A.24
Optical Multipath Interference Mitigation for PAM4 Transmission Using Line Coding and High-Pass Filtering, Ning Cheng[1], Dechao Zhang[2], Dawei Ge[2], Yan Song[1], Meijuan Lv[1], Shanglin Li[1], Bin Lv[1], Xuezhe Zheng[1]; [1]*Innolight, China;* [2]*China Mobile, China.* A simple method using DC-balanced line-coding and receiver-side high-pass filtering is proposed to mitigate MPI in high-speed PAM4 transmission. 5-dB improvement in MPI tolerance is achieved in both simulations and experiments for 25GBd PAM4 transmissions.

W2A.25
On the Impact of Spatial Mode Dispersion for Strongly-Coupled Multicore Fiber Submarine Transmission, Lin Sun[1], Bin Chen[2], Gordon Ning Liu[1], Yi Cai[1], Zhaohui Li[3], Chao Lu[4], Gangxiang Shen[1]; [1]*Soochow Univ., China;* [2]*Hefei Univ. of technology, China;* [3]*Sun Yat-sen Univ., China;* [4]*The Hong Kong Polytechnic Univ., Hong Kong.* Strongly-coupled multicore fibers exhibit the improved tolerance to fiber nonlinearity. Their potentials in optical submarine communications are investigated with considering the coupling length and spatial mode dispersion.

W2A.26
A Post-Equalization Technique for PDL Compensation in Coherent Optical Systems, Ahmed M. Medra[1], Hossein Najafi[1], Chuandong Li[1], Zhuhong Zhang[1]; [1]*Network, Huawei Technologies Canada, Canada.* A practical post-equalization technique is proposed to compensate the loss due to polarization gain imbalance in an optical channel. The proposed scheme is implemented after legacy adaptive channel equalization and shown to provide significant performance gains.

W2A.27
Low-Complexity RMS-Enhanced Digital Pre-Emphasis Under Limited Transmitter Power and ENoB, Wing-Chau Ng[1], Qingyi Guo[1], Junho Chang[1], Tianyu Zhao[1], Meng Qiu[1], Xuefeng Tang[1], Zhiping Jiang[1], Chuandong Li[1]; [1]*Huawei Technologies Canada, Canada.* We optimize digital pre-emphasis for narrow optical filtering using the balance among electrical RMS, equalization-enhanced noise and quantization, and experimentally show a low-complexity cutoff approach to enhance SNR in strong pre-emphasis.

W2A.28
Statistical Properties of NLIN in Presence of PDL, Ori Golani[3], David Dahan[1,2]; [1]*Toga Networks - a Huawei company, Israel;* [2]*Holon Inst. of Technology, Israel;* [3]*Tel Aviv Univ., Israel.* We model and investigate the statistical properties of the time-varying ISI model of XPM induced NLIN affected by PDL along the fiber link. We validate the analytical model by comparing to SSFM simulations.

W2A.29
A Closed-Form Expression for the ISRS GN Model Supporting Distributed Raman Amplification, Henrique Buglia[1], Mindaugas Jarmolovičius[1], Anastasiia Vasylchenkova[1], Eric Sillekens[1], Lidia Galdino[2], Polina Bayvel[1], Robert I. Killey[1]; [1]*Univ. College London, UK;* [2]*Corning, UK.* A closed-form model for the nonlinear interference in distributed Raman amplified links is presented, the formula accounts for both forward and backward pumping. The model accurately estimates the received SNR over a 10 THz bandwidth.

W2A.30
Nonlinear Distortion Mitigation With Non-Orthogonal DFT-Precoding for DML-Based OFDM Optical Systems, Peiji Song[1], Zhouyi Hu[2], Yizhan Dai[1], Chun-Kit Chan[1]; [1]*Department of Information Engineering, The Chinese Univ. of Hong Kong, China;* [2]*Aston Inst. of Photonic Technologies, Aston Univ., UK.* We propose to use non-orthogonal DFT-matrix precoding to mitigate the nonlinear distortion induced by chirp and fiber dispersion in a 10-Gb/s DML-based OFDM optical system, with 0.83-dB sensitivity improvement over the third-order Volterra nonlinear equalizer.

W2A.31
Phase-Preserving Amplitude Regeneration in a Mamyshev Regenerator With mid-Stage Optical Phase Conjugation, Cheng Guo[1], Michael Vasilyev[1]; [1]*Department of Electrical Engineering, Univ. of Texas at Arlington, USA.* We experimentally demonstrate phase-preserving amplitude regeneration of an RZ-QPSK signal by placing an optical phase conjugator between two Mamyshev regenerators, improving intensity noise 2.8 times, Q-factor by 2.4 dB and EVM by 4.0%.

W2A.32
Experimental Demonstration of Reconfigurable "Digital Average" of Two 20-Gbaud Phase-Encoded Data Channels Using Nonlinear Optical Wave Mixing, Amir Minoofar[1], Hao Song[1], Ahmed Almaiman[2], Narek Karapetyan[1], Wing Ko[1], Kaiheng Zou[1], Huibin Zhou[1], Muralekrishnan Ramakrishnan[1], Murali Annavaram[1], Jonathan Habif[1], Moshe Tur[3], Alan Willner[1]; [1]*Univ. of Southern California, USA;* [2]*King Saud Univ., Saudi Arabia;* [3]*Tel Aviv Univ., Israel.* We experimentally demonstrate the reconfigurable "digital average" of two 10/20-Gbaud phase-encoded data channels using two nonlinear optical stages. In the first nonlinear stage, we compute the average. In the second nonlinear stage, we multicast the average value to the input signals wavelengths.

W2A.33
Quantum Noise Secured Terahertz Communications, Qiuzhuo Deng[1], Lu Zhang[1,2], Hongqi Zhang[1], Zuomin Yang[1], Xiaodan Pang[3,4], Vjačeslavs Bobrovs[5], Sergei Popov[3], Yixin Wu[6], Xiongbin Yu[6], Oskars Ozolins[3,4], Xianbin Yu[1,2]; [1]*College of Information Science and Electrical Engineering, Zhejiang Univ., China;* [2]*Zhejiang Lab, China;* [3]*Department of Applied Physics, KTH Royal Inst. of Technology, Sweden;* [4]*RISE Research Inst.s of Sweden, Sweden;* [5]*Inst. of Telecommunications, Riga Technical Univ., Latvia;* [6]*Inst. of Strategic Research, Huawei Technologies Company, Ltd, China.* The quantum noise based terahertz signal encryption scheme is proposed, a 16 Gbits[-1] secure terahertz communication system at 300 GHz with the optical communication realms is demonstrated, taking a significant step toward high-security wireless communications.

W2A.34
Delay Compensated Quad-Level Delta-Sigma Modulation Dual-Color DRoF System for Beyond 5G Mobile Fronthaul, Zu-Kai Weng[1], Pham Tien Dat[1], Atsushi Kanno[2,1], Tetsuya Kawanishi[3,1], Kouichi Akahane[1]; [1]*National Inst. of Information and Communications Technology, Japan;* [2]*Nagoya Inst. of Technology, Japan;* [3]*Waseda Univ., Japan.* We demonstrated a high-performance dual-color B5G DRoF system using delay compensation. A quad-level 6-Gbit/s 64-QAM OFDM signal was successfully transmitted over the proposed system, showing a much better performance compared to the conventional 1-bit system.

W2A.35
Impact of Spatial Variations on Splitter-Tree-Based Integrated Optical Phased Arrays, Zhengxing Zhang[1], Milica Notaros[1], Zhengqi Gao[1], Uttara Chakraborty[1], Jelena Notaros[1], Duane Boning[1]; [1]*Massachusetts Inst. of Technology, USA.* We consider the impact of spatially correlated geometric variations on splitter-tree-based integrated optical phased arrays. These variations can substantially affect the emitted beam. Our analysis is shown to be consistent with experimental results.

W2A.36
Controllable Passive Multi-Polarization-States Generator Based on Silicon Photonics for Quantum Communication, Kap-Joong Kim[1], Kyongchun Lim[1], Byung-Seok Choi[1], Wook-Jae Lee[2], Young-Ho Ko[1], Joong-Seon Choe[1], Minchul Kim[1], Jong-Bum You[3], Chun Ju Youn[1]; [1]*ETRI, Korea (the Republic of);* [2]*Kongju National Univ., Korea (the Republic of);* [3]*National Nanofab Center, Korea (the Republic of).* We demonstrate a silicon-based controllable multi-polarization-states generator for quantum key distribution. Our device can effectively generate various sets of well-defined four-polarization states using the thermo-optics effect and combine them into one port at a telecom-wavelength.

W2A.37
Receiver Noise Stability Calibration for CV-QKD, Sjoerd P. van der Heide[1], João R. Frazão[1], Aaron Albores-Mejia[1], Chigo M. Okonkwo[1]; [1]*Eindhoven Univ. of Technology, Netherlands.* A method to investigate CV-QKD receiver stability is proposed and experimentally validated. Comparing <100kHz linewidth local oscillator lasers, we show long-term noise power variance differs more than tenfold, highlighting the importance of receiver hardware calibration.

W2A.38
Software-Defined Quantum Network Using a QKD-Secured SDN Controller and Encrypted Messages, Rodrigo Tessinari[1], Robert Woodward[1], Andrew Shields[1]; [1]*Toshiba Europe Ltd, UK.* We propose and implement a software-defined network architecture that integrates the QKD SDN Controller within the QKD node, enabling it to use quantum keys to secure its communication with SDN agents while optimizing QKD-keys consumption.

12:00–14:00 IEEE/Optica Publishing Group Journal of Lightwave Technology 40th Anniversary Luncheon, *Upper Level, Ballroom 20A*

12:30–14:00 Unopposed Exhibit-only Time, *Exhibit Hall*

Show Floor Programming

NOSK • Network Operator Summit: Keynote
10:15–10:45, *Theater I*

SWK Series: Next Generation Connectivity Presented by Sumitomo Electric Lightwave
10:15–10:45, *Theater III*

SF5 • Ethernet Alliance: Ethernet in Telecom: The Rise of ZR and ZR+ for Metro (and Beyond?)
10:30–11:30, *Theater II*

NOS1 • NOS Panel I: What's the Value of Optical Network Automation and How Can Optics Help
11:00–12:30, *Theater I*

OFCnet Quantum Network - Coexistence, Transporting Entanglements
11:00–11:30, *Theater III*

OFCnet High Performing Networks Demonstrations
11:40–12:10, *Theater III*

SF6 • OpenZR+: OpenZR+MSA - New Developments and Next Steps
11:45–12:45, *Theater II*

With Growing Bandwidth Demand Driving Innovative Optical Technologies, What Is the Impact on Network Architectures Today and Tomorrow?
Presented by Infinera
12:20–12:50, *Theater III*

NOS2 • NOS II: Brownfield Applications in Legacy Networks
13:00–14:30, *Theater I*

SF7 • OIF: Defining 800ZR and 800LR; an OIF Update
13:00–14:00, *Theater II*

OFCnet Backstage Pass: Highlighting the Unsung Heroes of Optical Connectivity
13:00–13:30, *Theater III*

SF8 • OpenROADM: Open ROADM MSA Updates and Demonstration
13:45–14:45, *Theater III*

10:30–12:30
W2B • Posters Session II (Remote)

W2B.1
Thin-Film Lithium Niobate Photonic Devices on 8-Inch Silicon Substrates, Hengyu Wang[1], Yang Xu[1], Zhaoyi Li[1], Lianxi Jia[2], Shiyang Zhu[3], Yuxi Wang[3], Zhanshi Yao[3], Shaonan Zheng[1], Qize Zhong[1], Yuan Dong[1], Ting Hu[1]; *[1]Shanghai Univ., China; [2]Shanghai Inst. of Microsystem and Information Technology, China; [3]Huawei Technologies, China.* Thin-film lithium niobate photonic devices are first demonstrated on 8-inch silicon substrates. The fabrication is done in a commercial semiconductor foundry. A waveguide propagation loss of 0.47±0.09 dB/cm is achieved at 1550 nm wavelength.

W2B.2
Heterogeneous Balanced Photodetector on Silicon Nitride With 30 GHz Bandwidth and 26 dB Common Mode Rejection Ratio, Junyi Gao[1], Ta Ching Tzu[1], Tasneem Fatema[1], Xiangwen Guo[1], Qianhuan Yu[1], Gabriele Navickaite[2], Michael Zervas[2], Michael Geiselmann[2], Andreas Beling[1]; *[1]Univ. of Virginia, USA; [2]LIGENTEC SA., Switzerland.* We demonstrate InGaAs/InP balanced photodiodes on Si_3N_4 waveguides with record-high 3-dB bandwidth of 30 GHz, 0.72 A/W responsivity, and high common mode rejection ratio (CMRR) of 26 dB at 30 GHz.

W2B.3
Spectral-to-Spatial Mapping for Channel-Definable Information Transmission in Multimode Fiber, Ming Zhu She[1], Zhao Wang[1], Wei Li Zhang[1]; *[1]Univ of Electronic Science & Tech China, China.* The concept of spectral coding to control light is proposed for arbitrary spatial focusing through multimode fiber, where, utilizing the randomness of speckle pattern, transmission channel is established for encrypting information.

W2B.4
Multimode Fiber Bandwidth Uniformity and its Impact on Optical Links in Hyperscale Datacenters, Qin Chen[1], Rui Lu[1], Peng Wang[1], Chongjin Xie[2]; *[1]Alibaba Cloud, China; [2]Alibaba Cloud, USA.* We characterize multimode fiber bandwidth uniformity and its impact on optical links in data centers, discussing the importance of MMF bandwidth uniformity to data center deployment of the next-generation 100-Gb/s multimode products.

W2B.5
Nonlinear Impairment Scaling in Few-Mode Fiber Transmission Systems With Mode Permutation Technique, Rui Xing[1], Xiaofan Ji[1], Yaping Liu[1], Zhiqun Yang[1], Zhanhua Huang[1], Lin Zhang[1,2]; *[1]Tianjin Univercity, China; [2]Peng Cheng Laboratory, China.* Few-mode fiber transmission systems with three states of the permutation strategies are evaluated using a GN model with MDL considered, for the first time. CMP strategy outperforms by 0.3 dB in terms of SNR difference among modes with an MDL of 0.1 dB/km.

W2B.6
Dependence of Raman Scattering in a Few-Mode Fiber Within Small Detuning Range, Hongtao Cheng[1], Shengjie Zhu[1], Liang Cui[1], Xiaoying Li[1]; *[1]tianjin Univ., China.* We measure the intensity of small detuning Raman scattering in different spatial and polarization mode in a common circular core few-mode fiber, and show the existence of principle mode affect the dependence of Raman scattering.

W2B.7
A Novel Distributed Spun Fiber Twist Sensor Based on Frequency-Scanning φ-OTDR, Can Chen[1], Zhiyong Zhao[1], Zhonghong Lin[1], Can Chen[1], Can Chen[1], Ming Tang[1]; *[1]Huazhong Univ. of Science and Techn, China.* A novel distributed twist sensor utilizing frequency-scanning φ-OTDR in a spun fiber is theoretically analyzed and experimentally demonstrated by tracking the fiber twist induced frequency shift of correlation peak, enabling distributed quantitative twist measurement.

W2B.8
Reliable and Low-Complexity Multiple Performance Parameters Prediction for Optical Network Equipment, Yu Chen[1], Danshi Wang[1], Chunyu Zhang[1], Bing Ye[2], Yinqiu Jia[2], Jin Li[1], Min Zhang[1]; *[1]BUPT, China; [2]State Key Laboratory of Mobile Network and Mobile Multimedia Technology, Shenzhen, 518055, China, China.* A multi-objective and multi-step performance parameters prediction scheme based on SCINet for optical network equipment is proposed. It not only saves 83.96% of training time on average, but also has high reliability.

W2B.9
Experimental Demonstration of an AWGR-Based Nanoseconds Optical Switching DCN, Yuanzhi Guo[1], Xuwei Xue[1], Bingli Guo[1], Daohang Dang[1], Yisong Zhao[1], Rui Ding[1], Jiapeng Zhao[1], Changsheng Yang[1], Shanguo Huang[1]; *[1]Beijing Univ. of Posts and Telecommunications, China.* An arrayed waveguide grating router based nanoseconds optical switching data center network is experimentally demonstrated and investigated. Experimental assessments validate the system achieves error-free communication with 465 ns server-to-server latency even at load of 0.9.

W2B.10
Real-Time Demonstration of a Low-Complexity PS Scheme for 130Gb/s WDM-OFDM-PON, Long Zhang[1], Kaihui Wang[1], Chen Wang[1], Junjie Ding[1], Ming Chen[2], Bohan Sang[1], Junting Shi[1], Bowen Zhu[1], Feng Wang[1], Li Zhao[1], Yun Chen[1], Ze Dong[3], Xiangjun Xin[4], Wen Zhou[1], Jianjun Yu[1]; *[1]Fudan Univ., China; [2]Hunan Normal Univ., China; [3]Beijing Inst. of Technology, China.* We experimentally demonstrated a low-complexity probabilistic shaping scheme in a real-time 16QAM-OFDM-based WDM-PON. The PS-OFDM signal with a net rate of 131.88-Gb/s transmission over 25-km SSMF can be achieved with the BER less than 3.8×10^{-3}.

W2B.11
A Low-Latency DSM-Based ONU Activation Scheme for in-Service TDM-PON Without Quiet Windows, Yang Zou[1], Borui Li[2], Linsheng Zhong[1], Shenmao Zhang[1], Xiaoxiao Dai[1], Mengfan Cheng[1], Lei Deng[1], Qi Yang[1], Deming Liu[1]; *[1]Huazhong Univ of Science and Technology, China; [2]Access Optical Technologies Lab, Optical Business Product Line, Huawei Technologies Co.,Ltd., China.* An activation method using DSM generated electrical tone as the identity of joining ONUs is proposed. The activation requests can be detected and distinguished without a quiet window or degradation on the upstream traffic.

W2B.12
Deep Reservoir Computing for 100 Gbaud PAM6 IM/DD Transmission Impairment Mitigation, Mengyao Han[1,2], Muguang Wang[1], Yuchuan Fan[2,3], Toms Salgals[5], Hadrien Louchet[6], Richard Schatz[2], Markus Gruen[6], Fabio Pittala[6], Benjamin Krüger[6], Thomas Dippon[6], Lu Zhang[4], Xianbin Yu[4], Sandis Spolitis[5], Vjačeslavs Bobrovs[5], Sergei Popov[2], Xiaodan Pang[2,3], Oskars Ozolins[3,2]; *[1]Beijing Jiaotong Univ., China; [2]KTH Royal Inst. of Technology, Sweden; [3]RISE Research Inst.s of Sweden, Sweden; [4]Zhejiang Univ., China; [5]Riga Technical Univ., Latvia; [6]Keysight Technologies GmbH, Germany.* We experimentally evaluate a deep Reservoir Computing (RC)-based post-equalization for 100 Gbaud PAM6 IM/DD transmissions. It achieves ~1 dB higher sensitivity than DFE, and ~50% implementation complexity reduction compared with the conventional RC configuration.

W2B.13
A More Than 20 Mrad/s Speed RSOP Monitoring Method With Large PMD Tolerance in Optical Coherent Communication Systems, Linan Shan[1], Xiaoguang Zhang[1], Peng Sun[1], Guanghao Yao[1], WanXin Zhao[1], Lixia Xi[1], Xiaosheng Xiao[1]; *[1]Beijing Univ of Posts & Telecom, China.* We propose a RSOP monitoring method, integrated in DSP of the coherent receiver, which can reach the RSOP speed of more than 20Mrad/s with tolerance for residual CD and large PMD along with second PMD.

W2B.14
Noisy Samples-Robust Neural Network Equalizer for Coherent Optical Transceiver Nonlinearity Compensation, Zicai Cao[1], Shuchang Yao[2], Longquan Dai[1], Ziheng Zhang[1], Jing Dai[2], Ming Luo[3], Xi Xiao[3,4], Yaqin Wang[2], Qi Yang[1], Deming Liu[1], Lei Deng[1]; *[1]School of Optical and Electronic Information, Huazhong Univ. of Science and Technology, China; [2]Fiberhome Telecommunication Technologies Co., LTD, China; [3]China Information and Communication Technologies Group Corporation (CICT), China; [4]National Information Optoelectronics Innovation Center, China.* We experimentally demonstrate a neural network equalizer with robustness for noisy samples on a silicon photonics coherent transceiver with a complexity reduction of over 50% at the BER of 1.25e-2 compared with a general structure.

W2B.15
Learned Perturbation-Aided Advanced Digital Backpropagation With Nonlinear Compensation Fusion for Subcarrier-Multiplexing Systems, Du Tang[1], Zhen Wu[1], Shuangyue Liu[2], Jiating Luo[3], Ji Luo[3], Bofang Zheng[3], Yaojun Qiao[1]; *[1]The State Key Laboratory of Information Photonics and Optical Communications, School of Information and Communication Engineering, Beijing Univ. of Posts and Telecommunications, China; [2]Department of Mobile Communications and Terminal Research, Research Inst. of China Telecommunication, China; [3]B&P Laboratory, Huawei Technologies Co. Ltd., China.* A learned perturbation-aided advanced digital backpropagation (LP-ADBP) with nonlinear compensation fusion is proposed for subcarrier-multiplexing systems. 1-Step and 5-Step LP-ADBP provide similar performance as 5-Step and 10-Step ADBP but save ~73.3% and ~44.5% complexity, respectively.

W2B.16
32-λ×400 Gb/s Single-Carrier 120-GBaud QPSK Coherent Transmission Over 3075-km G.652.D Fiber Link Using OE-MCM Prototype Under Field-Deployed Configuration, Mingqing Zuo[1], Baoluo Yan[2], Dawei Ge[1], Dong Wang[1], Jiabin Wang[2], Xuechuan Chen[2], Hu Shi[2], Philippe Jennevé[3], Shaoliang Zhang[3], Miquel A. Mestre[3], Dayou Qian[3], Sheng Liu[1], Yunbo Li[1], Liuyan Han[1], Dechao Zhang[1], Han Li[1], Xiaodong Duan[1]; *[1]China Mobile Research Inst., China; [2]ZTE corporation, China; [3]Cisco System Incorporation, USA.* Enabled by OE-MCM prototype, record 32-λ×400 Gb/s single-carrier 120-Gbaud DP-QPSK transmission is achieved over 49-span 3075-km G.652.D fiber with a link configuration emulating the legacy large-loss field deployment for the first time.

W2B.17
PS Factor-Independent and Joint Polarization, Frequency Offset and Carrier Phase Recovery Scheme for Probabilistically Shaped QAM, Linsheng Fan[1], Yanfu Yang[1], Siyu Gong[1], Yong Chen[1], Yong Yao[1]; *[1]Harbin Inst. of Technology, shenzhen, China.* A joint polarization, frequency offset and carrier phase recovery scheme based on frequency domain pilot is proposed for PS-QAM. Our scheme is independent of PS factor and can track polarization rotation rate up to 20Mrad/s.

W2B.18
208km Ultra-Long Single Span Hybrid BOTDR and Φ-OTDR With ROPA Technology, Jiasheng Liu[1,2], Ming Li[1,2], Jian Xu[1,2], Jiekui Yu[1,2], Mingchao Nie[1,2], Shiyu Zhang[2,3], Xingyun Chen[1,2], Guoliang He[1,2], Shujuan Sun[1,2], Man Tan[1,2], Qianggao Hu[1,2]; *[1]Accelink Technologies Co. Ltd, China; [2]State Key Laboratory of Optical Communication Technologies and Networks, China; [3]Wuhan Research Inst. of Posts and Telecommunications, China.* Ultra-long single span hybrid BOTDR and Φ-OTDR system with ROPA technology is proposed. Using double heterodyne detection configuration, high order Raman amplifiers, cascaded RGUs, 208km unrepeatered real time simultaneous temperature and vibration measurement is achieved.

W2B.19
Optoelectronic Oscillator Based on SBS-Assisted Parity-Time Symmetry, Lin Wang[1], Yifan Liu[1], Yuan Yu[1,2], Xinliang Zhang[1,2]; *[1]Huazhong Univ. of Science and Technology, China; [2]Optics Valley Laboratory, China.* A parity-time symmetric optoelectronic oscillator is constructed based on stimulated Brillouin scattering. A stable microwave signal at 9.66 GHz is generated with a phase noise of −103.9 dBc/Hz at an offset frequency of 10 kHz.

W2B.20
Accurate Extraction of Brillouin Frequency Shift Using Single Deep Neural Network in BOTDA Sensing System With Non-Local Effect, Yuhao Qian[1], Guijiang Yang[1], Keyan Zeng[1], Liang Wang[1], Ming Tang[1], Deming Liu[1]; *[1]Huazhong Univ. of Sci. & Tech., China.* A single DNN model has been developed for accurate extraction of both Brillouin frequency shift without and with NLE. The scheme is practical and greatly improves the system tolerance to NLE without any hardware modification.

W2B • Posters Session II (Remote)—Continued

W2B.21
Simultaneous Measurements of Angle of Arrival and Doppler Frequency Shift Based on Silicon Modulators, Sihan Chen[2], Qiang Zhang[1], Jingyang Fan[2], Xingyi Jiang[2], Shuyue Zhang[2], Hui Yu[1,2]; [1]*Zhejiang Lab, China;* [2]*College of Information Science and Electronic Engineering, Zhejiang Univ., China.* We experimentally demonstrate the simultaneous measurements of the microwave angle of arrival and Doppler frequency shift by silicon modulators. The measurement errors of AOA and DFS are less than 3° and 7.2×10^{-10} Hz at 30 GHz, respectively.

W2B.22
PAM8 WDM Transmission Based on a Single Time Lens Source With Geometric Shaping, Xiaoyu Xu[1], Peter David Girouard[1], Metodi Plamenov Yankov[1], Michael Galili[1], Leif Katsuo Oxenløwe[1], Pengyu Guan[1]; [1]*DTU Electro, Denmark.* We demonstrate a PAM8 WDM-PON transmission using a single time lens source. Geometric shaping is used to minimize the impact of power-dependent noise. 28×1.5 Gb/s WDM signals are transmitted over 26 km with BER below 3.8×10^{-3}.

W2B.23
A Multi-Source Signals Separation Algorithm for Identifying the Threatening Signals Applied in Fiber-Optic Distributed Acoustic Sensor, Tao He[1], Qizhen Sun[1], Zhang s. Xiong[1], Hao Li[1], Zhijun Yan[1], Deming Liu[1]; [1]*Huazhong Univ of Science and Technology, China.* A multi-source signals separation algorithm is proposed to identify the potential threatening signals submerged in the strong background noises. Finally, the recognition rate of the mixed signals is improved from 62.83% to 92.36%.

W2B.24
High-Resolution Frequency Identification of Wideband Microwave Signal Using a Hybrid Optical Filter, Haoyan Liu[1], Xu Hong[1], Yihao Cheng[1], Bin Wang[1], Weifeng Zhang[1]; [1]*Beijing Inst. of Technology, China.* We propose a photonic approach for frequency identification of broadband microwave signal with a high resolution using a hybrid optical filter. A frequency resolution of 20 MHz and a measurement accuracy of 5.6 MHz are experimentally demonstrated within a measurement range of 2-35 GHz.

W2B.25
Demonstration of PDM-2048QAM W-Band Signal Delivery Over 4.6 km Wireless Transmission Employing One bit DSM, Wen Zhou[1], Xiongwei Yang[1], Weiping Li[1], Feng Wang[1], Bowen Zhu[1], Huajiong Lin[2], Junting Shi[1], Tangyao Xie[3], Kaihui Wang[1], Li Zhao[1], Jianguo Yu[3], Feng Zhao[4], Jianjun Yu[1]; [1]*Fudan Univ., China;* [2]*Huawei Technologies Co., Ltd, China;* [3]*Beijing Univ. of Posts and Telecommunications, China;* [4]*School of Electronic Engineering, Xi'an Univ. of Posts and Telecommunications, China.* In a photonics-aided mm-wave communication system, we successfully achieved W-band long-distance transmission of PDM-1024QAM/2048QAM signals over 4.6 km by using a PTFE lenses and Delta-Sigma Modulator (DSM).

W2B.26
Deep Learning-Based End-to-End Bit-Wise Autoencoder for G-Band Fiber-Terahertz Integrated DFT-S-OFDM Communication System, Zhongya Li[1], Changle Huang[1], Junlian Jia[1], Guoqiang Li[1], Wangwei Shen[1], Jiangyang Shi[1], Junwen Zhang[1,2], Ziwei Li[1,2], Chao Shen[1,2], Nan Chi[1,2]; [1]*Fudan Univ., China;* [2]*Peng Cheng Lab, China.* We proposed and experimentally demonstrated a bit-wise end-to-end deep-learning-based autoencoder for a fiber-THz integrated DFT-S-OFDM communication system at 209 GHz. More than 5.5-dB sensitivity gain is achieved compared with traditional DFT-S-OFDM system at 50Gbps.

W2B.27
Millimeter-Level Resolution Photonic Multiband Radar Using a Single MZM and Sub-GHz-Bandwidth Electronics, Peixuan Li[1], Wenlin Bai[1], Xihua Zou[1], Ningyuan Zhong[1], Wei Pan[1], Lianshan Yan[1]; [1]*Southwest Jiaotong Univ., China.* We here propose a novel cost-effective millimeter-level resolution photonic multiband radar system using a single MZM driven by a 1-GHz-bandwidth LFM signal. It experimentally shows an ~8.5-mm range resolution through coherence-processing-free multiband data fusion.

W2B.28
Digital Filter Design for Experimental Continuous-Variable Quantum Key Distribution, Abdulmohsen Alsaui[1,2], Yazeed Alwehaibi[1,2], Anil Prabhakar[1], Deepa Venkitesh[1]; [1]*Department of Electrical Engineering, Indian Inst. of Technology Madras, India;* [2]*Research and Development Department, National Company of Telecommunications and Information Security, Saudi Arabia.* We explore the effect of digital filter design on enhancing the performance of an experimental CV-QKD system. The filtering procedure is anticipated to enable greater than 20 Mbaud/s at 20 km fiber length.

W2B.29
Integrated Source of Telecom-Band Photon-Pairs Based on High Index Silica Glass Spiral Waveguides, Liang Cui[1], Hao Feng[1], Xiaotian Zhu[2], Changyue Wang[1], Z. Y. Ou[2], Xiaoying Li[1], Brent E. Little[3], Sai T. Chu[2]; [1]*Tianjin Univ., China;* [2]*City Univ. of Hong Kong, Hong Kong;* [3]*QXP Inc., China.* We generate correlated photon-pairs via spontaneous four-wave mixing in high index silica glass spiral waveguides. Results show that spontaneous Raman scattering is the main noise origin, and propagation loss limits the optimum length of waveguides.

Show Floor Programming

NOSK • Network Operator Summit: Keynote
10:15–10:45, *Theater I*

Technology Showcase Presented by Sumitomo
10:15–10:45, *Theater III*

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OFCnet Backstage Pass: Highlighting the Unsung Heroes of Optical Connectivity
13:00–13:30, *Theater III*

SF8 • OpenROADM: Open ROADM MSA Updates and Demonstration
13:45–14:45, *Theater III*

Room 1AB

14:00–16:00
W3A • Symposium: Beyond the Hype of Network Analytics: Use Cases, Feasibility and Barriers I
Presider: Loukas Paraschis; IEEE Communication Society and Alphawave Semi, USA and Elaine Wong; Univ. of Melbourne, Australia

W3A.1 • 14:00 Invited
Title to be Announced, Andrew Lord[1]; [1]*BT Applied Research, UK.* Abstract not available.

W3A.2 • 14:20 Invited
How Traffic Analytics Shapes Traffic Engineering, Topology Engineering, and Capacity Planning of Jupiter, Anny Xijia Zheng[1]; [1]*Google LLC, USA.* Abstract not available.

Room 2

14:00–16:00
W3B • Special Session: Photonics for Visible Wavelengths II
Presider: Fotini Karinou; Microsoft Research Ltd, UK

W3B.1 • 14:00 Invited
Visible Light Components: Fibers and Photodetectors, Joyce K. Poon[1]; [1]*Max-Planck-Inst fur Mikrostrukturphysik, Germany.* Abstract not available.

W3B.2 • 14:20 Invited
From Device to Module: Silicon-Nitride for Visible Light, Douwe Geuzebroek[1]; [1]*LioniX International, Netherlands.* Abstract not available.

Room 3

14:00–16:00
W3C • Devices for Quantum Technologies (Joint D5/SCQ)
Presider: Michael Vasilyev; Univ. of Texas at Arlington, USA

W3C.1 • 14:00 Invited
Nonlinear and Quantum Optics in Periodically-Poled Optical Fiber, Li Qian[1]; [1]*Univ. of Toronto, Canada.* We will review methods of generating entangled and hyper-entangled photon pairs directly in periodically-poled silica fiber (PPSF) through spontaneous parametric down conversion (SPDC), based on the induced second-order nonlinearity in PPSF. Due to the extreme low birefringence in fibre, broadband polarization-entangled photon pairs can be generated without compensation or erasure of which-way information.

Room 6C

14:00–16:00
W3D • Modulators and Transceivers
Presider: Frank Chang; Source Photonics, USA

W3D.1 • 14:00 Invited
State of Art of 800G/1.6T for Datacom and Coherent and Outlook of 3.2T, Xiang Zhou[1], Cedric Lam[1], Ryohei Urata[1], Hong Liu[1]; [1]*Google LLC, USA.* We review state-of-the-art datacenter technologies for 800G, 1.6T and beyond interconnect speeds, focusing on 200G per-lane IM-DD (intensity modulated-direct detect) and 800G-LR1 coherent-lite transmissions.

Room 6D

14:00–16:00
W3E • Transmission Impairment Mitigation and Compensation Techniques
Presider: Dario Pilori; Istituto Nazionale di Ricerca Metrologic, Italy

W3E.1 • 14:00 Invited
Recent Advances in Carrier Phase Recovery Algorithms, Fernando Guiomar[1], Manuel Neves[1], Abel Lorences-Riesgo[2], Celestino Sanches Martins[2], Sami Mumtaz[2], Yann Frignac[2], Gabriel Charlet[2], Paulo Monteiro[1]; [1]*Instituto De Telecomunicacoes, Portugal;* [2]*Huawei Technologies France, France.* We review the most recent advances in carrier phase estimation algorithms for coherent optical communications, with special emphasis on multi-carrier modulation systems and on the interplay between linear and nonlinear phase noise sources.

Room 6E

14:00–16:00
W3F • Convergent Optical Access for Mobile Connectivity
Presider: Luiz Anet Neto; IMT Atlantique, France

W3F.1 • 14:00 Invited
Open RAN Mobile Access: the View of an Operator on an End-to-End Implementation, Carlo Cavazzoni[1], Marco Caretti[1], Alessandro Percelsi[1], Mauro Agus[1]; [1]*TIM (Telecom Italia), Italy.* This paper describes some challenges that an operator must face when setting up the environment to evaluate end-to-end 5G mobile networks, with a specific focus on the RAN segment implemented by disaggregated Open RAN solutions.

Room 6F

14:00–16:00
W3G • Photonic Processing for Computing and ML

W3G.1 • 14:00 ★ Top-Scored
DDOS Attack Identification via a Silicon Photonic Deep Neural Network With 50 GHz Input and Weight Update, Apostolos Tsakyridis[1], George Giamougiannis[1], Miltiadis Moralis-Pegios[1], George Mourgias-Alexandris[1], Angelina Totovic[1], George Dabos[1], Manos Kirtas[1], Nikolaos Passalis[1], Anastasios Tefas[1], Dimitrios Kalavrouziotis[2], Dimitris Syrivelis[2], Paraskevas Bakopoulos[2], Elad Mentovich[3], Nikos Pleros[1]; *[1]Aristotle Univ. of Thessaloniki, Greece; [2]NVIDIA, Greece; [3]NVIDIA, Israel.* We experimentally demonstrate distributed denial of service (DDOS) attack identification using Deep Learning over a photonic neuromorphic engine that supports both input signal and weight update at 50 GHz, reporting a Cohen's κ-score of 0.636.

W3G.2 • 14:15 Invited
Silicon Photonic Hopfield-Like Electro-Optical Recurrent Network for Time-Series Data Processing and Recognition, Guangwei Cong[1], Noritsugu Yamamoto[1], Rai Kou[1], Yuriko Maegami[1], Morifumi Ohno[1], Koji Yamada[1]; *[1]AIST (Natl Inst of Adv Indust Sci&Tech), Japan.* We propose and experimentally demonstrate a Hopfield-like electro-optical recurrent network based on silicon photonic circuits for processing time-series data to extract feature vectors just by one-time sampling, which can offer robust and simple waveform recognition.

Room 7AB

14:00–16:00
W3H • Coherent Pluggables and Field Trials
Presider: Dirk Van Den Borne; Juniper Networks Inc., Germany

W3H.1 • 14:00
Real-Time Point-to-Multipoint for Coherent Optical Broadcast and Aggregation – Enabled by Digital Subcarrier Multiplexing, Amir Rashidinejad[1], Amin Yekani[1], Tobias A. Eriksson[2], Antonio Napoli[3], Robert Maher[4], Aditya Kakkar[1], Vince Dominic[4], Thomas Duthel[3], Mark Missey[4], Parmijit Samra[4], Don Pavinski[4], Peter Evans[4], Warren Sande[4], Mehdi Torbatian[1], Chris Fludger[3], Han Sun[1], Mehrdad Ziari[4], Fady Masoud[1], Azmina Somani[1], Dave Welch[4]; *[1]Infinera Canada, Canada; [2]Infinera Sweden, Sweden; [3]Infinera Germany, Germany; [4]Infinera USA, USA.* We report on the first real-time operation of coherent point-to-multipoint in high-speed fiber-optic communications. The broadcast and aggregation network consists of a 400 Gb/s hub transceiver achieving post-FEC error-free communication with 4×100 Gb/s leaf nodes, 5 – 50 km away.

W3H.2 • 14:15
Interoperable 400ZR Deployment at Cloud Scale, Chuan Qin[1], Binbin Guan[1], Kyle Edwards[1], Jian Kong[1], Ryan Morgan[1], Yawei Yin[1], Avinash Pathak[1], Mounika Banda[1], Sridharan J[1], Govardan Chandrababu[1], Jeetesh Jain[1], Jamie Gaudette[1]; *[1]Microsoft Azure Networking, USA.* We report 400ZR deployment data from the Microsoft private network, highlighting module interoperability, performance stability and availability, and parallel module firmware upgrade at cloud scale.

Room 8

14:00–15:45
W3I • Enabling Technology for Free Space Optical Communications
Presider: Bernhard Schrenk; AIT Austrian Inst. of Technology, Austria

W3I.1 • 14:00 ★ Top-Scored
Plasmonic Modulators for Future Highest-Speed Free Space Optical Communications, Laurenz Kulmer[1], Yannik Horst[1], Bertold Ian Bitachon[1], Marcel Destraz[2], Tobias Blatter[1], Matthieu Rimlinger[1], Killian Keller[1], Valentino Tedaldi[2], Patrick Habegger[2], Eva De Leo[2], Wolfgang Heni[2], Claudia Hoessbacher[2], Aurélie Bonnefois[3], Caroline Lim[3,4], Jean-Marc Conan[3], Joseph Montri[3], Beatrice Sorrente[3], Cyril Petit[3], Nicolas Védrenne[3], Loann Pommarel[5], Hannah Lindberg[5], Laurent Francou[5], Daniel Matter[5], Arnaud Le Kernec[6], Anaëlle Maho[6], Simon Lévêque[6], Michael Sotom[6], Benedikt Baeuerle[2], Juerg Leuthold[1,2]; *[1]ETH Zurich, Switzerland; [2]Polariton Technologies AG, Switzerland; [3]ONERA, France; [4]LNE-SYRTE, France; [5]Thales-Alenia Space Switzerland, Switzerland; [6]Thales Alenia Space France, France.* Plasmonic modulators have been assessed for operation up to 200 GBaud in a turbulent 53 km free-space-optical link. They are shown to withstand space radiation and large temperature ranges making them ideal for space applications.

W3I.2 • 14:15 ★ Top-Scored
100-Gbps 2-SDM 2-WDM FSO Beam Direct Detection Using Resonant Cavity 4x4 Photodetector Array, Toshimasa Umezawa[1], Atsushi Matsumoto[1], Kouichi Akahane[1], Atsushi Kanno[1,2], Naokatsu Yamamoto[1]; *[1]National Inst of Information & Comm Tech, Japan; [2]Nagoya Inst. of Technology, Japan.* We fabricated a high-speed resonant cavity 4x4 photodetector array, which has two functions for high optical alignment robustness and specific wavelength selection. In the 2-SDM 2-WDM FSO communication, 100-Gbps high data rate was successfully demonstrated.

Room 9

14:00–16:00
W3J • Sensing, Devices and OTDR
Presider: Peng-Chun Peng; National Taipei Univ. of Technology, Taiwan

W3J.1 • 14:00
Frequency Averaging With Rotation Angle Tracking Technique in Phase-OTDR DAS for Large-Scale Vibration Measurement, Yoshifumi Wakisaka[1], Hiroshi Takahashi[1], Daisuke Lida[1], Takahiro Ishimaru[1], Yusuke Koshikiya[1]; *[1]NTT Corporation, Japan.* Sensitivity degradation specific to frequency-multiplexed phase OTDR in measuring large strain change is clarified for the first time. We demonstrate one solution based on frequency averaging with rotation angle tracking technique to measure sub-με vibrations.

W3J.2 • 14:15
Practical Considerations on Using Gaussian Shape Pulses in phi-OTDR Systems, Felipe M. Meijueiro[2], Pedro O. Mariz de Carvalho[2], Sérgio Barcelos[3], Luis Ernesto Y. Herrera[1]; *[1]Photonics Innovation Inst., Brazil; [2]Fiberwork Optical Communications Ltda, Brazil; [3]Future Photonics, USA.* This paper experimentally demonstrates practical advantages and limitations on using Gaussian shape pulses for phi-OTDRs systems by measuring the SNR of the detected vibration in the far end of a standard single mode fiber.

Show Floor Programming

SF8 • OpenROADM: Open ROADM MSA Updates and Demonstration
13:45–14:45, *Theater III*

SF9 • FBA: The State of Fiber in America
14:15–15:15, *Theater II*

Room 1AB

W3A • Symposium: Beyond the Hype of Network Analytics: Use Cases, Feasibility and Barriers I—Continued

W3A.3 • 14:40 Invited

Analytics for Datacenter Interconnect Optical Networks, Chongjin Xie[1]; [1]*Alibaba Group, USA*. Abstract not available.

W3A.4 • 15:00 Invited

DCI Analytics, Vipul Deokar[1]; [1]*Meta Platforms, USA*. Abstract not available.

Room 2

W3B • Special Session: Photonics for Visible Wavelengths II—Continued

W3B.3 • 14:40 Invited

Scaling Visible SiN Integrated Photonics and its Applications, Michael Geiselmann[1]; [1]*LIGENTEC, Switzerland*. Abstract not available.

W3B.4 • 15:00 Invited

Visible-Light Foundry Platform From AIM Photonics, Todd H. Stievater[1]; [1]*US Naval Research Laboratory, USA*. Abstract not available.

Room 3

W3C • Devices for Quantum Technologies (Joint D5/SCQ)—Continued

W3C.2 • 14:30

Entanglement Measurement Using Pump-Phase Control on an Up-Conversion Detector, Kim Lee[1], Paul Moraw[1], Daniel Reilly[1], Gregory S. Kanter[1]; [1]*NuCrypt, USA*. We measure sequential time-bin entangled light by dynamically adjusting the pump phase of an up-conversion detector, allowing fast basis state control without adding loss to the quantum signal.

W3C.3 • 14:45

An Acousto-Optic Modulator Based High Performance Optical Switch for Quantum Technology in Fiber Communication Band, Wen Qi Li[1], Qiqi Deng[1], Xueshi Guo[1], Xiaoying Li[1]; [1]*tianjin Univ., China*. We demonstrate an optical switch based on the interferometric enhancement of acousto-optic diffraction. The high transmitting efficiency of 92% and the high isolation of 74 dB make it a powerful tool for quantum technology.

W3C.4 • 15:00

Guard-Ring Free InGaAs/InP Single Photon Avalanche Diodes for C-Band Quantum Communication, Pascal Rustige[1], Jan Krause[1], Lorenz Eckoldt[1], Patrick Runge[1], Martin Schell[1,2]; [1]*Fraunhofer Heinrich Hertz Inst., Germany;* [2]*Technical Univ. Berlin, Germany*. We present a guard-ring free InGaAs/InP single photon avalanche diode with 20 µm diameter for the optical C-band. At 225 K, 25.6 µs dead time and 17% detection efficiency, the dark count rate is 3 kcps with 0.5% afterpulsing probability. This corresponds to a quantum bit error rate of about 1.2% for 625 MHz timebin-phase BB84 QKD over 125 km.

Room 6C

W3D • Modulators and Transceivers—Continued

W3D.2 • 14:30 ★ Top-Scored

3.2Tb/s Heterogeneous Photonic Integrated Circuit Chip in a Co-Packaged Optics Configuration, Damien Lambert[1], Jeff Rahn[2], Majid Sodagar[1], Murtaza Askari[1], Paveen Apiratikul[1], John Spann[1], Thang Pham[2], Yishen Huang[2], Stephen Krasulick[1]; [1]*Skorpios Technologies Inc., USA;* [2]*Meta Platforms, Inc., USA*. We present a low-cost, scalable 3.2Tbps heterogenous photonic integrated circuit chip assembled in a co-packaged optics configuration. The integration of III-V material directly into the Silicon-Photonic chip offers clear form-factor, density, and thermal dissipation advantages.

W3D.3 • 14:45 ★ Top-Scored

800 Gbps Silicon Photonics Transmitter PIC With Integrated Lasers in an Open Market Platform, Molly Piels[1], John Sonkoly[1], Krzysztof Szczerba[1], Brandon Gomez[1], Han Yun[1], Jared Bauters[1], Hongwei Zhao[1], Mark Williams[1], John Parker[1], Anand Ramaswamy[1], Erik Norberg[1]; [1]*OpenLight Photonics, USA*.An uncooled 800Gb/s-DR8 silicon photonics transmitter PIC with fully integrated lasers and 1.0 Vpp drive swing modulators in an open market platform is demonstrated for data center applications.

W3D.4 • 15:00

First Demonstration of MWDM-Based 400G-LR4 Over 10-km SSMF Supporting 400GE and OTN Dual Rates, Dong Wang[1], Mingqing Zuo[1], Wei Zhang[2], Tao Lin[3], Jiang Sun[1], Tao Gui[2], Wupin Zhang[3], Dawei Ge[1], Chendi Jiang[2], Chenggang Liu[3], Yunbo Li[1], Changsheng Li[2], Daheng Liu[3], Liuyan Han[1], Dechao Zhang[1], Xiaodong Duan[1], Han Li[1]; [1]*China Mobile Research Inst., China;* [2]*Huawei, China;* [3]*Accelink, China*. We report the first demonstration of cost-effective 400G-LR4 optical module based on O-band MWDM, achieving error-free transmission of both 400GE and OTN rates over 10-km SSMF with an optical link budget of over 6.7 dB.

Room 6D

W3E • Transmission Impairment Mitigation and Compensation Techniques—Continued

W3E.2 • 14:30

Pilot-Aided Pump Dithering Removal in Degenerate FWM-Based Optical Phase Conjugation Systems With Higher-Order QAM, Jiaqian Yang[1], Eric Sillekens[1], Ronit S. Sohanpal[1], Filipe Ferreira[1], Zhixin Liu[1], Polina Bayvel[1], Robert I. Killey[1]; [1]*Univ. College London, UK*. A pump dithering removal algorithm, based on pilot sequence-aided DSP, is proposed and experimentally validated in dual polarization 64QAM optical phase conjugation system. A 4.2dB SNR improvement was observed due to the SBS suppression.

W3E.3 • 14:45

MIMO Coding Technique for PDL and Crosstalk Mitigation in Optical Transmission Systems, Akram A. Abouseif[1], Ghaya Rekaya-Ben Othman[1,2], Yves Jaouen[2]; [1]*MI-MOPT Technology, France;* [2]*Telecom Paris, Institut Polytechnique de Paris, France*. We propose new coding technique, called IQ-code, to mitigate PDL and inter-channel crosstalk on optical fiber transmission. We obtain 0.3-0.5 dB OSNR gain at FEC limit for any number of sub-carrier by simple ZF decoding.

W3E.4 • 15:00

On the Nonlinearity Tolerance of Using Short DM Blocklengths for SOA Booster in Coherent Systems, Trung-Hien Nguyen[1], Celestino Sanches Martins[1], Abel Lorences-Riesgo[1], Dylan Le Gac[1], Sami Mumtaz[1], Losif Demirtzioglou[1], Nayla El Dahdah[1], Romain Brenot[1], Yann Frignac[1], Gabriel Charlet[1], Yu Zhao[1]; [1]*Huawei Technologies France, Paris Research Center, Optical Communication Technology Lab, France*. SOA nonlinearity tolerance is experimentally demonstrated for 68~Gbaud single-carrier/8-carrier PCS-64QAM systems. 1.4~dB additional output power is obtained with a 256 blocklength ESS, at the similar optimal SNR and rate loss of long blocklength CCDM.

Room 6E

W3F • Convergent Optical Access for Mobile Connectivity—Continued

W3F.2 • 14:30

Can LAN-Wavelength Division Multiplexing Meet the Evolution of B5G/6G Terabit/s Fronthaul Networks?, Qingsong Wang[1], Jiao Zhang[1,2], Junhao Zhang[1], Bingchang Hua[2], Jian Chen[1], Yuancheng Cai[1,2], Mingzheng Lei[2], Yucong Zou[2], Liang Tian[2], Min Zhu[1,2]; [1]*National Mobile Communications Research Laboratory, Southeast Univ., China;* [2]*Purple Mountain Laboratories, China*. We experimentally demonstrate a LAN-WDM access system with a record bit rate of 2 Tb/s (250 Gbit/s×8) PS-PAM-8 signal with joint equalization techniques to support the evolution of future mobile fronthaul networks with low cost.

W3F.3 • 14:45

Demonstration of Point-to-Multipoint 100G Coherent PON to Support Broadband Access and B5G/6G Mobile X-Haul., Yingxin Wei[1], Jiao Zhang[1,2], Weidong Tong[1], Bingchang Hua[2], Qinru Li[1], Junhao Zhang[1], Mingzheng Lei[2], Yuancheng Cai[1,2], Yucong Zou[2], Liang Tian[2], Min Zhu[1,2]; [1]*Southeast Univ., China;* [2]*Purple Mountain Laboratories, China*. We experimentally demonstrate a rate-flexible point-to-multipoint 100G coherent PON with downlink and uplink using digital subcarrier multiplexing to simultaneously support up to 64 nodes for fixed broadband and W-band mmWave wireless access.

W3F.4 • 15:00

End-to-End Slicing via O-RAN and Software Defined Optical Access, Carlo Centofanti[1], Andrea Marotta[1], Dajana Cassioli[1], Fabio Graziosi[1], Venkateswarlu Gudepu[2], Koteswararao Kondepu[2]; [1]*DISIM, Univ. of L'Aquila, Italy;* [2]*CSE, Indian Inst. of Technology Dharwad, India*. We propose an end-to-end slice management strategy which exploits the programmability of O-RAN and software defined optical access. Advantages in terms of user experienced latency and packet loss are experimentally evaluated.

Room 6F

W3G • Photonic Processing for Computing and ML—Continued

W3G.3 • 14:45
High-Speed and Energy-Efficient non-Volatile Memristive III-v-on-Silicon Photonic Phase Shifter, Zhuoran Fang[2,1], Bassem Tossoun[2], Antoine Descos[2], Di Liang[2], Xue Huang[2], Geza Kurczveil[2], Arka Majumdar[1], Raymond Beausoleil[2]; [1]*Univ. of Washington, USA;* [2]*Hewlett Packard Labs, USA.* We demonstrated a non-volatile III-V-on-silicon photonic phase shifter based on HfO_2 memristor with ~400 fJ switching energy, 100 ns switching speed, and an excellent endurance of over 800 cycles.

W3G.4 • 15:00
Wavelength-Parallel Photonic Tensor Core Based on Multi-FSR Microring Resonator Crossbar Array, Xian Xiao[1], Stanley Cheung[1], Sean Hooten[1], Yiwei Peng[1], Bassem Tossoun[1], Thomas Van Vaerenbergh[1], Geza Kurczveil[1], Raymond Beausoleil[1]; [1]*Hewlett Packard Enterprise, USA.* This paper proposes a wavelength-parallel photonic tensor core by exploiting multiple free spectral ranges (multi-FSRs) of the microring resonator crossbar array architecture. As an example, a four-FSR 4×4 crossbar array is designed and simulated.

Room 7AB

W3H • Coherent Pluggables and Field Trials—Continued

W3H.3 • 14:30 Invited
ZR 400G & 800G Use Cases, Trials, Deployments and Future Prospects, Russell Davey[1], Md Asif Iqbal[2], Paul Wright[2]; [1]*Networks, BT, UK;* [2]*Applied Research, BT, UK.* The paper will review options and use cases for 400Gbit/s and 800Gbit/s deployed in the core of a major national operator, including 400Gbit/s ZR/ZR+ optics embedded in routers and external transponders.

W3H.4 • 15:00 Top-Scored
Field Trial of Coexistence and Simultaneous Switching of Real-Time Fiber Sensing and 400GbE Supporting DCI and 5G Mobile Services, Yue-Kai Huang[3], Zehao Wang[2], Ezra Ip[3], Zhenzhou Qi[2], Gil Zussman[4], Daniel C. Kilper[1], Koji Asahi[5], Hideo Kageshima[5], Yoshiaki Aono[5], Tingjun Chen[2]; [1]*Trinity College Dublin, Ireland;* [2]*Electrical and Computer Engineering, Duke Univ., USA;* [3]*NEC Laboratories America, USA;* [4]*Electrical Engineering, Columbia Univ., USA;* [5]*Photonic System Development, NEC Corporation, Japan.* Coexistence of real-time constant-amplitude distributed acoustic sensing (DAS) and 400GbE signals is verified by field trial over metro fibers, demonstrating no QoT impact during co-propagation and supporting preemptive DAS-informed optical path switching before link failure.

Room 8

W3I • Enabling Technology for Free Space Optical Communications—Continued

W3I.3 • 14:30
Alignment-Tolerant Fi-Wi-Fi Free-Space Optical Bridge, Florian Honz[1], Aina Val-Marti[1], Philip Walther[2], Hannes Hübel[1], Bernhard Schrenk[1]; [1]*AIT Austrian Inst. of Technology, Austria;* [2]*Faculty of Physics, Univ. of Vienna, Universitat Wien, Wien, Wien, AT, academic, Austria.* We demonstrate a simplified out-door FSO link with modal split for down-/uplink and confirm its long-term stability without active beam tracking. We further prove the duality of modal and directional split through penalty-free full-duplex transmission.

W3I.4 • 14:45
High Data Rate Optical Wireless Communication Over Wide Range by Using Nonuniform-Space Optical Phased Array, Yingzhi Li[1], Baisong Chen[1], Min Tao[1], Quanxin Na[2], Xianshu Luo[2], Guo-Qiang Lo[3], Qijie Xie[2], Junfeng Song[1,2]; [1]*Jilin Univ., China;* [2]*Peng Cheng Laboratory, China;* [3]*Advance Micro Foundry, Singapore.* We demonstrate a high-data-rate optical wireless communication (OWC) system over wide steering range by using a nonuniform-space optical-phased-array (OPA) chip. More than 70 Gb/s data transmission covering 100° steering range over 10 m is achieved.

W3I.5 • 15:00
Chaotic-Cavity Surface-Emitting Lasers for Optical Wireless Communication, Omar Alkhazragi[1], Ming Dong[1], Liang Chen[1], Dong Liang[2], Tien Khee Ng[1], Junping Zhang[2], Hakan Bagci[1], Boon S. Ooi[1]; [1]*King Abdullah Univ. of Sci. & Technology, Saudi Arabia;* [2]*Huawei Technologies Co., Ltd., China.* We demonstrated using chaotic cavities to lower the spatial coherence of vertical-cavity surface-emitting lasers. Our design achieved a 10-Gb/s data rate with a 60% increase in the optical power and double the number of modes.

Room 9

W3J • Sensing, Devices and OTDR—Continued

W3J.3 • 14:30
Simultaneous Temperature and Acoustic Sensing With Coherent Correlation OTDR, André Sandmann[1], Florian Azendorf[1], Michael Eiselt[1]; [1]*ADVA Optical Networking SE, Germany.* Superimposed temperature variations and dynamic strain applied through a 400 Hz acoustic signal on a 195 m single-mode fiber section are successfully measured using a coherent correlation optical time domain reflectometry as an interrogator.

W3J.4 • 14:45
Hybrid Coding Ultra-Weak Fiber Bragg Grating (UWFBG) Array for High Spatial Resolution Temperature Sensing, Xiangpeng Xiao[1,2], Qingguo Song[1,2], Weiliang Zhao[1], Hao Li[1,2], Qizhen Sun[1,2], Zhijun Yan[1,2]; [1]*Huazhong Univ of Science and Technology, China;* [2]*Wuxi Research Inst., Huazhong Univ. of Science and Technology, China.* An UWFBG array containing 1000 UWFBGs spaced 10cm apart by time and wavelength division multiplexing was fabricated in UV-transparent coating optical fiber. The temperature sensing precision is around 0.1 under 1pm wavelength measuring accuracy.

W3J.5 • 15:00
Simultaneous Measurement of Temperature and Strain With Enhanced Accuracy by Using Forward Brillouin Scattering in Highly Nonlinear Fiber, Guijiang Yang[1], Keyan Zeng[1], Liang Wang[1], Ming Tang[1], Deming Liu[1]; [1]*Huazhong Univ. of Sci. & Tech., China.* Simultaneous temperature and strain sensing has been demonstrated for the first time by using forward Brillouin scattering in highly nonlinear fiber. The accuracy is improved by seven times compared with that using backward Brillouin scattering.

Show Floor Programming

SF9 • FBA: The State of Fiber in America
14:15–15:15, *Theater II*

MW4 • MW Panel IV: Performance-Centric Long Haul
14:45–16:15, *Theater I*

Bringing Order to Chaos – OIF – Part 1
Presented by OIF
15:00–15:30, *Theater III*

Room 1AB

W3A • Symposium: Beyond the Hype of Network Analytics: Use Cases, Feasibility and Barriers I—Continued

W3A.5 • 15:20 Invited
Analytics for Next-Gen Network Planning, Jian Kong[1]; [1]*Microsoft Corp, USA.* Abstract not available.

Room 2

W3B • Special Session: Photonics for Visible Wavelengths II—Continued

W3B.5 • 15:20 Invited
Heterogeneous Integration for Visible Light PIC, Brian Corbett[1]; [1]*Tyndall National Inst., Ireland.* Abstract not available.

Room 3

W3C • Devices for Quantum Technologies (Joint D5/SCQ)—Continued

W3C.5 • 15:15
Modulator-Free Intensity- and Phase-Modulated Optical Transmitter for Quantum Communications, Robert I. Woodward[1], Yuen San Lo[1,2], Nathan Walk[1], Marco Lucamarini[1], Innocenzo De Marco[1], Taofiq Paraiso[1], Mirko Pittaluga[1], Thomas Roger[1], Mirko Sanzaro[1], Zhiliang Yuan[1], Andrew Shields[1]; [1]*Toshiba Europe Ltd., UK;* [2]*Quantum Science & Technology Inst., UCL, UK.* We demonstrate a simplified optical transmitter design for generating intensity- and phase-modulated pulses, using injection locking and pulse interference. The transmitter is applied for proof-of-principle quantum key distribution, achieving Mbps secure bit rates.

W3C.6 • 15:30 Invited
Interference Beyond the Coherence by Using Classical Light, Yoon-Ho Kim[1]; [1]*Pohang Univ of Science & Technology, Korea (the Republic of).* The intensity correlation between the outputs of two unbalanced Mach-Zehnder interferometers with two classically correlated beams of thermal light at the input exhibits genuine second-order interference beyond the coherence length of the thermal light.

Room 6C

W3D • Modulators and Transceivers—Continued

W3D.5 • 15:15
Highly Optimized O-Band Si Ring Modulators for Low-Power Hybrid CMOS-SiPho Transceivers, Yoojin Ban[1], Minkyu Kim[1], Peter De Heyn[1], Davide Guermandi[1], Filippo Ferraro[1], Natarajan Rajasekaran[1], Peter Verheyen[1], Pieter Bex[1], Junwen He[1], Hakim Kobbi[1], Jeroen De Coster[1], Rafal Magdziak[1], Dieter Bode[1], Sebastien Lardenois[1], Nicolas Pantano[1], Dimitrios Velenis[1], Joris Van Campenhout[1]; [1]*imec, Belgium.* We present O-band Si ring modulators with up to 58pm/V electro-optic and 610pm/mW thermo-optic modulation efficiencies and >24GHz modulation bandwidth, enabling a hybrid CMOS-SiPho transceiver with error-free operation at 40Gbps NRZ with <4pJ/bit link energy

W3D.6 • 15:30 Invited
Monolithically Integrated InP-Based Transceiver Photonic ICs for 800G Solutions, Vikrant Lal[1]; [1]*Infinera Corporation, USA.* Abstract not available.

Room 6D

W3E • Transmission Impairment Mitigation and Compensation Techniques—Continued

W3E.5 • 15:15
Experimental Demonstration of a Simplified SOA Nonlinearity Mitigation Scheme, Eric Sillekens[1], Filipe Ferreira[1], Robert I. Killey[1], Polina Bayvel[1]; [1]*Univ. College London - Dpt E&EE, UK.* We experimentally demonstrated a digital learned-filter mitigation scheme for semiconductor optical amplifier-induced nonlinear distortion of single-polarisation 32 GBd 16QAM and 64QAM signals in a back-to-back configuration.

W3E.6 • 15:30
Inline Optical Compensation of Group Delay Ripple for Long-Haul Transmission Using Offloaded 2×2 MIMO Filter, Masaki Sato[1], Manabu Arikawa[1], Hldemi Noguchi[1], Junichiro Matsui[2], Jun'ichi Abe[1], Emmanuel Le Taillandier de Gabory[1]; [1]*NEC Corporation, Japan;* [2]*NEC Corporation, Japan.* We demonstrated inline optical compensation of group delay ripple estimated with offloaded 2×2 MIMO filter for 84-GBaud PM-PCS-16QAM over 10,200 km SMF. We showed 38 % reduction of MIMO taps, compared to the conventional method.

W3E.7 • 15:45
New Mode-Group-Permutation Strategies for MDL Reduction in Long-Haul MDM Systems, Huihui Wang[1], Xutao Wang[1], Yichen He[1], Zhiqun Yang[1], Yaping Liu[1], Qiang Guo[3], Rui Zhou[3], Xinhua Xiao[3], Zhanhua Huang[1], Lin Zhang[1,2]; [1]*Tianjin Univ., China;* [2]*Peng Cheng Laboratory, China;* [3]*Huawei Technologies Co., Ltd., China.* We compare 9 types of mode-permutation strategies (MPSs) aiming at MDL reduction in MDM systems, based on in-house low-DMD 6-mode optical fibers and MPLCs. Two new CMGP strategies are proposed, showing reach extension by 3~3.5 times.

Room 6E

W3F • Convergent Optical Access for Mobile Connectivity—Continued

W3F.5 • 15:15
New Photonic Gateway to Handle Digital-Coherent and IM-DD User Terminals and Enable Turn-Back Connections in Metro/Access-Integrated All-Photonics Network, Manabu Yoshino[1], Shin Kaneko[1], Naotaka Shibata[1], Ryo Igarashi[1], Jun-ichi Kani[1], Tomoaki Yoshida[1]; [1]*NTT Corporation, Japan.* We propose and demonstrate a novel Photonic Gateway architecture that can flexibly and scalably handle both 100-Gbit/s digital-coherent and IM-DD user terminals with direct optical connections including turn-back channels.

W3F.6 • 15:30 Invited
DSP-Enhanced Radio-Over-Fiber Xhaul Networks Toward Beyond-5G, Paikun Zhu[1], Yuki Yoshida[1], Atsushi Kanno[2,1], Kouichi Akahane[1], Ken-ichi Kitayama[3,1]; [1]*National Inst of Information & Comm Tech (NICT), Japan;* [2]*Nagoya Inst. of Technology, Japan;* [3]*Hamamatsu Photonics Central Research Laboratory, Japan.* We review recent progress on candidate DSP-enhanced radio-over-fiber techniques for Xhaul networks targeting 5G and beyond. Low-latency real-time link and layer-2 networking demonstrations will be discussed.

16:00–16:30 Coffee Beak, *Upper Level Corridors and Exhibit Hall*

Room 6F

W3G • Photonic Processing for Computing and ML—Continued

W3G.5 • 15:15
A Modified Mesh With Individually Monitored Interferometers for Fast Programmable Optical Processors, Hassan R. Mojaver[1], Bokun Zhao[1], Odile Liboiron-Ladouceur[1]; *[1]McGill Univ., Canada.* We demonstrate a novel mesh of interferometers for programmable optical processors. Employing an efficient programming scheme, the proposed architecture improves energy efficiency by 83% maintaining the same computation accuracy for weight matrix changes at 2 kHz.

W3G.6 • 15:30 Invited
VCSEL Based Neuromorphic Computing, Antonio Hurtado[1], Dafydd Owen-Newns[1], Matej Hejda[1], Joshua Robertson[1]; *[1]Univ. of Strathclyde, UK.* We report on Vertical-Cavity Surface-Emitting Lasers (VCSELs) for high-speed and energy-efficiency systems for photonic neuromorphic computing, yielding excellent performance in complex processing tasks whilst benefitting from hardware-friendly implementations and full compatibility with optical communication technologies.

Room 7AB

W3H • Coherent Pluggables and Field Trials—Continued

W3H.5 • 15:15 Invited
Deployment Results of Super C(120)+L(100) Long-Haul Optical Transmission System With Fast Distributed Fault Recovery, Chen Zhu[1], Xu Zhou[1], Shengnan Li[1]; *[1]Baidu Inc., China.* We discuss the hardware, architect and system control of a C+L long-haul transmission link with 11THz total bandwidth. We show that a hierarchy fast distributed fault recovery mechanism is critical for the successful system deployment.

W3H.6 • 15:45
Service Margins for Wide-Band Optical Spectrum Services Implemented in Long-Haul Raman-Enabled Networks, Kaida Kaeval[1,2], Sai Kireet Patri[1], José-Juan Pedreño-Manresa[1], Klaus Grobe[1], Joerg-Peter Elbers[1], Helmut Griesser[1], Marko Tikas[3], Gert Jervan[2]; *[1]ADVA Optical Networking, Germany; [2]TalTech, Estonia; [3]Tele2 Estonia, Estonia.* Operators depend on reliable Q-margin estimates to reliably operate wide-band Optical Spectrum Services. We use long-term performance tracking in a live Raman-enabled links to derive service margins for a 375-GHz Optical Spectrum Service.

Room 8

W3I • Enabling Technology for Free Space Optical Communications—Continued

W3I.6 • 15:15
Next Generation Wireless Fronthaul Using VCSEL-Based Free Space Optics, Tongyun Li[1], Wajahat Ali[1], Rui Chen[1], Yi Liu[1], Michael Crisp[1], Richard Penty[1]; *[1]Electrical Division, Engineering Department, Univ. of Cambridge, UK.* A free-space optics (FSO) based fronthaul final drop is proposed, enabling cost-effective remote unit deployment. Experimental results show >45dB RF dynamic range and an EVM of 1.1% for a 2x20MHz 64QAM RF signal.

W3I.7 • 15:30
Mitigation of Atmospheric Turbulence in an Optical Free Space Link With an Integrated Photonic Processor, Francesco Morichetti[1], Gabriele Cavicchioli[1], Andres Martinez[1], Seyedmohammad Seyedinnavadeh[1], Francesco Zanetto[1], Christian Mazzucco[2], Michele Re[2], Maurizio Mattivi[2], Filippo Morandi[1], Alessandro D'Acierno[2], Umberto Spagnolini[1], Andrea Melloni[1]; *[1]Dipartimento di elettronica informazione e bioingegneria, Politecnico di Milano, Italy; [2]Huawei Technologies Italia, Italy.* Mitigation of turbulence in a Free Space Optical communication link is demonstrated using an integrated programmable optical processor. 10Gbit/s OOK signals are successfully transmitted on an indoor setup emulating hundreds of meters link.

Room 9

W3J • Sensing, Devices and OTDR—Continued

W3J.6 • 15:15
Fast BOTDA Acquiring Method Based on Broadband Light as a Probe Signal, Takahiro Ishimaru[1], Yoshifumi Wakisaka[1], Hiroshi Takahashi[1], Daisuke Lida[1], Yusuke Koshikiya[1]; *[1]NTT corporation, Japan.* We propose a fast BOTDA-based large dynamic strain measurement technique with a broadband ASE probe light. We demonstrate the distributed measurement of 25 Hz vibration with the 380 με amplitude.

W3J.7 • 15:30 Invited
Integrated Antenna Modules for Photonic RF Sensing and Communications, Rod Waterhouse[1], Dalma Novak[2]; *[1]Octane Wireless, USA.* In this paper we present some recent advancements in antenna/photonic device integration for radio? over fiber applications. In our direct integration investigations we divide our approach based on frequency bands; below 6 GHz and above 26 GHz (Ka-band) to be consistent with such applications as present day 5G and 5G+ systems.

16:00–16:30 Coffee Beak, *Upper Level Corridors and Exhibit Hall*

Show Floor Programming

SF9 • FBA: The State of Fiber in America
14:15–15:15, *Theater II*

MW4 • MW Panel IV: Performance-Centric Long Haul
14:45–16:15, *Theater I*

Bringing Order to Chaos – OIF – Part 1
15:00–15:30, *Theater III*

Bringing Order to Chaos – OIF – Part 2
Presented by OIF
15:30–16:00, *Theater III*

SF10 • Broadband Forum: Technologies and Focus to Add Value to the Goal of a Single Multi-Access Optical PON Network
15:30–16:30, *Theater II*

Room 1AB

16:30–18:30
W4A • Symposium: Beyond the Hype of Network Analytics: Use Cases, Feasibility and Barriers II
Presider: Paolo Monti; Chalmers Univ. of Technology, Sweden and Christine Tremblay; École de technologie supérieure, Canada

W4A.1 • 16:30 Invited
When Digital Twins Meet Optical Networks Operations, Darli Mello[1]; [1]*UNICAMP, Brazil*. Abstract not available.

W4A.2 • 16:50 Invited
Combining Machine Learning and Analytical Models, Jelena Pesic[1]; [1]*Nokia, France*. Abstract not available.

Room 2

16:30–18:30
W4B • Lasers and CPO
Presider: Molly Piels; OpenLight, USA

W4B.1 • 16:30
8-Channel CWDM TOSA for CPO External Laser Sources Employing a Blind Mate Connector, Taketsugu Sawamura[1], Kyoko Nagai[1], Kazuhiko Kashima[1], Kohei Umeta[1], Daiki Takeda[1], Tsunetoshi Saito[1], Hideyuki Nasu[1]; [1]*Telecommunication & Energy Laboratories, Furukawa Electric Co., Ltd, Japan.* We report an 8-channel CWDM TOSA designed for CPO ELS modules adopted with a blind mate optical connector. The mechanical size of the TOSA is as small as 22.5 mm × 13.0 mm × 4.0 mm to be built in a standard QSFP housing. The fiber-coupled power is >20 dBm, PER is >20 dB for all channels over the case temperature range of 25 °C to 55 °C.

W4B.2 • 16:45 Invited
Solving the Escape Density Problem: Making Connections Count With SCIP, Rebecca K. Schaevitz[1], Karl Muth[1], Ying Luo[1], Vivek Raghuraman[1], Near Margalit[1]; [1]*Broadcom Corporation, USA*. Silicon Photonics Chiplets in Package (SCIP) creates a paradigm shift, enabling escape densities in optics that match the core silicon and creating a scalable platform that meets requirements of future data center and compute architectures.

Room 3

16:30–18:30
W4C • Advanced Optical Technologies
Presider: Peter Andrekson; Chalmers Tekniska Högskola, Sweden

W4C.1 • 16:30 Invited
Fabrication of Multicore Fibers for High Power Lasers, Sensing, and Communications, Nicoletta Haarlammert[1], Johannes Nold[1], Stefan Kuhn[1], Christian Hupel[1], Sigrun Hein[1], Arno Klenke[2,3], Cesar Jaurequi[2], Jens Limpert[1,2], Thomas Schreiber[1], Andreas Tünnermann[1,2]; [1]*Fraunhofer IOF, Germany;* [2]*Inst. of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität, Germany;* [3]*Helmholtz-Inst. Jena, Germany.* Many fiber applications require novel fiber concepts to overcome existing limitations. The advantages of multicore fibers as a promising fiber concept for fiber lasers, sensing and communications are discussed. Different fabrication technologies are presented.

W4C.2 • 17:00
Direct Electrostriction Measurement Using SPM for Fiber Type Identification, Fatima Al-Shaikhli[1], Maurice O'Sullivan[2], Rongqing Hui[1]; [1]*Univ. of Kansas, USA;* [2]*Ciena, Canada*. We present a simple technique for in-field determination of fiber types through the measurement of electrostriction effect based on self-phase modulation.

Room 6C

16:30–18:15
W4D • Hollow Core Fiber
Presider: Georg Rademacher; National Inst of Information & Comm Tech, Japan

W4D.1 • 16:30 Invited
Birefringent and Low Loss Semi-Tube Hollow-Core Fiber, Yingying Wang[1], Yifeng Hong[1], Shoufei Gao[1], Xiaosong Lu[1], Zhe Zhang[1], Wei Ding[1]; [1]*Inst. of Photonics Technology, Jinan Univ., China.* We summarize our recent work on design, fabrication and characterization of birefringent, low loss and broadband semi-tube hollow-core anti-resonant fiber. We also show its low loss interconnection with panda fiber.

W4D.2 • 17:00 ★ Top-Scored
Longitudinal Non-Destructive Characterization of Nested Antiresonant Nodeless Fiber Microstructure Geometry and Twist, Leonard Budd[1], Austin Taranta[1], Eric Numkam Fokoua[1], Francesco Poletti[1]; [1]*ORC, UK*. We demonstrate non-destructive measurement of nested antiresonant nodeless fiber (NANF) microstructure along 2.2 km of fiber using a side-scattering method. Additionally, using the same technique, we demonstrate measurement of twisting in NANF.

Room 6D

16:30–18:30
W4E • Direct Detection and Short Reach Transmission Systems
Presider: Hussam Batshon; Nokia Bell Labs, USA

W4E.1 • 16:30 Invited
Spiking Neural Network Linear Equalization: Experimental Demonstration of 2km 100Gb/s IM/DD PAM4 Optical Transmission, Georg Böcherer[1], Florian Strasser[1], Elias Arnold[2], Youxi Lin[1], Johannes Schemmel[2], Stefano Calabrò[1], Maxim Kuschnerov[1]; [1]*Huawei Technologies Duesseldorf GmbH, Germany;* [2]*Heidelberg Univ., Germany.* A linear feed-forward equalizer is implemented by a potentially low-power spiking neural network. For a 100Gb/s PAM-4 IM/DD optical 2km transmission, no performance penalty compared to a digital implementation is observed.

W4E.2 • 17:00
Demonstration of Real-Time Receiver for 30-GBaud PAM-6 Signal in IM/DD System, Shenmao Zhang[1], Xiaoxiao Dai[1], Zhuo Chen[1], Qi Yang[1], Chen Liu[1], Lei Deng[1], Mengfan Cheng[1], Deming Liu[1]; [1]*Huazhong Univ. of Science and Technology, China.* Using baud-rate timing recovery algorithm and a simple blind synchronization method, we experimentally demonstrate a real-time reception of 30-GBaud 6-level pulse amplitude modulation (PAM-6) signal with a baud-rate analog-to-digital converter (ADC).

Room 6E

16:30–18:30
W4F • Converged Fixed and Mobile Networks
Presider: Frank Effenberger; FutureWei Technologies Inc, USA

W4F.1 • 16:30 Invited
Inter-Channel FWM Mitigation Techniques for O-Band WDM Based 800G/1.6T LR and 5G Fronthaul Applications, Xiang Liu[1], Qirui Fan[1]; [1]*Huawei Hong Kong Research Center, Hong Kong*. We review recent advances in the mitigation of inter-channel four-wave-mixing (FWM) based on the "XYYX" input polarization alignment and unequal channel spacing to enable high-performance O-band WDM transmission for 800G-LR4, 1.6T-LR8 and bidirectional 5G fronthaul.

W4F.2 • 17:00 Invited
Optical Networks and Edge Computing, David Piehler[1], Raja Jayakumar[1]; [1]*Dell Technologies, USA*. Explosive growth in the number of edge devices highlights the need for distributed compute resources in the data path from edge to the network core. We discuss new applications that bring the need for lower latency, higher bandwidth, autonomous operation, and reduced overall cost compared to the (centralized) cloud computing model, as well as the evolving optical interconnection options that make effective solutions feasible.

Room 6F

16:30–18:30
W4G • Machine Learning for Estimation and Forecasting
Presider: Christine Tremblay; École de technologie supérieure, Canada

W4G.1 • 16:30
CompQoTE: Generalizing QoT Estimation With Composable ML and End-to-End Learning, Hanyu Gao[1], Xiaoliang Chen[1], Lu Sun[2], Zhaohui Li[1]; [1]*Sun Yat-sen Univ., China;* [2]*State Grid Information & Telecommunication Group Co., Ltd., China.* This paper proposes CompQoTE, a composable QoT estimation design with end-to-end learning capability. Results show CompQoT can generalize arbitrary lightpaths while achieving >90% estimation accuracy for unseen lightpaths.

W4G.2 • 16:45
QoT Violation in Low-Margin Optical Networks, Pooyan Safari[1], Behnam Shariati[1], Wanda Baltzer[1], Johannes Karl Fischer[1]; [1]*Fraunhofer HHI, Germany.* We approach the QoT estimation problem from a novel perspective revealing the hidden aspects of QoT violation avoidance procedure during lightpath provisioning and quantify the potential complexity when applied to low-margin networks.

W4G.3 • 17:00 Invited
Machine-Learning-as-a-Service for Optical Network Automation, Carlos Natalino da Silva[1], Nasser Mohammadiha[2,1], Ashkan Panahi[1]; [1]*Chalmers Tekniska Högskola, Sweden;* [2]*Ericsson AB, Sweden.* MLaaS is introduced in the context of optical networks, and an architecture to take advantage of its potential is proposed. A use case of QoT classification using MLaaS techniques is benchmarked against state-of-the-art methods.

Room 7AB

16:30–18:30
W4H • Transmission Systems and Modelling
Presider: To be announced.

W4H.1 • 16:30 Invited
Complexity Versus Accuracy Tradeoffs in Nonlinear Propagation Models, Gabriella Bosco[1]; [1]*Politecnico di Torino, Italy.* Some of the most widespread analytical models for nonlinear propagation in fiber optic coherent systems are reviewed, highlighting the tradeoffs between accuracy and complexity in different transmission scenarios, including wide-band optical systems and short-reach links.

W4H.2 • 17:00
Long-Haul Transmission of 1-Tb/s Data Rate Channel With Inline Filtering Based on 145-GBd Dual Polarization 16QAM, Sylvain Almonacil[1], Yang Hong[1], Haik Mardoyan[1], Xiaoyan Ye[1], Amirhossein Ghazisaeidi[1], Jérémie Renaudier[1]; [1]*Nokia Bell Labs, France.* We demonstrate Tb-class long-haul experiment based on 145-GBd signal occupying one 150-GHz slot. We achieve 1.0-Tb/s/λ over 3630-km distance with a spectral efficiency of 6.67-b/s/Hz while accounting for inline filtering from ROADM in transport networks.

Room 8

16:30–18:30
W4I • Open Networking Summit: Top to Bottom: Practical Approaches to Openness, Disaggregation, and Reaggregation in Optical Communication

Organizers: Yawei Yin, *Microsoft, USA;* Jim Zou, *ADVA, Germany;* Dan Pitt, *Palo Alto Innovation Advisors, USA*

Speakers: Óscar González de Dios, *Telefónica I+D, Spain;* Stephan Neidlinger, *ADVA, Germany;* Guohan Lu, *Microsoft, USA;* David Gomez, *X-Celeprint, USA;* Tino Jaeger, *X-FAB. Germany*

Description: As we look at the success of the "Open" and "Disaggregated" systems in data centers, it is not difficult to draw a few fundamental conclusions: #1, servers came easiest because of standardized processing units, whether it's x86-based CPU, GPU, or Arm processors, running in Linux-based white-box servers, which have become the norm for even the branded server vendors; #2, the standard interfaces that can connect servers together, i.e., the Ethernet-based NIC card and the BGP/TCP/IP protocol stack that enable the communication, and the appearance of Linux-based white-box switches have not yet resulted in their proliferation beyond the hyperscale realm because of the strength of incumbent brands and the challenges of integrating and supporting disaggregated components, and #3, the optical links, while disaggregated to the pluggable level with standardized interfaces, cannot match the density and scale of the computing world. Moreover, DSP algorithms are still being treated as "secret sauce," and advanced modulation schema is not connecting different light sources together. Finally, silicon photonics and III-V semiconductors remain silos not amenable to the integration density required for a wide-open market in co-packaged optics and the eye-popping applications in consumer, health, and civic technologies. In this session, we will paint a "coherent" portrait of advancing openness, manageable disaggregation, and heterogeneous integration and reaggregation in optical communication. We will look at the progress in open-source network operating systems, open-source coherent optical light sources, industry standards in DSP algorithms, and manufacturable heterogeneous-integration technologies. Join us to hear from and debate with the experts leading these innovations.

Room 9

16:30–18:30
W4J • Hybrid Communication/Sensing Systems
Presider: Oskars Ozolins; RISE Research Inst.s of Sweden AB, Sweden

W4J.1 • 16:30 Invited
Photonic-Wireless Communication and Sensing in the Terahertz Band, Xianbin Yu[1], Hongqi Zhang[1], Zuomin Yang[1], zhidong Lyu[1], Hang Yang[1], Yuqian He[1], Siqi Liu[1], Nan Li[1], Oskars Ozolins[2], Xiaodan Pang[2], Lu Zhang[1], Xianmin Zhang[1]; [1]*Zhejiang Univ., China;* [2]*KTH Royal Inst. of Technology, Sweden.* This paper reviews the potential of THz photonics in communication and sensing bypresenting our experimental results in the 300-500 GHz. Benefiting from the large availablebandwidth in both THz and photonics, THz communications with high speed and THz imagingwith high resolution have been achieved.

W4J.2 • 17:00
Photonics-Assisted Joint Radar and Communication System in W Band Using Electromagnetic Polarization Multiplexing, Mingzheng Lei[1], Yuancheng Cai[1,2], Jiao Zhang[1,2], Bingchang Hua[1], Yucong Zou[1], Wei Luo[2], Miaomiao Fang[2], Shitong Xiang[2], Jianjun Yu[1,3], Min Zhu[1,2]; [1]*Purple Mountain Labs, China;* [2]*Southeast Univ., China;* [3]*Fudan Univ., China.* We proposed and demonstrated a photonics-assisted joint radar and communication system in W band using electromagnetic polarization multiplexing. The spatial resolution and wireless rate have reached a record of 15 mm and 92 Gbit/s, respectively.

Room 4

16:30–18:15
W4K • Quantum Networks
Presider: Gregory Kanter; NuCrypt, USA

W4K.1 • 16:30 Invited
Deployed QKD Networks in Europe, Hannes Hübel[1], Florian Kutschera[1], Martin Achleitner[1], Christoph Pacher[1], Werner Strasser[2], Francesco Vedovato[3], Edoardo Rossi[3], Francesco Picciariello[3], Giuseppe Vallone[3], Paolo Villoresi[3], Luca Calderaro[4], Vicente Martin[5], Juan P. Brito[5], Laura Ortiz[5], Diego Lopez[6], Antonio Pastor[6], Marc Geitz[7], Ralf-Peter Braun[7], Piotr Rydlichowski[8]; [1]*AIT Austrian Inst. of Technology, Austria;* [2]*fragmentiX Storage Solutions GmbH, Austria;* [3]*Dipartimento di Ingegneria dell'Informazione, Universita degli Studi di Padova, Italy;* [4]*ThinkQuantum srl, Italy;* [5]*Center for Computational Simulation and ETSI Informáticos, Univ. Politécnica de Madrid, Spain;* [6]*Telefonica I+D, Spain;* [7]*T-Labs, Germany;* [8]*Poznan Supercomputing and Networking Center, Poland.* We report several use-case demonstrations for quantum key distribution in deployed fiber networks. The tests were carried out under real world conditions at the end-user premises using commercial QKD systems.

W4K.2 • 17:00
Multi-User Entanglement Routing in Quantum Mesh Networks, Evan Sutcliffe[1], Matty J. Hoban[2], Alejandra L. Beghelli[1]; [1]*UCL, UK;* [2]*Cambridge Quantum Computing Ltd, UK.* Multipath routing for sharing entanglement between multiple devices was simulated on real network topologies and compared against single-path routing. Results show improved entanglement rates, especially for topologies with a higher average nodal degree.

Show Floor Programming

SF10 • Broadband Forum: Technologies and Focus to Add Value to the Goal of a Single Multi-Access Optical PON Network
15:30–16:30, *Theater II*

Room 1AB

W4A • Symposium: Beyond the Hype of Network Analytics: Use Cases, Feasibility and Barriers II—Continued

W4A.3 • 17:10 Invited

Is Intelligence the Answer to Deal With the 5 v's of Telemetry Data?, Luis Velasco[1]; [1]*Universitat Politecnica de Catalunya, Spain.* Abstract not available.

W4A.4 • 17:30 Invited

Industry Leading Work in Telescent, Bob Shine, *Telescent, USA.* Abstract not available.

Room 2

W4B • Lasers and CPO—Continued

W4B.3 • 17:15

16-ch 1060-nm Single-Mode Bottom-Emitting Metal-Aperture VCSEL Array for Co-Packaged Optics, Liang Dong[1], Xiaodong Gu[1,2], Fumio Koyama[1]; [1]*Tokyo Inst. of Technology, Japan;* [2]*Ambition Photonics Inc., Japan.* We demonstrate 16-ch 1060-nm bottom-emitting metal-aperture VCSEL array for co-packaged optics transceivers. The transverse-control and bandwidth-enhancement is realized thanks to coupled cavity. A record bandwidth and fiber distance product of 250Gbps•km is obtained.

W4B.4 • 17:30

A 66-GHz Lumped-EML Submodule Using Resistance-Optimized LC Resonance With Low Temperature Dependence of 3-dB Bandwidth, Seokjun Yun[1], Youngtak Han[1], Donghun Lee[1], Donghyo Lee[1], Seoktae Kim[2], Janguk Shin[1], Sangho Park[1], Seoyoung Lee[1], Yongsoon Baek[1]; [1]*Photonics/Wireless Devices Research Division, ETRI, Korea (the Republic of);* [2]*Luvantix ADM, Korea (the Republic of).* We report on a lumped-EML submodule with 3-dB bandwidths of 68.2 GHz at 25°C and ~66 GHz at 70°C using a resistance-optimized LC resonance effect, showing low temperature dependence and making it suitable for 112-Gbaud operation.

Room 3

W4C • Advanced Optical Technologies—Continued

W4C.3 • 17:15

Broadband and Fine-Resolution Microwave Photonic Filtering With High-Speed Electronic Reconfigurability, Xinyi Zhu[1], Benjamin Crockett[1], Connor M. Rowe[1], Jose Azaña[1]; [1]*INRS-EMT, Canada.* We experimentally demonstrate electronically programmable, user-defined time-varying frequency filtering of continuous broadband signals, over a 22 GHz frequency tuning range and with >1 GHz reconfiguration speed, using electro-optic modulation of a reversible time-mapped spectrogram.

W4C.4 • 17:30

Nonlinear Tolerant Conjugated RoF System Secured by Physical Layer Encryption With Deliberate Signal Randomization, Tatsuki Ishijima[1], Shuhei Otsuka[1], Shun Harada[1], Takahide Sakamoto[1], Ken Tanizawa[2], Fumio Futami[2]; [1]*Tokyo Metropolitan Univ., Japan;* [2]*Quantum ICT Research Inst., Tamagawa Univ., Japan.* We propose and demonstrate conjugated RoF (C-RoF) secured by physical layer encryption with deliberate signal randomization, for high-RF-link-gain and high-security analog RoF transmission. 19.4-dBm high-power secured C-RoF-QPSK is experimentally achieved with improved fiber nonlinearity tolerance.

Room 6C

W4D • Hollow Core Fiber—Continued

W4D.3 • 17:15

A Method to Compute the Local Birefringence Vector in Twisted and Bent Antiresonant Hollow-Core Fibers., Gianluca Guerra[1], Seyed Mohammad Abokhamis Mousavi[1], Austin Taranta[1], Eric Numkam Fokoua[1], Marco Santagiustina[2], Andrea Galtarossa[2], Francesco Poletti[1], Luca Palmieri[2]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK;* [2]*Univ. of Padova, Italy.* This work proposes a technique to elucidate mode coupling when antiresonant fibers are twisted and bent.From this, we show how the birefringence of a nested antiresonant nodeless fiber changes as function of the deployment.

W4D.4 • 17:30

Near-Zero Radiation Induced Attenuation in Nested Anti-Resonant Nodeless Hollow-Core Fibers at 1550 nm, Sacha Medaer[1,2], Diego Di Francesca[1], Eric Numkam Fokoua[3], Francesco Poletti[3], Daniel Ricci[1], Bernhard Schmauss[2], Austin Taranta[3], Iacopo Toccafondo[1]; [1]*CERN, Switzerland;* [2]*Friedrich-Alexander Univ., Germany;* [3]*Optoelectronics Research Centre, UK.* The first nested anti-resonant hollow-core fiber radiation study is reported. A record near-zero radiation induced attenuation is observed under γ-rays and X-rays. These results open new possibilities for fiber-based applications in radiation environments.

Room 6D

W4E • Direct Detection and Short Reach Transmission Systems—Continued

W4E.3 • 17:15

Dispersion Compensation Over C-Band WDM Grid for 100Gb/s PAM4 System by Low-Complexity Optoelectronic Feedforward Equalization (OE-FFE), Paikun Zhu[1], Yuki Yoshida[1], Atsushi Kanno[2,1], Kouichi Akahane[1], Ken-ichi Kitayama[3,1]; [1]*National Inst of Information & Comm Tech (NICT), Japan;* [2]*Nagoya Inst. of Technology, Japan;* [3]*Hamamatsu Photonics Central Research Laboratory, Japan.* We experimentally investigate OE-FFE-enabled C-band 100Gb/s/λ PAM4 transmission over 50km with different carrier frequencies and linewidths. 3.8-THz range on ITU-T G.694.1 grid is supported with a single 1-tap optical delay line and ≤32-tap digital FFE.

W4E.4 • 17:30

Comparison Between PAM and DMT in a 200-Gb/s IM-DD System Considering the Interaction Between Bandwidth Limit and Peak Power Constraint at Transmitter, Di Che[1]; [1]*Nokia Bell Labs, USA.* We revisit the PAM vs DMT debate in a 200G-class IM-DD system. We study the interaction between bandwidth limit and peak power constraint in an IM transmitter with peak distortion, and involve DSP techniques like faster than Nyquist and entropy loading for a more comprehensive achievable information rate comparison.

Room 6E

W4F • Converged Fixed and Mobile Networks—Continued

W4F.3 • 17:30 ★ Top-Scored

Picosecond-Precision Clock Synchronized Radio Access Networks Using Optical Clock Distribution and Clock Phase Caching, Kari Clark[1], Zichuan Zhou[1], Zhixin Liu[1]; [1]*Univ. College London, UK.* We show 0.98-ps precision clock synchronization for radio access networks, in a real-time field-trial demonstration on 37.6-km dark fiber, with optical clock frequency synchronization and clock phase caching operating using 25.6-Gb/s commercial transceivers.

W4G • Machine Learning for Estimation and Forecasting—Continued

W4G.4 • 17:30
LSTM Assisted Optical Transmission Performance Analysis Over a 493-km Field-Trial, Sen Shen[1], Ruizhi Yang[1], Haiyuan Li[1], Ziming Shi[1], Rui Wang[1], Reza Nejabati[1], Shuangyi Yan[1], Dimitra E. Simeonidou[1]; [1]*HPN, UK*. We implement an LSTM-based algorithm to predict and analyse transmission performance and detect anomalies. Cross-validation of the model over two experimental datasets shows high precision of up to 96\% for R2 to predict short-term variations.

W4H • Transmission Systems and Modelling—Continued

W4H.3 • 17:15 ★ Top-Scored
241.92-Bit/s/Hz Spectral-Efficiency Transmission Over 14-km 7-Core Ring Core Fiber With Low-Complexity 4X4 MIMO Equalization, Zengquan Xu[1], Junyi Liu[1], Jie Liu[1], Zhenrui Lin[1], Junwei Zhang[1], Zhenhua Li[1], Lei Shen[2], Siyuan Yu[1]; [1]*Sun Yat-sen Univ., China;* [2]*State Key Laboratory of Optical Fiber and Cable Manufacture Technology, China*. The transmission of 84 OAM modes with spectral efficiency of 241.92 bit/s/Hz over 14 km 7-core ring core fiber whose cladding diameter is 180μm is demonstrated, using 4 × 4 MIMO equalizations.

W4H.4 • 17:30
Digital Twin of Unrepeatered Line Based on Raman and Remote Optically Pumped Amplifier Machine Learning Models, Arthur Minakhmetov[1], Benjamin Prieur[1], Maël Le Monnier[1], Delphine Rouvillain[1], Bruno Lavigne[1]; [1]*Alcatel Submarine Networks, Nokia, France*. We demonstrate an accurate digital representation of an unrepeatered line based on separate measurement-based machine learning models of Remote Optically Pumped Amplifier and Raman amplification. We assess the accuracy via OSNR measurements in the line.

W4I • Open Networking Summit: Top to Bottom: Practical Approaches to Openness, Disaggregation, and Reaggregation in Optical Communication—Continued

W4J • Hybrid Communication/Sensing Systems—Continued

W4J.3 • 17:15
An Integrated Radar Detection and Microwave Frequency Measurement System Based on an Optically Injected Semiconductor Laser, Zhigang Tang[1], Pei Zhou[1], Jian Zhu[1], Nianqiang Li[1], Shilong Pan[2]; [1]*Soochow Univ., China;* [2]*Nanjing Univ. of Aeronautics and Astronautics, China*. An integrated radar detection and microwave frequency measurement system has been proposed and experimentally demonstrated based on an optically injected semiconductor laser. Both high-resolution radar detection and accurate microwave frequency measurement are realized simultaneously.

W4J.4 • 17:30 Invited
Optically Upconverted, Spatially Coherent Phased-Array-Antenna Feed Networks for Beam-Space MIMO in 5G Cellular Communications, Dennis W. Prather[1,2]; [1]*Univ. of Delaware, USA;* [2]*Phase Sensitive Innovations, USA*. We present an RF-photonic phased-array receiver that provides simultaneous multi-band and multi-beam operation in the millimeter-wave region of the spectrum. It uses a photonic integrated circuit to perform RF beamforming with near unlimited beam-bandwidth product.

W4K • Quantum Networks—Continued

W4K.3 • 17:15
Optimum Switching Scenario Analysis in a Dynamic Entanglement Network, Rui Wang[1], Marcus Clark[1], Siddarth Koduru K. Joshi[1], Sima Bahrani[1], Obada Alia[1], Matej Peranić[2], Martin Lončarić[2], Mario Stipčević[2], John Rarity[1], Reza Nejabati[1], Dimitra E. Simeonidou[1]; [1]*Univ. of Bristol, UK;* [2]*Institut Ruder Bošković, Croatia*. We investigate the performance of a dynamical entanglement-based QKD network with various switching scenarios. The simulation results suggest the optimum scenario for different heralding efficiencies and detectors' jitter and the experimental results verify the benefit.

W4K.4 • 17:30
London Quantum-Secured Metro Network, Andrew Lord[1], Robert Woodward[2], Shinya Murai[3], Hideaki Sato[3], James Dynes[2], Paul Wright[1], Catherine White[1], Russell Davey[1], Mark Wilkinson[1], Piers Clinton-Tarestad[4], Ian Hawkins[1], Kristopher Farrington[1], Andrew Shields[2]; [1]*BT, UK;* [2]*Toshiba Research Europe, UK;* [3]*Toshiba, Japan;* [4]*EY, UK*. We describe a London Quantum-Secured Metro Network using Quantum Key Distribution between three London nodes together with customer access tails. The commercially-ready solution is fully integrated into the BT network and onboarded its first customer.

Room 1AB

W4A • Symposium: Beyond the Hype of Network Analytics: Use Cases, Feasibility and Barriers II—Continued

Room 2

W4B • Lasers and CPO—Continued

W4B.5 • 17:45
Lithium-Niobate-Based Narrow-Linewidth Frequency-Agile Integrated Lasers With Petahertz Frequency Tuning Rate, Viacheslav Snigirev[1], Annina Riedhauser[2], Grigorii Lihachev[1], Johann Riemensberger[1], Rui N. Wang[1], Charles Moehl[2], Mikhail Churaev[1], Anat Siddharth[1], Guanhao Huang[1], Youri Popoff[2,3], Ute Drechsler[2], Daniele Caimi[2], Simon Hoenl[2], Junqiu Liu[1], Paul Seidler[2], Tobias Kippenberg[1]; [1]*EPFL, Switzerland;* [2]*IBM Research Europe, Switzerland;* [3]*ETH Zurich, Switzerland.* We demonstrate an electro-optically tunable hybrid integrated laser self-injection locked to a mode of a heterogeneously integrated lithium-niobate-on-Damascene-silicon-nitride microresonator. An intrinsic linewidth of 3 kHz and a frequency tuning rate of 12 × 10^{15} Hz/s were observed. Proof-of-principle coherent LiDAR experiments were performed.

W4B.6 • 18:00 Invited
FMCW Lidar, Mehdi Asghari[1]; [1]*SiLC Technologies, Inc., USA.* Abstract not available.

Room 3

W4C • Advanced Optical Technologies—Continued

W4C.5 • 17:45
Experimental Demonstration of Chaotic Secure Transmission With Mutual-Injection of Semiconductor Laser Over 130-km Multi-Core Fiber, Lei Shen[2], Zhongyang Wang[1], Min Yang[1], Ziyi Tang[1], Lei Zhang[2], Changkun Yan[2], Liubo Yang[2], Ruichun Wang[2], Jun Chu[2], Jian Wang[1]; [1]*Huazhong Univ. of Science and Techn, China;* [2]*State Key Laboratory of Optical Fiber and Cable Manufacture Technology, China.* We propose and demonstrate chaotic synchronization and communication based on mutual-injection of the semiconductor laser over long-distance multi-core fiber (MCF). It achieves chaotic secure transmission with successful encryption and decryption through 130-km seven-core fiber in the experiment.

W4C.6 • 18:00
Hybrid Distributed Acoustic Sensing and Kramers-Kronig Communication System Over a two-Mode Fiber, Juan M. Marin Mosquera[1], Dmitrii Briantcev[1], Chun Hong Kang[1], Omar Alkhazragi[1], Tien Khee Ng[1], Islam Ashry[1], Abderrahmen Trichili[1], Boon S. Ooi[1]; [1]*KAUST, Saudi Arabia.* We report on the co-propagation of distributed acoustic sensing (DAS) and Kramers-Kronig communication scheme over a two-mode fiber, achieving DAS with a signal-to-noise ratio larger than 2 dB and gross data rate of 2.04 Gbps.

Room 6C

W4D • Hollow Core Fiber—Continued

W4D.5 • 17:45
Wideband Transmission in the 1-μm Band Based on a Hollow-Core Fiber and Wideband YDFA, Yang Hong[1,2], Xin Huang[1], Yong-Min Jung[1], Hans C. Mulvad[1], Hesham Sakr[1], Natsupa Taengnoi[1], Kyle R. Bottrill[1], Francesco Poletti[1], Periklis Petropoulos[1], David J. Richardson[1]; [1]*Optoelectronics Research Centre, Univ. of Southampton, UK;* [2]*Nokia Bell Labs, France.* We show the potential of combining a hollow-core NANF with a wideband YDFA for 1-μm transmission through a conceptual demonstration. Penalty-free transmission over a 2.24-km NANF at >100Gb/s is reported across a 16.3-THz bandwidth (1020-1080nm).

W4D.6 • 18:00
Estimation of Kerr Nonlinearity in an Anti-Resonant Hollow-Core Fiber by High-Order QAM Transmission, Dawei Ge[1], Shoufei Gao[2], Mingqing Zuo[1], Yuyang Gao[3], Yingying Wang[2], Baoluo Yan[4], Bing Ye[4], Dechao Zhang[1], Wei Ding[2], Han Li[1], Zhangyuan Chen[3]; [1]*China Mobile Research Inst., China;* [2]*Jinan Univ., China;* [3]*Peking Univ., China;* [4]*ZTE, China.* We propose a novel technique to measure Kerr nonlinearity in a hollow-core fiber based on nonlinear phase shift estimation by high-order QAM transmission. The measured $n_{2,Kerr}$ of the NANF-5 medium is <2.20×10^{-23} m^2/W.

Room 6D

W4E • Direct Detection and Short Reach Transmission Systems—Continued

W4E.5 • 17:45
Performance Evaluation of Low-Complexity Channel-Polarized Multilevel Coded 146-Gbaud PDM Probabilistically Shaped 16QAM Over 101-km Transmission, Takeshi Kakizaki[1], Masanori Nakamura[1], Fukutaro Hamaoka[1], Yoshiaki Kisaka[1]; [1]*NTT Corporation, Japan.* We experimentally show that low-complexity channel-polarized multilevel coding enables up to 74% decoding-complexity reduction compared to concatenated codes over a 101-km 146-Gbaud probabilistically shaped 16QAM signal transmission.

W4E.6 • 18:00 Invited
Single-Ended Coherent Receivers: From DC-Coupled to AC-Coupled Photodetectors, Son T. Le[1]; [1]*Nubis Communications, USA.* We review the concept of single-ended coherent receivers and discuss how LO power and signal power can be accurately estimated when AC-coupled photodetectors are used instead of DC-coupled photodetectors

Room 6E

W4F • Converged Fixed and Mobile Networks—Continued

W4F.4 • 17:45
Demonstration of Energy Efficient Optimization in Beyond 5G Systems Supported by Optical Transport Networks, Petros Georgiadis[1], Markos Anastasopoulos[1], Alexandros Ioannis Manolopoulos[1], Victoria Maria Alevizaki[1], Navid Nikaein[2], Anna Tzanakaki[1]; [1]*National and Kapodistrian Univ. of, Greece;* [2]*Department of Communication Systems, Eurecom, France.* The paper proposes an optimization framework using artificial intelligence to optimize the energy efficiency of a B5G system operating over an SDN controlled optical transport network. The system is evaluated over an operational B5G testbed

W4F.5 • 18:00 Invited
Efficient Transport of ECPRI Fronthaul Over PON, Jochen Maes[1], Sarvesh Bidkar[2], Michael Straub[2], Thomas Pfeiffer[2], Rene Bonk[2]; [1]*Nokia Bell Labs, Belgium;* [2]*Nokia Bell Labs, Germany.* Passive optical networks (PONs) facilitate small cell deployments. Back- and midhaul already make efficient use of PON. We explain the steps taken in mobile and in PON industries to enable efficient eCPRI fronthaul over PON.

W4G • Machine Learning for Estimation and Forecasting—Continued

W4G.5 • 17:45
986 km Field Trial of Cascaded ANN-Based Link-Penalty Models for QoT Prediction, Ruizhi Yang[1], Sen Shen[1], Haiyuan Li[1], Ziming Shi[1], Rui Wang[1], Reza Nejabati[1], Shuangyi Yan[1], Dimitra E. Simeonidou[1]; *[1]Univ. of Bristol, UK.*Cascaded ANN-based link penalty models are developed and demonstrated for QoT predictions over a 986-km field trial testbed, with precision of ± 0.16 dB. Co-training of ANN models allows network-level QoT prediction feasible.

W4G.6 • 18:00
QoT Estimation Improvement With Inputs Refinement Tool for C+L Networks, Xin Yang[1], Alessio Ferrari[1], Nathalie Morette[1], Yvan Pointurier[1]; *[1]Huawei Technologies France SASU, France*. We propose a technique to estimate lumped losses thus OSNR, nonlinear SNR, GSNR, and SNR in C+L optical networks. We show with simulations that SNR estimation accuracy is within 0.5dB and that the technique is robust to uncertainty due to aging.

W4H • Transmission Systems and Modelling—Continued

W4H.5 • 17:45
110.4 Tbit/s Same-Wavelength Bidirectional Optical Fiber Transmission Over 100 km G. 654D Fiber in Super-C Band With Rayleigh Scattering Noise Suppressed by Raman Amplifiers, Chengcheng Wu[1], Wei Li[1], Ming Luo[2], Shaohua Yu[3], Zhixue He[3], You Wang[1], Zhongshuai Feng[1], Peili He[1], Weihua Lian[1], Muyang Mei[1], Xu Zhang[2], Liang Mei[4], Xuefeng Wu[4]; *[1]Huazhong Univ of Science and Technology, China; [2]State Key Laboratory of Optical Communication Technologies and Networks, Wuhan 430200, China, China; [3]Peng Cheng Laboratory, Shenzhen, China, China; [4]Fiberhome Telecommunication Technologies Co., Ltd, Wuhan, China, China.* we have demonstrated a capacity of 111.6 Tbit/s over a 75-km G.654D fiber along with a capacity of 110.4 Tbit/s over 100 km in super C-band based on the same-wavelength bidirectional optical fiber transmission scheme.

W4H.6 • 18:00
Robust Longitudinal Power Profile Estimation in Optical Networks Using MMSE With Complex Scaling Factor, Inwoong Kim[1], Olga Vassilieva[1], Ryu Shinzaki[2], Motohiko Eto[2], Shoichiro Oda[2], Paparao Palacharla[1]; *[1]Fujitsu Network Communications, Inc, USA; [2]Fujitsu Limited, Japan*. We propose a power profile estimator using MMSE, that automatically adjusts the scaling and nonlinear rotation of constellation with complex scaling factor. We demonstrate robust performance in simulation and experiment, even at higher launch powers.

W4I • Open Networking Summit: Top to Bottom: Practical Approaches to Openness, Disaggregation, and Reaggregation in Optical Communication—Continued

W4J • Hybrid Communication/Sensing Systems—Continued

W4J.5 • 18:00 ★ Top-Scored
Photonic-Based W-Band Flexible TFDM Integrated Sensing and Communication System for Fiber-Wireless Network, Boyu Dong[1], Junlian Jia[1], Guoqiang Li[1], Jiangyang Shi[1,2], Haipeng Wang[1], Zhenzhou Tang[3], Junwen Zhang[1,2], Shilong Pan[3], Nan Chi[1,2]; *[1]Fudan Univ., China; [2]Peng Cheng Laboratory, China; [3]Nanjing Univ. of Aeronautics and Astronautics, China*. We proposed and experimentally demonstrated a novel W-band photonic-based integration of sensing and communication system for the fiber-wireless integrated network with flexible waveforms and TFDM resource allocation capability, achieving adaptive sensing resolution and communication data-rates.

W4K • Quantum Networks—Continued

W4K.5 • 17:45 Invited
Quantum Networks: the Path Beyond Just QKD, Siddarth Koduru K. Joshi[1]; *[1]Univ. of Bristol, UK*. Abstract not available.

Room 1AB	Room 2	Room 3	Room 6C	Room 6D	Room 6E
W4A • Symposium: Beyond the Hype of Network Analytics: Use Cases, Feasibility and Barriers II—Continued	**W4B • Lasers and CPO—Continued**	**W4C • Advanced Optical Technologies—Continued**	**W4D • Hollow Core Fiber—Continued**	**W4E • Direct Detection and Short Reach Transmission Systems—Continued**	**W4F • Converged Fixed and Mobile Networks—Continued**

W4C.7 • 18:15
Direct Intensity Detection of Complex Communication Data Signals Using a Real-Time Photonics Spectrogram, Connor M. Rowe[1], Benjamin Crockett[1], Jose Azaña[1]; [1]*INRS, Canada.* We use a time-lens spectrogram for real-time recovery of complex modulation data signals using a single photodiode, no local oscillator, and simple decision method. Our proof-of-concept experiment decodes QAM4 and QAM8 under the FEC limit.

Room 6F

W4G • Machine Learning for Estimation and Forecasting—Continued

W4G.7 • 18:15
Traffic Prediction Based on P-ConvLSTM in Optical Transport Networks, Xin Qin[1], Qian Hu[1], Xiaoli Huo[1], Jiuyu Xie[1]; [1]*China Telecom Research Inst., China.* Based on Prophet-guided neural network, P-ConvLSTM is proposed for traffic prediction. Proved by multi-group real traffic data in OTN, P-ConvLSTM has high accuracy and strong generalization.

Room 7AB

W4H • Transmission Systems and Modelling—Continued

W4H.7 • 18:15
Nonlinear-Penalty-Free Real-Time 40×800Gb/s DP-64QAM-PCS Transmission With Launch Power of 28 dBm Over a Conjoined-Tube Hollow-Core Fiber, Dawei Ge[1], Shoufei Gao[2], Mingqing Zuo[1], Yuyang Gao[3], Yingying Wang[2], Dechao Zhang[1], Wei Ding[2], Han Li[1], Xiaodong Duan[1], Zhangyuan Chen[3]; [1]*China Mobile Research Inst., China;* [2]*Jinan Univ., China;* [3]*Peking Univ., China.* Real-time 40×800Gb/s DP-64QAM-PCS transmissions over three different optical fibers (i.e., CTF, G.652.D, G.654.E) are tested under 28-dBm launch power for the first time. No nonlinear penalty is observed in the CTF link.

Room 8

W4I • Open Networking Summit: Top to Bottom: Practical Approaches to Openness, Disaggregation, and Reaggregation in Optical Communication—Continued

Room 9

W4J • Hybrid Communication/Sensing Systems—Continued

W4J.6 • 18:15
Duobinary-Coded Coherent ΣΔ Radio-Over-Fiber Transmission at 9 GHz Downlink Channel Spacing, Bernhard Schrenk[1], Florian Honz[1]; [1]*AIT Austrian Inst. of Technology, Austria.* We show digitized radio-over-fiber transmission using coherent envelope detection. A low EVM of 1.3%, a high optical budget of 34.6dB and 25% improvement in spectral occupancy are found when introducing duobinary signaling and coherent detection.

Room 4

W4K • Quantum Networks—Continued

06:00–07:30 Rise and Shine Morning Run/Walk, *Hilton Bayfront*

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

08:00–10:00 Th1A • Novel Photonic Devices and Applications

Presider: Samuel Palermo; Texas A&M Univ., USA

Th1A.1 • 08:00 Invited

Integrated Comb-Driven Silicon Photonics, Xingjun Wang[1], Bitao Shen[1], Haowen Shu[1], Lin Chang[2], Yuansheng Tao[1], Weiqiang Xie[2], John E. Bowers[2]; [1]*State Key Laboratory of Advanced Optical Communications System and Networks, School of Electronics, Peking Univ., China;* [2]*Department of Electrical and Computer Engineering, Univ. of California, Santa Barbara, Armenia.* We realize the combination of integrated microcomb and silicon photonics, employing the advanced AlGaAsOI optical nonlinear platform and novel SiPh chips. Data link with 2-Tbps aggregate rate and highly reconfigurable radio frequency filter are demonstrated.

08:00–10:00 Th1B • Nonlinear-Optical Amplifiers and Oscillators

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

Th1B.1 • 08:00 Invited

Design and Applications of Highly Nonlinear Fibers, Ryuichi Sugizaki[1], Masanori Takahashi[1], Shigehiro Takasaka[1], Toshio Kimura[1]; [1]*Furukawa Electric, Japan.* Highly nonlinear fibers which can be utilized in all-optical signal processing is introduced. Characteristics of highly nonlinear fiber and requirements from various applications are summarized.

08:00–10:00 Th1D • Data Center Networks and Control

Presider: To be announced.

Th1D.1 • 08:00

PROPH: A Contention-Free and Elastic Bandwidth Scheduling Scheme for AWGR-Based Optical DCN, Xinwei Zhang[1], Xuwei Xue[1], Bingli Guo[1], Xiaoyue Su[1], Yisong Zhao[1], Yuanzhi Guo[1], Shanguo Huang[1]; [1]*Beijing Univ. of Post and Telecommu, China.* A contention-free scheduling scheme PROPH is proposed for AWGR-based optical DCN to elastically allocate adaptable bandwidth. Assessments validate that the network deploying PROPH decreases 73.6% packet loss and 11.9% server-to-server latency, improves 11.6% network throughput.

Th1D.2 • 08:15

GCN-Assisted SnF Scheduling Method for Inter-Datacenter Bulk Transfers, Xiao Lin[1], Lanfang Zheng[1], Yajie Li[3], Keqin Shi[2]; [1]*College of Physics and Information Engineering, Fuzhou Univ., China;* [2]*Shanghai Jiao Tong Univ., China;* [3]*Beijing Univ. of Posts and Telecommunications, China.* A GCN-assisted scheduling method is presented to schedule bulk transfers across the inter-DCN in a store-and-forward manner. Simulations demonstrate that the proposed method obtains better network performance and lower complexity than the conventional methods.

08:00–10:00 Th1C • Panel: Promises, Prospects and Challenges of VCSELs for Data Center Interconnects, Free-Space Communications, and Sensing

Organizers: Connie Chang-Hasnian, *Brexel Photonics, China;* Fotini Karinou, *Microsoft Research Ltd, UK;* Hai-Feng Liu, *HG Genuine, China;* Jim Lott, *Technical University Berlin, Germany*

Speakers: Ernesto Ciaramella, *Scuola Superiore Sant'Anna, Italy;* John R. Joseph, *OptiPulse Inc, USA;* Cy Lu, *Lumentum Operations Inc, USA;* Ramana Murty, *Broadcom, USA;* Jiaxing Wang, *Berxel Photonics, China*

Description: We aim for thought-provoking presentations and discussions on future promises and challenges of VCSELs for data center interconnects, free space optical communications, and sensing applications.

VCSELs are the light source of choice for short-reach data center interconnects, with 53 Gbps per lane (26.5 Gbaud PAM4) arrays being widely deployed and 106 Gbps per lane (via 53 Gbaud PAM4) arrays under pilot runs. However, can they scale up to 200 Gbps per channel with the same oxide-confined VCSEL structure? Will it require a radically different device technology to bring the bandwidth to 40 GHz and to mitigate the reliability issues due to increased operating temperatures when moving the pluggable transceivers from the front plate to the ASIC? What are the cost drivers and challenges to overcome?

Will VCSELs or VCSEL arrays enable fifth (5G) and sixth generation (6G or Next G) optical wireless communication at 10 to 50 Gbps per lane over meters to kilometers? What role will VCSELs play in 5G and 6G optical wireless communication and sensing for Internet of Things, manufacturing, backhaul, last mile, urban mesh networks, and more?

08:00–10:00 Th1E • Beyond 400G Transmission

Presider: Hungchang (James) Chien; Marvell Technology Inc., USA

Th1E.1 • 08:00 Invited

System Impact of Laser Phase Noise on 400G and Beyond Coherent Pluggables, Hai Xu[1], Marcos O. Rebellato[2], Shih-Cheng Wang[1]; [1]*Marvell Technology, Inc, USA;* [2]*Marvell Technology, Inc, Argentina.* We show that 800G systems are highly sensitive to phase noise of local oscillator. We introduce a PI model that correlates well with measured performance. We present performance simulations and limitations of current timing recovery.

08:00–10:00 Th1F • Machine Learning and Advanced Digital Signal Processing

Presider: Kohki Shibahara; NTT Network Innovation Laboratories, Japan

Th1F.1 • 08:00 Invited

Real-Time MIMO Adaptive Equalization With Carrier-Phase Recovery for Mode-Division Multiplexed Optical Coherent System, Koji Igarashi[1]; [1]*Osaka Univ., Japan.* We review our designed and implemented real-time MIMO adaptive equalization with carrier-phase recovery and frequency offset, which has been introduced to real-time mode-division multiplexed transmission experiments.

06:00–07:30 Rise and Shine Morning Run/Walk, *Hilton Bayfront*

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

08:00–10:00
Th1G • Signal Processing in Next-Generation PON

Presider: Paola Parolari; Politecnico di Milano, Italy

Th1G.1 • 08:00
Interoperability and Experimental Evaluation of TDEC(Q) Testing for 50 and 100G PONs, Dora van Veen[1], Robert Borkowski[1], Amitkumar Mahadevan[1], Vincent Houtsma[1]; [1]*Nokia Bell Labs, USA*. We detail the TDEC(Q) method and its usage in the context of system level specifications for 50 and 100G PONs. Real-time experimental results obtained with representative PON transmitters are used to analyze and validate interoperability of these PONs.

Th1G.2 • 08:15
Study of TDEC for 50G-PON Upstream at 50 Gb/s in Negative Dispersion Regime Using 25G-Class Transceivers, Giuseppe Caruso[2,1], Ivan N. Cano[2], Giuseppe Talli[2], Derek Nesset[3], Roberto Gaudino[1]; [1]*Politecnico di Torino, Italy;* [2]*Munich Research Center, Huawei Technologies, Germany;* [3]*Ipswich Research Center, Huawei Technologies, UK*. We evaluate TDEC and Rx sensitivity in a negative dispersion regime with 25G-class DML and EML modulated at 50 Gb/s. Results show that TDEC can effectively predict the performance of both transmitters for 50G-PON upstream.

08:00–10:00
Th1J • Panel: How Can We Start to Consistently and Quantitatively Account for End-to-End Power Consumption, Beginning with a Focus on 100 Meter Datacenter Links?

Organizers: Trey Greer, *NVIDIA, USA;* Clint Schow, *University of California, Santa Barbara ECE, USA*

Speakers: Andreas Bechtolsheim, *Arista Networks, USA;* Tom Gray, *Nividia Research, USA;* Thomas Lijeberg, *Intel Corporation, USA;* Alexander Rylakov, *Nokia, Canada*

Description: The power efficiency of short (<100 m) datacenter optical links has become increasingly important, and pJ/bit has become a ubiquitous figure of merit. However, it is difficult or often impossible to assess and compare true end-to-end power dissipation for various link architectures. Optical link papers often stop power accounting at the optical transducer edges, and do not include the power costs of (de) serialization and clock distribution on the PIC. Furthermore, as we progress toward co-packaged optics, we need a consistent framework for estimating the power of various electrical links to the host ASIC. This panel has a broad scope that extends from systems to devices, and is targeted at beginning to build consensus on how to consistently and quantitatively account for end-to-end power in optical links.

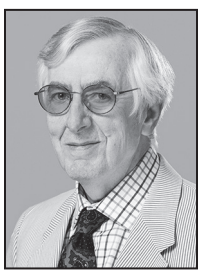
Our goal is to provide researchers with the tools they need to fit their link components into an overall link power consumption budget. We hope to start discussions on the power costs of:

- FEC power per bit vs BER.
- DFE, FFE, and receiver linear EQ.
- Clock distribution and data (de)serialization at various symbol rates.
- 'Gear Boxes' for converting data stream formats between optical vs electrical layers.
- The electrical links for CPO vs NPO vs pluggable.
- Optical losses at package connections and within PICs that drive up laser power.

08:00–10:00
Th1I • THz Optical Communications

Presider: Lalitha Ponnampalam; Univ. College London, UK

Th1I.1 • 08:00 **Tutorial**
THz Technologies for Optical Communications, Alwyn J. Seeds[1]; [1]*Univ. College London, UK*. Connections between user devices and the immense bandwidth of the optical fibre network are usually by microwave wireless, limiting the user bandwidth. This tutorial describes how the use of THz technologies could overcome this limitation.Abstract not available.



08:00–10:00
Th1H • Satellite Communications and UV, LWIR Free Space Optical Communications

Presider: Morio Toyoshima; National Inst of Information & Comm Tech, Japan

Th1H.1 • 08:00
8.1 Gbps PAM8 Long-Wave IR FSO Transmission Using a 9.15-μm Directly-Modulated QCL With an MCT Detector, Mahdieh Joharifar[1], Mengyao Han[2,1], Richard Schatz[1], Rafael Puerta[3,1], Yan-Ting Sun[1], Yuchuan Fan[4], Grégory Maisons[5], Johan Abautret[5], Roland Teissier[5], Lu Zhang[6], Sandis Spolitis[7,8], Muguang Wang[2], Vjačeslavs Bobrovs[7], Sebastian Lourdudoss[1], Xianbin Yu[6], Sergei Popov[1], Oskars Ozolins[1,4], Xiaodan Pang[1,4]; [1]*KTH, Sweden;* [2]*Inst. of Lightwave Technology, Key Lab of All Optical Network & Advanced Telecommunication Network, Ministry of Education, Beijing Jiaotong Univ., China;* [3]*Ericsson, Sweden;* [4]*RISE Research Inst.s, Sweden;* [5]*mirSense, France;* [6]*College of Information Science and Electronic Engineering, Zhejiang Univ., China;* [7]*Inst. of Telecommunications, Riga Technical Univ., Latvia;* [8]*Communication Technologies Research Center, Riga Technical Univ., Latvia.* We experimentally demonstrate a Long-Wave IR FSO link with a 9.15-μm directly modulated quantum cascade laser at room temperature. Up to 8.1 Gb/s PAM8 transmission over 1.4 meter is achieved with a wideband MCT detector.

Th1H.2 • 08:15
Gbps-Class Solar-Blind WDM Optical Wireless Communication by (264, 274, 282)-nm Deep-UV LEDs and CsTe Photomultiplier Tube, Yuki Yoshida[1], Kazunobu Kojima[2], Masaki Shiraiwa[1], Atsushi Kanno[3,1], Akira Hirano[4], Yosuke Nagasawa[4], Masamichi Ippommatsu[4], Naokatsu Yamamoto[1], Shigefusa F. Chichibu[5], Yoshinari Awaji[1]; [1]*National Inst of Information & Comm Tech, Japan;* [2]*Graduate School of Engineering, Osaka Univ., Japan;* [3]*Nagoya Inst. of Technology, Japan;* [4]*UV Craftory Co. Ltd., Japan;* [5]*Inst. for Multidisciplinary Research for Advanced Materials, Tohoku Univ., Japan.* A Gbps-class wavelength-division multiplexing transmission within the solar-blind band was demonstrated for the first time with (264, 274, 282)-nm AlGaN-based LEDs and a CsTe photomultiplier-tube over a 2-m weakly-collimated free-space link in standard indoor illumination.

Room 1AB

Th1A • Novel Photonic Devices and Applications—Continued

Th1A.2 • 08:30
Automatic in-Situ Optical Linearization of Silicon Photonic Ring-Assisted MZ Modulator for Integrated RF Photonic SoCs, Md Jubayer Shawon[1], Vishal Saxena[1]; [1]*Univ. of Delaware, USA.* We experimentally demonstrate automatic optical linearization of a Ring-Assisted MZ modulator with SFDR > 110dB.Hz2/3, fabricated in a silicon photonic foundry process. The linearization algorithm reconfigures the modulator to its optimum SFDR or other desired regimes regardless of random phase offsets and process/temperature variations.

Th1A.3 • 08:45
Fast (<9.4 µs) Full-C-Band Tuning of Silicon Photonics Double-Ring Filters Using Feed-Forward Control, Ryotaro Konoike[1], Hiroyuki Matsuura[1], Keijiro Suzuki[1], Ryosuke Matsumoto[1], Kazuhiro Ikeda[1], Ken-ichi Sato[1]; [1]*AIST, Japan*. We demonstrate full-C-band (1530-1565 nm) tuning of narrowband (~20 GHz) silicon ring filters with <9.4 µs optical 60% rise time, which is >25 times faster than step-function control, by adopting inverse-designed feed-forward analog control.

Th1A.4 • 09:00
Slim Push-Pull Fiber Array Connector for Optical Chips, Lars Brusberg[1], Jürgen Matthies[2], Jason Grenier[1], Jeffrey Clark[1], Betsy Johnson[1], Chad Terwilliger[1]; [1]*Corning Inc, USA;* [2]*Corning Optical Communications GmbH & Co KG, Germany.* We report connector loss of 0.42 dB for a low-profile fiber-to-chip connector to replace fiber pigtails and enable flip-chip electronic assembly of optical chips for co-packaged optics.

Room 2

Th1B • Nonlinear-Optical Amplifiers and Oscillators—Continued

Th1B.2 • 08:30
Temperature-Tuned two-Segment Highly-Nonlinear Fiber With Increased Stimulated Brillouin Scattering Threshold, Cheng Guo[1], Michael Vasilyev[1], Youichi Akasaka[2], Paparao Palacharla[2], Shigehiro Takasaka[3], Ryuichi Sugizaki[3]; [1]*Department of Electrical Engineering, Univ. of Texas at Arlington, USA;* [2]*Advanced Technology Labs, Fujitsu Network Communications, USA;* [3]*Furukawa Electric Co. Ltd, Japan*. We apply temperature tuning to align zero-dispersion wavelengths of two fiber segments with different Brillouin frequencies. The resulting two-segment highly-nonlinear fiber exhibits 2.1-dB-increased stimulated Brillouin scattering threshold and flattened parametric gain.

Th1B.3 • 08:45
Mid-Span Pump Phase Shift Applied to WDM Wavelength Conversion for the Suppression of FWM Crosstalk, Kyle Bottrill[1], Natsupa Taengnoi[1], Hao Liu[1], Periklis Petropoulos[1]; [1]*Univ. of Southampton, UK.* We apply mid-span pump-phase shifting to the wavelength conversion of a 9 channel WDM band in order to suppress inter-channel nonlinear crosstalk. SNR improvements between 3-6dB are observed through the use of the technique.

Th1B.4 • 09:00
Low-Noise Phase-Sensitive Optical Parametric Amplifier With Local Pump Generation Using Digital Frequency and Phase Control, Rasmus Larsson[1], Kovendhan Vijayan[1], Jochen Schröder[1], Peter A. Andrekson[1]; [1]*Chalmers Univ. of Technology, Sweden.* We demonstrate a novel, lossless approach, eliminating the need to co-propagate pumps in phase-sensitive parametric amplifier-based links, by control loops creating a locked pump within the amplifier. Gain, noise and BER measurements validate the performance.

Room 3

Th1D • Data Center Networks and Control—Continued

Th1D.3 • 08:30 Invited
How Data Center Networks Can Improve Through Co-Packaged Optics, Pavlos Maniotis[1], Laurent Schares[1], Daniel Kuchta[1]; [1]*IBM TJ Watson Research Center, USA.* Building higher-radix switches with co-packaged optics can help improving network locality in data center networks. Simulations show completion time reductions of up to 40% for an all-to-all communication pattern and a network stack latency of 1.25 us.

Th1D.4 • 09:00
P4INC-AOI: When in-Network Computing Meets All-Optical Interconnect for Adaptive and Low-Latency Optical DCN, Xuexia Xie[1], Hao Yang[1], Zuqing Zhu[1]; [1]*Univ of Science and Technology of China, China.* We propose and experimentally demonstrate P4INC-AOI for orchestrating in-network computing and all-optical interconnect in an optical data-center network. Experimental results show that P4INC-AOI reduces job completion time of Hadoop MapReduce jobs by 77.9% on average.

Room 6C

Th1C • Panel: Promises, Prospects and Challenges of VCSELs for Data Center Interconnects, Free-Space Communications, and Sensing—Continued

Decades of manufacturing and deployment experience in communication systems have provided a foundation in two new markets for VCSELs: 3D sensing and automotive LiDAR. Can the rapid innovations in 3D sensing and LiDAR help to transform the VCSEL in other market segments, and if yes, how?

In this Panel, we will discuss state-of-the-art VCSEL technologies, remaining device and systems challenges, synergies across different market segments, and future emerging applications.

Room 6D

Th1E • Beyond 400G Transmission—Continued

Th1E.2 • 08:30
Transmission and Reception of 17×480 Gbit/s PDM-16QAM With Tx/Rx I/Q Imbalance Compensation and Simplified MLSE for Metro-Regional 400G Optical Communications, Fan Li[1], Dongdong Zou[1], Weihao Ni[1], Zhiwei Chen[1], Xingwen Yi[1], Zhaohui Li[1]; [1]*Sun Yat-Sen Univ., China.* We experimentally demonstrate a single-carrier 400G Metro/regional communications based on 60-GBaud PDM-16QAM over 430-km SMF-28. Joint GPD and GSOP and 4×4 MIMO LMS equalizer are adopted to compensate Rx/Tx I/Q imbalance, and simplified MLSE with 99.61% computational complexity reduction is employed to mitigate channel bandwidth constraint.

Th1E.3 • 08:45
Impact of Laser Impairments on DSCM-Based 800G Point-to-MultiPoint Coherent Transmission Systems, Sami Mumtaz[1], Trung-Hien Nguyen[1], Abir Hraghi[1], Abel Lorences-Riesgo[1], Yann Frignac[1], Gabriel Charlet[1], Yu Zhao[1]; [1]*Huawei Technologies, France.* We experimentally investigate the impact of laser frequency linewidth and jitter on the design of uplink point-to-multipoint DSCM systems. The performance degradation due to sub-band overlap, bandwidth limitation and DSP penalty is quantified.

Th1E.4 • 09:00
Multi-Parameter AI-Based Bandwidth Compensation for Energy-Efficient 800G Transmission, Marco A. Fernandes[1,2], Adriano C. Messias[3], Tomaz d. Vilela[3], Daniel A. Formiga[3], Jacklyn D. Reis[3], Paulo Monteiro[2,1], Fernando Guiomar[1,2]; [1]*Instituto de Telecomunicacoes, Portugal;* [2]*Univ. of Aveiro, Portugal;* [3]*Idea! Electronic Systems, Brazil.* We propose a novel energy-efficient AI-based bandwidth compensation technique that jointly optimizes Tx and Rx static filters. Experimental demonstration in a 800G system reveals gains of more than 1 dB when compared with typical digital pre-emphasis.

Room 6E

Th1F • Machine Learning and Advanced Digital Signal Processing—Continued

Th1F.2 • 08:30
Pre-Link Compensation of Nonlinear Signal Distortion by a Phase Conjugation and Parameter Profiled Fiber Module, Mark D. Pelusi[1], Ryosuke Matsumoto[1], Takashi Inoue[1], Shu Namiki[1]; [1]*AIST, Japan*. Pre-compensation of nonlinear signal distortion in a transmission link by optical phase conjugation is enhanced by a Raman-amplified parameter-profiled fiber for improved propagation symmetry. Application to 5×12-Gb/s-DP-16QAM signals before a 2×160-km link demonstrates 2.2-dB higher Q^2-factor.

Th1F.3 • 08:45
On the Impact of Frequency Variation on Nonlinearity Mitigation Using Frequency Combs, Ronit S. Sohanpal[1], Eric Sillekens[1], Filipe Ferreira[1], Robert I. Killey[1], Polina Bayvel[1], Zhixin Liu[1]; [1]*Univ. College London, UK.* We investigated the impact of linewidth and dithering-induced frequency variation on the performance of nonlinearity mitigation using frequency combs. Compared to independent laser arrays, >2dB SNR gain can be achieved using comb sources.

Th1F.4 • 09:00
Highly Scalable WDM Nonlinear Frequency Division Multiplexed Transmission System Using Spectral Overlap, Olaf Schulz[1], Alvaro Moscoso-Mártir[2], Jeremy Witzens[2], Stephan Pachnicke[1]; [1]*Kiel Univ., Germany;* [2]*RWTH Aachen Univ., Germany.* We present a highly scalable PIC-based nonlinear frequency division multiplexed transmission system in which b-modulated channels are wavelength division multiplexed with spectral overlap so as to obtain a seamless spectrum without frequency guard bands.

Room 6F

Th1G • Signal Processing in Next-Generation PON—Continued

Th1G.3 • 08:30
Equalizer Convergence for Various Transmission Channels and Multi-Rate Upstream 50G-PON, Gael Simon[1], Flavio Nogueira Sampaio[1], Fabienne Saliou[1], Jeremy Potet[1], Georges Gaillard[1], Philippe Chanclou[1]; [1]*Orange, France.* We assess the feasibility of multiple transmission channel and multi-rate upstream 50G-PON. The TDEC shows that a unique preset filter may be used at both 50Gb/s and 25Gb/s to meet interoperability without adaptive equalization.

Th1G.4 • 08:45
Real-Time Software Implementation of Coherent Receiver DSP Adopting Multiplication-Based Parallel Frequency Offset Compensation 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 multiplication-based parallel frequency offset compensation (FOC) for virtualized access networks and demonstrates real-time softwarization of the full DSP function suite, including polarization demultiplexing, FOC, carrier phase recovery, and decoding, on a server.

Th1G.5 • 09:00 **Tutorial**
FEC and Equalization Implementation Options for 50Gb/s PON and Beyond: a Reality Check, Alexandre Graell i Amat[1]; [1]*Chalmers Univ., Sweden.* Abstract not available.

Room 7AB

Th1J • Panel: How Can We Start to Consistently and Quantitatively Account for End-to-End Power Consumption, Beginning with a Focus on 100 Meter Datacenter Links?—Continued

Room 8

Th1I • THz Optical Communications—Continued

Th1I.2 • 09:00
OFDM-1024QAM Transmission Over 400m at THz Band With Delta-Sigma-Modulation, Kaihui Wang[1], Jianjun Yu[1], Weiping Li[1], Junjie Ding[1], Feng Wang[1], Chen Wang[1], Wen Zhou[1], Jiao Zhang[2], Min Zhu[2], Tangyao Xie[3], Jianguo Yu[3], Li Zhao[1], Feng Zhao[4]; [1]*Fudan Univ., China;* [2]*Purple Mountain Laboratories, China;* [3]*Beijing Univ. of Posts and Telecommunications, China;* [4]*Xi'an Univ. of Posts and Telecommunications, China.* For the first time, we successfully transmit 1.25GBaud OFDM-256QAM/1024QAM signals over 20km SMF and 400m wireless link at the terahertz band with 1-bit DSM. The BER of OFDM-256QAM/1024QAM can satisfy the FEC threshold of 3.8×10^{-3}/4.0×10^{-2}.

Room 9

Th1H • Satellite Communications and UV, LWIR Free Space Optical Communications—Continued

Th1H.3 • 08:30 **Invited**
Adaptive Optics for Satellite Laser Communications, Yoshihiko Saito[1], Dimitar Kolev[1], Jun Nakazono[1], Yuma Abe[1], Morio Toyoshima[1]; [1]*NICT Hokuriku Research Center, Japan.* The development of laser communication technology between satellites and ground stations has been paid attention recently. On the other hand, the laser communication between satellites and ground stations is always affected by the atmospheric condition. We can compensate this effect by applying the technology of Adaptive Optics that is used for astronomical observation.

Th1H.4 • 09:00 **Tutorial**
Space-Grade Analogue and Digital Photonics for Satellite Communications, Antonella Bogoni[1]; [1]*CNIT, Italy.* The talk concerns the potential, the current issues and the emerging technologies for space-grade photonics for satellite communications and not only.

Room 1AB

Th1A • Novel Photonic Devices and Applications—Continued

Th1A.5 • 09:15
Self-Aligned Fiber Attach on Monolithic Silicon Photonic Chips: Moisture Effect and Hermetic Seal, Zhuojie Wu[1], Ping-Chuan Wang[1,2], Seungman Choi[1], Patrick Justison[1], Martin Gall[1], Jae-Kyu Cho[1], Takako Hirokawa[1], Yusheng Bian[1], Thomas Houghton[1], Vaishnavi Karra[1], Dan Moy[1], Karen Nummy[1], Dave Riggs[1], Norman Robson[1], Ian Melville[1], Ken Giewont[1]; [1]*GLOBALFOUNDRIES, USA;* [2]*State Univ. of New York at New Paltz, USA.* We report a study on moisture effect on optical performance of monolithic silicon photonics technologies featuring V-grooves for self-aligned fiber attach. Chip-level hermetic sealing was achieved by implementing moisture barrier for the fiber coupler.

Th1A.6 • 09:30 Invited
Pioneering Silicon Photonics for Wearable Sensors, Jeffrey B. Driscoll[1], Philip Perea[1], Ariel Kauffman[1], Aaron J. Zilkie[1], Benjamin Ver Steeg[1]; [1]*Rockley Photonics, USA.* The Rockley silicon photonics platform has unique advantages perfectly suited to addressing the needs of wearable health sensors. An overview of the platform is presented including its application to non-invasive continuous monitoring of body temperature.

Room 2

Th1B • Nonlinear-Optical Amplifiers and Oscillators—Continued

Th1B.5 • 09:15
Low-Noise, Flat-Spectrum, Polarization-Maintaining All-Fiber Frequency Comb for Wideband Communications, Yijia Cai[1], Ronit S. Sohanpal[1], Yuan Luo[2], Alexander Heidt[3], Zhixin Liu[1]; [1]*Univ. College London, UK;* [2]*Chinese Univ. of Hong Kong, China;* [3]*Univ. of Bern, Switzerland.* We design and optimize a parametric frequency comb generator using all polarization-maintaining components, highly-doped PM fiber and PM highly-nonlinear fibers, obtaining 500 tones over 100nm with >-5dBm per tone and less than 40kHz linewidth.

Th1B.6 • 09:30
High-Efficiency Microcombs Aligned With ITU-T Grid for WDM Optical Interconnects, Jizhao Zang[1,2], Su-peng Yu[1,2], David Carlson[1], Travis Briles[1], Yan Jin[1,2], Scott Papp[1,2]; [1]*NIST, USA;* [2]*Univ. of Colorado Boulder, USA.* We report generation of flat soliton microcombs aligned with ITU-T grid. We demonstrate close to 70% pump-to-comb conversion efficiency and the required on-chip pump power is below 40 mW.

Th1B.7 • 09:45 ★ Top-Scored
30-Gbaud PM-16-QAM Transmission Over E-, S-, C- and L-Band With Hybrid Raman Amplifier, Pratim Hazarika[1], Aleksandr I. Donodin[1], Mingming Tan[1], Ian Phillips[1], Paul Harper[1], Wladek Forysiak[1]; [1]*Aston Univ., UK.* We demonstrate 50km, 30-Gbaud PM-16QAM transmission with a hybrid distributed-discrete Raman amplifier over 25.8THz bandwidth. E-band distributed Raman amplification shows 0.7dB averaged Q^2-penalty, versus 1.9dB and 0.9dB due to S-band and C+L-band discrete Raman amplification.

Room 3

Th1D • Data Center Networks and Control—Continued

Th1D.5 • 09:15
P4-Based Hitless FaaS Load Balancer for Packet-Optical Network Edge Continuum, Istvan Pelle[1,2], Francesco Paolucci[3], Balazs Sonkoly[1,2], Filippo Cugini[3]; [1]*HSN-Lab, Budapest Univ. of Technology and Economics, Hungary;* [2]*ELKH-BME Cloud Applications Research Group, Hungary;* [3]*CNIT, Italy.* P4 and novel node telemetry are leveraged to provide load balancing of ultra-low latency serverless application to multiple edges. Handling the overload of one edge without observable change in application delay is demonstrated.

Th1D.6 • 09:30 Invited
Interconnection Networks With Co-Packaged Photonics, Fabrizio Petrini[1]; [1]*Intel Corporation, USA.* Abstract not available.

10:00–15:45 OFC Career Zone, *Exhibit Hall*
OFC Career Zone Job Fair | Resume Critique Workshop | Mock Interviews

10:00–16:00 Exhibition and Show Floor, *Exhibit Hall, (coffee service 10:00–10:30)*

10:30–12:30 Th2A • Posters Session III, In-Person, *Exhibit Hall B1*
Lunch Break *(on own; concessions available in Exhibit Hall)*

Room 6C

Th1C • Panel: Promises, Prospects and Challenges of VCSELs for Data Center Interconnects, Free-Space Communications, and Sensing—Continued

Room 6D

Th1E • Beyond 400G Transmission—Continued

Th1E.5 • 09:15
1.96Tbps and 256-Gbaud Dual-Carrier Faster Than Nyquist Signal Transmission Using Two Narrow-Bandwidth Modulators and Single Coherent Receiver, Guoxiu Huang[1], Hisao Nakashima[1], Jun Matsui[1], Yohei Sobu[1], Shinsuke Tanaka[1], Takeshi Hoshida[1]; [1]*Fujitsu Ltd., Japan.* A large capacity system basing on Faster-than-Nyquist technologies using narrow-bandwidth components was experimentally demonstrated with a hybrid of simple transmitter DSP and optical-equalization for an efficient spectrum-shaping to achieve 1.96Tbps net rate over 120km transmission.

Th1E.6 • 09:30
4.8 Tb/s PS-PAM-8 Bidirectional Transmission Over 10-km 24-Core Fiber Using Linear Equalization at O-Band, Chao Yang[1], Runzhe Fan[1], Huang Yu[2], Hao Guo[2], Chuyu Peng[2], Ming Luo[1], Xi Xiao[1,3]; [1]*China Information Communication Technologies Group, China;* [2]*Fiberhome Fujikura Optic Technology, China;* [3]*National Information Optoelectronics Innovation Center, China.* 4.8-Tb/s PS-PAM-8 bidirectional transmission is experimentally demonstrated over 10-km 24-core fiber with SOA using only linear equalization at O-band. The experimental results indicate that the MCFs are well-suited for optical short-reach systems employing IM/DD.

Th1E.7 • 09:45
Four-Wave Mixing Mitigation by Using Waveguide-Based 4λ-WDM Filters for 800 and 400 GbE, Ai Yanagihara[1], Mingchen Chen[1], Shigeru Kanazawa[1], Yasuhiko Nakanishi[1], Masahiro Nada[1], Hiroki Taniguchi[2], Kenya Suzuki[1]; [1]*NTT Device Innovation Center, NTT Corporation, Japan;* [2]*NTT Network Innovation Laboratories, NTT Corporation, Japan.* We report four-wave mixing mitigation by 4λ-WDM filters fabricated by silica-based planar lightwave circuits for 800- and 400-GbE application. The multiplexing filter integrates a simple polarization-alternating structure on arbitrary lanes for the impairment mitigation.

Room 6E

Th1F • Machine Learning and Advanced Digital Signal Processing—Continued

Th1F.5 • 09:15
PINN for Power Evolution Prediction and Raman Gain Spectrum Identification in C+L-Band Transmission System, Yuchen Song[1], Yao Zhang[1], Chunyu Zhang[1], Jin Li[1], Min Zhang[1], Danshi Wang[1]; [1]*Beijing Univ. of Post and Telecommu, China.* We experimentally demonstrate multi-channel power evolution prediction and identification of frequency-dependent fiber characteristics using PINN. A maximum absolute error of 0.3 dB for power prediction is observed on C+L-band transmission under different loadings.

Th1F.6 • 09:30
Digital Pre-Distortion Coefficients Identification Using Gauss-Newton Based Direct Learning Architecture, hexun jiang[1], Mengfan Fu[1], Yixiao Zhu[1], Lilin Yi[1], Weisheng Hu[1,2], Qunbi Zhuge[1,2]; [1]*Shanghai Jiao Tong Univ., China;* [2]*Peng Cheng Laboratory, China.* We propose to identify the coefficients of a digital pre-distortion equalizer based on direct learning architecture (DLA) using the Gauss-Newton method. Experimental results show that DLA outperforms indirect learning architecture by 0.5dB.

Th1F.7 • 09:45
Knowledge Distillation Applied to Optical Channel Equalization: Solving the Parallelization Problem of Recurrent Connection, Sasipim Srivallapanondh[1], Pedro J. Freire[1], Bernhard Spinnler[2], Nelson Costa[3], Antonio Napoli[2], Sergei K. Turitsyn[1], Jaroslaw E. Prilepsky[1]; [1]*Aston Univ., UK;* [2]*Infinera, Germany;* [3]*Infinera, Portugal.* To circumvent the non-parallelizability of recurrent neural network-based equalizers, we propose *knowledge distillation* to recast the RNN into a parallelizable feedforward structure. The latter shows 38% latency decrease, while impacting the Q-factor by only 0.5dB.

Room 6F

Th1G • Signal Processing in Next-Generation PON—Continued

Room 7AB

Th1J • Panel: How Can We Start to Consistently and Quantitatively Account for End-to-End Power Consumption, Beginning with a Focus on 100 Meter Datacenter Links?—Continued

Room 8

Th1I • THz Optical Communications—Continued

Th1I.3 • 09:15
Mitigating the Timing-Jitter in Terahertz Communications via Nyquist Pulse Shaping, Mohamed Shehata[1], Ke Wang[2], Julian Webber[3], Masayuki Fujita[3], Tadao Nagatsuma[3], Withawat Withayachumnankul[1]; [1]*School of Electrical and Electronic Engineering, The Univ. of Adelaide, Australia;* [2]*School of Engineering, Royal Melbourne Inst. of Technology, Australia;* [3]*Graduate School of Engineering Science, Osaka Univ., Japan.* We propose and experimentally demonstrate a Nyquist pulse that can improve the error rate of a 311 GHz photonic-terahertz communications system by more than an order of magnitude at a normalized timing-jitter of 22.5% and 1.44 Gbit/s bit rate.

Th1I.4 • 09:30
300-GHz-Band Wireless Link Using Photonics-Based Ultralow-Noise Transmitter and Receiver, Keisuke Maekawa[1], Yuma Kawmoto[1], Tomoya Nakashita[1], Toki Yoshioka[1], Takashi Hori[2], Brendan Heffernan[2], James Greenberg[2], Rubab Amin[2], Tatsuya Tanigawa[2], Antoine Rolland[2], Tadao Nagatsuma[1]; [1]*Osaka Univ., Japan;* [2]*IMRA America Inc, Japan.* We present a THz wireless link using photonics-based signal generators using ultralow amplitude- and phase-noise Brillouin laser sources for both the transmitter and receiver, and demonstrate successful transmission of over-100-Gbit/s signals at 300 GHz with on-line signal processing.

Th1I.5 • 09:45
Demonstration of Wireless Transmission of QPSK Signals at 2 THz, Isao Morohashi[1], Yoshihisa Irimajiri[1], Akira Kawakami[1], Tadashi Kishimoto[1], Pham Tien Dat[1], Atsushi Kanno[1], Norihiko Sekine[1], Iwao Hosako[1]; [1]*National Inst of Information & Comm Tech, Japan.* Wireless transmission of QPSK signals at 2 THz has been demonstrated using modulator-based optical combs for the transmitter and hot electron bolometer mixers combined with phase-locked terahertz quantum cascade lasers for the receiver.

Room 9

Th1H • Satellite Communications and UV, LWIR Free Space Optical Communications—Continued

10:00–15:45 OFC Career Zone, *Exhibit Hall*
OFC Career Zone Job Fair | Resume Critique Workshop | Mock Interviews

10:00–16:00 Exhibition and Show Floor, *Exhibit Hall, (coffee service 10:00–10:30)*

10:30–12:30 Th2A • Posters Session III, In-Person, *Exhibit Hall B1*
Lunch Break *(on own; concessions available in Exhibit Hall)*

Show Floor Programming

QXP Innovative Silicon-based Midex Materials for Photonic Integration
Presented by QXP Technologies Inc.
10:15–10:45, *Theater III*

10:30–12:30
Th2A • Posters Session III (In-Person)

Th2A.1
Transfer Learning-Based ROADM EDFA Wavelength Dependent Gain Prediction Using Minimized Data Collection, Zehao Wang[1], Daniel C. Kilper[2], Tingjun Chen[1]; [1]*Duke Univ., USA;* [2]*CONNECT Centre, Ireland*. We implement and test transfer learning-based gain models across 16 ROADM EDFAs, which achieve less than 0.17/0.30 dB mean absolute error for booster/pre-amplifier gain prediction using only 0.5% of the full target EDFA dataset.

Th2A.2
First Monolithically-Integrated Silicon CMOS Coherent Optical Receiver, Ghazal Movaghar[1], Viviana Arrunategui[1], Aaron Maharry[1], Evan D. Chansky[1], Junqian Liu[1], Hector Andrade[1], Clint Schow[1], James Buckwalter[1]; [1]*UC Santa Barbara, USA*. An O-band coherent optical receiver (CORX) is integrated in a 45-nm monolithic CMOS SOI process. The CORX operates to 80 Gbps with FEC-acceptable BER at 1.2 pJ/bit energy efficiency. To our knowledge, this is the first monolithically-integrated Silicon CMOS CORX.

Th2A.3
Automatic Tuning of Vernier Microring Filters Using Comprehensive Characterization Models and Hybrid Optimization Algorithms, Saif Alnairat[1,2], Benjamin Wohlfeil[1], Stevan Djordjevic[1], Bernhard Schmauss[2]; [1]*ADVA Optical Networking SE, Germany;* [2]*Inst. of Microwaves and Photonics (LHFT), Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany.* An efficient approach to automatically configure and tune Vernier microring filters by utilizing hybrid optimization algorithms and robust characterization models is presented. Automatic tuning of a four-ring Vernier filter over the entire C-band is experimentally demonstrated to evaluate this method.

Th2A.4
Composite Morphology Laser Written 3D Waveguides With Reduced Bend Loss, Andrew J. Ross-Adams[1], Michael Withford[1], Simon Gross[1]; [1]*Macquarie Univ., Australia*. We demonstrate a composite laser written 3D waveguide in boro-aluminosilicate glass, with an estimated index contrast of 1.7%, providing a 2.5x improvement of minimum bend radius down to 4.0 mm at 1550 nm.

Th2A.5
Broadband High-Performance 2×2 MMI 3-dB Coupler Enabled by SWG Lateral Cladding for the Silicon-on-Insulator Platform, Luhua Xu[2,1], Weijia Li[2], Jinsong Zhang[2], Deng Mao[2], Md Samiul Alam[2], Yannick D'Mello[2], Santiago Bernal[2], Zixian Wei[2], David Plant[2]; [1]*CMC Microsystems, Canada;* [2]*Department of Electrical and Computer Engineering, McGill Univ., Canada*. We demonstrate a high-performance silicon photonic 2×2 MMI 3-dB coupler enabled by SWG lateral cladding. Measured imbalance below 0.3 dB and phase error below 1.83° are achieved over a 130 nm bandwidth covering the C-band.

Th2A.6
Temperature-Insensitive Pulse and 120°C CW Operation of 1550nm-Band p-Doped InAs/InGaAlAs Quantum Dot Lasers on InP(311)B Substrate, Ryota Yabuki[1], Atsushi Matsumoto[2], Ryumi Katsuhara[1], Siim Heinsalu[1], Kouichi Akahane[2], Yuichi Matsushima[1], Hiroshi Ishikawa[1], Katsuyuki Utaka[1]; [1]*Waseda Univ., Japan;* [2]*National Inst. of Information and Communications Technology (NICT), Japan*. We fabricated 1550nm-band, p-doped, InAs/InGaAlAs quantum-dot(QD) lasers on an InP(311)B substrate. The device showed extremely high temperature stability and lasing up to 120°C was confirmed under CW condition.

Th2A.7
High-Power Performance of Type-II GaInAsSb/InP Uniform Absorber Uni-Traveling Carrier Photodiodes, Rimjhim Chaudhary[1], Akshay M. Arabhavi[1], Laurenz Kulmer[1], Sara Hamzeloui[1], Marco Eppenberger[1], Martin Leich[1], Olivier Ostinelli[1], Juerg Leuthold[1], Colombo Bolognesi[1]; [1]*ETH Zurich, Switzerland*. We report the first power performance of Type-II GaInAsSb/InP UTC-PDs. The UTC-PDs attain a zero-bias output power of -14 dBm at 100 GHz, one of the highest reported for any zero-bias photodiodes.

Th2A.8
Low Insertion Loss 128-Gbaud HB-CDM With 3D-Printed Spot Size Converter Integrated InP-Based Modulator, Yasutaka Mizuno[1], Munetaka Kurokawa[1], Naoki Itabashi[1], Taichi Misawa[1], Masaru Takechi[1], Hiroshi Uemura[1], Hajime Tanaka[1], Tsutomu Ishikawa[1], Tomoya Saeki[1], Keiji Tanaka[1], Takatoshi Kato[1], Manabu Shiozaki[1], Katsumi Uesaka[1]; [1]*Transmission Devices Laboratories, Sumitomo Electric Industries, Ltd., Japan*. We demonstrate 128 Gbaud HB-CDM with InP-based modulator having 3D-printed SSCs on chip facet. Optical coupling loss of 1.1 dB and Telcordia compliant reliability promise practical usage of 3D-print technology based on two photon polymerization.

Th2A.9
Full 3-Inch Wafer Processed 1060 nm Single-Mode Transverse Coupled-Cavity VCSEL for Data Transmission in Standard 1300nm Single-Mode Fiber, Chang Ge[1], Boxuan Zhang[1], Xiaodong Gu[1,2], Susumu Kinoshita[1], Fumio Koyama[1]; [1]*Tokyo Inst. of Technology, Japan;* [2]*Ambision Photonics, Japan*. We demonstrate full-3inch-wafer processed 1060nm single-mode metal-aperture VCSEL, exhibiting 1300nm-standard single-mode fiber transmission. We obtained a bandwidth·distance product of 2.5Tbps·km. The modal-intensity noise in two-modes fiber link is suppressed with mode-filters.

Th2A.10
Low Fusion Splice Loss Technique for Multicore Fiber With 2- and 3-Electrode Fusion Splicers, Toshiyuki Fujii[1], Masanori Takahashi[1], Ryuichi Sugizaki[1], Akio Tanabe[1], Yoshihiro Arashitani[1]; [1]*Furukawa Electric Co., Ltd., Japan*. Splice loss of 4-core fiber using 2-electrode fusion splicer by automatic rotational alignment with duration time of 150 sec is reduced to 0.07 dB, getting closer to 0.02 dB by 3-electrode fusion splicer.

Th2A.11
Pump Optimization of E-Band Bismuth-Doped Fiber Amplifier, Aleksandr I. Donodin[1], Egor Manuylovich[1], Vladislav Dvoyrin[1], Forysiak Wladek[1], Sergei K. Turitsyn[1]; [1]*Aston Univ., UK*. We experimentally investigate different bi-directional pumping schemes of an E-band bismuth-doped fiber amplifier. Best performance is achieved with 1320nm pumps, and features 38.9dB gain, 4.7dB NF, and 32.6% power conversion efficiency.

Th2A.12
Nonlinear Optical Loop Mirror for Waveband-Shift Free Optical Phase Conjugation, Vladimir Gordienko[1], Mariia Bastamova[1], Andrew Ellis[1], Nick Doran[1]; [1]*Aston Univ., UK*. We introduce a novel concept for waveband-shift free optical phase conjugation and experimentally demonstrate idler-to-signal extinction ratio up to 18dB by recombining signals and idlers at different output ports of a nonlinear optical loop mirror.

Th2A.13
SINET6: Nationwide 400GE-Based Academic Backbone Network in Japan, Takashi Kurimoto[1], Koji Sasayama[1], Osamu Akashi[1], Shigeo Urushidani[1]; [1]*nii, Japan*. This paper describes the practical network design of a newly-launched nationwide 400GE-based academic backbone network called SINET6. Its fully-meshed architecture with multi-layer network coordination, network services with on-demand capabilities, and performance evaluations are reported.

Th2A.14
Technical Study on the Viability of Hollow-Core and Ultra-Low-Loss Silica Fibres in Metro-Core Optical Networks, Md Asif Iqbal[1], Paul Wright[1], Andrew Lord[1]; [1]*British Telecommunications, UK*. We numerically compare the performance benefits and viability of deploying hollow-core-fibre (HCF) and ultra-low-loss (ULL) fibre in metro-core optical network considering practical traffic growth, limitations of transceiver OSNR and output power from commercial optical amplifiers.

Th2A.15
Software-Defined, Programmable L1 Dataplane: Demonstration of Fabric Hardware Resilience Using Optical Switches, Giannis Patronas[3], Dimitris Syrivelis[3], Paraskevas Bakopoulos[3], Prethvi Kashinkunti[1], Louis Capps[1], Nikos Argyris[3], Nikos Terzenidis[3], Eitan Zahavi[2], Luke Yeager[1], Elad Mentovich[2], Julie Bernauer[1]; [1]*NVIDIA, USA;* [2]*NVIDIA, Israel;* [3]*NVIDIA, Greece*. We propose a programmable optical fabric design for Data Center networks that extends SDN to L1. We present experiments on our HPC/ML testbed leveraging the programmable network to automatically failover from hardware or software failures.

Th2A.16
Confidential Detection of Multiple Failures in Optical Networks: an Experimental Evaluation, Moisés F. Silva[2], Andrea Sgambelluri[1], Alessandro Pacini[1], Francesco Paolucci[3], Andre Green[2], David Mascarenas[2], Luca Valcarenghi[1]; [1]*Scuola Superiore Sant Anna di Pisa, Italy;* [2]*Los Alamos National Laboratory, USA;* [3]*CNIT, Italy*. This paper presents a Machine Learning technique based on Principal Component Analysis (PCA) combined with telemetry data scrambling to detect multiple types of failure in optical networks while preserving data confidentiality. Experiments in an optical testbed show the effectiveness of the proposed solution.

Th2A.17
Reinforcement Learning for Provisioning OTN Leased Lines, Ashwin Gumaste[1], João Pedro[1], Harald Bock[1]; [1]*Infinera Corporation, USA*. We discuss reinforcement learning-based strategies for provisioning OTN leased-lines including all-optical provisioning and strategic aggregation subject to stochastic traffic in metro/regional networks. We show benefit in transceiver count and reduction of OTN cross-connect capacity.

Th2A.18
An Optical Network Emulator for Testing Open-ROADM Controller and Training Students, Tianliang Zhang[1], Muhammad Ridwanur Rahim[1], Salem Blue Davidson[1], Brandon Hunter Grona-Gardom[1], Cristina Marie Kobierowski[1], Nathan Andrew Ellsworth[1], Gilles Thouenon[2], Christophe Betoule[2], Olivier Renais[2], Andrea Fumagalli[1]; [1]*The Univ. of Texas at Dallas, USA;* [2]*Orange Labs, France*. The Optical Network Emulation (ONE) engine is a real-time and realistic platform for testing functionalities and FCAPS features of OpenROADM controllers. Its decentralized architecture, potential applications, and educational purposes are presented in this paper.

Th2A.19
Multi-Node Cooperative Recovery Against IP Node Failure Enabled by Flexible Optical Network, Yunxuan Li[1], Rentao Gu[1], Yuefeng Ji[1]; [1]*BUPT, China.* We propose a multi-node cooperative recovery method against IP node failure through joint selection and flow table splitting. The recovery time saves by 89.5%, and the success rate improves by 25.6% in heavily loaded network.

Th2A.20
Real-Time 50Gb/s Upstream Transmission in TDM-PON With Class E1 Power Budget Using Ge/Si Avalanche Photodiode and Bismuth-Doped Fiber as Preamplifier, Ning Wang[1], Junwei Li[1], Dechao Zhang[1], Han Li[1], Jin Cheng[2], Wang Chen[2], Vitaly Mikhailov[3], Daryl Inniss[3], Yan Chen[2], Xiaodong Duan[1], Lirong Bai[4], Rangchen Yu[2]; [1]*China Mobile Research Inst., China;* [2]*SiFotonics Technologies Co., Ltd., USA;* [3]*OFS Laboratories, USA;* [4]*China Mobile Communications Corporation Group Co., Ltd., China*. We experimentally demonstrate a real-time 20km transmission of 50Gb/s NRZ upstream signal in TDM-PON using a BDFA preamplifier and a Ge/Si APD receiver. The sensitivity of -27.8dBm is achieved due to the low noise figure of the BDFA.

Th2A.21
Nonlinear Phase Shift Pre-Compensation for Improved Power Budget in a 200 Gbps Simplified Coherent PON, Pablo Torres-Ferrera[1], Md Saifuddin Faruk[1], Istvan B. Kovacs[1], Seb J. Savory[1]; [1]*Univ. of Cambridge, UK*. We experimentally investigate a simple fiber nonlinearity pre-compensation technique for 200 Gbps PON downstream using a simplified coherent receiver. A power budget improvement of 1.0 dB is achieved for 50 km reach in C-band.

Th2A • Posters Session III (In-Person)—Continued

Th2A.22
Device Engineering and Performance Optimization of Silicon PICs for 800Gb/s Coherent Transmission, Hao Wu[1], Chen Zhu[2], Ning Cheng[1], Chenlei Li[1], Min Teng[1], Pan Su[1], Feng Wang[1], Yinchao Du[1], Gang Cheng[2], Xuezhe Zheng[1]; *[1]Innolight Technology Research Inst. (ITRI), InnoLight Technology (Suzhou) Ltd., China; [2]Network Infrastructure Department, Baidu, China.* An end-to-end link model is developed to optimize silicon PIC and evaluate the coherent system performance. 128Gbaud 16-QAM data transmission based on silicon photonics is achieved with -9.1dBm Tx-output power and 26dB Rx OSNR sensitivity.

Th2A.23
Maximizing 425G SWDM VCSEL-MMF Systems Reach Through Variable Rate per λ, Ann Margareth Rosa Brusin[1], Antonino Nespola[2], Giuseppe Rizzelli[2], Francesco Aquilino[2], Fabrizio Forghieri[3], Andrea Carena[1]; *[1]Politecnico di Torino, Italy; [2]LINKS Foundation, Italy; [3]Cisco Photonics srl, Italy.* We demonstrate the maximization of reach for 425G SWDM systems based on VCSEL-MMF links through variable rate solutions, reaching up to >100 m for 99% of tested links.

Th2A.24
Polarization Mode Dispersion in CMOS-Integrated Monolithic SiPh Components: Simulations and Experiments, Yusheng Bian[1]; *[1]GLOBALFOUNDRIES, USA.* We simulated and experimentally characterized the differential group delay induced from polarization mode dispersion (PMD) of key components on a monolithic SiPh platform. Strategy for compensating PMD was introduced for high-speed applications beyond 100 Gbit/s.

Th2A.25
Adaptive Log-Likelihood-Ratio for Optical Channels With Non-Additive-White-Gaussian-Noise, Chunpo Pan[1], Xuefeng Tang[1], Meng Qiu[1], Tianyu Zhao[1], Wenjing Chen[2], Chuandong Li[1], Zhuhong Zhang[1]; *[1]Huawei Technologies Canada Co., Ltd., Canada; [2]Huawei Technologies Co., Ltd., China.* An adaptive LLR calculation algorithm is proposed for non-additive-white-Gaussian-noise (non-AWGN) optical channels. The noise distribution is continuously updated based on previous decisions. The performance is tested experimentally using 16-QAM and soft-DQPSK systems.

Th2A.26
Adaptive Turbo Equalization of Probabilistically Shaped Constellations, Edson Porto da Silva[1], Metodi Plamenov Yankov[2]; *[1]Universidade Federal de Campina Grande, Brazil; [2]DTU Electro, Technical Univ. of Denmark, Denmark.* Fiber nonlinearity compensation of probabilistically shaped constellations with adaptive turbo equalization is investigated for the first time. Potential for more than 100% transmission reach extension is demonstrated by combining probabilistic shaping, single-channel digital backpropagation, and adaptive turbo equalization.

Th2A.27
SOA-Amplified 100 Gbit/s/λ PAM-8 WDM Transmission for Optical Access Networks Enabled by Probabilistic Shaping, Marcos Troncoso Costas[1,2], Ahmed Galib Reza[1], Colm Browning[1], Francisco Diaz Otero[2], Liam Barry[1]; *[1]Dublin City Univ., Ireland; [2]Univ. of Vigo, Spain.* We demonstrate a 4-channel SOA-amplified 100 Gbit/s/λ probabilistically shaped PAM-8 C-band transmission for next-generation optical access networks. Power budgets up to 30.25 dB were obtained using T-spaced equalization on a 20-GHz bandwidth-limited system.

Th2A.28
Inter-Core Crosstalk Sense-and-Compensate for Multi-Core Fiber Transmission With CAZAC Training Sequence, Chen Cheng[1], Can Zhao[1], Junda Chen[1], Weihao Li[1], Maoqi Zhang[2], Ming-Ming Zhang[1], Yizhao Chen[1], Zihe Hu[1], Jiajun Zhou[1], Ming Tang[1]; *[1]Huazhong Univ. of Science and tech., China; [2]Nanjing Univ., China.* We demonstrate a novel inter-core crosstalk sense-and-compensate method with the CAZAC sequence as the frame header in the crosstalk-limited IMDD SDM system, achieving 2.5 dB sensitivity improvement and ensuring the quality of transmission.

Th2A.29
Disaggregated SCI Estimation for QoT-E in Mixed Fibers Network Segments, Emanuele E. Virgillito[1], Andrea Castoldi[2], Andrea D'Amico[1], Stefano Straullu[3], Rudi Bratovich[2], Fransisco Martinez Rodriguez[2], Andrea Bovio[2], Rosanna Pastorelli[2], Vittorio Curri[1]; *[1]Politecnico di Torino, Italy; [2]SM-Optics, Italy; [3]LINKS Foundation, Italy.* We propose a spatially disaggregated model for self-channel noise coherent buildup in mixed fibers lines including dispersion compensated spans. We show that properly modeling coherence is crucial for accurate GSNR estimation.

Th2A.30
Upgrade of Deep Neural Network-Based Optical Monitors by Communication-Efficient Federated Learning, Takahito Tanimura[1], Masayuki Takase[1]; *[1]Hitachi Ltd., Japan.* We present an efficient scheme to upgrade DNN-based optical monitors collaboratively trained through multiple network operators without revealing each confidential data, applying federated learning with pre-model size reduction based on transferable lottery ticket hypothesis.

Th2A.31
On the Advantages of Principal Modes for Multimode SDM Transmission Systems, Fabio A. Barbosa[1], Filipe Ferreira[1]; *[1]Univ. College London, UK.* MISO array size is shown to scale sublinearly with an increasing number of tributaries under modal dynamics and mode-dependent loss with up to 330 principal modes over a fibre optimised for low modal dispersion.

Th2A.32
NR Conformance Testing of Analog Radio-Over-LWIR FSO Fronthaul Link for 6G Distributed MIMO Networks, Rafael Puerta[1,2], Mengyao Han[2,7], Mahdieh Joharifar[2], Richard Schatz[2], Yan-Ting Sun[2], Yuchuan Fan[2,3], Anders Djupsjobacka[3], Grégory Maisons[4], Johan Abautret[4], Roland Teissier[4], Lu Zhang[5], Sandis Spolitis[6], Muguang Wang[7], Vjačeslavs Bobrovs[6], Sebastian Lourdudoss[2], Xianbin Yu[5], Sergei Popov[2], Oskars Ozolins[2,3], Xiaodan Pang[2,3]; *[1]Ericsson Research, Sweden; [2]KTH Royal Inst. of Technology, Sweden; [3]RISE Research Inst.s of Sweden, Sweden; [4]mirSense, France; [5]Zhejiang Univ., China; [6]Riga Technical Univ., Latvia; [7]Beijing Jiaotong Univ., China.* We experimentally test the compliance with 5G/NR 3GPP technical specifications of an analog radio-over-FSO link at 9 μm. The ACLR and EVM transmitter requirements are fulfilled validating the suitability of LWIR FSO for 6G fronthaul.

Th2A.33
Phase Locking of an Optical Injection Phase-Lock Loop Coherent Receiver Under Emulated Atmospheric Fading Conditions, Alexis Bernini[1], Martyn J. Fice[1], Katarzyna Balakier[1]; *[1]Department of Electronic and Electrical Engineering, Univ. College London (UCL), UK.* An Optical Injection Phase-Lock Loop coherent receiver has been tested against various levels of deep atmospheric fading to experimentally evaluate its feasibility in a ground-to-satellite optical communications application.

Th2A.34
Improving the Performance of Variable Data Rate Architectures for Optical LEO Direct-to-Earth Links, Bertold Ian Bitachon[1], Michael Baumann[1], Johannes Widmer[2], Michal Kuklewski[2], Hannah Lindberg[2], Mathieu Berges[2], Juerg Leuthold[1]; *[1]ETH Zurich, Switzerland; [2]Thales Alenia Space, Thales Alenia Space, Toulouse, Midi-Pyrénées, FR, corporate/aero, Switzerland.* Usage of new spreading factors is shown to improve the rate granularity, performance and photon efficiency of variable data rate architectures intended for optical low earth orbits to earth links.

Th2A.35
Experimental Evaluation of MPI Noise Mitigation Effects for Various Modulation Schemes in Analog IFoF-Based Mobile Fronthaul Link, Hirotaka Ochi[1], Kazuki Tanaka[1], Shinji Nimura[1], Kosuke Nishimura[1], Ryo Inohara[1], Masatoshi Suzuki[1]; *[1]KDDI Research, Inc., Japan.* Effects of multipath interference (MPI) mitigation for different modulation schemes in analog IFoF link is experimentally evaluated. The results show phase-dithered and polarization-scrambled IFoF signal could tolerate 30-dB MPI for two types of external modulations.

Th2A.36
Photon-Pair Generation From two Silicon Micro-Rings Using the Recycled Optical Power From a Contra-Directional Pump-Reject Filter, Abdelrahman Afifi[1], Andreas Pfenning[2], Sudip Shekhar[1], Lukas Chrostowski[1,2], Jeff F. Young[3,2]; *[1]Electrical and Computer Engineering, Univ. of British Columbia, Canada; [2]Stewart Blusson Quantum Matter Inst., Univ. of British Columbia, Canada; [3]Department of Physics and Astronomy, Univ. of British Columbia, Canada.* Two micro-ring resonators are integrated with two contra-directional pump-reject filters in a pump-reuse configuration showing a 55\% increase in the coincidence counts from both sources compared to a single source at 1mW input pump power.

Th2A.37
Towards Optimized Demand Routing in QKD Networks, Mario Wenning[1,2], Sai K. Patri[1,2], Jasper Mueller[1,2], Achim Autenrieth[1], Joerg-Peter Elbers[1], Piotr Rydlichowski[3], Carmen Mas Machuca[2]; *[1]ADVA Optical Networking SE, Germany; [2]Chair of Communication Networks, Technical Univ. of Munich, Germany; [3]PSNC, Poland.* We investigate buffer-aware demand-routing of key-consumption demands in QKD networks and implement a measurement-based framework for path selection. The proposed ML-based algorithm outperforms state-of-the-art heuristics by 22 % and 92 % for networks under test.

12:30–14:00 Unopposed Exhibit-only Time, *Exhibit Hall*

13:00–14:00 Personal Branding for Social Media Workshop, *OFC Career Zone, Exhibit Hall*

Show Floor Programming

MW5 • MW Panel V: Perspectives on the Future of ROADM Technologies and Architectures for Next-Gen Networks
10:30–12:00

SF11 • AIM Photonics and the Next PIC Generation
11:00–12:00, *Theater II*

OFCnet Emerging Technologies
11:00–11:30, *Theater III*

MW6 • MW Panel VI: Satellite Communications - Coherent Optics in Free Space
12:15–13:45, *Theater I*

SF12 • OIF: Enabling Next Generation Co-Packaging Solutions
12:15–13:15, *Theater II*

Room 1AB

14:00–16:00
Th3A • Novel Enabling Devices
Presider: To be announced.

Th3A.1 • 14:00 Invited
Micro-Transfer Printing for Silicon Photonics, Gunther Roelkens[1]; [1]*Ghent Univ. - imec, Belgium*. We describe our work on heterogeneous photonic integrated circuits realized using micro-transfer printing, a versatile integration approach for the integration of III- V semiconductors, LiNbO3 and silicon photonic/electronic chiplets on Si/SiN photonic integrated circuits.

Th3A.2 • 14:30
27 Hz Integral Linewidth Laser Based on a 5-Billion Q Microfabricated Reference Cavity, Andrei Isichenko[1], Flame Feng[1], Naijun Jin[2], Kaikai Liu[1], Mark W. Harrington[1], Peter Rakich[2], Daniel J. Blumenthal[1]; [1]*Department of Electrical and Computer Engineering, UC Santa Barbara., USA;* [2]*Department of Applied Physics, Yale Univ., USA*. We stabilize a semiconductor laser to a manufacturable, microfabricated micro-Fabry-Perot dielectric reference cavity of 5 billion quality factor, achieving thermorefractive-noise-limited performance. A 27 Hz 1/pi integral linewidth and 1.5×10^{-13} fractional frequency stability are measured.

Room 2

14:00–16:00
Th3B • Silicon Photonics Devices and Integrated Circuits
Presider: Hai-Feng Liu; HG Genuine Optics Tech Co Ltd, USA

Th3B.1 • 14:00 Invited
Silicon Photonics for Next-Generation Optical Connectivity, Ling Liao[1], Saeed Fathololoumi[1], Kimchau Nguyen[1], Hari Mahalingam[1], David Hui[1], John Heck[1], Harel Frish[1], Reece Defrees[1], Christian Malouin[1], Pegah Seddighian[1], Mengyuan Huang[1], Kadhair Al-hemyari[1], Yen-Jung Chen[1], Ye Wang[1], Thomas Liljeberg[1]; [1]*Intel Corp., USA*. We review advancements in silicon photonic (SiPh) devices and integrated circuits (SiPICs) to enable high density, low power, multi-Tb/s optical solutions for next-generation Ethernet networking and compute connectivity.

Th3B.2 • 14:30 Invited
Ultrahigh-Speed Silicon-Based Modulators/Photodetectors for Optical Interconnects, Xiao Hu[1], Dingyi Wu[1], Hongguang Zhang[1], Daigao Chen[1], Lei Wang[1], Xi Xiao[1], Shaohua Yu[1]; [1]*Nat Optoelectronics Innovation Center, China*. We present our recent progress on the silicon photonic devices for next-generation optical interconnects. The 300 Gbit/s silicon microring modulator, 200 Gbit/s Ge EAM and 408 Gbit/s GeSi photodetectors with the highest bandwidth of 110 GHz are presented. Single-chip 1.6 Tbit/s silicon-based optical transceiver is also demonstrated.

Room 3

14:00–16:00
Th3C • Doped Fiber Amplifiers
Presider: Hidehisa Tazawa; Sumitomo Electric Industries Ltd, Japan

Th3C.1 • 14:00 ★ Top-Scored
1255-1355 nm (17.6 THz) Bandwidth O-Band Bismuth Doped Fiber Amplifier Pumped Using Uncooled Multimode (MM) 915 nm Laser Diode, Vitaly Mikhailov[1], Yingzhi Sun[1], Jiawei Luo[1], Farooq Khan[1], Daryl Inniss[1], Yuriy Dulashko[1], Mark Lee[1], Joel Mann[1], Robert S. Windeler[1], Paul Westbrook[1], Jeffrey W. Nicholson[1], David J. DiGiovanni[1]; [1]*OFS Laboratories, USA*. We report BDFA with >20 dB gain over 1255-1355 nm bandwidth (17.6 THz) with maximum gain of 29.3 dB and corresponding NF of 4.6 dB (λ=1300 nm, Pin=-20 dBm). The BDFA has electrical power consumption of 8.1-9.6 W over 20-70 C

Th3C.2 • 14:15
A Highly Temperature-Insensitive Bi-Doped Fiber Amplifier in the E+S-Band With 20 dB Flat Gain From 1435-1475 nm, Yu Wang[1], Arindam Halder[1], David J. Richardson[1], Jayanta K. Sahu[1]; [1]*Univ. of Southampton, UK*. We report a bismuth-doped fiber amplifier operating in the E+S-band providing a 20.5±1dB flat gain with 5.5±2dB NF from 1435-1475nm for -10dBm input signal. The gain coefficient and temperature-dependent-gain coefficient are 0.065dB/mW and -0.005±0.001dB/°C, respectively.

Th3C.3 • 14:30
Bandwidth-Dependent Gain Deviation in E+S Band Bismuth Doped Fiber Amplifier Under Automatic Gain Control, Lixian Wang[1], Yiki Fung[1], Sharma Manish[1], Corentin Botzung[2], Sophie LaRochelle[2], Zhiping Jiang[1]; [1]*Huawei Technologies Canada, Canada;* [2]*Université Laval, Canada.* Although bismuth doped fiber amplifier could provide ultra-wideband gain, the gain inhomogeneity might ultimately restrict its applicable bandwidth. This work explores this limitation through experimental measurements of signal dependent gain deformation.

Room 6C

14:00–16:00
Th3D • Advances in Data Center Switching and Interconnects
Presider: To be announced.

Th3D.1 • 14:00 Invited
X-NEST+: a High Bandwidth and Reconfigurable Optical Interconnects for Distributed Machine Learning and High- Performance Computing, Huaxi Gu[1], Xiaoshan Yu[1], Yunfeng Lu[1], Hong Zou[1], Shuo Li[1]; [1]*Xidian Univ., China.* We propose X-NEST+, a scalable and high-bandwidth optical interconnects capable of reconfiguring both intra- and inter- cluster topology based on traffic demands. The experiment results indicate up to 8%~36% reduction in completion time for HPC and ML applications compared with Helios and RotorNet.

Th3D.2 • 14:30
Jitter Compensation Mechanism for Dynamic Deterministic Networks, Guillaume Soudais[2,1], Tarik Graba[1], Yves Mathieu[1], Sébastien Bigo[2]; [1]*Telecom Paris, France;* [2]*Nokia Bell Labs, France*. We compensate jitter between any two unsynchronized endpoints by tracking their clocks and re-creating flows by retiming packets. After implementation over FPGA, we achieve ~10ms synchronization setup time with no more than 70ns jitter.

Room 6D

14:00–16:00
Th3E • Modulation Formats
Presider: David Millar; Infinera Corporation, USA

Th3E.1 • 14:00
Revisiting Probabilistic Constellation Shaping in Unamplified Coherent Optical Links, Beatriz Manata de Oliveira[1], Jorge Silva[1], Manuel Neves[1], Fernando Guiomar[1], Maria do Carmo Medeiros[3], Paulo Monteiro[2]; [1]*Instituto de Telecomunicações, Portugal;* [2]*Universidade de Aveiro, Portugal;* [3]*Universidade de Coimbra, Portugal*. Considering an unamplified 400ZR-compatible system, we experimentally demonstrate that the reverse Maxwell-Boltzmann distribution significantly enhances PCS performance. With bit-rate adaptation down to 250 Gbps, we find power budget gains of more than 2 dB.

Th3E.2 • 14:15 Invited
Probabilistic Shaping Methods for Linear and Nonlinear Channels, Stella Civelli[1,2], Enrico Forestieri[1,2], Marco Secondini[1,2]; [1]*Scuola Superiore Sant Anna di Pisa, Italy;* [2]*PNTLab, CNIT, Italy.* The main methods and achievements regarding probabilistic shaping are reviewed, highlighting the primary difficulties and opportunities.

Room 6E

14:00–16:00
Th3F • Wideband Transmission Systems
Presider: Fatima Garcia Gunning; Tyndall National Inst., Ireland

Th3F.1 • 14:00 Invited
Practical Fiber Considerations for High Capacity Systems: From Campus to Long Haul, Roshene McCool[1]; [1]*Corning Optical Communications, Germany.* The challenges and opportunities for optical fibers in high-capacity systems from Campus to Long-Haul is discussed. System enhancements can be delivered by constrained fiber zero-dispersion wavelengths, increased fiber bend resilience and reduced fiber outer diameter.

Th3F.2 • 14:30 ★ Top-Scored
173.7-Tb/s Triple-Band WDM Transmission Using 124-Channel 144-GBaud Signals With SE of 9.33 b/s/Hz, Fukutaro Hamaoka[1], Masanori Nakamura[1], Minami Takahashi[1], Takayuki Kobayashi[1], Yutaka Miyamoto[1], Yoshiaki Kisaka[1]; [1]*NTT Network Innovation Laboratories, Japan.* We demonstrate 173.7-Tb/s 101-km transmission in an 18.6-THz bandwidth, achieving a 9.33-b/s/Hz spectral efficiency at 144 GBaud with 124-WDM channels of net bitrates between 1.18 and 1.54 Tb/s/wavelength using entropy and code-rate optimized PCS-64QAM signals.

Room 6F

14:00–15:45
Th3G • High Data-Rate Direct Detection in Access
Presider: Yuanqiu Luo; FutureWei Technologies Inc, USA

Th3G.1 • 14:00
Real-Time 400 Gbit/s PAM-4 Optical Link Over 30 km for Future Access Network, Jeremy Potet[1,2], Mathilde Gay[2], Laurent Bramerie[2], Fabienne Saliou[1], Gaël Simon[1], Philippe Chanclou[1], Monique Thual[2]; [1]*Orange, France;* [2]*Univ Rennes, CNRS, Institut FOTON, France*. We experimentally demonstrate a 4λ WDM real-time 100 Gbit/s/λ PAM-4 fiber link supporting 30 km of fiber propagation and 23.5 dB supported channel insertion losses using analog pre-equalization and common semiconductor based optical pre-amplification.

Th3G.2 • 14:15
Withdrawn

Th3G.3 • 14:15
Uncooled High Speed Ge/Si Avalanche Photodiode for 50 Gbit/s-PON With 60 km Reach, Jeremy Potet[1,2], Gaël Simon[1], Georges Gaillard[1], Camille Dessemond[1], Fabienne Saliou[1], Mathilde Gay[2], Philippe Chanclou[1]; [1]*Orange, France;* [2]*Univ Rennes, CNRS, Institut FOTON, France*. A high-speed germanium on silicon APD is demonstrated for DSP-free 50G-PONs. Sensitivities of -24 dBm at 58.2 Gbit/s and -26.5 dBm at 50 Gbit/s over 60 km of fiber are experimentally obtained in real time with temperature from -40°C to 80°C.

Th3G.4 • 14:30
A Simple 25 and 12.5 Gb/s Dual-Rate Burst-Mode Receiver Compliant With ITU-T G.9804.3 N1-Class, Hayato Suga[1], Takanori Kawanaka[1], Satoshi Yoshima[1], Satoshi Shirai[1]; [1]*Mitsubishi Electric, Japan*. Our simple dual-rate burst-mode receiver in a TO-46 package is compliant with the 50G-PON N1-class specifications. Receiver sensitivities of -26.5dBm and -27.8dBm were achieved for 25 and 12.5 Gb/s signals with 200ns preamble length.

Room 7AB

14:00–16:00
Th3I • Panel: Roadmap for Photonic AI Accelerators

Organizers: Glenn Bartolini, *Coherent Corp, USA;* Nikos Pleros, *Aristotle University of Thessaloniki, Greece;* Volker Sorger, *George Washington University, USA;* Xian Xiao, *Hewlett Packard Labs, USA*

Speakers: Darius Bunandar, *Lightmatter, USA;* Hamed Dalir, *University of California, Los Angeles, USA;* Johannes Feldmann, *Salience Labs, UK;* Bahram Jalali, *University of California, Los Angeles, USA:* Francesca Parmigianni, *Microsoft Research Cambridge, UK*

Description: In addition to the known high-bandwidth benefit, photonics offers two key functionalities with relevance to AI accelerators for machine learning, namely, multiplication and accumulation such as enabled via, for example, modulators and photodetectors, respectively. However, photonics is challenged to provide end-to-end neural network solutions reflected by the challenge of a nonlinear activation function leading to OEO conversions. This channels realisations of deep neural network architectures in the optical domain requiring electronics introducing parasitic conversions. In addition optical accelerators being analog compute engines may require (depending on the application) digital-to-analog domain crossing which is expensive.

In this panel we will review the state-of-the-art in photonic AI accelerators and will project challenges and solutions into the future for photonic and hybrid accelerators for AI and machine intelligence. Here our perspective is open to application spaces in network edge AI and to machine learning training in the cloud.

Room 8

14:00–15:45
Th3H • Free Space and Optical Camera Communications
Presider: Eduward Tangdiongga; Technische Universiteit Eindhoven, Netherlands

Th3H.1 • 14:00
Demonstration of "Automatic" Turbulence Mitigation of 4 QPSK Channels in a Self-Coherent Free-Space Mode-Division-Multiplexed Link Using a Pilot Beam and Photodetector Array, Huibin Zhou[1], Hao Song[1], Xinzhou Su[1], Yuxiang Duan[1], Kaiheng Zou[1], Runzhou Zhang[1], Moshe Tur[2], Alan Willner[1]; [1]*Univ. of Southern California, USA;* [2]*School of Electrical Engineering, Tel Aviv Univ., Israel*. We experimentally demonstrate "automatic" turbulence mitigation of a self-coherent FSO MDM link with four 1-Gbaud QPSK channels using a transmitted pilot beam and PD array without power-splitting losses or detector-bandwidth sharing. Results show <3-dB turbulence-induced penalty, compared to a >16-dB penalty for a conventional LO-based MDM system.

Th3H.2 • 14:15
Net 1 Tbps Multi-User Indoor FSO Downlink Over 25 m Based on Cost-Effective Point-to-Multipoint Coherent Optics and Probabilistic Shaping, chen cheng[1,2], Xueyang Li[1], Yongchao Jin[2], Zhixue He[1], Yanfu Yang[1,2], Weisheng Hu[1]; [1]*Peng Cheng Laboratory, China;* [2]*Harbin Inst. of Technology, China*. We demonstrate a cost-effective point-to-multipoint free-space optical downlink using digital subcarriers and achieve an aggregated net data rate beyond 1 Tbps over 25 m with 8 edge nodes while meeting the eye-safety standard.

Th3H.3 • 14:30
Experimental Demonstration of a 96 Channel WDM-FSO System Based Mobile Fronthaul With 1024QAM Delta-Sigma-Modulation, Kaihui Wang[1], Bowen Zhu[1], Yi Wei[1], Chen Wang[1], Wen Zhou[1], Li Zhao[1], Yun Chen[1], Xianmin Zhao[2], Jianjun Yu[1]; [1]*Fudan Univ., China;* [2]*Harbin Inst. of Technology, China*. For the first time, we experimentally demonstrate a 96-Channel WDM-FSO mobile fronthaul system, which can support 7.68Tbit/s PDM-OFDM-1024QAM signals delivery over 2-km SMF and 104m FSO link with the aid of 1-bit delta-sigma modulation.

Room 9

14:00–16:00
Th3J • Advanced Control in Quantum Systems
Presider: To be announced.

Th3J.1 • 14:00 Invited
Benchmarking of Scalable Photonic Quantum Systems, Christine Silberhorn[1]; [1]*Department Physics, Inst. of Photonic Quantum Systems (PhQS), Paderborn Univ., Germany*. Scaling photonic quantum simulations and computations requires many controllable modes and input states with many photons. Here we review different approaches for the experimental implementation of future multi-dimensional photonic quantum systems.

Th3J.2 • 14:30
Machine Learning Based Joint Polarization and Phase Compensation for CV-QKD, Hou-Man Chin[1], Adnan Hajomer[1], Nitin Jain[1], Ulrik L. Andersen[1], Tobias Gehring[1]; [1]*Technical Univ. of Denmark, Denmark*. We investigated a machine learning method for joint estimation of polarization and phase for use in a Gaussian modulated CV-QKD system, over an 18 hour period measured on a installed fiber with 5.5 dB attenuation.

Show Floor Programming

SF13 • IPEC: IPEC Overview of Optoelectronic Technology and Industry Standards in the Cloud Era
13:30–14:30, *Theater II*

SF14 • MOPA: Mobile Optics (MOPA) for the 6G Era
13:30–15:00, *Theater III*

Cisco Sponsored Session
14:00–14:30

Room 1AB

Th3A • Novel Enabling Devices—Continued

Th3A.3 • 14:45
Low-Loss Wide-FSR Miniaturized Racetrack Style Microring Filters for ≥1 Tbps DWDM, Asher S. Novick[1], Kaylx Jang[1], Anthony Rizzo[1], Robert Parsons[1], Keren Bergman[1]; [1]*Columbia Univ., USA*. We demonstrate add-drop microring filters based on 180° varied-width hybrid Euler bends, suitable for supporting >Tbps DWDM. We measure FSR>40nm, 0.64nm/mW thermal tuning efficiency, and IL_{off} ≤ 0.02dB across the C- and L-bands

Th3A.4 • 15:00
Dispersion-Engineered and Fabrication-Robust SOI Waveguides for Ultra-Broadband DWDM, Yuyang Wang[1], Songli Wang[1], Asher S. Novick[1], Aneek E. James[1], Robert Parsons[1], Anthony Rizzo[1], Keren Bergman[1]; [1]*Columbia Univ., USA*. We present a measurement-validated design methodology for engineering the width of silicon-on-insulator waveguides for co-optimized group velocity dispersion and fabrication robustness, paving the way for ultra-broadband dense wavelength-division multiplexing silicon photonic communication solutions.

Th3A.5 • 15:15
Universal CMOS-Foundry Compatible Platform for Ultra-Low Loss SOI Waveguide Bends, Kaylx Jang[1], Asher S. Novick[1], Anthony Rizzo[1], Keren Bergman[1]; [1]*Columbia Univ., USA*. We report a universal, foundry-agnostic, broadband, and ultra low-loss platform for SOI waveguide bends using fully-parameterized, varying-width, hybrid-Euler geometry. We measure record R = 1.75 μm IL of 0.0055 dB/180 at 1550 nm

Room 2

Th3B • Silicon Photonics Devices and Integrated Circuits—Continued

Th3B.3 • 15:00 Invited
Foundry's Perspective on Laser and SOA Module Integration With Si-Photonics, Chao Li[1], Feng Gao[1], James You Sian Tan[1], Guo-Qiang Lo[1]; [1]*Advanced Micro Foundry, Singapore*. An effective solution to integrating light source onto silicon photonics platform would be highly useful. Here, we discuss the integration solutions (i.e., hetero-epitaxial, heterogeneous and hybrid integration) and present foundry's perspective toward implementing of such.

Room 3

Th3C • Doped Fiber Amplifiers—Continued

Th3C.4 • 14:45
Record Gain of 18-dB for Broadband Single-Model Cr-Doped Crystalline Core Fiber by Small Core Diameter, Kai-Chieh Chang[1], Chia-Ling Tsai[2], Wei-Chih Cheng[2], Zon Ma[3], Liu Chun-Nien[3], Tien-Tsorng Shih[4], Sheng-Lung Huang[1], Wood-Hi Cheng[2]; [1]*Graduate Inst. of Photonics and Optoelectronics, National Taiwan Univ., Taiwan;* [2]*Graduate Inst. of Optoelectronic Engineering, National Chung Hsing Univ., Taiwan;* [3]*Department of Electronic Engineering, National Chung Hsing Univ., Taiwan;* [4]*Department of Electronic Engineering, National Kaohsiung Univ. of Applied Sciences, Taiwan*. We demonstrate record gain of 18-dB broadband single-mode Cr-doped crystalline core fiber employing small core diameter. The gain-per-unit-length is 90 dB/m, which is higher than currently achieved Er and Bi-doped fibers of 0.6 - 3 dB/m.

Th3C.5 • 15:00
Erbium-Doped Fiber Amplifier With Extended L-Band Gain to 1625 nm, Ziwei Zhai[1], Arindam Halder[1], Jayanta K. Sahu[1]; [1]*Univ. of Southampton, UK*. We report a double-pass L-band erbium-doped fiber amplifier providing ≥20dB gain from 1565-1625nm, with 46dB maximum gain at 1600nm. At 1625nm, the NF, OSNR, gain coefficient, and temperature-dependent-gain-coefficient were 7.2dB, 25dB, 0.045dB/mW, and -0.037dB/°C, respectively.

Th3C.6 • 15:15
Self-Compensation of Spectral Hole Burning Effect in Super C-Band EDFA, Lixian Wang[1], Yang Lan[1], Sharma Manish[1], Xiaolei Peng[1], Zhiping Jiang[1]; [1]*Huawei Technologies Canada, Canada*. This work investigates theoretically and experimentally the physical counterpart to the conventional spectral hole burning effect in erbium-doped fiber amplifiers: the inhomogeneous saturable absorption. Using this effect, a cost-effective compensation method is proposed.

Room 6C

Th3D • Advances in Data Center Switching and Interconnects—Continued

Th3D.3 • 14:45
Scalability Assessment of O-Band SOA-Based Broadcast and Select Switch With 100Gb/s LWDM Commercial Transceivers, Marijn Rombouts[1], Nicola Calabretta[1]; [1]*Eindhoven Univ. of Technology, Netherlands*. Scalability and operation of O-band SOA-based Broadcast & Select switches are experimentally assessed using 100Gb/s commercial transceivers. Results show error-free operation for a 32-port switch with <1.8dB power penalty and 10^−8 for a 64-port switch.

Th3D.4 • 15:00 Invited
Programmable Photonic Neural Networks for Advanced Machine Learning Tasks, Angelina Totovic[2,1], Apostolos Tsakyridis[1], George Giamougiannis[1], Miltiadis Moralis-Pegios[1], Anastasios Tefas[1], Nikos Pleros[1]; [1]*Department of Informatics, Aristotle Univ. of Thessaloniki, Greece;* [2]*Celestial AI, USA*. Photonics holds the promise of reshaping Machine Learning and High-Performance Computing hardware landscape, stripping it of unnecessary signal conversion overhead, complying with strict power dissipation envelopes while unlocking unrivaled compute and bandwidth capacity.

Room 6D

Th3E • Modulation Formats—Continued

Th3E.3 • 14:45
Geometric Constellation Shaping With Low-Complexity Demappers for Wiener Phase-Noise Channels, Andrej Rode[1], Laurent Schmalen[1]; [1]*Karlsruhe Inst. of Technology, Germany*. We show that separating the in-phase and quadrature component in optimized, machine-learning based demappers of optical communications systems with geometric constellation shaping reduces the required computational complexity whilst retaining their good performance.

Th3E.4 • 15:00
Mode Vector Modulation: Optimal Signal Sets With Signal Shaping, Ioannis Roudas[1], Eric R. Fink[2], Jaroslaw Kwapisz[2]; [1]*Electrical and Computer Engineering, Montana State Univ., USA;* [2]*Mathematical Sciences, Montana State Univ., USA*. For mode vector modulation, used in conjunction with direct-detection, we present geometrically-optimized signal sets that correspond to the densest sphere packing in the generalized Stokes space. We show that the best trade-off between spectral and energy efficiency occurs for simplex constellations.

Th3E.5 • 15:15 ★ Top-Scored
Practical Implementation of Sequence Selection for Nonlinear Probabilistic Shaping, Stella Civelli[1,2], Enrico Forestieri[1,2], Marco Secondini[1,2]; [1]*Scuola Superiore Sant Anna di Pisa, Italy;* [2]*PNTLab, CNIT, Italy*. We propose two novel techniques to implement sequence selection (SS) for fiber nonlinearity mitigation, demonstrating a nonlinear shaping gain of 0.24 bits/s/Hz, just 0.1 bits/s/Hz below the SS capacity lower bound.

Room 6E

Th3F • Wideband Transmission Systems—Continued

Th3F.3 • 14:45
38.4-Tbps Inline-Amplified Transmission Using PPLN-Based Optical Parametric Amplifier Over 6 THz Within L- and U-Bands, Shimpei Shimizu[1], Takayuki Kobayashi[1], Akira Kawai[1], Takushi Kazama[1,2], Masanori Nakamura[1], Koji Enbutsu[2], Takahiro Kashiwazaki[2], Masashi Abe[2], Takeshi Umeki[1,2], Yutaka Miyamoto[1], Tomoyuki Kato[3], Yu Tanaka[3], Takeshi Hoshida[3]; [1]*NTT Network Innovation Laboratories, NTT Corporation, Japan;* [2]*NTT Device Technology Laboratories, NTT Corporation, Japan;* [3]*Fujitsu Limited, Japan*. We demonstrate a 5×80-km WDM transmission over 6 THz within 1597.19–1649.93 nm. PPLN-based optical parametric amplifiers provide sufficient gain for inline amplification of 60-channel 640-Gbps/λ signals allocated in L- and U-bands.

Th3F.4 • 15:00
Modeling and Optimization of Experimental S+C+L WDM Coherent Transmission System, Salma Escobar Landero[1], Xiaohui Zhao[1], Abel Lorences-Riesgo[1], Dylan Le Gac[1], Yann Frignac[1], Gabriel Charlet[1]; [1]*Huawei Technologies France, France*. Using accurate ISRS GN modeling and the fast-converging ASE-NL optimization algorithm, we demonstrate 6.2 Tbit/s throughput improvement in a 2-span ultra-wide-band system thanks to the use of the predicted total and per channel power.

Th3F.5 • 15:15
Coherent O-Band Transmission of 4×25 GBd DP-16QAM Channels Over a 50 km BDFA-Equipped Link, Natsupa Taengnoi[1], Kyle Bottrill[1], Yang Hong[2,1], Yu Wang[1], Jayanta K. Sahu[1], Lajos Hanzo[3], David J. Richardson[1], Periklis Petropoulos[1]; [1]*Optoelectronics Research Centre, UK;* [2]*Nokia Bell Labs, France;* [3]*School of Electronics and Computer Science, Univ. of Southampton, UK*. The first WDM O-band coherent transmission experiment in a BDFA-amplified link is reported. Four 25 GBd DP-16QAM channels (4×200 Gb/s) are transmitted over 50km of fiber, occupying a bandwidth of 4.7 THz.

Room 6F

Th3G • High Data-Rate Direct Detection in Access—Continued

Th3G.5 • 14:45 Tutorial

100G and Beyond for PON and Short Reach Optical Networks, Weisheng Hu[1]; [1]*Shanghai Jiaotong Univ., China.* Abstract not available.

Room 7AB

Th3I • Panel: Roadmap for Photonic AI Accelerators—Continued

Room 8

Th3H • Free Space and Optical Camera Communications—Continued

Th3H.4 • 14:45

Experimental Demonstration of All-Optical 8-Gbit/s Secure Free-Space Chaotic Communications Over 8.2-Meter Link Based on Unidirectional Injection-Locking Chaos Synchronization, Yiqun Zhang[1,2], Mingfeng Xu[1,3], Qiang Chen[1,4], Mengjie Zhou[5], Shuangcheng Chen[5], Mingbo Pu[1,3], Ning Jiang[2], Kun Qiu[2], Martin Lavery[6], Hasan Abbas[6], Xiangang Luo[1,4]; [1]*State Key Laboratory of Optical Technologies on Nano-Fabrication and Micro-Engineering, Inst. of Optics and Electronics, Chinese Academy of Sciences, China;* [2]*School of Information and Communication Engineering, Univ. of Electronic Science and Technology of China, China;* [3]*Research Center on Vector Optical Fields, Inst. of Optics and Electronics, Chinese Academy of Sciences, China;* [4]*School of Optoelectronics, Univ. of Chinese Academy of Sciences, China;* [5]*Tianfu Xinglong Lake Laboratory, China;* [6]*James Watt School of Engineering, Univ. of Glasgow, UK.* We first experimentally demonstrate an 8-Gbit/s free-space secure chaotic optical communications link over 8.2 meters in a long corridor with satisfactory BER performance by achieving one-way injection locking chaos synchronization.

Th3H.5 • 15:00

100G FSO Transmission Using 3-Bit DAC and Self-Coherent Detection, Romil Patel[1,2], Guilherme A. Domingues[1,2], Nelson J. Muga[1,2], Armando N. Pinto[1,2], Marco A. Fernandes[1,2], Gil M. Fernandes[1], Paulo Monteiro[1,2], Fernando Guiomar[1,2]; [1]*Instituto de Telecomunicações, Portugal;* [2]*DETI, Universidade de Aveiro, Portugal.* Using a virtual-carrier-assisted self-coherent system aided by a digital resolution enhancement technique, we experimentally demonstrate 100 Gbps FSO transmission over an outdoor 42 m link, supported by a single photoreceiver and a simplified transmitter with a 3-bit DAC.

Th3H.6 • 15:15

Lightweight Light-Diffusing Fiber Transmitter Equipped Unmanned-Aerial-Vehicle (UAV) for Large Field-of-View (FOV) Optical Wireless Communication, Yun-Han Chang[1], Deng-Cheng Tsai[1], Chi-Wai Chow[1], Chih-Chun Wang[1], Shang-Yen Tsai[1], Yang Liu[2], Chien-Hung Yeh[3]; [1]*National Yang Ming Chiao Tung Univ., Taiwan;* [2]*Philips, Hong Kong;* [3]*Feng Chia Univ., Taiwan.* We propose a light-diffusing-fiber transmitter (LDF-Tx) equipped unmanned-aerial-vehicle (UAV) for optical-wireless-communication (OWC). Long-short-term-memory-neural-network (LSTMNN) provides efficient rolling-shutter-pattern decoding at 360° around LDF-Tx circumference.

Room 9

Th3J • Advanced Control in Quantum Systems—Continued

Th3J.3 • 14:45

MDI-QKD With Resource-Efficient Polarization Compensation, Olinka Bedroya[1], Chenyang Li[1,2], Wenyuan Wang[2], Jianyong Hu[1], Hoi-Kwong Lo[1,2], Li Qian[1]; [1]*Univ. of Toronto, Canada;* [2]*Univ. of Hong Kong, Hong Kong.* We implemented MDI-QKD with a novel polarization compensation scheme using discarded bits without reducing the key-sharing cycle or demanding additional resources. Polarization drift was maintained below 0.13 rad over a 40 km unisolated fibre spool for four hours, and the average secret key rate generated was 7.45 $\times 10^{-6}$ bits per pulse.

Th3J.4 • 15:00

Simple and Fast Polarization Tracking Algorithm for Continuous-Variable Quantum Key Distribution System, Yan Pan[1], Heng Wang[1], Yun Shao[1], Yaodi Pi[1], Ting Ye[1], Yang Li[1], Wei Huang[1], Bingjie Xu[1]; [1]*Science and Technology on Communication Security Laboratory, Inst. of Southwestern Communication, China.* A simple and fast polarization tracking algorithm for pilot tone-assisted CV-QKD system is demonstrated. Experimental results show that the proposed algorithm can track polarization scrambling rate ≥12.57 krad/s with a good performance.

Th3J.5 • 15:15

Open Quantum Channel Stabilization for Twin-Field Quantum key Distribution, Lai Zhou[1], Jinping Lin[1], Yumang Jing[1], Zhiliang Yuan[1]; [1]*Beijing Academy of Quantum Information Sciences, China.* We develop a novel technique to stabilize an open channel without using frequency dissemination for twin-field quantum key distribution. A versatile setup is demonstrated at a distance of 615.6 km, achieving the repeater-like behaviour.

Show Floor Programming

SF14 • MOPA: Mobile Optics (MOPA) for the 6G Era
13:30–15:00, *Theater III*

SF15 • 3D Sensing in High Volume Consumer and Automotive Applications
14:45–15:45, *Theater I*

SF16 • F5G Update: The Second Release of Use Cases and Demonstrations
14:45–15:45, *Theater II*

Room 1AB

Th3A • Novel Enabling Devices—Continued

Th3A.6 • 15:30
Novel Blue-Green Light Phase Array by Light-Sheet-Excited One-Dimension Strip Grating Array, Weiwei Liu[1], Binghui Li[2], Caiming Sun[1,2]; [1]*Peng Cheng Laboratory, China;* [2]*The Chinese Univ. of Hong Kong (CUHK), Shenzhen, China.* We demonstrate a novel blue-green light phased array by light-sheet-excited 1D strip waveguide grating with nearly spot emission profile. By tuning wavelength, the range 15° of beam steering was achieved.

Th3A.7 • 15:45
Multifunctional Anisotropic Thermo-Optic Mach-Zehnder Interferometer on LNOI, Lijia Song[1], Weixi Liu[1], Huan Li[1], Yaocheng Shi[1], Daoxin Dai[1]; [1]*Zhejiang Univ., China.* Harnessing the strong anisotropy of lithium niobate, we have proposed a multifunctional thermo-optic Mach-Zehnder interferometer on x-cut LNOI and experimentally demonstrated its versatile configurations as a polarization-insensitive switch and a polarization beam splitter.

Room 2

Th3B • Silicon Photonics Devices and Integrated Circuits—Continued

Th3B.4 • 15:30
Single Lane 330 Gb/s Silicon Photonic Microring Modulator With sub 2 V_{pp} Driving Voltage, David Chan[1], Xiong Wu[2], Alan Pak Tao Lau[3], Chao Lu[2], Hon Ki Tsang[1]; [1]*Department of Electronic Engineering, The Chinese Univ. of Hong Kong, Hong Kong;* [2]*Department of Electronic and Information Engineering, The Hong Kong Polytechnic Univ., Hong Kong;* [3]*Department of Electrical Engineering, The Hong Kong Polytechnic Univ., Hong Kong*. We present the first silicon photonic microring modulator operating at up to 330 Gb/s. The modulator can support PAM-8 with driving voltage under 2 V_{pp} in C-band using a polynomial nonlinear equalizer.

Th3B.5 • 15:45
III-v-on-Silicon Nitride Narrow-Linewidth Tunable Laser Based on Micro-Transfer Printing, Biwei Pan[1,2], Jerome Bourderionnet[3], Vincent Billault[3], Arnaud Brignon[3], Sarvagya Dwivedi[4], Marcus Dahlem[4], Cian Cummins[4], Sandeep S. Saseendran[4], Nga Pham[4], Philippe Helin[4], Nicolas Vaissière[5], Delphine Néel[5], Joan Ramirez[5], Jean Decobert[5], Johanna Rimböck[6], Ruggero Loi[7], Alin Fecioru[7], Emadreza Soltanian[1,2], Jing Zhang[1,2], Bart Kuyken[1,2], Gunther Roelkens[1,2]; [1]*Photonics Research Group, INTEC, Ghent Univ. - imec, Belgium;* [2]*Center for Nano- and Biophotonics, Ghent Univ. - imec, Belgium;* [3]*Thales Research and Technology, France;* [4]*IMEC, Belgium;* [5]*III-V Lab, France;* [6]*EV Group, Austria;* [7]*X-Celeprint, Ireland.* We demonstrate a narrow-linewidth tunable laser through micro-transfer printing a pre-fabricated III-V gain section on imec's 200-mm Si/SiN platform. Lasing in distinct bands in the C+L band is demonstrated, with linewidth down to 2.87-kHz.

Room 3

Th3C • Doped Fiber Amplifiers—Continued

Th3C.7 • 15:30 Invited
High Power EDFAs for Free Space Communication, Jeffrey W. Nicholson[1], Andrew Grimes[1], Anand Hariharan[1], V. Sudarshanam[1], Cang Jin[1], Yingzhi Sun[1]; [1]*OFS, USA.* Progress and performance of high-power EDFAs, in-band pumped by Raman fiber lasers operating at 1480 nm will be reviewed. Applications of these laser systems to free-space communications will be discussed.

Room 6C

Th3D • Advances in Data Center Switching and Interconnects—Continued

Th3D.5 • 15:30 Invited
Integrating Nanosecond Optical Switching in Deep Distributed Learning System, Cen Wang[1]; [1]*KDDI R&D Laboratories, Japan.* We propose O(10ns) optical switching structure with wavelength-elastic and topology-flexibility in support of distributed deep learning platform. Our experimental demonstration shows accelerations for three use cases.

Room 6D

Th3E • Modulation Formats—Continued

Th3E.6 • 15:30
Demonstration of Polar Coded Truncated Probabilistic Shaped 64-QAM Transmission Over 2000-km G.654E Fiber, Xiaoshuo Jia[1], Ming Luo[2], Yan Li[1], Chao Yang[2], Wu Liu[2], Xiaobin Hong[1], Hongxiang Guo[1], Jifang Qiu[1], Jian Wu[1]; [1]*Beijing Univ of Posts & Telecom, China;* [2]*China Information and Communication Technologies Group Corporation, State Key Laboratory of Optical Communication Technologies and Network, China.* In this paper, a polar coded truncated probabilistic shaped 64-QAM (PTPS-64QAM) scheme is proposed and investigated over the G.654E fiber. Results show that about 2000-km transmission could be achieved aided by the novel proposed scheme.

Th3E.7 • 15:45
C-Band 100 Gb/s Transmission Over 40 km SSMF Using a Silicon Photonic Vestigial Sideband Transmitter Based on Dual-Drive MZM and Passive Optical Delay Line, Essam Berikaa[1], Md Samiul Alam[1], Yixiang Hu[1], Weijia Li[1], David Plant[1]; [1]*McGill Univ., Canada.* We demonstrate a filter-free silicon photonic VSB transmitter, enabling the C-band transmission of 56 Gbaud PAM4 over 40 km of dispersion-uncompensated SSMF under the 6.7% overhead HD-FEC with a single DAC channel and non-linear equalization.

Room 6E

Th3F • Wideband Transmission Systems—Continued

Th3F.6 • 15:30
U-Band Transmission of Real-Time 200-Gb/s Signal Co-Propagating With C+L-Band WDM Signal, Tomoyuki Kato[1], Hiroyuki Irie[1], Hidenobu Muranaka[1], Yu Tanaka[1], Yuichi Akiyama[1], Takeshi Hoshida[1]; [1]*Fujitsu Limited, Japan.* We propose a U-band transmission added to the C+L-band that can mitigate large loss at long wavelength by inter-channel SRS. The benefit is demonstrated in 80-km SSMF transmission of real-time 200-Gb/s DP-QPSK signal.

Th3F.7 • 15:45
O-Band Transmission Over High-Cutoff G.654.C Fiber, John D. Downie[1], Petr Sterlingov[1], Jason Hurley[1], Hector De Pedro[1], Xin Chen[1], David Seddon[1]; [1]*Corning Inc, USA.* We demonstrate via modeling and experiments the feasibility of O-band transmission over ultra-low loss G.654.C fiber in cabled conditions. Lab experiments with a 100G O-band transceiver show no penalty and transmission up to 99 km.

16:00–16:30 Coffee Break, *Upper Level Corridors*

16:30–18:30 Postdeadline Paper Sessions, *Room 6C, 6D, 6E, 6F*

Room 6F

Th3G • High Data-Rate Direct Detection in Access—Continued

Room 7AB

Th3I • Panel: Roadmap for Photonic AI Accelerators—Continued

Room 8

Th3H • Free Space and Optical Camera Communications—Continued

Th3H.7 • 15:30
First Demonstration of 512-Color Shift Keying Signal Demodulation Using Neural Equalization for Optical Camera Communication, Yukito Onodera[1], Daisuke Hisano[2], Kazuki Maruta[3], Yu Nakayama[1]; *[1]Tokyo Univ. of Agriculture and Technology, Japan; [2]Osaka Univ., Japan; [3]Tokyo Univ. of Science, Japan.* This paper experimentally demonstrates 512 color shift keying (CSK) signal transmission for optical camera communication (OCC). We achieved error-free operation with a CMOS image sensor module and a multi-label classification neural network-based equalizer.

Room 9

Th3J • Advanced Control in Quantum Systems—Continued

Th3J.6 • 15:30 ★ Top-Scored
Enhancing the Quantum Correlation of Biphotons via Coherent Energy Redistribution, Benjamin G. Crockett[1], Nicola Montaut[1], James van Howe[1,2], Piotr Roztocki[1,3], Yang Liu[1,4], Robin Helsten[1], Wei Zhao[4,5], Roberto Morandotti[1], Jose Azaña[1]; *[1]INRS, Canada; [2]Department of Physics and Astronomy, Augustana College, USA; [3]Ki3 Photonics Technologies, Canada; [4]Xi'an Inst. of Optics and Precision Mechanics, Chinese Academy of Sciences, China; [5]Univ. of Chinese Academy of Sciences, China.* Towards meeting the strict demands of practical quantum networks, we leverage coherent energy redistribution for noise-tolerant quantum signal processing. We demonstrate the enhancement of noisy biphoton coincidence-to-accidental ratios by up to 3.8 times.

Th3J.7 • 15:45
Spectroscopy Characterization of Quantum Modes in an on-Chip Squeezed Microcomb, Mandana Jahanbozorgi[1], Zijiao Yang[1], Emily Parnell[1], Dongin Jeong[2], Shuman Sun[1], Olivier Pfister[1], Hansuek Lee[2], Xu Yi[1]; *[1]Univ. of Virginia, USA; [2]Korea Advanced Inst. of Science and Technology, Korea (the Republic of).* We characterized the spectrum of 40 quantum modes in an on-chip squeezed microcomb. A theoretical model is developed to explain how cavity dispersion affects the squeezing and the frequency equidistance of these quantum modes.

16:00–16:30 Coffee Break, *Upper Level Corridors*

16:30–18:30 Postdeadline Paper Sessions, *Room 6C, 6D, 6E, 6F*

Show Floor Programming

SF15 • 3D Sensing in High Volume Consumer and Automotive Applications
14:45–15:45, *Theater I*

SF16 • F5G Update: The Second Release of Use Cases and Demonstrations
14:45–15:45, *Theater II*

Key to Authors and Presiders

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