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The information in this program is as of 01 February 2022.

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

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

Conference Schedule

Conference Schedule at a Glance

All times reflect Pacific Time Zone	Sunday 06 March	Monday 07 March	Tuesday 08 March	Wednesday 09 March	Thursday 10 March
Registration	07:30–19:00	07:30–18:00	07:00–18:00	07:30–17:00	07:30–16:00
Programming					
Short Courses	09:00–20:00	08:30–17:30			
Workshops	13:00–18:30				
Lab Automation Hackathon	20:00–22:00				
Technical Sessions		08:00–18:30	14:00–18:30	08:00–18:15	08:00–16:00
Symposium: Optical Satellite Communications – Entering a New Era		08:00–12:30			
Symposium: Multi-access Network Leveraging Edge Computing for Energy-efficient, Ultra-reliable, and Low Latency Services		14:00–18:30			
Symposium: Emerging Photonic Interconnects and Architectures for Femtojoule per Bit Intra Data Center Links			14:00–18:30		
Special Chairs' Sessions: Reflections of the Pandemic		08:00–12:30			
Special Session: Network Intelligence				08:00–10:00	
Special Chairs' Sessions: Network Evolution & Adaptation to Environmental Change				14:00–18:30	
Open Networking Summit: Open Optical Disaggregation: What the Heck is Going On?				08:00–10:00	
Demo Zone		14:00–16:15			
Rump Session: Will Quantum Always Remain Basic Research or is it Ready to Power Great Products?			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 (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 Infinera			10:30–16:00	15:30–17:00	10:30–14:00
Network Operator Summit - Expo Theater I				10:30–15:00	
Data Center Summit – Expo Theater II Sponsored by Amphenol			10:30–15:00		
Expo Theater II and III Programs			10:15–17:00	10:15–17:00	10:30–15:15
Suzanne R. Nagel Lounge			10:00–17:00	10:00–17:00	10:00–16:00
OFC Career Zone			10:00–17:00	10:00–17:00	10:00–16:00
Special Events					
Plenary Session			08:00–10:00		
Awards Ceremony and Luncheon Supported by CORNING			12:00–14:00		
Conference Reception			18:30–20:00		
Rise and Shine Fun Run/Walk				06:00–07:00	
Rise and Relax Yoga					06:00–07:00

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Convention Center Lobby

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

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

Event Policies and Terms/Code of Conduct

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

First Aid Station

Box Office E

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

First Aid Station Hours

Sunday, 06 March	08:00–17:00
Monday, 07 March	08:00–17:00
Tuesday, 08 March	08:00–17:00
Wednesday, 09 March	08:00–17:00
Thursday, 10 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, 06 March	12:00–16:00
Monday, 07 March	07:30–18:00
Tuesday, 08 March	07:30–18:00
Wednesday, 09 March	07:30–18:00
Thursday, 10 March	07:30–16:00

OFC Career Zone

Exhibit Hall C

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

Job Seekers
Meet Participating Companies

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

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 OFC 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.

OFC Conference App

OFC offers more than 100 sessions featuring 120+ invited speakers and 20+ tutorial presentations in the technical conference along with hundreds of exhibitors. Manage your conference experience by downloading the OFC Conference App to your smartphone or tablet. (See steps below).

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

Exhibit Hall
Search for exhibitors 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
Full technical registrants can navigate directly to the technical papers right from the OFC Conference App. Locate the session or talk in "Event Schedule" and click on the "Download PDF" link that appears in the description.

Important - Log in with your registration email and password to access the technical papers. Access is limited to Full Conference Attendees.

Download the OFC Conference App!
Plan your day with a personalized schedule and browse exhibitors, maps and general show information while engaging with your fellow attendees. iPhone/iPod, iPad, Android, and Kindle Fire compatible. Download the conference app one of three ways:

1. Search for 'OFC Conference' in the app store.
2. Go to ofcconference.org/app
3. Scan the QR code

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

Registration

Lobby D

Hours:

Sunday, 06 March	07:30–19:00
Monday, 07 March	07:30–18:00
Tuesday, 08 March	07:00–18:00
Wednesday, 09 March	07:30–17:00
Thursday, 10 March	07:30–16:00

Join the Conversation!

Get the latest updates from OFC via Twitter at @OFCConference. Use the hashtag #OFC22 and join in the conversation today!

Speaker Ready Room

Room 11

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

Speaker Ready Room Hours*

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

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

Sponsoring Society Exhibits

Exhibit Hall F

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

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

Wireless Internet Access

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

- SSID: OFC
- Password: OFC2022

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

Conference Materials

OFC Technical Digest

The OFC Technical Digest, composed of the 3-page summaries of invited and accepted contributed papers, as well as, tutorial presentations notes will be accessible on the OFC web site. The Technical Digest is included with a technical conference registration. Accepted and presented papers are published in the IEEE Xplore Digital Library and on the Optica Publishing Group platform. In addition, OFC further supports the visibility of your paper by indexing in Ei Compendex, Scopus and Google Scholar.

Online Access to Technical Digest

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

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

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

Postdeadline Papers

The 3-page summaries of accepted Postdeadline Papers will be available to download online on Tuesday, 08 March. The papers will be presented Thursday, 10 March, 16:30–18:30.

Short Course Notes

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

Buyers' Guide

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

Captured Session Content

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

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

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Special Events and Programming

Workshops

Sunday, 06 March, 13:00 – 15:30

S1A: Is Paradigm Shift from Pluggable Optics to Co-packaged Optics Inevitable in the Next Generation of Datacenters?
Room: 6C

Organizers: Andreas Matiss, *Corning Inc., USA;* Reza Motaghian, *Amazon Web Services, USA;* Hideyuki Nasu, *Furukawa Electric, Japan;* Hanxing Shi, *Juniper Networks, USA;* Mike Tan, *Hewlett Packard Enterprise, USA*

Co-packaged optics (CPO) has been introduced as a promising technology to fulfill power consumption and bandwidth density requirements in the next generation of datacenters ecosystem. However, there is a need for an industry wide strategic roadmap to identify key limitations and challenges of both CPO and pluggable optics technologies and potentially define transition point and adoption rate from pluggable optics to CPO. In addition, different requirements need to be met to deliver a reliable, cost effective, and competitive solution for different platforms including HPCs and AI Clusters over a particular time horizon.

This workshop debates several controversial ideas to visualize the future directions by focusing on the key topics including a) coexistence of both technologies vs ultimate life time of pluggable optics, b) CPO realization difficulties vs innovative ultra-high speed pluggable optics challenges, c) industry readiness, concerns, applications, and adoption rate through this paradigm shift, d) cost trajectories, e) optical technologies (IMDD/coherent, parallel fiber/WDM, etc.), f) advanced light source development and integration, g) BW requirements for different future topologies/ architectures relying on disaggregated compute and storage, and h) standardization. Different aspects of both solutions including high speed electrical interfaces, packaging, signal integrity, system integration, form factors, thermal managements, reliability, redundancy/serviceability, test/diagnosis, scalability are also discussed as important factors in this workshop.

Speakers:

Brad Booth, *Microsoft, USA*
Transition Drivers for Photonic Integration

Loi Nguyen, *Marvell, USA*
2.5D/3D Silicon Photonics Enables High Density Pluggable and Co-packaged Optics

Po Dong, *II-VI Incorporated, USA*
From Optics on Board to CPO, Did We Miss Something?

Matt Traverso, *Cisco, USA*
Perspectives on Co-packaged Optics

Ted Schmidt, *Lumentum, USA*
Disaggregating Lasers - Why, Where and When?

Rebecca Schaevitz, *Broadcom, USA*
Scaling into the Next Decade: Highly Integrated Silicon as the Building Block of the Future

Robert Blum, *Intel, USA*
Silicon Photonics for Co-packaged Optics and High Speed Optical I/O

Hamid Arabzadeh, *Ranovus, Canada*
Connecting the End Points: CPO vs. Pluggable

Erik Norberg, *Juniper, USA*
Silicon Photonics with Integrated Laser - Enabling the Paradigm Shift from Pluggable Optics to CPO in Datacenters

Henning Lysdal, *Nvidia, Denmark*
CPO is Inevitable - But Not Like You Might Think

S1B: Will Machine Learning Replace QoT/ Performance Estimation and Has it Reached the Stage of Commercial Deployment?
Room: 6D

Organizers: Hussam Batschon, *NEC Laboratories America Inc., USA;* Zuqing Zhu, *University of Science & Technology of China, China*

Machine Learning (ML) is playing an increasingly important role in many areas of optical communications research. It is crucial in cases where clear analytical solutions may not be available or are computationally prohibitive (e.g., system modeling and quality-of-transmission (QoT)/ performance estimation). Moreover, in the past couple of years ML has also shown promising performance in other parts of the field, such as network monitoring and failure detection and correction. However, to bring ML from research into real-world applications there are many technical questions to be answered and commercial challenges to be considered. For instance, one question would be on whether traditional QoT/performance estimation schemes based on deterministic models and algorithms are still needed, or should they be replaced with more adaptive and smart algorithms based on ML? Meanwhile, commercial challenges may include finding sources and sufficient access to training data and dealing with the different laws and regulations to name a few. Other technical obstacles may include functionality and reliability, in addition to model size and hardware requirements.

In this workshop, we invite experts on ML and optical networking, to discuss the future role of ML in optical networks. The topics that will be covered in this workshop include, but are not limited to:

- What are the steps needed to commercialize ML in optical transmission applications?
- How long will it take before making it a reality?
- What are the obstacles that may prevent translation from research to commercial products?

- How to develop a practical ML-based QoT/performance estimation technique that can be put into production networks?
- What are the prerequisites to deploy a ML-based QoT/performance estimation technique?
- How to generate standard and reliable data sets to train and test ML-based QoT/performance estimation models?
- Will scalability and universality be an issue for ML-based QoT/performance estimation technique?
- Can we trust and operate fully autonomously with ML-based QoT/performance estimation? What are the negative cases, and will there be any vulnerability to careless errors and intentional attacks?
- If we only want to partially replace the traditional QoT/performance estimation scheme with an ML-based one, what is the proper approach to take?
- Will the advances on telemetry-based network monitoring promote the application of ML-based QoT/performance estimation?

Speakers:

Behnam Shariati, *Fraunhofer HHI, Germany*
ML-assisted QoT Estimators in Disaggregated Open Optical Networks: A Data Ownership Perspective

Maximilian Schädler, *Huawei Munich Research Center, Germany*
Quality Metrics Provided by AI-based PHY Layer

Roberto Proietti, *University of California, Davis, USA*
Transfer Learning for QoT Estimation in Multi-Domain Optical Networks

Josep Fabrega, *CTTC, Spain*
Optical Signal Performance Monitoring Enhanced by Artificial Intelligence

David Côté, *Ciena Corporation, USA*
Automating Network Operations with Artificial Intelligence

Massimo Tornatore, *Politecnico di Milano, Italy*
Machine Learning for Low-Margin Routing and Spectrum Assignment

Antonio Napoli, *Infinera, Germany*
The Three Pillars of Realistic Neural Network Implementation for Nonlinear Compensation in Coherent Optical Transmission: Performance, Computational Complexity, and Flexibility

Alan Pak, *Hong Kong Polytechnic University, Hong Kong*
Comparison between ML and Analytical Models for QoT Estimation

Metodi Yankov, *Technical University of Denmark, Denmark*
Design, Monitoring and Control of WDM Systems Using ML-based Component Models: Opportunities and Possibilities

S1C: How Will the Future DC Infrastructure be in the Hyperconnectivity Era?

Room: 6E

Organizers: Nicola Calabretta, *Eindhoven University of Technology, Netherlands;* Wenhua Lin, *Intel Corp., USA;* Michela Svaluto Moreolo, *Ctr Tecnològic de Telecom de Catalunya, Spain*

Hyperconnectivity is driving a radical change in our society and posing several technological challenges, fueling changes in communications because of the complexity, diversity and integration of new applications and devices using the network. This is particularly crucial for the design and implementation of future DC networks and edge computing interconnects envisioning a DC infrastructure, in which all computing (CPU, GPU, TPU, photonic computing), memory and storage elements can communicate through the network. This trend, boosted by the need of intelligent and efficient interconnected computing and heterogenous AI and ML-based workload applications in DC and edge nodes, is therefore opening several challenges to be urgently addressed by the scientific community. This includes a huge capacity demand at reduced cost, power consumption and footprint, the need for efficient resource utilization with improved flexibility and scalability, transparency and low latency protocol, just to name some of them.

So, how will the future DC infrastructure be designed to support hyperconnectivity? Aim of the workshop is to explore photonic technologies and network architectures for enabling the next generation DC infrastructure and edge computing, with focus on machine learning (photonic neural networks) applications, co-package optics and flexible Tb/s capacity solutions. Furthermore, innovative architectures based on fiber to the servers and disaggregation/composition of IT resources will be also discussed with special focus on their scalability and requirements.

Some of the key questions that will be discussed by industry and academic panelists, considering ultimately cost and power consumption, are:

- How to scale the DC infrastructures while enabling power-efficient intelligent computing?
- What is the required server/blade connectivity in next generation DC infrastructures?
- What is next after 100 Tb/s electronic switch to support high capacity and high connectivity networks?
- Which are the promising DCI solutions for flexibly supporting Tb/s capacities?
- Is coherent technology the option to be adopted?
- Can photonic switches (in combination with novel network architectures) play a role?
- What is the optimal interface bandwidth/format of next generation edge nodes?
- Are current technologies mature or an evolution is needed? In what direction?
- Is fiber to the servers a viable solution or it only further exacerbates the network and switches requirements?
- Can disaggregation be practical to efficiently use the IT resources and replace inefficient server centric architectures?
- Is the transparency of the photonic switches a real enabler of low latency protocol for disaggregated architectures?

Speakers:

Ryohei Urata, *Google, USA*
Datacenter Networks and Interconnect: Challenges and Requirements for the Next Decade

Jiajia Chen, *Facebook, USA*
Title to be Determined

Chongjin Xie, *Alibaba, USA*
Optics will Play a Bigger Role in Future DC Infrastructure

Kai Shi, Microsoft, *UK*
Towards Power-Efficient Data Center Networks

Andy Bechtolsheim, *Arista Networks, USA*
Power-Efficient High-speed Datacenter Networks

Rob Sherwood, *Intel, USA*
Title to be Determined

Aaron Zilkie, *Rockley Photonics, UK*
High Density and Power Efficient Silicon Photonics for Advanced Datacenter Architectures

Shu Namiki, *AIST, Japan*
Disaggregated Optical Layer Switching That Turn Servers Inside Out

Paraskevas Bakopoulos, *Nvidia, Greece*
Opportunities for Photonics in AI Datacenters

Bert-Jan Offrein, *IBM Switzerland*
Neuromorphic Computing Technologies and the Anticipated Impact on Datacenters

Jose Capmany, *iPronics, Spain*
Programmable Photonics for Data Center Applications: Edge and Cloud Scenarios

S1D: Is Optical Wireless Still Relevant for 6G or Will Fiber-radio be Enough?

Room: 6F

Organizers: Chi-Wai Chow, *National Yang Ming Chiao Tung University, Taiwan;* Anthony Ng'oma, *Corning Inc., USA;* Eduward Tangdiongga, *Eindhoven University of Technology, Netherlands*

Optical-Wireless Communications (OWC) has evolved in many significant ways recently and is now employed in a wide range of applications – beyond free-space terrestrial communication and extending to in-space and under-sea communications. The biggest attractions to OWC are its extremely high spectral efficiency (bit/s/Hz/sq. m) – owing to its high carrier frequency and the ease of OWC signal confinement, which enables superior frequency reuse and its immunity to EM interference. On the other hand, Fiber-Radio (FR) communications, which combines the best of two worlds - optical fiber and radio communications continues to be widely used in wireless and mobile applications including 3G and 4G and the newest mobile standard – 5G.

At the dawn of 5G mobile, many had hoped that perhaps OWC in one of its many flavors – including VLC/Li-Fi would, on the basis of its key advantages have a natural role to play in the new era. However, as it turns out, today 5G mobile is mostly relying on Radio, Optical Fiber and FR technologies. This workshop will discuss the reasons why OWC hasn't had the anticipated success in today's 5G deployments. In addition, we will consider the question of whether the evolution towards 6G, which promises exceedingly higher wireless data speeds, ultra-low latency communications and a host of new applications will provide that long-awaited opportunity for OWC to play a significant role in edge and end-user communications. The workshop will aim to identify areas of potential limitations for FR systems and specific areas of opportunity for OWC in the 6G era and provide the accompanying rationale for the optimism.

Speakers:
Abdelmoula Bekkali, *Tokyo Electric Corp., Japan*
Alberto Bianchi, *Ericsson, USA*
Pham Tien Dat, *NICT, Japan*
Nathan Gomes, *University College London, UK*
Harald Haas, *Univ. of Strathclyde, UK*
Volker Jungnickel, *Fraunhofer HHI, Germany*
Xu Li, *Huawei Technologies, Canada*
Michael Sauer, *Corning, USA*
Mark Watts, *Verizon Wireless, USA*
Jing Wang, *Cable Labs, USA*

S1E: Time to Face the Cost Per Bit "Crunch": Trends and Expectations for the Next Decade

Room: 7AB

Organizers: Amirhossein Ghazisaeidi, *Nokia Bell Labs, France;* Taiji Sakamoto, *NTT Access Service Systems Laboratories, Japan;* Chester Shu, *Chinese University of Hong Kong, Hong Kong;* Oleg Sinkin, *SubCom, USA*

Cost per bit has experienced exponential decrease with time historically. This trend is expected to continue as future capacity demand continues to grow. Many current technologies are mature and are close to fundamental limits: Improvements in modulation formats, FEC, improvements in fiber loss and nonlinearity are expected to be relatively minor and cannot accommodate increasing capacity demand. There are research studies on space division multiplexing (SDM) and bandwidth extension; however, there is no clear path to addressing capacity and economic challenges ahead.

The SDM transmission has been on the spotlight of optical communications for the past ten years already, and extensive research efforts on SDM fiber technologies, amplifiers, and other components have clearly shown the great potential of this approach to scale the capacity of optical systems. At the same time, the ever-increasing capacity requirements in almost every application space are bringing SDM closer to deployment, but that bridge has not yet been crossed.

We will ask:

- Why hasn't SDM been commercialized after more than a decade of research?
- Where are the bottlenecks of the SDM technology?
- What prevents the industry from starting the shift from single-mode to multi-mode technology?
- Which will be the first application? Data centers? Terrestrial? Submarine?
- What are the limits of the current multiple single-mode fibers per cable?

Enlarging the transmission bandwidth in the wavelength domain is a proven and mature technology that has been widely adopted by system developers. A natural question asked is how far can we practically go beyond the C+L band? Recent progress in wideband optical frequency comb source, high-speed modulators, low-loss hollow-core transmission fibers, wide-band fiber amplifiers, semiconductor optical amplifiers, and other active and passive devices may shed light towards realization of new transmission windows, but at what cost?

The workshop will attempt to stimulate the discussion on potential cost-effective solutions to future capacity scaling, emphasizing techno-economic analysis in the horizon of next 5 to 10 years. Our goal is to focus on the current bottlenecks for cost/bit reduction and potential solutions, and the time-line of the proposed solution. We will kindly ask all our invited speakers to finish their presentations with a vision/trend take-away slide to help having focused and useful panel discussions.

Speakers:
Brandon Collings, *Lumentum, USA*
Oliver Courtois, *Nokia Bell Labs, USA*
John Downie, *Corning, USA*
Jozeph Kahn, *Stanford University, USA*
Yutaka Miyamoto, *NTT, Japan*
Massimiliano Salsi, *Google, USA*
Lynn Nelson, *AT&T, USA*
Stefan Voll, *Infinera, USA*

Sunday, 06 March, 16:00–18:30

S2A: How Will 200G (and Beyond) per Lambda IM/DD Compete with Coherent Technology?

Room: 6C

Organizers: Frank Chang, *Source Photonics, USA;* Hai-Feng Liu, *HG Genuine, China;* Sam Palermo, *Texas A&M University, USA;* Mitsuru Takenaka, *University of Tokyo, Japan*

Ethernet speeds continue to climb up to serve the bandwidth needs by hyperscale data centers. Today, IM/DD has been extensively used in intra-data center interconnects for its lower cost/power and simplicity while coherent technology has been widely used in metro data center interconnects for its higher capacity/l and capability to compensate various link impairments. With the recent advances in DSP and photonic integration, the complexity and power consumption of coherent systems have been decreasing rapidly. As the data rate moves from 100G/l to 200G/l and beyond, the question arises as to whether IM/DD can continue to scale or migration of coherent technology into intra-data center networks is inevitable.

This WS aims to stimulate debates on IM/DD vs. coherent detection for intra data center applications. Topics will include but not limited to:

- What are the viable 200G/l IM/DD technologies including approaches and modulation schemes, taking ADC/DAC, DSP, FEC, etc. into account?
- Is higher spectral efficiency offered by coherent technology worth the extra complexity?
- How to tailor the complexity of coherent electronics to be more competitive in terms of cost, power and latency?
- Are there foreseeable feasible technologies for beyond 200G/l?
- What will be the application boundaries between IM/DD and coherent to achieve reach objectives required?
- What are the aspects and key trade-offs of using coherent for intra data centers?
- Is it just simpler and better to make use of more wavelengths and more fibers?

This WS will solicit experts from data center operators, system and module vendors, and IC suppliers to share their views on those debatable issues. Interaction b/w speakers and audience through Q&A is highly encouraged.

Speakers:

Mark Heimbuch, *Cisco, USA*
Coherent Technology for Intra-Datacenter Applications

Kishore Kota, *Marvell, USA*
IMDD & Coherent Technology Overview Beyond 800G

Hong Liu, *Google, USA*
Coherent or Non-Coherent: What's the Story?

Shinji Matsuo, *NTT, Japan*
Membrane DML and EAM on Si for 200G and Beyond Data Rate

Haisheng Rong, *Intel, USA*
Silicon Photonic Transmitter with Micro-Ring Modulator and Integrated Laser for >200Gbps per Wavelength IMDD Data Link

Clint Schow, *University of California, Santa Barbara, USA*
Low-Power Analog Coherent Links at 200G/Lambda

Martin Schell, *Fraunhofer HHI, Germany*
InP EMLs and Photodetectors – The Road to 200 GB/s/Lambda IMDD

James Steward, *Meta (formerly Facebook), USA*
Perspective on Coherent in the DC for 100Tbps Switch Fabrics and Beyond

Peter Winzer, *Nubis Communications, USA*
IMDD vs Coherent for Ultra-Dense High-Speed Interfaces

Xi Xiao, *NOEIC, China*
Considerations and Potential Solutions of Silicon Photonics for 200G/Lambda IMDD

S2B: Can Optical Communication Infrastructure Double its Values by Introducing Fiber Sensing?

Room: 6D

Organizers: Zhensheng Jia, *CableLabs, USA;* Tiejun (TJ) Xia, *Verizon Communications Inc., USA*

After more than 30 years of development a ubiquitous optical fiber infrastructure for communications has become a reality. The infrastructure had been supporting various data transportation needs solely with continuous channel-rate, fiber-capacity, and spectral-efficiency growth until a few years ago.

Recently, networking-service providers and fiber network owners have begun to introduce fiber sensing technologies to explore many potential applications leveraging the existing optical communication

infrastructure. The applications include those which can improve the efficiencies of the infrastructure and those which can create new services for the providers and the owners to increase their revenues. This workshop will gather experts in multiple fields and focus on discussion of the following questions:

- What applications and services are most promising when using deployed fiber networks to perform fiber optic sensing?
- What technologies are particularly needed to develop the applications and the services?
- How much benefits and values can the new fiber optic sensing technologies bring to fiber-network owners?
- From trans-oceanic connection to metro and smart city, which part of the optical fiber network will be the first to lead the coexistent development of communication and sensing?
- What are the challenges and potential solutions when using deployed fiber to increase the values of the optical communication infrastructure?

Speakers:

González Herráez Miguel, *Universidad de Alcala, Spain*
What Value Proposition Can be Made for Fiber Sensing Using the Available Optical Network?

Valey Kamalov, *Google, USA*
MilliHz Telecom Cable Spectrometers for Ocean & Earth System

Vincent Lecoeuche, *VIAVI Solutions, France*
Monitoring Critical Infrastructure and Environment Utilizing Optical Fiber Networks

Chris Minto, *OptaSense, USA*
Delivering Value from Backscatter Sensing at Multiple Scales – From the Data Center to the Ocean

Neil Parkin, *BT, UK*
Obstacles and Solutions to Generating New Revenue from Sensing in Installed Fibre Networks from an Operator Perspective

Danny Peterson, *OFS, USA*
Backscattering Enhanced Fiber for Sensing with Telecom Cables to Enrich Future Networks

Yoshifumi Wakisaka, *NTT, Japan*
Distributed Acoustic Sensing for Optical Communication Networks – Current Status and Perspectives

Ting Wang, *NEC, Japan*
New Applications Utilizing Telecom Network as a Sensor

Glenn Wellbrock, *Verizon Wireless, USA*
Benefits and Challenges of Fiber Sensing for Network Service Providers

Zongwen Zhan, *Caltech, USA*
Fiber-optic Networks as a Key Component of the Next-generation Seismic Networks

S2C: What Will the Future Machine Learning and Artificial Intelligence Systems Look Like?

Room: 6E

Organizers: Sonia Buckley, *NIST, USA;* Martin Schell, *Fraunhofer Institut, Germany;* Volker Sorger, *George Washington University, USA;* S.J. Ben Yoo, *University of California Davis, USA*

What will the future ML and AI Systems look like? Will photonic quantum and neuromorphic computing play a role?

This workshop addresses the future of the machine learning and artificial intelligence systems facing significant challenges from ML related workloads doubling every 3-4 months while Dennard's law scaling has ceased to keep pace with Moore's law nearly 15 years ago. Modern data centers and computing systems are now showing intelligence comparable or surpassing the capabilities of human intelligence, but at the cost of extremely high power consumption. On the other hand, neuromorphic accelerators promise 3-6 orders of magnitude improvements in energy-efficiency and throughput compared to the traditional von Neumann computing, and quantum computing claims quantum supremacy to solve nearly unsolvable problems in a record time. What will the future ML and AI systems look like? Will quantum and neuromorphic computing play an active role? What role will photonics play in this context?

The workshop will be organized in two parts.

AI/ML Computing & Data Systems at Scale (TRL)
Part I will address the challenges faced by today's data centers and computing systems in coping with explosively growing ML and AI workloads. In particular, Part I will discuss future trends and ML and AI computing systems, and covers opportunities for fundamental changes in computing system architectures enabled by intelligent programmable photonics.

AI/ML Emerging Photonic Computing Paradigms
Part II will discuss emerging neuromorphic and quantum computing technologies to efficiently and effectively accelerate ML training and inference workloads. In particular, we will address opportunities and challenges of photonics in computing for future hyperscale data centers and computing systems handling AI and machine learning workloads

Speakers:

Part 1:

Catherine (Katie) Schuman, *University of Tennessee, USA*
Neuromorphic Computing: From HPC to Edge

Michael Förtsch, *Q.ANT, Germany*
The Q.ANT Approach Towards Solving Industry-Relevant Use Cases on Integrated Photonic Quantum Circuits

Hamed Dalir, *Optelligence Company, USA*
Electronic-Photonic Tensor Processor ASICs

Part 2

Demetri Psaltis, *EPFL, Switzerland*
History and Rationale for Optics for Computing

Hideo Mabuchi, *Stanford University, USA*
Ising Machine

Wolfram Pernice, *University of Münster, Germany*
Photonic Neuromorphic Processing

S2D: What are the Prospects and Challenges for Hollow-Core Fibers in Optical Communications?

Room: 6F

Organizers: Rodrigo Amezcua-Correa, *University of Central Florida, CREOL, USA;* Eric Numkam Fokoua, *University of Southampton, UK;* Chigo Okonkwo, *Technische Universiteit Eindhoven, Netherlands;* Radan Slavik, *University of Southampton, UK*

Unlike conventional optical fibers, hollow-core optical fibers confine and guide light in an air core. The advantages of guiding light in such a hollow core are many and quite compelling. Their combination of low chromatic dispersion and virtually no optical nonlinearity provides a unique operating regime for telecom applications over a wide range of transmission distances. They can potentially achieve low-loss operation over hundreds of nanometers of bandwidth, and allow signals to propagate with one third lower latency in comparison to standard SMFs.

After nearly two decades of intense research, hollow-core optical fiber (HCF) technology has recently started showing signs of fulfilling some of these prospects, with the latest results showing transmission losses as low as 0.22 dB/km and DWDM transmission over 2000 km distance in recirculating loop experiments. Over the past few years also, an important step has been the emergence of HCF-based field deployable cables and solutions in the commercial arena, with such cables now carrying live traffic.

However, HCF manufacturing, cabling, and interfacing with conventional components is not as developed as for standard optical fibres, which are manufactured at incredible volume with high reliability, and low-cost to address the very cost-sensitive telecom/datacom market.

Other potential applications of HCFs include sensing, high power laser delivery, biosensing, frequency and time transfer and metrology, etc. However, this workshop proposes to discuss whether there is genuine reason to be excited about the prospects of hollow-core fiber technology as a disruptive transmission medium for optical communications.

Topics to be addressed include:

- What are the prospects of hollow-core fibers in telecoms and other applications?
- What is the price/volume/performance sweet spot for applications of hollow-core fibers?
- Which telecom applications are these fibers best suited for? Which telecom sectors will be the first (or are there already any?) and which will follow?
- What are the current challenges preempting widespread adoption of these fibers within telecoms?
- What challenges in design, manufacturing, cabling, interconnection and fiber components still have to be addressed?
- How will DSP be different with hollow-core fibers?

Speakers:

Andrew Lord, *British Telecommunications, UK*
Title to be Determined

Francesco Poletti, *University of Southampton, UK*
Title to be Determined

Antonio Nespola, *Politecnico di Torino, Italy*
The Potential Impact of High-Performance NANF on Long-Haul Optical Communication Systems: Experimental Validation of Current Fiber and Emerging Landscapes Allowed by Future Solutions

Maurice O'Sullivan, *Ciena, USA*
Coherent Transmission Over Nested Anti-Resonant Hollow Core Fiber

Brian Mangan, *OFS Labs, USA*
Title to be Determined

Russell Ellis, *Lumenisity, Ltd., USA*
Title to be Determined

S2E: Single-Carrier Versus Multi-Carrier for >800G Coherent Optics: A Revived Debate After a Decade

Room: 6F

Organizers: Di Che, *Nokia Bell Labs, USA;* Hungchang (James) Chien, *Marvell Technology Inc., USA;* Sander Jansen, *ADVA, Germany*

With the advent of coherent detection well over ten years ago, many different modulation formats were investigated to reduce implementation complexity and optimize performance. Multi-carrier modulation formats such as coherent optical OFDM (CO-OFDM) got lots of attention at the time, achieving the first transmission experiment of single-channel 100G and 1T transmission and ultimately leading to the concept of DWDM superchannels. However, the multi-carrier path was not followed by the industry and only single-carrier systems were commercialized at the time. The situation seems to change after a decade. Commercial coherent optics have evolved from 100G to 800G, and a number of industry players have included subcarrier multiplexing (SCM) mode in the latest 800G coherent products.

Will there be a multi-carrier revival? The last workshop at the OFC on multi-carrier modulation formats was back in 2009: "Single-Carrier Versus Multiple-Carrier Modulation Formats for WDM Systems", so it is about time for an update. This workshop revives the debate from 2009 and address questions like:

1. Does single-carrier or multi-carrier transmission have any fundamental and unique advantages over its counterpart?
2. What fundamentally changed in the last 10 years to revive multi-carrier modulation in the latest 800G coherent optics?
3. Is multi-carrier more difficult than single-carrier to be implemented by real-time DSP? What are the challenges to enable multi-carrier modes for coherent 800G pluggables?
4. Multi-carrier is known to have better nonlinear tolerance for QPSK by optimizing the symbol rate per subcarrier. Does this scale to modern systems that employ probabilistically-shaped QAM?

5. As the transceiver symbol rate increases, high-frequency degradation issue with higher symbol rate per transceiver and more cascaded ROADMs. Will adaptive multicarrier formats like bit/entropy loading be essential in those bandwidth-constraint scenarios?
6. In the Terabit era, will the single-carrier encounter a bandwidth barrier limited by electronics? Will the optical multi-carrier (superchannel) eventually dominate?

The workshop will combine the historical and the state-of-the-art insights on the controversy, aiming to shed light on the future design of ultrahigh speed coherent optics for the Terabit era.

Speakers:

Fred Buchali, *Nokia Bell Labs, Germany*
Title to be Determined

Andrea Carena, *Politecnico di Torino, Italy*
Multi-Sub-Carriers Systems: A Robust, Resilient and Flexible Solution

Alejandro Castrillon, *Marvell, USA*
Practical Considerations in Single-Carrier vs Subcarrier Multiplexing for Low Power DSPs

Junho Cho, *Nokia Bell Labs, USA*
Title to be Determined

Ian Dedic, *Acacia Communications, UK*
Component Performance Limitations and Tradeoffs for High Baud Rate Coherent Transceivers

Maxim Kushnerov, *Huawei, Germany*
Title to be Determined

Han Sun, *Infinera, Canada*
Title to be Determined

Sorin Tibuleac, *ADVA, Germany*
Title to be Determined

Qunbi Zhuge, *Shanghai Jiaotong University, China*
Title to be Determined

Lab Automation Hackathon

Sunday, 06 March, 20:00–22:00
Room: 17AB

Organizers: Nicolas Fontaine, *Nokia Bell Labs, USA*; Binbin Guan, *Acacia Communications, USA*; Roland Ryf, *Nokia Bell Labs, USA*; Jochen Schroeder, *Chalmers University of Technology, Sweden;* Marco Eppenberger, *ETH Zurich, Switzerland*

Come network with students and professional wizards of lab automation and programming! Food and drinks provided to facilitate discussion!

Lab work is most efficient when data can be acquired in an automated way, especially when taking measurements over long durations. Automated acquisition avoids introducing human error and allows researchers to concentrate on the fun part of experimental work. Open source software in easy-to-learn languages such as Python provides just as much, or even more features/interoperability for lab automation than alternative commercial software. On top of that, the many packages written by the large community allow you to quick and easily write graphical user interfaces, create numerical simulations or design your components.

The hackathon format will consist of multiple interactive demos, discussion tables, and an informal Q&A. Researchers, students, and industry professionals will show you how to get your lab experiment running, your design space explored, or your machines to learn. Attendees will learn from companies that work in photonics and how they take advantage of Python to create easy interfaces to their software and hardware. Students will be able to show how they are developing new tools to complete their PhD.

Symposia

Three symposia are scheduled for OFC 2022. Please refer to the abstract section or Conference App for full details.

Optical Satellite Communications - Entering a New Age

Monday, 07 March, 08:00–12:30
Room: 2

Organizers: Jörg-Peter Elbers, *ADVA, Germany;* Randy Giles, *Nubis Communications, USA;* Scott Hamilton, *MIT, USA*

Satellite communications have long been used to provide connectivity to airborne, maritime and space users. Also, in areas where terrestrial network access is neither possible nor desired, satellite communications is the solution of choice. Gigabit per second optical inter-satellite links have been used commercially for many years. Very High Throughput Satellite (VHTS) constellations in GEO, MEO and LEO orbits now aim at terabit per second capacities with the vision to construct a "fiber network" in space. Such an approach does not only require a new generation of inter-satellite links and switching functions on space nodes, but also a terrestrial network of ground stations to feed the satellite constellations with the necessary capacity and reliability. Satellite orbits and atmospheric obscuration call for new networking paradigms, as a frequent switch-over between ground stations and satellites becomes a normal mode of operation. There will also be a strong interdependency between these non-terrestrial networks and terrestrial networks to optimize end-to-end link performance and network efficiency. From a hardware perspective, there is pressure to minimize the SWAP-C (Size, Weight, Power and Cost) of space-based components and to maximize the re-use of terrestrial transceiver, amplification and switch technology in satellite payloads if functional and reliability targets can be met.

This symposium aims at bringing the optical communication and satellite communities together. With distinguished speakers from space agencies, industry, and academia, we will hear how satellite communications may look like in the future and the role played by optical communications technologies.

Multi-Access Network Leveraging Edge Computing for Energy-Efficient, Ultra-Reliable, and Low Latency Services

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

Organizers: Albert Rafel, *BT Applied Research, UK;* Kota Asaka, *NTT Access Service Systems and Labs, Japan*; Anna Tzanakaki, *University of Athens, Greece*

This symposium covers "Network Edge" considerations to address multi-access, open access and disaggregated architectures. These are expected to adopt comprehensive Artificial Intelligence (AI) approaches to support predictive and optimized Real Time (RT) and Near-RT operation, automation, and improved user experience.

Ultra-Reliable Low Latency (URLL) type of services require Network Edge compute applications support, i.e., compute & storage capabilities at the edge of the network. This requirement introduces the need for:

- Multi-access technology support (i.e., fixed, mobile & wi-fi) in a disaggregated architecture
- System technologies to minimize transport latency (e.g., TSN switching, CO-DBA PON, RT/Near-RT latency monitoring, etc.)
- AI techniques for predictive operations to attain RT/Near-RT response
- AI techniques for automation and optimization to increase user experience
- However, distributed edge computing brings about several challenges:
- Increased Energy consumption
- Optimal resource (equipment) planning and allocation
- Unavailability of equipment accommodation facilities
- Guaranteeing ultra-low latency service delivery through NFV architectural models
- Dynamic/automatic reconfiguration with predictive, RT/Near-RT performance monitoring operating in a distributed manner

Emerging Photonic Interconnects and Architectures for Femtojoule per Bit Intra Data Center Links Networks

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

Organizers: Madeleine Glick, *Columbia University, USA*; Trey Greer, *NVIDIA, USA*; Hai-Feng Liu, *HG Genuine, China*

There are many emerging technologies addressing femtojoule per bit optical components (lasers, modulators, receivers, …) and low power electronic links (serdes, 2.5D integration, ...). It is now time to look at the landscape to determine how to integrate these advances into practical link applications for intra data center interconnects for near term deployment. This integration will involve examining architectures and will include choices on optical and electrical components, cooling, and optical and electrical connectorization.

This symposium will address the above trade-offs, including but not limited to the following topics:

- How do we / can we combine femtojoule per pit technologies into sub pJ/bit links?
- Is water cooling required? Do the benefits outweigh the added complexity and risks?
- How do we achieve the necessary bandwidth density to support 100 Tb/s switches?
- Does meeting these power and density goals require 2.5 D integration (interposers/ silicon bridges)?
- What is the optimum data rate / channel to achieve these power and density goals?
- What is the appropriate light source technology to achieve the required wavelength count and spacing for a near term solution?

Special Sessions

Reflections on the Pandemic

Monday, 07 March, 08:00–12:30
Room: 1AB

Organizers: Chris Fludger, *Infinera, Germany*; Roland Ryf, *Nokia Bell Labs, USA;* Dimitra Simeonidou, *Bristol University, UK*

The COVID-19 pandemic has resulted in an enormous loss of life and livelihood, disruption to work, education and leisure. Physical separation and restrictions on travel have resulted in a stronger than ever dependency on digital devices and connectivity to provide schooling, healthcare, remote-working and entertainment. We experienced virtual conferences, rapid-growth in e-commerce, video-conferences, virtual sports and cultural events. School children were encouraged to spend more time in front of their monitors and tablets. Some changes can be celebrated as a success of our technology and infrastructure, in other aspects we are seeing long term consequences and challenges in our society and economy.

Although the impact has been experienced differently across the world, it has commonly highlighted the need for resiliency and digital inclusion, giving persistent internet access across the global population.

This special session looks back on the way the pandemic has changed the demands on our networks, creating different traffic demands, challenges and opportunities.

We will also be looking forward, towards a post-pandemic world. What changes are here to stay? Should communications networks plan for future lock-downs? What innovations and technology drivers are being proposed? How do we bridge the digital divide?

Experts from across regions including industry, academia, operators, engineers and futurists will discuss the global impact of COVID-19, and network infrastructure actions for a post-pandemic world.

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Network Intelligence
Wednesday, 09 March, 08:00–10:00
Room: 1AB

Organizers: Ramon Casellas, *CTTC, Spain;* Loukas Paraschis, *IEEE Communication Society, USA;* Vijay Vusirikala, *Google, USA*

Network Intelligence has increasingly become an important new area of innovation given its potential to improve network dependability and efficiency. There are many exciting use-cases which collectively promise to catalyze the paradigm shift from event (often still human) driven networking to machine-driven and eventually autonomous networking. There are also many exciting recent innovations in software automation in telemetry and provisioning with model driven abstractions, combined with AI/ML data analytics towards proactive (even predictive) network (often multilayer optimized) protection or restoration. This special OFC 2022 session will focus on promising contributions to network intelligence from fiber sensing techniques like SOP monitoring based on coherent transponders or distributed acoustic sensing (DAS). The recent advancements of such fiber sensing techniques in subsea, LH, and metro optical transport will be reviewed and debated. The combination of fiber sensing techniques at scale to predict and pinpoint physical layer issues and powerful software automation, design and operational tools to mitigate those issues, paves the path to self-healing and self-adjusting networks.

Network Evolution and Adaptation to Environmental Changes
Wednesday, 09 March, 14:00–18:30
Room: 1AB

Organizers: Chris Fludger, *Infinera, Germany*; Roland Ryf, *Nokia Bell Labs, USA;* Dimitra Simeonidou, *Bristol University, UK*

This special session will cover fundamental and long-term trends that the industry will have to address in order to deliver scalable and flexible high-capacity networks in an environmentally compatible way, while adapting to the challenges imposed by natural disasters caused by global warming

Whilst progress in the telecommunications industry has reduced travel, enabled remote working and encouraged e-commerce across the globe, the increased internet traffic demand has led to an increased focus on the technologies that we develop and deploy. Ways to rapidly provide network services in a flexible and scalable way are of essential importance, and will require networks that are simpler to evolve and operate, following the general trends of disaggregation and network convergence across the whole telecommunication infrastructure.

Additionally, equipment that is deployed today will quickly become outdated and superseded. We examine the global impact of optical communications equipment and invite distinguished speakers from academia and industry to discuss the environmental strategies towards a circular economy.

Extreme weather patterns are also correlated with global warming, leading to events such as floods and fires. We are also becoming more and more dependent upon our communications infrastructure, and even natural disasters such as volcanoes, tsunami and earthquakes result in extensive damage. With the bulk of data traffic passing through optical fiber, how do we plan for the worst-case? What technologies are providing resilience or deployed during disaster scenarios, and can optical play a role?

Experts and visionaries from industry, academia, and operators, will discuss their vision of the future of the telecommunication infrastructure.

Integrated Photonics for Energy Efficient Data Centers and Computing: The ARPA-E ENLITENED Program
Monday, March 07, 10:30–12:30
Room: 9

Organizers**:** John Qi; *Booz Allen Hamilton, USA;* Olga Spahn; *ARPA-E, USA;* James Zahler; *ARPA-E, USA*

The ARPA-E ENergy-efficient Light-wave Integrated Technology Enabling Networks that Enhance Dataprocessing (ENLITENED) program seeks to improve HPC and data center energy efficiency by advancing transformative integrated photonic technologies for data transmission and switching to enable novel co-designed network topologies. This session will provide a comprehensive overview of the ENLITENED portfolio, which includes technologies such as optical switching, co-packaged photonics, and coherent links for the data center; as well as network concepts ranging from Clos variants to reconfigurable topologies. The program has entered its final year, with activities primarily centered on prototype maturation and demonstration, while ensuring that critical design features of the full-scale system can be validated and de-risked. The overall goal of the program is to enable photonic network fabrics which, when deployed at scale, would realize an overall doubling of system-level efficiency.

Speakers:
Olga Spahn, *ARPA-E, USA*
Dan Kuchta, *IBM TJ Watson Research Center, USA*
George Papen, *University of California, San Diego, USA*
John Shalf, *Lawrence Berkeley National Laboratory, USA*
Clint Schow, *University of California, Santa Barbara, USA*
Geza Kurczveil, *Hewlett Packard Enterprise, USA*
Dan Blumenthal, *University of California, Santa Barbara, USA*
Ming Wu, *University of California, Berkeley, USA*

Optica Technical Group on Fiber Optics Technology and Applications Panel Discussion: Are Broadband Amplifiers Useful for Data Center Communication?
Monday, 07 March, 12:45 –13:45
Room: 9

You are invited to join the Optica Technical Group on Fiber Optics Technology and Applications for a panel discussion during lunch on Monday. Attendees will have the opportunity to hear short presentations from our featured panelists exploring whether broadband amplifiers are useful for data center communications. The talks will be followed by a moderated question and answer session, helping facilitate the exchange of information with our community.

Hosted by: OPTICA Advancing Optics and Photonics Worldwide — Fiber Optics Technology and Applications

Demo Zone

Monday, 07 March, 14:00–16:15
Room 6A

Organizers: Paolo Monti, *Chalmers University of Technology, Sweden;* Reza Nejabati, *University of Bristol, United Kingdom;* Marco Ruffini, *University of Dublin Trinity College, Ireland*

Committee: Eleni Diamanti, *Universite Pierre et Marie Curie, France;* Dan Kilper, *University of Dublin Trinity College, Ireland;* Michela Svaluto Moreolo, *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), Spain;* Chigo Okonkwo, *Technische Universiteit Eindhoven, Netherlands;* Ben Puttnam, *National Institute of Information and Communications Technology (NICT), Japan;* Rui Wang, *University of Bristol, United Kingdom*

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

Such demonstrations occur in a dedicated booth in the demo zone equipped with a table, a monitor, and a bulletin board. They are shown to small groups, favoring an interactive format with real-time exchanges between attendees and demo presenters. Demonstrations are typically executed on demand and may involve a combination of on-site and remote equipment. They can include recorded video or live connections to remote hardware or experiments.

The Demo Zone covers aspects of network orchestration and intelligence, hardware, and physical layer transmission. These include, but are not limited to:

- Automated device alignment or characterization setups
- Automated measurement setups for high capacity transmission experiment
- Systems, sub-systems (and devices) for free-space, microwave, or optical fiber transmission
- Digital processing sub-systems and sensing
- Optical access networks and their convergence with metro transport, wireless access networks, and MEC
- Application of AI and ML to optical networking, including autonomous network management and control
- Quantum networking, including demonstration of entanglement distribution, implementing advanced QKD applications and quantum protocols
- Novel networking elements and concepts, including those supporting time deterministic and low latency
- Programmable networks, including software network functions and programmable hardware

Conversation with the Plenary Speakers

Tuesday, 08 March, 10:15–10:45
Theater III, Exhibit Hall

Join OFC General Chairs Shinji Matsuo, David Plant and Jun Shan Wey for a conversation with Plenary Speakers, John Bowers, James Green and Elise Neel.

Conference Reception – Celebrating International Year of Glass

Tuesday, 08 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.

Rump Session: Will Quantum Always Remain Basic Research or is it Ready to Power Great Products?

Tuesday, 08 March, 19:30–21:30
Room: 6F

Moderator: Chris Cole, *II-VI Incorporated, USA;* **Co-moderator:** Emina Soljanin, *Rutgers University, USA*

Quantum Enthusiasts Team Captain: Mekena Metcalf, *Lawrence Berkeley National Laboratory, USA;* **Co-Captain:** Andrew Lord, *British Telecom, UK*

Provocateurs: Bruno Huttner, *ID Quantique, Switzerland;* Inder Monga, *ESnet, USA;* Yong Zhao, *Quantum CTek, China*

Quantum Sceptics Team Captain: Peter Winzer, *Nubis Communications, USA;* **Co-Captain:** Glenn Wellbrock, *Verizon, USA*

Provocateurs: Charles Clancy, *MITRE, USA;* Takehisa Iwakoshi, *Mie University, Japan;* David Neilson, *Nokia Bell Labs, USA*

Quantum has received widespread publicity as a solution to otherwise insurmountable technical problems in areas of networking and cryptography. The Rump Session will debate whether Quantum products in these areas will become real in the near future. Quantum has been a boon to the research community and start-ups, receiving generous grants and major venture funding, respectively. But is it ready to for mainstream industry to add it to its technology toolbox? Same metrics that are used to judge any useful product will be applied to potential Quantum products, including relative performance, R&D cost and time, unit cost, energy use, testability, yield and manufacturability. Since there is broad agreement about the basic Science, the debate is about feasibility and practicality for commercial applications.

Format:

- The Session is introduced by the Moderator, who facilitates a wide-ranging discussion.
- Next are introductory presentations by the opposing Team Captains.
- This is followed by alternating presentations by opposing Team Co-Captains and Provocateurs
- Each presentation is followed by vigorous audience participation
- Presentations and audience participation are each 50% of Session time
- The audience is encouraged to ask tough questions, make insightful comments, offer different perspectives, challenge the Teams and each other, and be entertained.
- Long-winded comments and corporate pitches are cut-off.
- May the Force be with you.

Rise and Shine Morning Run/Walk

Wednesday, 09 March, 06:00–07:00
Bottom of San Diego Convention Center Stairs (front entrance)

Pack your running shoes and meet up for an early morning, 3-mile run or walk with fellow OFC colleagues. Can't make it in person? No problem, join us virtually! Take a selfie, tag #OFC22 and #werunOFC and share it with the rest of the OFC Twitter community @OFCConference.

Open Networking Summit: Open Optical Disaggregation: What the Heck is Going On?

Wednesday, 09 March, 08:00–10:00
Room: 9

Organizers: Dan Pitt, *Palo Alto Innovation Advisors, USA;* Stephan Pachnicke, *Kiel University, Germany*

Open disaggregation has revolutionized the world of servers (enabling hyperscale cloud computing) and is surging to upend switches and routers. Optical communication is next, at all distance scales. We have seen some success with initial efforts in OCP, TIP, MEF, and ONF but these are the tip of the iceberg. In this summit we delve into the most profound developments in open optical disaggregation as we hear from the leading disruptors along with the incumbents trying to smooth the transition.

Among the key topics to explore are where disaggregation is emerging in the most unexpected places, how disaggregation has boosted innovation due to unbundling, what the fundamental APIs and interfaces are and who defines them, and what challenges or unanticipated consequences inhibit the speed of disaggregation.

In both individual talks and a panel discussion, we will hear from the leading voices in this transformational change to the optical communications industry. Ponder this: How will these developments affect your job in five years?

Speakers:
Andy Bechtolsheim, *Arista Networks, USA*
Robert Blum, *Intel, USA*
Eric Breverman, *Google, USA*
Ramon Casellas, *CTTC, Spain*
Ron Cok, *X-Celeprint, USA*
Jörg-Peter Elbers, *ADVA, Germany*
Andreas Gladisch, *Deutsche Telekom, Germany*
Karl May, *Lumen Networks, USA*
Yawei Yin, *Microsoft, USA*

Optica Technical Group on Optical Communications Panel Discussion: Research Lab Stories

Wednesday, 09 March, 11:30 – 12:30
Room: 9

Leading a research group is never easy and can involve many unexpected challenges. The Optica Technical Group on Optical Communications invites you to join them for this special event to hear the stories of their panelists on leading a research lab, going from their starting days through the challenges of expansion and into becoming leading photonics centers. The session will be an opportunity for PhD students, early career researchers, and others to hear first-hand experiences about starting a research lab and solving issues along the way from several leading photonics researchers.

Hosted by: OPTICA Advancing Optics and Photonics Worldwide — Optical Communications

Rise and Relax Yoga

Thursday, 10 March, 06:00–07:00
Pavilion Terrace (back of Convention Center)

Rise and relax to an hour of guided yoga with your fellow OFC attendees. Yoga mats will be provided. Namaste! Cost: USD 10

Postdeadline Paper Presentations

Thursday, 10 March, 16:30–18:30
Rooms: 6C, 6D, 6E, 6F

Discover the best and most cutting-edge research in optical communications. The OFC 2022 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, 08 March. Please visit ofcconference.org and click the "Download Digest Papers" button to access these papers.

OFC Plenary Session

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

Present and Future Silicon Photonics

John Bowers, *Director, Institute of Energy Efficiency, University of California, Santa Barbara, USA*

Silicon photonics is advancing rapidly in performance and capability with multiple fabrication facilities and foundries having advanced passive and active devices, including modulators, photodetectors and lasers. Integration of photonics with electronics is key to advanced photonics and advanced electronics. The low cost and scaling ability of silicon photonics is expanding the market beyond datacom and telecom to sensors, navigation and IoT. Qi Bi is the President of China Telecom Technology Innovation Center and the CTO of China Telecom Beijing Research Institute, managing R&D organizations with responsibilities in wireless communications. His current focus is on 5G innovations responsible for technologies, standards and trials in China Telecom.

John Bowers holds the Fred Kavli Chair in Nanotechnology, and is the Director of the Institute for Energy Efficiency and a Distinguished Professor in the Departments of Electrical and Computer Engineering and Materials at the University of California, Santa Barbara.

Dr. Bowers received his MS and PhD degrees from Stanford University and worked for AT&T Bell Laboratories and Honeywell before joining UC Santa Barbara. He is a cofounder of Nexus Photonics, Quintessent, Aurrion, Aerius Photonics, Terabit Technology and Calient Networks.

Dr. Bowers is a member of the National Academy of Engineering, the National Academy of Inventors, a fellow of the IEEE, OSA and the American Physical Society. He is a recipient of the IEEE Photonics Award, OSA/IEEE Tyndall Award, the OSA Holonyak Award, the IEEE LEOS William Streifer Award and the South Coast Business and Technology Pioneer and Entrepreneur of the Year Awards.

He has published two books, 10 book chapters, 850 journal papers, 1,200 conference papers and has received 70 patents. He and coworkers received the EE Times Annual Creativity in Electronics (ACE) Award for Most Promising Technology for the hybrid silicon laser in 2007.

Exploration Technologies: Communicating with Spacecraft, Landers, Rovers, and Human Missions

James Green, *Scientist and Senior Advisor, NASA, USA*

We are in a golden age of robotic and human exploration requiring new and exciting architectures and technologies. One top goal for NASA is to provide optical communications supporting humans on the Moon and Mars. This talk will discuss the evolution and architecture of advanced communication technologies for exploring the planets.

Jim Green serves as scientist and senior advisor in the Office of the Chief Scientist. Prior to this appointment, he had been NASA's Chief Scientist and was the longest serving director of the Planetary Science Division with overall programmatic responsibility for the New Horizons spacecraft flyby of Pluto, the Juno spacecraft to Jupiter, and the landing of the Curiosity rover on Mars to name a few.

Dr. Green was awarded Japan's Kotani Prize in 1996 in recognition of his international science data management activities and received the NASA Exceptional Achievement Medal for the New Horizons flyby of the Pluto system. He has written over 115 scientific articles in refereed journals and over 50 technical articles. In 2015 Jim helped coordinate the NASA involvement with the film *The Martian*.

5G and the Promise of Industry 4.0

Elise Neel, *Senior Vice President, Verizon New Business Incubation, USA*

Industry 4.0 is a new technology chapter promising fully autonomous, self-improving processes of matching work to the most appropriate set of resources; robot, human, drone or machine. This session will cover how 5G is foundational technology enabling connection, management & operation of the physical, digital & biological elements required for this autonomous world.

Elise Neel is harnessing her fiercely curious builder mindset to scale new software automation businesses fueled by the orchestration power of the 5G future.

Elise's team houses industry experts across strategy, product, technology, sales, marketing and R&D in the areas of location technology, aerial and terrestrial robotics, industrial IoT and other emergent technologies. Bringing to bear her experience in new business development, big data platforms, geospatial intelligence, analytics and IoT, the transformative work she leads is directly fueling Industry 4.0.

In addition to leading New Business Incubation, Elise recently served as the Global Lead of the Women's Association of Verizon Employees (WAVE) employee resource group. With more than 12,000 members in 32 countries, WAVE is a pivotal advocate for women at Verizon, arming members with real-life skills, training and leadership development opportunities.

Jane Simmons Memorial Speakership

Created in honor of Jane Simmons and her contributions to optical fiber communications, this new Optica Foundation recognition is awarded to one invited speaker selected annually by the OFC General Chairs.
You can support the endowment by visiting **optica.org/donate** and selecting donate online or contacting **foundation@optica.org**.

> Naming this speakership after Dr. Jane Simmons is a fitting tribute to her unmatched contributions to optical network architecture, design, and planning. We are pleased to select Dr. Ghobadi for this honor.
>
> Jun Shan Wey
> *Verizon Communications Inc*
> OFC General Chair

The inaugural recipient Manya Ghobadi was selected for her contribution to AI systems and optically interconnected networks, in particular, utilizing newly emerging photonic technologies in data centers. Her presentation "Emerging Optical Interconnects for AI Systems" will be Thursday, 10 March at 8:00 UTC-8.

optica.org/SimmonsSpeakership

OPTICA FOUNDATION | Formerly OSA

Manya Ghobadi
Massachusetts Institute of Technology

OFC and Co-Sponsor Awards and Honors

Awards Ceremony and Luncheon

Tuesday, 08 March, 12:00–14:00
Ballroom 20A

Supported by CORNING

Join conference co-sponsors IEEE Communications Society, IEEE Photonics Society, and Optica (formerly OSA) for a special luncheon to recognize the award and honor recipients from each society. The event is open to anyone who purchases a ticket, 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:

2022 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.

IEEE Communications Society 2022 Fellows

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

IEEE Photonics Society 2022 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.

Optica 2022 Fellows

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

IEEE/Optica Journal of Lightwave Technology Best Paper Award

Recognizes the top cited original papers published in the Journal in 2019, as determined by a variety of citation metrics and databases. It is presented by the Journal's Coordinating and Steering Committees. Copies of the winning papers will be available at various places throughout OFC and will be made open access on the IEEE Xplore Digital Library.

Jane Simmons Memorial Speakership

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

The Corning Outstanding Student Paper Competition

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

The Corning Women in Optical Communications Scholarship

Endowed through the Optica Foundation by Corning Incorporated, these scholarships recognize three outstanding women graduate students studying optical communications and networking to support their travel, registration and lodging to attend OFC.

The Tingye Li Innovation Prize

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

Anritsu

400G Testing and Beyond

Visit us in the
Corporate Village
#1931

Be sure to see our presentations in the
Technology Showcase:

Wed., March 9 / 11:45 - 12:15
"Optical Fiber Communication, a Key Enabler for O-RAN"
Presenter: Sundara Venkatesh "Venky" (Theater 3)

Wed., March 9 / 16:15 – 16:45
"400Gbps Post FEC BER and Jitter Tolerance Test"
Presenter: Hiroshi Goto "G2" (Theater 2)

Thurs., March 10 / 14:45– 15:15
"Next Generation Opto-electronic Devices - Measurement Challenges"
Presenter: Navneet Kataria (Theater 3)

Learn about our latest 100G/400G testing solutions

www.anritsu.com

Activities on the Show Floor

The OFC 2022 Exhibition is the perfect place to build and maintain professional contacts and to 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 to 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

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 2022 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, 08 March	10:00–17:00	10:00–10:30 16:00–16:30
Wednesday, 09 March	10:00–17:00	10:00–10:30 16:00–16:30
Thursday, 10 March	10:00–16:00	10:00–10:30

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

Poster Presentations

Exhibit Hall B2

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.

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.

Exhibit Hall, Expo Theater I

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.

Sponsored by Infinera

Market Watch Schedule at a Glance

Tuesday, 08 March	
10:30–12:00	Panel I: State of the Industry
12:30–14:00	Panel II: The Path to Co-Packaged Optics for Switching Applications
14:30–16:00	Panel III: Building the Ecosystem for Converged IP/Optical Networks – Beyond 400G Pluggables
Wednesday, 09 March	
15:30–17:00	Panel IV: The Role of Optics in Future Machine Architectures
Thursday, 10 March	
10:30–12:00	Panel V: Evolution of Coherent Transceiver Architectures for Specific Applications
12:30–14:00	Panel VI: Building the Next Generation 3.2T Transceiver

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 at a Glance

Wednesday, 09 March	
10:30–11:00	 Network Operator Summit: Keynote Lynn Nelson, *Director, Optical Platform Development, Network Infrastructure and Services, AT&T, USA*
11:30–13:00	Panel I: Operator Investment Directions for FTTH and Access Networks
13:30–15:00	Panel II: Using Disaggregation as a Strategy to Modernize the Network

Expo Theater II Programming, *Exhibit Hall E*

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.

Sponsored by Amphenol

Schedule at a Glance

Tuesday, 08 March	
10:30–11:00	 **Data Center Summit:** Keynote Ashish Vengsarkar, *Head of Optical Networking Technologies, Google, USA*
11:30–13:00	**Data Center Summit Panel I:** Scaling Data Center Interconnect
13:30–15:00	**Data Center Summit Panel II:** Solving the Challenge of Moving Data Centers to the Network Edge
15:30–16:30	The Converged Mobile Xhaul and FTTH Fiber Access Opportunity
Wednesday, 09 March	
10:30–11:30	Ethernet Alliance: What Makes Ethernet, Ethernet?
12:00–13:00	OIF: Deployment of 400ZR and the Ongoing OIF Work to Define 800ZR/LR
13:30–14:30	MOPA: Evolution of Optics for Mobile

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.

15:00–16:00	OpenROADM: Updates and Demo
16:15–16:45	Technology Showcase: 400Gbps Post FEC BER and Jitter Tolerance Test Presented by Anritsu
Thursday, 10 March	
10:30–11:30	F5G Update: Emerging Use Cases and Demonstrations
12:00–13:00	Hollow Core Fiber – Ready for Prime Time?
13:30–14:30	The Edge Cloud: Descending Cloud – Ascending Edge, and What it Means for Optical Networks
14:45–15:15	Technology Showcase: Next Generation Opto-Electronic Devices-Measurement Challenges Presented by Anritsu

Expo Theater III Programming, *Exhibit Hall F*

Schedule at a Glance

Tuesday, 08 March	
10:15–10:45	Conversation with the Plenary Speakers
11:30–12:30	AIM Photonics and the Next PIC Generation
13:00–14:00	The Future of PON: 25G or 50G
14:30–15:30	DARPA Photonics Programs
16:00–17:00	An OIF Update on Electrical Rates: 112G Technical Closure and The Latest Progress and Challenges for 224G to Create the Next Speed Node
Wednesday, 09 March	
10:15–10:45	Technology Showcase: 2.4Tb SmartPHY: Solutions for Next Generation 2.4Tb+ Line Systems Presented by Xilinx, Inc.
11:00–11:30	Technology Showcase: The Future of Coherent Optical Engines Presented by Infinera
11:45–12:15	Technology Showcase: Optical Fiber Communication, a Key Enabler for O-RAN Presented by Anritsu
12:30–13:00	Technology Showcase: Hybrid Integration Platform for Co-packaged Photonics using POET's CMOS based Optical Interposer Presented by POET Technologies, Inc.
14:30–15:30	Space-Based Optical Communications – Unleashing the Potential of Space
16:00–17:00	Beyond 400G – IEEE Update on Progress Towards 800 GbE and 1.6 TbE
Thursday, 10 March	
11:30–12:30	OpenZR+: Enabling High-performance Router-based Optics
13:00–14:00	Building Open & Disaggregated Networks

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General Chairs

Shinji Matsuo, *NTT Device Tech Labs, Japan*
David Plant, *McGill University, Canada*
Jun Shan Wey, *Verizon Communications Inc., USA*

Program Chairs

Chris Fludger, *Infinera, Germany*
Roland Ryf, *Nokia Bell Labs, USA*
Dimitra Simeonidou, *University of Bristol, UK*

Subcommittees

Track D: Components, Devices and Fiber

D1: Advances in Prototypes and Product Developments of Components and Subsystems for Data Centers and Optical Networks

Di Liang, *Hewlett Packard Labs, UCSB, USA, Subcommittee Chair*
Frank Chang, *Source Photonics, USA*
Long Chen, *Cisco Systems, USA*
Minghua Chen, *Tsinghua Univ., China*
Fred Kish, *North Carolina State Univ., USA*
Andreas Matiss, *Corning Inc., USA*
Sylvie Menezo, *SCINTIL Photonics, France*
Reza Motaghian, *Amazon Web Services, USA*
Hideyuki Nasu, *Furukawa Electric, Japan*
Sam Palermo, *Texas A&M Univ., USA*
Zuowei Shen, *Google LLC, USA*
Joris Van Campenhout, *IMEC, Belgium*

D2: Passive Optical Devices for Switching and Filtering

Kenya Suzuki, *NTT Device Innovation Center, Japan, Subcommittee Chair*
Glenn Bartolini, *II-VI Photonics, USA*
Stefano Camatel, *Finisar Australia, Australia*
Qixang Cheng, *Cambridge Research Inst., UK*
Lukas Chrostowski, *Univ. of British Columbia, Canada*
Kazuhiro Ikeda, *AIST, Japan*
Yuqing Jiao, *Technische Universiteit Eindhoven, Netherlands*
Christi Madsen, *Texas A&M Univ., USA*
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Cheryl Sorace-Agaskar, *MIT Lincoln Laboratory, USA*
Yikai Su, *Shanghai Jiao Tong Univ., China*
Ming Wu, *Univ. of California Berkeley, USA*

D3: Active Optical Devices and Photonic Integrated Circuits

Geert Morthier, *Ghent Univ., imec, Belgium, Subcommittee Chair*
Tomoyuki Akiyama, *Fujitsu Laboratories Ltd., Japan*
Gloria Höefler, *Infinera Corp., USA*
Omer Khayam, *Google LLC, USA*
Hai-Feng Liu, *HG Genuine, China*
Delphine Marris-Morini, *Univ. Paris Saclay, France*
Martin Schell, *Fraunhofer Institut, Germany*
Hanxing Shi, *Juniper Networks, USA*
Matthew Sysak, *Ayar Labs, USA*
Mitsuru Takenaka, *Univ. of Tokyo, Japan*
Michael Tan, *Hewlett Packard Enterprise, USA*

D4: Fiber and Propagation Physics

Eric Rodrigue Numkam Fokoua, *Univ. of Southampton, UK, Subcommittee Chair*
Rodrigo Amezcua Correa, *Univ. of Central Florida, CREOL, USA*
Peter Andrekson Chalmers, *Tekniska Hogskola, Sweden*
Cristian Antonelli, *Universita degli Studi dell'Aquil, Italy*
Sophie Camille Bres, *EPFL, Switzerland*
Xin Chen, *Corning Inc., USA*
Louis-Anne De Montmorillon, *Prysmian Group, USA*
Ivana Gasulla, *Mestre Polytechnic Univ. of Valencia, Spain*
Alexei Pilipestkii, *Subcom, USA*
Taiji Sakamoto, *NTT Access Service Systems Laboratories, Japan*
Toshiki Taru, *Sumitomo Electric Industries Ltd., Japan*
Benyuan Zhu, *OFS Laboratories, USA*

D5: Fiber-optic and Waveguide Devices and Sensors

Hidehisa Tazawa, *Sumitomo Electric Industries Ltd., Japan, Subcommittee Chair*
Raja Ahmad, *Molex, USA*
John Ballato, *Clemson Univ., USA*
Xiaoyi Bao, *Univ. of Ottawa, Canada*
Zeinab Sanjabi Eznaveh, *Corning Inc., USA*
Yong-min Jung, *Optoelectronics Research Centre (ORC), UK*
Yosuke Mizuno, *Yokohama National Univ., Japan*
Chigo Okonkwo, *Technische Universiteit Eindhoven, Netherlands*
Chester C.T. Shu, *Chinese Univ. of Hong Kong, Hong Kong*
Michael Vasilyev, *Univ. of Texas at Arlington, USA*
Joel Villatoro, *Univ. of the Basque Country UPV/EHU, Spain*
Yingying Wang, *Beijing Univ. of Technology, China*
Changyuan Yu, *The Hong Kong Polytechnic Univ., Hong Kong*

Track S: Systems and Subsystems

S1: Subsystems and Systems for Data Centers and High Performance Computing

Madeleine Glick, *Columbia Univ., USA, Subcommittee Chair*
Brad Booth, *Microsoft Corp., USA*
Sai Chen, *Alibaba Group, China*
Trey Greer, *NVIDIA, USA*
Yue-Kai Huang, *NEC Laboratories America Inc., USA*
Hoon Kim, *KAIST, South Korea*
Theodor Kupfer, *Cisco Systems Inc., Germany*
Wenhua Lin, *Intel Corp., USA*
Xiaodan Pang, *Kungliga Tekniska Hogskolan Kista, Sweden*
Stephen Ralph, *Georgia Tech, USA*
Norman Swenson, *Collinear Networks, USA*
Brian Taylor, *Inphi, USA*
Hongbin Zhang, *Acacia Communications , USA*

S2: Optical, Photonic and Microwave Photonic Subsystems

Ana Pejkic, *ADVA Optical Networking, USA, Subcommittee Chair*
Bill Corcoran, *Monash Univ., Australia*
Fumio Futami, *Tamagawa Univ., Japan*
David Hillerkus, *Huawei Technologies, Germany*
Michael Kues, *Leibniz Univ., Germany*
Lan Liu, *Facebook Inc., USA*
David Marpaung, *Universiteit Twente, Netherlands*
Mikael Mazur, *Nokia Bell Labs, USA*
Benjamin Puttnam, *National Inst. Info & Comm Tech (NICT), Japan*
Radan Slavik, *Univ. of Southampton, UK*
Dawn Tan, *Singapore Univ. of Technology & Design, Singapore*
Darko Zibar, *DTU Fotonik, Denmark*

S3: Fiber-radio, Optical Wireless and Sensing Systems

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Nan Chi, *Fudan Univ., China*
Chi-Wai Chow, *National Yang Ming Chiao Tung Univ., Taiwan*
Thomas Clark, *John Hopkins Univ., USA*
Baris Erkmen, *Google LLC, USA*
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Luca Palmieri, *Universita degli Studi di Padova, Italy*
Peng-Chun Peng, *National Taipei Univ. of Technology, Taiwan*
Maria Morant Perez, *Universitat Politecnica de Valencia, Spain*
Eduward Tangdionga, *Eindhoven Univ. of Technology, Netherlands*
Morio Toyoshima, *National Inst. of Information & Comm Tech, Japan*
Stefan Wolf, *Infinera Corp., USA*

S4: Digital and Electronic Subsystems

Zhensheng Jia, *CableLabs, USA, Subcommittee Chair*
Hussam Batshon, *NEC Laboratories America Inc., USA*
Di Che, *Nokia Bell Labs, USA*
Hungchang (James) Chien, *Marvell Technology Inc., USA*
Ivan Djordjevic, *Univ. of Arizona, USA*
Christian Häger, *Chalmers Univ. of Technology, Sweden*
Tetsuya Kawanishi, *Waseda Univ., Japan*
Jianqiang Li, *Kuaishou Technology, USA*
Xiaojun Liang, *Corning Inc., USA*
Laurent Schmalen, *Karlsruher Institut für Technologie, Germany*
Jiang, Xu, *Hong Kong Univ. of Science & Technology, Hong Kong*
Xian Zhou, *Univ. of Science & Technology Beijing, China*

S5: Digital Transmission Systems

Johannes Fischer, *Fraunhofer Heinrich-Hertz-Institut, Germany, Subcommittee Chair*
Eleni Diamanti, *Universite Pierre et Marie Curie, France*
Tobias Eriksson, *Infinera, Sweden*
Lidia Galdino, *Univ. College London, UK*
Amirhossein Ghazisaeidi, *Nokia Bell Labs, France*
Helmut Griesser, *ADVA, Germany*
Ezra Ip, *NEC Laboratories America Inc., USA*
Toshiaki Koike-Akino, *MERL, USA*
Rui Lin, *Chalmers Univ. of Technology, Sweden*
Hisao Nakashima, *Fujitsu Limited, Japan*
Kohki Shibahara, *NTT, Japan*
Oleg Sinkin, *TE SubCom, USA*

Track N: Networks, Applications and Access

N1: Advances in System, Network and Service Developments and Field Trials in Commerical Data Centers and Networks

Georg Mohs, *SubCom, USA, Subcommittee Chair*
Frank Effenberger, *Futurewei, USA*
Qian Hu, *Nokia Bell Labs, Germany*
Priyanth Mehta, *Ciena Corp., USA*
Stephan Pachnicke, *Univ. Kiel, Germany*
Pascal Pecci, *ASN, France*
Albert Rafel, *British Telecommunications, UK*
Liz Rivera Hartling, *Facebook Inc., USA*
Dirk van den Borne, *Juniper, Germany*
Sheldon Walklin, *Nokia Corp., Canada*
Tiejun (TJ) Xia, *Verizon Communications Inc., USA*
Xiang Zhou, *Google LLC, USA*

N2: Optical Networking for Data Center and Computing Applications

S. J. Ben Yoo, *Univ. of California Davis, USA, Subcommittee Chair*
Hitesh Ballani, *Microsoft Research Ltd., UK*
Sonia Buckley, *NIST, USA*
Nicola Calabretta, *Technische Universiteit Eindhoven, Netherlands*
Xiaoliang Chen, *Sun Yat Sen Univ., China*
Admela Jukan, *Technische Universität Braunschweig, Germany*
Greg Kanter, *Nucrypt, USA*
Mekena Metcalf, *Lawrence Berkeley Natl. Lab, USA*
Volker Sorger, *George Washington Univ., USA*
Michela Svaluto Moreolo, *Ctr Tecnològic de Telecom de Catalunya, Spain*
Thomas Van Vaerenbergh, *Hewlett Packard Ent., Belgium*
Lieven Verslegers, *Google LLC, USA*
Ying-Ju Wang, *ColdQuanta, USA*
Naoaki Yamanaka, *Keio Univ., Japan*
Georgios Zervas, *Univ. College London, UK*

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

António Eira, *Infinera, USA, Subcommittee Chair*
Maite Brandt-Pearce, *Univ. of Virginia, USA*
Konstantinos (Kostas) Christodoulopoulos, *Nokia Bell Labs Germany, Germany*
Mark Filer, *Microsoft Corp., USA*
Dan Kilper, *Trinity College Dublin, Ireland*
Ricardo Martínez, *Centre Tecn. Telecom. Catalunya (CTTC), Spain*
Paolo Monti, *Chalmers Tekniska Hogskola, Sweden*
Hidenori Takahashi, *KDDI Research, Inc., Japan*
Christine Tremblay, *École de Technologie Supérieure, Canada*
Rui Wang, *Univ. of Bristol, UK*
Zuqing Zhu, *Univ. of Science & Technology of China, China*

N4: Optical Access Networks for Fixed and Mobile Services

Junwen Zhang, *Fudan Univ., China, Subcommittee Chair*
Luiz Anet Neto, *IMT Atlantique, France*
Liang Du, *Amazon Web Services, USA*
Michael Freiberger, *Verizon Communications Inc., USA*
Naveena Genay, *Orange Labs Network, France*
Xingang Huang, *ZTE, China*
Shin Kaneko, *NTT Access Service Systems Laboratories, Japan*
Xinying Li, *Corning Inc., USA*
Paola Parolari, *Politecnico di Milano, Italy*
Marco Ruffini, *Univ. of Dublin Trinity College, Ireland*
Dora van Veen, *Nokia Corp., USA*
Mu Xu, *CableLabs, USA*

N5: Market Watch, Network Operator Summit & Data Center Summit

Andrew Schmitt, *Cignal AI, USA, Subcommittee Chair*
Robert Blum, *Intel Corp., USA*
Tim Doiron, *Infinera, USA*
Mehran Esfandiari, *AT&T Corp., USA*
Ed Harstead, *Nokia Corp., USA*
Hideki Isono, *Fujitsu Optical Components, Japan*
Donyel Jones-Willaims, *Cisco Systems Inc., USA*
Art Nichols, *Windstream, USA*
Sanjai Parthasarathi, *II-VI, USA*
Lian Qin, *Marvell, USA*
Takashi Saida, *NTT Corp., Japan*
Ryohei Urata, *Google LLC, USA*
Helen Xenos, *Ciena Corp., USA*

Expo Theater II & III Programming

Scott Wilkinson, *Cignal AI, USA*

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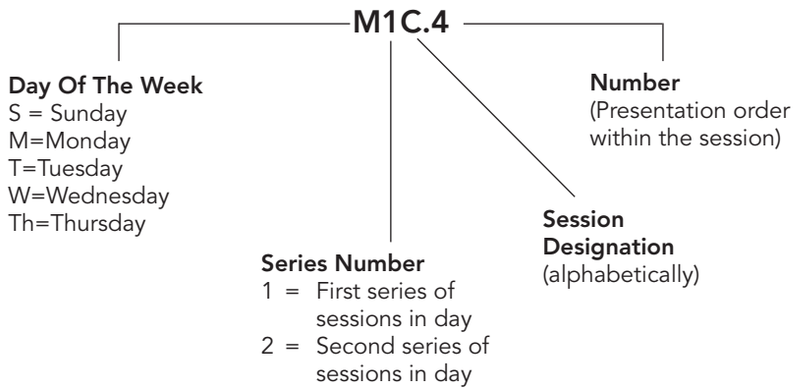
Vijay Vusirikala, *Google, USA*
Glenn Wellbrock, *Verizon Communications, Inc., USA*
Peter Winzer, *Nubis Communications, USA*

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

NOTES

Agenda of Sessions — Sunday, 6 March

	Room 6C	Room 6D	Room 6E	Room 6F	Room 7AB
09:00–12:00	**SC177, SC444, SC460, SC470, SC485**				
09:00–13:00	**SC105, SC208, SC328, SC395, SC443, SC461, SC469**				
13:00–15:30	**S1A • Is Paradigm Shift from Pluggable Optics to Co-packaged Optics Inevitable in the Next Generation of Datacenters?**	**S1B • Will Machine Learning Replace QoT/Performance Estimation and Has it Reached the Stage of Commercial Deployment?**	**S1C • How Will the Future DC Infrastructure be in the Hyperconnectivity Era?**	**S1D • Is Optical Wireless Still Relevant for 6G or Will Fiber-radio be Enough?**	**S1E • Time to Face the Cost Per Bit "Crunch": Trends and Expectations for the Next Decade**
13:00–17:00	**SC203, SC267, SC369, SC384, SC390, SC463**				
13:30–17:30	**SC452**				
15:30–16:00	**Coffee Break**				
16:00–18:30	**S2A • How Will 200G (and Beyond) per Lambda IM/DD Compete With Coherent Technology?**	**S2B • Can Optical Communication Infrastructure Double its Values by Introducing Fiber Sensing?**	**S2C • What Will the Future Machine Learning and Artificial Intelligence Systems Look Like?**	**S2D • What are the Prospects and Challenges for Hollow-core Fibers in Optical Communications?**	**S2E • Single-carrier Versus Multi-carrier for >800G Coherent Optics: A Revived Debate After a Decade**
17:00–20:00	**SC428, SC484**				
20:00–22:00	**Sp1 • Lab Automation Hackathon** *(Room 17AB)*				

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, 7 March

	Room 1AB	Room 2	Room 3	Room 6C	Room 6D
08:00–10:00	**M1A • Special Session: Reflections on the Pandemic I**	**M1B • Symposia: Optical Satellite Communications Entering a New Era Session I**	**M1C • DSP and Beamforming for Wireless Communications**	**M1D • Advanced Coherent Technology**	**M1E • Multi-core Fibers and Applications**
08:30–12:30	**SC102, SC160, SC178, SC448, SC453A, SC468, SC472, SC473, SC483, SC487**				
09:00–12:00	**SC261, SC341, SC359, SC433, SC450, SC465, SC486**				
10:00–10:30	**Coffee Break**				
10:30–12:30	**M2A • Special Session: Reflections on the Pandemic II**	**M2B • Symposia: Optical Satellite Communications Entering a New Era Session II**	**M2C • Long-haul Transmission**	**M2D • High-speed Electronics and Photonics**	**M2E • Novel Applications of Passive Photonic Circuits**
12:30–14:00	**Lunch Break** *(on own)*				
12:45–13:45	**SpE3 • Optica Technical Group on Fiber Optics Technology and Applications Panel Discussion: Are Broadband Amplifiers Useful for Data Center Communication?** *(Room 9)*				
13:30–16:30	**SC114, SC205, SC217, SC408, SC429, SC447, SC459, SC464**				
13:30–17:30	**SC325, SC327, SC347, SC357, SC393, SC431, SC451, SC453B, SC454**				
14:00–16:00	**M3A • Symposia: Multi-access Network Leveraging Edge Computing for Energy-efficient, Ultra-reliable, and Low Latency Services Session I**	**M3B • Panel: Programmable Photonic Chips for Artificial Intelligence, Computing and Optical Networks**	**M3C • Towards THz Communications**	**M3D • High-speed Semiconductor Lasers**	**M3E • Component Optimization**
14:00–16:15	**M3Z • OFC Demo Zone**				
16:00–16:30	**Coffee Break**				
16:30–18:30	**M4A • Symposia: Multi-access Network Leveraging Edge Computing for Energy-efficient, Ultra-reliable, and Low Latency Services Session II** (ends at 18:00)	**M4B • SDM Transmission** (ends at 18:00)		**M4D • Semiconductor Lasers** (ends at 18:15)	**M4E • Specialty Fibers, Cables and Connectors**

Key to Shading

Short Courses

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Room 6E	Room 6F	Room 7AB	Room 8	Room 9
M1F • Innovation for Subsea Networks	**M1G • Photonic Neuromorphic Computing**	**M1H • Advanced Digital Signal Processing for Coherent System**	**M1I • Optical Logic and Memory**	
SC102, SC160, SC178, SC448, SC453A, SC468, SC472, SC473, SC483, SC487				
SC261, SC341, SC359, SC433, SC450, SC465, SC486				
Coffee Break				
M2F • Sensing on Fibre Optic Networks	**M2G • Programmable and Intelligent Photonic Information Processing**	**M2H • Advanced Digital Signal Processing for Direct Detection System** (ends at 12:00)	**M2I • Optical Signal Processing** (ends at 12:15)	**SpE2 • Integrated Photonics for Energy Efficient Data Centers and Computing: The ARPA-E ENLITENED Program**
Lunch Break *(on own)*				
SpE3 • Optica Technical Group on Fiber Optics Technology and Applications Panel Discussion: Are Broadband Amplifiers Useful for Data Center Communication? *(Room 9)*				
SC114, SC217, SC429, SC447, SC459, SC464				
SC325, SC327, SC347, SC357, SC393, SC431, SC451, SC453B, SC454				
M3F • Machine Learning for Network Operation (ends at 15:45)	**M3G • Next-gen High-speed PON I: Advanced DSP**	**M3H • Ultra-high Baud Rate Systems** (ends at 15:45)	**M3I • Quantum and Neural Networks** (ends at 15:30)	
M3Z • OFC Demo Zone				
Coffee Break				
M4F • Open Networking and Streaming Telemetry	**M4G • Next-gen High-speed PON II: Optoelectronic Subsystems** (ends at 18:15)	**M4H • Ultra-high Baud Rate Data Center Technologies** (ends at 18:15)	**M4I • Free-space Optical Communications**	**M4J • Passive Devices for Next Generation Transmission** (ends at 18:15)

Agenda of Sessions — Tuesday, 8 March

	Room 1AB	Room 2	Room 3	Room 6C	Room 6D	Room 6E	Room 6F
07:30–8:00	**Plenary Session Coffee Break**						
08:00–10:00	**Tu1A • Plenary Session** *(Ballroom 20BCD)*						
10:00–14:00	**Exhibit Only Time**						
10:30–12:00	**How to (Re) Start your Career in the Midst of a Pandemic (Part 1)** *(OFC Career Zone, Exhibit Hall)*						
11:30–12:30	**Optica Technical Group on Optical Communications Panel Discussion: Research Lab Stories** *(Room 9)*						
12:15–15:30	**How to (Re) Start your Career in the Midst of a Pandemic (Part 2)** *(OFC Career Zone, Exhibit Hall)*						
12:00–14:00	**OFC and Co-sponsors Awards Ceremony and Luncheon** *(Ballroom 20A)*						
14:00–16:00	**Tu2A • Symposia: Emerging Photonic Interconnects and Architectures for Femtojoule per Bit Intra Data Center Links Session I**	**Tu2B • Panel: What is the Role of Machine Learning in Optical Access Networks?**	**Tu2C • Panel: Technologies for Breaking the Metro/ Access Barrier**	**Tu2D • Light Source for Datacom Applications**	**Tu2E • Comb and Multi-wavelength Sources** (ends at 15:30)	**Tu2F • High Capacity Networks** (ends at 15:15)	**Tu2G • Optical Access for Mobile, Industry and More**
16:00–16:30	**Coffee Break**						
16:30–18:30	**Tu3A • Symposia: Emerging Photonic Interconnects and Architectures for Femtojoule per Bit Intra Data Center Links Session II**	**Tu3B • Optical Subsystem Implementations**	**Tu3C • VLC for Indoor Applications** (ends at 18:15)	**Tu3D • Narrow Linewidth and Tunable Lasers**	**Tu3E • Raman Amplification and Frequency Comb Generation** (ends at 18:00)	**Tu3F • Optical Transport for 5G** (ends at 18:00)	**Tu3G • Novel and Emerging Networks**
17:15–18:15	**Exhibitor Reception** *(Center Terrace)*						
18:30–20:00	**Conference Reception** *(Ballroom 20)*						
19:30–21:30	**SpE5 • Rump Session: Will Quantum Always Remain Basic Research or is it Ready to Power Great Products?** *(Room 6F)*						

<table>
<tr><th colspan="2">Room 7AB</th><th>Room 8</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</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 • Market Watch I: State of the Industry
10:30–12:00

MW2 • Market Watch II: The Path to Co-packaged Optics for Switching Applications
12:30–14:00

MW3 • Market Watch III: Building the Ecosystem for Converged IP/Optical Networks - Beyond 400G Pluggables
14:30–16:00</td><td rowspan="11">DCSK • Data Center Summit: Keynote
10:30–11:00

DCS1 • Data Center Summit Panel I: Scaling Data Center Interconnect
11:30–13:00

DCS2 • Data Center Summit Panel II: Solving the Challenge of Moving Data Centers to the Network Edge
13:30–15:00

SF4 • The Converged Mobile Xhaul and FTTH Fiber Access Opportunity
15:30–16:30</td><td rowspan="11">SpE14 • Conversation with the Plenary Speakers
10:15–10:45

SF1 • AIM Photonics and the Next PIC Generation
11:30–12:30

SF2 • The Future of PON: 25G or 50G?
13:00–14:00

SF3 • DARPA Photonics Programs
14:30–15:30

SF5 • An OIF Update on Electrical Rates: 112G Technical Closure and the Latest Progress and Challenges for 224G to Create the Next Speed Node
16:00–17:00</td></tr>
<tr><td colspan="3">Exhibit Only Time</td></tr>
<tr><td colspan="3">How to (Re) Start your Career in the Midst of a Pandemic (Part 1)
(OFC Career Zone, Exhibit Hall)</td></tr>
<tr><td colspan="3">Optica Technical Group on Optical Communications Panel Discussion: Research Lab Stories (Room 9)</td></tr>
<tr><td colspan="3">How to (Re) Start your Career in the Midst of a Pandemic (Part 2)
(OFC Career Zone, Exhibit Hall)</td></tr>
<tr><td colspan="3">OFC and Co-sponsors Awards Ceremony and Luncheon (Ballroom 20A)</td></tr>
<tr><td colspan="2">Tu2H • Panel: What are the Parallelization Technologies for Cost and Energy Efficient 1.6Tb Links?</td><td>Tu2I • Integrated Photonic Subsystems</td></tr>
<tr><td colspan="3">Coffee Break</td></tr>
<tr><td colspan="2">Tu3H • Enablers and Disrupters in Data Center and HPC
(ends at 18:15)</td><td>Tu3I • Quantum Communications</td></tr>
<tr><td colspan="3">Exhibitor Reception (Center Terrace)</td></tr>
<tr><td colspan="3">Conference Reception (Ballroom 20)</td></tr>
<tr><td colspan="3">SpE5 • Rump Session: Will Quantum Always Remain Basic Research or is it Ready to Power Great Products? (Room 6F)</td><td colspan="3">Exhibit Hall Closes 17:00</td></tr>
</table>

Agenda of Sessions — Wednesday, 9 March

	Room 1AB	Room 2	Room 3	Room 6C	Room 6D	Room 6E	Room 6F
06:00–07:00	**Rise and Shine Run/Walk**						
07:30–08:00	**Coffee Break**						
08:00–10:00	**W1A • Special Session: Network Intelligence**	**W1B • Panel: Progress and Roadmap in Silicon Photonics Foundries and Supply Chains**	**W1C • Panel: Optical Wireless Communications for Indoor Access Networks - Practical Solutions Beyond Table-top Demos**	**W1D • Sensing in Fibers and Networks** (ends at 09:30)	**W1E • Packaging and Co-packaged Optics** (ends at 09:30)	**W1F • Network Automation**	
10:00–10:30	**Coffee Break**						
10:30–11:30	**Tools to Take Your Career to the Next Level** *(OFC Career Zone, Exhibit Hall)*						
10:30–12:30	**W2A • Posters Session I**						
12:00–15:00	**15-Minute one-on-one Resume Reviews** *(OFC Career Zone, Exhibit Hall)*						
12:30–14:00	**Exhibit Only**						
14:00–16:00	**W3A • Special Session: Network Evolution and Adaptation to Environmental Change Session I**	**W3B • Panel: The Role of Photonics for Artificial Intelligence/ Machine Learning at the Edge: What, Why and How?**	**W3C • High Symbol Rate and Wideband Transmission**	**W3D • Photodetectors, Sensing and Microwave Photonics** (ends at 15:45)	**W3E • Fiber Nonlinearity** (ends at 15:30)	**W3F • High-capacity and Flexible Networks**	**W3G • Machine Learning and Virtualisation in Optical Access** (ends at 16:15)
16:00–16:30	**Coffee Break**						
16:30–18:15	**W4A • Special Session: Network Evolution and Adaptation to Environmental Change Session II** (ends at 18:00)	**W4B • Advances in Optical Switching** (ends at 18:30)	**W4C • RoF Systems**	**W4D • Fiber Sensors** (ends at 18:00)	**W4E • Hollow-core Fibers**	**W4F • Emerging Network Architectures and Service** (ends at 18:30)	**W4G • Network Performance** (ends at 18:00)

Room 7AB	Room 8	Room 9	Exhibit Hall Theater I	Exhibit Hall Theater II	Exhibit Hall Theater III
Rise and Shine Run/Walk			**Exhibit Hall Opens at 10:00**		
Coffee Break					
W1G • Coherent DSP for DCI applications (ends at 09:30)	**W1H • Microwave Photonics**	**W1I • Open Networking Summit: Open Optical Disaggregation: What the Heck is Going On?**	**NOSK • Network Operator Summit Keynote** 10:30–11:00 **NOS1 • Network Operator Summit Panel I: Operator Investment Directions for FTTH and Access Networks** 11:30–13:00 **NOS2 • Network Operator Summit Panel II: Using Disaggregation as a Strategy to Modernize the Network** 13:30–15:00 **MW4 • Market Watch IV: The Role of Optics in Future Machine Learning Architectures** 15:30–17:00	**SF6 • What Makes Ethernet, Ethernet?** (Ethernet Alliance) 10:30–11:30 **SF7 • Deployment of 400ZR and the Ongoing OIF Work to Define 800ZR/LR** 12:00–13:00 **SF8 • Evolution of Optics for Mobile (MOPA)** 13:30–14:30 **SF10 • OpenROADM Updates and Demo** 15:00–16:00 **TS1 • 400Gbps Post FEC BER and Jitter Tolerance Test** Presented by Anritsu Corporation 16:15–16:45	**TS2 • 2.4Tb SmartPHY: Solutions for Next Generation 2.4Tb+ Line Systems** Presented by Xilinx Inc. 10:15–10:45 **TS3 • The Future of Coherent Optical Engines** Presented by Infinera 11:00–11:30 **TS4 • Optical Fiber Communication, a Key Enabler for O-RAN** Presented by Anritsu Corporation 11:45–12:15 **TS5 • Hybrid Integration Platform for Co-Packaged Photonics Using POET's CMOS Based Optical Interposer** Presented by POET Technologies Inc. 12:30–13:00 **SF9 • Space-based Optical Communications – Unleashing the Potential of Space** 14:30–15:30 **SF11 • Beyond 400G – IEEE Update on Progress Towards 800 GbE and 1.6 TbE** 16:00–17:00
Coffee Break					
Tools to Take Your Career to the Next Level *(OFC Career Zone, Exhibit Hall)*					
W2A • Posters Session I					
15-Minute one-on-one Resume Reviews *(OFC Career Zone, Exhibit Hall)*					
Exhibit Only					
W3H • Forward Error Correction (ends at 15:30)	**W3I • Artificial Intelligence-enhanced Optical Wireless Systems**	**W3J • Doped Amplifiers in Fibers and Waveguides** (ends at 15:45)			
Coffee Break					
W4H • High Bandwidth Density Technologies to XPU	**W4I • Machine Learning/ Artificial Intelligence Methods in Transmission Systems** (ends at 18:00)	**W4J • Optical Parametric Amplification and its Applications**	**Exhibit Hall Closes 17:00**		

Agenda of Sessions — Thursday, 10 March

	Room 1AB	Room 2	Room 3	Room 6C	Room 6D	Room 6E	Room 6F
06:00–07:00	**Rise and Relax Yoga**						
07:30–08:00	**Coffee Break**						
8:00–10:00	**Th1A • Panel: Has the Time Come for Coherent Optics in Access Networks?**	**Th1B • Panel: Fiber Optic Sensor Technologies and Their Applications**	**Th1C • Optical Performance Monitoring and Signal Characterization**	**Th1D • Optical Signal Processing Devices**	**Th1E • Fiber and Integrated-photonics Devices** (ends at 09:45)	**Th1F • Network Planning and Techo-economics** (ends at 09:30)	**Th1G • Intelligent and Artificial Intelligence Network Architectures**
10:00–10:30	**Coffee Break**						
10:00–14:00	**OFC Career Zone Job Fair** *(Exhibit Hall)*						
10:30–12:30	**Th2A • Posters Session II**						
12:30–14:00	**Exhibit Only Time**						
14:00–16:00			**Th3A • Energy Efficient Subsystems for the Data Center**	**Th3B • Photonic Signal Processing** (ends at 15:45)	**Th3C • Si Photonics**	**Th3D • Quantum Networking and Resiliency** (ends at 15:30)	**Th3E • Coherent Optical Access Networks** (ends at 15:45)
16:00–16:30	**Coffee Break**						
16:30–18:30	**Postdeadline Papers** *(Rooms 6C, 6D, 6E, 6F)*						

<table>
<tr><th>Room 7AB</th><th>Room 8</th><th>Room 9</th><th>Exhibit Hall
Theater I</th><th>Exhibit Hall
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Theater III</th></tr>
<tr><td colspan="3">Rise and Relax Yoga</td><td colspan="3">Exhibit Hall Opens at 10:00</td></tr>
<tr><td colspan="3">Coffee Break</td><td rowspan="10">MW5 • Market Watch V: Evolution of Coherent Transceiver Architectures for Specific Applications
10:30–12:00

MW6 • Market Watch VI: Building the Next Generation 3.2T Transceiver
12:30–14:00</td><td rowspan="10">SF12 • F5G Update: Emerging Use Cases and Demonstrations
10:30–11:30

SF14 • Hollow Core Fiber - Ready for Prime Time?
12:00–13:00

SF16 • The Edge Cloud: Descending Cloud – Ascending Edge, and What it Means for Optical Networks
13:30–14:30

TS6 • Next Generation Opto-Electronic Devices-Measurement Challenges
Presented by Anritsu Corporation
14:45–15:15</td><td rowspan="10">SF13 • OpenZR+: Enabling High-performance Router-based Optics (OpenZR+ MSA)
11:30–12:30

SF15 • Building Open and Disaggregated Networks (TIP)
13:00–14:00</td></tr>
<tr><td>Th1H • Advanced Modulation and Signal Processing</td><td>Th1I • 6G Systems and Technologies</td><td>Th1J • Thin Film and Organic Modulators</td></tr>
<tr><td colspan="3">Coffee Break</td></tr>
<tr><td colspan="3">OFC Career Zone Job Fair (Exhibit Hall)</td></tr>
<tr><td colspan="3">Th2A • Posters Session II</td></tr>
<tr><td colspan="3">Exhibit Only Time</td></tr>
<tr><td>Th3F • Advanced Modulation Formats</td><td>Th3G • Sensing and Radar Applications
(ends at 15:15)</td><td></td></tr>
<tr><td colspan="3">Coffee Break</td></tr>
<tr><td colspan="3">Postdeadline Papers (Rooms 6C, 6D, 6E, 6F)</td></tr>
<tr><td colspan="3"></td><td colspan="3">Exhibit Hall Closes at 16:00</td></tr>
</table>

Room 1AB

08:00–10:00
M1A • Special Session: Reflections on the Pandemic Session I
Presider: Roland Ryf; Nokia Bell Labs, USA

M1A.1 • 08:00 Invited
Digital Inclusion / Digital Divide, Stephen Alexander[1]; [1]*Ciena Corp., USA.* Abstract not available.

M1A.2 • 08:30 Invited
A New Era of Video Transmission Using Open Transport System: Challenges in 2020 Sporting Events, Daisuke Shirai[1]; [1]*NTT Corp., Japan.* Abstract not available.

Room 2

08:00–10:00
M1B • Symposia: Optical Satellite Communications Entering a New Era Session I
Presider: Jörg-Peter Elbers; ADVA Optical Networking SE, Germany

M1B.1 • 08:15 Invited
Title to be Announced, Elodie Viau[1]; [1]*European Space Agency, Belgium.* Abstract not available.

Room 3

08:00–10:00
M1C • DSP and Beamforming for Wireless Communications

M1C.1 • 08:00
Demonstration of 74.7 Gbit/s 4096QAM OFDM E-Band Wireless Delivery Over 700 m Employing Advanced DSP, Li Zhao[1], Bohan Sang[1], Junting Shi[1], Yuxuan Tan[1], Kaihui Wang[1], Junjie Ding[1], Yanyi Wang[1], Wen Zhou[1], Jianjun Yu[1]; [1]*Fudan Univ., China.* We experimentally demonstrate a transmission of 74.7 Gbit/s 4096QAM OFDM signal at 73.5 and 83.5 GHz over 700m wireless distance using probabilistic shaping and Volterra nonlinearity compensation.

M1C.2 • 08:15
10 Gbps Laser Communication for Low Earth Orbit Satellites With Volterra and Machine Learning Nonlinear Compensation Providing Link Budget up to 74 dB, Yi-Jun Cai[1], Shao-Hung Yu[1], Zheng-Wei Huang[1], Yu-Wei Wang[1], Pin-Hsuan Ting[1], Yu-Pin Lan[1], Chen-Joe Fang[2], Hsin-Chia Lin[2], Chun-Ting Lin[1], Bor-Chwan Chen[2]; [1]*National Yang-Ming Chiao Tung Univ., Taiwan;* [2]*National Space Organization, Taiwan.* We invesigate the power-link budget of 10Gbps laser communication. The comparison of the DML nonlinearity effects between OFDM and SC-FDE is discussed. With Volterra and machine-learning nonlinear compensation, the power-link budget achieve up to 74 dB.

M1C.3 • 08:30
A Novel Structure Design of Delta-Sigma Modulator Based on Genetic Algorithm for Mobile Fronthaul, Dayong Tan[1], Linsheng Zhong[1], Yang Zou[1], Jie Zhang[1], Weiqi Lu[1], Xiaoxiao Dai[1], Qi Yang[1], Songnian Fu[2], Mengfan Cheng[1], Lei Deng[1], Deming Liu[1]; [1]*HUST, China;* [2]*Guangdong Univ of Technology, China.* We proposed a novel structure design method of delta-sigma modulator based on genetic algorithm. Compared to the traditional method, SNR of the restored signal under the optimized structure at the receiver is increased by ~6dB.

Room 6C

08:00–10:00
M1D • Advanced Coherent Technology
Presider: Andreas Matiss; Corning Inc, USA

M1D.1 • 08:00 Invited
Role of Coherent System in the Next DCI Generation, Daniel Tauber[1]; [1]*Lumentum Operations LLC, USA.* Coherent Transmission has been the standard for fiber optic transmission beyond 40 km for over a decade. We review its continuing role for DCI at 400 and 800 Gbps and higher rates.

M1D.2 • 08:30
Demonstration of Thin-Film Lithium Niobate High-Bandwidth Coherent Driver Modulator, Shuntaro Makino[1], Shintaro Takeuchi[1], Shinji Maruyama[1], Masaharu Doi[1], Yasuhiro Ohmori[1], Yoshinobu Kubota[1]; [1]*Fujitsu Optical Components Limited, Japan.* We demonstrate the performance of a high-bandwidth coherent driver modulator device, based on thin-film lithium niobate DP-IQ MZI modulators with excellent DC drift characteristics making it suitable for commercial applications.

Room 6D

08:00–10:00
M1E • Multi-core Fibers and Applications
Presider: Cristian Antonelli; Universita degli Studi dell'Aquila, Italy

M1E.1 • 08:00 Invited
Uncoupled Multi-Core Fiber Design for Practical Bidirectional Optical Communications, Tetsuya Hayashi[1], Takuji Nagashima[1], Ayumi Inoue[1], Hirotaka Sakuma[1], Takahiro Suganuma[1], Takemi Hasegawa[1]; [1]*Optical Communications Laboratory, Sumitomo Electric Industries Ltd, Japan.* We review and discuss the design factors and considerations on MCFs for bidirectional transmissions, including connection polarity and crosstalk requirements. We also introduce MCFs suitable for bidirectional long-haul and short-reach transmissions.

M1E.2 • 08:30 ★ Top-Scored
Comparison of Transfer Matrix Stability Between a 110km 7-Core Coupled-Core Multi-Core Fiber and Single-Mode Fiber, Mikael Mazur[1], Nicolas Fontaine[1], Steve Corteselli[1], Haoshuo Chen[1], Lauren Dallachiesa[1], Tetsuya Hayashi[2], Hirotaka Sakuma[2], Takemi Hasegawa[2], Roland Ryf[1], David T. Neilson[1]; [1]*Nokia Bell Labs, USA;* [2]*Sumitomo Electric Industries, Japan.* We use dual-comb spectroscopy to compare the stability and wavelength dependence of mode coupling in a 110\,km coupled multi-core and a regular single-mode fiber. Phase and intensity fluctuations are compared, revealing differences in coupling dynamics.

Room 6E

08:00–10:00
M1F • Innovations for Subsea Networks
Presider: Qian Hu; Nokia Bell Labs, Germany

M1F.1 • 08:00 Tutorial
Modern Subsea Networks, Mei Du[1]; [1]*Tata Communications, USA.* This tutorial will discuss the key components in building a subsea cable system from concept to service, and will review the recent technical innovations in advancing the performance and new applications of subsea cable system.

Mei Du received her Ph.D from The University of Chicago studying femtosecond spectroscopy. She started her telecommunication career in Lucent Techology, Bell labs, then worked for several telecom companies. Her experience involved working on forward pumping distributed Raman and highspeed optical transmission of 40Gb/s, 100Gb/s and above. Currently, her work focuses on building new subsea cables and upgrading legacy cables.

Room 6F

08:00–10:00
M1G • Photonic Neuromorphic Computing
Presider: Sonia Buckley; National Inst of Standards & Technology, USA and Nicola Calabretta; Technische Universiteit Eindhoven, Netherlands

M1G.1 • 08:00 Tutorial
Neuromorphic Photonics, Paul R. Prucnal[1]; [1]*Princeton Univ., USA.* Abstract not available.
Biography not available.

Room 7AB

08:00–10:00
M1H • Advanced Digital Signal Processing for Coherent System
Presider: Di Che; Nokia Bell Labs, USA

M1H.1 • 08:00 Invited
Neural Network-Based Fiber Nonlinearity Mitigation in High-Speed Coherent Optical Transmission Systems, Fan Zhang[1,2], Xiansong Fang[1], Xinyu Chen[1]; [1]*Peking Univ., China;* [2]*Peng Cheng Laboratory, China.* In this paper, we review the recent progress of neural network-based Kerr nonlinearity mitigation techniques in high-speed coherent optical fiber transmission systems. Current studies in both single-carrier and nonlinear frequency division multiplexing systems are discussed.

M1H.2 • 08:30
4-Dimensional IQ Characteristic Estimation for Polarization-Multiplexed Coherent Transceivers, Akira Kawai[1], Masanori Nakamura[1], Takayuki Kobayashi[1], Yutaka Miyamoto[1]; [1]*NTT Network Innovation Laboratories, Japan.* We developed an estimation method that enables frequency-resolved 4-Dimensional (4D) IQ impairment characterization of polarization-multiplexed transceivers in the presence of arbitrary crosstalk across four IQ lanes. We demonstrated the method with 96-Gbaud 16QAM signals.

Room 8

08:00–10:00
M1I • Optical Logic and Memory
Presider: Lan Liu; Univ. of California San Diego, USA

M1I.1 • 08:00 ★ Top-Scored
16-bit (4x4) Optical Random Access Memory (RAM) Bank, Christos Pappas[1,2], Theodoros Moschos[1,2], Theoni Alexoudi[1,2], Christos Vagionas[1,2], Nikos Pleros[1,2]; [1]*Informatics, Aristotle Univ. of Thessaloniki, Greece;* [2]*Centre for Interdisciplinary Research and Innovation, Greece.* A complete 16-bit all-optical RAM bank capable of storing 4×4-bit WDM-formatted optical data words at a 20Gb/s memory-throughput is experimentally presented for the first time, using sixteen 5Gb/s monolithic InP Flip-Flops and all-passive Row/Column Decoding circuits.

M1I.2 • 08:15
Optical Content Addressable Memory Matchline and RAM Table Encoding/Decoding Using an Integrated CAM Cell, Theodoros Moschos[1,2], Stelios Simos[1,2], Christos Pappas[1,2], Theoni Alexoudi[1,2], Christos Vagionas[1,2], Nikos Pleros[1,2]; [1]*Aristotle Univ. of Thessaloniki, Greece;* [2]*Centre for Interdisciplinary Research and Innovation, Greece.* We experimentally demonstrate for the first time an all-optical fully-integrated InP CAM cell within a complete CAM Matchline architecture with RAM table Encoding and Decoding functionalities. Error-free operation has been evaluated at 5 Gb/s.

M1I.3 • 08:30 Invited
Scalable and Fast Optical Circuit Switch Exploiting Colorless Coherent Detection, Ryosuke Matsumoto[1], Ryotaro Konoike[1], Keijiro Suzuki[1], Takashi Inoue[1], Shu Namiki[1], Kenichi Sato[1]; [1]*National Inst. of Advanced Industria, Japan.* We present a scalable and fast wavelength-routing switch employing colorless coherent detection. Some thousand port-count and a few microsecond switching time are realized by using a Silicon-Photonic tunable-filter-based local oscillator bank that enables colorless detection.

Room 1AB

M1A • Special Session: Reflections on the Pandemic Session I—Continued

M1A.3 • 09:00 Invited

Bridging the Digital Divide, and the Future of Work, Mischa Dohler[1]; [1]*King's College London, UK*. Abstract not available.

Room 2

M1B • Symposia: Optical Satellite Communications Entering a New Era Session I—Continued

M1B.2 • 08:45 Invited

Title to be Announced, Bernie Edwards[1]; [1]*NASA, USA*. Abstract not available.

M1B.3 • 09:15 Invited

Applicability of Space Laser Communications for Low Earth Orbit Satellite Constellations, Morio Toyoshima[1]; [1]*National Inst of Information & Comm Tech, Japan*. Many satellite constellations have been planned from various countries. Optical communications are expected to realize wide bandwidths and the immunity to the interference under the environment of a huge number of satellites in the future.

Room 3

M1C • DSP and Beamforming for Wireless Communications—Continued

M1C.4 • 08:45

Delivery of 103.2 Gb/s 4096QAM Signal Over 180m Wireless Distance at D-Band Enabled by Truncated Probabilistic Shaping and MIMO Volterra Compensation, Weiping Li[1], Yanyi Wang[1], Junjie Ding[1], Jiaxuan Liu[1], Kaihui Wang[1], Feng Wang[1], Chen Wang[1], Li Zhao[1], Cuiwei Liu[1], Wen Zhou[1], Jianguo Yu[2], Feng Zhao[3], Jianjun Yu[1]; [1]*Fudan Univ., China;* [2]*Beijing Univ. of Posts and Telecommunications, China;* [3]*School of Electronic Engineering, Xi'an Univ. of Posts and Telecommunications, China*. We experimentally demonstrated the delivery of 103.2 Gb/s 4096QAM signal over 180m wireless distance at D-band employing truncated probabilistic shaping and MIMO Volterra Compensation, with the value of NGMI exceeds the threshold of 0.83.

M1C.5 • 09:00

Mobile 14-GHz Bandwidth Fronthaul Link Supporting 128 RF-Chain Signals for 6G MIMO Beamforming, Yu-Jen Huang[1], Guan-Ting Lin[1], Pin-Hsuan Ting[1], Zheng-Wei Huang[1], Shao-Hung Yu[1], Yi-Jun Cai[1], Chia Chien Wei[2], Sien Chi[1], Chun-Ting Lin[1]; [1]*National Yang Ming Chiao Tung Univ., Taiwan;* [2]*Photonics, National Sun Yat-sen Univ., Taiwan*. We demonstrate fronthual links with delay-division-multiplexing 14-GHz bandwidth 64- QAM OFDM for 128 RF-chain signals. The corresponding CPRI-based capacity is 860.16 Gb/s. With I/Q Volterra nonlinear compensation, EVMs can be improved from 7.5% to 6%.

M1C.6 • 09:15

Variable Focus Lens-Based Beam Steering and Divergence Control for WDM Free-Space Optical Communication, Vuong V. Mai[1], Hoon Kim[1]; [1]*School of Electrical Engineering, Korea Advanced Inst of Science & Tech, Korea (the Republic of)*. We investigate through experiments the wavelength dependence of optical beam steering and divergence control technique realized by variable focus lenses (VFLs). We also transmit 4×10-Gb/s signals over a 104-m free-space link using the VFL-based system.

Room 6C

M1D • Advanced Coherent Technology—Continued

M1D.3 • 08:45 Invited

Development of Low-Power Coherent ASIC, Kiran Puttegowda[1], Christian Lutkemeyer[1], Elvio Serrano[1], Damian Morero[1], Kishore Kota[1]; [1]*Marvell Semiconductor Inc, USA*. The latest generation of coherent pluggable modules impose strict power limits on the coherent ASIC. The development process for a low-power coherent ASIC designed in a 7nm FINFET process is described. The ASIC enables pluggable coherent modules with energy efficiency of 40-60pJ/bit for various 400G DWDM applications.

M1D.4 • 09:15

Highly Power-Efficient (2 pJ/bit), 128Gbps 16QAM Signal Generation of Coherent Optical DAC Transmitter Using 28-nm CMOS Driver and All-Silicon Segmented Modulator, Yohei Sobu[1,2], Guoxiu Huang[2], Toshihiko Mori[1,2], Yukito Tsunoda[1,2], Takuji Yamamoto[1,2], Shinsuke Tanaka[1,2], Takeshi Hoshida[2]; [1]*PETRA, Japan;* [2]*Fujitsu Limited, Japan*. We demonstrated a highly power-efficient coherent optical digital-to-analog converter transmitter. 2pJ/bit operation was realized by combining an all-silicon segmented modulator and a CMOS inverter driver. The bit-error-rate was less than the 25.5% of SD-FEC limit.

Room 6D

M1E • Multi-core Fibers and Applications—Continued

M1E.3 • 08:45

Method of Estimating Inter-Core Crosstalk for Constructing Uncoupled Multi-Core Fiber Transmission Line, Atsushi Nakamura[1], Tomokazu Oda[1], Yusuke Koshikiya[1]; [1]*NTT Corporation, Japan*. We propose and experimentally demonstrate a method based on optical time domain reflectometry for evaluating splices in terms of ensuring the total end-to-end inter-core crosstalk of transmission lines consisting of uncoupled multi-core fibers.

M1E.4 • 09:00

Simultaneously Measuring Group Delays, Chromatic Dispersion and Skews of Multicore Fibers Using a Frequency Domain Method, Xin Chen[1], Kangmei Li[1], Jason E. Hurley[1], Ming-Jun Li[1]; [1]*Corning Inc, USA*. A frequency domain method is proposed to measure group delays, chromatic dispersion and skews of multicore fibers. We present detailed studies through measuring a 2×2 multicore fiber which agree well with the time domain method.

M1E.5 • 09:15

Wideband Impulse Response Measurement of Coupled 2-Core Fibers of Various Lengths Employing Dual-Comb Coherent Sampling, Masafumi Uyama[1], Masaki Uno[1], Shuki Okamura[2], Chao Zhang[2], Fumihiko Ito[1], Atsushi Nakamura[3], Tatsuya Okamoto[3], Yusuke Koshikiya[3]; [1]*Graduate School of Natural Science and Technology, Shimane Univ., Japan;* [2]*Interdisciplinary Faculty of Science and Engineering, Shimane Univ., Japan;* [3]*NTT Access Service Systems Laboratories, NTT Corporation, Japan*. Transmission length dependency of complex impulse responses of coupled 2-core fibers are investigated using coherent sampling with picosecond time resolution over 20-nm bandwidth. Spectrally decomposed analysis is accomplished to observe the statistical nature.

Room 6E

M1F • Innovations for Subsea Networks—Continued

M1F.2 • 09:00 ★ Top-Scored

SDM Enabled Record Field Trial Achieving 300+ Tbps Trans-Atlantic Transmission Capacity, Siddharth Varughese[1], Sumudu Edirisinghe[1], Marc Stephens[1], Buen Boyanov[2], Pierre Mertz[1]; [1]*Subsea, Infinera Corporation, USA;* [2]*Smartcom, Bulgaria.* A per fiber-pair real-time capacity of 25.6 Tbps is demonstrated with 0.5 dB Q-factor commissioning margin across 6611 km of SDM enabled trans-Atlantic link aggregating to a record 307.2 Tbps on a single submarine cable.

M1F.3 • 09:15

200µm Diameter Fiber for SDM Submarine Networks: Cabling Performance and Record Transmission Result, Takanori Inoue[1], Kohei Nakamura[1], Yuushi Matsuo[1], Fatih Yaman[2], Sergejs Makovejs[3], Jennifer T. Prater[3], Juan C. Aquino[4], Daishi Masuda[4], Yoshihisa Inada[1], Mateo Eduardo[1]; [1]*NEC, Japan;* [2]*NEC Laboratories America, USA;* [3]*CORNING, USA;* [4]*OCC Corporation, Japan.* 200µm-diameter fiber is analyzed for SDM submarine systems and fully characterized over 15000km transmission. This represents, to our knowledge, the first ever ultra-long-haul transmission with 200µm large effective-area fiber.

Room 6F

M1G • Photonic Neuromorphic Computing—Continued

M1G.2 • 09:00 ★ Top-Scored

WDM-Conscious Synaptic Receptor Assisted by SOA+EAM, Margareta Vania Stephanie[1], Michael Waltl[2], Tibor Grasser[2], Bernhard Schrenk[1]; [1]*AIT (Austrian Inst. of Technology), Austria;* [2]*Inst. for Microelectronics, TU Wien, Austria.* We experimentally demonstrate the simultaneous weighing and summation of two 23-nm spaced, frequency-coded spike trains with 100-ps spike width. Operation of the synaptic receptor at low BER is confirmed at 10 Gb/s information rate.

M1G.3 • 09:15

Experimental Demonstration of an Extreme Learning Machine Based on Fabry Perot Lasers for Parallel Neuromorphic Processing, George C. Sarantoglou[1], Kostas Sozos[2], Thomas Kamalakis[3], Charis Mesaritakis[1], Adonis Bogris[2]; [1]*Department of Information and Communication Systems Engineering, Univ. of the Aegean, Greece;* [2]*Department of Informatics & Computer Engineering, Univ. of West Attica, Greece;* [3]*Department of Informatics &Telematics, Harokopio Univ. of Athens, Greece.* We present experimental results regarding dispersion equalization in IM-DD transmission systems with an extreme learning machine based on a Fabry Perot laser. The exploitation of two longitudinal modes yields enhanced computational power and processing speed.

Room 7AB

M1H • Advanced Digital Signal Processing for Coherent System—Continued

M1H.3 • 08:45

Efficient Training of Volterra Series-Based Pre-Distortion Filter Using Neural Networks, Vinod Bajaj[1,2], Mathieu Chagnon[2], Sander Wahls[1], Vahid Aref[2]; [1]*TU Delft, Germany;* [2]*Nokia Bell Labs, Germany.* We present a simple, efficient "direct learning" approach to train Volterra series-based digital pre-distortion filters using neural networks. We show its superior performance over conventional training methods using a 64-QAM 64 GBaud simulated transmitter with varying transmitter nonlinearity and noisy conditions.

M1H.4 • 09:00 Invited

Optical Polarization-Based Sensing and Localization of Submarine Earthquakes, Jorge C. Castellanos[2], Zhongwen Zhan[1], Valey Kamalov[2], Mattia Cantono[2], Shuang Yin[2], Antonio Mecozzi[3], Shirshendu Bhattacharya[2], Richard Allen[4]; [1]*California Inst. of Technology, USA;* [2]*Google LLC, USA;* [3]*Univ. of L'Aquila, Italy;* [4]*UC Berkeley, USA.* Optical polarization-based sensing is applied to multiple submarine cables around the world. Earthquakes are detected by their shear waves at the closest fiber section. Synchronized detection on multiple cables enables potential localization of major earthquakes.

Room 8

M1I • Optical Logic and Memory—Continued

M1I.4 • 09:00

Flexible and Transparent Optical Labelling in Coherent Optical Wavelength Division Multiplexing Networks, Chao Yang[1], Ming Luo[1], Zhixue He[1], Xi Xiao[1]; [1]*Wuhan Research Inst. of Post & Tele, China.* Multichannel 10-Kb/s optical labelling signal added on the 100-Gbit/s DP-QPSK signals is experimentally demonstrated after 600-km SSMF transmission. By down sampling and low pass filtering, we successfully recovered the multichannel labels using only one photodetector.

M1I.5 • 09:15

Frequency Comb and Injection Locking Based Mutual Protections in Coherent Optical Access Network, Haipeng Zhang[1], Mu Xu[1], Zhensheng Jia[1], L. Alberto Campos[1]; [1]*CableLabs, USA.* A P2MP coherent network features mutual protection between adjacent networks, and remote delivery of optical carriers that are injection locked to an optical frequency comb is proposed. System functionality and performance has been verified experimentally.

Room 1AB

M1A • Special Session: Reflections on the Pandemic Session I—Continued

M1A.4 • 09:30 Invited
The Future of Virtual Meetings, Jamie Gaudette[1]; [1]*Microsoft, USA.* Abstract not available.

Room 2

M1B • Symposia: Optical Satellite Communications Entering a New Era Session I—Continued

Room 3

M1C • DSP and Beamforming for Wireless Communications—Continued

M1C.7 • 09:30 ★ Top-Scored
Actively Steerable Integrated Optical Phased Array (OPA) for Optical Wireless Communication (OWC), Pin-Cheng Kuo[1], Sheng-I Kuo[1], Ju-Wei Wang[1], Yin-He Jian[1], Z Ahmad[2], Po-Han Fu[5], You-Chia Chang[1], Jin-Wei Shi[2], Ding-Wei Huang[5], Yang Liu[3], Chien-Hung Yeh[4], Chi-Wai Chow[1]; [1]*National Yang Ming Chiao Tung Univ., Taiwan;* [2]*National Central Univ., Taiwan;* [3]*Philips Electronics Ltd, Hong Kong;* [4]*Feng Chia Univ., Taiwan;* [5]*National Taiwan Univ., Taiwan.* We propose and demonstrate an actively-controlled optical-beam-steering optical-wireless-communication (OWC) system using an integrated optical-phased-array (OPA). We numerically and experimentally evaluate field-of-view (FOV), beam divergence angle and bit-error-rate (BER) performance of the emitted optical signal.

Room 6C

M1D • Advanced Coherent Technology—Continued

M1D.5 • 09:30 Invited
Fast Optical Frequency Detection Techniques for Coherent Distributed Sensing and Communication Systems, Steve Yao[1,2]; [1]*Photonics Information and Innovation Center, Hebei Univ., China;* [2]*NuVision Photonics, USA.* We present techniques for detecting fast optical frequency variations with high spectral resolution for coherent detection based distributed sensing and communication systems, for which conventional spectral measurement techniques cannot meet the speed and spectral resolution requirements.

Room 6D

M1E • Multi-core Fibers and Applications—Continued

M1E.6 • 09:30 Invited
Quantum Communications With Space Encoding Technique, Davide Bacco[1,2], Mujtaba Zahidy[1], Nicola Biagi[2,3], Daniele Cozzolino[1], Yaoxin Liu[1], Yunhong Ding[1], Toshio Morioka[1], Cristian Antonelli[4], Antonio Mecozzi[4], Alessandro Zavatta[2,3], Leif K. Oxenløwe[1]; [1]*DTU Fotonik, Denmark;* [2]*QTI s.r.l., Italy;* [3]*CNR-INO, Italy;* [4]*Physical and Chemical Sciences, Universita' degli Studi dell'Aquila, Italy.* Quantum communications are a key enabler for multiple applications, from information-theoretic communications to advanced remote quantum simulations. We here report our recent results on generation, transmission and detection of space encoded quantum states multicore.

08:30–12:30 SC102, SC160, SC178, SC433 (ends at 11:30)**, SC448, SC453A, SC468, SC472, SC473, SC483, SC487**

09:00–12:00 SC261, SC341 (ends at 13:00)**, SC359, SC450, SC465, SC486**

10:00–10:30 Coffee Break

Room 6E

M1F • Innovations for Subsea Networks—Continued

M1F.4 • 09:30 Invited

Agile Subsea Networks, Lara D. Garrett[1]; [1]*SubCom LLC, USA*. Approaches to configurable capacity routing including optical fiber switching and WSS spectrum routing have become ubiquitous in undersea optical fiber transmission systems. However, the agile architectures of these systems must continuously be reconsidered as the capacity, fiber pair count, and branching node complexity of those systems continues to grow. The impact of C+L spectrum bands and Multiple Core Fiber on agile undersea systems will also be discussed. 2022 The Author(s).

Room 6F

M1G • Photonic Neuromorphic Computing—Continued

M1G.4 • 09:30 Invited

Photonic Neuromorphic Computing: Architectures, Technologies and Training Models, Miltiadis Moralis-Pegios[1], Angelina Totovic[1], Apostolos Tsakyridis[1], George Giamougiannis[1], George Mourgias-Alexandris[1], George Dabos[1], Nikolaos Passalis[1], Manos Kirtas[1], Anastasios Tefas[1], Nikos Pleros[1]; [1]*Aristoteleio Panepistimio Thessalonikis, Greece*. We summarize recent developments in neuromorphic photonics, including our work and the advances it brings beyond the state-of-the-art demonstrators in terms of architectures, technologies, and training models for a synergistic hardware/software codesign approach.

Room 7AB

M1H • Advanced Digital Signal Processing for Coherent System—Continued

M1H.5 • 09:30

Mitigation of Transmitter Impairment With 4×2 WL MIMO Equalizer Embedding Preliminary CPR, Masaki Sato[1], Manabu Arikawa[1], Hidemi Noguchi[1], Junichiro Matsui[1], Jun'ichi Abe[1], Emmanuel Le Taillandier de Gabory[1]; [1]*NEC Corporation, Japan*. Transmitter impairment mitigation for 58-GBaud PM-64QAM with 4×2 WL MIMO embedding preliminary CPR was demonstrated over 100 km SSMF. Q-penalties of 0.1 dB with 14 ps IQ skew and 10 degree phase error were achieved.

M1H.6 • 09:45

Real-Time in-Field Automatic Bias Control and Self-Calibration Module for High-Baud Coherent Driver Modulator, Hongyu Li[1], Yu Yang[1], YuanXiang Wang[1], Mengfan Cheng[1], Qi Yang[1], Ming Tang[1], Deming Liu[1], Lei Deng[1]; [1]*Huazhong Univ. of Science and Technology, China*. We report a real-time in-field low-cost module that can simultaneously realize self-calibration and automatic-bias-control for coherent driver modulators. Precise frequency-response (<0.5dB) and IQ skew (<0.2ps) correction are achieved in experiments of 25/20GBaud 16/64QAM signal transmissions.

Room 8

M1I • Optical Logic and Memory—Continued

M1I.6 • 09:30 Invited

Photonic Integrated Unitary Processor Based on Multi-Plane Light Conversion, Takuo Tanemura[1], Rui Tang[1], Ryota Tanomura[1], Yoshiaki Nakano[1]; [1]*The Univ. of Tokyo, Japan*. Recent progress of developing universal optical unitary processors (OUPs) based on the concept of multi-plane light conversion (MPLC) is reviewed. The inherent redundancy of MPLC provides unique scalability and excellent robustness against fabrication imperfectness, enabling large-scale OUPs integrated on silicon and InP platforms.

08:30–12:30 SC102, SC160, SC178, SC433 (ends at 11:30)**, SC448, SC453A, SC468, SC472, SC473, SC483, SC487**

09:00–12:00 SC261, SC341 (ends at 13:00)**, SC359, SC450, SC465, SC486**

10:00–10:30 Coffee Break

Room 1AB

10:30–12:30
M2A • Special Session: Reflections on the Pandemic Session II
Presider: Dimitra Simeonido; University of Bristol, UK

M2A.1 • 10:30 Invited
Capacity and Connectivity Impact of the Pandemic Seen by a Global Carrier, Mattias Fridstrom[1]; [1]*Telia Carrier, Sweden*. During the pandemic we saw an increase in traffic in a shorter period than ever before. How did we cope with this waterfall of traffic and what do we see going forward?

M2A.2 • 10:45 Invited
Was There a Noticable Impact in Traffic Capacity and Connectivity Due to the Pandemic? What is the Future Planning?, Junjie Li[1]; [1]*China Telecom, China*. Abstract not available.

Room 2

10:30–12:30
M2B • Symposia: Optical Satellite Communications Entering a New Era Session II
Presider: Scott Hamilton, MIT Lincoln Labs, USA

M2B.1 • 10:30 Invited
Title to be Announced, Wiegand Matthias[1]; [1]*Airbus Defence and Space, Germany*. Abstract not available.

Room 3

10:30–12:30
M2C • Long-haul Transmission
Presider: Oleg Sinkin; SubCom LLC, USA

M2C.1 • 10:30 Tutorial
The Next Decade of Optical Fibres: Outlook and Implications for Long-Haul Transmission Systems, Sergejs Makovejs[1]; [1]*Corning, UK*. We will review drivers behind innovation in long-haul and subsea optical fiber technology and potential paths in which these fibers could evolve. We will also discuss the ecosystem changes required for each future fiber pathway.

Sergejs Makovejs is a Senior Commercial Technology Associate at Corning with global strategic responsibility for development direction of long-haul and submarine fibers. He received a Ph.D. in Electrical Engineering from UCL and an Executive MBA from Warwick Business School. He has authored >50 peer-reviewed papers on optical fiber communications.

Room 6C

10:30–12:30
M2D • High-speed Electronics and Photonics
Presider: Sylvie Menezo; SCINTIL Photonics, France

M2D.1 • 10:30 ★ Top-Scored
A 106 Gb/s 2.5 v_{ppd} Linear Microring Modulator Driver With Integrated Photocurrent Sensor in 28nm CMOS, Hao Li[1], Meer Sakib[1], Duanni Huang[1], Ranjeet Kumar[1], Haisheng Rong[1], Ganesh Balamurugan[1], James Jaussi[1]; [1]*Intel Corporation, USA*. A low-power CMOS linear driver IC, optimized for microring modulator-based co-packaged optics, is presented. This 2.5 V_{ppd} driver, assembled with a photonic IC, achieves 2 dB TDECQ at 106 Gb/s PAM4 with 1.33 pJ/bit efficiency.

M2D.2 • 10:45
A Low-Power, 128-Gbit/s, DC-Coupled Linear Driver IC for Electro-Absorption Modulated DFB Laser, Taichi Misawa[1], Yoshiyuki Sugimoto[1], Keiji Tanaka[1]; [1]*Sumitomo Electric Industries, Ltd., Japan*. We demonstrate a 128-Gbit/s/l optical transmitter with newly developed DC-coupled linear driver IC for electro-absorption modulator. High-quality PAM-4 eye diagram with higher extinction ratio is obtained with low-power consumption, which is suitable for 100G-LR1/ER1 application.

Room 6D

10:30–12:30
M2E • Novel Applications of Passive Photonic Circuits
Presider: Ming Wu; Univ. of California Berkeley, USA

M2E.1 • 10:30 Invited
Integrated Optical Phased Arrays for Augmented Reality, LiDAR, and Beyond, Jelena Notaros[1]; [1]*Massachusetts Inst. of Technology, USA*. Recent integrated optical phased array architectures, results, and applications will be reviewed, including beam steering for LiDAR and communications, near-field optical manipulation, and holographic displays for augmented reality.

10:30–12:30 SpE2 • Integrated Photonics for Energy Efficient Data Centers and Computing: The ARPA-E ENLITENED Program *(Room 9)*

Room 6E

10:30–12:30
M2F • Sensing on Fiber-optic Networks
Presider: Tiejun Xia; Verizon Communications Inc, USA

M2F.1 • 10:30 Invited
Optical Network Sensing: Opportunities and Challenges, Mattia Cantono[1], Jorge C. Castellanos[1], Valey Kamalov[1], Shirshendu Bhattacharya1[1], Shuang Yin[1], Zhongwen Zhan[1], Antonio Mecozzi[2]; [1]*Google LLC, USA;* [2]*Universita degli studi de L'Aquila, Italy.* The scientific community is exploring complementary applications for optical fiber networks. We review recent developments in seismic sensing and discuss the challenge of telemetry pipelines to enable novel fundamental science and wider societal benefits.

Room 6F

10:30–12:30
M2G • Programmable and Intelligent Photonic Information Processors
Presider: Volker Sorger; George Washington Univ., USA and Thomas Van Vaerenbergh; Hewlett Packard Enterprise Company, Belgium

M2G.1 • 10:30 Tutorial
Self-Configuring Programmable Photonics for Processing, Communications and Sensing, David A. B. Miller[1]; [1]*Stanford Univ., USA.* Silicon photonics allows remarkably complex interferometric optical circuits. Novel algorithms and architectures, including self-configuring and self-stabilizing approaches, can control these, enabling new functions and applications, and a new class of programmable optical components and systems.

David Miller is an Electrical Engineering Professor at Stanford. He has a Google h-index > 100 for his published papers, patents and a quantum mechanics text. He received several awards, is a Fellow of six professional societies, and is a Member of the US National Academies of Sciences and Engineering.

Room 7AB

10:30–12:30
M2H • Advanced Digital Signal Processing for Direct Detection System
Presider: Jianqiang Li; Kuaishou Technology, USA

M2H.1 • 10:30
Partial Response O-Band EML Transmission Beyond 300-GBd With a 128/256 GSa/s DAC, Md Sabbir-Bin Hossain[1,2], Talha Rahman[1], Nebojša Stojanović[1], Fabio Pittalà[1], Stefano Calabrò[1], Georg Böcherer[1], Tom Wettlin[2], Jinlong Wei[1], Changsong Xie[1], Maxim Kuschnerov[1], Stephan Pachnicke[2]; [1]*Huawei Technologies Duesseldorf GmbH, Germany;* [2]*Chair of Communication, Kiel Univ., Germany.* We experimentally compared 128 and 256-GSa/s DACs using partial response signaling. Transmission of 310-GBd OOK is demonstrated with a single 128 GSa/s DAC for up to 5-km without optical amplification (net 268.84Gb/s, AIR ≈ 300Gb/s).

M2H.2 • 10:45
Real-Time Feedforward Clock Recovery for Optical Burst-Mode Transmission, Patrick Matalla[1], Md Salek Mahmud[1], Christoph Füllner[1], Wolfgang Freude[1], Christian Koos[1], Sebastian Randel[1]; [1]*Karlsruhe Inst. of Technology, IPQ, Germany.* We compare three feedforward non-data aided clock recovery algorithms suitable for burst-mode operation in PONs and datacenters. Our experimental setup allows real-time OOK transmission at 3Gbit/s. The tolerable clock frequency mismatch is 475ppm.

Room 8

10:30–12:30
M2I • Optical Signal Processing
Presider: Benjamin Puttnam; National Inst Info & Comm Tech (NICT), Japan

M2I.1 • 10:30 ★ Top-Scored
Slice-Less Optical Arbitrary Waveform Measurement (OAWM) in a Bandwidth of More Than 600 GHz, Daniel Drayß[1], Dengyang Fang[1], Christoph Füllner[1], Grigorii Likhachev[2], Thomas Henauer[1], Yung Chen[1], Huanfa Peng[1], Pablo Marin-Palomo[1], Thomas Zwick[1], Wolfgang Freude[1], Tobias J. Kippenberg[2], Sebastian Randel[1], Christian Koos[1]; [1]*Karlsruhe Inst. of Technology, Germany;* [2]*Swiss Federal Inst. of Technology Lausanne (EPFL), Switzerland.* We demonstrate an optical arbitrary waveform measurement technique that exploits optical frequency combs as local oscillators and that does not require any optical slicing filters. In a proof-of-concept experiment, we achieve record-high bandwidths exceeding 600GHz.

M2I.2 • 10:45 ★ Top-Scored
200 GBd 16QAM Signals Synthesized by an Actively Phase-Stabilized Optical Arbitrary Waveform Generator (OAWG), Thomas Henauer[1], Alban Sherifaj[1], Christoph Füllner[1], Wolfgang Freude[1], Sebastian Randel[1], Thomas Zwick[1], Christian Koos[1]; [1]*Karlsruhe Inst. of Technology (KIT), Germany.* We implement an optical arbitrary-waveform generator (OAWG) that relies on spectrally sliced signal synthesis with well-defined feedback-stabilized phase relations. We demonstrate the viability of the approach by generating high-quality 16QAM signals with record-high symbol rates of up to 200 GBd.

10:30–12:30 SpE2 • Integrated Photonics for Energy Efficient Data Centers and Computing: The ARPA-E ENLITENED Program *(Room 9)*

Room 1AB

M2A • Special Session: Reflections on the Pandemic Session II—Continued

M2A.3 • 11:00 Invited

Network Impact of the Pandemic in North America?, Kevin Smith[1]; [1]*Verizon, USA.* Abstract not available.

Room 2

M2B • Symposia: Optical Satellite Communications Entering a New Era Session II—Continued

M2B.2 • 10:30 Invited

Title to be Announced, Christian Fuchs[1]; [1]*German Aerospace Center (DLR), Germany.* Abstract not available.

Room 3

M2C • Long-haul Transmission—Continued

Room 6C

M2D • High-speed Electronics and Photonics—Continued

M2D.3 • 11:00

180 GBd Electronic-Plasmonic IC Transmitter, David Moor[1], Yuriy Fedoryshyn[1], Henning Langenhagen[2], Jens Müllrich[2], Rolf Schmid[2], Christopher Uhl[3], Michael Möller[2,3], Ueli Koch[1], Yannik Horst[1], Bertold I. Bitachon[1], Wolfgang Heni[1,4], Benedikt Baeuerle[1,4], Marcel Destraz[1,4], Huajun Xu[5], Delwin Elder[5,6], Lewis Johnson[5,6], Paraskevas Bakopoulos[7], Elad Mentovich[8], Lars Zimmermann[9], Juerg Leuthold[1,4]; [1]*ETH Zurich, Switzerland;* [2]*MICRAM Microelectronic GmbH, Germany;* [3]*Saarland Univ., Germany;* [4]*Polariton Technologies, Switzerland;* [5]*Department of Chemistry, Univ. of Washington, USA;* [6]*Nonlinear Materials Corporation, USA;* [7]*NVIDIA, Greece;* [8]*NVIDIA, Israel;* [9]*IHP, Germany.* A monolithically integrated plasmonic SiGe-BiCMOS electronic transmitter operating at 180 GBd is demonstrated. Such compact high-speed electronic-photonic integrated circuit (EPIC) transmitters are key components for future high-performance computing (HPC) and data center interconnects (DCI).

M2D.4 • 11:15

A 240 Gb/s PAM4 Silicon Micro-Ring Optical Modulator, MeerNazmus Sakib[1], Ranjeet Kumar[1], Chaoxuan Ma[1], Duanni Huang[1], Xinru Wu[1], Guan-Lin Su[1], Haisheng Rong[1]; [1]*Intel Corporation, USA.* We report a micro-ring modulator with 0.53 Vcm phase efficiency, 54 GHz bandwidth, and 16.3 nm FSR. We have achieved 224 and 240 Gb/s PAM4 eye diagrams with 1.6 dB and 3.9 dB TDECQ, respectively.

Room 6D

M2E • Novel Applications of Passive Photonic Circuits—Continued

M2E.2 • 11:00 ★ Top-Scored

Wide-Field-of-View Perovskite Quantum-Dots Fibers Array for Easing Pointing, Acquisition and Tracking in Underwater Wireless Optical Communication, Chun Hong Kang[1], Omar Alkhazragi[1], Lutfan Sinatra[2], Sultan Alshaibani[1], Yue Wang[1], Kuang-Hui Li[1], Meiwei Kong[1], Marat Lutfullin[2], Osman M. Bakr[1], Tien Khee Ng[1], Boon S. Ooi[1]; [1]*King Abdullah Univ. of Science and Technology (KAUST), Saudi Arabia;* [2]*Quantum Solutions, UK.* We demonstrated, for the first time, perovskite quantum-dots optical fibers array successfully eases the pointing, acquisition and tracking requirement facing visible-laser-based underwater wireless optical communication.

M2E.3 • 11:15

Light-Induced Thermomagnetic Recording of Ferromagnetic Thin-Film on Silicon Waveguide for Solid-State Magneto-Optical Memory, Toshiya Murai[1], Yuya Shoji[1], Tetsuya Mizumoto[1]; [1]*Tokyo Inst. of Technology, Japan.* We firstly demonstrate light-induced thermomagnetic recording of a ferromagnetic thin-film CoFeB placed on a silicon waveguide. The magnetization reversal is observed when light propagates in the waveguide and evanescently heats up the thin-film magnet.

Room 6E

M2F • Sensing on Fiber-optic Networks—Continued

M2F.2 • 11:00 ★ Top-Scored

Transoceanic Phase and Polarization Fiber Sensing Using Real-Time Coherent Transceiver, Mikael Mazur[1], Jorge C. Castellanos[2], Roland Ryf[1], Erik Borjeson[3], Tracy Chodkiewicz[4], Valey Kamalov[2], Shuang Yin[2], Nicolas Fontaine[1], Haoshuo Chen[1], Lauren Dallachiesa[1], Steve Corteselli[1], Philip Copping[4], Jurgen Gripp[4], Aurelien Mortelette[4], Benoit Kowalski[4], Rodney Dellinger[4], David T. Neilson[1], Per Larsson-Edefors[3]; [1]*Nokia Bell Labs, USA;* [2]*Google, USA;* [3]*Chalmers Univ. of Technology, Sweden;* [4]*Nokia, USA.* We implement a real-time coherent transceiver with fast streaming outputs for environmental sensing. Continuous sensing using phase and equalizer outputs over 12800 km of submarine cable enabled time resolved interferometry in broad spectral range of 10 mHz-1 kHz.

M2F.3 • 11:15

Vibration Detection and Localization in Buried Fiber Cable After 80km of SSMF Using Digital Coherent Sensing System With Co-Propagating 600Gb/s WDM Channels, Sterenn Guerrier[1,2], Kaoutar Benyahya[1], Christian Dorize[1], Elie Awwad[2], Haik Mardoyan[1], Jérémie Renaudier[1]; [1]*Nokia Bell Labs, France;* [2]*Télécom Paris, France.* We report detection-localization-identification of true mechanical events on a buried fiber cable up to 82km SSMF using a digital sensing system copropagating with adjacent 600Gb/s WDM channels. Non-intrusive coexistence with WDM channels is demonstrated.

Room 6F

M2G • Programmable and Intelligent Photonic Information Processors—Continued

Room 7AB

M2H • Advanced Digital Signal Processing for Direct Detection System—Continued

M2H.3 • 11:00

Single-Span IM/DD Transmission Over 120-km SMF With a Silicon Photonic Mach-Zehnder Modulator and THP, Jingchi Li[1], Zhen Wang[1], Xingfeng Li[1], Yikai Su[1]; [1]*Shanghai Jiao Tong Univ., China.* We experimentally demonstrate up to 120-km dispersion-uncompensated transmission in a SiP MZM-based IM/DD system. 28/42-Gbaud DSB PAM4 signal is transmitted over 80/120-km SMF enabled by Tomlinson-Harashima precoding and receiver-side linear equalization.

M2H.4 • 11:15

Simplified TC-MLSE Equalizer for 210-Gb/s PAM-8 Signal Transmission in IM/DD Systems, Jiahao Zhou[1], Jing Zhang[1], Xue Zhao[1], Wenshan Jiang[1], Shaohua Hu[1], Mingyue Zhu[1], Kun Qiu[1]; [1]*Univ of Electronic Science & Tech China, China.* We propose and experimentally demonstrate a trellis-compression MLSE in a 210-Gb/s PAM-8 signal transmission over 2-km SSFM transmission. We find TC-MLSE can reduce the complexity by 98% with only 0.2-dB penalty compared with conventional MLSE.

Room 8

M2I • Optical Signal Processing—Continued

M2I.3 • 11:00 Invited

Frequency-Time-Division-Multiplexed Single-Pixel Imaging for Biomedical Applications, Hideharu Mikami[1]; [1]*Hokkaido Univ., Japan.* We demonstrate high-speed single-pixel imaging by integrating frequency-division multiplexing and time-division multiplexing and applying the combined technique, namely frequency-time-division multiplexing (FTDM), to optical imaging. We employ the technique to obtain fluorescence images from biological cells.

Room 1AB

M2A • Special Session: Reflections on the Pandemic Session II—Continued

Room 2

M2B • Symposia: Optical Satellite Communications Entering a New Era Session II—Continued

M2B.3 • 10:30 Invited

Comparing LEO Mega-Networks : Assessing Relative Performance and Challenges, Bruce G. Cameron[1], Nils Pachler[1]; [1]*MIT, USA.* The four major LEO Mega-Networks (SpaceX, OneWeb, Amazon, Telecast) has proposed thousands of satellites, but their network performance is yet to be demonstrated. We review an apple-to-apples comparison of the four for total throughput.

Room 3

M2C • Long-haul Transmission—Continued

M2C.2 • 11:30

Analysis of Impact of Polarization Dependent Loss in Point to Multi-Point Subsea Communication Systems, Kaoutar Benyahya[1], Christian Simonneau[2], Amirhossein Ghazisaeidi[1], Philippe Plantady[2], Alexis Carbo Meseguer[2], Alain Calsat[2], Haik Mardoyan[1], Vincent Letellier[2], Jérémie Renaudier[1]; [1]*Nokia Bell Labs, France;* [2]*Alcatel Submarine Networks, France.* We report on numerical investigation of the impact of polarization dependent loss generated by the wavelength selective switches as well as the amplifiers in a point to multi-point subsea- systems. We show that penalties due to R-OADM do not exceed 0.5dB when WSS PDL's is below 0.33dB for 15 in-line WSS.

M2C.3 • 11:45 Invited

Capacity Maximization of Power-Constrained Submarine Systems, Alberto Bononi[1], Juliana Tiburcio de Araujo[1], Chiara Lasagni[1], Paolo Serena[1], Jean-Christophe Antona[2]; [1]*Universita degli Studi di Parma, Italy;* [2]*Alcatel Submarine Networks, France.* We review a novel semi-analytical approach to the achievable information rate maximization of submarine links with gain-shaped EDFAs, and provide the optimal pre-emphasis in presence of both amplified noise and fiber nonlinearity.

Room 6C

M2D • High-speed Electronics and Photonics—Continued

M2D.5 • 11:30

High Performance Thin-Film Lithium Niobate MZ Modulator Ready for Massive Production, Heng Li[1], Quanan Chen[2], Ye Liu[1], Yongqian Tang[1], Qiaoyin Lu[1], Mingzhi Lu[2], Weihua Guo[1]; [1]*Huazhong Univ. of Science and Technology, China;* [2]*Ningbo Ori-chip Optoelectronics Technology LTD, China.* Through photolithography we fabricated high-performance thin-film lithium niobate modulators on full 4-inch wafers with low $V_{\pi}L$, wide bandwidth and low insertion loss. The waveguide loss is one of the lowest among similar work.

M2D.6 • 11:45

Ultra Compact Athermal 400G-FR4 Silicon Photonics Receiver With Polarization Diversity, Atsunobu Ohta[1], Dogan Atlas[2], Erman Timurdogan[2], Skylar Deckoff-Jones[2], Mike R Watts[2], Michihiro Komoto[1], Hironori Honda[1], Naoto Yoshimoto[3]; [1]*Kyosemi, Japan;* [2]*Analog Photonics, USA;* [3]*Chitose Inst. of Science and Technology, Japan.* We have successfully demonstrated an ultra-compact WDM 400G-FR4 ROSA module integrated with silicon photonics circuits operating at 53.125Gbaud PAM4 signal with a sensitivity of -6.0dBm optical modulation amplitude at KP4 Pre-FEC-BER=2.4e-4.

Room 6D

M2E • Novel Applications of Passive Photonic Circuits—Continued

M2E.4 • 11:30

Photonic Tensor Core With Photonic Compute-in-Memory, Xiaoxuan Ma[1], Jiawei Meng[1], Nicola Peserico[1], Mario Miscuglio[1], Yifei Zhang[2], Juejun Hu[2], Volker J. Sorger[1]; [1]*The George Washington Univ., USA;* [2]*Massachusetts Inst. of Technology, USA.* Here we demonstrate a photonic tensor core based on a silicon photonics dot-product engine. Utilizing compact electronic phase-change-material based photonic memory and WDM we show the highest throughput density to date of 3.8 MAC/s/mm2.

M2E.5 • 11:45

Comparison of Al_2O_3 and HfO_2 MOSCAP III-v/Si Power Splitters and (De-) Interleavers for DWDM Optical Links, Stanley Cheung[1], Geza Kurczveil[1], Yingtao Hu[1], Yuan Yuan[1], Bassem Tousson[1], Yiwei Peng[1], Mingye Fu[1], Di Liang[1], Ray Beausoleil[1]; [1]*Hewlett Packard Labs, USA.* We compare III-V/Si MZIs and (de-)interleavers using Al_2O_3- and HfO_2-based MOSCAP structures as phase tuners. HfO_2 twice as thick as Al_2O_3 exhibited lower $V_{\pi}L$. We demonstrate crosstalk improvement of ring-assisted (de-) interleavers with both structures.

Room 6E

M2F • Sensing on Fiber-optic Networks—Continued

M2F.4 • 11:30
Microwave Frequency Dissemination Systems as Sensitive and Low-Cost Interferometers for Earthquake Detection on Commercially Deployed Fiber Cables, Adonis Bogris[1], Christos Simos[2], Iraklis Simos[1], Thomas Nikas[3], Nikos Melis[4], Konstantinos Lentas[4], Charis Mesaritakis[5], Ioannis Chochliouros[6], Christina Lessi[6]; [1]*Univ. of West Attica, Greece;* [2]*Univ. of Thessaly, Greece;* [3]*Univ. of Athens, Greece;* [4]*National Observatory of Athens, Inst. of Geodynamics, Greece;* [5]*Univ. of the Aegean, Greece;* [6]*Hellenic Telecommunications Organization, Greece*. We experimentally demonstrate a microwave frequency dissemination system operating as a sensitive interferometric sensor of seismic waves on commercially deployed fiber networks in Attika, Greece. Efficient detection of seismic waves from distant epicenters (>400km) is presented.

M2F.5 • 11:45
Perimeter Intrusion Detection With Backscattering Enhanced Fiber Using Telecom Cables as Sensing Backhaul, Glenn Wellbrock[1], Tiejun J. Xia[1], Ming-Fang Huang[2], Jian Fang[2], Yuheng Chen[2], Chaitanya Narisetty[2], Daniel Peterson[3], James Moore[4], Annabelle Scarpaci[3], Paul Westbrook[3], Jie Li[3], Robert Lingle[3], Ting Wang[2], Yoshiaki Aono[5]; [1]*Verizon, USA;* [2]*NEC Labs America, USA;* [3]*OFS, USA;* [4]*Verizon, USA;* [5]*NEC Corporation, Japan*. We report field test results of facility perimeter intrusion detection with distributed-fiber-sensing technology and backscattering-enhanced-fiber by using deployed telecom fiber cables as sensing backhaul. Various intrusive activities, such as walking/jumping at >100ft distance, are detected.

Room 6F

M2G • Programmable and Intelligent Photonic Information Processors—Continued

M2G.2 • 11:30
Digital-Analog Co-Design for Precision Compressed Integrated Photonic Convolution Neural Network, Jiang Yue[1], Wenjia Zhang[1], Zuyuan He[1]; [1]*State Key Laboratory of Advanced Optical Communication Systems and Networks, Shanghai Jiao Tong Univ., China*. Digital-Analog Co-design for photonic CNN with compressed precision is proposed to answer 3 practical concerns about analog precision: measurement and its mapping to digital domain, minimum demand of physical layer conditions and cheap methods to improve the performance of photonic CNN with poor precision.

M2G.3 • 11:45
CHAMP: Coherent Hardware-Aware Magnitude Pruning of Integrated Photonic Neural Networks, Sanmitra Banerjee[1], Mahdi Nikdast[2], Sudeep Pasricha[2], Krishnendu Chakrabarty[1]; [1]*Electrical and Computer Engineering, Duke Univ., USA;* [2]*Electrical and Computer Engineering, Colorado State Univ., USA*. We propose a novel hardware-aware magnitude pruning technique for coherent photonic neural networks. The proposed technique can prune 99.45% of network parameters and reduce the static power consumption by 98.23% with a negligible accuracy loss.

Room 7AB

M2H • Advanced Digital Signal Processing for Direct Detection System—Continued

M2H.5 • 11:30
112-Gb/s PAM-4 IM/DD Optical Transmission Over 100-km Single Mode Fiber With Linear Equalizer, Shaohua Hu[1], Jing Zhang[1], Jianming Tang[2], Qun Liu[1], Wei Jin[2], Zhuqiang Zhong[2], Roger Giddings[2], Jiahao Zhou[1], Taowei Jin[1], Xue Zhao[1], Bo Xu[1], Xiang Gao[3], Kun Qiu[1]; [1]*Univ of Electronic Science & Tech China, China;* [2]*Bangor Univ., UK;* [3]*Southwest China Inst. of Electronic Technology, China*. We propose a hybrid linearization algorithm combining the multi-constraint iteration and linear equalization. We experimentally demonstrate a 112-Gb/s PAM-4 signal transmission over 100-km SSMF in IM/DD optical transmission system with one single-ended photodiode.

M2H.6 • 11:45
Low-Complexity and Non-Iterative SSBI Decomposition and Cancellation Algorithm for SSB Direct Detection System, Qi Wu[1], Yixiao Zhu[1], Weisheng Hu[1]; [1]*Shanghai Jiao Tong Univ., China*. We propose a low-complexity and non-iterative SSBI cancellation algorithm operating at the Nyquist sampling rate employing SSBI decomposition followed by sqrt operation, and experimentally validate it in a 58GBaud 16-QAM transmission system with 80km reach.

Room 8

M2I • Optical Signal Processing—Continued

M2I.4 • 11:30
Propagation Symmetry Enhanced Distortion Compensation by Optical Phase Conjugation via Step-Profiling Fiber Links, Mark D. Pelusi[1], Ryosuke Matsumoto[1], Takashi Inoue[1], Shu Namiki[1]; [1]*National Inst. of Advanced Industrial Science and Technology (AIST), Japan*. Fiber-spans tailored with stepwise-approximate decreasing-dispersion and increasing-nonlinearity parameters demonstrate enhanced compensation of nonlinear signal distortion by optical phase conjugation. WDM-QAM signal simulations and experiment show gaining >1.2dB Q^2-factor and 5~6dB power tolerance over non-profiled links.

M2I.5 • 11:45
64-Channel WDM Transmitter Based on Optical Fourier Transformation Using a Portable Time Lens Assembly, Mads Lillieholm[1], Michael Galili[1], Leif K. Oxenløwe[1], Pengyu Guan[1]; [1]*Technical Univ. of Denmark, Denmark*. We demonstrate 64-WDM-channel generation with 25-GHz spacing from a single SFP+ transceiver using a portable time lens optical processor. After transmission in a 50-km unamplified link,-39.1 dBm average received power sensitivity at BER=10^{-3} is measured.

Room 1AB	Room 2	Room 3	Room 6C	Room 6D
M2A • Special Session: Reflections on the Pandemic Session II—Continued	**M2B • Symposia: Optical Satellite Communications Entering a New Era Session II—Continued**	**M2C • Long-haul Transmission—Continued**	**M2D • High-speed Electronics and Photonics—Continued**	**M2E • Novel Applications of Passive Photonic Circuits—Continued**

M2D.7 • 12:00
800Gbps Fully Integrated Silicon Photonics Transmitter for Data Center Applications, Haijiang Yu[1], David Patel[1], Wei Liu[1], Yann Malinge[1], Pierre Doussiere[1], Wenhua Lin[1], Sanjeev Gupta[1], Karthik Narayanan[1], Isako Hoshino[1], Michael Bresnehan[1], Sravan Kumar Sunkoju[1], Davide Mantegazza[1], Robert Herrick[1], Ranju Venables[1], Hari Mahalingam[1], Pegah Seddighian[1], Avi Fuerst[1], Jordan Davis[1], David Gold[1], Xing Pan[1], Kadhair Al-hemyari[1], Ankur Agrawal[1], Yi Li[1], Xueyan Zheng[1], Mala Geethachar[1], Michael Favaro[1], Daniel Zhu[1], Ansheng Liu[1], Yuliya Akulova[1]; *[1]Intel, USA.* A 800Gbps PAM-4 fully integrated 2xFR4/DR8 silicon photonics transmitter with eight heterogeneously integrated DFB lasers has been demonstrated for data center applications over a temperature range of 0~70°C and a reach of up to 2km.

M2C.4 • 12:15
Hollow-Core Fiber Capacities With Receiver Noise Limitations, Werner Klaus[1], Peter Winzer[2]; *[1]National Inst of Information & Comm Tech, Japan; [2]Nubis Communications, USA.* Hollow-core fiber promises low loss and low nonlinearity over wide operational bandwidths. However, considering realistic transponder noise floors reveals much lower capacity gains over standard single-mode fiber than generally assumed, even for optimistic fiber designs.

M2D.8 • 12:15
Low-Loss Wafer-Bonded Silicon Photonic MEMS Switches, Amirmahdi Honardoost[1], Johannes Henriksson[1], Kyungmok Kwon[1], Jianheng Luo[1], Ming C. Wu[1]; *[1]Univ. of California, Berkeley, USA.* We report on 32x32 silicon photonic switches realized through wafer bonding. Broadband operation is demonstrated over 1260-1320 nm range. The maximum on-chip loss is measured to be 4 dB and the cross-talk is -80 dB.

12:30–14:00 Lunch Break *(on own)*

12:45–13:45 SpE3 • Optica Technical Group on Fiber Optics Technology and Applications Panel Discussion: Are Broadband Amplifiers Useful for Data Center Communication? *(Room 9)*

13:30–16:30 SC114, SC205, SC217, SC408, SC429, SC447, SC459, SC464

13:30–17:30 SC325, SC327, SC347, SC357, SC393, SC431, SC451, SC453B, SC454

Room 6E

M2F • Sensing on Fiber-optic Networks—Continued

M2F.6 • 12:00 Invited

Advanced Fiber Sensing Leveraging Coherent Systems Technology for Smart Network Monitoring, Christian Dorize[1], Sterenn Guerrier[1], Elie Awwad[2], Kaoutar Benyahya[1], Haik Mardoyan[1], Jérémie Renaudier[1]; [1]*Nokia Bell Labs France, France;* [2]*Telecom-Paris, France*. We show that coherent technology developed in the past decade for transmission over core optical networks can benefit to Distributed Fiber Sensing technology in various fields as sensitivity, sensing range, and coexistence with data traffic.

Room 6F

M2G • Programmable and Intelligent Photonic Information Processors—Continued

M2G.4 • 12:00

Solving Vertex Cover Problem Using Quadrature Photonic Spatial Ising Machine, Wenchen Sun[1], Wenjia Zhang[1], Zuyuan He[1]; [1]*Shanghai Jiao Tong Univ., China*. In this paper, we solve the 1600-vertex cover problem by a novel quadrature photonic spatial Ising machine. Our work suggests flexible combinational optimization problem solving for Ising models with external magnetic field.

M2G.5 • 12:15

Comparison of Models for Training Optical Matrix Multipliers in Neuromorphic PICs, Ali Cem[1], Siqi Yan[1,2], Uiara Celine de Moura[1], Yunhong Ding[1], Darko Zibar[1], Francesco Da Ros[1]; [1]*DTU Fotonik, Technical Univ. of Denmark, Denmark;* [2]*School of Optical & Electrical Information, Huazhong Univ. of Science and Technology, China*. We experimentally compare simple physics-based vs. data-driven neural-network-based models for offline training of programmable photonic chips using Mach-Zehnder interferometer meshes. The neural-network model outperforms physics-based models for a chip with thermal crosstalk, yielding increased testing accuracy.

Room 7AB

M2H • Advanced Digital Signal Processing for Direct Detection System—Continued

Room 8

M2I • Optical Signal Processing—Continued

M2I.6 • 12:00

Simultaneously Calibration of Tx/Rx Frequency Response and IQ Skew for Coherent Optical Transceiver, Longquan Dai[1], Hongyu Li[1], Mengfan Cheng[1], Qi Yang[1], Ming Tang[1], Deming Liu[1], Lei Deng[1]; [1]*Huazhong Univ of Science and Technology, China*. We report a calibration method that can simultaneously characterize frequency-response and IQ-skew of coherent optical transceivers with laser frequency offset and phase noise. 50/40GBaud Nyquist-16/64QAM signals transmission is achieved using 22GHz commercial coherent optical transceiver.

12:30–14:00 Lunch Break *(on own)*

12:45–13:45 SpE3 • Optica Technical Group on Fiber Optics Technology and Applications Panel Discussion: Are Broadband Amplifiers Useful for Data Center Communication? *(Room 9)*

13:30–16:30 SC114, SC205, SC217, SC408, SC429, SC447, SC459, SC464

13:30–17:30 SC325, SC327, SC347, SC357, SC393, SC431, SC451, SC453B, SC454

Room 1AB

14:00–16:00
M3A • Symposia: Multi-access Network Leveraging Edge Computing for Energy-efficient, Ultra-reliable, and Low Latency Services Session I
Presider: Anna Tzanakaki, University of Athens, Greece

M3A.1 • 14:00 Invited
The Pandemic and 5G: the Lasting Impact on Optical Networks and Edge Computing, Theodore Sizer[1]; [†]*Nokia Bell Labs, USA*. Abstract not available.

M3A.2 • 14:30 Invited
Evolution of Network Edge Leveraging Disaggregated Architecture for Supporting Multi-Access Network, Clara Qian Li[1]; [†]*Intel Corporation, USA*. Abstract not available.

Room 2

14:00–16:00
M3B • Panel: Programmable Photonic Chips for Artificial Intelligence, Computing and Optical Networks

As integrated photonics technology enables increasingly large-scale photonic circuits, a new generation of photonic chips that can be programmed for a wide variety of functions is being developed. Such "programmable photonic circuits" have strong potential in key areas such as artificial intelligence, quantum computing, and optical networks. However, many open questions remain at each layer in the technology stack:

- What are the key photonic building blocks of such circuits? What are the best circuit architectures? At what level should components be provided vs. synthesized?
- Which foundry technologies are best suited to developing these chips? What device performance metrics need to be achieved? How should specialty devices be included?
- What electrical control is needed? How can it best be integrated into the chip? What programming strategies should be employed?
- What interfaces should be provided for the programmer? How will these chips be packaged to interact with the rest of the system?
- Which applications can most benefit and how? When does a programmable chip make more sense than an application specific circuit? When do we expect such chips to be in wide-spread use?

This panel aims to address these important questions related to the technological barriers, current performance, and potential applications of programmable photonic chips.

Speakers:

Keren Bergman, *Columbia University, USA*

Wim Bogaerts, *Ghent University, Begium*

Jose Capmany, *IPronics, Spain*

Joyce Poon, *Max Planck Institute, Germany*

Room 3

14:00–16:00
M3C • Towards THz Communications

M3C.1 • 14:00 Invited
Resonant Structures and Metasurfaces for Local Field Enhancement and Beam Steering, Jaime G. Rivas[1]; [†]*Technische Universiteit Eindhoven, Netherlands*. We present active control of resonant plasmonic structures. Beam steering and resonance control in structures relevant for wireless communication are demonstrated. This demonstration is done at THz and optical frequencies using photoexcited semiconductors and liquid crystals.

M3C.2 • 14:30 ★ Top-Scored
Demonstration of Real-Time 125.516 Gbit/s Transparent Fiber-THz-Fiber Link Transmission at 360 GHz ~ 430 GHz Based on Photonic Down-Conversion, Jiao Zhang[1,2], Min Zhu[1,2], Mingzheng Lei[2], Bingchang Hua[2], Yuancheng Cai[1,2], Yucong Zou[2], Liang Tian[2], Aijie Li[2], Yongming Huang[1,2], Jianjun Yu[2,3], Xiaohu You[1,2]; [†]*National Mobile Communications Research Laboratory, Southeast Univ., China; [2]Purple Mountain Laboratories, China; [3]Fudan Univ., China*. The first real-time transparent fiber-THz-fiber 2 × 2 MIMO transmission system with a record line rate of 125.516 Gbit/s and net data rate of 103.125 Gbit/s is demonstrated at 360 GHz-430GHz based on photonic down-conversion.

Room 6C

14:00–16:00
M3D • High-speed Semiconductor Lasers
Presider: Gloria Hoefler; Infinera Corporation, USA

M3D.1 • 14:00 Tutorial
Directly Modulated Lasers in a 3.2 Tb Era, Yasuhiro Matsui[1]; [†]*II-VI Inc., USA*. Recent progress in high-speed directly modulated lasers (DMLs) will be reviewed with a focus on device physics, including a chirp reduction, dispersion tolerance, and isolator-free operations. Applications to future 3.2 Tb systems will be discussed.

Yasuhiro Matsui joined Oki Electric in 1988, then received his Ph.D. from Tokyo University in 2000. He joined CoreTek (later Nortel Networks) in 2000. He co-founded AZNA in 2002 (later acquired by Finisar, then II-VI). He has authored or co-authored around 150 papers, in the area of InP-based high-speed devices.

Room 6D

14:00–16:00
M3E • Component Optimization
Presider: Cheryl Sorace-Agaskar; MIT Lincoln Laboratory, USA

M3E.1 • 14:00 Tutorial
Optimized Photonics, Jelena Vuckovic[1]; [†]*Stanford Univ., USA*. Abstract not available. Biography not available.

Room 6E

14:00–16:00
M3F • Machine Learning for Network Operation

M3F.1 • 14:00
On the Robustness of a ML-Based Method for QoT Tool Parameter Refinement in Partially Loaded Networks, Nathalie Morette[1], Ivan Fernandez de Jauregui Ruiz[1], Hartmut Hafermann[1], Yvan Pointurier[1]; [1]*Huawei, France.* The robustness of a ML-based QoT input parameters refinement technique in partially loaded networks (both static and dynamic) is assessed using experimental data. SNR prediction error is reduced by up to 1dB over >40000 services.

M3F.2 • 14:15
Addressing Traffic Prediction Uncertainty in Multi-Period Planning Optical Networks, Tania Panayiotou[1], Georgios Ellinas[1]; [1]*Department of Electrical and Computer Engineering and the KIOS Research and Innovation Center of Excellence, Univ. of Cyprus, Cyprus.* Deep-quantile regression is leveraged to capture traffic prediction uncertainty over future network planning intervals. We show that quantile predictions, acting as discriminative margins, result to significant spectrum savings compared to empirically estimated myopic margins considered.

M3F.3 • 14:30 Invited
Intelligent Use of Machine Learning for QoT Estimation, Yvan Pointurier[1]; [1]*Huawei, France.* In this invited talk, we will review the latest developments on how machine can be used to make Quality of Transmission (QoT) more accurate, with a focus on lowering margins in transport optical networks.

Room 6F

14:00–16:00
M3G • Next-gen High-speed PON I: Advanced DSP
Presider: Mu Xu; CableLabs, USA

M3G.1 • 14:00 Invited
DSP Enabled Next Generation Flexible PON for 50G and Beyond, Borui Li[1], Derek Nesset[1], Dekun Liu[1], Zhicheng Ye[1], Liangchuan Li[1]; [1]*Huawei Technologies Co Ltd, China.* In fiber access, DSP is used for the first time in the ITU-T 50G-PON. Here, we review the benefits of DSP in enabling more flexible PON systems today with 50G-PON and into the future.

M3G.2 • 14:30
Real-Time 58,2Gb/s Equalization-Free NRZ Mode Burst Transmission for Upstream HS-PON and Beyond With Monolithically Integrated SOA-UTC Receiver, Gael Simon[1], Jérémy Potet[1,2], Fabienne Saliou[1], Philippe Chanclou[1], Fabrice Blache[3], Philippe Charbonnier[3], Bernadette Duval[3], Christophe Caillaud[3], Franck Mallecot[3]; [1]*Orange, France;* [2]*Université Rennes 1, France;* [3]*III-V Lab, France.* We demonstrate the capacity of a monolithically integrated SOA-UTC photodiode to meet the HS-PON upstream burst mode sensitivity requirements at 50Gb/s (-26.5dBm and 20km achieved), and record error free performances at 58,2Gb/s.

Room 7AB

14:00–16:00
M3H • Ultra-high Baud Rate Systems
Presider: Di Che; Nokia Bell Labs, USA

M3H.1 • 14:00 ★ Top-Scored
High Information Rate of 128-GBaud 1.8-Tb/s and 64-GBaud 1.03-Tb/s Signal Generation and Detection Using Frequency-Domain 8×2 MIMO Equalization, Masanori Nakamura[1], Takayuki Kobayashi[1], Fukutaro Hamaoka[1], Yutaka Miyamoto[1]; [1]*NTT Network Innovation Laboratories, Japan.* We demonstrate 1-Tb/s and 1.8-Tb/s net rate signals with 16- and 14-bit/4Dsymbol information rates at 64 and 128 GBaud by precisely equalizing transmitter- and receiver-side imperfections with frequency-domain 8×2 MIMO linear equalization and nonlinear pre-distortion.

M3H.2 • 14:15 ★ Top-Scored
Experimental Investigation of Influence of SOA-Induced Nonlinear Distortion on High-Symbol-Rate 168-GBaud Signal for Achieving Ultra-Broadband Optical Frontend, Fukutaro Hamaoka[1], Masanori Nakamura[1], Takayuki Kobayashi[1], Munehiko Nagatani[1,2], Hitoshi Wakita[2], Hiroshi Yamazaki[1,2], Yoshihiro Ogiso[2,3], Yutaka Miyamoto[1]; [1]*NTT Network Innovation Laboratories, Japan;* [2]*NTT Device Technology Laboratories, Japan;* [3]*NTT Device Innovation Center, Japan.* We propose a transmitter configuration using an ultra-broadband optical frontend integrated with a bandwidth multiplexer and SOA. Experiments demonstrate the SOA-induced nonlinear distortion slightly affects (<1-dB SNR degradation) the 1-Tb/s 168-GBaud signal using AMUX-integrated frontend.

M3H.3 • 14:30
Demonstration of 120-GBaud 16-QAM Driver-Less Coherent Transmitter With 80-km SSMF Transmission, Xi Chen[1], Prashanta Kharel[2], Greg Raybon[1], Di Che[1], Mian Zhang[2]; [1]*Nokia Bell Labs, USA;* [2]*HyperLight, USA.* We demonstrated a driver-less coherent optical transmitter enabled by a low-V_π high-bandwidth thin-film $LiNbO_3$ I/Q modulator. We successfully transmitted a 120-Baud 16-QAM signal with net data rate of 836.2 Gb/s over 80-km SSMF.

Room 8

14:00–16:00
M3I • Quantum and Neural Networks

M3I.1 • 14:00 Invited
Photonic Neural Networks, Maxim Karpov[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland.* Abstract not available.

M3I.2 • 14:30
Self-Tuning Quantum Key Distribution Transmitter Based on a Genetic Algorithm, Yuen San Lo[2,1], Robert Woodward[1], Thomas Roger[1], Victor Lovic[1,3], Zhiliang Yuan[1], Andrew J. Shields[1]; [1]*Toshiba Europe Ltd, UK;* [2]*Quantum Science & Technology Inst., Univ. College London, UK;* [3]*Imperial College London, UK.* We demonstrate a self-tuning QKD transmitter by employing a genetic algorithm for automated optimisation. Without user intervention, laser parameters are determined automatically to minimise quantum bit error rates to similar levels achieved by QKD specialists.

Room 1AB

M3A • Symposia: Multi-access Network Leveraging Edge Computing for Energy-efficient, Ultra-reliable, and Low Latency Services Session I—Continued

M3A.3 • 15:00 Invited

AI Techniques for Automation and Optimization to Increase User Experience, Achim Autenrieth[1]; [1]*ADVA Optical Networking AG, Germany.* Abstract not available.

Room 2

M3B • Panel: Programmable Photonic Chips for Artificial Intelligence, Computing and Optical Networks—Continued

Room 3

M3C • Towards THz Communications—Continued

M3C.3 • 14:45

104-m Terahertz-Wave Wireless Transmission Employing 124.8-Gbit/s PS-256QAM Signal, Junjie Ding[1], Weiping Li[1], Yanyi Wang[1], Jiao Zhang[2,3], Feng Wang[1], Chen Wang[1], Jiaxuan Liu[1], Kaihui Wang[1], Li Zhao[1], Cuiwei Liu[1], Miao Kong[1], Wen Zhou[1], Min Zhu[2,3], Jianguo Yu[4], Feng Zhao[5], Jianjun Yu[1]; [1]*Fudan Univ., China;* [2]*Purple Mountain Laboratories, China;* [3]*Southeast Univ., China;* [4]*Beijing Univ. of Posts and Telecommunications, China;* [5]*Xi'an Univ. of Posts and Telecommunications, China.* We experimentally demonstrate 16-GBaud PS-256QAM signal transmission over 104-m wireless distance at 339 GHz in a photonics-aided THz-wave communication system, achieving a record single line rate of 124.8 Gbit/s and net SE of 6.2 bit/s/Hz.

M3C.4 • 15:00

Implementation of Digital Chaotic Encryption in THz Wireless Communication, Feng Wang[1], Bowen Zhu[1], Cuiwei Liu[1], Kaihui Wang[1], Junjie Ding[1], Junting Shi[1], Chen Wang[1], Li Zhao[1], Miao Kong[1], Yanyi Wang[1], Wen Zhou[1], Min Zhu[3], Jianguo Yu[2], Feng Zhao[4], Jianjun Yu[1]; [1]*Fudan Univ., China;* [2]*Beijing Univ. of Posts and Telecommunications, China;* [3]*Purple Mountain Laboratories and National Mobile Communications Research Laboratory, Southeast Univ., China;* [4]*School of Electronic Engineering, Xi'an Univ. of Posts and Telecommunications, China.* We implement a digital chaos-based encryption scheme in a photonics-aided terahertz radio-over-fiber (ROF) system operating at 340 GHz. The encrypted PS-64QAM-OFDM signal is successfully transmitted over 20 km SSMF and 54 m wireless link.

Room 6C

M3D • High-speed Semiconductor Lasers—Continued

M3D.2 • 15:00 ★ Top-Scored

Over-67-GHz-Bandwidth Membrane InGaAlAs EADFB Laser on Si Platform, Tatsurou Hiraki[1], Takuma Aihara[1], Yoshiho Maeda[1], Takuro Fujii[1], Tomonari Sato[1], Tai Tsuchizawa[1], Kiyoto Takahata[2], Takaaki Kakitsuka[2], Shinji Matsuo[1]; [1]*NTT Device Technology Labs, NTT Corporation, Japan;* [2]*Graduate School of Information, Production and Systems, Waseda Univ., Japan.* A membrane InGaAlAs electro-absorption modulator with an over 67-GHz bandwidth is integrated with a DFB laser on a Si platform. The integrated device shows a dynamic extinction ratio of 3.8 dB for 100-Gbit/s non-return-to-zero signals.

Room 6D

M3E • Component Optimization—Continued

M3E.2 • 15:00

Automatic Waveguide Balancing Using Point Set Operations, Won Lee[1]; [1]*Globalfoundries, USA.* An algorithm based on point set operations is developed to solve the waveguide length-balancing problem in silicon photonics layout. The method is applicable to complex photonic circuits incorporating multiple waveguide levels (e.g. Si and SiN).

Room 6E

M3F • Machine Learning for Network Operation—Continued

M3F.4 • 15:00 ★ Top-Scored

ADMIRE: Demonstration of Collaborative Data-Driven and Model-Driven Intelligent Routing Engine for IP/Optical Cross-Layer Optimization in X-Haul Networks, Zhuo Chen[1], Jiawei Zhang[1], Bojun Zhang[1], Ruikun Wang[1], Huangxu Ma[1], Yuefeng Ji[1]; [1]*Beijing Univ of Posts & Telecom, China*. We first demonstrate a collaborative data-driven (using deep reinforcement learning) and model-driven (using experience knowledge) routing engine for cross-layer optimization in a real X-Haul testbed with a real dataset, which achieves 23% wavelength saving.

Room 6F

M3G • Next-gen High-speed PON I: Advanced DSP—Continued

M3G.3 • 14:45

50Gb/s Real-Time Transmissions With Upstream Burst-Mode for 50G-PON Using a Common SOA Pre-Amplifier/Booster at the OLT, Gael Simon[1], Fabienne Saliou[1], Jérémy Potet[1], Philippe Chanclou[1], Ricardo Rosales[2], Ivan N. Cano[2], Derek Nesset[2]; [1]*Orange, France;* [2]*Huawei Technologies, France*. We perform real-time 50Gb/s transmission targeting the HS-PON standard. An SOA shared at OLT enables 30dB optical budget and 50km upstream burst-mode transmission. The SOA's XGM impact from upstream to downstream is studied.

M3G.4 • 15:00 Invited

Architectures and Key DSP Techniques of Next Generation Passive Optical Network (PON), Fan Li[1], Zhibin Luo[1], Mingzhu Yin[1], Xiaowu Wang[1], Zhaohui Li[1,2]; [1]*Guangdong Provincial Key Laboratory of Optoelectronic Information Processing Chips and Systems, School of Electronics and Information Technology, Sun Yat-sen Univ., China;* [2]*Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai), China*. Passive optical network (PON) is continuously explored for new architectures and effective DSP techniques to adapt to the next generation communication. In this paper, we summarize our work and discuss the challenges and potential solutions for the next-generation PON.

Room 7AB

M3H • Ultra-high Baud Rate Systems—Continued

M3H.4 • 14:45

OSNR-Aware Digital Pre-Emphasis for High Baudrate Coherent Optical Transmissions, Son T. Le[1], Junho Cho[1]; [1]*Nokia Bell Labs, USA*. We derive and experimentally verify an analytical expression for adaptive digital pre-emphasis in coherent optical transmission systems with severe bandwidth limitation by considering both the transmitter response and optical link OSNR

M3H.5 • 15:00 Invited

Generation and Detection of 200-GBaud Signals via Electrical Multiplexing, Xi Chen[1]; [1]*Nokia Bell Labs, USA*. We review the generation and detection of 200-GBaud optical signals and discuss the system design metrics and signal integrity.

Room 8

M3I • Quantum and Neural Networks—Continued

M3I.3 • 14:45

Demonstration of an Algorithm for Quantum State Generation in Polarization-Encoding QKD Systems, Sara T. Mantey[1,2], Mariana F. Ramos[1,2], Nuno Silva[1], Armando N. Pinto[1,2], Nelson Muga[1,3]; [1]*Instituto de Telecomunicações, Portugal;* [2]*Department of Electronics, Telecommunications, and Informatics, Univ. of Aveiro, Portugal;* [3]*Department of Physics, Univ. of Aveiro, Portugal*. We experimentally demonstrate a polarization-state generation algorithm using off-the-shelf components. The method was implemented using a laboratory QKD testbed running for 21 hours with an average QBER of 1.8%.

M3I.4 • 15:00

A Continuous Variable Quantum Microcomb With 2.1 dB Raw Squeezing, Mandana Jahanbozorgi[1], Zijiao Yang[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 demonstrate a squeezed quantum microcomb consisting of 22 simultaneously two-mode squeezed comb pairs (44 qumodes) with maximum raw squeezing of 2.1dB, which can serve as the building bricks for scalable continuous-variable-based quantum computing.

Room 1AB

M3A • Symposia: Multi-access Network Leveraging Edge Computing for Energy-efficient, Ultra-reliable, and Low Latency Services Session I—Continued

M3A.4 • 15:30 Invited

SLA-Aware Real Time Control Technology Across Optical and Mobile Networks, Hiroshi Ou[1], Kota Asaka[1], Tatsuya Shimada[1], Tomoaki Yoshida[1]; [1]*NTT Access Network Service Systems Laboratories, NTT Corporation, Japan.* Low latency services such as remote drone control are expected to be provided by future optical and mobile networks. This paper covers the issues and possible technology candidates to resolve them.

Room 2

M3B • Panel: Programmable Photonic Chips for Artificial Intelligence, Computing and Optical Networks—Continued

Room 3

M3C • Towards THz Communications—Continued

M3C.5 • 15:15

A Bi-Directional Fiber-FSO-5G MMW/5G NR Sub-THz Converged System, Poh-Suan Chang[1], Chen-Xuan Liu[1], Yan-Yu Lin[1], Chung-Yi Li[2], Hai-Han Lu[1]; [1]*National Taipei Univ. of Technology, Taiwan;* [2]*National Taipei Univ., Taiwan.* A bi-directional fiber-FSO-5G wireless converged system with downlink 40-Gb/s/100-GHz 5G NR sub-THz, and uplink 10-Gb/s/28-GHz and 10-Gb/s/24-GHz 5G MMW signals is constructed. It develops a brilliant convergence for high-speed and long-reach transmission with qualified performance.

M3C.6 • 15:30 Invited

THz Transport Technologies and Strategists Beyond 5/6G Systems, Hiroshi Okazaki[1], Yasunori Suzuki[1], Satoshi Suyama[1], Takahiro Asai[1]; [1]*NTT DOCOMO, Japan.* Utilization of THz wave is being considered to achieve the target expected for 6th Generation Mobile Communication System (6G). The research topics and considerations how to use the bands in 6G era is addressed.

Room 6C

M3D • High-speed Semiconductor Lasers—Continued

M3D.3 • 15:15

1060nm Single-Mode Transverse Coupled Cavity VCSEL With Surface Relief Engineering for 80Gbps PAM4 Modulation, Shanting Hu[1], Xiaodong Gu[1,2], Hameeda R. Ibrahim[1], Masanori Nakahama[1,2], Satoshi Shinada[3], Fumio Koyama[1]; [1]*Tokyo Inst. of Technology, Japan;* [2]*Ambition Photonics Inc., Japan;* [3]*National Inst. of Information and Communications Technology, Japan.* We demonstrate 1060nm VCSELs with surface relief engineering, providing transverse-resonance in transverse-coupled cavity VCSELs, which enables single-mode operation and bandwidth enhancement. We obtained a large signal modulation of 54 Gbps NRZ and 80 Gbps PAM4.

M3D.4 • 15:30

Uncooled 100 GBd O-Band EML for Datacom Transmitter Arrays, Ute Troppenz[1], Michael Theurer[1], Martin Moehrle[1], Ariane Sigmund[1], Marko Gruner[1], Martin Schell[1]; [1]*Fraunhofer Heinrich-Hertz-Inst., Germany.* 100 GBd is demonstrated from 30°C to 70°C with O-Band InP EML array chips. Modulation bandwidths are above 50 GHz, and an integrated SOA ensures 10 dBm, while a single active layer allows for cost effective manufacturing.

M3D.5 • 15:45

Regrowth-Free 1.3μm Directly Modulated DBR Lasers Based on Inverted Trapezoid High-Order Surface-Gratings, Wei Sun[1], Shuangzhi Wei[1], Qiaoyin Lu[1], John F. Donegan[2], Weihua Guo[1]; [1]*Huazhong Univ. of Science & Techno, China;* [2]*Trinity College Dublin, Ireland.* We demonstrate 1.3 μm regrowth-free directly-modulated DBR lasers based on Inverted-Trapezoid high-order slotted surface-gratings. The laser fabricated by standard photolithography exhibited a threshold current ~10 mA, SMSR ~50 dB, 3-dB bandwidth ~14 GHz, and RIN<-140dB/Hz.

Room 6D

M3E • Component Optimization—Continued

M3E.3 • 15:15

Reflectionless Standing-Wave Operation in Microring Resonators, Kenaish Al Qubaisi[1], Djordje Gluhovic[1], Deniz Onural[1], Milos Popovic[1]; [1]*Boston Univ., USA.* We demonstrate a scheme for microring resonators to operate as standing-wave resonators while eliminating reflections and maintaining traveling-wave-resonator-like through-port response, potentially enabling interdigitated p-n junction microring modulators to achieve higher performance than other junction geometries.

M3E.4 • 15:30

High-Speed Performance of 140 cm-Long Flexible Multimode Polymer Waveguides Link Supporting 1 mm-Radius Bend, Ying Shi[1], Lin Ma[1], Motoya Kaneta[2], Yudi Zhuang[1], Zuyuan He[1]; [1]*Shanghai Jiao Tong Univ., Chile;* [2]*Sumitomo Bakelite Co., Ltd., Japan.* We achieved 30 Gb/s error-free transmission using 140 cm-long flexible multimode polymer waveguides link with a measured bandwidth of 42 GHz•m. Bandwidth degradation is negligible under a bending radius of 1 mm with 3-turn twists.

M3E.5 • 15:45

Fast-Response, Energy-Efficient Thermo-Optic Silicon Phase Shifter Based on Non-Hermitian Engineering, Chang Chang[1], Ting Li[1], Yulin Wu[1], Peiji Zhou[1], Yi Zou[1]; [1]*Shanghai Tech Univ., China.* We present a fast response, energy-efficient thermo-optic silicon phase shifter based on Non-Hermitian engineering. A 729 kHz bandwidth and an 11.3 mW π-phase-shift (Pπ) power consumption are demonstrated at 1550 nm wavelength.

Room 6E

M3F • Machine Learning for Network Operation—Continued

M3F.5 • 15:15 Invited

On the Application of Explainable Artificial Intelligence to Lightpath QoT Estimation, Omran Ayoub[2], Andrea Bianco[1], Davide Andreoletti[2], Sebastian Troia[3], Silvia Giordano[2], Cristina Rottondi[1]; [1]*DET, Politecnico di Torino, Italy;* [2]*SUPSI, Switzerland;* [3]*DEIB, Politecnico di Milano, Italy.* We demonstrate the potentialities of explainable AI when applied to distill knowledge from a trained supervised machine learning model for lightpath quality of transmission estimation in optical networks, showing results obtained with synthetic datasets.

Room 6F

M3G • Next-gen High-speed PON I: Advanced DSP—Continued

M3G.5 • 15:30

Flexible Upstream FEC for Higher Throughput, Efficiency, and Robustness for 50G PON, Amitkumar Mahadevan[1], Yannick Lefevre[2], Ed Harstead[3], Werner van Hoof[4], Dora van Veen[1], Vincent Houtsma[1]; [1]*Nokia Bell Labs, USA;* [2]*Nokia Bell Labs, Antwerp, Belgium;* [3]*Nokia Fixed Networks, USA;* [4]*Nokia Fixed Networks, Antwerp, Belgium.* A low-complexity flexible forward error correction scheme based on different shortening and puncturing of the standard G.hsp 50G PON LDPC mother code to achieve enhanced throughput and robustness in upstream PON is motivated and presented.

M3G.6 • 15:45

>87%Complexity Reduction at 25-GS/s, 50-Gbps and 30-dB Loss Budget LR-OFDM PON Using Digital Predistortion, Hong-Minh Nguyen[1], Chia Chien Wei[2], Chun-Yen Chuang[1], Jyehong Chen[1]; [1]*National Yang Ming Chiao Tung Univ., Taiwan;* [2]*National Sun Yat-sen Univ., Taiwan.* We demonstrate the digital predistortion (DPD) at a reduced sampling rate in high-loss-budget 10G-class LR-PONs. A >50-Gbps transmission was achieved over 30-70 km using fixed DPD with >87% complexity reduction, compared to fully optimized DPD.

Room 7AB

M3H • Ultra-high Baud Rate Systems—Continued

M3H.6 • 15:30

FrFT Based Joint Time/Frequency Synchronization for Digital Subcarrier Multiplexing System, Zihe Hu[1], Li Wang[1], Junda Chen[1], Yizhao Chen[1], Can Zhao[1], Weihao Li[1], Ming Tang[1]; [1]*School of Optical and Electronic Information, Huazhong Univ. of Science and Technology, China.* We propose an in-advance time/frequency synchronization method for SCM using fractional Fourier transform pilot. With low complexity and fast speed, the proposed method is validated to be robust against strong filtering and fiber nonlinearity.

Room 8

M3I • Quantum and Neural Networks—Continued

M3I.5 • 15:15

Time-bin Quantum Key Distribution Exploiting the IPO-GNAC Polarization Moulator and Qubit4Sync Temporal Synchronization, Costantino Agnesi[1], Davide Scalcon[1], Marco Avesani[1], Luca Calderaro[1,2], Giulio Foletto[1], Andrea Stanco[1], Giuseppe Vallone[1], Paolo Villoresi[1]; [1]*Universita degli Studi di Padova, Italy;* [2]*ThinkQuantum S.r.l., Italy.* Here we present cross-encoded Quantum Key Distribution where state encoding is performed with a self-compensating and calibration-free polarization modulator, while transmission is performed in time-bin encoding resistant to perturbances from the fiber channel.

Room 6A

14:00–16:15
M3Z • OFC Demo Zone

M3Z.1
A Fibre Bragg Grating Sensor-Based Instrumented Glove for Virtual Rehabilitation Applications, Chandan K. Jha[1], Arup L. Chakraborty[1]; [1]*Indian Inst of Technology, Gandhinagar, India.* A fibre Bragg grating sensor-based instrumented glove being developed for medical applications will be demonstrated that can be used to measure finger joint angles with a resolution of 0.1°.

M3Z.2
QTReX : a Semi-Autonomous Continuous-Variable Quantum Key Distribution System, Nitin Jain[1], Hou-Man Chin[2,1], Hossein Mani[1], Erik Bidstrup[3], Ulrik L. Andersen[1], Tobias Gehring[1]; [1]*Department of Physics, Technical Univ. of Denmark, Denmark;* [2]*Department of Photonics, Technical Univ. of Denmark, Denmark;* [3]*Zybersafe ApS, Denmark.* Continuous-variable quantum cryptography can leverage existing telecommunication technology for solving the cryptographic task of secure key distribution. We present *qTReX*: A low-noise, highly stable, semi-autonomous prototype using optical coherent states for quantum key distribution.

M3Z.3
Kubernetes Orchestration in SDN-Based Edge Network Infrastructure, Alessio Giorgetti[2], Davide Scano[1], Javad Chamanara[4], Mustafa Albado[5], Edgar Marx[6], Sean Ahearne[5], Andrea Sgambelluri[1], Francesco Paolucci[3], Filippo Cugini[3]; [1]*Scuola Superiore Sant'Anna, Italy;* [2]*IEIIT, CNR, Italy;* [3]*CNIT, Italy;* [4]*Leibniz Universität, Germany;* [5]*DELL, Ireland;* [6]*Eccenca, Germany.* This demo presents a comprehensive framework providing effective cooperation among K8s scheduler, SDN controller, telemetry system, and SLA broker. The framework enables orchestrated provisioning and adaptation in distributed edge resources across a metro optical network.

M3Z.4
Proof-of-Concept Demonstration of Time Critical Periodic Traffic in Industry-Grade Passive Optical Networks, Konstantinos (Kostas) Christodoulopoulos[1], Sarvesh Bidkar[1], Thomas Pfeiffer[1], Rene Bonk[1]; [1]*Nokia Bell Labs Germany, Germany.* We demonstrate a standards compliant, but enhanced XGS-PON as part of a TSN network that supports industrial (time critical periodic) traffic with sub-microsecond jitter. Adding best effort traffic does not degrade this performance.

M3Z.5
Demonstration of a Resilient and Quantum-Secured Time-Shared Optical Network With Multi-Level Programmability, Romerson Oliveira[1], Ekin Arabul[1], Rui Wang[1], George Kanellos[1], Reza Nejabati[1], Dimitra E. Simeonidou[1]; [1]*Univ. of Bristol, UK.* We have successfully implemented a multilevel programmable network resilience and security for Time-Shared Optical Networks (TSON). A SDN controller enables flexible control of FPGA-based network coding and encryption/decryption cores for secured and resilient TSON.

M3Z.6
Optical Field Characterization Using Off-Axis Digital Holography, Sjoerd P. van der Heide[1], Bram van Esch[1], Menno van den Hout[1], Thomas Bradley[1], Amado Velazquez-Benitez[1,2], Nicolas Fontaine[3], Roland Ryf[3], Haoshuo Chen[3], Mikael Mazur[3], Jose Antonio-Lopez[4], Juan Carlos Alvarado Zacarias[4], Rodrigo Amezcua Correa[4], Chigo M. Okonkwo[1]; [1]*Eindhoven Univ. of Technology, Netherlands;* [2]*Instituto de Ciencias Aplicadas y Tecnologia, Mexico;* [3]*Nokia Bell Labs, USA;* [4]*CREOL, The College of Optics and Photonics, USA.* Angular resolved digital holography is presented as a technique for real-time characterization of the full optical field (amplitude and phase) of space-division multiplexing components and fibers, here a 6-mode photonic-lantern is characterized.

M3Z.7
Demonstration of a Low Latency Bandwidth Allocation Mechanism for Mission Critical Applications in Virtual PONs With P4 Programmable Hardware, Diego Rossi Mafioletti[1], Frank Slyne[1], Robin Giller[2], Michael O Hanlon[2], David Coyle[2], Brendan Ryan[2], Marco Ruffini[1]; [1]*Trinity College Dublin, Ireland;* [2]*Intel Corporation, Ireland.* We provide a real-time demonstration of a low-latency PON DBA mechanism, optimised for virtual PONs. Our implementation mixes P4 programmable data plane and software-based virtual DBA to provide efficient fast-track allocation for low latency applications.

M3Z.8
Using Network Operations Platform and Orchestrator to Enhance Programmable OpenROADM Optical Networks, Nathan A. Ellsworth[1], Behzad Mirkhanzadeh[1], Tianliang Zhang[1], Miguel Razo[1], Andrea Fumagalli[1]; [1]*The Univ. of Texas at Dallas, USA.* Automatic provisioning of server-to-server data transfer over OpenROADMcompliant equipment is achieved through the combined use of NOP/PROnet Orchestrator.User's request for datarate is achieved while accounting for the equipment's ability to createwave services.

M3Z.9
6G Oriented 100 GbE Real-Time Demonstration of Fiber-THz-Fiber Seamless Communication Enabled by Photonics, Jiao Zhang[1,2], Min Zhu[1,2], Bingchang Hua[2], Mingzheng Lei[2], Yuancheng Cai[1,2], Yucong Zou[2], Liang Tian[2], Aijie Li[2], Yongming Huang[1,2], Jianjun Yu[2,3], Xiaohu You[1,2]; [1]*Southeast Univ., China;* [2]*Purple Mountain Laboratories, China;* [3]*Fudan Univ., China.* We demonstrate 6G-oriented 100 GbE real-time streaming service applications in fiber-THz-fiber seamless transmission with a record net data rate of 103.125 Gbps at 370 GHz enabled by photonic up-/down-conversion and digital coherent modules.

M3Z.10
Interactive Visual Analytics Dashboard for the Paradigm of ML-Assisted Autonomous Optical Networking, Behnam Shariati[1], Wanda Baltzer[1], Geronimo Bergk[1], Pooyan Safari[1], Johannes Fischer[1]; [1]*Fraunhofer Inst Nachricht Henrich-Hertz, Germany.* We demonstrate a novel visualization dashboard, compatible with multiple data and telemetry sources, which offers dataset quality evaluation, dataset comparison, ML model error analysis interpretation, and network health monitoring.

M3Z.11
DeepALM: Holistic Optical Network Monitoring Based on Machine Learning, Joo Y. Cho[1], Jose-Juan Pedreno-Manresa[1], Sai Patri[1], Khouloud Abdelli[1,2], Carsten Tropschug[1], Jim Zou[1], Piotr Rydlichowski[3]; [1]*ADVA Optical Networking SE, Germany;* [2]*Christian-Albrechts-Universität zu Kiel, Germany;* [3]*Poznan Supercomputing and Networking Center, Poland.* We demonstrate a machine learning-based optical network monitoring system which can integrate fiber monitoring, predictive maintenance of optical hardware, and security information management in a single solution.

M3Z.12
Demonstration of Real-Time Photonics-Assisted mm-Wave Communication Based on Ka-Band Large-Scale Phased-Array Antenna and Automatic Beam Tracking Technique, Yuancheng Cai[1,2], Min Zhu[1,2], Sheng Liang[1], Jiao Zhang[1,2], Mingzheng Lei[2], Bingchang Hua[2], Pengyuan Wang[1], Liang Tian[2], Yucong Zou[2], Aijie Li[2], 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.* Based on 256-element phased-array antenna and photonics-assisted mm-Wave communication, we successfully demonstrate real-time bi-directional 1.5Gbps uncompressed high-definition video transmissions at 26.5~29.5GHz. The FPGA-based self-steering beamforming has been implemented using the proposed automatic beam tracking technique.

M3Z.13
LYNX: a GNPy-Based Web Application for Multi-Vendor Optical Network Planning, Mohammad S. Raza[1], Andrea D'Amico[2], Fehmida Usmani[1], Sami M. Alavi[1], Ali Taimoor[1], Vittorio Curri[2], Arsalan Ahmad[1]; [1]*National Univ. of Sciences and Tech, Pakistan;* [2]*Politecnico di Torino, Italy.* We demonstrate LYNX, a web-based application for network planning. Built on top of GNPy, it automates the design of user-defined or already built-in network topology, dynamic resource provisioning, network recovery and optimization.

M3Z.14
Demonstration of AI-Light: an Automation Framework to Optimize the Channel Powers Leveraging a Digital Twin, Alessio Ferrari[1], Venkata Virajit Garbhapu[1,2], Dylan Le Gac[1], Ivan Fernandez de Jauregui Ruiz[1], Gabriel Charlet[1], Yvan Pointurier[1]; [1]*Huawei Technologies France, France;* [2]*Télécom Paris, France.* We demonstrate a network automation framework called AI-Light able to: create a digital twin based on the monitoring, perform an SNR-based optimization by leveraging the digital twin and, push the optimized configuration into the network.

M3Z.15
Demonstration of Zero-Touch Device and L3-VPN Service Management Using the TeraFlow Cloud-Native SDN Controller, Lluis Gifre Renom[1], Carlos Natalino[2], Sergio Gonzalez Diaz[3], Fotis Soldatos[4], Samier Barguil Giraldo[5], Christos Aslanoglou[4], Francisco Javier Moreno Muro[3], Andy Quispe[1], Luis Cepeda Martinez[5], Ricardo Martínez[1], Carlos Manso[1], Vasileios Apostolopoulos[4], Sami Petteri Valiviita[6], Oscar Gonzalez de Dios[5], Julia Rodriguez[6], Ramon Casellas[1], Paolo Monti[2], Georgios Katsikas[4], Raul Muñoz[1], Ricard Vilalta[1]; [1]*CTTC, Spain;* [2]*Chalmers Univ. of Technology, Sweden;* [3]*ATOS, Spain;* [4]*UBITECH, Greece;* [5]*Telefonica I+D, Spain;* [6]*Infinera, Finland.* We demonstrate zero-touch device bootstrapping, monitoring, and L3-VPN service management using the novel TeraFlow OS SDN controller prototype. TeraFlow aims at producing a cloud-native carrier-grade SDN controller offering scalability, extensibility, high-performance, and high-availability features.

M3Z.16
Autonomous Pulse Control for Quantum Transducers With Deep Reinforcement Learning, Mekena Metcalf[1], Huo Chen[1], Anastasiia Butko[1], Mariam Kiran[1]; [1]*Lawrence Berkeley National Laboratory, USA.* Quantum transducers are the back-bone technology and enabler for the Quantum Internet. We created a Deep Reinforcment Learning control framework to overcome current, low conversion efficiencies, bringing quantum transducers towards practical use.

16:00–16:30 Coffee Break

NOTES

Room 1AB

16:30–18:30
M4A • Symposia: Multi-access Network Leveraging Edge Computing for Energy-efficient, Ultra-reliable, and Low Latency Services Session II
Presider: Albert Rafel, British Telecommunications, UK

M4A.1 • 16:30 Invited
6G and the Internet of Skills, Mischa Dohler[1]; *[1]King's College London, UK.* 5G has offered a local low latency in the order of milliseconds. However, an important design paradigm still requires solving: the provisioning of ultra-low latency services globally. In this talk, I will explain how 6G could play an instrumental role in enabling such paradigm shift, and what exciting applications are expected to emerge over the coming years.

M4A.2 • 17:00 Invited
Exploration and Practice of Computing Power Network(CPN) to Realize Convergence of Computing and Network, Gefan Zhou[1], Bo Lei[1]; *[1]Research Inst. of China Telecom, China.* For the optimum leveraging of the distributed computing, network and storage resources in the network with edge computing, we proposed a novel network technology-Computing Power Network (CPN) for the convergence of computing and network resources.

Room 2

16:30–18:30
M4B • SDM Transmission
Presider: Kohki Shibahara; NTT Network Innovation Laboratories, Japan

M4B.1 • 16:30 ★ Top-Scored
First Demonstration of Uncoupled 4-Core Multicore Fiber in a Submarine Cable Prototype With Integrated Multicore EDFA, Hitoshi Takeshita[1], Kohei Nakamura[1], Yuushi Matsuo[1], Takanori Inoue[1], Daishi Masuda[2], Tetsuya Hiwatashi[2], Kohei Hosokawa[1], Yoshihisa Inada[1], Emmanuel Le Taillandier de Gabory[1]; *[1]NEC Corpration, Japan; [2]OCC Corporation, Japan.* We demonstrate the first 15.2 km prototype of submarine cable with 4-core MCF. Cabled MCF changes are negligible. We confirmed MC-EDFA integration to the cable improves Q-value by 0.6 dB through real-time 5,350 km transmission.

M4B.2 • 16:45 Invited
High-Capacity Mode Division Multiplexing Transmission Technology, Daiki Soma[1], Shohei Beppu[1], Noboru Yoshikane[1], Takehiro Tsuritani[1]; *[1]KDDI Research, Inc., Japan.* Mode division multiplexing is an attractive method of increasing the transmission capacity. This paper presents the 402.7-Tbit/s weakly coupled 10-mode-multiplexed transmission over 48 km and 50.47-Tbit/s standard cladding coupled 4-core fiber transmission over 9,150 km.

Room 3

Room 6C

16:30–18:30
M4D • Semiconductor Lasers
Presider: Tomoyuki Akiyama; Fujitsu Laboratories Ltd., Japan

M4D.1 • 16:30 Invited
1.5-um Indium Phosphide-Based Quantum Dot Lasers and Optical Amplifiers, Johann Peter Reithmaier[1], Gadi Eisenstein[2]; *[1]Universitat Kassel, Germany; [2]Technion, Israel.* An overview is given on the progress of QD laser materials addressing the telecom-C-band and their high potential for the application in optical communication systems, where temperature stability and narrow linewidth plays an important role.

M4D.2 • 17:00
Single-Mode Emission From a Topological Lattice With Distributed Gain and Dmedium, Markus Scherrer[1,4], Seonyeong Kim[2], Hee Jin Choi[3], Heinz Schmid[1], Chang-Won Lee[3], Kirsten Emilie Moselund[1]; *[1]IBM Research Europe, Switzerland; [2]Sejong Univ., Korea (the Republic of); [3]Hanbat National Univ., Korea (the Republic of); [4]ETH Zurich, Switzerland.* We demonstrate a monolithically integrated active topological photonic structure. Using a unique design with distributed gain/dielectric medium, we selectively address the topological mode to achieve robust and tunable continuous-wave single-mode emission at room temperature.

Room 6D

16:30–18:30
M4E • Specialty Fibers, Cables and Connectors
Presider: Alexei Pilipetskii; SubCom LLC, USA

M4E.1 • 16:30 Invited
Reduced Coating Diameter Fibers for High Density Cables, Ming-Jun Li[1], Arash Abedijaberi[1], Weijun Niu[1], Eric E. Leonhardt[1], Donald A. Clark[1], Garth W. Scannell[1], Matthew R. Drake[1], Jeffery S. Stone[1], Joseph E. McCarthy[1], Arthur L. Wallace[1], Huayun Deng[1], Linda S. Baker[1], Hector M. De Pedro[1], Brian A. Kent[1], Yunfeng Gu[1]; *[1]Corning Inc, USA.* We review recent progress on reduced coating diameter fibers for increasing core density for optical interconnect applications. We discuss design considerations on microbending and mechanical reliability and present new experimental results.

M4E.2 • 17:00
Reduced-Coated Fibers and Micro-Duct Cables, Pierre Sillard[1], Adrian Amezcua-Correa[2], Cyril Mentzler[1], Giuseppe Ferri[3]; *[1]Prysmian Group, France; [2]Prysmian Group, France; [3]Prysmian Group, Italy.* We investigate the cable miniaturizations and densities enabled by 180µm coated fibers with standard 125µm cladding. We then explore the possibility to reduce the coating diameter down to 165µm while keeping a standard 125µm cladding.

Room 6E

16:30–18:30
M4F • Open Networking and Streaming Telemetry

M4F.1 • 16:30
Dynamic Reconfiguration of WDM Virtual Network Topology Over SDM Networks for Spatial Channel Failure Recovery With GRPC Telemetry, Raul Muñoz[1], Carlos Manso[1], Filippos Balasis[2], Ramon Casellas[1], Ricard Vilalta[1], Ricardo Martínez[1], Cen Wang[2], Noboru Yoshikane[2], Takehiro Tsuritani[2], Itsuro Morita[2]; *[1]CTTC, Spain; [2]KDDI Research, Japan*. We experimentally demonstrate the dynamic reconfiguration of WDM VNTs in response to SDM spatial channel failures. We present an SDN control architecture with gRPC-telemetry and analytics to detect failures and restore failed virtual WDM links.

M4F.2 • 16:45
A Control Hierarchy for Integrated Packet-Optical Networks Utilizing Pluggable Transceivers, Ori Gerstel[1], Brent Foster[1], Gabriele Galimberti[1]; *[1]Cisco Systems, USA*. A proposed architecture for control of packet-optical networks is analyzed and demonstrated. The specific challenge of managing routers with integrated pluggable WDM transceivers with open optical line systems is addressed while considering standards alignment.

M4F.3 • 17:00 Invited
Applications of P4-Based Network Programmability in Optical Networks, Filippo Cugini[1], Davide Scano[2], Alessio Giorgetti[3], Andrea Sgambelluri[2], Francesco Paolucci[1], Juan Jose Vegas Olmos[4], Piero Castoldi[2]; *[1]CNIT, Italy; [2]Scuola Superiore Sant'Anna, Italy; [3]IEIIT Inst., CNR, Italy; [4]Nvidia, Denmark*. This paper presents potentials and challenges of disaggregated metro-edge networking based on open packet-optical nodes encompassing coherent pluggable modules, SONiC open operating system, and P4-based packet switching programmability.

Room 6F

16:30–18:30
M4G • Next-gen High-speed PON II: Optoelectronic Subsystems
Presider: Luiz Anet Neto; IMT Atlantique, France

M4G.1 • 16:30 Invited
Reconfigurable PIC Transmitter for Short Reach Applications, Aleksandra Kaszubowska-Anandarajah[1], Krishna Sivapalan[2], Eamonn Martin[3], Deseada Gutierrez-Pascual[3], Frank Smyth[3], Jules Braddell[3], Prajwal Lakshmijayasimha[2], Prince Anandarajah[2]; *[1]Univ. of Dublin Trinity College, Ireland; [2]Photonics Systems and Sensing Group, Dublin City Univ., Ireland; [3]Pilot Photonics Ltd., Ireland*. A novel reconfigurable photonic integrated transmitter, enabling dynamic resource allocation and sharing, is proposed. Architecture, functionality and a deployment scenario are discussed. Preliminary work on machine learning methods for controlling the device are also presented.

M4G.2 • 17:00 Invited
High Speed Ge/Si Avalanche Photodiode With High Sensitivity for 50Gbit/s and 100Gbit/s Optical Access Systems, Chingyin Hong[1], Bin Shi[1], Fan Qi[1], Pengfei Cai[1], Yanhui Duan[1], Guanghui Hou[1], Tzungi Su[1], Tehuang Chiu[1], Su Li[1], Wang Chen[1], Dong Pan[1]; *[1]SiFotonics Technologies Co Ltd, USA*. 25GBaud and 50GBaud APDs with high sensitivity gain compared with PDs are reviewed. The great consistency and excellent performance of the APDs could great satisfy the requirements of 50Gbit/s and 100Gbit/s optical access systems, such as 400GbE datacenters, 100G ER1 and 50G PON etc.

Room 7AB

16:30–18:30
M4H • Ultra-high Baud Rate Data Center Technologies
Presider: Stephen Ralph; Georgia Tech, USA

M4H.1 • 16:30 Invited
Silicon Photonics for 800G and Beyond, Po Dong[1], Jing Chen[1], Argishti Melikyan[1], Tianren Fan[1], Taylor Fryett[1], Changyi Li[1], Jiashu Chen[1], Chris Koeppen[1]; *[1]II-VI Incorporated, USA*. Future optical transceivers will rely on silicon photonics to address the increasing need for high capacity density and energy efficiency. We review its applications in 800G and beyond and highlight the challenges ahead.

M4H.2 • 17:00
288 Gb/s 850 nm VCSEL-Based Interconnect Over 100 m MMF Based on Feature-Enhanced Recurrent Neural Network, Yunfeng Gao[1], Chuanchuan Yang[1], Jiaxing Wang[2], Xin Qin[1], Haipeng Guo[1], Xiaoyu Zhang[1], Chih-Chiang Shen[2], Hongbin Li[1], Zhangyuan Chen[1], Constance J. Chang-Hasnain[2]; *[1]Peking Univ., China; [2]Berxel Photonics Co. Ltd., China*. We experimentally demonstrate an ultra-high speed record of single-lane 288 Gb/s PAM-8 signal transmission over 100 m MMF attributed to the proposed design-optimized 850 nm VCSEL and feature-enhanced RNN equalization.

Room 8

16:30–18:30
M4I • Free-space Optical Communications

M4I.1 • 16:30 Invited
Free-Space Laser Communications for Small Moving Platforms, Alberto Carrasco-Casado[1]; *[1]Space Communication Systems Laboratory, National Inst. of Information and Communications Technology (NICT), Japan*. This paper describes NICT's current efforts in developing a series of miniaturized free-space laser-communication terminals to meet the requirements of a variety of different platforms, and to be applied in a variety of different scenarios.

M4I.2 • 17:00
Experimental Demonstration of Adaptive-Optics-Based Turbulence Mitigation in a Mode-Multiplexed Free-Space Optical Link by Using Both Radial and Azimuthal Spatial Indices, Xinzhou Su[1], Yuxiang Duan[1], Huibin Zhou[1], Hao Song[1], Kai Pang[1], Cong Liu[1], Kaiheng Zou[1], Runzhou Zhang[1], Haoqian Song[1], Nanzhe Hu[1], Moshe Tur[2], Alan E. Willner[1]; *[1]Univ. of Southern California, USA; [2]Tel Aviv Univ., Israel*. We experimentally demonstrate turbulence mitigation by adaptive optics for a 400-Gbit/s free-space link multiplexing four Laguerre Gaussian modes using both radial and azimuthal indices. The turbulence-induced power loss and crosstalk are reduced by ~10 dB and ~18 dB, respectively.

Room 9

16:30–18:30
M4J • Passive Devices for Next Generation Transmission
Presider: Glenn Bartolini; II-VI Photonics, USA

M4J.1 • 16:30 Invited
Momentum Space Controlled Flexible Spatial Light Modulator for Optical Wireless Communication, Zizheng Cao[1], Xinda Yan[1], Yiwen Zhang[2], Chao Li[3], Juhao Li[4], Chia Wei Hsu[2], Ton Koonen[1]; *[1]Technische Universiteit Eindhoven, Netherlands; [2]Univ. of southern california, USA; [3]Peng Cheng Laboratory, China; [4]Peking Univ., China*. Traditional spatial light modulators (SLMs) shape an incident wavefront pixel-by-pixel. This talk explores a new class of SLMs named momentum space controlled spatial light modulators (MSC-SLMs). An optical-wireless-communication link enabled by MSC-SLMs is demonstrated.

M4J.2 • 17:00 ★ Top-Scored
Core Selective Switch Supporting 15 Cores per Port Using Bundled Three 5-Core Fibers, Yudai Uchida[1], Tsubasa Ishikawa[1], Itsuki Urashima[1], Shoma Murao[1], Takahiro Kodama[1], Yasuki Sakurai[2], Ryuichi Sugizaki[3], Masahiko Jinno[1]; *[1]Kagawa Univ., Japan; [2]Santec Corporation, Japan; [3]Furukawa Electric Co., Ltd., Japan*. We prototyped a 15-core 1×8 core selective switch (CSS). The high core count CSS is achieved by bundling three 5-core fibers (5-CFs) and collimating/demultiplexing beams from the input bundled three 5-CFs using a single microlens.

Room 1AB

M4A • Symposia: Multi-access Network Leveraging Edge Computing for Energy-efficient, Ultra-reliable, and Low Latency Services Session II—Conrinued

M4A.3 • 17:30 Invited

Energy Efficiency in Multi-Access Technologies With a Disaggregated Architecture, Dominique Chiaroni[1], Raffaele Luca Amalfi[2]; *[1]Nokia Bell Labs France, France; [2]Nokia Bell Labs, USA*. We describe key technologies for a greener ICT for the fixed & mobile access, in-building optical backbones including a novel cooling technology, for DC to ensure energy savings and flexibility for different ICT market segments.

Room 2

M4B • SDM Transmission—Conrinued

M4B.3 • 17:15

372 Tb/s Unrepeatered 213 km Transmission Over a 125 Micrometer Cladding Diameter, 4-Core MCF, Ruben S. Luis[1], Benjamin J. Puttnam[1], Georg Rademacher[1], Yoshinari Awaji[1], Hideaki Furukawa[1]; *[1]National Inst of Information & Comm Tech, Japan*. We demonstrate a 372.8 Tb/s unrepeatered 213.3 km link using a 4-core multicore fiber with standard cladding diameter and bidirectional Raman amplification.We transmit 424×24.5 GBaud PM-64QAM signals in the C+L bands for a capacity-distance product of 79.5 Pb/s×km.

M4B.4 • 17:30

3-Mode Real-Time MDM Transmission Using Single-Mode OTN Transceivers Over 300 km Weakly-Coupled FMF, Mingqing Zuo[1], Dawei Ge[2], Yuyang Gao[1], Jian Cui[1], Shuailuo Huang[1], Rui Zhou[3], Qiang Guo[3], Yin Zhang[3], Ding Zhang[3], Xinhua Xiao[3], Lei Shen[4], Dong Wang[2], Yunbo Li[2], Liuyan Han[2], Lei Zhang[4], Xiaobo Lan[4], Dechao Zhang[2], Han Li[2], Yongqi He[1], Zhangyuan Chen[1], Juhao Li[1]; *[1]Peking Univ., China; [2]China Mobile Research Inst., China; [3]Huawei, China; [4]Yangtze Optical Fibre and Cable, China*. Utilizing non-degenerate LP_{01}/LP_{02}/LP_{03} modes in a weakly-coupled 10-LP-mode multiple-ring-core FMF and corresponding mode multiplexers/demultiplexers consisting of cascaded mode-selective fiber couplers, we experimentally demonstrate a real-time 300-km MDM transmission with commercial single-mode 200G OTN transceivers.

Room 3

Room 6C

M4D • Semiconductor Lasers—Conrinued

M4D.3 • 17:15

Over 100 mW Uncooled Operation of SOA-Integrated 1.3-µm Highly Reliable CW-DFB Laser, Shoko Yokokawa[1], Atsushi Nakamura[1], Shigetaka Hamada[1], Ryosuke Nakajima[1], Kaoru Okamoto[1], Masatoshi Arasawa[1], Kouji Nakahara[1], Shigehisa Tanaka[1]; *[1]Lumentum Japan, Inc., Japan*. We demonstrate the first SOA-integrated CW-DFB laser at 1.3 µm with kink-free and stable single-mode operation over 100 mW at up to 80 °C. We also achieved reliable operation over 700 hours at 80 °C.

M4D.4 • 17:30 Invited

III-v Micro- and Nano-Lasers/Photodetectors in the Telecom Band Grown on SOI, Kei May Lau[1]; *[1]Hong Kong Univ of Science & Technology, Hong Kong*. We present our recent progress on the III-V micro/nano-lasers and photodetectors (PD) grown on (001) silicon-on-insulators (SOI) for integrated silicon photonics (Si-photonics) using vertical and lateral selective epitaxy.

Room 6D

M4E • Specialty Fibers, Cables and Connectors—Conrinued

M4E.3 • 17:15

Comparison of Different Deformation Functions Modeling Micro-Bending Loss of Optical Fibers on Sandpaper Test, Zoltan Varallyay[1], Tamas Mihalffy[1], Kazunori Mukasa[2]; *[1]Furukawa Electric Inst. of Tech Ltd., Hungary; [2]Telecommunication and Energy Lab., Furukawa Electric Co. Ltd., Japan*. Different deformation functions to find the best fit to the experimental data of micro-bending loss measurements of optical fibers are investigated. Best outcome, fitting the parameters is in the form of a Gaussian power spectrum.

M4E.4 • 17:30

Side-View Rotational Alignment Method for Trench-Assisted 4-Core Fibers, Masaki Ohzeki[1], Yusuke Sasaki[1], Katsuhiro Takenaga[1], Kentaro Ichii[1], Kazuhiko Aikawa[1]; *[1]Optical Technologies R&D Center, Fujikura Ltd., Japan*. A trench-assisted 4-core fiber has been successfully aligned in fusion splicing by determining an optimal focus position of a fusion splicer and matching the two fibers at the marker using a side-view rotational alignment method.

Room 6E

M4F • Open Networking and Streaming Telemetry

M4F.4 • 17:30 ★ Top-Scored

Experimental Demonstration of a Metro Area Network With Terabit-Capable Sliceable Bitrate Variable Transceiver Using Direct Modulated VCSELs and Coherent Detection, Josep M. Fabrega[1], F. Javier Vilchez[1], Michela Svaluto Moreolo[1], Ricardo Martinez[1], Andy Quispe[1], Laia Nadal[1], Ramon Casellas[1], Ricard Vilalta[1], Raul Muñoz[1], Cristian Neumeyr[2], Seoyoung Lee[3], JangUk Shin[3], HyunDo Jung[3], Giordano Mariani[4], Roland Heuvelmans[4], Alberto Gatto[5], Paola Parolari[5], Pierpaolo Boffi[5], Netsanet Tessema[6], Nicola Calabretta[6], David Larrabeiti[7], Juan Pedro Fernández-Palacios[8]; [1]*Centre Tecnologic de Telecomunicacions de Catalunya (CTTC/CERCA), Spain;* [2]*Vertilas GmbH, Germany;* [3]*Electronics and Telecommunications Research Inst. (ETRI), Korea (the Republic of);* [4]*Effect Photonics B. V., Netherlands;* [5]*Politecnico di Milano, Italy;* [6]*Technical Univ. of Eindhoven (TUE), Netherlands;* [7]*Universidad Carlos III de Madrid, Spain;* [8]*Telefonica global CTO, Spain.* We experimentally demonstrate a disaggregated metro area network that includes new photonic devices, node architectures, and sliceable bandwidth/bitrate variable transceiver, transmitting up to 8x11=88 spatial/spectral channels to achieve 1.676Tb/s.

Room 6F

M4G • Next-gen High-speed PON II: Optoelectronic Subsystems—Conrinued

M4G.3 • 17:30

Surface Normal Electro-Absorption Modulators as Colorless Upstream Transmitters in a WDM Passive Optical Network, Patrick Iannone[1], Stefano Grillanda[1], Xi Chen[1], Ting-Chen Hu[1], Nagesh Basavanhally[1], Alaric Tate[1], Rose Kopf[1], Mark Cappuzzo[1], Yee Low[1], Mark Earnshaw[1], David T. Neilson[1]; [1]*Nokia, USA. We demonstrate a WDM passive optical network that uses high-speed, polarization-independent surface normal modulators as upstream 25-Gb/s transmitters. A band of CW wavelengths, sourced at the optical line terminal, establishes the upstream channels.*

Room 7AB

M4H • Ultra-high Baud Rate Data Center Technologie—Conrinued

M4H.3 • 17:15

Reach Extension for 100 Gb/s PAM-4 IM/DD Transmission by Chirp Managed Laser, Son T. Le[1], Yasuhiro Matsui[2], Greg Raybon[1], Ashish Verma[2], Martin Kwakernaak[2], Tsurugi Sudo[2]; [1]*Nokia Bell Labs, USA;* [2]*II-VI, USA.* We demonstrate the first chirp managed laser (CML) supporting 100 Gb/s PAM-4 IM/DD transmissions over a record dispersion range of -70 ps/nm to +53 ps/nm considering KP4 FEC and a low complexity 7-tap FFE.

M4H.4 • 17:30

Real-Time 100 Gb/s IM/DD DMT With Chirp Managed Laser Supporting 400 Gb/ CWDM-4 Over 20 km, Son T. Le[1], Tomislav Drenski[2], Andrew Hills[2], Malcolm King[2], Yasuhiro Matsui[3], Ashish Verma[3], Martin Kwakernaak[3], Tsurugi Sudo[3]; [1]*Nokia Bell Labs, USA;* [2]*Socionext, UK;* [3]*II-VI, USA.* We demonstrate the first real-time 100 Gb/s IM/DD DMT transmission with a chirp managed laser over - 65.6 ps/nm to + 48.6 ps/nm of dispersion which is sufficient to support 400 Gb/s CWDM-4 transmission over 20 km.

Room 8

M4I • Free-space Optical Communications

M4I.3 • 17:15 ★ Top-Scored

400-Pixel High-Speed Photodetector for High Optical Alignment Robustness FSO Receiver, Toshimasa Umezawa[1], Atsushi Matsumoto[1], Kouichi Akahane[1], Atsushi Kanno[1], Naokatsu Yamamoto[1]; [1]*National Inst of Information & Comm Tech, Japan.* We fabricated a 400-pixel high-speed photodetector with a 0.85-mm large square size, while maintaining high frequency performance. The high frequency characteristics and optical alignment robustness in a 20-m long distance FSO communication was demonstrated.

M4I.4 • 17:30

Demonstration of Turbulence Resilient Self-Coherent Free-Space Optical Communications Using a Pilot Tone and an Array of Smaller Photodiodes for Bandwidth Enhancement, Hao Song[1], Runzhou Zhang[1], Huibin Zhou[1], Xinzhou Su[1], Kaiheng Zou[1], Yuxiang Duan[1], Haoqian Song[1], Kai Pang[1], Nanzhe Hu[1], Narek Karapetyan[1], Amir Minoofar[1], Moshe Tur[2], Alan E. Willner[1]; [1]*Univ. of Southern California, USA;* [2]*School of Electrical Engineering, Tel Aviv Univ., Israel.* We demonstrate a 4-Gbit/s 16-QAM turbulence-resilient self-coherent free-space optical link using a pilot tone. An array of smaller photodiodes is used to potentially increase the overall bandwidth under turbulence (D/r_0 = ~8.4).

Room 9

M4J • Passive Devices for Next Generation Transmission—Conrinued

M4J.3 • 17:15

A CMOS Compatible on-Chip MMI Based Wavelength Diplexer With 60 Gbit/s System Demonstration, Zakriya Mohammed[1], Bruna Paredes[2], Mahmoud Rasras[2]; [1]*Electrical and Computer Engineering, New York Univ.- Tandon School of Engineering, USA;* [2]*Electrical and Computer Engineering, New York Univ. Abu Dhabi, United Arab Emirates.* An ultra-compact (41μm) 1310/1550 nm diplexer with an insertion loss < 1 dB and extinction ratio > 20 dB for both the wavelengths is demonstrated. Furthermore, experiments show clear eye diagrams at 60 Gbit/s signals.

M4J.4 • 17:30

Silica-PLC Based Mode-Dependent-Loss Equalizer for Two LP Mode Transmission, Takeshi Fujisawa[1], Takayoshi Mori[2], Junji Sakamoto[3], Yoko Yamashita[2], Taiji Sakamoto[2], Ryota Imada[2], Ryoto Ima[1], Takanori Sato[1], Kei Watanabe[3], Ryoichi Kasahara[3], Toshikazu Hashimoto[3], Kazuhide Nakajima[2], Kunimasa Saitoh[1]; [1]*Hokkaido Univ., Japan;* [2]*NTT Access Network Service Laboratories, NTT, Japan;* [3]*NTT Device Technology Laboratories, NTT, Japan.* A mode-dependent-loss (MDL) equalizer based on silica-PLC is proposed for three-mode transmission and experimentally demonstrated for the first time. By selectively attenuating LP_{01}-mode, 1.5-dB MDL equalization is demonstrated for the setup with large LP_{11}-mode loss.

Room 1AB

M4A • Symposia: Multi-access Network Leveraging Edge Computing for Energy-efficient, Ultra-reliable, and Low Latency Services Session II—Conrinued

Room 2

M4B • SDM Transmission—Conrinued

M4B.5 • 17:45
Novel Mirror-Flipped Mode Permutation Technique for Long-Haul Mode-Division Multiplexing Transmissions, Yanze Wang[1], Tianyu Gao[1], Yaping Liu[1], Tao Xu[1], Wenbo Yu[1], Zhiqun Yang[1], Qiang Guo[2], Rui Zhou[2], Shiyi Cao[2], Xinhua Xiao[2], Lin Zhang[1]; [1]*Key Laboratory of Opto-electronic Information Technology of Ministry of Education, School of Precision Instruments and Opto-electronics Engineering, Tianjin Univ., China;* [2]*Huawei Technologies Co., Ltd., China.* We propose a mirror-flipped mode permutation scheme based on symmetric-differential-mode-delay fibers, which could further suppress modal-dispersion-impact by 30% and mitigate mode-dependent-loss-impact with 3.8-dB Q-factor improvement after 1028-km 6-mode transmission compared with the traditional permutation method.

Room 3

Room 6C

M4D • Semiconductor Lasers—Conrinued

M4D.5 • 18:00
Electrically Pumped High Power Laser Transmitter Integrated on Thin-Film Lithium Niobate, Amirhassan Shams-Ansari[1], Dylan Renaud[1], Rebecca Cheng[1], Linbo Shao[1], Lingyan He[2], Di Zhu[1], Mengjie Yu[1], Hannah Grant[3], Leif Johansson[3], Mian Zhang[2], Marko Loncar[1]; [1]*Harvard Univ., USA;* [2]*Hyperlight Corporation, USA;* [3]*Freedom Photonics, USA.* We demonstrate an integrated high-power laser on thin-film lithium niobate with 60-mW of optical power in the waveguides. We use this platform to realize a high-power transmitter consisting an electrically-pumped laser integrated with a 50-GHz modulator.

Room 6D

M4E • Specialty Fibers, Cables and Connectors—Conrinued

M4E.5 • 17:45
No-Polish Air-gap Single-Mode Low-Loss Multi-Fiber Anti-Reflection Coated Connector, Kaz K. Wojewoda[1], Ian Murgatroyd[1], Ivo Radice[1], Michael Kearney[1], Uchan Thapa[1]; [1]*Oxford Fiber Ltd, UK.* We developed a multi-fiber air-gap optical connector which does not require polishing or physical contact between fibers. The developed single-mode connector has an average IL of 0.36dB and RL of 59.3dB with anti-reflective coating.

M4E.6 • 18:00
Stripping-Free Direct Fiber Insertion Connectors Using Thin-Coated Optical Fibers, Jie Liu[1], Randy McClure[1], Qi Wu[1], Weijun Niu[1], Matthew R. Drake[1], Joseph E. McCarthy[1], Jeffery S. Stone[1], Yunfeng Gu[1], Ming-Jun Li[1]; [1]*Corning Inc, USA.* Single-mode fiber connectors are demonstrated with 125 µm diameter thin-coated fibers directly inserted into connector ferrules. Low insertion loss of less than 0.3 dB is achieved due to the high concentricity of the coating.

M4E.7 • 18:15
Low-Loss Mode Field Adapter Using Reverse Tapering for Fundamental Mode Transmission Over MMF, Linbo Yang[1], Zhiqun Yang[1], Tao Xu[1], Lijie Hou[1], Rui Zhou[2], Lin Gan[2], Shiyi Cao[2], Xinhua Xiao[2], Lin Zhang[1]; [1]*Tianjin Univ., China;* [2]*Huawei, China.* We fabricate a low-loss mode field adapter based on reverse tapering for fundamental mode transmission in MMF, which achieves 7-dB MPI reduction and 2-dB Q factor improvement compared with the center-launching situation.

Room 6E

M4F • Open Networking and Streaming Telemetry

M4F.5 • 17:45
QoT-Driven Optical Control and Data Plane in Multi-Vendor Disaggregated Networks, Giacomo Borraccini[1], Stefano Straullu[2], Alessio Giorgetti[3], Rocco D'Ingillo[1], Davide Scano[4], Emanuele Virgillito[1], Andrea D'Amico[1], Antonino Nespola[2], Nicola Sambo[4], Filippo Cugini[5], Vittorio Curri[1]; *[1]Department of Electronics and Telecommunications, Politecnico di Torino, Italy; [2]LINKS Foundation, Italy; [3]CNR, Italy; [4]Scuola Superiore Sant'Anna, Italy; [5]CNIT, Italy.* A novel disaggregated network architecture with independent PCE and optical control based on GNPy is proposed and experimentally validated over a network including two independent OLSs for total 1400 km, ROADM whiteboxes and pluggable transceivers.

M4F.6 • 18:00
GNPy Experimental Validation for Nyquist Subcarriers Flexible Transmission up to 800 G, Andrea D Amico[1], Bertrand Le Guyader[2], Florian Frank[2], Esther Le Rouzic[2], Erwan Pincemin[2], Antonio Napoli[3], Han Sun[4], Bernhard Spinnler[5], Nicolas Brochier[2], Vittorio Curri[1]; *[1]Politecnico di Torino, Italy; [2]Orange Labs, France; [3]Infinera, UK; [4]Infinera, Canada; [5]Infinera, Germany.* We test the performance of Nyquist subcarriers flexible transponders up to 800 Gbit/s over a 20×80-km optical link operated at full WDM spectral load, obtaining excellent accuracy in GSNR and optimal power predictions using GNPy.

M4F.7 • 18:15
Bringing Disaggregated Telemetry and ML to the Transceiver for Autonomic Signal Adaptation, Moisés F. Silva[1], Alessandro Pacini[1], Andrea Sgambelluri[1], Luca Valcarenghi[1], Francesco Paolucci[2]; *[1]Scuola Superiore Sant'Anna, Italy; [2]CNIT, Italy.* Soft failure localization is performed at SDN transceiver agents with peer-to-peer optical telemetry and lightweight ML-based algorithm. Results on a real disaggregated testbed dataset show the effectiveness in terms of accuracy and computational complexity.

Room 6F

M4G • Next-gen High-speed PON II: Optoelectronic Subsystems—Conrinued

M4G.4 • 17:45
Analysis of Potential Four-Wave Mixing Risk in 5G Front-Haul System, Dawei Ge[1], Dong Wang[1], Dechao Zhang[1], Jiang Sun[1], Yunbo Li[1], Sheng Liu[1], Liuyan Han[1], Han Li[1]; *[1]China Mobile Research Inst., China.* FWM is proposed as a new major impairment for 5G front-haul network for the first time. Corresponding theoretical analysis and experiment in FWM penalty have been done for two main commercial plans for comparison.

M4G.5 • 18:00
Experimental Characterization of Colorless Phase Retrieval Under Ultrafast Wavelength Drift for Upstream PON Transmission, Hanzi Huang[1,2], Haoshuo Chen[2], Nicolas Fontaine[2], Yingxiong Song[1], Mikael Mazur[2], Lauren Dallachiesa[2], Yuanhang Zhang[2], Chenhui Ye[3], Dora van Veen[2], Vincent Houtsma[2], Roland Ryf[2], David T. Neilson[2]; *[1]Shanghai Univ., China; [2]Nokia Bell Labs, USA; [3]Nokia Bell Labs, China.* We successfully recover 40-GBaud QPSK signal under ultrafast wavelength drift up to 20,000 nm/s after 40-km single-mode fiber (SMF) transmission employing colorless phase retrieval receiver tackling upstream burst-mode issues in high-speed PON.

Room 7AB

M4H • Ultra-high Baud Rate Data Center Technologie—Conrinued

M4H.5 • 17:45 ★ Top-Scored
Up to 360 Gb/s Optical Interconnects With Ultra-High Bandwidth Thin Film Lithium Niobate Modulator, Fan Yang[1], Xiansong Fang[1], Xinyu Chen[1], Fan Zhang[1,2], Yanping Li[1]; *[1]Peking Univ., China; [2]Peng Cheng Laboratory, China.* We demonstrate ultrahigh-speed optical interconnects with single lane bit rate up to 360Gb/s (120GBaud) PAM-8 signal based on thin film lithium niobate modulator with a 3-dB bandwidth larger than 110GHz.

M4H.6 • 18:00
Experimental Evaluation of PAM and Polybinary Modulation for Intra-DCI Optical Lanes With up to 300 Gbit/s Net Bitrates, Robert Borkowski[1], Qian Hu[1], Yannick Lefevre[2], Fred Buchali[1], Rene Bonk[1], Karsten Schuh[1], Junho Cho[3], Juerg Leuthold[4,5], Wolfgang Heni[4], Benedikt Baeuerle[4], Claudia Hoessbacher[4]; *[1]Nokia Bell Labs, Germany; [2]Nokia Bell Labs, Belgium; [3]Nokia Bell Labs, USA; [4]Polariton Technologies Ltd., Switzerland; [5]Inst. of Electromagnetic Fields (IEF), ETH Zürich, Switzerland.* We experimentally test PAM and polybinary modulation in a wide range of symbol rates, as potential candidates to realize next-generation optical lanes. 306-Gbit/s bitrate is demonstrated with 140-GBd PAM-6 signal at sensitivity -17.9-dBm with EDFA-preamplifier.

Room 8

M4I • Free-space Optical Communications

M4I.5 • 17:45
Demonstration of an Air-Water Communication Link Through Dynamic Aerosol and Water Curvature When Considering the 2-D Modal Coupling of a Spatially Structured Beam, Haoqian Song[1], Runzhou Zhang[1], Huibin Zhou[1], Kaiheng Zou[1], Nanzhe Hu[1], Xinzhou Su[1], Hao Song[1], Kai Pang[1], Yuxiang Duan[1], Daeyoung Park[2], Brittany Lynn[3], Greg Gbur[4], Aristide Dogariu[5], Richard J. Watkins[6], Jerome Miller[6], Eric Johnson[6], Moshe Tur[7], Alan E. Willner[1]; *[1]Univ. of Southern California, USA; [2]Inha Univ., Korea (the Republic of); [3]Naval Information Warfare Center Pacific, USA; [4]Univ. of North Carolina at Charlotte, USA; [5]Univ. of Central Florida, USA; [6]Clemson Univ., USA; [7]Tel Aviv Univ., Israel.* We experimentally investigate the 2-D modal power coupling of LG_{11} and HG_{11} beams under dynamic aerosol and water curvature, and demonstrate a 1-Gbit/s LG_{11} FSO link, having a penalty of ~3-dB compared with no-effect cases.

M4I.6 • 18:00 Invited
Free-Space Optics for Communications at Sea, Katherine Newell[1], Michelle O'Toole[1], Krunal Patel[1], Raef Youssef[1], Radha Venkat[1], Adam Willitsford[1], Noah Talisa[1]; *[1]Johns Hopkins Univ. Applied Physics Laboratory, USA.* We discuss our free-space-optical communication system, specifically exploring tradeoffs in pointing, acquisition, and tracking design and the use of retransmission to mitigate the impact of turbulence-induced fades.

Room 9

M4J • Passive Devices for Next Generation Transmission—Conrinued

M4J.5 • 17:45
Surface-Normal Stokes Vector Receiver Based on Superimposed Metasurface, Go Soma[1], Yoshiro Nomoto[2], Yoshiaki Nakano[1], Takuo Tanemura[1]; *[1]School of Engineering, The Univ. of Tokyo, Japan; [2]Central Research Laboratory, Hamamatsu Photonics K.K., Japan.* We demonstrate normal-incident Stokes vector receiver with superimposed metasurfaces to realize sorting and focusing in three different polarization bases. By using the fabricated metasurface with Si nanopost array, we successfully retrieve arbitrary state of polarization.

M4J.6 • 18:00
64-QAM Self-Coherent Transmission Using Symmetric Silicon Photonic Stokes-Vector Receiver, Shota Ishimura[1,2], Taichiro Fukui[1], Ryota Tanomura[1], Go Soma[1], Yoshiaki Nakano[1], Takuo Tanemura[1]; *[1]School of Engineering, The Univ. of Tokyo, Japan; [2]KDDI Research Inc., Japan.* We propose a robust silicon photonic Stokes-vector receiver based on fully symmetric waveguides without a mode-selective directional coupler. By using a fabricated receiver, we experimentally demonstrate 30-Gb/s 64-QAM self-coherent transmission over a 25-km single-mode fiber.

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

07:30–8:00 Plenary Session Coffee Break

08:00–10:00 Tu1A • Plenary Session *(Ballroom 20BCD)*

10:00–14:00 Exhibit Only Time

10:30–12:00 How to (Re) Start your Career in the Midst of a Pandemic (Part 1) *(OFC Career Zone, Exhibit Hall)*

11:30–12:30 Optica Technical Group on Optical Communications Panel Discussion: Research Lab Stories *(Room 9)*

12:00–14:00 OFC and Co-sponsors Awards Ceremony and Luncheon *(Ballroom 20A)*

12:15–15:30 How to (Re) Start your Career in the Midst of a Pandemic (Part 2) *(OFC Career Zone, Exhibit Hall)*

14:00–16:00
Tu2A • Symposia: Emerging Photonic Interconnects and Architectures for Femtojoule per Bit Intra Data Center Links Session I

Presider: Madeleine Glick, Columbia University, USA

Tu2A.1 • 14:00 Invited

Title to be Announced, William Dally[1]; [1]*NVIDIA and Stanford, USA.* Abstract not available.

14:00–16:00
Tu2B • Panel: What is the Role of Machine Learning in Optical Access Networks?

Artificial Intelligence (AI) and Machine Learning (ML) have attracted increasing interests across a wide range of applications for optical access networks. From physical-layer transmission to wavelength routing, we have experienced over the past decade an increase in complexity of optical access networks, due to increasing data transmission speed, more dynamic and connections and more complicated use cases.

AI and ML have shown promising results for optimization, prediction and identification in systems that exhibit nonlinear, dynamic and complex behaviors and are thus good candidates to tackle optical access networks problems. For instance, recently studies have shown ML algorithms can improve the transmission performance by non-linearity impairments compensation. It has also been reported that ML can achieve better efficiency for bandwidth allocations. We have also seen promising results of using ML for pro-active virtual topology management, efficient network operations, and scalable network automation in access networks.

14:00–16:00
Tu2C • Panel: Technologies for Breaking the Metro/ Access Barrier

Capacity demands continue unabated, with traffic doubling every two to three years, and 5G putting an unprecedented level of pressure on the network with bandwidth requirements increasing 10x to 100x. Network operators are exploring innovative ways to scale while leveraging existing network assets and rearchitecting the network to cope with connectivity challenges triggered by cloud, 5G, and multi-access edge computing. This panel discusses emerging technologies to break metro/access barriers by extending coherent technology to the edge. Panelists will highlight new access technologies and architectures aimed at delivering new levels of capacity and service agility. Panelists will also discuss techno-economical case studies to quantify the benefits of such emerging technologies.

Speakers

Paul Choiseul, *American Tower, USA*

Curtis Knittle, *CableLabs, USA*

Kevin Noll, *Vecima Networks, Canada*

Raja Jayakumar, *Dell Technologies, USA*

David Welch, *Infinera, USA*

14:00–16:00
Tu2D • Light Source for Datacom Applications

Presider: Reza Motaghian; Amazon Web Services, USA and Hideyuki Nasu; Furukawa Electric, Japan

Tu2D.1 • 14:00 Tutorial

Performance and Reliability of Advanced CW Lasers for Silicon Photonics Applications, John Johnson[1], Kenneth Bacher[1], Rebecca Schaevitz[2], Vivek Raghunathan[2]; [1]*Optical Systems Division, Broadcom Inc., USA;* [2]*Optical Systems Division, Broadcom Inc., USA.* Co-Packaged Optics (CPO) using Silicon Photonics Chiplets in Package (SCIP) is an essential technology for flattening the power consumption curve for Networking and Compute applications in Hyperscale Datacenters. CW lasers are integral to the operation of these systems and are an important part of the power solution. This talk will review the impact of advanced CW lasers on the architecture, performance, efficiency and reliability of CPO systems.

14:00–16:00
Tu2E • Comb and Multi-wavelength Sources

Presider: Matthew Sysak; Ayar Labs, USA

Tu2E.1 • 14:00 Invited

Heterogeneous III-v-on Silicon Nitride Mode Locked Lasers, Bart Kuyken[1]; [1]*Ghent Univ. - imec, Belgium.* Abstract not available.

Room 6E	Room 6F	Room 7AB	Room 8

07:30–8:00 Plenary Session Coffee Break

08:00–10:00 Tu1A • Plenary Session *(Ballroom 20BCD)*

10:00–14:00 Exhibit Only Time

10:30–12:00 How to (Re) Start your Career in the Midst of a Pandemic (Part 1) *(OFC Career Zone, Exhibit Hall)*

11:30–12:30 Optica Technical Group on Optical Communications Panel Discussion: Research Lab Stories *(Room 9)*

12:00–14:00 OFC and Co-sponsors Awards Ceremony and Luncheon *(Ballroom 20A)*

12:15–15:30 How to (Re) Start your Career in the Midst of a Pandemic (Part 2) *(OFC Career Zone, Exhibit Hall)*

14:00–16:00
Tu2F • High Capacity Networks

Presider: Dirk Van Den Borne; Juniper Networks Inc., Germany

Tu2F.1 • 14:00 **Tutorial**

Building a Global Content Provider Network at Scale, Alexander I. Nikolaidis[1], John Eason[1], Jeff Rahn[1], Elizabeth Rivera Hartling[1]; [1]*Facebook Inc., USA.* This tutorial covers scaling the backbone network of a global content provider. Key constraints on network growth are classified and scaling strategies discussed. Optimizations and architecture changes for higher scale are presented.

Alexander Nikolaidis is a Network Planner working in the Backbone Engineering Department at Meta, specializing in long range plan-

14:00–16:00
Tu2G • Optical Access Networks for Mobile, Industry and More

Tu2G.1 • 14:00 **Invited**

New Use-Cases for PONs Beyond Residential Services, Rene Bonk[1], Thomas Pfeiffer[1]; [1]*Nokia Bell Labs, Germany.* New use cases for PON are highlighted in critical network infrastructures and industrial factories. Introduction of more flexibility and increased determinism including bounded latency, low jitter, highly secure and available connectivity over PON is addressed. Alexander Nikolaidis is a Network Planner working in the Backbone Engineering Department at Meta, specializing in long range planning, where he has been for the past 6 years. Previously, he worked in the Office of the CTO at Ciena specializing in design optimization and new technology introduction.

14:00–16:00
Tu2H • Panel: What are the Parallelization Technologies for Cost and Energy Efficient 1.6Tb Links?

The deployment of 400G optics is ramping up quickly. On the short reach side, the direct-detection 100G/lambda PAM4 in parallel (DR4) or CWDM (FR4) are implemented at low cost and high energy efficiency with either EMLs or silicon photonic transmitters. On the longer reach side, 400G ZR / ZR+ / Open ROADM coherent pluggables bring fast, streamlined network architectures to hyperscale data centers and carriers. The next generation 800G PAM4 optics with DR8 is expected to deploy next year, followed by 800G coherent solutions.

What would the generation of 1.6T optics look like? One frequently cited viewpoint is that as the data rate goes up, coherent becomes more advantageous because of its higher link margin. Would simplified coherent, or coherent light, become energy efficient to compete against direct-detection in short reach? For coherent, 1x 1.6Tb, 2x800G, 4x400G, which one is more cost and energy efficient? For direct-detect, would the 200G/lambda still be PAM4, or higher format such as PAM6 at lower baud rate? Would it be 8 parallel fibers, or a mixture of parallel fibers and CWDM (2xCWDM4 or 1xCWDM8)? Also, as the chip-to-chip intercon-

14:00–16:00
Tu2I • Integrated Photonic Subsystems

Presider: David Hillerkuss; Huawei Technologies, Germany

Tu2I.1 • 14:00 **Tutorial**

Hybrid Nonlinear Integrated Photonics: From Chipscale Frequency Combs, Ultra Narrow Linewidth Frequency Agile Lasers to Traveling Wave Parametric Amplifiers on Chip, Tobias J. Kippenberg[1]; [1]*Ecole Polytechnique Federale de Lausanne, Switzerland.* Abstract not available.

Biography not available.

Show Floor Programming

SpE14 • Conversation with the Plenary Speakers
10:15–10:45, *Theater III*

DCSK • Data Center Summit: Keynote
10:30–11:00, *Theater II*

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

SF1 • AIM Photonics and the Next PIC Generation
11:30–12:30, *Theater III*

DCS1 • Data Center Summit Panel I: Scaling Data Center Interconnect
11:30–13:00, *Theater II*

MW2 • Market Watch II: The Path to Co-packaged Optics for Switching Applications
12:30–14:00, *Theater I*

SF2 • The Future of PON: 25G or 50G?
13:00–14:00, *Theater III*

DCS2 • Data Center Summit Panel II: Solving the Challenge of Moving Data Centers to the Network Edge
13:30–15:00, *Theater II*

SF3 • DARPA Photonics Programs
14:30–15:30, *Theater III*

MW3 • Market Watch III: Building the Ecosystem for Converged IP/Optical Networks - Beyond 400G Pluggables
14:30–16:00, *Theater I*

SF4 • The Converged Mobile Xhaul and FTTH Fiber Access Opportunity
15:30–16:30, *Theater II*

Room 1AB

Tu2A • Symposia: Emerging Photonic Interconnects and Architectures for Femtojoule per Bit Intra Data Center Links Session I—Continued

Tu2A.2 • 14:30 Invited

(Integrated or not?) Laser Source for a few pJ/bit DWDM Links, Sylvie Menezo[1]; [1]*SCINTIL Photonics, France*. Abstract not available.

Tu2A.3 • 15:00 Invited

Title to be Announced, Mark Wade[1]; [1]*Ayar Labs, USA*. Abstract not available.

Room 2

Tu2B • Panel: What is the Role of Machine Learning in Optical Access Networks?—Continued

This panel will provide a forum for a wide range of speakers to share their ideas on ML/AI over novel applications in optical access networks. The panel will discuss the use of AI and ML in areas such as: DSP for signal impairment compensation; dynamic network capacity allocation; network management and resilience; optical/wireless and access/metro integration; in-home intelligent access network and more.

Speakers

Marija Furdek, *Chalmers University, Sweden*

Leigh Ann Herhold, *Verizon, USA*

Room 3

Tu2C • Panel: Technologies for Breaking the Metro/ Access Barrier—Continued

Room 6C

Tu2D • Light Source for Datacom Applications—Continued

John Johnson holds a Ph.D. from Cornell University and is currently Director of Component R&D at Broadcom's Optical Systems Division, a business descended from AT&T Bell Laboratories which he joined in 1993. His research has included a wide range of optical components including DFB lasers, electroabsorption modulated lasers, tunable lasers and coherent receivers. He is an active participant in multiple global standards development organizations and MSAs.

Tu2D.2 • 15:00

Integrated Optical Transmitter With Micro-Transfer-Printed Widely Tunable III-v-on-Si Laser, Jing Zhang[1], Emadreza Soltanian[1], Bahawal Haq[1], Stefan Ertl[3], Johanna Rimbock[3], Bozena Matuskova[3], Emanuele Pelucchi[4], Agnieszka Gocalinska[4], Joris Van Campenhout[2], Guy Lepage[2], Peter Verheyen[2], Wim Bogaerts[1], Gunther Roelkens[1]; [1]*INTEC, Ghent Univ.-imec, Belgium;* [2]*imec, Belgium;* [3]*EV Group, Austria;* [4]*Tyndall National Inst., Ireland.* We demonstrate a C-band optical transmitter with an integrated widely-tunable III-V-on-silicon laser on the imec iSiPP50G platform using micro-transfer printing. Back-to-back operation at 40 Gbit/s non-return-to-zero On-Off keying over the C-band is presented.

Room 6D

Tu2E • Comb and Multi-wavelength Sources—Continued

Tu2E.2 • 14:30

High-Temperature Error-Free Operation in a Heterogeneous Silicon Quantum Dot Comb Laser, Geza Kurczveil[1], Xian Xiao[1], Antoine Descos[1], Sudharsanan Srinivasan[1], Di Liang[1], Ray Beausoleil[1]; [1]*Hewlett Packard Laboratories, USA*. We show error-free operation in over 40 comb lines from a heterogeneous silicon comb laser operating continuous-wave at a substrate temperature of 50°C. Such devices are attractive sources for optical interconnects in next-generation HPC systems.

Tu2E.3 • 14:45

Dual Laser Indium Phosphide Photonic Integrated Circuits for Remote Active Carbon Dioxide Sensing, Fengqiao Sang[1], Victoria Rosborough[1], Joseph Fridlander[1], Fabrizio Gambini[2,3], Simone Šuran Brunelli[1], Jeffrey R. Chen[2], Stephan R. Kawa[2], Kenji Numata[2], Mark Stephen[2], Larry Coldren[1], Jonathan Klamkin[1]; [1]*Univ. of California, Santa Barbara, USA;* [2]*NASA Goddard Space Flight Center, USA;* [3]*Univ. of Maryland Baltimore County, USA*. Two generations of indium phosphide photonic integrated circuits were fabricated, characterized, and their performance compared. Successful sampling of carbon dioxide was performed in a laboratory setting under continuous wave sampling.

Tu2E.4 • 15:00

16 Wavelengths Comb Source Using Large-Scale Hybrid Photonic Integration, Stefano Grillanda[1], Cristian Bolle[1], Mark Cappuzzo[1], Rick Papazian[1], Bob Farah[1], Nicolas Fontaine[1], Mikael Mazur[1], Rose Kopf[1], Mark Earnshaw[1]; [1]*Nokia Bell Labs, USA*. We demonstrate a 16 wavelengths comb source using hybrid integration of 16 gain chips, 32 balls lenses and an arrayed waveguide grating, with total output power >20 mW, SMSR > 56 dB, and kHz-scale linewidths.

Tu2F • High Capacity Networks—Continued

ning, where he has been for the past six years. Previously, he worked in the Office of the CTO at Ciena specializing in design optimization and new technology introduction.

Tu2F.2 • 15:00
High-Capacity 400Gb/s Real-Time Transmission Over SCUBA110 Fibers for DCI/Metro/Long-Haul Networks, Benyuan Zhu[1], Tommy Geisler[2], Peter Borel[2], R Jensen[2], Matthias Stegmaier[2], Bera Palsdottir[2], David Peckham[3], Robert Lingle[3], Man Yan[1], David DiGiovanni[1]; [1]*OFS Laboratories, USA;* [2]*OFS, Denmark;* [3]*OFS, USA.* We demonstrate real-time transmission 23.2 Tb/s (58x400Gb/s) DWDM signals over 1507km of G.654E SCUBA110 fiber using 400ZR+ pluggable coherent transceiver modules, additionally, 26Tb/s (65x400Gb/s) is transmitted over 200km SCUBA110 fiber link using 400ZR pluggable modules.

Tu2G • Optical Access Networks for Mobile, Industry and More—Continued

Tu2G.2 • 14:30
Radio-Over-Fiber Transmission Supporting 65536-QAM at 25GHz Band With High-Pass Delta-Sigma Modulation and RF Fading Mitigation, Yixiao Zhu[1], Xiansong Fang[2], Longjie Yin[1], Fan Zhang[2], Weisheng Hu[1]; [1]*Shanghai Jiao Tong Univ., China;* [2]*Peking Univ., China.* We experimentally demonstrate radio-over-fiber transmission of 44.4Gb/s 65536-QAM at 25GHz employing 2-bit high-pass delta-sigma modulation. 0.19% EVM is achieved after 10km C-band SSMF transmission, and dispersion-induced RF fading is mitigated by differential skew-enabled spectral shaping.

Tu2G.3 • 14:45 Invited
Latency-Aware Network Architectures for 5G Backhaul and Fronthaul, David Larrabeiti[1], Gabriel Otero[1], Juan Pedro Fernández-Palacios[2], Luis M. Contreras[2], Jose A. Hernández[1]; [1]*Universidad Carlos III de Madrid, Spain;* [2]*Telefónica Global CTO, Spain.* 5G poses important challenges regarding latency management, specially in fronthaul and backhaul traffic transport. Operators are combining standards in search of a unified architecture that features virtualization, programmability and performance control.

Tu2H • Panel: What are the Parallelization Technologies for Cost and Energy Efficient 1.6Tb Links?—Continued

nects gain more visibility, what would the optics look like for ultimate efficiency?

The panelists would share their viewpoints on these topics and open discussion with the audience.

Speakers

Arash Farhoodfar, *Marvell, USA*

Xiang Zhou, *Google, USA*

Osa Mok, *Innolight, China*

Karl Muth, *Broadcom, USA*

Sergey Shumarayev, *Intel, USA*

Tu2I • Integrated Photonic Subsystems—Continued

Tu2I.2 • 15:00
Photonic Interferometric Imager With Monolithic Silicon CMOS Photonic Integrated Circuits, Humphry Z. Chen[1], Mehmet Berkay On[1], Yun-Jhu Lee[1], Li Zhang[1], Roberto Proietti[1], S. J. Ben Yoo[1]; [1]*Univ. of California, Davis, USA.* : We demonstrate, for the first time to our knowledge, a monolithically-integrated photonic interferometric imager circuit with on-chip detectors, CMOS trans-impedance-amplifiers, and associated photonic imager components. A proof-of-principle demonstration of interferogram fringe generation will be discussed.

Show Floor Programming

DCS2 • Data Center Summit Panel II: Solving the Challenge of Moving Data Centers to the Network Edge
13:30–15:00, *Theater II*

SF3 • DARPA Photonics Programs
14:30–15:30, *Theater III*

MW3 • Market Watch III: Building the Ecosystem for Converged IP/Optical Networks - Beyond 400G Pluggables
14:30–16:00, *Theater I*

SF4 • The Converged Mobile Xhaul and FTTH Fiber Access Opportunity
15:30–16:30, *Theater II*

Room 1AB

Tu2A • Symposia: Emerging Photonic Interconnects and Architectures for Femtojoule per Bit Intra Data Center Links Session I—Continued

Tu2A.4 • 15:30 Invited

Title to be Announced, Ashish Raniwala[1]; [1]*Microsoft, USA.* Abstract not available.

Room 2

Tu2B • Panel: What is the Role of Machine Learning in Optical Access Networks?—Continued

Room 3

Tu2C • Panel: Technologies for Breaking the Metro/ Access Barrier—Continued

Room 6C

Tu2D • Light Source for Datacom Applications—Continued

Tu2D.3 • 15:15

Up to 600 Gbit/s Data Transmission Over 100 m of Single Multi-Mode Fiber Using 4×λ 850-940 nm VCSELs, Nikolay Ledentsov Jr.[1,2], Christoph Kottke[3], Lukasz Chorchos[1,2], Vitaly A. Shchukin[1], Oleg Y. Makarov[1], Marwan Bou Sanayeh[1], Vladimir P. Kalosha[1], Volker Jungnickel[3], Ronald Freund[3], Jaroslaw P. Turkiewicz[2], Nikolay N. Ledentsov[1]; [1]*VI Systems GmbH, Germany;* [2]*Warsaw Univ. of Technology, Poland;* [3]*Fraunhofer Heinrich Hertz Inst., Germany.* We demonstrate parallel high speed data transmission over single multimode fiber using VCSELs operating in the SWDM wavelength range (850 nm – 940 nm). Total demonstrated throughput of such system reaches 500 Gbit/s with 4-PAM modulation and 600 Gbit/s with DMT modulation.

Tu2D.4 • 15:30

Behavioral PAM-4 VCSEL Model Using Stochastic Multimode Rate Equations for Link Design Optimization, Alirio Melgar[1], Varghese A. Thomas[1], Benjamin D. Klein[2], Itshak Kalifa[3], Paraskevas Bakopoulos[3], Elad Mentovich[3], Stephen E. Ralph[1]; [1]*Georgia Inst. of Technology, USA;* [2]*Department of Electrical and Computer Engineering, Kennesaw State Univ., USA;* [3]*Nvidia Networking, Israel.* A stochastic multimode laser model aimed at optimizing optical links is proposed. The model simulates experimental results from commercial VCSELs and depicts transverse mode effects that are increasingly important in high-speed PAM-4 links.

Tu2D.5 • 15:45

Highly Reliable 106 Gb/s PAM-4 850 nm Multi-Mode VCSEL for 800G Ethernet Applications, Mirko Hoser[1], Wolfgang Kaiser[1], David Quandt[1], Julián Bueno[1], Stéphanie Saintenoy[1], Sven Eitel[1]; [1]*II-VI Incorporated, Switzerland.* This paper reviews II-VI's 106 Gb/s PAM-4 multi-mode VCSELs for commercial 800G transceiver applications. The VCSEL provides 27 GHz bandwidth, RIN of -150 dB/Hz, 0.25 nm spectral width and shows an excellent reliability.

Room 6D

Tu2E • Comb and Multi-wavelength Sources—Continued

Tu2E.5 • 15:15

Demonstration of a Hybrid III-v/Si Multi-Wavelength DFB Laser for High-Bandwidth Density I/O Applications, Ranjeet Kumar[1], Duanni Huang[1], Meer Sakib[1], Guan-Lin Su[1], Chaoxuan Ma[1], Xinru Wu[1], Haisheng Rong[1]; [1]*Intel Corporation, USA.* We demonstrate a 4-wavelength DFB laser with >8dBm output power per wavelength, <±0.5dB power variations, 140GHz wavelength spacing, and <-140dB/Hz RIN. For data transmission at 64 Gb/s, we obtained comparable performance to a benchtop laser.

16:00–16:30 Coffee Break

Room 6E

Tu2F • High Capacity Networks—Continued

Room 6F

Tu2G • Optical Access Networks for Mobile, Industry and More—Continued

Tu2G.4 • 15:15
Multipoint-to-Point Data Aggregation Using a Single Receiver and Frequency-Multiplexed Intensity-Modulated ONUs, Zichuan Zhou[1], Jinlong Wei[2], Eric Sillekens[1], Callum Deakin[1], Ronit Sohanpal[1], Yuan Luo[3], Radan Slavik[4], Zhixin Liu[1]; *[1]Univ. College London, UK; [2]Huawei Technologies Duesseldorf GmbH, Germany; [3]The Chinese Univ. of Hong Kong (Shenzhen), China; [4]Univ. of Southampton, UK.* We demonstrate 2.5-GHz-spaced frequency multiplexing capable of aggregating 64 intensity-modulated end-users using low-speed electronic and optoelectronic components. All optical network units (ONUs) achieved high per-user capacity with dedicated optical bands, enabling future low latency applications.

Tu2G.5 • 15:30
White Rabbit Protocol Enhanced TDM-PON With Nanoseconds Clock and Data Recovery and Picoseconds Time Synchronization Accuracy, Yisong Zhao[1], Xuwei Xue[1], Bingli Guo[1], Zuoqing Zhao[1], Yuanzhi Guo[1], Shanguo Huang[1]; *[1]State Key Laboratory of Information Photonics and Optical Communications, Beijing Univ. of Posts and Telecommunications, China.* White Rabbit protocol enhanced TDM-PON is proposed first time for fast clock and data recovery (CDR) and accurate time synchronization. Experimental results validate 38ns CDR time without cost-high burst-mode receiver and 390ps average time skew.

Tu2G.6 • 15:45
Demonstration of Industrial-Grade Passive Optical Network, Konstantinos (Kostas) Christodoulopoulos[1], Sarvesh Bidkar[1], Wolfram Lautenschlaeger[1], Thomas Pfeiffer[1], Rene Bonk[1]; *[1]Nokia Bell Labs Germany, Germany.* We demonstrate a TDM-PON operating according to industrial-grade standards. Using a suitably configured PON-MAC and jitter compensation we achieved constant low latency upstream transmission and successful interworking with a TSN network and time-critical flows.

Room 7AB

Tu2H • Panel: What are the Parallelization Technologies for Cost and Energy Efficient 1.6Tb Links?—Continued

16:00–16:30 Coffee Break

Room 8

Tu2I • Integrated Photonic Subsystems—Continued

Tu2I.3 • 15:15 Invited
Narrow Linewidth Lasers for Low-Energy Coherent Communications, Grant M. Brodnik[1], Mark W. Harrington[1], John H. Dallyn[7], Wei Zhang[2,3], Liron Stern[2,4], Paul Morton[5], Ryan O. Behunin[7,6], Scott B. Papp[2,8], Daniel J. Blumenthal[1]; *[1]Univ. of California Santa Barbara, USA; [2]Time and Frequency Division, National Inst. of Standards and Technology, USA; [3]Jet Propulsion Laboratory, USA; [4]Department of Applied Physics, Hebrew Univ. of Jerusalem, Israel; [5]Morton Photonics, USA; [6]Center for Materials Interfaces in Research and Applications, Northern Arizona Univ., USA; [7]Department of Applied Physics and Material Sciences, Northern Arizona Univ., USA; [8]Department of Physics, Univ. of Colorado, Boulder, USA.* We present chip-scale lasers with ~1Hz fundamental linewidths, ~30Hz integral linewidths, and stability better than $2x10^{-13}$ (50ms) enabling energy-efficient, ultra-low residual phase error carrier recovery for DSP-free high-capacity coherent communications in tomorrow's data center interconnects.

Tu2I.4 • 15:45
Photonics-Based 300 GHz Band Wireless Terahertz Link Using 10Gbps Directly-Modulated Monolithically-Integrated Novel Dual-Mode Laser as Beating Light Source, Younghoon Kim[1], Dong Woo Park[1], Jinchul Cho[1], Eui Su Lee[1], Da-Hye Choi[1], Jun-Hwan Shin[1], Mugeon Kim[1], Seung-Hyun Cho[1], Sang-Rok Moon[1], Eon-Sang Kim[1], Yongsoon Baek[1], Donghoon Lee[1], Sangho Park[1], Young Ahn Leem[1], Il-Min Lee[1], Kyung Hyun Park[1]; *[1]ETRI, Korea (the Republic of).* We demonstrate a photonics-based 300GHz band wireless terahertz (THz) link using our directly modulated novel dual-mode laser (DML) as the beating light source. We have obtained 10Gbps transmission over a single channel.

Show Floor Programming

SF3 • DARPA Photonics Programs
14:30–15:30, *Theater III*

MW3 • Market Watch III: Building the Ecosystem for Converged IP/Optical Networks - Beyond 400G Pluggables
14:30–16:00, *Theater I*

SF4 • The Converged Mobile Xhaul and FTTH Fiber Access Opportunity
15:30–16:30, *Theater II*

Room 1AB

16:30–18:30
Tu3A • Symposia: Emerging Photonic Interconnects and Architectures for Femtojoule per Bit Intra Data Center Links Session II
Presider: Hai-Feng Liu; HG Genuine Optics Tech Co Ltd., USA

Tu3A.1 • 16:30 Invited
Title to be Announced, Gordon Keeler[1]; [1]*DARPA, USA*. Abstract not available.

Tu3A.2 • 17:00 Invited
Realizing Pb/s IO With Silicon Photonic Chiplets, Keren Bergman[1]; [1]*Columbia Univ., USA*. Computing performance is increasingly bottlenecked by the energy and communications costs of interconnection networks. We show how comb driven dense-WDM silicon photonics can realize Pb/s scale chip escape bandwidths with sub-pJ/bit energy consumption.

Room 2

16:30–18:30
Tu3B • Optical Subsystem Implementations
Presider: Hungchang (James) Chien; Marvell Technology Inc., USA

Tu3B.1 • 16:30 Invited
Coherent DSP and System Integration Technologies for 800G, Tony S. Wang[1], Hai Xu[1], Alejandro Castrillon[1], Marcos Macchi[1], Alfredo Taddei[1], Damian Morero[1], Hungchan Chien[1], Oscar Agazzi[1]; [1]*Marvell Technology Inc., USA*. This paper discusses challenges in achieving low-power coherent pluggables for 800G, and innovations required to overcome those challenges. Recent progress in the areas of system integration and low-power DSP design and implementation will be surveyed.

Tu3B.2 • 17:00
On the Performance of Digital Resolution Enhancement and Waterfilling in Digital Subcarrier Multiplexing Systems With Low-Resolution DACs, Trung-Hien Nguyen[1], Youssef Nasser[1], Yu Zhao[1], Sami Mumtaz[1], Abel Lorences-Riesgo[1], Celestino Sanches Martins[1], Gabriel Charlet[1], Stefanos Dris[1]; [1]*Huawei Technologies France, OCT lab., France*. Digital resolution enhancement is experimentally demonstrated for 800G 107 Gbaud 8-subcarrier PCS-256QAM employing waterfilling. 1.4 dB SNR and 1 dB Q^2-factor gains are obtained using 4-bit DAC resolution at 1.125 samples/symbol.

Room 3

16:30–18:30
Tu3C • VLC for Indoor Applications

Tu3C.1 • 16:30
High-Speed White Light Visible Light Communication (VLC) Based on Semipolar (20-21) Blue Micro-Light Emitting Diode (μ-LED), Yun-Han Chang[1], Fang-Jyun Liou[1], Yu-Ming Huang[1], Wahyu Hendra Gunawan[1], Chi-Wai Chow[1], Hao-Chung Kuo[1], Yang Liu[2], Chien-Hung Yeh[3]; [1]*National Yang Ming Chiao Tung Univ., Taiwan;* [2]*Philips Electronics Ltd, Hong Kong;* [3]*Feng Chia Univ., Taiwan*. We demonstrate a record 2.473-Gbit/s white-light visible-light-communication (VLC) using semipolar (20-21) blue InGaN/GaN μ-LED with yellow-phosphor. The measured 3-dB-bandwidth of blue and white lights are 1042.5 MHz and 772.4 MHz respectively.

Tu3C.2 • 16:45
8.205-Gbit/s Visible Light Communication Utilizing 4×4 Si-Substrate μLED-Based Photodetector Array, Wenqing Niu[1], Jianyang Shi[1], Zengyi Xu[1], Dong Li[1], Weihuang Xiao[2], Guangxu Wang[2], Jianli Zhang[2], Zhixue He[3], Chao Shen[1], Nan Chi[1]; [1]*Fudan Univ., China;* [2]*Nanchang Univ., China;* [3]*Peng Cheng Laboratory, China*. We demonstrate an 8.205-Gbit/s VLC transmission over 0.5-m free-space link based on 4×4 Si-substrate InGaN/GaN MQW micro-LED-based photodetector array. Adaptive bit-power-loading scheme is applied to maximize the spectral efficiency for the OFDM VLC system.

Tu3C.3 • 17:00
Wide Field-of-View (FOV) Light-Diffusing Fiber Optical Transmitter for Rolling Shutter Based Optical Camera Communication (OCC), Deng-Cheng Tsai[1], Yun-Han Chang[1], Yang Liu[2], Chi-Wai Chow[1], Yun-Shen Lin[1], Chien-Hung Yeh[3]; [1]*National Yang Ming Chiao Tung Univ., Taiwan;* [2]*Philips Electronics Ltd, Hong Kong;* [3]*Feng Chia Univ., Taiwan*. We propose a wide field-of-view (FOV) light-diffusing-fiber (LDF) transmitter optical-camera-communication (OCC). Pixel-row-per-bit-neural-network (PRPB-NN) is employed for rolling-shutter-pattern decoding. PRPB-NN provides efficient decoding at 360° around LDF circumference and 160° Rx rotation-angle at 2100-bit/s.

Room 6C

16:30–18:30
Tu3D • Narrow Linewidth and Tunable Lasers
Presider: Geert Morthier; Universiteit Gent, Belgium

Tu3D.1 • 16:30 Invited
Integrated Ultra-Narrow Linewidth Stabilized SBS Lasers, Daniel J. Blumenthal[1]; [1]*Univ. of California Santa Barbara, USA*. Frequency-stabilized, spectrally-pure lasers are key to precision scientific applications including quantum, atomic clocks, and metrology. We discuss progress towards integrating aspects of these systems to the chip-scale using Si_3N_4 Brillouin lasers and ultra-high Q resonators.

Tu3D.2 • 17:00
Semiconductor Laser Stabilized by a 4 Meter Coil-Waveguide Resonator, Kaikai Liu[1], Nitesh Chauhan[1], Jiawei Wang[1], Andrei Isichenko[1], Grant M. Brodnik[1], Paul Morton[2], Ryan O. Behunin[3], Scott B. Papp[4], Daniel J. Blumenthal[1]; [1]*Univ. of California, Santa Barbara, USA;* [2]*Morton Photonics Inc, USA;* [3]*Northern Arizona Univ., USA;* [4]*Univ. of Colorado Boulder, USA*. We stabilize a semiconductor laser to a photonic-integrated, Si_3N_4, 4 meter coil resonator, achieving thermorefractive-noise-limited frequency noise. The laser exhibits a record low 87 Hz 1/p and 2.1 kHz -separation integral linewidth and 2.6×10^{-13} fractional frequency stability.

Room 6D

16:30–18:30
Tu3E • Raman Amplification and Frequency Comb Generation
Presider: Raja Ahmad; OFS Laboratories, USA

Tu3E.1 • 16:30
Investigation of Wideband Distributed Raman Amplification in a Few-Mode Fiber Link, Georg Rademacher[1], Ruben S. Luis[1], Benjamin J. Puttnam[1], Juan Carlos Alvarado Zacarias[2], Rodrigo Amezcua Correa[2], Kazuhiko Aikawa[3], Yoshinari Awaji[1], Hideaki Furukawa[1]; [1]*National Inst of Information & Comm Tech, Japan;* [2]*CREOL, Univ. of Central Florida, USA;* [3]*Fujikura Ltd., Japan*. We experimentally investigate distributed Raman amplification in a graded-index three-mode fiber over more than 80 nm signal bandwidth. We measured gain of up to 6 dB with 0.3 dB mode-dependence when pumping only the highest-order modes.

Tu3E.2 • 16:45
210 nm E, S, C and L Band Multistage Discrete Raman Amplifier, Pratim Hazarika[1], Mingming Tan[1], Aleksandr Donodin[1], Ian Phillips[1], Paul Harper[1], Ming-Jun Li[2], Wladek Forysiak[1]; [1]*Aston Univ., UK;* [2]*Corning Incorporated, USA*. We demonstrate a multistage Raman amplifier for 210 nm signal amplification with 15 dB gain and 8.1 dB maximum noise figure enabling ESCL-band transmission with 10 Gb/s NRZ signals over 70 km SMF.

Tu3E.3 • 17:00 Invited
Harnessing Multi-Octave Coherent Light Using Anti-Resonant Fibers, David Novoa[1,2]; [1]*Univ. of the Basque Country, Spain;* [2]*Ikerbasque, the Basque Foundation for Science, Spain*. Gas-filled anti-resonant fibers enable an ultrafast source of phase-stable waveforms with tunable ultra-broadband spectrum spanning from the ultraviolet to the terahertz. The system features higher brightness than synchrotrons, opening horizons in spectroscopy and strong-field physics.

Room 6E

16:30–18:30
Tu3F • Optical Transport for 5G Applications
Presider: Frank Effenberger; FutureWei Technologies Inc, USA

Tu3F.1 • 16:30 Invited
Timing and Synchronization in Optical Networks for 5G Transport, Nir Laufer[1]; [1]*Oscilloquartz SA, Switzerland.* In this session we will review the options for delivering accurate timing using PTP+Sync-E over OTN/WDM networks. We will focus on out of band optical timing channel which overcome many of the technical and economical challenges and provide a sub 100nsec accuracy.

Tu3F.2 • 17:00
A Field Trial of 50G TDM-PON Based 5G Small Cell Backhaul, Ning Wang[1], Junwei Li[1], Dekun Liu[2], Yu Wu[3], Jinglong Zhu[1], Da Liu[3], Lirong Bai[3], Dechao Zhang[1], Han Li[1], Borui Li[2]; [1]*China Mobile Research Inst., China;* [2]*Huawei Technologies Co., Ltd., China;* [3]*China Mobile Communications Corporation Group Co., Ltd., China.* We demonstrate a field trial of 50G TDM-PON based small cell backhaul. Multiple user equipment are connected to two 5G base stations simultaneously. The maximum download speed of each user equipment reaches nearly 1000 Mbps.

Room 6F

16:30–18:30
Tu3G • Novel and Emerging Networks
Presider: Yingju Wang; HIST, China

Tu3G.1 • 16:30 Invited
Optical Neuromorphic Processor at 11 TeraOPs/s Based on Kerr Soliton Crystal Micro-Combs, Mengxi Tan[1], Xingyuan Xu[4], Jiayang Wu[1], Roberto Morandotti[2], Arnan Mitchell[3], Bill P. Corcoran[4], Sai Chu[5], Brent Little[6], Andreas Boes[3], Thach Nguyen[3], Damien Hicks[1], David J. Moss[1]; [1]*Swinburne Univ. of Technology, Australia;* [2]*INRS, Canada;* [3]*RMIT Univ., Australia;* [4]*Monash Univ., Australia;* [5]*City Univ. of Hong Kong, Hong Kong;* [6]*xi'an Univ., China.* We demonstrate a universal optical vector convolutional accelerator operating at 11 Tera-OPS, generating convolutions of images of 250,000 pixels with 8-bit resolution for 10 kernels simultaneously. We use the same hardware to form a deep optical CNN with ten output neurons, achieving successful recognition of full 10 digits with 88% accuracy. Our approach is scalable and trainable for applications to unmanned vehicle and real-time video recognition.

Tu3G.2 • 17:00
Ultra-low Latency Short Packet Transmission Experiments With Optical Bus Platform Based on PCIe, Toshiya Matsuda[1], Kota Nishiyama[1], Kana Masumoto[1], Masahiro Nakagawa[1], Takashi Miyamura[1]; [1]*NTT Network Service Systems Laboratories, Japan.* We propose an optical bus platform architecture that provides an ultra-low latency path for small traffic on metro-scale networks. We experimentally demonstrate that remote memory can be accessed over 25 km in 244.2 μs.

Room 7AB

16:30–18:30
Tu3H • Enablers and Disrupters in Data Center and HPC
Presider: Brian Taylor; Inphi, USA

Tu3H.1 • 16:30 Invited
Digital Subcarriers: a Universal Technology for Next Generation Optical Networks, David F. Welch[1], Antonio Napoli[1], Johan Bäck[1], Norm Swenson[1], Warren Sande[1], João Pedro[1], Fady Masoud[1], Aaron Chase[1], Chris R. Fludger[1], Han Sun[1], Ting-Kuang Chiang[1], Atul Mathur[1], Kuang-Tsan Wu[1]; [1]*Infinera Corporation, USA.* Coherent technology can be operated with independent digital subcarriers to realize point-to-point and point-to-multipoint optical networks. Enabled by configurable software management, it creates a simple, scalable, low-cost solution, compatible across network, vendors, and generations.

Tu3H.2 • 17:00 Invited
New Trend of Open and Disaggregated Optical Networks, Dou Liang[1], Sai Chen[2], Huan Zhang[2], Jingchi Cheng[2], Fan Gao[2], Boyuan Yan[2], Shuai Zhang[1], Zhao Sun[1], Lei Wang[1], Chongjin Xie[3]; [1]*Alibaba Cloud, Alibaba Group, China;* [2]*Alibaba Cloud, Alibaba Group, China;* [3]*Alibaba Cloud, Alibaba Group, USA.* Open and disaggregated systems supporting flexgrid operation and ROADM are being introduced to data center interconnect networks. System integration and network automation are effective to further increase the network efficiency in the future.

Room 8

16:30–18:30
Tu3I • Quantum Communications
Presider: Helmut Griesser; ADVA Optical Networking AG, Germany

Tu3I.1 • 16:30 Tutorial
Introduction to Continuous Variable Quantum Key Distribution, Takuya Hirano[1]; [1]*Gakushuin Univ., Japan.* In this talk, we will review the present status of continuous-variable quantum key distribution, including optical configuration and security analysis, and would like to discuss future prospects for integration with coherent optical communications.

Takuya Hirano has been a Professor of Physics at Gakushuin University in Japan since 2005. He received his Ph.D in 1992 from the University of Tokyo. His research interests are in Quantum Optics, especially continuous-variable (CV) quantum key distribution, CV entanglement, and a spinor Bose-Einstein condensate of neutral atoms.

Show Floor Programming

SF5 • An OIF Update on Electrical Rates: 112G Technical Closure and the Latest Progress and Challenges for 224G to Create the Next Speed Node
16:00–17:00, *Theater III*

Room 1AB

Tu3A • Symposia: Emerging Photonic Interconnects and Architectures for Femtojoule per Bit Intra Data Center Links Session II—Continued

Tu3A.3 • 17:30 Invited

Glass Interposer for High-Density Photonic Packaging, Lars Brusberg[1], Jason R. Grenier[1], Sükrü Ekin Kocabas[1], Aramais R. Zakharian[1], Lucas W. Yeary[1], Daniel W. Levesque[1], Barry J. Paddock[1], Robert A. Bellman[1], Robin M. Force[1], Chad C. Terwilliger[1], Clifford G. Sutton[1], Jeffrey Clark[1], Katerina Rousseva[1]; [1]*Corning Research & Development Corporation, USA.* A circuit on glass with optical fiber interfaces, integrated planar waveguides, and through glass vias is demonstrated for co-packaged optics hosting and interconnecting electrical and photonic integrated circuits by flip-chip bonding.

Room 2

Tu3B • Optical Subsystem Implementations—Continued

Tu3B.3 • 17:15

Complementary Polarization-Diversity Self-Coherent Homodyne Receiver With Rapid Polarization Tracking for Remote LO, Honglin Ji[1], Jingchi Li[2], Xingfeng Li[2], Shuangyu Dong[1], Zhaopeng Xu[1], Yikai Su[2], William Shieh[1]; [1]*Department of Electrical and Electronic Engineering, The Univ. of Melbourne, Australia;* [2]*State Key Lab of Advanced Optical Communication Systems and Networks, Department of Electronic Engineering, Shanghai Jiao Tong Univ., China.* We propose a complementary polarization-diversity coherent receiver (C-PDCR) based on complementary polarization detection. The proposed C-PDCR features rapid polarization tracking for remote LO using electronic DSP. The robustness is verified by a 1.08-Tb/s dual-polarization PCS-256QAM signal with up to 314-Krad/s polarization tracking speed.

Tu3B.4 • 17:30

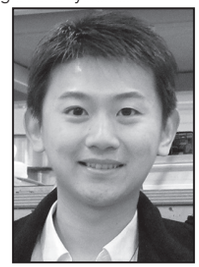
Capacity Region Bounds for K-User Optical WDM Channels With Peak Power Constraints, Viswanathan Ramachandran[1], Gabriele Liga[1], Astrid Barreiro[1], Alex Alvarado[1]; [1]*TU Eindhoven, Netherlands.* We study an optical WDM channel from an interference channel viewpoint. An achievable rate region that strictly outperforms treating interference as noise is presented, along with a capacity region outer bound.

Room 3

Tu3C • VLC for Indoor Applications—Continued

Tu3C.4 • 17:15 Tutorial

Evolution of Optical-Wireless Communications, Ke Wang[1], Tingting Song[2], Yitong Wang[1], Chengwei Fang[1], Ampalavanapillai Nirmalathas[2], Christina Lim[2], Elaine Wong[2], Sithamparanathan Kandeepan[1]; [1]*Royal Melbourne Inst. of Technology, Australia;* [2]*Department of Electrical and Electronic Engineering, The Univ. of Melbourne, Australia.* Optical wireless communications (OWC) explore the broad unregulated optical spectrum to provide high-speed wireless communications, which are promising in beyond-5G. We will review the recent developments of short-range OWC technologies and systems.



A/Prof Ke Wang is currently an Associate Professor with the School of Engineering, Royal Melbourne Institute of Technology (RMIT University), Australia. He has published over 150 papers in peer-reviewed journals and conferences. His current research interests include optical and wireless communications and convergence, optical interconnects, satellite communications and networks.

Room 6C

Tu3D • Narrow Linewidth and Tunable Lasers—Continued

Tu3D.3 • 17:15

Hybrid InP-SiN Microring-Resonator Based Tunable Laser With High Output Power and Narrow Linewidth for High Capacity Coherent Systems, Cosimo Calo[1], Kaoutar Benyahya[2], Haik Mardoyan[2], Philippe Charbonnier[1], Davide Sacchetto[3], Michael Zervas[3], Karim Mekhazni[1], Delphine Lanteri[1], Harry Gariah[1], Catherine Fortin[1], Nicolas Vaissière[1], Antoine Elias[1], Olivier Parillaud[1], Franck Mallecot[1], Jean Decobert[1], Frederic Pommereau[1], Jérémie Renaudier[2]; [1]*III-V Lab, France;* [2]*Nokia Bell Labs - Paris-Saclay, France;* [3]*Ligentec SA, Switzerland.* A hybrid InP/SiN tunable laser based on microring resonators exhibiting 40mW fiber-coupled output power and 5kHz linewidth is demonstrated. The device shows performance comparable with commercial external cavity lasers in 90GBd 64QAM coherent system.

Tu3D.4 • 17:30

A Hybrid-Integrated External Cavity Laser With Ultra-Wide Wavelength Tuning Range and High Side-Mode Suppression, Yuyao Guo[1], Xinhang Li[1], Weihan Xu[1], Chuxin Liu[1], Minhui Jin[1], Liangjun Lu[1,2], Jingya Xie[3], Anton Stroganov[4], Jianping Chen[1,2], Linjie Zhou[1,2]; [1]*Electronic Engineering, Shanghai Jiao Tong Univ., China;* [2]*SJTU-Pinghu Inst. of Intelligent Optoelectronics, China;* [3]*Univ. of Shanghai for Science and Technology, China;* [4]*LIGENTEC SA, Switzerland.* We present a III-V/Si_3N_4 hybrid-integrated tunable laser. The laser shows a record of ~170-nm tuning range with a side mode suppression ratio above 64 dB and an intrinsic linewidth below 2.8 kHz.

Room 6D

Tu3E • Raman Amplification and Frequency Comb Generation—Continued

Tu3E.4 • 17:30

Generation of Optical Frequency Comb via Cross-Phase Modulation in an SOI Waveguide, Yuanfei Zhang[1], Honghui Zhang[1], Chester C.T. Shu[1]; [1]*The Chinese Univ. of Hong Kong, Hong Kong.* Using temporal Talbot processing followed by cross-phase modulation in a silicon-on-insulator waveguide, we experimentally multiply the repetition rate of a 10-GHz optical pulse train and generate widely spaced optical frequency combs up to 50 GHz.

Tu3F • Optical Transport for 5G Applications—Continued

Tu3F.3 • 17:15
Stimulated Raman Scattering and Power-Over-Fiber Property of Multi-Core Fiber, Kenji Kurokawa[1], Hiroyuki Iida[2], Nobutomo Hanzawa[2], Takaya Oguma[1], Yoko Yamashita[2], Takayoshi Mori[2], Takashi Matsui[2], Kazuhide Nakajima[2]; [1]*Kitami Inst. of Technology, Japan;* [2]*NTT Access Network Service Systems Laboratories, Japan.* We show that 4-core multi-core fiber provides 2.6 times higher stimulated Raman scattering threshold than single-core fiber, and potentially enables over 5-km long signal transmission with self-power feeding of more than 600 mW.

Tu3F.4 • 17:30 Invited
Demonstration and Trial of a New CWDM and Circulator Integrated Semi-Active System for 5G Fonthual, Dezhi Zhang[1], Zhe Du[1], Ming Cheng[1], Ming Jiang[1], XinFeng Liu[2], Xin Li[3]; [1]*China Telecom, China;* [2]*Fiberhome Telecommunication Technologies Co.,LTD, China;* [3]*Jiangsu Etern Company Limited, China.* We demonstrate a new CWDM and Circulator integrated semi-active system for 5G fronthaul, and key test data. The system can support 6-channel 25 Gbit/s fronthaul channel capability, and support protection switching function, real-time signal power of multiple working wavelengths Online detection function, and reflected interference signal power detection function.

Tu3G • Novel and Emerging Networks—Continued

Tu3G.3 • 17:15
High-Speed Time Series Prediction and Classification on an All-Optical Neural Network, Aashu Jha[1], Chaoran Huang[2,1], Hsuan-Tung Peng[1], Weipeng Zhang[1], Bhavin Shastri[3], Paul Prucnal[1]; [1]*Princeton Univ., USA;* [2]*Chinese Univ. of Hong Kong, Hong Kong;* [3]*Queens Univ., Canada.* We experimentally demonstrate high-speed time series prediction and binary classification tasks using an all-optical integrated SiN-based nonlinear photonic node in a time-delay based reservoir architecture.

Tu3G.4 • 17:30 Invited
What's the Fuss: the Excitement, Prospects and Software/Hardware Challenges of Distributing Entanglement Over a Quantum Network, Neil Zimmerman[1]; [1]*NIST, USA.* In this paper, I review the notion of a quantum network, which I define as one that can distribute entanglement between stationary qubits, and then discuss challenges relevant for the Optical Fiber Conference (OFC).

Tu3H • Enablers and Disrupters in Data Center and HPC—Continued

Tu3H.3 • 17:30 Invited
Monolithically Integrable Optical Single Sideband Transmitters for Inter-Datacenter Applications, Tianwai Bo[1], Zhongwei Tan[1], Hoon Kim[2], Yi Dong[1]; [1]*Beijing Inst. of Technology, China;* [2]*KAIST, Korea (the Republic of).* We review the monolithically integrable optical single sideband transmitter schemes for inter-datacenter applications. The schemes based on monolithic integration of laser with Mach-Zehnder modulator, optical injection-lock laser, and electro-absorption modulation laser are discussed.

Tu3I • Quantum Communications—Continued

Tu3I.2 • 17:30 Invited
Quantum Key Distribution in the Service Provider Network, Catherine White[1], Adrian Wonfor[2], Paul Wright[1], Emilio Hugues Salas[1], Andrew Lord[1]; [1]*BT, UK;* [2]*Engineering, Univ. of Cambridge, UK.* We review and discuss the practicalities of integrating Quantum Key Distribution within the service provider fiber network.

Room 1AB

Tu3A • Symposia: Emerging Photonic Interconnects and Architectures for Femtojoule per Bit Intra Data Center Links Session II—Continued

Tu3A.4 • 18:00 Invited

Title to be Announced, Peter O'Brien[1]; [1]*Tyndall National Inst., Ireland.* Abstract not available.

Room 2

Tu3B • Optical Subsystem Implementations—Continued

Tu3B.5 • 17:45

SDM-TDM Reception Based on MIMO Carrier Phase Recovery Technique for Scalable SDM Transmission, Kohki Shibahara[1], Megumi Hoshi[1], Yutaka Miyamoto[1]; [1]*NTT Network Innovation Laboratories, Japan.* We propose MIMO carrier phase recovery (CPR) scheme and its application into SDM-TDM reception. The use of MIMO-CPR with SDM-TDM reception simplifies local oscillator input architecture, hence enabling three-mode-multiplexed 4600-km transmission with single coherent receiver.

Tu3B.6 • 18:00

Weak Carrier Assisted Phase Retrieval Receiver, Qi Wu[1], Yixiao Zhu[1], Weisheng Hu[1]; [1]*Shanghai Jiao Tong Univ., China.* We propose a weak carrier-assisted phase-retrieval receiver to obtain initial phase for modified Gerchberg-Saxton algorithm with fast convergence to realize hardware-efficient, computationally-efficient, and pilot-symbol-free optical field recovery, and compare it with other phase retrieval schemes.

Tu3B.7 • 18:15

Influence of SOA Parameters on the Nonlinear Impairments Experienced by QAM Modulated Signals, Djalal F. Bendimerad[1], Romain Brenot[1], Dylan Le Gac[1], Abel Lorences-Riesgo[1], Marti Sales-Llopis[1], Yann Frignac[1], Gabriel Charlet[1]; [1]*Paris Research Center, Huawei Technologies France, France.* We propose an experimental method to tune SOA model parameters that yields good prediction abilities of nonlinear distortions induced on PCS-QAM signals. We show that reducing SOA nonlinearities is achieved by a trade-off between a high P_{sat} and a low α_H.

Room 3

Tu3C • VLC for Indoor Applications—Continued

Room 6C

Tu3D • Narrow Linewidth and Tunable Lasers—Continued

Tu3D.5 • 17:45

Nanosecond-Scale Hitless λ-Switching of SOA-Integrated Electro-Optically Tunable RTF Laser With +/-2.5-GHz Dynamic Frequency Accuracy, Yuta Ueda[1], Yusuke Saito[1], Takahiko Shindo[1], Shigeru Kanazawa[1], Wataru Kobayashi[2], Hideaki Matsuzaki[2], Mitsuteru Ishikawa[1]; [1]*NTT Device Innovation Center, Nippon Telegraph and Telephone Corporation, Japan;* [2]*NTT Device Technology Laboratories, Nippon Telegraph and Telephone Corporation, Japan.* We developed an SOA-integrated electro-optically tunable RTF laser with suppressed spurious wavelengths during dynamic tuning. The laser exhibited hitless (no interference with other channels) nanosecond-scale λ-switching for 128-Gbps coherent signals.

Tu3D.6 • 18:00

Nano-ITLA Based on Multi-Channel Interference Widely Tunable Laser, Zifeng Chen[3], Kuankuan Wang[3], Quanan Chen[2], Chun Jiang[1], Qiaoyin Lu[3], Weihua Guo[3]; [2]*Ori-Chip Optoelectronics Technology Co. Ltd, China;* [3]*Huazhong Univ. of Science and Technology, China.* A nano-iTLA based on multi-channel interference widely tunable lasers was demonstrated for the first time. The module exhibits a tuning range > 48 nm, SMSR > 45 dB and Lorentzian linewidth < 100 kHz.

Tu3D.7 • 18:15

Sub-10 kHz Intrinsic Linewidth Extended Cavity DBR Laser on InP Generic Foundry Platform, Rakesh Ranjan Kumar[1], Andreas Hansel[1], Monica Far Brusatori[1], Lars Nielsen[1], Niklas Hedegaard Arent[1], Nicolas Volet[1], Martijn J. R. Heck[1,2]; [1]*Aarhus Univ., Denmark;* [2]*Eindhoven Univ. of Technology, Netherlands.* We report an extended-cavity DBR laser with an intrinsic linewidth of 10 kHz and an output power of ~18 mW at an injection current of < 100 mA, on an InP generic foundry platform.

Room 6D

Tu3E • Raman Amplification and Frequency Comb Generation—Continued

Tu3E.5 • 17:45

Generation of Coherent Multi-Wavelength Lights With Hundreds GHz Frequency Spacing From an Injected Fiber Laser With an Intracavity Tunable Micro-Ring Resonator, Yen-Chu Chen[1], Yi-Jang Hsu[1], Yinchieh Lai[1]; [1]*National Yang Ming Chiao Tung Univ., Taiwan.* Coherent multi-wavelength lights with 133 and 266 GHz frequency spacing are successfully generated from a new fiber laser scheme. The phase-locking characteristics are examined through the auto-correlation contrast as well as the down-converted beating linewidth.

Room 6E	Room 6F	Room 7AB	Room 8
Tu3F • Optical Transport for 5G Applications—Continued	**Tu3G • Novel and Emerging Networks—Continued**	**Tu3H • Enablers and Disrupters in Data Center and HPC—Continued**	**Tu3I • Quantum Communications—Continued**

Tu3G.5 • 18:00 Invited
IOWN for Digital Twin Enabled Societies, Masahisa Kawashima[1]; [1]*NTT Corporation, Japan.* Achieving the extreme data volume and velocity requirements of digital twin applications energy-efficiently is challenging. IOWN will address this challenge by making architectural shifts in computing and networking with the evolution of optical technologies.

Tu3H.4 • 18:00
DSP-Free IM/DD MDM Optical Interconnection Based on Side-Polished Degenerate-Mode-Selective Fiber Couplers, Jian Cui[1], Yuyang Gao[1], Jinyi Yu[1], Jiaixn Liu[1], Junchi Jia[1], Yongqi He[1], Zhangyuan Chen[1], Juhao Li[1]; [1]*Peking Univ., China.* Low-insertion-loss degenerate-mode-selective fiber couplers for mode demultiplexing are designed and fabricated with side-polishing and mating process, based on which stable 5-LP-mode DSP-free IM/DD MDM optical interconnection over 10 km weakly-coupled FMF are experimentally demonstrated.

Tu3I.3 • 18:00
Entanglement Distribution in Installed Fiber With Coexisting Classical Light for Quantum Network Applications, Jordan M. Thomas[1], Gregory S. Kanter[1], Ely M. Eastman[1], Kim F. Lee[1], Prem Kumar[1]; [1]*Northwestern Univ., USA.* We show polarization entangled photons coexisting with milliwatt power classical light over 45.6 km of installed optical fiber. The entanglement source has a built-in alignment signal for quantum transmitter-receiver polarization basis alignment.

Tu3I.4 • 18:15
254.6 Mb/s Secret Key Rate Transmission Over 13.5 km SMF Using PCS-256QAM Super-Channel Continuous Variable Quantum Key Distribution, François Roumestan[1], Amirhossein Ghazisaeidi[1], Haik Mardoyan[1], Jérémie Renaudier[1], Eleni Diamanti[2,3], Philippe Grangier[4,3]; [1]*Nokia Bell Labs France, France;* [2]*LIP6, France;* [3]*CNRS, France;* [4]*LCF, France.* We experimentally validate the feasibility of wavelength-division multiplexing for continuous-variable quantum-key-distribution, transmitting four 600 MBaud probabilistically-shaped 256-QAM signals with 4 GHz spacing, achieving total 254.6 Mb/s average secret key rate.

17:15–18:15 Exhibitor Reception *(Center Terrace)*

18:30–20:00 Conference Reception *(Ballroom 20)*

19:30–21:30 SpE5 • Rump Session: Will Quantum Always Remain Basic Research or is it Ready to Power Great Products? *(Room 6F)*

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

06:00–07:00 SpE6 • Rise and Shine Run/Walk

07:30–08:00 Coffee Break

08:00–10:00
W1A • Special Session: Network Intelligence

Presider: Loukas Paraschis, Infinera Corp., USA

W1A.1 • 08:00 Invited

Title to be Announced, Eric Breverman[1], [1]*Google LLC, USA*. Abstract not available.

W1A.2 • 08:20 Invited

Modern Applications of Total Network Awareness, Mark Englund[1], Nate Lindsey[1]; [1]*FiberSense, Australia*. Recent advances in distributed fiber sensing allow new forms of total network awareness and intelligence to be added to layer 1 of optical fiber networks for material improvements in network protection, performance, resilience, and maintenance.

08:00–10:00
W1B • Panel: Progress and Roadmap in Silicon Photonics Foundries and Supply Chains

Commercial foundry services and supply chain enablement play a critical role in the ecosystem, particularly to realize the scale and low-cost promise of silicon photonics (SiPho). In this panel, we will invite SiPho-related foundries to discuss their short- and long-term commercial offering and roadmap to advance SiPho technology for next-gen applications in datacom/telecom (800G and beyond, 5G, CPO), optical compute, optical sensing (LiDAR, spectroscopy), and more. Topics covered will include state-of-the-art photonics building blocks, III-V light source implementation, E-O integration/packaging, fiber attachment solutions, design enablement and reliability & qualification testing.

Speakers

Robert Blum, *Intel, USA*

Patrick Lo Guo Qiang, *AMF, Singapore*

Anthony Yu, *GlobalFoundries, USA*

Edward Presiler, *Towerjazz, USA*

Yutong Wu, *TSMC, Taiwan*

Marcel Boudreau, *NeoPhotonics, USA*

Andy McKee, *Sivers Photonics, UK*

Lars Zimmerman, *IHP, Germany*

Oliver Sun, *Innolight, China*

Gunther Vollrath, *Aifotech, Germany*

08:00–10:00
W1C • Panel: Optical Wireless Communications for Indoor Access Networks - Practical Solutions Beyond Table-top Demos

This panel session will focus on optical wireless systems and technologies for indoor access networks and what it will take to see ubiquitous adoption and become a major part of the wireless strategy for Beyond 5G and 6G networks. Such networks are expected to take advantage of the inherent benefits of communication over light such as high capacity, immunity to electromagnetic interference and possibilities for massive connectivity. However, to become a serious part of the solution portfolio, these systems must find ways to overcome inherent drawbacks such as physical blockages as well as cooperatively co-exist with other access technologies (for instance WiFi) to realize more robust and capability enhancing access network systems. This session will feature discussions on the enabling technologies for the physical layer, topology control, routing and network architectures and what it will take to get to the practical solutions required for future indoor access networks.

Presentations from the assembled panel of experts will set up important discussion topics and viewpoints and multiple opportunities for audience contributions will be provided.

Speakers

Mostafa Afgani, *PureLifi, UK*

Lian Chen, *Chinese University of Hong Kong, China*

Zabih Ghassembooy, *Northumbria University, UK*

Nathan Gomes, *University College London, UK*

Boon Ooi, *KAUST, Saudia Arabia*

08:00–10:00
W1D • Sensing in Fibers and Networks

W1D.1 • 08:00 Invited

Enhanced Back Scatter Fibers for Sensing in Telecom Networks, Paul Westbrook[1], Ken Feder[1], Tristan Kremp[1]; [1]*OFS Laboratories, USA*. We discuss the application of enhanced backscattering fiber in telecom networks. Such fibers can greatly increase the potential of telecom networks to be used as sensors of network health and its surrounding environment

08:00–10:00
W1E • Packaging and Co-packaged Optics

Presider: Long Chen; Cisco, USA

W1E.1 • 08:00 Invited

Microled Array-Based Optical Links Using Imaging Fiber for Chip-to-Chip Communications, Bardia Pezeshki[1], Farzad Khoeini[2], Alex Tselikov[1], Rob Kalman[1], Cameron Danesh[1], Emad Afifi[1]; [1]*Avicena Tech Corp, USA;* [2]*ECS, Univ. of Michigan, USA*. We demonstrate high density (2Tb/mm^2), very low energy per bit (<2pJ/bit), high sensitivity (<-21dBm), and low crosstalk (<-20dB) in various configurations for optical transmission using high speed blue LEDs and integrated photodetector/amplifiers fabricated in 130nm CMOS process.

Room 6E	Room 7AB	Room 8	Room 9

06:00–07:00 SpE6 • Rise and Shine Run/Walk

07:30–08:00 Coffee Break

08:00–10:00 W1F • Network Automation

Presider: Paolo Monti; Chalmers Tekniska Högskola, Sweden

W1F.1 • 08:00 **Tutorial**

Perspectives and Challenges on Autonomous Networking, David W. Boertjes[1]; *[1]Ciena Corporation, Canada.* The properties that make optical networks the best choice for transporting data are what make them difficult to control and monitor. This tutorial will explore how to apply instrumentation and algorithms to achieve autonomous operation.

David W. Boertjes: BSc physics, UNB, Fredericton NB 1993. MSc physics, Dalhousie University, Halifax NS 1995. PhD electrical engineering, University of Alberta, Edmonton AB 1998. David is a director in R&D working on Liquid Spectrum applications at Ciena in Ottawa Canada. Dr. Boertjes is a senior member of the OSA.

08:00–10:00 W1G • Coherent DSP for DCI Applications

Presider: Yue-Kai Huang; NEC Laboratories America Inc., USA

W1G.1 • 08:00 **Top-Scored**

Intra-Data Center 120Gbaud/DP-16QAM Self-Homodyne Coherent Links With Simplified Coherent DSP, Rui Zhang[1,2], You-Wei Chen[2], Konstantin Kuzmin[2], Winston I. Way[2]; *[1]Georgia Inst. of Technology, USA; [2]Neophotonics, USA.* The first 120Gbaud-based C-band self-homodyne 800Gb/s coherent links using low-latency FEC are experimentally demonstrated. A minimum coherent DSP is proposed to compensate fiber dispersion, phase mismatch between signal and local oscillator, and transceiver I-Q impairments.

W1G.2 • 08:15

Experimental Demonstration of Real-Time 400G Coherent Transmission Over 300m OM3 MMF, Giuseppe Rizzelli Martella[1], Fabrizio Forghieri[2], Roberto Gaudino[1]; *[1]Politecnico di Torino, Italy; [2]CISCO Photonics Italy, Italy.* We experimentally demonstrate real-time coherent transmission up to 400Gbps over 300m OM3 multimode fibers, showing resilience to connector offsets up to 3-6 μm and fiber mechanical shaking using rigorous TIA-455-203 procedures.

08:00–10:00 W1H • Microwave Photonics

Presider: David Marpaung; Univ. of Twente, Netherlands

W1H.1 • 08:00 **Invited**

Large-Scale Programmable Integrated Photonic Circuits: From Microwave Photonics to Optical Computing, Daniel Perez[1]; *[1]Universitat Politècnica de València, Spain.* Abstract not available.

08:00–10:00 W1I • Open Networking Summit: Open Optical Disaggregation: What the Heck is Going On?

Open disaggregation has revolutionized the world of servers (enabling hyperscale cloud computing) and is surging to upend switches and routers. Optical communication is next, at all distance scales. We have seen some success with initial efforts in OCP, TIP, MEF, and ONF but these are the tip of the iceberg. In this summit we delve into the most profound developments in open optical disaggregation as we hear from the leading disruptors along with the incumbents trying to smooth the transition. Among the key topics to explore are where disaggregation is emerging in the most unexpected places, how disaggregation has boosted innovation due to unbundling, what the fundamental APIs and interfaces are and who defines them, and what challenges or unanticipated consequences inhibit the speed of disaggregation.

In both individual talks and a panel discussion we will hear from the leading voices in this transformational change to the optical communications industry. Ponder this: How will these developments affect your job in five years?

Speakers

Andy Bechtolsheim, *Arista Networks, USA*

Robert Blum, *Intel, USA*

Eric Breverman, *Google, USA*

Ramon Casellas, *CTTC, Spain*

Ron Cok, *X-Celeprint, USA*

Jörg-Peter Elbers, *ADVA, Germany*

Andreas Gladisch, *Deutsche Telekom, Germany*

Karl May, *Lumen Networks, USA*

Yawei Yin, *Microsoft, USA*

Room 1AB

W1A • Special Session: Network Intelligence—Continued

W1A.3 • 08:40 Invited

Seismic Event Detection and Localization Using Submarine Optical Cables, Pierre Mertz[1], Siddharth Varughese[1], Sumudu Edirisinghe[1], Mattia Cantono[2], Valey Kamalov[2], Antti Kankkunen[1]; [1]*Infinera Corporation, USA;* [2]*Google LLC, USA.* We report on the results of a field trial on a submarine cable utilizing existing coherent transponders and few additional equipment to both detect and localize seismic events by taking advantage of FBG based HLLBs.

W1A.4 • 09:00 Invited

Title to be Announced, Glenn Wellbrock[1], [1]*Verizon Communications Inc., USA.* Abstract not available.

Room 2

W1B • Panel: Progress and Roadmap in Silicon Photonics Foundries and Supply Chains—Continued

Room 3

W1C • Panel: Optical Wireless Communications for Indoor Access Networks - Practical Solutions Beyond Table-top Demos—Continued

Room 6C

W1D • Sensing in Fibers and Networks—Continued

W1D.2 • 08:30 Invited

Polarization Sensing With Transmission Fibers in Undersea Cables, Antonio Mecozzi[1]; [1]*Universita degli Studi dell'Aquila, Italy.* We show that from the state of polarization of the received signal transmitted in an undersea cable, information on geophysical events occurring on the ocean floor and surface can be extracted without disturbing the ongoing data communication.

W1D.3 • 09:00 Invited

Multicore Fibers for Lensless Endoscopy, Hervé Rigneault[1], Esben Ravn Andresen[2], Matthias Hofer[1], Naveen Gajendra Kumar[1], Siddharth Sivankutty[1], Viktor Tsvirkun[1], Karen Baudelle[2], Olivier Vanvincq[2], Géraud Bouwmans[2]; [1]*Institut Fresnel, Aix Marseille Univ., France;* [2]*Physique des Lasers, Atomes et Molécules, Univ. of Lille, France.* We review how multi-core fibers (MCF) can be employed in the smallest imaging endoscope that reduces to the size of the fiber itself and known as lensless endoscope.

Room 6D

W1E • Packaging and Co-packaged Optics—Continued

W1E.2 • 08:30

84-Fiber MPO Connector Employing Solid Refractive Index Matching Material Formed on Perpendicularly Polished MT Ferrule End, Yoshiteru Abe[1], Ryo Koyama[1], Kazunori Katayama[1]; [1]*NTT, Japan.* We demonstrate 84-fiber MPO connector with a perpendicular MT ferrule and solid refractive index matching material that enables us to overcome the extreme difficulty posed by the design and manufacture of multi-fiber connectors holding many fibers.

W1E.3 • 08:45 Invited

GI-Core Multimode and Single-Mode Polymer Waveguides for High-Density Co-Packaging, Takaaki Ishigure[1]; [1]*Keio Univ., Japan.* We present unique polymer optical waveguide coupler devices fabricated using the Mosquito method to apply for adiabatic coupling with Si photonics chips, three-dimensional fan-in/fan-out devices for multicore fibers, and MUX devices for mode division multiplexing.

W1F • Network Automation—Continued

W1F.2 • 09:00
An SDN Control Plane for Multiband Networks Exploiting a PLI-Aware Routing Engine, Ramon Casellas[1], Evangelos Kosmatos[2], Andrew Lord[3], Chris Matrakidis[2], Ricardo Martínez[1], Dimitris Uzunidis[2], Ricard Vilalta[1], Alexandros Stavdas[2], Raul Muñoz[1]; *[1]CTTC, Spain; [2]OpenLightComm Europe, Czechia; [3]BT, UK.* We report the design of a TAPI SDN control plane for multi-band networks with externalized PLI-aware RMSA. We detail the architecture, data model extensions,algorithms and the implementation and validation in an emulated BT 22-ROADM network.

W1G • Coherent DSP for DCI Applications—Continued

W1G.3 • 08:30
Beyond Mrad/s Polarization Tracking Speed of Complementary Polarization-Diversity Coherent Receiver for Remote LO, Honglin Ji[1], Jingchi Li[2], Xingfeng Li[2], Shuangyu Dong[1], Zhaopeng Xu[1], Yikai Su[2], William Shieh[1]; *[1]Department of Electrical and Electronic Engineering, The Univ. of Melbourne, Australia; [2]State Key Lab of Advanced Optical Communication Systems and Networks, Department of Electronic Engineering, Shanghai Jiao Tong Univ., China.* We demonstrate a complementary polarization-diversity coherent receiver (C-PDCR) to accommodate arbitrarily varying SOP of remotely delivered LO. The polarization tracking speed can reach 1 Mrad/s without performance degradation and exceed 2 Mrad/s with a 1-dB OSNR penalty for a 1.08-Tb/s dual-polarization (DP) PCS-256QAM signal.

W1G.4 • 08:45
Distributed Acoustic Sensing for Datacenter Optical Interconnects Using Self-Homodyne Coherent Detection, Ezra Ip[1], Yue-Kai Huang[1], Ting Wang[1], Yoshiaki Aono[2], Koji Asahi[2]; *[1]NEC Laboratories America Inc., USA; [2]1st Network Solution Division, NEC Corporation, Japan.* We demonstrate distributed acoustic sensing (DAS) over a bidirectional datacenter link which uses self-homodyne coherent detection for the data signal. Frequency multiplexing allows sharing the optoelectronic hardware, and enables DAS as an auxiliary function.

W1G.5 • 09:00
Mismatch Length Estimation of Self-Homodyne Coherent Optical Systems by Using Carrier-Pilot-Assist Method, Yuyuan Gao[1], Xian Zhou[1], Feiyu Li[1], Jiahao Huo[1], Jinhui Yuan[1], Keping Long[1]; *[1]Univ. of Science and Technology Bei, China.* The SHC is a promising solution for inter- or intra datacenter application in future. We proposed a carrier-pilot-assist (CPA) method to estimate mismatch length, which provides guidance for alleviating phase noise of SHC system. This method is robust and is independent of performance of DSP algorithm and IQ imbalance impairment.

W1H • Microwave Photonics—Continued

W1H.2 • 08:30
Ultra-low Noise Microwave Photonic Oscillator Using Free Running Kerr Soliton Microcomb With Inhibited Raman Scattering and Dispersive Wave Emission, Wenwen Cui[1], Yong Geng[1], Zheng Yi[1], Yanlan Xiao[1], Kun Qiu[1], Jing Xu[1], Qiang Zhou[1], Heng Zhou[1]; *[1]Univ of Electronic Science & Tech China, China.* We demonstrate that K-band microwave with ultra-low phase noise (-60dBc/Hz@10Hz; -110dBc/Hz@1kHz; -140dBc/Hz@100kHz) can be generated by photo-detecting the repetition rate of a soliton microcomb with largely restricted Raman scattering and dispersive wave emission.

W1H.3 • 08:45
Elimination of the PMD Related Delay Jitter in an Ultra-Stable Microwave Signal Distribution System, Xi Wang[1], Wei Wei[1], Xiyi Weng[1], Danyang Wang[1], Jiawang Wei[1], Weilin Xie[1], Yi Dong[1]; *[1]Beijing Inst. of Technology, China.* We realize an ultra-stable frequency signal distribution system. The relative delay jitter of the 24 GHz signal is only 13.0 fs after eliminating the PMD-related jitter originated from the stretching of the piezoelectric fiber stretcher.

W1H.4 • 09:00 Invited
Ultra-low Noise 300 GHz Wave Generated With a Dissipative Kerr Soliton, Antoine Rolland[1]; *[1]IMRA America Inc., USA.* We demonstrate low phase noise 300 GHz wave generation through optical frequency division using an integrated dissipative Kerr soliton. The obtained phase noise at 10 kHz Fourier frequency, measured with a devised system, is -100 dBc/Hz.

W1I • Open Networking Summit: Open Optical Disaggregation: What the Heck is Going On?—Continued

Room 1AB	Room 2	Room 3	Room 6C	Room 6D
W1A • Special Session: Network Intelligence—Continued	**W1B • Panel: Progress and Roadmap in Silicon Photonics Foundries and Supply Chains—Continued**	**W1C • Panel: Optical Wireless Communications for Indoor Access Networks - Practical Solutions Beyond Table-top Demos—Continued**	**W1D • Sensing in Fibers and Networks—Continued**	**W1E • Packaging and Co-packaged Optics—Continued**

W1A.5 • 09:20 Invited

Future Demands on Data Centers and Data-center Interconnect Networks, Chongjin Xie[1], [1]*Alibaba Group, USA*. Automation and intelligence are needed to operate data center optical networks at scale. Data analytics technologies to improve efficiency and intelligence of data center optical networks are discussed, including both intra- and inter-data center networks.

W1E.4 • 09:15

Ultra-Compact Multi-Fiber Connector With Magnetic Physical Contact, Kota Shikama[1], Norio Sato[1], Ryo Nagese[1], Yoshiyuki Doi[1], Hiromasa Tanobe[1], Satoshi Tsunashima[1], Yuzo Ishii[1]; [1]*Nippon Telegraph and Telephone, Japan*. An ultra-compact multi-fiber connector features a novel magnetic attraction structure for high-density on-board connector. The fabricated connectors show low-insertion losses comparable to those of conventional MPO connectors while achieving space-saving connection with an angled physical-contact.

10:00–10:30 Coffee Break

10:30–11:30 Tools to Take Your Career to the Next Level *(OFC Career Zone, Exhibit Hall)*

12:00–15:00 15-Minute One-on-One Resume Reviews *(OFC Career Zone, Exhibit Hall)*

Room 6E

W1F • Network Automation—Continued

W1F.3 • 09:15 Invited

Carrier Grade AI/ML for Network Automation, Achim Autenrieth[1]; [1]*ADVA Optical Networking AG, Germany.* Abstract not available.

W1F.4 • 09:45

Architecture to Deploy and Operate a Digital Twin Optical Network, Ricard Vilalta[1], Ramon Casellas[1], Lluis Gifre[1], Raul Muñoz[1], Ricardo Martínez[1], Antonio Pastor[2], Diego López[2], Juan Pedro Fernández-Palacios[2]; [1]*CTTC, Spain;* [2]*Telefónica I+D, Spain.* We propose an architecture to deploy Digital Twin Optical Networks (DTON), which provide a virtual representation of the physical optical network. DTON allow the assessment of specific behaviors before actual implementation in the physical network.

Room 7AB

W1G • Coherent DSP for DCI Applications—Continued

W1G.6 • 09:15

Experimental Study of Bandwidth Loading With Modulated Signals Versus ASE Noise in 400ZR Single-Span Transmission, Steven Searcy[1], Thomas Richter[1], Sorin Tibuleac[1]; [1]*ADVA Optical Networking, USA.* We compare performance of a single-span 400ZR system with bandwidth loading over 2.4 THz from independent modulated signals, channelized ASE noise, or flat ASE noise bands, and quantify the impact on optimum launch power.

Room 8

W1H • Microwave Photonics—Continued

W1H.5 • 09:30

Terahertz Band Data Communications Using Dielectric Rod Waveguide, Muhsin Ali[1], Jonas Tebart[2], Alejandro Rivera-Lavado[1,3], Dmitri Lioubtchenko[4], Luis Enrique Garcia Muñoz[1], Andreas Stöhr[2], Guillermo Carpintero[1]; [1]*Universidad Carlos III de Madrid, Spain;* [2]*ZHO / Optoelectronics, Univ. of Duisburg-Essen, Germany;* [3]*Yebes Observatory, Dirección General del Instituto Geográfico Nacional, Spain;* [4]*Department of Micro and Nano Systems, KTH Royal Inst. of Technology, Sweden.* A terahertz data link is presented using dielectric rod waveguide (DRW) at 300 GHz and complex modulations for speeds up to 120 Gbps. Performance comparison with WR-3 rectangular waveguide validates the low-dispersion behaviour of DRW.

W1H.6 • 09:45

4-Antenna Distributed Receiving System for Broadband Signal Transmission and Combination, Kai Wang[1], Wei Wei[1], Pengyu Wang[1], Danyang Wang[1], Weilin Xie[1], Yi Dong[1]; [1]*Beijing Inst. of Technology, China.* We demonstrate a stable distributed receiving antenna system for broadband signal transmission and combination. A simple remote structure, a large link compensation range, and improved signal SNR have been achieved simultaneously with 4 remote ends.

Room 9

W1I • Open Networking Summit: Open Optical Disaggregation: What the Heck is Going On?—Continued

10:00–10:30 Coffee Break

10:30–11:30 Tools to Take Your Career to the Next Level *(OFC Career Zone, Exhibit Hall)*

12:00–15:00 15-Minute One-on-One Resume Reviews *(OFC Career Zone, Exhibit Hall)*

10:30–12:30
W2A • Poster Session I

W2A.1
3D-Printed Optical Elements for Coupling of VCSEL and Photodiode Arrays to Multi-Core Fibers in an SFP Transceiver Assembly, Pascal Maier[1,2], Yilin Xu[1,2], Matthias Lauermann[3], Alexandra Henniger-Ludwig[4], Hermann Kapim[4], Mareike Trappen[1,2], Torben Kind[5], Achim Weber[5,3], Matthias Blaicher[1,2], Philipp-Immanuel Dietrich[1,2], Clemens Wurster[6], Sebastian Randel[1], Wolfgang Freude[1], Christian Koos[1,2]; *[1]Inst. of Photonics and Quantum Electronics (IPQ), Karlsruhe Inst. of Technology (KIT), Germany; [2]Inst. of Microstructure Technology (IMT), Karlsruhe Inst. of Technology (KIT), Germany; [3]Vanguard Automation GmbH, Germany; [4]Rosenberger Hochfrequenztechnik GmbH & Co. KG, Germany; [5]ficonTEC Service GmbH, Germany; [6]Rosenberger OSI GmbH & Co. OHG, Germany.* We demonstrate a 3×25Gbit/s SFP transceiver assembly using 3D-printed optical coupling elements to connect multimode multi-core fibers to linear VCSEL and photodiode arrays. Passive alignment yields coupling losses <0.7dB, ensuring conformity with the IEEE802.3 power budget.

W2A.2
Streamlined Architecture for Thermal Control and Stabilization of Cascaded DWDM Micro-Ring Filters Bus, Maarten Hattink[1], Liang Yuan Dai[1], Ziyi Zhu[1], Keren Bergman[1]; *[1]Columbia Univ., USA.* We demonstrate the thermal control of cascaded micro-ring DWDM filters using a single photodiode. The streamlined implementation maintains stable operation of the 8-ring bus with less than 0.1dB BER power penalty on an 8x10Gb/s link.

W2A.3
A 10-Gb/s, -32.6dBm Receiver With 3.5Gbps APD for XGPON/XGSPON Mass Production, Rui Wang[1], Xin Zhao[1], Yingfan Ling[1], Gaoyong Fan[1], Zhijun Cai[1], Rui Tao[1]; *[1]Chengdu Meenyi Electronic Technology Co., China.* A 10-Gb/s low-power low-noise optical receiver in 65nm CMOS is presented and can achieve a sensitivity of -32.6dBm after pairing with a 3.5Gbps low-cost APD, which provides a solution necessary for mass production of XGPON/XGSPON.

W2A.4
Reduce Footprints of Multiport Interferometers by Cosine-Sine-Decomposition Unfolding, Yinyi Liu[1], Jiaxu Zhang[1], Jun Feng[1], Shixi Chen[1], Jiang Xu[2,1]; *[1]ECE Department, The Hong Kong Univ. of Science and Technology, Hong Kong; [2]Microelectronics Thrust, The Hong Kong Univ. of Science and Technology, Hong Kong.* We present a novel 3D-unfolding method based on Cosine-Sine-Decomposition (CSD) to enable an alternative arrangement of unitary blocks towards plane normal, which reduces the planar footprints of universal multiport interferometers exponentially.

W2A.5
Design of Asymptotically Perfect Linear Feedforward Photonic Circuits, Ryan Hamerly[1,2], Saumil Bandyopadhyay[1], Alexander J. Sludds[1], Dirk R. Englund[1]; *[1]Massachusetts Inst. of Technology, USA; [2]PHI Laboratories, NTT Research, USA.* We propose a new architecture for feedforward photonic circuits based on a 3-splitter MZI. This architecture is more error tolerant than the standard mesh, supports self-configuration, and yields asymptotically perfect circuits for large mesh sizes.

W2A.6
Dimensional Variation Tolerant Inverse Designed Broadband Mode Converter, Md Mahadi Masnad[1], Guowu Zhang[1], Dan-Xia Xu[2], Yuri Grinberg[3,1], Odile Liboiron-Ladouceur[1]; *[1]McGill Univ., Canada; [2]Advanced Electronics and Photonics Research Center, National Research Council Canada, Canada; [3]Digital Technologies Research Center, National Research Council Canada, Canada.* We report on a low-loss (<1dB) TE1-TE3 mode converter, robust to ±10 nm etch-errors, operating over a wavelength range of 1.5-1.58 µm with modal crosstalk below -20dB. 20 GBaud PAM-4 signal transmission validates the conversion.

W2A.7
Single-Mode 850nm VCSELs Demonstrate 96 Gb/s PAM4 OM4 Fiber Link for Extended Reach to 1km, Dufei Wu[1], Xin Yu[2], Haonan Wu[1], Wenning Fu[1]; *[1]Univ. of Illinois, Urbana-Champaign, USA; [2]USA Research and Development Group, Foxconn Interconnect Technology, USA.* Due to modal dispersion in OM4 fiber, multi-mode VCSELs have a limited high-speed NRZ and PAM4 transmitting distance of below 100 meters. The single-mode VCSELs with integrated mode-selective filter has been developed and demonstrated 96 Gb/s PAM4 transmitting distance to 1km with 1.78 dB TDECQ and 112Gb/s over 100 m OM4 fibers.

W2A.8
Highly-Reflective Facet-Coated 16-Wavelength DFB Laser Array With Exact Wavelength Spacings, Gen Lv[2], Rulei Xiao[2], Zijiang Yang[2], Zhenxing Sun[2], Yating Zhou[1], Yi-Jen Chiu[3], Xiangfei Chen[2]; *[1]School of Mathematics & Physics and Chemical Engineering, Changzhou Inst. of Technology, China; [2]Key Laboratory of Intelligent Optical Sensing and Manipulation of the Ministry of Education & National Laboratory of Solid State Microstructures & College of Engineering and Applied Sciences & Inst. of Optical Communication Engineering, Nanjing Univ., China; [3]Inst. of Electro-Optical Engineering and Semiconductor Technology Research Development Center, National Sun Yat-Sen Univ., Taiwan.* An HR-AR-coated sixteen-wavelength DFB laser array is experimentally demonstrated with exact wavelength spacings. The spacing accuracy is preliminary guaranteed by the reconstruction-equivalent-chirp technique. The further exact wavelength spacing is achieved by distributed phase compensation.

W2A.9
63 fJ/bit Heterogeneous III-v on Si Modulator for the C Band, Rosalyn Koscica[1], Paolo Pintus[1], Minh Tran[1,2], MJ Kennedy[1], Chao Xiang[1], John E. Bowers[1]; *[1]Uni. of California Santa Barbara, USA; [2]Nexus Photonics, USA.* Heterogeneous III-V on Si electro-optic Mach-Zehnder modulator with a p-i-n junction demonstrates $V_\pi L$ of 3.4 Vmm, eye diagram opening up to 12 Gb/s, and small average energy per bit of 63 fJ/bit at 12Gb/s.

W2A.10
Design Analysis of a High-Speed Directly Modulated Laser With Push-Pull Silicon Ring Modulators, Chenlei Li[1], Min Teng[1], Hao Wu[1], Ning Cheng[1], Xuezhe Zheng[1]; *[1]InnoLight Technology (Suzhou) Ltd., China.* We design and analyze a novel high-speed directly-modulated laser combining a pair of push-pull ring modulators. The mechanism of push-pull modulators makes the laser immune to phase-change induced wavelength chirp and other cavity-related modulation penalties.

W2A.11
32 GHz High-Power MUTC Waveguide Photodiode for 1310 nm, Fengxin Yu[1], Keye Sun[1], Junyi Gao[1], Andreas Beling[1]; *[1]Univ. of Virginia, USA.* We demonstrate evanescently coupled modified uni-traveling carrier (MUTC) waveguide photodiodes for 1310 nm wavelength with saturation photocurrent >20 mA and high radio frequency (RF) output power of 5.7 dBm at 30 GHz.

W2A.12
Spatio-Temporal Statistical Model of Free-Space-to-Fiber Coupling Under Atmospheric Turbulence, Jonas Krimmer[1], Lennart Schmitz[1], Wolfgang Freude[1], Christian Koos[1], Sebastian Randel[1]; *[1]Karlsruhe Inst. of Technology, Germany.* Simulating the temporal evolution of the free-space-to-fiber coupling efficiency for a Gaussian beam after traversing a turbulent atmospheric channel reveals that using a few-mode instead of a single-mode fiber significantly reduces link downtimes.

W2A.13
Kerr-Induced Rotation of Mixed Orbital Angular Momentum States in Hollow Ring-Core Fibers, Sai Kanth Dacha[1], Wenqi Zhu[2], Amit Agrawal[2], Thomas E. Murphy[1]; *[1]Inst. for Research in Electronics and Applied Physics, Univ. of Maryland, USA; [2]National Inst. of Standards and Technology, USA.* We experimentally demonstrate that in the presence of Kerr nonlinearity, the spatial pattern caused by unequal excitation of two degenerate spin-orbit anti-aligned modes in an optical fiber exhibits a power-dependent rotation effect.

W2A.14
Wearable Smartwatch Based on Optical Fiber for Continuous Blood Pressure Monitoring, Liangye Li[1], Yunfei Liu[1], Shunfeng Sheng[1], Changying Song[1], Wei Fan[2], Qizhen Sun[1]; *[1]Huazhong Univ. of Science and Technology, China; [2]Huawei Technologies Co., Ltd, China.* We present a wearable smartwatch based on optical fiber for continuous blood pressure monitoring. Clinical results show errors of systolic pressure and diastolic pressure are 0.93 ± 3.97 mmHg and -3.07 ± 2.69 mmHg.

W2A.15
Groundwater Level Remote Monitoring Using Optical Power Measurement in Fiber Bragg Grating, Steven Binder[1], Mei Yang[1], Victor Qiu[1], Alexander Bucksch[1], Mable P. Fok[1]; *[1]Univ. of Georgia, USA.* Groundwater level provides critical insight to public resource allocation and climate variability. Remote monitoring of groundwater level is demonstrated, based on wavelength-shift induced optical power change in fiber Bragg grating caused by water pressure fluctuations.

10:30–12:30
W2A • Poster Session I

W2A.16
Performance Enhanced BOTDA Sensor Using Differential Golay Coding and Deconvolution Algorithm, Weilun Wei[1], Li Shen[1], Zhiyong Zhao[1], Can Zhao[1], Ming Tang[1]; [1]*Huazhong Univ. of Science and Technology, China*. A novel BOTDA sensor that uses differential Golay coding and deconvolution algorithm is demonstrated utilizing conventional coded BOTDA sensors system, which paves the way to enable both long sensing range and high spatial resolution simultaneously.

W2A.17
Techno-Economics of Terrestrial Extensions of Subsea Routes, Sergejs Makovejs[1], John D. Downie[2], Hatem Abdelwahab[3], Walaa Abdrabo[3]; [1]*Corning Optical Communications, UK;* [2]*Corning Research and Development Corporation, USA;* [3]*Telecom Egypt, Egypt*. This paper investigates the benefit of using ultra-low-loss G.654.E fiber in the terrestrial section of PoP-PoP route in terms of GSNR improvement, higher fiber pair and cable capacity, and increased system value.

W2A.18
Multi-Cluster Reconfiguration With Traffic Prediction in Hyper-Flex-LION Architecture, Sandeep Kumar Singh[1], Roberto Proietti[1], Che-Yu Liu[1], S. J. Ben Yoo[1]; [1]*Univ. Of California, Davis, USA*. We study the performance of Hyper-Flex-LION optical interconnect architecture under dynamic traffic with traffic-prediction-aided multi-cluster reconfiguration. The simulation results show a 17.2% latency improvement and 36.9% packet loss reduction as compared to a fixed topology.

W2A.19
Bandwidth Reconfigurable Optical Switching Architecture for CPU-GPU Computing Systems With Shared Memory, Arastu Sharma[1], Qixiang Cheng[1], Nikolaos Bamiedakis[1], Madeleine Glick[3], Fotini Karinou[2], Keren Bergman[3], Richard Penty[1]; [1]*Univ. of Cambridge, UK;* [2]*Microsoft Research Cambridge, UK;* [3]*Columbia Univ., USA*. We propose a reconfigurable optical switching architecture for shared-memory CPU- GPU systems. System-level simulations show improved execution time and energy efficiency up to 34% and 25% respectively compared to a static point-to-point architecture for specific application sets.

W2A.20
To Cooperate or Not to Cooperate: Service Function Chaining in Multi-Domain Edge-Cloud Elastic Optical Networks, Sijia Li[1], Baojia Li[1], Zuqing Zhu[1]; [1]*Univ of Science and Technology of China, China*. We study the the non-cooperative provisioning of service function chains in a multi-domain edge-cloud elastic optical network (EC-EON), leverage game theory to design an algorithm for it, and analyze its performance difference from the cooperative scheme with simulations.

W2A.21
Traffic Monitoring System for 100-Gbps Virtualized Optical Networks, Yusuke Sekihara[1], Namiko Ikeda[1], Hiroyuki Uzawa[1], Shoko Ohteru[1], Saki Hatta[1], Shuhei Yoshida[1], Kimikazu Sano[1]; [1]*NTT Device Innovation Center, Japan*. We propose a system to get flow information of virtualized logical networks in support of 100-Gbps optical networks. By using packet sampling, we can create monitoring rules even when the monitoring target is unknown.

W2A.22
Load-Balancing Routing Algorithm Against Inter-Satellite Link Congestion in LEO Satellite Optical Networks, Yunxiao Ning[1], Yongli Zhao[1], Xin Li[1], Sabidur Rahman[2], Huibin Zhang[1], Jie Zhang[1]; [1]*Beijing Univ. of Posts and Telecomm, China;* [2]*Sonama State Univ., USA*. A novel load-balancing routing algorithm based on satellite-ground cooperation is proposed to reduce the impact of inter-satellite link congestion in LEO satellite optical networks. Simulations prove that our proposal can significantly improve the network throughput.

W2A.23
Datacenter-Carrier Cooperation Over Optical Networks During Disaster Recovery, Subhadeep Sahoo[1], Sugang Xu[2], Sifat Ferdousi[1], Yusuke Hirota[2], Massimo Tornatore[1,3], Yoshinari Awaji[2], Biswanath Mukherjee[1,4]; [1]*Univ. of California, Davis, USA;* [2]*National Inst. of Information and Communications Technology (NICT), Japan;* [3]*Politecnico di Milano, Italy;* [4]*Soochow Univ., China*. A novel cooperation strategy among DC service provider and carriers (operating optical networks) is proposed for disaster recovery. This cooperation improves service restoration by 70% w.r.t. benchmark methods for typical scenarios, with reduced cost.

W2A.24
Techno-Economic Potential of Wavelength-Selective Band-Switchable OXC in S+C+L Band Optical Networks, Masahiro Nakagawa[1], Takeshi Seki[1], Takashi Miyamura[1]; [1]*NTT, Japan*. Techno-economic performance of an S+C+L-band network employing the wavelength-selective band-switchable optical cross-connect is investigated. Numerical results verify that a significant cost-per-bit reduction can be achieved compared to conventional multi-band and multi-fiber solutions under realistic conditions.

W2A.25
Demonstration of 128×100-Gb/s Real-Time Coherent UDWDM-PON With >35-dB Power Budget, Jie Li[1,2], Ming Luo[1,2], Zhixue He[1,2], Xi Xiao[3,1], Shaohua Yu[1,2]; [1]*China Information Communication Technologies Group Corporation, China;* [2]*Peng Cheng Laboratory, China;* [3]*National Information Optoelectronics Innovation Center, China*. We propose a coherent UDWDM-PON scheme and experimentally demonstrate a real-time 128×100-Gb/s downlink coherent UDWDM-PON at 37.5-GHz channel spacing. The power budget can achieve more than 35 dB after 48-km SSMF transmission.

W2A.26
Computationally-Efficient Sparsely-Connected Multi-Output Neural Networks for IM/DD System Equalization, Zhaopeng Xu[1], Shuangyu Dong[1], Honglin Ji[1], Jonathan H. Manton[1], William Shieh[1]; [1]*Univ. of Melbourne, Australia*. Low-complexity sparsely-connected multi-output neural networks are proposed for equalization in a 50-Gb/s 25-km PAM4 IM/DD system. Compared with traditional fully-connected single-output counterparts, a gross complexity reduction of 60.4%/56.7% can be achieved with 2-layer FNN/C-FNN architecture.

W2A.27
Optical Multi-Path Interference Noise Mitigation for 56 Gb/s PAM4 IMDD Transmission System, Chuanming Huang[1], Haiping Song[1], Mengfan Cheng[1], Qi Yang[1], Ming Tang[1], Deming Liu[1], Lei Deng[1]; [1]*School of Optical and Electronic Information, Huazhong Univ. of Science and Technology, China*. We experimentally demonstrate two multi-path-interference (MPI) mitigation algorithms that can effectively suppress the MPI noise in 56Gb/s PAM4 signal transmission over 15.5km SSMF system, under the signal-to-interference ratio of 18dB and laser linewidth of 4MHz.

W2A.28
Modulation Format Aggregation of Nyquist Channels by Spectral Superposition With Electro-Optic Modulators, Arijit Misra[1], Stefan Preussler[1], Karanveer Singh[1], Janosch Meier[1], Thomas Schneider[1]; [1]*Technische Universität Braunschweig, Germany*. We propose and experimentally demonstrate a new scheme for all-optical coherent modulation format conversion based on vector summation facilitated by coherent spectral superposition with an electro-optic modulator without using any optical nonlinearity.

W2A.29
Comparison of Transmitter Nonlinearity Impairments in Externally Modulated Sigma-Delta-Over Fiber Versus Analog Radio-Over-Fiber Links, Frida Olofsson[1], Lise Aabel[2,1], Magnus Karlsson[1], Christian Fager[1]; [1]*Chalmers Univ. of Technology, Sweden;* [2]*Ericsson Research, Sweden*. Sigma-Delta-over-Fiber and Analog-Radio-over-Fiber are compared in terms of non-linearity impairments in a transmitter with external optical modulation. The results show that Sigma-Delta-over-Fiber is more robust towards nonlinear characteristics in the modulator.

W2A.30
Design and Prototype of Auto-Track Long-Range Free-Space Optical Communication, Xun Li[1], Mustafa M. Bayer[1], George N. Guentchev[1], Ozdal Boyraz[1]; [1]*Electrical Engineering and Computer Science, Univ. of California, Irvine, USA*. We present a free-space optical communication module for the NSF PAWR program with an auto-tracking over ±6.5° angle of arrival with <1μrad resolution. The module is designed to work for rural area deployment.

Show Floor Programming

TS2 • 2.4Tb SmartPHY: Solutions for Next Generation 2.4Tb+ Line Systems
Presented by Xilinx Inc.
10:15–10:45, *Theater III*

NOSK • Network Operator Summit Keynote
10:30–11:00, *Theater I*

SF6 • What Makes Ethernet, Ethernet?
(Ethernet Alliance)
10:30–11:30, *Theater II*

TS3 • The Future of Coherent Optical Engines
Presented by Infinera
11:00–11:30, *Theater III*

NOS1 • Network Operator Summit Panel I: Operator Investment Directions for FTTH and Access Networks
11:30–13:00, *Theater I*

TS4 • Optical Fiber Communication, a Key Enabler for O-RAN
Presented by Anritsu Corporation
11:45–12:15, *Theater III*

SF7 • Deployment of 400ZR and the Ongoing OIF Work to Define 800ZR/LR
12:00–13:00, *Theater II*

TS5 • Next Generation Opto-Electronic Devices – Measurement Challenges
Presented by POET Technologies Inc.
12:30–13:00, *Theater III*

W2A • Poster Session I—Continued

W2A.31
Coherent Combining at Ultra-low Optical Signal Powers Based on Optically Amplified Error Feedback, Rasmus Larsson[1], Jochen Schröder[1], Magnus Karlsson[1], Peter A. Andrekson[1]; [1]*Chalmers Univ. of Technology, Sweden.* Coherent combining in multi-aperture reception for free-space communication applications requires active phase alignment. Here, using 50/50-fiber-couplers and optically preamplified error feedback, coherent combining of four -80dBm, 10Gbaud QPSK signals is demonstrated with 95.4% efficiency.

W2A.32
Passive Nonlinear Compensation Circuits for Photovoltaic Visible Light Communications Under Low Illuminance, Shuyan Chen[1], Liqiong Liu[1], Lian-Kuan Chen[1]; [1]*The Chinese Univ. of Hong Kong, Hong Kong.* For photovoltaic nonlinearity, the distortion is much exacerbated at a low illumination level. We propose and experimentally demonstrate a simple passive post-distortion compensation circuit without complex DSP and achieve one-order of magnitude reduction in BER.

W2A.33
Experimental Demonstration of Learned Pulse Shaping Filter for Superchannels, Zonglong He[1], Jinxiang Song[1], Christian Häger[1], Alexandre Graell I Amat[1], Henk Wymeersch[1], Peter A. Andrekson[1], Magnus Karlsson[1], Jochen Schröder[1]; [1]*Chalmers Univ. of Technology, Sweden.* We demonstrate a pulse shaping filter enabled by machine learning for spectral superchannels. In contrast to a 1% roll-off root-raised cosine filter, our learned filter reduces the adaptive equalizer length by 47% for the same spectral efficiency.

W2A.34
A Simple and Accurate Method to Estimate the Nonlinear Performance of VCSEL IM-DD System, Chengwu Yang[1], Tong Ye[1], Ke Zhang[1], Zhenning Tao[1], Hisao Nakashima[2], Takeshi Hoshida[2]; [1]*Fujitsu R&D Center, China;* [2]*Fujitsu Limited, Japan.* We experimentally demonstrated that, for VCSEL IM-DD systems, spectrum of nonlinear distortion can be accurately measured by adding frequency-domain notch, even the stimulus is non-Gaussian. With measured spectrum, nonlinear performance was estimated accurately.

W2A.35
Perturbation-Aided Deep Neural Network for Dual-Polarization Optical Communication Systems, Xiang Lin[1], Shenghang Luo[2], Octavia Dobre[1], Lutz Lampe[2], Deyuan Chang[3], Chuandong Li[3]; [1]*Memorial Univ. of Newfoundland, Canada;* [2]*The Univ. of British Columbia, Canada;* [3]*Huawei Technologies Co Ltd Canada, Ottawa R&D Centre, Canada.* We propose a perturbation-aided deep neural network for fiber nonlinearity compensation in polarization-multiplexed optical communication systems. The proposed technique achieves a fast convergence that is facilitated by the perturbation analysis and attains an enhanced performance.

W2A.36
Volterra Equalization to Compensate for Transceiver Nonlinearity: Performance and Pitfalls, Junho Cho[1], Son Thai Le[1]; [1]*Nokia Bell Labs, USA.* We present an efficient training method of Volterra nonlinear equalization to compensate for transceiver nonlinearity in an experiment sending periodic symbols, analyze its performance, and discuss pitfalls leading to overestimation or underestimation of performance.

W2A.37
Symbiotic Joint Operation of Quantum and Classical Coherent Communications, Raphael Aymeric[1], Yves Jaouen[1], Cédric Ware[1], Romain Alleaume[1]; [1]*Télécom Paris, France.* We report successful joint operation of quantum and classical communications with shared hardware. Leveraging information learned from the classical DSP, low-noise quantum communications (0.009 SNU at 15 km) compatible with 15 Mbit/s QKD is demonstrated.

W2A.38
Neural Network-Enhanced Optical Phase Conjugation for Nonlinearity Mitigation, Morteza Kamalian Kopae[1], Abdallah Ali[1], Karina Nurlybayeva[1], Andrew Ellis[1], Sergei K. Turitsyn[1]; [1]*Aston Univ., UK.* Using a multi-layer perceptron to equalise the residual nonlinearity from the transmission of PDM 28 Gbaud 64QAM over 400km of SSMF employing midlink optical phase conjugation, we demonstrate 12-fold reduction in the BER.

W2A.39
Experimental Validation of Nonlinear Fourier Transform-Based Kerr-Nonlinearity Identification Over a 1600 km SSMF Link, Pascal de Koster[1], Jonas Koch[2], Olaf Schulz[2], Stephan Pachnicke[2], Sander Wahls[1]; [1]*Delft Center for Systems and Control, Delft Univ. of Technology, Netherlands;* [2]*Chair of Communications, Kiel Univ., Germany.* Recently, a nonlinear Fourier transform-based Kerr-nonlinearity identification algorithm was demonstrated for a 1000 km NZDSF link with accuracy of 75%. Here, we demonstrate an accuracy of 99% over 1600 km SSMF. Reasons for improved accuracy are discussed.

12:30–14:00 Exhibit Only Time

NOTES

Room 1AB

14:00–16:00
W3A • Special Session: Network Evolution and Adaptation to Environmental Change Session I
Presider: Roland Ryf; Nokia Bell Labs, USA

W3A.1 • 14:00 Invited
Growth and Sustainability of WDM, Klaus Grobe[1]; [†]*Global Sustainability, ADVA Optical Networking SE, Germany.* Internet growth leads to exponentially increasing WDM-systems energy consumption. WDM systems should be replaced by more-efficient successors after certain time to optimize related use-phase carbon emissions. These emissions are overcompensated by the Greening-by-ICT effect.

Room 2

14:00–16:00
W3B • Panel: The Role of Photonics for Artificial Intelligence/ Machine Learning at the Edge: What, Why and How?

Edge Computing has become extremely important due to the rapid increases of data volume, low latency, privacy/security needs, 5G/6G. The ambition is to stop the need to rely on the cloud all the time, and process information at the location where it makes sense, which in some cases means where the data is generated. To process this massive amount of data, advanced techniques from the AI/ML community are required, whereas photonics has a crucial role to play to increase throughput and reduce overall latency and energy-consumption. Examples of application domains with AI/ML opportunities in an Edge Computing context are ubiquitous: autonomous Vehicles, (Mobile) Medical Facilities, high frequency trading, (industrial) IoT based manufacturing and farming, 5G smart cell edge data center, AR/VR…

Our panellists will discuss how recent advances in photonics are critical to address some of the challenges that appear in this diverse set of workloads.

(Speakers): To be determined

Room 3

14:00–16:00
W3C • High Symbol Rate and Wideband Transmission
Presider: Hisao Nakashima; Fujitsu Limited, USA

W3C.1 • 14:00 ★ Top-Scored
1.0-Tb/s/λ 3840-km and 1.2-Tb/s/λ 1280-km Transmissions With 168-GBaud PCS-QAM Signals Based on AMUX Integrated Frontend Module, Masanori Nakamura[1], Takeo Sasai[1], Kohei Saito[1], Fukutaro Hamaoka[1], Takayuki Kobayashi[1], Hiroshi Yamazaki[2,1], Munehiko Nagatani[2,1], Yoshihiro Ogiso[3], Hitoshi Wakita[2], Yoshiaki Kisaka[1], Yutaka Miyamoto[1]; [†]*NTT Network Innovation Laboratories, Japan;* [2]*NTT Device Technology Laboratories, Japan;* [3]*NTT Device Innovation Center, Japan.* We successfully demonstrate 1.0-Tb/s/λ 3840-km and 1.2-Tb/s/λ 1280-km long-haul transmissions in 4.2-THz full C-band 175-GHz-spaced WDM configuration with improving signal noise tolerance using 168-GBaud high-symbol-rate PCS-16QAM and PCS-36QAM signals generated by our AMUX-integrated frontend module.

W3C.2 • 14:15
Impact of Local Oscillator Phase Noise on Long-Haul Transmission of 120-Gbaud Digital Sub-Carrier Signals, Kohei Saito[1], Masanori Nakamura[1], Takeo Sasai[1], Takeshi Kakizaki[1], Fukutaro Hamaoka[1], Takayuki Kobayashi[1], Etsushi Yamazaki[1], Yoshiaki Kisaka[1]; [†]*Nippon Telegraph and Telephone, Japan.* The EEPN penalty was measured separately from other factors in 5120-km transmission of 120-Gbaud 16QAM signal for different LO lasers. Digital subcarrier multiplexing suppressed the EEPN-induced NGMI deterioration by ~0.4 at 102,400 ps/nm.

Room 6C

14:00–16:00
W3D • Photodetectors, Sensing and Microwave Photonics
Presider: Martin Schell; Fraunhofer HHI, Germany

W3D.1 • 14:00 ★ Top-Scored
High Performance Avalanche Photodiode in a Monolithic Silicon Photonics Technology, Asif J. Chowdhury[1], Subramanian Krishnamurthy[1], Abdelsalam Aboketaf[1], Jacquelyn Phang[1], Ludmila Popova[1], Michelle Zhang[1], Javier Ayala[1], Yusheng Bian[1], Michal Rakowski[1], Francis Afzal[1], Takako Hirokawa[1], Won Suk Lee[1], Judson Holt[1], Massimo Sorbara[1], Vishal Dhrugude[1], Crystal Hedges[1], Frank Pavlik[1], Stan Senger[1], Kate McLean[1], Andy Stricker[1], Ryan Sporer[1], Karen Nummy[1], Dave Riggs[1], Rod Augur[1], Wenhe Lin[1], Jae Gon Lee[1], Vikas Gupta[1], Eng Hua Lim[1], Ken Giewont[1], Ted Letavic[1], John Pellerin[1]; [†]*Globalfoundries, USA.* We demonstrate a waveguide-integrated germanium-on-silicon avalanche pho-todiode in a monolithic silicon photonics technology, with TE responsivity of 26 A/W at1310 nm wavelength at -5V operating bias with a 3-dB bandwidth of>30 GHz.

W3D.2 • 14:15
106-Gb/s Waveguide AlInAs/GaInAs Avalanche Photodiode With Butt-Joint Coupling Structure, Takuya Okimoto[1,2], Ken Ashizawa[2], Hiroki Mori[2], Koji Ebihara[2], Kouichiro Yamazaki[2], Satoru Okamoto[2], Kazuhiko Horino[2], Yusuke Ohkura[2], Hideki Yagi[1,2], Mitsuru Ekawa[1,2], Yoshihiro Yoneda[2,1]; [1]*Sumitomo Electric Indutries, Ltd., Japan;* [2]*Sumitomo Electric Device Innovations, Inc., Japan.* A waveguide AlInAs/GaInAs APD with the butt-joint coupling structure for 106-Gb/s PAM4 applications is demonstrated for the first time. A maximum 3-dB bandwidth of 38 GHz and high responsivity at unity gain of 0.90 A/W are exhibited at 1.55 μm.

Room 6D

14:00–16:00
W3E • Fiber Nonlinearity
Presider: Taiji Sakamoto; NTT Access Service Systems Laboratories, Japan

W3E.1 • 14:00 Invited
Impact of GAWBS in Communication Systems, Maxim A. Bolshtyansky[2], Jin-Xing Cai[1]; [†]*SubCom LLC, USA;* [2]*CACI, USA.* Guided acoustic wave Brillouin scattering (GAWBS) in modern communication system is overviewed. We discuss induced penalties, GAWBS scattering coefficient estimation, GAWBS detection, compensation, and modeling of various aspects of GAWBS.

Room 6E

14:00–16:00
W3F • High-capacity and Flexible Networks
Presider: Hidenori Takahashi; KDDI Research, Inc., Japan

W3F.1 • 14:00
Raman Amplification for Simplified Channel Provisioning in Wide-Band Optical Networks, Andre Souza[1,2], Nelson Costa[1], João Pedro[1,2], João Pires[2]; [†]*Infinera, Unipessoal LDA, Portugal;* [2]*Instituto de Telecomunicações, Instituto Superior Técnico, Portugal.* This work provides evidence that jointly optimizing the signal launch power and a counter-propagating Raman pump can both improve and equalize the capacity of an S+C+L-band network, enabling higher throughput and simpler optical channel provisioning.

W3F.2 • 14:15
Optimized Physical Design of Metro Aggregation Networks Using Point to Multipoint Transceivers, Mohammad Mohammad Hosseini[1], João Pedro[2,3], Nelson Costa[2], Antonio Napoli[4], Jaroslaw E. Prilepsky[1], Sergei K. Turitsyn[1]; [†]*Aston Inst. of Photonic Technologies, Aston Univ., UK;* [2]*Infinera Unipessoal, Lda, Portugal;* [3]*IST, Instituto de Telecomunicações, Portugal;* [4]*Strategy, Architecture, Infinera, UK.* We present an ILP-based optimization for deploying transceivers exploiting digital subcarrier multiplexing while fulfilling filterless node conditions. Applying this method to a reference mesh network reduces transceiver cost by a figure between 18% and 38%.

Room 6F

14:00–16:15
W3G • Machine Learning and Virtualization in Optical Access
Presider: Michael Freiberger; Verizon Communications Inc, USA

W3G.1 • 14:00 Tutorial
The Evolution of Machine Learning in Optical Access Networks, Elaine Wong[1], Lihua Ruan[2], Sourav Mondal[3]; [1]*Univ. of Melbourne, Australia;* [2]*Chinese Univ. of Hong Kong, China;* [3]*Trinity College Dublin, Ireland.* This tutorial will provide a comprehensive review of the evolution of machine learning in optical access neworks, from drivers, supporting technologies, through to novel applications and new use cases.

Prof. Elaine Wong received her Ph.D. degree in electronic and electrical engineering from the University of Melbourne in 2002. In 2003, she was appointed research lead at the Australian Photonics CRC to develop optical signal monitoring techniques for optical networks. In 2006, she joined UC Berkeley to develop advanced wavelength-seeding and injection-locking technologies of source-free transmitters for optical access networks. She joined the University of Melbourne in 2007 where she has since led the development of optical technologies and subsystems for broadband access networks, energy-efficient and resilient optical communication networks. She is currently Associate Dean (Diversity and Inclusion) and Professor at the Faculty of Engineering and Information Technology, University of Melbourne. Her current research interests lies in advancing optical technologies in conjunction with prescriptive analytics based optical networking to realise human-to-machine/robot collaboration for the Internet-of-Sense and 6G. She has co-authored more

Room 7AB

14:00–16:00
W3H • Forward Error Correction
Presider: Ivan Djordjevic; Univ. of Arizona, USA

W3H.1 • 14:00 ★ Top-Scored
Investigation of Potential FEC Schemes for 800G-ZR Forward Error Correction, Weiming Wang[1]; [1]*ZTE Corporation, China.* With a record 400Gbps 100-piece-FPGA implementation, we investigate performance of the potential FEC schemes for OIF-800GZR. By comparing the power dissipation and correction threshold at 10^{-15} BER, we proposed the simplified OFEC for the 800G-ZR FEC.

W3H.2 • 14:15
Improved Soft-Aided Error-and-Erasure Decoding of Product Codes With Dynamic Reliability Scores, Sisi Miao[1], Lukas Rapp[1], Laurent Schmalen[1]; [1]*Karlsruhe Inst. of Technology, Germany.* We propose a novel soft-aided low-complexity decoder for product codes based on dynamic reliability scores and error-and-erasure decoding. We observe coding gains of up to 1.2 dB compared to conventional hard-decision decoders.

Room 8

14:00–16:00
W3I • Artificial Intelligence-enhanced Optical Wireless Systems

W3I.1 • 14:00
Intelligent End-to-end Nonlinear Constellation Auto-Optimization in W-Band Fiber-MMW Integrated Transmission for 6G Access, Junlian Jia[1], Jiang Chen[1], Guoqiang Li[1], Li Tao[2], Junwen Zhang[1,3], Nan Chi[1], Jianyang Shi[1], Chao Shen[1], Boyu Dong[1], Ziwei Li[1]; [1]*Fudan Univ., China;* [2]*CSDDC, China;* [3]*Peng Cheng Laboratory, China.* We propose and experimentally demonstrate an intelligent end-to-end nonlinear constellation auto-optimization method for fiber-MMW integrated 6G access network. Up to 60% lower bit-error-rate compared with the conventional constellation is achieved at 50-Gbps W-band fiber-MMW access.

W3I.2 • 14:15
Implementation of Machine Learning-Based Emergency Communication Using RoFSO-VLC/RF Convergence Link, Song Song[1], Xiangyu Liu[2], Yejun Liu[1], Junxian Wu[1], Tingwei Wu[1], Lei Guo[1]; [1]*Chongqing Univ. of Posts and Telecommunications, China;* [2]*Southern Univ. of Science and Technology, China.* This paper firstly experimentally demonstrates an ease of deployment integrated system to provide communication services for emergency responders, which employs machine-learning-based Radio-over-FSO system for outdoor fronthaul network and hybrid VLC/RF system for indoor access network.

Room 9

14:00–16:00
W3J • Doped Amplifiers in Fibers and Waveguides

W3J.1 • 14:00 Invited
Amplification of Structured Light in Optical Fibers, Kazi S. Abedin[1]; [1]*CACI International, Inc., USA.* In this talk, the potential of optical fiber in amplifying structured light will be presented. To this end, several multimode fibers with index profile tailored to guide mode with different structures, such as super-Gaussian, Sinc, Bessel will be shown.

Show Floor Programming

SF8 • Evolution of Optics for Mobile (MOPA)
13:30–14:30, *Theater II*

NOS2 • Network Operator Summit Panel II: Using Disaggregation as a Strategy to Modernize the Network
13:30–15:00, *Theater I*

SF9 • Space-based Optical Communications – Unleashing the Potential of Space
14:30–15:30, *Theater III*

SF10 • OpenROADM Updates and Demo
15:00–16:00, *Theater II*

MW4 • Market Watch IV: The Role of Optics in Future Machine Learning Architectures
15:30–17:00, *Theater I*

Room 1AB

W3A • Special Session: Network Evolution and Adaptation to Environmental Change Session I—Continued

W3A.2 • 14:30 Invited
Designs for a Circular Economy, Stefan Wiese[1]; [1]*Cisco Optical GmbH, Germany.* Abstract not available.

Room 2

W3B • Panel: The Role of Photonics for Artificial Intelligence/ Machine Learning at the Edge: What, Why and How?—Continued

Room 3

W3C • High Symbol Rate and Wideband Transmission—Continued

W3C.3 • 14:30 Invited
High Capacity Innovations Enabling Scalable Optical Transmission Networks, Yu Rong Zhou[1], John Keens[2], Walid Wakim[2]; [1]*BT Group plc, UK;* [2]*Cisco Systems Inc., USA.* We review the key optical innovations that enable scalable, efficient high capacity optical transmission networks and present results from recent industry leading technology trials in field deployed network and successful demonstration of emerging 400ZR/ZR+ technologies.

Room 6C

W3D • Photodetectors, Sensing and Microwave Photonics—Continued

W3D.3 • 14:30
Degradation Mechanisms and Lifetime Assessment of Ge Vertical PIN Photodetectors, Kristof Croes[1], Veerle Simons[1], Brecht Truijen[1], Philippe Roussel[1], Koen Van Sever[1], Artemisia Tsiara[1], Jacopo Franco[1], Philippe Absil[1]; [1]*imec, Belgium.* Dark current degradation mechanisms in Ge VPIN photodetectors were studied. A methodology to estimate the failure percentages has been developed and applied. Degradation/recovery processes and E_a-decrease of I_{dark} after stress suggest increased TAT during degradation.

W3D.4 • 14:45
Development and Modeling of Ge-Free Microring Avalanche Photodiode in Optical Communication Band, Yuan Yuan[1], Wayne V. Sorin[1], Di Liang[1], Stanley Cheung[1], Yiwei Peng[1], Mudit Jain[1], Zhihong Huang[1], Marco Fiorentino[1], Ray Beausoleil[1]; [1]*Hewlett Packard Labs, USA.* A physical model was developed to unfold different optical absorption mechanisms in a Germanium-free microring avalanche photodiode. Fabricated pure-Silicon microring detector showed competitive performance to support 100 Gb/s PAM4 operations at O-band.

Room 6D

W3E • Fiber Nonlinearity—Continued

W3E.2 • 14:30
Alignment of Zero-Dispersion Wavelength Along Highly-Nonlinear Fiber Length With Simultaneous Increase in the Stimulated Brillouin Scattering Threshold, Cheng Guo[1], Michael Vasilyev[1], Youichi Akasaka[2], Paparao Palacharla[2]; [1]*Department of Electrical Engineering, Univ. of Texas at Arlington, USA;* [2]*Advanced Technology Labs, Fujitsu Network Communications, USA.* We apply temperature tuning to several segments of a highly-nonlinear fiber with decreasing zero-dispersion wavelength (ZDW) to simultaneously align the segments' ZDWs and separate their stimulated Brillouin scattering (SBS) spectra, yielding higher SBS threshold.

W3E.3 • 14:45
Random Number Generation by Brillouin-Enhanced Four-Wave-Mixing in Polarization Maintaining Fiber, Pedro Tovarbr[1], Xiaoyi Bao[1]; [1]*Department of Physics, Univ. of Ottawa, Canada.* We report a novel real-time true random number generator based on Brillouin-enhanced FWM. Random bit sequences produced from the idler's intensity fluctuation, due to position and time dependent stochastic birefringence changes, passed all NIST tests.

Room 6E

W3F • High-capacity and Flexible Networks—Continued

W3F.3 • 14:30
Core Selective Switch Based Branching Unit Architectures and Efficient Bidirectional Core Assignment Scheme for Regional SDM Submarine System, Kako Matsumoto[1], Masahiko Jinno[1]; [1]*Kagawa Univ., Japan.* We propose core-selective-switch-based branching-unit architectures and an efficient bidirectional core-assignment scheme for regional space-division-multiplexing submarine systems. The architectures increase the number of reconfigurable cores and halve the number of multi-core fibers in branching cables.

W3F.4 • 14:45
Optimal Pay-as-you-Grow Deployment on S+C+L Multi-Band Systems, Andre Souza[1,2], Raoul Sadeghi Yamchi[3], Bruno V. Araujo Correia[3], Nelson Costa[1], Antonio Napoli[4], Vittorio Curri[3], João Pedro[1,2], João Pires[2]; [1]*Infinera, Unipessoal LDA, Portugal;* [2]*Instituto de Telecomunicações, Instituto Superior Técnico, Portugal;* [3]*Politecnico de Torino, Italy;* [4]*Infinera, UK.* We investigate the best band upgrade order on an S+C+L system in a pay-as-you-grow approach, aiming to maximize the end-of-life system capacity under the constraint of not disrupting already running services.

W3G • Machine Learning and Virtualization in Optical Access—Continued

than 200 peer-reviewed refereed publications, 4 book chapters and 5 patents. Elaine has held visiting faculty positions at Google Inc., USA (2011) and at MIT, USA (2019). Elaine was awarded the IEEE Photonics Society (formerly LEOS) Graduate Student Fellowship (2011) and the Australia Research Council Future Fellowship (2011). She was elevated to Fellow of the OSA in 2020 for "sustained pioneering contributions to the research of next-generation optical access networks and technologies".

W3H • Forward Error Correction—Continued

W3H.3 • 14:30 Invited

Fiber-on-Chip: Digital FPGA Emulation of Channel Impairments for Real-Time Evaluation of DSP, Per Larsson-Edefors[1], Erik Borjeson[1]; [1]*Chalmers Tekniska Högskola, Sweden.* We describe the Fiber-on-Chip (FoC) approach, in which digital models are used for real-time emulation of an optical communication system, to achieve cost-effective and reproducible long-term DSP evaluations inside a single chip.

W3I • Artificial Intelligence-enhanced Optical Wireless Systems—Continued

W3I.3 • 14:30

Computationally Efficient Pre-Distortion Based on Adaptive Partitioning Neural Network in Underwater Visible Light Communication, Hui Chen[1,2], Wenqing Niu[1], Guoqiang Li[1], Zhixue He[2], Junwen Zhang[1,2], Nan Chi[1], Ziwei Li[1,2]; [1]*Fudan Univ., China;* [2]*Peng Cheng Laboratory, China.* We proposed a computationally efficient pre-distortion scheme based on adaptive partitioning neural network to mitigate nonlinear impairments in high-speed UVLC system. We demonstrated a 56.3% computational complexity reduction in 2.85Gbit/s 64QAM-CAP UVLC system.

W3I.4 • 14:45

Highly Reliable Outdoor 400G FSO Transmission Enabled by ANN Channel Estimation, Marco A. Fernandes[1], J. Leonardo Nascimento[1], Paulo P. Monteiro[1], Fernando P. Guiomar[1]; [1]*Instituto de Telecomunicações de Aveiro, Portugal.* Using an ANN channel estimator, we experimentally demonstrate an outdoor 400G FSO-link with slow-fading prediction and compensation. A transmission reliability of more than 99% is obtained after 3-hour BER measurements.

W3J • Doped Amplifiers in Fibers and Waveguides—Continued

W3J.2 • 14:30

Mode-Dependent Gain Reduction in Coupled Multi-Core EDF With Smaller Core Pitch, Ryota Imada[1], Taiji Sakamoto[1], Shinichi Aozasa[1], Kazuhide Nakajima[1]; [1]*NTT Corporation, Japan.* We discuss the reduction in mode-dependent gain (MDG) in coupled-multi-core erbium-doped fiber (C-MC-EDF) with smaller core pitch by optimizing the bending radius. Our results indicate the possibility of C-MC-EDFA with both low power consumption and MDG.

W3J.3 • 14:45

Temperature Dependent Characteristics of L-Band EDFA Using Phosphorus- and High Aluminum- Co-Doped Silica Fibers, Ziwei Zhai[1], Arindam Halder[1], Yu Wang[1], Martin Núñez-Velázquez[1], Jayanta Sahu[1]; [1]*Univ. of Southampton, UK.* We report a hybrid L-band amplifier employing phosphosilicate and high-aluminosilicate EDFs with 20.2±3.7dB gain and 4.2dB average NF from 1575-1615nm. The temperature-dependent-gain coefficient remains almost constant from 1585-1615nm over the temperature range -60 to +80°C.

Show Floor Programming

NOS2 • Network Operator Summit Panel II: Using Disaggregation as a Strategy to Modernize the Network
13:30–15:00, *Theater I*

SF9 • Space-based Optical Communications – Unleashing the Potential of Space
14:30–15:30, *Theater III*

SF10 • OpenROADM Updates and Demo
15:00–16:00, *Theater II*

MW4 • Market Watch IV: The Role of Optics in Future Machine Learning Architectures
15:30–17:00, *Theater I*

Room 1AB

W3A • Special Session: Network Evolution and Adaptation to Environmental Change Session I—Continued

W3A.3 • 15:00 Invited

The Interdependency of Telco- and Non-Telco Networks With a Focus on Increasing Risk and Resilience, a New Use Case for Network Convergence, Andreas Gladisch[1], Michael Dueser[1]; [1]*Deutsche Telekom AG, Germany.* Convergence happens at different levels, fixed and mobile, smart grids, network sharing. Future risks in interruptions are not only intrinsic to telecommunications networks, but increasingly inter-relate with events in non-telco networks. Resilience concepts need to adapt accordingly.

Room 2

W3B • Panel: The Role of Photonics for Artificial Intelligence/ Machine Learning at the Edge: What, Why and How?—Continued

Room 3

W3C • High Symbol Rate and Wideband Transmission—Continued

W3C.4 • 15:00

72.64 Tb/s DWDM Transmission Over 100 km G.654D Fiber Using Super C-Band Erbium-Doped Fiber Amplification, Fabio Pittalà[2], Georg Böcherer[2], Patrick Schulte[2], Maximilian Schaedler[2], Stefano Calabrò[2], Bofang Zheng[1], Changsong Xie[2], Maxim Kuschnerov[2]; [1]*B&P Laboratory, Uawei Technologies Co. Ltd., China;* [2]*Munich Research Center, Huawei Technologies Duesseldorf GmbH, Germany.* We report a record of 72.64 Tb/s WDM transmission at 12.65 bits/s/Hz over 100 km G.654D fiber. Super C-band EDFAs with 6 THz gain spectrum are used to transmit 43 130 GBaud DP-PCS256QAM channels.

W3C.5 • 15:15

Investigation of Long-Haul S-, C- + L-Band Transmission, Benjamin J. Puttnam[1], Ruben S. Luis[1], Georg Rademacher[1], Yoshinari Awaji[1], Hideaki Furukawa[1]; [1]*National Inst Info & Comm Tech (NICT), Japan.* We investigate long-distance transmission of a 120nm S+C+L-band signal, observing a small improvement in throughput by launching higher power in S-band. We then measure a fully decoded throughput of 43.5 Tb/s after 10,072 km transmission.

Room 6C

W3D • Photodetectors, Sensing and Microwave Photonics—Continued

W3D.5 • 15:00

Ultra-low Loss Silicon Nitride Ring Modulator With Low Power PZT Actuation for Photonic Control, Jiawei Wang[1], Kaikai Liu[1], Mark W. Harrington[1], Ryan Q. Rudy[2], Daniel J. Blumenthal[1]; [1]*Univ. of California Santa Barbara, USA;* [2]*U.S. Army Research Laboratory, USA.* A wafer-scale PZT-actuated ultra-low loss, low-power, stress-optic Si_3N_4 ring modulator is realized with 7 million Q, 0.03 dB/cm loss, 20 nW power consumption and 20 MHz 3-dB bandwidth, is demonstrated to track a laser.

W3D.6 • 15:15

Hybrid Polymer THz Receiver PIC With Waveguide Integrated Photoconductive Antenna: Concept and 1st Characterization Results, Tianwen Qian[1], Milan Deumer[1], Y Durvasa Gupta[1], Simon Nellen[1], Ben Schuler[1], Hauke Conradi[1], Martin Kresse[1], Jakob Reck[1], Klara Mihov[1], Moritz Kleinert[1], Madeleine Weigel[1], Crispin Zawadzki[1], David de Felipe[1], Björn Globisch[1], Moritz Baier[1], Norbert Keil[1], Martin Schell[1]; [1]*Fraunhofer HHI, Germany.* An all-photonic THz-receiver PIC comprising an on-chip frequency stabilization scheme and a novel InP-based photoconductive antenna is presented. Characterization of the key photonic building blocks shows the functionality of the PIC.

Room 6D

W3E • Fiber Nonlinearity—Continued

W3E.4 • 15:00

Effective Area Tilt Impact in S+C+L Band Long-Haul Fiber Optic Transmission Systems, Viacheslav V. Ivanov[1], Petr Sterlingov[1], Snigharaj Mishra[1], John D. Downie[1], Sergejs Makovejs[1]; [1]*Corning, Inc., Russian Federation.* In this paper we investigate the impact of effective area tilt on the performance of wideband fiber optic transmission systems, and quantify transmission performance variability associated with the use of different types of terrestrial fibers.

W3E.5 • 15:15

Modal Loss Characterisation of Thick Ring Core Fiber Using Perfect Vortex Beams, Mai Banawan[1], Satyendra K. Mishra[1], Sophie LaRochelle[1], Leslie A. Rusch[1]; [1]*Department of Electrical and Computer Engineering , COPL, Universite Laval, Canada.* Using a programmable demultiplexer to validate launch conditions, we develop a mode-dependent loss (MDL) measurement method for fiber orbital angular momentum modes. We uncover spread in MDL and confirm low crosstalk in our fiber design.

Room 6E

W3F • High-capacity and Flexible Networks—Continued

W3F.5 • 15:00

Enabling Router Bypass and Saving Cost Using Point-to-Multipoint Transceivers for Traffic Aggregation, Antonio Napoli[1], Zdravko Stevkovski[2], Jose Jimenez[3], Edward Echeverry[3], Johan Bäck[4], João Pedro[5], Julia Rodriguez[6], Rafael Diaz[6], Jose Carrallo[6], Atul Mathur[7], Juan Pedro Fernández-Palacios[3], Fady Masoud[8], David F. Welch[7]; [1]*Infinera UK, UK;* [2]*Infinera Germany, Germany;* [3]*Telefonica GCTO, Spain;* [4]*Infinera Sweden, Sweden;* [5]*Infinera Portugal, Portugal;* [6]*Infinera Spain, Spain;* [7]*Infinera USA, USA;* [8]*Infinera Canada, Canada.* We propose combining point-to-multipoint coherent transceivers with a hybrid ROADM/filterless line system to enable a flatter IP-architecture for cost-effectively scaling metro-core/access networks. Considering various traffic and link engineering scenarios, we show CAPEX savings exceeding 40%.

W3F.6 • 15:15

Design and Dynamic Control of Fiber-Granular Routing Networks With Next-Generation Optical Paths, Takeshi Matsuo[1], Ryuta Shiraki[1], Yojiro Mori[1], Hiroshi Hasegawa[1]; [1]*Nagoya Univ., Japan.* Efficient network design and control algorithms for fiber-granular routing networks are proposed. Routing performance of next-generation broad-bandwidth optical paths on fiber-granular routing networks with over 100×100 fiber-cross-connects is verified.

Room 6F

W3G • Machine Learning and Virtualization in Optical Access—Continued

W3G.2 • 15:00
ANN-Based Optimization of Probabilistic and Geometric Shaping for Flexible Rate 50G and Beyond PON, Shuang Yao[1,2], Amitkumar Mahadevan[1], Yannick Lefevre[3], Noriaki Kaneda[1], Vincent Houtsma[1], Dora van Veen[1]; [1]*Nokia Bell Labs, USA;* [2]*Georgia Inst. of Technology, USA;* [3]*Nokia Bell Labs, Belgium.* Joint probabilistic and geometric shaping is considered for flexible PON. Optimal modulation is found through ANN, which generalizes to various ROPs and fiber lengths while taking dispersion, limited bandwidth, and receiver-side DSP into account.

W3G.3 • 15:15 Invited
PON Virtualization Including PHY Softwarization, Takahiro Suzuki[1], Sang Yeup Kim[1], Kota Asaka[1], Jun-ichi Kani[1], Tomoaki Yoshida[1]; [1]*NTT Corporation, Japan.* This paper summarizes studies on passive optical network (PON) virtualization, including the softwarization of physical-layer (PHY) coding and digital signal processing (DSP), as well as PON abstraction, which provide flexibility and agility to access networks.

Room 7AB

W3H • Forward Error Correction—Continued

W3H.4 • 15:00
Low-Complexity Channel-Polarized Multilevel Coding for Probabilistic Amplitude Shaping, Takeshi Kakizaki[1], Masanori Nakamura[1], Fukutaro Hamaoka[1], Yoshiaki Kisaka[1]; [1]*NTT Network Innovation Laboratories, NTT, Japan.* We propose a low-complexity FEC scheme for PAS, which applies SD-FEC to unreliable bits converted by channel polarization. It reduces the complexity by up to 83% compared with changing the decoding iterations in PAS.

W3H.5 • 15:15
Practical Entropy Loading Enabled by Enumerative Sphere Shaping With Short Block Lengths, Yizhao Chen[1], Weihao Li[1], Junda Chen[1], Yating Xiang[1], Mingming Zhang[1], Deming Liu[1], Ming Tang[1]; [1]*Huazhong Univ of Science and Technology, China.* We propose a practical entropy loading scheme using enumerative sphere shaping, providing considerable shaping gain even with ultra-short block lengths. In the experimental validation, up to 6.0% capacity improvement is achieved.

Room 8

W3I • Artificial Intelligence-enhanced Optical Wireless Systems—Continued

W3I.5 • 15:00
Long Short-Term Memory Neural Network to Enhance the Data Rate and Performance for Rolling Shutter Camera Based Visible Light Communication (VLC), Ching-Wei Peng[1], Deng-Cheng Tsai[1], Yun-Shen Lin[1], Chi-Wai Chow[1], Yang Liu[2], Chien-Hung Yeh[3]; [1]*National Yang Ming Chiao Tung Univ., Taiwan;* [2]*Philips Electronics Ltd, Hong Kong;* [3]*Feng Chia Univ., Taiwan.* We propose and demonstrate using Long-Short-Term-Memory neural-network (LSTM-NN) to mitigate inter-symbol-interference (ISI) in 4-level pulse-amplitude-modulation (PAM4) camera based visible-light-communication (VLC) system. Data-rate of 14.4-kbit/s with 3-m free-space transmission is achieved.

W3I.6 • 15:15
Using Received-Signal-Strength (RSS) Pre-Processing and Convolutional Neural Network (CNN) to Enhance Position Accuracy in Visible Light Positioning (VLP), Li-Sheng Hsu[1], Deng-Cheng Tsai[1], Hei Man Chen[1], Yun-Han Chang[1], Yang Liu[2], Chi-Wai Chow[1], Shao-Hua Song[1], Chien-Hung Yeh[3]; [1]*National Yang Ming Chiao Tung Univ., Taiwan;* [2]*Philips Electronics Ltd, Hong Kong;* [3]*Feng Chia Univ., Taiwan.* We propose and demonstrate a received-signal-strength (RSS) pre-processing scheme to mitigate light-deficient-region occurred in visible-light-positioning (VLP) and convolutional-neural-network (CNN) to enhance VLP performance. The RSS pre-processing and CNN model are discussed.

Room 9

W3J • Doped Amplifiers in Fibers and Waveguides—Continued

W3J.4 • 15:00
Low Cost Solution for Super L-Band Fiber Amplifier Based on Single-Mode and Multi-Mode Hybrid Pumping Scheme, Lixian Wang[1], Manish Sharma[1], Frédéric Maes[1], Saber Jalilpiran[2], Firat Durak[2], Younes Messaddeq[2], Sophie LaRochelle[2], Zhiping Jiang[1]; [1]*Huawei Technologies Canada, Canada;* [2]*Center for Optics, Photonics and Lasers (COPL), Universite Laval, Canada.* A super L-band amplifier (21 dB gain over 1575~1626 nm) is demonstrated using two types of erbium doped fibers designed for single-mode and multi-mode pumping. Noise figure, power consumption and fabrication cost are analyzed.

W3J.5 • 15:15
50 Gbaud QPSK E-Band Transmission Using Bismuth Doped Fiber Amplifiers, Aleksandr I. Donodin[1], Mingming Tan[1], Ian Phillips[1], Abdallah A. Ali[1], Pratim Hazarika[1], Mohammed Patel[1], Paul Harper[1], Vladislav Dvoyrin[1,2], Wladek Forysiak[1], Sergei K. Turitsyn[1,2]; [1]*Aston Univ., UK;* [2]*Aston-Novosibirsk International Centre for Photonics, Novosibirsk State Univ., Russian Federation.* We experimentally demonstrate 35nm E-band transmission through 60km SSMF using 50Gbaud QPSK signals with Q^2 factor penalties less than 2.75dB enabled by a bismuth doped fiber amplifier with 29.8dB gain and 6.25dB noise figure.

Show Floor Programming

SF9 • Space-based Optical Communications – Unleashing the Potential of Space
14:30–15:30, *Theater III*

SF10 • OpenROADM Updates and Demo
15:00–16:00, *Theater II*

MW4 • Market Watch IV: The Role of Optics in Future Machine Learning Architectures
15:30–17:00, *Theater I*

Room 1AB

W3A • Special Session: Network Evolution and Adaptation to Environmental Change Session I—Continued

W3A.4 • 15:30 Invited
Network Disaggregation, Mallik Tatipamula[1]; [1]*Ericsson, USA.* Abstract not available.

Room 2

W3B • Panel: The Role of Photonics for Artificial Intelligence/ Machine Learning at the Edge: What, Why and How?—Continued

Room 3

W3C • High Symbol Rate and Wideband Transmission—Continued

W3C.6 • 15:30 Invited
Modeling of Fiber Nonlinearity in Wideband Transmission, Daniel Semrau[1]; [1]*Infinera Corporation, UK.* The ISRS GN model is reviewed which models nonlinear transmission performance including inter-channel stimulated Raman scattering. Utilizing the model, a convex launch power optimization approach is proposed and applied to a transatlantic S+C+L band system

Room 6C

W3D • Photodetectors, Sensing and Microwave Photonics—Continued

W3D.7 • 15:30
InP-Si3N4 Hybrid Integrated Optical Source for High-Purity Mm-Wave Communications, Luis Gonzalez[1], Robinson Guzman[1], Muhsin Ali[1], Jessica Cesar Cuello[1], Devika Dass[2], Colm Browning[2], Liam P. Barry[2], Ilka Visscher[3], Robert Grootjans[3], Chris G. H. Roeloffzen[3], Guillermo Carpintero[1]; [1]*Univ. Carlos III of Madrid, Spain;* [2]*Dublin City Univ., Ireland;* [3]*LioniX International BV, Netherlands.* We present the optical injection locking to a comb of a hybrid InP-Si3N4 dual laser source for high-purity mm-wave generation. Key performance parameters such as adjacent-comb-line side mode suppression ratio and locking range are reported.

Room 6D

W3E • Fiber Nonlinearity—Continued

Room 6E

W3F • High-capacity and Flexible Networks—Continued

W3F.7 • 15:30
Optimal Spectral Usage for Energy Efficient S-to-U Multiband Networking, Raoul Sadeghi Yamchi[1], Bruno V. Araujo Correia[1], Emanuele E. Virgillito[1], Antonio Napoli[2], Nelson Costa[3], João Pedro[3], Vittorio Curri[1]; [1]*Politecnico di Torino, Italy;* [2]*Infinera UK, UK;* [3]*Infinera Por, Portugal.* We investigated and showed that using the U-band instead of the entire S-band is an optimal solution of increasing capacity while reducing energy consumption and cost in transparent and two different translucent strategy network designs.

W3F.8 • 15:45
Transport Network Upgrade Exploiting Multi-Band Systems: S- Versus E-Band, Nicola Sambo[1], Bruno V. Araujo Correia[2], Antonio Napoli[3], João Pedro[4], Piero Castoldi[1], Vittorio Curri[2]; [1]*Scuola Superiore Sant Anna di Pisa, Italy;* [2]*Politecnico di Torino, Italy;* [3]*Infinera, UK;* [4]*Infinera, Portugal.* Exploiting bands beyond C+L can effectively upgrade network capacity, but Stimulated Raman Scattering (SRS) affects wideband-transmission, potentially degrading active channels. Upgrades exploiting E- and S-band are compared in terms of capacity and number of reconfigurations.

16:00–16:30 Coffee Break

Room 6F

W3G • Machine Learning and Virtualization in Optical Access—Continued

W3G.4 • 15:45
Demonstration of in-Service Protocol-Independent End-to-end Optical Path Control and Restoration in All-Photonics Network, Yumiko Senoo[1], Shin Kaneko[1], Takuya Kanai[1], Naotaka Shibata[1], Jun-ichi Kani[1], Tomoaki Yoshida[1]; *[1]NTT Corporation, Japan*. We propose a control method for in-service end-to-end optical paths, and experimentally demonstrate the simultaneous restoration of Ethernet, CPRI, and HDMI signals, which is the world's first operation of protocol-independent control for end-to-end optical-path.

W3G.5 • 16:00
Any-Double-Link Failure Tolerant Bypass/Backup Switchable WDM-PON Employing Path-Pair Shared Protection and Bidirectional Wavelength Pre-Assignment, Takahiro Kodama[1,2], Tomoya Nakagawa[1], Ryosuke Matsumoto[2]; *[1]Kagawa Univ., Japan; [2]National Inst. of Advanced Industrial Science and Technology (AIST), Japan*. We propose two-of-four long-link failure tolerant path-pair shared protection and bi-directional wavelength pre-assignment for robust bypass/backup-path switchable wavelength-division multiplexing based coherent optical access network systems that experimentally achieve < 2-dB penalty for any double-link failure.

Room 7AB

W3H • Forward Error Correction—Continued

Room 8

W3I • Artificial Intelligence-enhanced Optical Wireless Systems—Continued

W3I.7 • 15:30 Invited
Towards AI-Enhanced VLC Systems, Wesley Costa[1], Higor Camporez[1], Marcelo Segatto[1], Helder Rocha[1], Jair L. Silva[1]; *[1]UFES, Brazil*. We demonstrate that position prediction is feasible in industrial applications with visible light communication (VLC), using artificial intelligence. Accordingly, a long short-term memory neural network is suggested, after experimental demonstrations of the optimized VLC systems.

Room 9

W3J • Doped Amplifiers in Fibers and Waveguides—Continued

W3J.6 • 15:30
3D Printed and Spiral Lithographically Patterned Erbium-Doped Polymer Micro-Waveguide Amplifiers, Hongwei Gao[2], Huimin Li[2], George Feng Rong Chen[2], Peng Xing[2], Mei Chee Tan[2], Dawn T. Tan[2,1]; *[1]Inst. of Microelectronics, A*star, Singapore; [2]EPD, Singapore Univ. of Technology and Design, Singapore*. We present spiral erbium-doped polymer micro-waveguide amplifiers fabricated using lithographic patterning and the first demonstration of 3D printed polymer waveguide amplifiers. A maximum gain of 8 dB and gain bandwidth of 60 nm is achieved.

16:00–16:30 Coffee Break

Show Floor Programming

SF10 • OpenROADM Updates and Demo
15:00–16:00, *Theater II*

MW4 • Market Watch IV: The Role of Optics in Future Machine Learning Architectures
15:30–17:00, *Theater I*

SF11 • Beyond 400G – IEEE Update on Progress Towards 800 GbE and 1.6 TbE
16:00–17:00, *Theater III*

TS1 • 400Gbps Post FEC BER and Jitter Tolerance Test
Presented by Anritsu Corporation
16:15–16:45, *Theater II*

Room 1AB

16:30–18:00
W4A • Special Session: Network Evolution and Adaptation to Environmental Change Session II
Presider: Chris Fludger; Infinera GmbH, Germany

W4A.1 • 16:30 Invited
Future Demands on Data Centers and Data-Center Interconnect Networks, Chongjin Xie[1]; [1]*Alibaba Group, USA*. Alibaba Group has committed to achieve carbon neutrality by 2030 for sustainable development. We discuss various technologies to support future development of data center and data-center interconnect networks in an environmentally friendly way.

Room 2

16:30–18:30
W4B • Advances in Optical Switching
Presider: Yikai Su; Shanghai Jiao Tong Univ., China

W4B.1 • 16:30 Invited
Multiband Optical Switch Technology, Takashi Goh[2], Keita Yamaguchi[1], Ai Yanagihara[1]; [1]*NTT Corporation, Japan;* [2]*NTT Electronics Corporation, Japan*. We developed a broadband switch using a MZI with π shift utilizing wide and narrow waveguides. The fabricated 8×8 matrix switch exhibited switch extinction ratios of more than 47 dB in wavelength from 1260 to 1675 nm.

Room 3

16:30–18:30
W4C • RoF Systems

W4C.1 • 16:30 ★ Top-Scored
First Demonstration of a Single-λ, Full-Duplex RRH Transceiver With Single RF Carrier for Bidirectional Radio, Bernhard Schrenk[1], Fotini Karinou[2]; [1]*AIT Austrian Inst. of Technology, Austria;* [2]*Microsoft Research Ltd, UK*. We successfully the reception and transmission of radio signals over the same opto-electronic port and at the same RF carrier frequency at the same time. We find >2% EVM margins for 16/64-QAM OFDM down-/uplink transmission.

W4C.2 • 16:45
1.314-Tbit/s (576 × 380.16-MHz 5G NR OFDM Signals) SDM/WDM/SCM-Based if-Over-Fiber Transmission for Analog Mobile Fronthaul, Kazuki Tanaka[1], Shinji Nimura[1], Shota Ishimura[1], Kosuke Nishimura[1], Ryo Inohara[1], Takehiro Tsuritani[1], Masatoshi Suzuki[1]; [1]*KDDI Research, Inc., Japan*. 576 × 64-QAM 5G NR OFDM signals with a net bit rate of 1.314-Tbit/s are successfully transmitted over a 12.8-km uncoupled 4-core fiber, using subcarrier multiplexing for the 18 OFDM signals and eight wavelength-division multiplexing.

Room 6C

16:30–18:30
W4D • Fiber Sensors
Presider: Raja Ahmad; OFS Laboratories, USA

W4D.1 • 16:30 Invited
Photoacoustic Spectroscopy of Gas Filled Hollow Core Fiber, Wei Jin[1], Yan Zhao[1], Yun Qi[1], Hoi Lut Ho[1], Shoufei Gao[2], Yingying Wang[2]; [1]*The Hong Kong Polytechnic Univ., Hong Kong;* [2]*Jinan Univ., China*. Photoacoustic spectroscopy is demonstrated with gas filled microstructured hollow core optical fibers. This technique may be used for high sensitivity gas sensing, non-invasive fiber characterization, and fiber-optic phase modulation devices

Room 6D

16:30–18:30
W4E • Hollow-core Fibers
Presider: Raja Ahmad; OFS Laboratories, USA

W4E.1 • 16:30 Tutorial
Hollow-Core Fibers: Key Properties, Technology Status and Telecommunication Opportunities, David J. Richardson[1,2]; [1]*Univ. of Southampton, UK;* [2]*Lumenisity Limited, UK*. We review the state-of-the-art in hollow-core optical fibers, describe some of their unique and enabling properties, which include amongst others low-latency, low optical nonlinearity, low chromatic dispersion and the potential for wideband ultralow loss, and discuss application opportunities in telecommunications.

David Richardson is currently Deputy Director of the Optoelectronics Research Centre at Southampton University UK with overall responsibility for optical fiber and laser related research. His current research interests include both hollow-core optical fibers and optical fiber communications. He is also a co-founder of Lumenisity Ltd who are developing hollow-core fibre cable solutions for the telecommunications industry.
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Room 6E

16:30–18:30
W4F • Emerging Network Architectures and Services

W4F.1 • 16:30 Tutorial
The Future of Optical Transport: Architectures and Technologies From an Operator Perspective, Andrew Lord[1]; [1]*BT Applied Research, UK*. This tutorial paper reviews recent developments in optical transport architectures from an operator's perspective, focusing on how coherent technologies will push towards the network edge

Andrew joined BT in 1985 after a BA in Physics from Oxford University. He leads BT's optical and quantum research. He is Editor in Chief for JOCN; he will be co-TPC for ECOC 2023. He was co-TPC for OFC 2015 and co-GC for OFC 2017. He is a Visiting Professor at Essex University, Senior Member of the IEEE and a Chartered Engineer with the IET.

Room 6F

16:30–18:30
W4G • Network Performance
Presider: Stephan Pachnicke; Christian-Albrechts Universität zu Kiel, Germany

W4G.1 • 16:30 Invited
Unified Software Controllers: Operating a Global Cloud Network, Mark A. McKillop[1]; [1]*Facebook, UK*. Abstract not available.

Room 7AB

16:30–18:30
W4H • High Bandwidth Density Technologies to XPU

W4H.1 • 16:30 Invited
Optical Opportunities in Datacenter Servers, Ram Huggahalli[1]; [1]*Microsoft, USA*. To support an increasing range of applications in datacenters, server designs are adapting with new SoC-level packaging and platform-level cabling technologies. Optical technologies can intercept these trends to simplify designs while enabling high bandwidth efficiencies.

Room 8

16:30–18:30
W4I • Machine Learning/ Artificial Intelligence Methods in Transmission Systems
Presider: Tobias Eriksson; Infinera, Sweden

W4I.1 • 16:30
Modified Weighted Learned Digital Backpropagation With Pre-Optimization in High-Symbol-Rate Coherent Systems, Du Tang[1], Zhen Wu[1], Xizi Tang[1], Jiating Luo[2], Ji Luo[3], Bofang Zheng[2], 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]*B&P Laboratory, Huawei Technologies Co. Ltd., China;* [3]*Moscow Optic Algorithm Lab, Huawei Moscow Research Center, Russian Federation*. A modified weighted learned digital backpropagation (M-W-LDBP) with pre-optimization is proposed for fiber nonlinearity compensation in high-symbol-rate coherent systems. Compared with LDBP, M-W-LDBP exhibits 1/0.7 dB signal-to-noise ratio gain in 90/128-GBaud systems, respectively.

W4I.2 • 16:45
Machine Learning Based EDFA Channel in-Band Gain Ripple Modeling, Zhiping Jiang[1], Jiachuan Lin[1], Hangting Hu[2]; [1]*Huawei Technologies Canada, Canada;* [2]*Optical Technologies Engineering Dept, NW, Huawei Technologies Co., Ltd, China*. For the first time, a framework is proposed to model EDFA's channel in-band gain ripple by machine learning. The achieved model accuracy (standard deviation) is 0.022dB/nm for gain tilt and 0.053dB for overall gain spectrum.

Room 9

16:30–18:30
W4J • Optical Parametric Amplification and its Applications
Presider: Michael Vasilyev; Univ. of Texas at Arlington, USA

W4J.1 • 16:30
Polarization Insensitive Fiber Optic Parametric Amplifier With a Gain Bandwidth of 22 nm in S-Band, Chandra Bhanu Gaur[1], Vladimir Godienko[1], Pratim Hazarika[1], Nick J Doran[1]; [1]*Aston Inst. of Photonic Technologies, UK*. We demonstrate a polarization insensitive fiber optic parametric amplifier to provide net gain >10dB and polarization dependent gain <1dB for up to 19 WDM channels in the range 1508– 1530nm.

W4J.2 • 16:45
Suppression of Spurious Mixing in FWM-Based Systems Through Mid-Span Pump Phase Shift, Kyle Bottrill[1], Natsupa Taengnoi[1], Hao Liu[1], Ravikiran Kakarla[1], Yang Hong[1], Periklis Petropoulos[1]; [1]*Univ. of Southampton, UK*. We propose and demonstrate a new technique to suppress spurious idler generation during four-wave mixing, by applying a π radian phase shift to the pumps at the mid-point of the processing medium.

Show Floor Programming

MW4 • Market Watch IV: The Role of Optics in Future Machine Learning Architectures
15:30–17:00, *Theater I*

SF11 • Beyond 400G – IEEE Update on Progress Towards 800 GbE and 1.6 TbE
16:00–17:00, *Theater III*

TS1 • 400Gbps Post FEC BER and Jitter Tolerance Test
Presented by Anritsu Corporation
16:15–16:45, *Theater II*

Room 1AB

W4A • Special Session: Network Evolution and Adaptation to Environmental Change Session II—Continued

W4A.2 • 17:00 Invited

Optical Communications in Disaster Zones, Findlay Faubion[1]; [1]*Verizon Wireless, USA*. Abstract not available.

Room 2

W4B • Advances in Optical Switching—Continued

W4B.2 • 17:00

Edge Wavelength Selective Switch for Optical Access Networks, Evan D. Chansky[1], Viviana Arrunategui-Norvick[1], Takako Hirokawa[1,3], L. Alberto Campos[2], Haipeng Zhang[2], Mu Xu[2], Zhensheng Jia[2], Clint Schow[1]; [1]*Univ. of California Santa Barbara, USA;* [2]*CableLabs, USA;* [3]*GlobalFoundries, USA*. We demonstrate a novel C-band wavelength selective switch well equipped to handle the demands of scaling access at the edge. The 1x4 switch block has two drops per port with thermo-optic tuning.

W4B.3 • 17:15 ★ Top-Scored

Path-Independent Insertion-Loss (PILOSS) 8 × 8 Silicon Photonics Switch With <8 Nsec Switching Time, Ryotaro Konoike[1], Keijiro Suzuki[1], Kazuhiro Ikeda[1]; [1]*AIST, Japan*. We demonstrate strictly non-blocking and 8 × 8 silicon photonics switch with 10-90% switching time of <8 nsec, on-chip loss of 3.8±0.19 dB independent of path settings, and 20-dB crosstalk bandwidth of ~30 nm.

Room 3

W4C • RoF Systems—Continued

W4C.3 • 17:00

>100 Gbps 3×3 MIMO v-Band RoF System for up to 100 m Wireless Transmission Enabled by NN-Based Equalization, Chia Chien Wei[2], Yu-Jen Huang[1], Zhen-Xiong Xie[1], Ping-Yao Huang[1], Pin-Hsuan Ting[1], Chun-Ting Lin[1]; [1]*Photonics, National Yang Ming Chiao Tung Univ., Taiwan;* [2]*Photonics, National Sun Yat-sen Univ., Taiwan*. This study employs a single neural-network-based nonlinear equalizer in a 3×3 MIMO V-band RoF system for the first time. Experiment results demonstrate >30% improvement in data rate and >100-Gbps wireless transmission over 100 m.

W4C.4 • 17:15

Radio Beamsteering for a 2×5 Remote Radio Head Assisted by a Shared Wideband Etalon Cascade, Aina Val Martí[1], David Löschenbrand[1], Thomas Zemen[1], Bernhard Schrenk[1]; [1]*AIT Austrian Inst. of Technology, Austria*. We demonstrate RF beamsteering through cascaded Gires-Tournois etalons, yielding a delay-tailored DWDM feed for a 2×5 antenna configuration. 64-QAM OFDM radio is transmitted under 32° beam deflection. We further show kHz carrier phase switching.

Room 6C

W4D • Fiber Sensors—Continued

W4D.2 • 17:00

Kalman Filter Assisted Tracking of Microparticles in Hollow-Core Photonic Crystal Fibers for Sensor Applications, Max Koeppel[1,3], Jasper Podschus[1], Nicolas Y. Joly[1,2], Philip S. Russell[2,1], Bernhard Schmauss[1,2]; [1]*Univ. of Erlangen-Nurnberg, Germany;* [2]*Max Planck Inst. for the Science of Light, Germany;* [3]*Graduate School in Advanced Optical Technologies, Germany*. Accurate tracking of optically levitated microparticles inside hollow-core photonic crystal fibers is a key requirement for novel "flying particle sensors". We demonstrate a significantly improved tracking accuracy for accelerated particles by applying a Kalman filter.

W4D.3 • 17:15 ★ Top-Scored

Remote Drone Detection and Localization With Fiber-Optic Microphones and Distributed Acoustic Sensing, Jian Fang[1], Yaowen Li[1], Philip N. Ji[1], Ting Wang[1]; [1]*NEC Laboratories America, USA*. We demonstrate the first fiber-optic drone detection method with ultra-highly sensitive optical microphones and distributed acoustic sensor. Accurate drone localization has been achieved through acoustic field mapping and data fusion.

Room 6D

W4E • Hollow-core Fibers—Continued

Room 6E

W4F • Emerging Network Architectures and Services—Continued

Room 6F

W4G • Network Performance—Continued

W4G.2 • 17:00 Invited

Field Learnings of Deploying Model Assisted Network Feedback Systems, Alex W. MacKay[1]; [1]*Ciena Corporation, Canada*. Latent SNR margin in optical transport networks is investigated using performance monitoring SDN applications. An observed network can increase capacity by 13.8%, maintaining ≥1 dB of SNR margin at full fill without modifying any equipment.

Room 7AB

W4H • High Bandwidth Density Technologies to XPU—Continued

W4H.2 • 17:00

Temperature Tolerant on-Chip WDM Silicon Photonic Transmitter and AWGR-Based Routing Interconnects, Ioannis Roumpos[1], Themistoklis Chrysostomidis[1], Vittorio Grimaldi[2], Francesco Zanetto[2], Fabio Toso[2], Peter De Heyn[3], Yoojin Ban[3], Joris Van Campenhout[3], Giorgio Ferrari[2], Marco Sampietro[2], Francesco Morichetti[2], Andrea Melloni[2], Konstantinos Vyrsokinos[1], Theoni Alexoudi[4], Nikos Pleros[4], Miltiadis Moralis-Pegios[4]; [1]*Physics, Aristotle Univ. of Thessaloniki, Greece;* [2]*Electronics, Information and Bioengineering, Politecnico di Milano, Italy;* [3]*IMEC, Belgium;* [4]*Informatics, Aristotle Univ. of Thessaloniki, Greece*. We demonstrate automated thermal drift compensation in a two-socket AWGR interconnect, incorporating a ring-modulator transmitter. Stable operation with an average Q=5.8 over a range of 9°C is achieved for 25 Gb/s on-chip modulated data.

W4H.3 • 17:15 Tutorial

High Density Silicon Photonics for Co-Packaged Ethernet Switch and XPUs, Ling Liao[1]; [1]*Intel Corporation, USA*. This tutorial will provide an overview of co-packaged optics for integration with switch ASICs and XPUs to meet the reach, bandwidth density and power performance needs of future data center networks and compute platform connectivity.

Liao Ling is an Intel Fellow and chief architect of photonic integration in Intel's Silicon Photonic Product Division. She joined Intel in 1997 and leads the development of co-package optics. Ling earned her BS and MS from the Massachusetts Institute of Technology and PhD from the University of Surrey, England.

Room 8

W4I • Machine Learning/ Artificial Intelligence Methods in Transmission Systems—Continued

W4I.3 • 17:00 Invited

End-to-end Learning of Joint Geometric and Probabilistic Constellation Shaping, Vahid Aref[1], Mathieu Chagnon[1]; [1]*Nokia, Germany*. We present a novel autoencoder-based learning of joint geometric and probabilistic constellation shaping for coded-modulation systems. It can maximize either the mutual information (for symbol-metric decoding) or the generalized mutual information (for bit-metric decoding).

Room 9

W4J • Optical Parametric Amplification and its Applications—Continued

W4J.3 • 17:00 Invited

Ultralow-Loss Silicon Nitride Waveguides for Parametric Amplification, Victor Torres Company[1], Zhichao Ye[1], Ping Zhao[1], Magnus Karlsson[1], Peter A. Andrekson[1]; [1]*Chalmers Tekniska Högskola, Sweden*. We report net gain in a continuous-wave-pumped parametric amplifier implemented in a meter-long dispersion-engineered silicon nitride waveguide. These results are enabled by the record-low loss (1.4dB/m) of the waveguide.

Room 1AB

W4A • Special Session: Network Evolution and Adaptation to Environmental Change Session II—Continued

W4A.3 • 17:30 Invited

Optical Communications in Disaster Zones, Mattia Cantono[1]; [1]*Google LLC, USA*. Abstract not available.

Room 2

W4B • Advances in Optical Switching—Continued

W4B.4 • 17:30

Broadband, Low-Crosstalk and Power-Efficient 32×32 Optical Switch on a Dual-Layer Si_3N_4-on-SOI Platform, Wei Gao[1], Xin Li[1], Liangjun Lu[1,2], Jianping Chen[1,2], Linjie Zhou[1,2]; [1]*Shanghai Jiao Tong Univ., China;* [2]*SJTU-Pinghu Inst. of Intelligent Optoelectronics, China*. We demonstrate a 32×32 optical switch on a dual-layer Si_3N_4-on-SOI platform with low fiber-to-fiber insertion loss (9.61~14.51 dB), low crosstalk (~-35 dB), broad 3-dB bandwidth (~57 nm) and low power consumption (~0.83 W).

W4B.5 • 17:45

Digitally Controlled Silicon Nitride Optical Switch, Suraj Sharma[1], Niharika Kohli[2], Jonathan Brière[3], Frederic Nabki[1], Michaël Ménard[1]; [1]*École de Technologie Supérieure, Canada;* [2]*CMC Microsysystems, Canada;* [3]*AEPONYX Inc., Canada*. We report the first 1 x 3 silicon nitride optical switch using silicon electrostatic MEMS actuator with a 4.97 dB average insertion loss over the 1530 nm to 1580 nm wavelength range.

Room 3

W4C • RoF Systems—Continued

W4C.5 • 17:30

Transmission of Tb/s CPRI-Equivalent Rate Using Coherent Digital-Analog Radio-Over-Fiber (DA-RoF) System, Qunbi Zhuge[1], Yicheng Xu[1], Yunyun Fan[1], Xiaobo Zeng[1], Mengfan Fu[1], Lilin Yi[1], Weisheng Hu[1], Xiang Liu[2]; [1]*Shanghai Jiao Tong Univ., China;* [2]*Huawei Technologies, China*. A coherent digital-analog radio-over-fiber (DA-RoF) system is proposed and experimentally demonstrated. An EVM below 3.5% with a CPRI equivalent rate of 1 Tb/s is achieved using a 25 Gbaud dual-polarization signal over a 10-km distance.

W4C.6 • 17:45

A Dynamically Reconfigurable Optical Switching Node for Hybrid Analog/Digital RoF Transport, Panagiotis Toumasis[1], Konstantina Kanta[1], Konstantinos Tokas[1], Giannis Giannoulis[1], Dimitris Apostolopoulos[1], Hercules Avramopoulos[1]; [1]*School of Electrical & Computer Engineering, ICCS/ National Technical Univ. of Athens, Greece*. We demonstrate a dynamically reconfigurable optical switching node interconnecting both Digital and Analog RoF interfaces. Successful optical/wireless transmission is verified, and real-world services are showcased over the deployed WDM infrastructure.

Room 6C

W4D • Fiber Sensors—Continued

W4D.4 • 17:30

246km Long Distance Fiber Optic DAS System Based on Multi-Span Bidirectional EDFAs and Cascaded AOMs, Cunzheng Fan[1], Hao Li[1], Baoqiang Yan[1], Zhijun Yan[1], Qizhen Sun[1]; [1]*Huazhong Univ of Science and Technology, China.* A long-distance DAS system based on multi-span bidirectional erbium-doped fiber amplifier was proposed. Assisted with high ER pulse from cascaded AOMs, 246km sensing distance was realized using four-segment relays.

W4D.5 • 17:45

Method of Widening Dynamic Range of Measurable Vibration in FDM-Based Sampling-Rate-Enhanced Φ-OTDR, Yoshifumi Wakisaka[1], Daisuke Iida[1], Hiroshi Takahashi[1], Yusuke Koshikiya[1]; [1]*NTT Corporation, Japan*. We propose and demonstrate a method to suppress the infidelity effect in FDM-based sampling-rate-enhanced Φ-OTDR vibration sensing; it extends the dynamic range without increase of the system complexity or prior knowledge of the vibration.

Room 6D

W4E • Hollow-core Fibers—Continued

W4E.2 • 17:30

Coupling NANF to Silicon Photonics Circuits, Carmelo Scarcella[1], Roxana Soos[1], Jan Troska[1], Daniel Ricci[1], Iacopo Toccafondo[1], Sacha Medaer[1], Austin Taranta[2], Francesco Poletti[2]; [1]*CERN - European Council for Nuclear Research, Switzerland;* [2]*Optoelectronics Research Centre, Univ. of Southampton, UK*. We present the first demonstration of optical coupling between hollow core fibers and Silicon Photonics circuits. We achieved moderate excess coupling loss with respect to SMF-28 and achieved 25 Gb/s data transmission over NANF fibers.

W4E.3 • 17:45 ★ Top-Scored

Comparison Between the Optical Performance of Photonic Bandgap and Antiresonant Hollow Core Fibers After Long-Term Exposure to the Atmosphere, Shuichiro Rikimi[1], Yong Chen[1,2], Thomas Bradley[1], Ian Davidson[1], Hesham Sakr[1], Austin Taranta[1], Kerrianne Harrington[1], Francesco Poletti[1], Marco Petrovich[1,2], David J. Richardson[1,2], Natalie Wheeler[1]; [1]*Univ. of Southampton, UK;* [2]*Lumenisity Ltd., UK*. We measure the changes in transmission properties of two different hollow core fiber types exposed to standard atmosphere over nearly one year. No degradation of transmitted power is observed for the hollow-core NANF studied.

Room 6E

W4F • Emerging Network Architectures and Services—Continued

W4F.2 • 17:30

Delay Advantage of Optical Satellite Networks (OSN) in Long-Distance Transoceanic Communication, Jipu Li[1], Nan Hua[1], Yanhe Li[1], Xiaoping Zheng[1]; [1]*Tsinghua Univ., China*. We study the impacts of traffic source/destination location, routing strategy and load on the end-to-end delay benefit of OSN. Simulation and emulation results show that OSN has great delay advantage over terrestrial/undersea optical networks.

W4F.3 • 17:45 ★ Top-Scored

Hitless Transmission Baud Rate Switching in a Real-Time Transponder Assisted by an Auto-Negotiation Protocol, Eric Dutisseuil[1], Arnaud Dupas[1], Alexandre Gouin[1], Fabien Boitier[1], Patricia Layec[1]; [1]*Nokia Bell Labs, France*. We propose a novel coherent receiver architecture that allows an instantaneous and hitless variable baud rate transmission. This solution is demonstrated in a real-time experiment. We also show how the baud rate variation can leverage an in-line auto-negotiation protocol.

Room 6F

W4G • Network Performance—Continued

W4G.3 • 17:30
Experimental Assessment of Capacity Prediction From G-SNR Measurements for Submarine Systems, Alexis Carbo Meseguer[1], Jean-Christophe Antona[1], Juan U. Esparza[1], Alain Calsat[1], Philippe Plantady[1], Andrea Quintana[1], Vincent Letellier[1]; [1]*Alcatel Submarine Networks, France*. We experimentally assessed that total net throughput of submarine cables can be predicted from G-SNR measurements with inaccuracy <3% when the system is operated close or below the nonlinear threshold using probabilistic constellation shaping modulation formats.

W4G.4 • 17:45
Concatenated GSNR Profiles for End-to-end Performance Estimations in Disaggregated Networks, Kaida Kaeval[1,3], Jani Myyry[2], Klaus Grobe[1], Helmut Griesser[1], Gert Jervan[3]; [1]*ADVA Optical Networking, Germany;* [2]*CSC - IT Center for Science Ltd, Finland;* [3]*Tallinn Univ. of Technology, Estonia*. The performance of a wideband optical spectrum service is computed using individual segment characterizations and compared to measured end-to-end performance. An accuracy of ±1.4 dB is achieved for live network routes up to 3116 km.

Room 7AB

W4H • High Bandwidth Density Technologies to XPU—Continued

Room 8

W4I • Machine Learning/ Artificial Intelligence Methods in Transmission Systems—Continued

W4I.4 • 17:30
Digital Twin-Assisted Optical Power Allocation for Flexible and Customizable SNR Optimization, Xuhao Pang[1], Shengnan Li[1], Qirui Fan[2], Min Zhang[1], Chao Lu[2], Alan Pak Tao Lau[2], Danshi Wang[1]; [1]*Beijing Univ. of Posts and Telecommunications, China;* [2]*The Hong Kong Polytechnic Univ., China*. A digital twin-enabled power allocation scheme is proposed to realize flexible SNR optimization using Autoencoder. Three customized SNR targets are achieved, which is useful for accurate margin planning in mixed-line-rate transmission systems.

W4I.5 • 17:45
Link Power Optimization for S+C+L Multi-Band WDM Coherent Transmission Systems, Salma Escobar Landero[1], Ivan Fernandez de Jauregui Ruiz[1], Alessio Ferrari[1], Dylan Le Gac[1], Yann Frignac[1], Gabriel Charlet[1]; [1]*Huawei Technologies France, France*. We compare S+C+L link power optimization based on the fast and simple heuristic balance of linear and nonlinear noises versus more complex ML-based techniques to estimate optimum per-band line amplifier settings for system capacity maximization.

Room 9

W4J • Optical Parametric Amplification and its Applications—Continued

W4J.4 • 17:30 Invited
Hybrid Amplification Approach to Communications Beyond C- and L-Bands, Youichi Akasaka[1]; [1]*Fujitsu Network Communications Inc, USA*. This report introduces novel techniques to amplify new bandwidths rather than C- and L-band by utilizing advantages of each amplification phenomena such as high power efficiency and flexible bandwidth to overcome each of its drawback.

Room 1AB

W4A • Special Session: Network Evolution and Adaptation to Environmental Change Session II—Continued

Room 2

W4B • Advances in Optical Switching—Continued

W4B.6 • 18:00 Invited

Recent Advances in Large-Scale Optical Switches Based on Silicon Photonics, Keijiro Suzuki[1], Ryotaro Konoike[1], Hiroyuki Matsuura[1], Ryosuke Matsumoto[1], Takashi Inoue[1], Shu Namiki[1], Hitoshi Kawashima[1], Kazuhiro Ikeda[1]; [1]*National Inst. of Advanced Industrial Science and Technology (AIST), Japan.* We review our recent results in multi-port strictly non-blocking silicon photonics switches. Challenges for polarization and wavelength insensitive operations are discussed. These results indicate the Si-photonics switch is suitable for the data center network applications.

Room 3

W4C • RoF Systems—Continued

W4C.7 • 18:00

5G Millimeter-Wave Analog RoF System Employing Optical Injection Locking and Direct Modulation of DFB Laser, Amol Delmade[1], Eamonn Martin[1], Colm Browning[1], Liam P. Barry[1]; [1]*Dublin City Univ., Ireland.* We demonstrate the successful generation of 28.2 and 35.3 GHz mm-wave signals through optical injection locking and direct modulation of a DFB laser. The low phase noise mm-wave signal generated supports 5G compatible OFDM signals.

Room 6C

W4D • Fiber Sensors—Continued

Room 6D

W4E • Hollow-core Fibers—Continued

W4E.4 • 18:00

Ultralow-Loss, Plug-and-Play Hollow-Core Fiber Interconnections, Zhe Zhang[1], Anqing Jia[1], Yifeng Hong[1], Wei Ding[1], Shoufei Gao[1], Yingying Wang[1]; [1]*Inst of Photonics Technology, Jinan Univ, China.* An ultralow-loss, plug-and-play single-mode hollow-core fiber (HCF) interconnection is developed. Insertion loss of 0.13 dB and 0.10 dB for HCF to itself @1550 nm and to a standard single-mode fiber @1489 nm, respectively, is demonstrated.

Room 6E

W4F • Emerging Network Architectures and Services—Continued

W4F.4 • 18:00

An Error Compensation Method of Time Synchronization for Cross-Domain Interconnection in SD-TSN, Peter Zhang[1]; [1]*BUPT, China.* We propose a time synchronization modeling and error compensation method for Software-Defined TSN. Experiments verify that the combination method of POE and NNPID can effectively improve time synchronization performance in SD-TSN for cross-domain interconnection.

W4F.5 • 18:15

Fiber-to-Application: Optical Slicing to Enhance Application Performance Over a Metro Transport Network, Cen Wang[1], Xue Xiao[2], Noboru Yoshikane[1], Filippos Balasis[1], Hongxiang Guo[2], Takehiro Tsuritani[1]; [1]*KDDI Research Inc., Japan;* [2]*Beijing Univ. of Posts and Telecommunications, China.* We demonstrate the fiber-to-application transport slicing architecture and mechanism. The experiment shows ultrahigh throughput (> 5Gbps per application) and significant acceleration for 100 applications in 4 categories.

W4G • Network Performance—Continued

W4H • High Bandwidth Density Technologies to XPU—Continued

W4I • Machine Learning/ Artificial Intelligence Methods in Transmission Systems—Continued

W4J • Optical Parametric Amplification and its Applications—Continued

W4J.5 • 18:00
Power Consumption and FWM Crosstalk Analysis of a Hybrid S-Band Abased on Two Parametric Wavelength Converters and an EDFA, Cheng Guo[1], Michael Vasilyev[1], Youichi Akasaka[2], Paparao Palacharla[2]; *[1]Department of Electrical Engineering, Univ. of Texas at Arlington, USA; [2]Advanced Technology Labs, Fujitsu Network Communications, USA.* We measure and analyze the power efficiency and four-wave-mixing crosstalk of a hybrid S-band amplifier based on parametric wavelength converters and EDFA at input signal levels from –30 to –20 dBm/ch and 20-dB gain.

06:00–07:00 Rise and Relax Yoga

07:30–08:00 Coffee Break

08:00–10:00 Th1A • Panel: Has the Time Come for Coherent Optics in Access Networks?

Coherent optical communication is a game-changer technology for high-speed data transmissions in long-haul networks and data center interconnects, enabling a widespread upgrade and new deployment of optical transport networks to speeds of 100 Gbps, 200 Gbps, and 400 Gbps per wavelength. Recently, the potential of using coherent optics in access networks incurs a lot of discussions in both industry and academia. Following the continuation of growing bandwidth demands in ultra-high-definition video streaming, cloud computing, immersive gaming, 5G, VR, and remote healthcare, we are pushing really hard on conventional intensity-modulation direct-detection (IMDD) systems and approaching their performance limit. On the other hand, with the progress of silicon photonics, semiconductor fabrication process, and new form factor, the cost of coherent systems continues to reduce, which may enable coherent optics to partly replace direct-detection links in mobile xHaul, edge networks, and fiber to the home (FTTH) in high density communities. It is anticipated that, with the greatly improved receiver sensitivity and stronger robustness under chromatic dispersion, coherent optics could significantly enhance the number of connected users and transmission distance for next-generation passive optical networks (PONs). The

08:00–10:00 Th1B • Panel: Fiber Optic Sensor Technologies and Their Applications

The scope of the panel speakers includes speciality optical fiber and waveguide devices for sensing various physical parameters. Such sensing devices enable the measurement of these parameters in a 1D space for the typical distributed sensor schemes, as well as in a 3D space for the more advanced applications. In addition, the materials used for fabricating the optical sensors can range from the conventional SiO2 glass to soft glasses, polymers, and other specialty materials. The applications of the fiber and waveguide sensors can be adopted in aerospace, infrastructure health monitoring, robotics, biotechnology, and telecommunications, which will be further discussed during panel discussion.

Speakers

Olav Solgaard, *Stanford University, USA*

Yuan Wang, *University of Ottawa, Canada*

Paul Westbrook, *OFS Labs, USA*

Sylvain Girard, *Université Jean Monnet de Saint-Etienne, France*

Vasilis Ntziachristos, *Helmholtz Zentrum München, Germany*

Yongkang Dong, *Harbin Institute of Technology, China*

08:00–10:00 Th1C • Optical Performance Monitoring and Signal Characterization

Presider: Zhensheng Jia; CableLabs, USA

Th1C.1 • 08:00
Exact Component Parameter Agnostic QoT Eusing Spectral Data-Driven LSTM in Optical Networks, Lars E. Kruse[1], Sebastian Kühl[1], Stephan Pachnicke[1]; [1]*Christian-Albrechts-Universität zu Kiel, Germany.* We propose the use of spectral data-driven LSTM-based machine learning to improve generalized signal-to-noise ratio (gSNR) quality-of-transmission estimation in component parameter-agnostic network scenarios. We show gSNR estimation improvements up to 1.1 dB for unseen networks.

Th1C.2 • 08:15
Location-Resolved PDL Monitoring With Rx-Side Digital Signal Processing in Multi-Span Optical Transmission System, Motohiko Eto[1], Kazuyuki Tajima[1], Setsuo Yoshida[1], Shoichiro Oda[1], Takeshi Hoshida[1]; [1]*Fujitsu Limited, Japan.* We propose a novel monitoring that enables to localize PDL in multi-span transmission using only Rx-side DSP and experimentally demonstrate sufficient accuracy within error of 1km with eighty-two polarization combinations in three-span, 180-km transmission line.

08:00–10:00 Th1D • Optical Signal Processing Devices

Presider: Milos Popovic; Boston Univ., USA

Th1D.1 • 08:00 Invited
Exploiting Ultra-low Loss Silicon Nitride Platform for Various Applications, Xingchen Ji[1,2], Michal Lipson[1]; [1]*Columbia Univ., USA;* [2]*John Hopcroft Center for Computer Science, Shanghai Jiao Tong Univ., China.* Si_3N_4 has attracted extensive interest because of its wide applications in the field of biophotonics, telecommunications, nonlinear optics, and sensing. Here, we focus on exploiting ultra-low loss Si_3N_4 for on-chip delay line and frequency comb generation.

08:00–10:00 Th1E • Fiber and Integrated-photonics Devices

Presider: Hidehisa Tazawa; Sumitomo Electric Industries Ltd, Japan

Th1E.1 • 08:00 Invited
Photonic Lanterns as Wavefront Sensors, Sergio G. Leon-Saval[1]; [1]*Univ. of Sydney, Australia.* Photonic lanterns are low-loss mode convertors easily integrated with optical fiber technologies. We present the proof of concept of a focal plane low-order wavefront sensor based on a 19-core multicore photonic lantern and deep learning.

08:00–10:00 Th1F • Network Planning and Techno-economics

Presider: Mark Filer; Google LLC, USA

Th1F.1 • 08:00
Optimal Deployments of 400 Gb/s Multihaul CFP2-DCO Transponders in Transparent IPoWDM Core Networks, Thierry Zami[1], Bruno Lavigne[1]; [1]*Nokia Corporation, France.* By comparing different strategies for deploying pluggable CFP2-DCO transponders interconnecting 400 Gb/s ports of distant IP routers in core WDM networks, we identify the one minimizing the number of required IP ports and/or of transponders per Gb/s.

Th1F.2 • 08:15
Hardware Comparison of Xponders and ZR+ in Metro and Core Networks With Mixed IP and OTN Traffic, Ashwin Gumaste[1], João Pedro[1], Paul Momtahan[1], Harald Bock[1]; [1]*Infinera Corporation, USA.* We evaluate the role of transponders-muxponders (Xponders) and ZR+-pluggable interfaces in metro and core networks beyond 400Gb/s across 3-metro and 3-core topologies. The stochastic study computes hardware-count and overbuilds with Xponders resulting in lowest counts.

Room 6F	Room 7AB	Room 8	Room 9
06:00–07:00 Rise and Relax Yoga			
07:30–08:00 Coffee Break			

08:00–10:00
Th1G • Intelligent and Artificial Intelligence Network Architectures

Presider: S. J. Ben Yoo; Univ. of California Davis, USA and Georgios Zervas; Univ. College London, UK

Th1G.1 • 08:00 Invited

Emerging Optical Interconnects for AI Systems, Manya Ghobadi[1]; [1]*Massachusetts Inst. of Technology, USA*. The ever-growing demand for accurate machine learning models resulted in an increase in dataset and model sizes of deep neural networks. This paper discusses reconfigurable optical networks as the key enabler for scaling AI systems.

08:00–10:00
Th1H • Advanced Modulation and Signal Processing

Presider: Amirhossein Ghazisaeidi; Nokia Bell Labs France, France

Th1H.1 • 08:00 ★ Top-Scored

Link Tomography for Amplifier Gain Profile Estimation and Failure Detection in C+L-Band Open Line Systems, Matheus R. Sena[1], Robert Emmerich[1], Behnam Shariati[1], Johannes Fischer[1], Ronald Freund[1]; [1]*Fraunhofer HHI, Germany*. We experimentally demonstrate a distance-wise, wavelength-dependent link tomography extraction scheme using receiver DSP. This approach permits the estimation of gain spectrum and tilt in C+L-band EDFAs with a maximum mean absolute error of 0.6 dB.

Th1H.2 • 08:15

A Fast Amplifier Gain and Tilt Configuration Algorithm for Dynamic C+L-Band Networks, Yuchen Song[1], Qirui Fan[2], Danshi Wang[1], Chao Lu[3], Alan Pak Tao Lau[2]; [1]*Beijing Univ. of Post and Telecommu, China;* [2]*Department of Electrical Engineering, The Hong Kong Polytechnic Univ., Hong Kong;* [3]*Department of Electronic and Information Engineering, The Hong Kong Polytechnic Univ., Hong Kong*. We propose a fast amplifier gain/tilt configuration algorithm for C+L-band systems in presence of Stimulated Raman Scattering (SRS). The running time is less than 5 seconds which can be used for real-time dynamic network control.

08:00–10:00
Th1I • 6G Systems and Technologies

Th1I.1 • 08:00 Invited

Role of Analogue Radio-Over-Fibre Technology Beyond 5G, Liam P. Barry[1], Amol Delmade[1], Devika Dass[1], Colm Browning[1]; [1]*Dublin City Univ., Ireland*. Photonics-based mm-wave communication systems employing optical heterodyning can enable high-capacity wireless networks for systems beyond 5G. This work presents photonic, optoelectronic and signal processing technologies to overcome phase/frequency noise issues associated with photonics-based mm-wave systems.

08:00–10:00
Th1J • Thin Film and Organic Modulators

Presider: Hanxing Shi; Juniper Networks Inc., USA

Th1J.1 • 08:00 Invited

BTO-Enhanced Silicon Photonics – a Scalable PIC Platform With Ultra-Efficient Electro-Optical Modulation, Lukas Czornomaz[1], Stefan Abel[1]; [1]*Lumiphase AG, Switzerland*. We demonstrate an advanced BTO-enhanced silicon photonic platform for high-volume applications in communication, optical computing, and sensing. Our platform exploits an ultra-strong Pockels effect, enabling large-scale, high-speed electro-optic photonic circuits with low power consumption and loss.

Th1A • Panel: Has the Time Come for Coherent Optics in Access Networks?—Continued

legacy ODN (Optical Distribution Network) deployed based on previous generations of PONs such as GPON, XG(S)-PON and recently the 50G-PON currently undergoing standardization has optical budget as high as 32 dB. With emerging higher data rates, operators need to capitalize on legacy ODN, whether by migration or coexistence with already deployed PON systems, with the challenge of meeting the high budget constraints. Hence at 100Gbit/s per wavelength, coherent systems could address the high optical budget as well as the penalties due to dispersion which are inherent to IMDD. On the other hand, using coherent optics in access networks faces a lot of challenges making IMDD still a very competitive and reliable low-cost solution. It may require significant changes in today's PON architecture, PHY, and MAC layers to introduce coherent PON. A great number of technical issues await to be resolved. The increased cost is also a major concern, which requires strategic cost-per-bit analysis for future network evolution.

So, as an effort for pioneering future explorations, in this panel, discussions are anticipated to address some of the following key questions. Will coherent optics be an answer for access networks? What will be the target bandwidth for next-generation PON? What are the roles of coherent optics and IMDD in future broadband access? Wat about WDM-PON? What are the driven forces and bottlenecks? What are the differences of using coherent optics in metro vs access and can these differences lead to simplified design or DSP to bring down the cost? Any new solutions to control the cost?

Th1B • Panel: Fiber Optic Sensor Technologies and Their Applications—Continued

Th1C • Optical Performance Monitoring and Signal Characterization—Continued

Th1C.3 • 08:30
Localization of Reflection Induced Multi-Path-Interference Over Multi-Span Transmission Link by Receiver-Side Digital Signal Processing, Choloong Hahn[1], Junho Chang[1], Zhiping Jiang[1]; [1]*Huawei Technologies Canada, Canada.* We propose and experimentally demonstrate a localization method of reflection induced multi-path-interference over multi-span transmission link by post digital signal processing of received signal obtained by a coherent receiver at the end of the transmission.

Th1C.4 • 08:45
Precise Longitudinal Power Monitoring Over 2,080 km Enabled by Step Size Selection of Split Step Fourier Method, Takeo Sasai[1], Masanori Nakamura[1], Etsushi Yamazaki[1], Yoshiaki Kisaka[1]; [1]*NTT Corporation, Japan.* We propose a step-size optimization scheme of the split-step Fourier method for longitudinal power profile monitoring. We observe only a 1.06-dB root-mean-square error from the theoretical power profile for a 2,080-km transmission link.

Th1D • Optical Signal Processing Devices—Continued

Th1D.2 • 08:30
Optical Binary Switched Delay Line Based on Low Loss Multi-mode Waveguide, Samer Idres[1], Hossein Hashemi[1]; [1]*Univ. of Southern California, USA.* We demonstrate low loss, 7-bit, switched delay line, with 6.4 ns measured delay span. The geometrically-optimized delay lines achieve 3.3 dB/m (0.25 dB/ns) measured loss. The design is fabricated in a commercial silicon photonics process.

Th1D.3 • 08:45
Group-Velocity Dispersion Compensation of Telecom Data Signals Using Compact Discrete Phase Filters in Silicon, Saket Kaushal[1], Jose Azana[1]; [1]*INRS-EMT, Canada.* We propose a discrete phase filter design suitable for group-velocity dispersion compensation of data signals in fiber-optics telecommunication links using waveguide Bragg gratings in silicon. Dispersion compensation of a 24-Gbps NRZ-OOK signal after propagation through 31.12 km of SMF is experimentally demonstrated using mm-long phase filters.

Th1E • Fiber and Integrated-photonics Devices—Continued

Th1E.2 • 08:30
Ultra-low-Loss MCF Fanouts for Submarine SDM Applications, Victor I. Kopp[1], Jongchul Park[1], Jon Singer[1], Dan Neugroschl[1], Takahiro Suganuma[2], Takemi Hasegawa[2], Takafumi Ohtsuka[2], Hidehisa Tazawa[2]; [1]*Chiral Photonics Inc, USA;* [2]*Sumitomo Electric Industries, Japan.* MCFs have been developed for submarine deployment. Reliability and insertion loss are gating factors for this demanding application. Here we demonstrate a 0.15-dB-loss fanout, which is fusion spliced to a pure-silica two-core submarine-grade MCF.

Th1E.3 • 08:45
Optical Fiber Micro Spectrometer Employing Self-Focusing Radiated Tilted Fiber Grating, Qingguo Song[1], Yuze Dai[1], Chengjun Huang[1], Xiangpeng Xiao[1], Haoshuo Chen[2], Kaiming Zhou[3], Lin Zhang[3], Qizhen Sun[1], Zhijun Yan[1]; [1]*Huazhong Univ of Science and Technology, China;* [2]*Nokia Bell Labs, USA;* [3]*Aston Univ., UK.* We propose and demonstrate an all-fiber micro spectrometer based on self-focusing radiated tilted fiber grating, which has the tunability in both spectral resolution and measurement range by simply changing the radian curvature of the self-focusing radiated tilted fiber grating.

Th1F • Network Planning and Techno-economics—Continued

Th1F.3 • 08:30 Invited
Long-Term Capacity Planning in Flexible Optical Transport Networks, Carmen Mas Machuca[1], Sai Patri[1,2], Saquib Amjad[1]; [1]*Technische Universität Munchen, Germany;* [2]*ADVA Optical Networking SE, Germany.* We evaluate four Routing, Configuration and Spectrum Assignment alternatives to increase provisioned capacity in optical networks. Long-term planning shows that regenerators extend the C-Band capacity, whereas multi-band solutions outperform in terms of throughput and under-provisioning.

Room 6F

Th1G • Intelligent and Artificial Intelligence Network Architectures—Continued

Th1G.2 • 08:30
Accelerating Distributed Machine Learning in Disaggregated Architectures With Flexible Optically Interconnected Computing Resources, Shijia Yan[1], Ziyi Zhu[1], Madeleine Glick[1], Zhenguo Wu[1], Keren Bergman[1]; [1]*Columbia Univ., USA*. We introduce an optically interconnected disaggregated architecture for GPU resources and demonstrate a 3× increase in GPU utilization and up to 73.2% acceleration of application runtime for distributed machine learning workloads.

Th1G.3 • 08:45
When Task Scheduling Meets Flexible-Bandwidth Optical Interconnects: a Cross-Layer Resource Orchestration Design, Xiaoliang Chen[1], Che-Yu Liu[2], Roberto Proietti[3], Shaoyi Chen[1], Zhaohui Li[1], S. J. Ben Yoo[3]; [1]*Sun Yat-sen Univ., China*; [2]*CS, UC Davis, USA*; [3]*ECE, UC Davis, USA*. We propose a cross-layer resource orchestration design for task scheduling in flexible-bandwidth optical data center networks. Results show the proposed design can achieve ~8.2x, ~1.9x and ~4.8x reductions of request blocking probability, end-to-end delay and packet loss rate, compared with the baseline.

Room 7AB

Th1H • Advanced Modulation and Signal Processing—Continued

Th1H.3 • 08:30
Model-Aided Geometrical Shaping of Dual-Polarization 4D Formats in the Nonlinear Fiber Channel, Gabriele Liga[1], Bin Chen[2,1], Alex Alvarado[1]; [1]*Eindhoven Univ. of Technology (TUe), Netherlands*; [2]*Hefei Univ. of Technology, China*. The geometry of dual-polarization four-dimensional constellations is optimized in the optical fiber channel using a recent nonlinear interference model. A 0.27 bit/4D rate gain and 13% reach increase are attained compared to polarization-multiplexed formats.

Th1H.4 • 08:45
Mutual Shaping and Pre-Emphasis Gain Magnification in the Throughput Maximisation for Ultrawideband Transmission, Anastasiia Vasylchenkova[1], Eric Sillekens[1], Robert Killey[1], Polina Bayvel[1]; [1]*Univ. College London, UK*. For the ultrawideband scenario, we demonstrate that the gains from probabilistic shaping and power preemphasis magnify each other providing up to 20% increase of total mutual information, twice higher than from individual optimisations.

Room 8

Th1I • 6G Systems and Technologies—Continued

Th1I.2 • 08:30
Spectrally Efficient Non-Orthogonal Multi-Band CAP UDWDM Fiber-MMW Integration for 6G RAN Employing NN-Based Direct Waveform to Symbol Conversion, Jiang Chen[1], Boyu Dong[1], Junlian Jia[1], Junwen Zhang[1], Nan Chi[1], Jianyang Shi[1], Chao Shen[1], Li Tao[2]; [1]*Fudan Univ., China*; [2]*STEC Lab, China*. We propose a novel neural-network-based direct waveform-to-symbol conversion method in non-orthogonal multi-band CAP based UDWDM fiber-MMW integration system for 6G radio-access-network. Spectrally efficient fiber-MMW transmission is achieved at totally 384-Gbps capacity with 24 non-orthogonal sub-bands.

Th1I.3 • 08:45
Hybrid CAP / mm-Wave OFDM Vector Modulation for Photonic Frequency Conversion in a Single-Sideband Feeder, Aina Val Martí[1], Nemanja Vokić[1], Thomas Zemen[1], Bernhard Schrenk[1]; [1]*AIT Austrian Inst. of Technology, Austria*. We demonstrate the simultaneous radio-over-fiber feed of 16-QAM 10-Gb/s CAP and 1-GHz OFDM radio at 28-GHz for HetNets. Independent sideband modulation yields photonic up-conversion to the mm-wave band and a dispersion-tolerant feed over 70km.

Room 9

Th1J • Thin Film and Organic Modulators—Continued

Th1J.2 • 08:30 ★ Top-Scored
Thin-Film Lithium Niobate DP-IQ Modulator for Driverless 130 Gbaud 64 QAM Transmission, Mengyue Xu[1], Fabio Pittalà[2], Jin Tang[2], Yuntao Zhu[1], Mingbo He[1], Wing Chau Ng[2], Ziliang Ruan[3], Xuefeng Tang[2], Maxim Kuschnerov[2], Liu Liu[3], Siyuan Yu[1], Bofang Zheng[2], Xinlun Cai[1]; [1]*Sun Yat-Sen Univ., China*; [2]*Huawei, China*; [3]*Zhejiang Univ., China*. We report the first integrated LN DP-IQ modulator with 1-V V_{π} and electro-optic response with 1.7 dB roll-off at 67 GHz. We achieve 1.56 Tb/s line rate without electrical driver using 130 GBaud DP-64QAM.

Th1J.3 • 08:45
CMOS-Level-Voltage Substrate-Removed Thin-Film Lithium Niobate Modulator, Mengyue Xu[1], Shengqian Gao[1], Heyun Tan[1], Xinlun Cai[1]; [1]*Sun Yat-Sen Univ., China*. We demonstrate an O-band substrate-removed thin-film lithium niobate modulator with a low microwave loss of 0.24 dB cm^{-1} $GHz^{-1/2}$. The device features a 1-V half-wave voltage and 1.4 dB EO response roll-off at 50 GHz.

Room 1AB

Th1A • Panel: Has the Time Come for Coherent Optics in Access Networks?—Continued

Topics may include, but will not be limited to:

- Comparison of coherent optics vs IMDD in technical and marketing perspectives
- Cost per bit analysis of coherent optics and IMDD
- Architecture and system design for coherent optical access
- Adaptation and optimization of coherent optics for access networks
- Simplified coherent transmitter and receiver
- New IMDD technologies to maintain its competitiveness
- Coexistence of IMDD and coherent optics
- Cost reduction of coherent optical systems
- Integrated photonics and packaging technology for coherent systems
- Low-complexity DSP for coherent access
- The role of IMDD WDM-PON

Speakers

Ed Harstead, *Nokia, USA*

Zhensheng Jia, *CableLabs, USA*

Argishti Melikyan, *II-VI Optical Systems, USA*

Albert Rafel, *British Telecom, UK*

Seb Savory, *University of Cambridge, UK*

Antonio Teixeira, Sr., *University of Aveiro, Portugal*

Room 2

Th1B • Panel: Fiber Optic Sensor Technologies and Their Applications—Continued

Room 3

Th1C • Optical Performance Monitoring and Signal Characterization—Continued

Th1C.5 • 09:00 Invited

How to Connect Device Nonlinear Specification and System Nonlinear Penalty, Zhenning Tao[1], Ke Zhang[1], Chengwu Yang[1], Xiaofei Su[1], Tong Ye[1], Hisao Nakashima[2], Takeshi Hoshida[2]; *[1]Fujitsu R&D Center, China; [2]Fujitsu Limited, Japan.* From system design point of view, it's required to estimate nonlinear system performance from device nonlinear specification. We discuss various technologies about this topic and find the problem is only partially solved.

Room 6C

Th1D • Optical Signal Processing Devices—Continued

Th1D.4 • 09:00

Dispersion Compensation of 30GBaud/s NRZ and PAM4 Data Using Integrated Silicon Nitride Gratings, George Feng Rong Chen[1], Kenny Yong Keng Ong[1], Xavier Xujie Chia[1], Yanmei Cao[1], Dawn T. Tan[1,2]; *[1]Singapore Uni of Technology and Design, Singapore; [2]Inst. of Microelectronics, Agency for Science, Technology and Research, Singapore.* Dispersion compensation is demonstrated using on-chip Silicon Nitride Bragg Gratings. Impaired 30GBaud/s NRZ and PAM4 eye diagrams are restored and a power penalty improvement of 1.3dB at a Bit Error Rate of 10^{-12} is achieved.

Th1D.5 • 09:15

High-Performance and Ultra-Compact Endless Automatic Polarization Controller Based on Thin-Film Lithium Niobate, Zhongjin Lin[1,2], Yanmei Lin[1], Hao Li[1], Mengyue Xu[1], Mingbo He[1], Wei Ke[1], X.Steve Yao[3], Siyuan Yu[1], Xinlun Cai[1]; *[1]State Key Laboratory of Optoelectronic Materials and Technologies, School of Electronics and Information Technology, Sun Yat-sen Univ., China; [2]Department of Electrical and Computer Engineering, The Univ. of British Columbia, Canada; [3]Photonics Information Innovation Center and Hebei Provincial Center for Optical Sensing Innovations, College of Physics Science and Technology, Hebei Univ., China.* Based on thin-film lithium niobate platform, we experimentally demonstrate an endless automatic polarization controller which only requires a driving voltage range of 10 V, and achieves a polarization tracking speed of 10 Krad/s.

Room 6D

Th1E • Fiber and Integrated-photonics Devices—Continued

Th1E.4 • 09:00 ★ Top-Scored

Fully Integrated Solid-State LiDAR Transmitter on a Multi-Layer Silicon-Nitride-on-Silicon Photonic Platform, Weihan Xu[1], Yuyao Guo[1], Xinhang Li[1], Chuxin Liu[1], Liangjun Lu[1,2], Jianping Chen[1,2], Linjie Zhou[1,2]; *[1]State Key Laboratory of Advanced Optical Communication Systems and Networks, Shanghai Jiao Tong Univeristy (SJTU), China; [2]SJTU-Pinghu Inst. of Intelligent Optoelectronics, China.* We demonstrated a LiDAR transmitter incorporating both a hybrid-integrated tunable external cavity laser and a high-resolution 2-D optical phased array beam-steerer on a tri-layer silicon-nitride-on-silicon photonic platform.

Th1E.5 • 09:15

Optical Phased Array for 905-nm LIDAR Applications Integrated on 300mm Si-Photonic Platform, Stephane Monfray[1], Sylvain Guerber[2], Aude Montagne[1], David Fowler[2], Philippe Grosse[2], Jonathan Planchot[1], Delia Ristoiu[1], Fabrice Baron[1], Melissa Brihoum[1], Laurene Babaud[1], Arnaud Taute[1], Eva Kempf[1], Karine Rovayaz[1], Paul Chantraine[1], Sylvie Delmedico[1], François Leverd[1], Lionel Balme[1], Denis Pellissier-tanon[1], Katia Haxaire[1], Marc Guillermet[2], Sebastien Mermoz[1], Metig Hello[1], Sebastien Jan[1], Pascal Chevalier[1], Frederic Boeuf[1]; *[1]STMicroelectronics, Crolles, France; [2]CEA-LETI, France. In this paper we present the first integration of a 2D Optical Phased Array (OPA) for 905nm LIDAR applications on our 300mm SWIR photonic platform DAPHNE, based on Si & SiN components.*

Room 6E

Th1F • Network Planning and Techno-economics—Continued

Th1F.4 • 09:00

Spectrum and Cost Savings From Beyond-100Gbaud Optical Transponders, Oleg Karandin[1], Francesco Musumeci[1], Alessio Ferrari[2], Gabriel Charlet[2], Yvan Pointurier[2], Massimo Tornatore[1]; *[1]Politecnico di Milano, Italy; [2]Huawei Technologies, Paris Research Center, France.* We quantify spectrum usage and transponder cost when deploying next-generation transponders that support up to 1.6 Tbit/s, in both C- and C+L bands. We compare two transponder architectures: a) single-carrier, operating beyond 100 Gbaud and b) multi-carrier with each carrier operating below 100 Gbaud.

Th1F.5 • 09:15

Message Passing: Towards Low-Complexity, Global Optimal Routing and Wavelength Assignment Solutions for Optical Networks, Ruijie Luo[2], Yi-Zhi Xu[1], Robin Matzner[2], Georgios S. Zervas[2], David Saad[1], Polina Bayvel[2]; *[1]Aston Univ., UK; [2]Univ. College London, UK.* We introduce a polynomial-time distributed message passing algorithm for routing and wavelength assignment. Exact global solutions are obtained for small-scale networks and improvements are demonstrated on network scales beyond the reach of established global algorithms.

Room 6F

Th1G • Intelligent and Artificial Intelligence Network Architectures—Continued

Th1G.4 • 09:00
Data Plane Technology-Agnostic Control and Orchestration Architecture for Optical Disaggregated Data Centers, Fernando Agraz[1], Albert Pagès[1], Salvatore Spadaro[1]; [1]*Univ Politècnica de Catalunya (UPC), Spain*. We propose a novel SDN control and orchestration architecture to provide composed IaaS over optical disaggregated data centers. We experimentally validate intent-based mechanisms that make the architecture independent from the underlying physical infrastructure technology.

Th1G.5 • 09:15
Which can Accelerate Distributed Machine Learning Faster: Hybrid Optical/Electrical or Optical Reconfigurable DCN?, Hao Yang[1], Zuqing Zhu[1], Roberto Proietti[2], S. J. Ben Yoo[2]; [1]*Univ of Science and Technology of China, China;* [2]*Univ. of California, Davis, USA*. We run various distributed machine learning (DML) architectures in a hybrid optical/electrical DCN and an optical DCN based on Hyper-FleX-LION. Experimental results show that Hyper-FleX-LION gains faster DML acceleration and improves acceleration ratio by up to 22.3%.

Room 7AB

Th1H • Advanced Modulation and Signal Processing—Continued

Th1H.5 • 09:00 Invited
Probabilistic Versus Geometric Constellation Shaping in Commercial Applications, Olga Vassilieva[1], Inwoong Kim[1], Hiroyuki Irie[2], Yohei Koganei[2], Hisao Nakashima[2], Yuichi Akiyama[2], Takeshi Hoshida[2], Paparao Palacharla[1]; [1]*Fujitsu Network Communications Inc, USA;* [2]*Fujitsu Ltd., Japan*. We discuss performance and implementation aspects of geometric and probabilistic constellation shaping, which can be optimized for different applications. We show that symbol rate optimization with probabilistic shaping can further improve reach/capacity.

Room 8

Th1I • 6G Systems and Technologies—Continued

Th1I.4 • 09:00 Tutorial
Holographic Beam Forming and Massive MIMO From Optical Communication Perspective, Eric Black[1]; [1]*Pivotal Commware, USA*.
Abstract not available.
Biography not available.

Room 9

Th1J • Thin Film and Organic Modulators—Continued

Th1J.4 • 09:00 Invited
Highly Reliable Organic Polymer Optical Modulators, Shiyoshi Yokoyama[1], Guo-Wei Lu[1,2], Hiromu Sato[1], Jiawei Mao[1], Alisa Bannaron[1]; [1]*Kyushu Univ., Japan;* [2]*the Univ. of Aizu, Japan*. We demonstrate a >100 Gbaud transmission using a thermophysically enhanced EO polymer modulator. The error-free signal over a distance of 2.0 km was successfully demonstrated under high-temperature exposure at up to 110°C.

Room 1AB	Room 2	Room 3	Room 6C	Room 6D	Room 6E
Th1A • Panel: Has the Time Come for Coherent Optics in Access Networks?—Continued	**Th1B • Panel: Fiber Optic Sensor Technologies and Their Applications—Continued**	**Th1C • Optical Performance Monitoring and Signal Characterization—Continued**	**Th1D • Optical Signal Processing Devices—Continued**	**Th1E • Fiber and Integrated-photonics Devices—Continued**	**Th1F • Network Planning and Techno-economics—Continued**

Th1C.6 • 09:30
Demonstration of Enhanced Power Losses Characterization in Optical Networks, Alix A. May[1,2], Fabien Boitier[1], Aymeric Courilleau[1], Bichr Al Ayoubi[1], Patricia Layec[1]; *[1]Nokia Bell Labs France, France; [2]Télécom Paris, France.* We generalize our receiver-based power losses characterization in a networking scenario. We show that combining monitored information from several lightpaths increases the estimation accuracy with an estimation error reduced from 1.40 dB to 0.50 dB.

Th1C.7 • 09:45
Simple and Ultrafast Automatic Bias Control for Optical IQ Modulators Enabled by Dither Vector Mapping Monitoring, Hongyu Li[1], Chuanming Huang[1], YuanXiang Wang[1], Rui Deng[2], Mengfan Cheng[1], Qi Yang[1], Deming Liu[1], Ming Tang[1], Lei Deng[1]; *[1]Huazhong Univ. of Science and Technology, China; [2]Optical Technologies Engineering Department, Huawei Technologies Co., Ltd., China.* A simple and ultrafast automatic bias control for optical IQ modulators is proposed using dither-vector-mapping monitoring. It is verified in 40/20Gbaud 16/64QAM signal transmissions, and the tracking time (0.3~0.5s) is 30-times faster than commercial products.

Th1D.6 • 09:30 Invited
Automated Tuning for Silicon Photonic Filters, Kamran Entesari[1], Samuel Palermo[1], Christi K. Madsen[1], Gihoon Choo[1], Ramy Rady[1], Shengchang Cai[1], Binhao Wang[2]; *[1]Texas A&M Univ., USA; [2]HP Labs, USA.* An automatic monitor-based filter tuning technique for APF-based silicon photonic filters is presented. The proposed tuning approach calibrates the initial distorted filter response due to process variation by adjusting the locations of each pole and zero to reconfigure to different bandwidths and center wavelengths.

Th1E.6 • 09:30 ★ Top-Scored
850 nm Hybrid-Integrated Tunable Laser With Si_3N_4 Microring Resonator Feedback Circuits, Noor Schilder[1], Arnoud Everhardt[1], Tom Horner[1], Dimitri Geskus[2], Edwin Klein[1], Maaike Benedictus[1], Sesilia Krishwandi[1], Erik Schreuder[1], René Heideman[1]; *[1]LioniX International B.V., Netherlands; [2]Chilas B.V., Netherlands.* A novel hybrid integrated tunable laser at 850 nm wavelength has been demonstrated, with a tuning range of >50 nm, an intrinsic linewidth <600 Hz and optical output power of 7.5 dBm.

10:00–10:30 Coffee Break

10:00–14:00 OFC Career Zone Job Fair *(Exhibit Hall)*

Room 6F

Th1G • Intelligent and Artificial Intelligence Network Architectures—Continued

Th1G.6 • 09:30 Invited

Digitalizing Optical Layer for the Green Computing Continuum as the Future Digital Infrastructure, Shu Namiki[1], Kiyo Ishii[1]; [1]*Natl Inst of Adv Industrial Sci & Tech, Japan.* This talk will introduce the functional block-based disaggregation model as the key to digitalize the optical layer to incorporate with the digital infrastructure migrating toward the "computing continuum," where optical networks and computing are converged.

Room 7AB

Th1H • Advanced Modulation and Signal Processing—Continued

Th1H.6 • 09:30

An Optimized Full-Spectrum Modulated NFDM System by Combining Geometric Shaping and Linear Minimum Mean Square Error Estimator, Jiacheng Wei[1], Lixia Xi[1], Xulun Zhang[1], Jiayun Deng[1], Ruofan Zhang[1], Shucheng Du[2], Wenbo Zhang[1], Xiaoguang Zhang[1]; [1]*Beijing Univ of Posts & Telecom, China;* [2]*Beijing Normal Univ., China.* We elaborately design a full-spectrum modulated NFDM system with *b*-scheme. A 1120km transmission with BER < 3.8×10^{-3} at 103.75 Gbps is achieved through geometric shaping (GS) and linear minimum mean square error (LMMSE) estimator.

Th1H.7 • 09:45

Nonlinear Pre-Distortion in DML-Based OFDM Transmission Enabled by Low-Complexity Sparse Volterra Filtering, Kuang-Yu Ku[1], Yu-Cheng Yu[1], Shiuan-Mao Chi[1], Chia Chien Wei[1]; [1]*National Sun Yat-Sen Univ., Taiwan.* A nonlinear pre-distorter is proposed in DML-based OFDM transmission. The complexity of pre-distorter is reduced by >90% using the l_0-regularization, l_1-regularization, or re-orthogonalization, and the data rate is still increased by >50% after ≥150-km fiber.

Room 8

Th1I • 6G Systems and Technologies—Continued

Room 9

Th1J • Thin Film and Organic Modulators—Continued

Th1J.5 • 09:30

Generation and Transmission of 160-Gbaud QPSK Coherent Signals Using a Dual-Drive Plasmonic-Organic Hybrid I/Q Modulator on Silicon Photonics, Haik Mardoyan[1], Filipe Jorge[2], Marcel Destraz[3], Bernadette Duval[2], Bertold I. Bitachon[4], Yannik Horst[4], Kaoutar Benyahya[1], Fabrice Blache[2], Michel Goix[2], Eva De Leo[3], Patrick Habegger[3], Norbert Meier[3], Nino Del Medico[3], Valentino Tedaldi[3], Christian Funck[3], Nicholas Güsken[3], Juerg Leuthold[3,4], Jérémie Renaudier[1], Claudia Hoessbacher[3], Wolfgang Heni[3], Benedikt Baeuerle[3]; [1]*Nokia Bell Labs, France;* [2]*III-V Lab, France;* [3]*Polariton Technologies AG, Switzerland;* [4]*ETH Zurich, Inst. of Electromagnetic Fields (IEF), Switzerland.* We report on coherent transmission of beyond 100 GBd signaling based on plasmonic technology. Using dual-drive plasmonic-organic-hybrid I/Q modulator on silicon photonics platform, we demonstrate the successful transmission of 160-GBaud QPSK and 140-GBaud 16QAM modulations.

Th1J.6 • 09:45

A Highly Compact Thin-Film Lithium Niobate Modulator With Low Half-Wave Voltage, Xuecheng Liu[1], Bing Xiong[1], Changzheng Sun[1], Zhibiao Hao[1], Lai Wang[1], Jian Wang[1], Yanjun Han[1], Hongtao Li[1], Yi Luo[1]; [1]*Tsinghua Univ., China.* Meandered thin-film lithium niobate modulators with capacitively loaded travelling-wave electrodes are demonstrated. Interdigitated T-rails are employed for reversed electric field, resulting in 1.08 V half-wave voltage and 3-dB bandwidth beyond 50 GHz for 8-mm-long devices.

10:00–10:30 Coffee Break

10:00–14:00 OFC Career Zone Job Fair *(Exhibit Hall)*

10:30–12:30
Th2A • Poster Session II

Th2A.1
Characteristics of Field Operation Data for Optical Transceivers in Hyperscale Data Centers, Chongjin Xie[2], Chunxiao Wang[1], Qin Chen[3], Zhicheng Wang[3], Peng Wang[3], Rui Lu[3], Lei Wang[1]; *[1]Beijing, Alibaba Cloud, China; [2]California, Alibaba Cloud, USA; [3]Hangzhou, Alibaba Cloud, China.* We collect and analyze field operation data of optical transceivers in hyperscale data centers, including temperatures, infant mortality and causes of failures, to shed some light on reliability of optical transceivers in data centers.

Th2A.2
Realization of EML Submodule for 100-Gbaud Operation Using LC Resonance With Optimization of Load Resistance, Seokjun Yun[1], YoungTak Han[1], Donghoon Lee[1], Seoktae Kim[2], MinJun Kwak[1], JangUk Shin[1], Sangho Park[1], Seoyoung Lee[1], Yongsoon Baek[1]; *[1]Electronics and Telecommunications Research Inst., Korea (the Republic of); [2]Luvantix ADM, Inc., Korea (the Republic of).* By using LC resonance effect with optimization of load resistance, the 3-dB bandwidth of a lumped-EML submodule can be enhanced to > 55 GHz although an EAM length is 150 um, making it enable 100-Gbaud operations.

Th2A.3
Liquid Waveguide Cladding for 2D Beam Steering of an Optical Phased Array at a Single Wavelength, Binghui Li[1], Caiming Sun[1], Aidong Zhang[1]; *[1]The Chinese Univ. of Hong Kong, shenzhen, China.* We present the replacing of waveguide liquid claddings to implement 2D beam steering of an optical phased array. A maximum steering angle of >10° was achieved with RI from 1.0 to 1.63 at 940 nm.

Th2A.4
Free-Space Coupling Type Fan-in/Fan-out Device for 4-Core Fiber With Low Insertion Loss, Tomoaki Kiriyama[1], Katsuhiro Iwasaki[1], Katsuya Kito[1], Takashi Kato[1]; *[1]Kohoku Kogyo Co. Ltd., Japan.* We present a pair of free-space coupling type fan-in and fan-out devices for 4-core fiber having an insertion loss of 0.42 dB or less within C-band over the range of -10 to 70°C.

Th2A.5
O-Band Fiber-to-Chip Edge Coupler for High NA Fiber Based on a CMOS Compatible SOI Platform, Min Teng[1], Hao Wu[1], Chenlei Li[1], Feng Wang[1], Yinchao Du[1], Xuezhe Zheng[1]; *[1]Inno-Light Technology (Suzhou) Ltd., China.* A SiN edge coupler is experimentally demonstrated with a < 1.9 dB/facet loss over the whole O band for a 4μm MFD fiber. The power is further transformed into Si waveguide using a SiN-to-Si transition.

Th2A.6
Microscale Mode-Selective Photonic Lantern Multiplexer Compatible With 3D Nanoprinting Technology, Yoav Dana[1], Dan Marom[1]; *[1]Applied Physics, Hebrew Univ. of Jerusalem, Israel.* We design mode-selective photonic lantern multiplexer using 3D waveguides made of photopolymer core and air cladding. Although the waveguides exhibit high index contrast, low loss (0.14dB), MDL (-0.06db), and mode group crosstalk (-21.2dB) are obtained.

Th2A.7
Widely Tunable 1030 nm Gallium Arsenide Sampled Grating Distributed Bragg Reflector Lasers and Photonic Integrated Circuits, Paul Verrinder[1], Lei Wang[1], Fengqiao Sang[1], Victoria Rosborough[1], Guangning Yang[2], Mark Stephen[2], Larry Coldren[1], Jonathan Klamkin[1]; *[1]Univ. of California, Santa Barbara, USA; [2]Nasa Goddard Space Flight Center, USA.* A widely tunable 1030 nm gallium arsenide laser with an integrated semiconductor optical amplifier was demonstrated. Continuous tuning across 22.2 nm and up to 70 mW output power was achieved.

Th2A.8
Ultrahigh Extinction Ratio Silicon Micro-Ring Modulator by MDM Resonance for High Speed PAM Modulation, Jiacheng Liu[1], Jiangbing Du[1], Weihong Shen[1], Gangqiang Zhou[1], Linjie Zhou[1], Ke Xu[2], Zuyuan He[1]; *[1]Shanghai Jiao Tong Univ., China; [2]Harbin Institude of Technology, China.* Silicon micro-ring modulator assisted by MDM resonance is experimentally demonstrated. Ultrahigh ER up to 55 dB was obtained for supporting 50 Gb/s PAM4 signaling with 0.79-Vcm VpiL. indicating promising performance for advanced modulation formats.

Th2A.9
Federated Learning Approach for Lifetime Prediction of Semiconductor Lasers, Khouloud Abdelli[1,2], Helmut Griesser[1], Stephan Pachnicke[2]; *[1]ADVA, Germany; [2]Kiel Univ., Germany.* A new privacy-preserving federated learning framework allowing laser manufacturers to collaboratively build a robust ML-based laser lifetime prediction model, is proposed. It achieves a mean absolute error of 0.1 years and a significant performance improvement.

Th2A.10
High Output Power DBR Laser for FMCW LiDAR System, Gong Zhang[1], ZhiHuan Ding[1], Kuankuan Wang[1], Qiaoyin Lu[1], Weihua Guo[1]; *[1]HUST, China.* We demonstrated a DBR laser with the output power reaching 96 mW. The linear frequency sweep of 24 GHz has been achieved with nonlinearity of 0.021% and 0.02% in the up and down ramps, respectively.

Th2A.11
Multi-Fiber Cylindrical Ferrule for Remote Rotary Optical Fiber Switching, Chisato Fukai[1], Yoshiteru Abe[1], Kazunori Katayama[1]; *[1]NTT copropation, Japan.* We devise a multi-fiber cylindrical ferrule for a rotary optical switch. We design the ferrule to achieve the equivalent loss to a conventional optical connector, and show the optical switching properties of the fabricated ferrule.

Th2A.12
Lightning-Related ELF Transients as a Potential Source of Rapid State of Polarization Changes in Shielded OPGW, Joshua A. Santos[1], Robert Moore[1], William Snider[1], Dave Doucet[2], Doug Charlton[2]; *[1]Univ. of Florida ECE Department, USA; [2]Ciena Corporation, Canada.* This paper demonstrates that typical lightning currents cannot produce observed rapid state of polarization changes in shielded optical ground wires. Lightning flashes associated with large extremely-low-frequency components, however, are capable of doing so.

Th2A.13
Long-Distance Random Fiber Laser Sensing System With Ultra-Fast Signal Demodulation, Shengtao Lin[1], Zinan Wang[1], Yifei Qi[1], Yunjiang Rao[1,2]; *[1]Univ. Electronic Sci. & Tech. of China, China; [2]Research Center for Optical Fiber Sensing, China.* Based on shape characteristics of the Raman gain spectrum, we extend the Random fiber laser remote sensing scenarios from quasi-static to dynamic, achieving 10 kHz signal demodulation over 100 km fiber.

Th2A.14
Non-Intrusive and Highly Sensitive Gas Flow Monitoring Based on Distributed Acoustic Sensing, Baoqiang Yan[1], Hao Li[1], Ming Li[2], Cunzheng Fan[1], Keqing Zhang[1], Hao Qian[2], Fei Xiao[2], Zhijun Yan[1], Qizhen Sun[1]; *[1]Huazhong Univ of Science and Technology, China; [2]Southwest Oil & Gas Field Company, PetroChina, China.* We propose and demonstrate a non-intrusive pipeline flow monitoring system based on the DAS. To the best of our knowledge, this is the first time a DAS system has been used for gas flow monitoring.

Th2A.15
Single-Shot Hybrid CP- φOTDR/CP-BOTDA System for Simultaneous Distributed Temperature/Strain Sensing, Yuan Wang[1], Xiaoyi Bao[1]; *[1]Univ. of Ottawa, Canada.* A real-time simultaneous temperature and strain measurement based on hybrid chirped pulsed φ-OTDR and BOTDA is demonstrated for the first time. The high accuracy of 4.3 με for strain and 0.32°C for temperature is achieved over 5 km non-uniform fiber.

Th2A.16
Transmission of 400GBASE-LR8 Over 15~km Deployed Step-Index 4-Core Fiber for Data Centre Interconnects, Daniel J. Elson[1], Yuta Wakayama[1], Daiki Soma[1], Shohei Beppu[1], Noboru Yoshikane[1]; *[1]KDDI Research, Inc., Japan.* We demonstrate transmission of 400GBASE-LR8 signals over 15~km of installed simple step-index 4-core fiber. Resultant symbol error rate was below the KP4-FEC threshold showing the suitability for multicore fibers as data centre interconnects.

Th2A.17
Traffic Tolerance of Nanosecond Scheduling on Optical Circuit Switched Data Center Network, Joshua L. Benjamin[1], Alessandro Ottino[1], Christopher Parsonson[1], Georgios S. Zervas[1]; *[1]Univ. College London, UK.* PULSE's ns-speed NP-hard network scheduler delivers skew-tolerant performance at 90% input loads. It achieves >90% throughput, 1.5-1.9μs mean and 16-24μs tail latency (99%) for up to 6:1 hot:cold skewed traffic in OCS DCN.

Th2A.18
Graph Sequence Attention Network-Enabled Reinforcement Learning for Time-Aware Robust Routing in OSU-Based OTN, Huangxu Ma[1], Jiawei Zhang[1], Yuefeng Ji[1]; *[1]Beijing Univ. of Posts & Telecommun, China.* We propose a time-aware robust routing in OSU-based OTN through the newly designed graph sequence attention network-enabled reinforcement learning. Simulation results show > 28% OSU frame loss reduction compared to the baselines.

Th2A.19
Evaluation of Deep Reinforcement Learning for Restoration in Optical Networks, Carlos Hernandez-Chulde[1], Ramon Casellas[1], Ricardo Martínez[1], Ricard Vilalta[1], Raul Muñoz[1]; *[1]Centre Tecnològic Telecomunicacions Cata, Spain.* A deep reinforcement learning-based agent is presented to perform autonomous lightpath restoration upon a link failure event. The agent is evaluated against other heuristic algorithms under different traffic load and failure duration scenarios.

10:30–12:30
Th2A • Poster Session II

Th2A.20
Non-Linear Effects of WDM Transmission Versus Optical Routing Impairments: Does One Prevail at Network Level?, Thierry Zami[1], Matteo Lonardi[2], Nicola Rossi[1], Bruno Lavigne[1]; *[1]Nokia Corporation, France; [2]Nokia Bell-Labs, France.* The influence on network performance of WDM transmission non-linear effects is compared to the impact of optical filtering and crosstalk induced by the wavelength routing cross-connects, for 3 network topologies and 2 distinct transponder technologies.

Th2A.21
High Degree ROADM Cluster Node, Hamid Mehrvar[1], Xiang Hui[2], Sun Jun[1], Eric Bernier[1]; *[1]Huawei Technologies Canada, Canada; [2]Huawei Technologies Co, China.* A low-cost ROADM cluster with flexible add-drop and scalable to hundred degree is proposed. It disaggregate line and add-drop functions and uses an order-based connection algorithm that offers 10^{-4} blocking despite 30% dilation in cluster.

Th2A.22
Dynamic and Efficient Point-to-Point and Point-to-Multipoint Communications by Slicing the Optical Constellation, Masab Iqbal[1], Marc Ruiz[1], Nelson Costa[2], Antonio Napoli[3], João Pedro[2], Luis Velasco[1]; *[1]Universitat Politecnica de Catalunya, Spain; [2]Infinera Unipessoal, Portugal; [3]Infinera, UK.* Optical Constellation Slicing is proposed to convey heterogenous traffic from a source to multiple destinations, while supporting dynamic capacity allocation. Illustrative numerical results reveal the potential of the proposed scheme, while providing significant cost reduction.

Th2A.23
First 100Gb/s Fine-Granularity Flexible-Rate PON Based on Discrete Multi-Tone and PAPR Optimization, Ji Zhou[1], Jiale He[2], Xiaofeng Lu[2], Guanyu Wang[2], Yu Bo[2], Gengchen Liu[2], Yuanda Huang[2], Liangchuan Li[2], Haide Wang[1], Wenxuan Mo[1], Weiping Liu[1], Changyuan Yu[4], Zhaohui Li[3]; *[1]Jinan Univ., China; [2]Optical Research Department, Huawei Technologies, China; [3]Sun Yat-sen Univ., China; [4]The Hong Kong Polytechnic Univ., China.* We propose the first 100Gb/s fine-granularity flexible-rate PON based on discrete multi-tone and PAPR optimization. The proposed flexible-rate PON can achieve the widest-range rate adjustment from 25Gb/s to 100Gb/s with a granularity of ~50Mbit/s under the optical power budget from 36dB to 26dB.

Th2A.24
High Speed RGB Visible Light Communication (VLC) Using Digital Power-Domain Multiplexing (DPDM) of Orthogonal Frequency Division Multiplexed (OFDM) Signals, Wahyu Hendra Gunawan[1], Yun-Han Chang[1], Chi-Wai Chow[1], Yang Liu[2], Chien-Hung Yeh[3]; *[1]National Yang Ming Chiao Tung Univ., Taiwan; [2]Philips Electronics Ltd, Hong Kong; [3]Feng Chia Univ., Taiwan.* We experimentally demonstrate a record 21 red-green-blue (RGB) laser-diode (LD) visible-light-communication (VLC) using digital-power-domain-multiplexing (DPDM) of orthogonal-frequency-division-multiplexed (OFDM) signals. 21.01-Gbit/s RGB DPDM-OFDM VLC transmission is achieved.

Th2A.25
800-Gbps PAM-4 2-km Transmission Using 4-λ LAN-WDM TOSA With MLSE Based on Deep Neural Network, Hiroki Taniguchi[1], Shuto Yamamoto[1], Akira Masuda[1], Yoshiaki Kisaka[1], Shigeru Kanazawa[2]; *[1]NTT Network Innovation Laboratories, Japan; [2]NTT Device Innovation Center, Japan.* We propose an MLSE based on a deep neural network that estimates nonlinear channel responses. We demonstrate 224-Gbps/λ 2-km transmission using 4-λ LAN-WDM TOSA and the proposed method with a BER below the HD-FEC limit.

Th2A.26
100 Gbit/s THz Data Transmission and Beyond Using Multicore Fiber Combined With UTC Photodiode Array, Bewindin Alfred Sawadogo[1], Aritrio Bandyopadhyay[2], Malek Zegaoui[2], Mohammed Zaknoune[2], Pascal Szriftgiser[1], Karen Baudelle[1], Monika Bouet[1], Géraud Bouwmans[1], Davy Gaillot[2], Esben Andresen[1], Guillaume Ducournau[2], Laurent Bigot[1]; *[1]Université de Lille, France; [2]IEMN, France.* Photonics-driven transmitters are leading the race towards high data-rates at THz frequencies. Here, spatial-multiplexing based on multicore fiber and photodiodes array is considered to alleviate the limited output power. Sub-systems have been developed and validated.

Th2A.27
Simultaneous Noise Mitigation of Wavelength-Multiplexed Signals by Self-Tracking Passive Amplification, Benjamin G. Crockett[1], Luis Romero Cortés[1], Reza Maram[2], Jose Azana[1]; *[1]INRS, Canada; [2]Fonex, Canada.* We demonstrate the self-tracking abilities of Talbot-based denoising by simultaneously processing 4 signals in a WDM scheme using a single device, without stabilization or alignment procedures, enabling significant BER and SNR improvements in all channels.

Th2A.28
Seven-Aperture Direct-Detection Receiver for Free-Space Optical Communication Systems, Mat Nguyen[1], Vuong Mai[1], Hoon Kim[1]; *[1]School of Electrical Engineering, Korea Advanced Inst. of Science and Technology, Korea (the Republic of).* We experimentally demonstrate a free-space optical communication system utilizing seven-aperture direct-detection receiver. We estimate the instantaneous SNR from the AC-coupled photo-currents and implement the maximal ratio combining by optimizing the averaging time of the photo-current.

Th2A.29
Polarization Crosstalk Reduction by Successive Interference Cancellation for Polarization-Tracking-Free PDM Radio Over Fiber Mobile Fronthaul System, Chang-Ying Lin[3], Jhih-Heng Yan[2], Kuan-Heng Chen[3], Kai-Ming Feng[3,1]; *[1]Inst. of Communications Engineering, National Tsing Hua Univ., Taiwan; [2]Chunghwa Telecom Laboratories, Taiwan; [3]Inst. of Photonics Technologies, National Tsing Hua Univ., Taiwan.* We propose a novel polarization-tracking-free PDM fiber-wireless mobile fronthaul system by using SIC to reduce the crosstalk caused by imperfect PDM demultiplexing. Our experimental results show this proposed PDM demultiplexing scheme greatly relieves spectral limitation.

Th2A.30
A Rotated QAM-Based Probabilistically Shaped OFDM With ANN Scheme for W-Band RoF System, Jing He[1], Zhihua Zhou[1], Jing He[1]; *[1]Hunan Univ., China.* In the paper, a rotated QAM-based probabilistically-shaped (PS) OFDM with artificial neural network (ANN) scheme is proposed in W-band RoF system. After 50-km SSMF and 1-m wireless transmission, the experimental results show that its ROP sensitivity outperforms PS-OFDM.

Th2A.31
Optical Performance Monitoring for Commercial Transceivers Using Constellations: Practical Considerations, Daniel Lippiatt[1], Hyung Joon Cho[1], Alex Kaylor[1], Varghese A. Thomas[1], Steven Searcy[2], Thomas Richter[2], Sorin Tibuleac[2], Stephen E. Ralph[1]; *[1]Georgia Inst. of Technology, USA; [2]ADVA Optical Networking, USA.* We demonstrate an ML-based optical performance monitoring technique using constellation diagrams which accurately assess OSNR and generalized OSNR in a realistic deployment environment with product constraints. Limitations of OSNR estimation in commercial deployments are discussed.

Th2A.32
Geometric Constellation Shaping for Phase-Noise Channels Using a Differentiable Blind Phase Search, Andrej Rode[1], Benedikt Geiger[1], Laurent Schmalen[1]; *[1]Karlsruhe Inst. of Technology, Germany.* We perform geometric constellation shaping with optimized bit labeling using a binary auto-encoder including a differential blind phase search (BPS). Our approach enables full end-to-end training of optical coherent transceivers taking into account the digital signal processing.

Th2A.33
Ultra-low-Complexity MAP Demapper for Bandwidth-Limited Pluggable Coherent Optics Beyond 800G, Di Che[1]; *[1]Nokia Bell Labs, USA.* We reveal the benefit of adding a MAP demapper in bandwidth-limited coherent systems, and study a simplified MAP algorithm achieving a comparable performance with the conventional MAP for 100-GBd 16/64-QAM with more than 8-fold complexity reduction.

Show Floor Programming

SF12 • F5G Update: Emerging Use Cases and Demonstrations
10:30–11:30, *Theater II*

MW5 • Market Watch V: Evolution of Coherent Transceiver Architectures for Specific Applications
10:30–12:00, *Theater I*

SF13 • OpenZR+: Enabling High-performance Router-based Optics (OpenZR+ MSA)
11:30–12:30, *Theater III*

SF14 • Hollow Core Fiber - Ready for Prime Time?
12:00–13:00, *Theater II*

MW6 • Market Watch VI: Building the Next Generation 3.2T Transceiver
12:30–14:00, *Theater I*

SF15 • Building Open and Disaggregated Networks (TIP)
13:00–14:00, *Theater III*

SF16 • The Edge Cloud: Descending Cloud – Ascending Edge, and What it Means for Optical Networks
13:30–14:30, *Theater II*

Th2A • Poster Session II—Continued

Th2A.34
Reduced Complexity Adaptive Background Compensation of Electro-Optic Tx Impairments in Coherent Optical Transceivers, James J. Kunst[1], Juan Bonetti[1], Benjamin Reyes[1], Damian Morero[2], Mario Hueda[2]; [1]*Fulgor Foundation, Argentina;* [2]*Communications Research Laboratory, FCEFyN, UNC, Argentina.* We propose a novel background compensation of electro-optic Tx impairments for coherent optical transmitters based on the backpropagation algorithm and a direct detection low bandwidth feedback channel. Its excellent effectiveness is demonstrated by computer simulations.

Th2A.35
Domain Adaptation: the Key Enabler of Neural Network Equalizers in Coherent Optical Systems, Pedro Jorge Freire de Carvalho Souza[1,2], Bernhard Spinnler[2], Daniel Abode[1], Jaroslaw E. Prilepsky[1], Nelson Costa[2], Abdallah Ali[1], Wolfgang Schairer[2], Antonio Napoli[2], Andrew Ellis[1], Sergei K. Turitsyn[1]; [1]*Aston Univ., UK;* [2]*Infinera, Germany.* We introduce the domain adaptation and randomization approach for calibrating neural network-based equalizers for real transmissions, using synthetic data. The approach renders up to 99% training process reduction, which we demonstrate in three experimental setups.

Th2A.36
Double-Effect DNN-Based DBP Scheme for Integrated Sensing and Communications (ISAC), Feiyu Li[1], Xian Zhou[1], Qirui Fan[2], Yuyuan Gao[1], Jiahao Huo[1], Jinhui Yuan[1], Keping Long[1]; [1]*Univ. of Science & Technology Beijing, China;* [2]*The Hong Kong Polytechnic Univ., Hong Kong.* A double-effect deep neural network (DNN)-based DBP scheme is developed to integrate communication and sensing, which can mitigate nonlinear interference effectively and estimate optical power distribution accurately through the optimized nonlinear parameters.

Th2A.37
Core and Wavelength Allocation of Sending-or-not-Sending Quantum Key Distribution for Future Metropolitan Networks Over Multicore Fiber, Weiwen Kong[1], Yongmei Sun[1], Yaoxian Gao[1], Yuefeng Ji[1]; [1]*Beijing Univ. of Posts & Telecomm., China.* We propose core and wavelength allocation schemes of SNS-QKD for future metropolitan transmission over multicore fiber. Experiments verify that the proposed schemes can suppress noise photons up to 57.54% compared to conventional channel allocation.

Th2A.38
Full Spectrum b-Modulation of Time-Limited Signals Using Linear Programming, Sander Wahls[1]; [1]*Technische Universiteit Delft, Netherlands.* We present the first method for the joint modulation of the continuous and the discrete nonlinear Fourier spectrum of finite duration signals.

Th2A.39
Optical Damage Threshold Screening Methodology for 28 GBd, Long Wavelength Avalanche Photodiodes, Alberto A. Ciarrocchi[1], Wei Quan[1], Markus Blaser[1], Maria Hämmerli[1], Hektor Meier[1]; [1]*Albis Optoelectronics AG, Switzerland.* We present a novel scalable wafer screening method that guarantees an optical damage threshold larger than +5 dBm for 28 GBd long wavelength avalanche photodiodes over large-scale production volumes.

12:30–14:00 Exhibit Only Time

NOTES

Room 3

14:00–16:00
Th3A • Energy Efficient Subsystems for the Data Center
Presider: Madeleine Glick; Columbia Univ., USA

Th3A.1 • 14:00 Invited
Towards Energy Efficient Cloud Networking for Post-Moore's Law Era, Fotini Karinou[1], Hitesh Ballani[1], Paolo Costa[1], Thomas Karagiannis[1], Vassily Lyutsarev[1], Kai Shi[1]; [1]*Microsoft Research Ltd, UK*. The trend of rapidly increasing intra-DC traffic due to AI and disaggregation driven workloads call for low latency and high bandwidth networks that are ultra-power efficient. In this talk we will discuss how innovation in optical technologies and cross-layer cloud network architectures could help overcome those challenges in the post-Moore's law era.

Th3A.2 • 14:30
Demonstration of High-Throughput Intra-Datacenter Switches Using Interleaved AWGs for Nyquist WDM, Takuma Kuno[1], Takumi Mitsuya[1], Yojiro Mori[1], Hiroshi Hasegawa[1], Ken-ichi Sato[2]; [1]*Nagoya Univ., Japan;* [2]*The National Inst. of Advanced Industrial Science and Technology (AIST), Japan*. We demonstrate a high-throughput optical circuit switch for intra-datacenter networks. DP-32QAM and Nyquist WDM are used to enhance the spectral efficiency of the switch. Experiments show the total switch throughput of 8.512 Pbps.

Room 6C

14:00–16:00
Th3B • Photonic Signal Processing
Presider: Changyuan Yu; Hong Kong Polytechnic Univ., Hong Kong

Th3B.1 • 14:00 Invited
Biomimicry in Microwave Photonic and Fiber Optic Sensors Embedded Soft Robotics, Mable P. Fok[1], Qidi Liu[1], Mei Yang[1]; [1]*Univ. of Georgia, USA*. Biomimicry offers natural and effective solutions to solve critical challenges in wide range of emerging technologies. This paper introduces several bio-inspired dynamic microwave photonic technologies as well as biomimicry in fiber-optic sensors enhanced soft robotics.

Th3B.2 • 14:30 Tutorial
Passive Amplification and Noise Mitigation of Optical Signals Through Talbot Processing, Jose Azana[1], Benjamin Crockett[1], Luis Romero Cortés[1]; [1]*INRS-Energie Materiaux et Telecom, Canada*. This tutorial will review recent work on noiseless passive amplification of arbitrary optical waveforms along the time and frequency domains using Talbot processing, and its application for real-time in-band and out-of-band noise mitigation of optical signals.

José Azaña is a Professor and Canada Research Chair at the Institut National de la Recherche Scientifique - Center of Energy, Materials and Telecommunications (INRS-EMT)

Room 6D

14:00–16:00
Th3C • Si Photonics
Presider: Hai-Feng Liu; HG Genuine Optics Tech Co Ltd, USA

Th3C.1 • 14:00
Segmented Silicon Photonic Modulator With a 67-GHz Bandwidth for High-Speed Signaling, Abdolkhalegh Mohammadi[1], Zibo Zheng[1], Jiachuan Lin[2], Mohammad M.Rad[2], Xiaoguang Zhang[3], Leslie A. Rusch[1], Wei Shi[1]; [1]*COPL, Université Laval, Canada;* [2]*Huawei Technologies Canada, Canada;* [3]*Beijing Univ of Posts & Telecom, China*. We experimentally demonstrate an all-silicon segmented modulator with an electro-optic bandwidth beyond 67 GHz and a Vπ of 5V. Transmission of 120-Gbaud 8-ASK (336.4 Gb/s net) is achieved.

Th3C.2 • 14:15
40GBaud PAM4 Silicon Mach-Zehnder Modulator Boosted by a Heterogeneously Integrated SOA With 10dB-Gain, Sylvie Menezo[1], Zheng Yong[2], Kevin Froberger[1], Torrey Thiessen[2], Jason C. Mak[2], Florian Denis-le Coarer[1], Martin Peyrou[1], Laurent Milord[1], Jeremy Da Fonseca[3], Christophe Jany[3], Philippe Grosse[3], Frederic Mazur[1], Joyce K. Poon[2]; [1]*SCINTIL Photonics, France;* [2]*Department of Electrical and Computer Engineering, Univ. of Toronto, Canada;* [3]*CEA-Leti, France*. We report a silicon IQ modulator integrated with a III-V/Si semiconductor optical amplifier (SOA) at the output. We demonstrate 40GBaud PAM4 operation of one of the Mach Zehnder modulators with an SOA gain of 10dB.

Th3C.3 • 14:30
Enhanced Stability of Resonant Racetrack Plasmonic-Organic-Hybrid Modulators, Marco Eppenberger[1], Bertold I. Bitachon[1], Andreas Messner[1], Wolfgang Heni[2], David Moor[1], Laurenz Kulmer[1], Patrick Habegger[2], Marcel Destraz[2], Eva De Leo[2], Norbert Meier[2], Nino Del Medico[2], Claudia Hoessbacher[2], Benedikt Baeuerle[2], Juerg Leuthold[1,2]; [1]*ETH Zurich, Switzerland;* [2]*Polariton Technologies AG, Switzerland*. A high-speed and compact plasmonic organic racetrack modulator is shown to be orders of magnitude more robust against operating condition changes compared to resonant modulators based on the plasma dispersion effect while maintaining thermal tunability. Stable operation at 80°C is shown with no degradation.

Room 6E

14:00–16:00
Th3D • Quantum Networking and Resiliency
Presider: Daniel Kilper; Univ. of Dublin Trinity College, USA

Th3D.1 • 14:00 Invited
Dynamic Quantum Network: From Quantum Data Center to Quantum Cloud Computing, Reza Nejabati[1], Rui Wang[1], Dimitra E. Simeonidou[1]; [1]*Univ. of Bristol, UK*. This paper presents challenges and solutions for creating a dynamic entangled quantum network as the main technology enabler for realizing scalable quantum data centres and future quantum cloud computing infrastructure serving a large number of users.

Th3D.2 • 14:30
Auxiliary Graph Based QKD Key Provisioning for End-to-end Security Service in Optical Networks, Qingcheng Zhu[1], Xiaosong Yu[1], Yongli Zhao[1], Avishek Nag[2], Hua Wang[1], Liquan Chen[3], Jie Zhang[1]; [1]*Beijing Univ. of Posts and Telecommunications, China;* [2]*Univ. College Dublin, Ireland;* [3]*School of Cyber Science and Engineering, Southeast Univ., China*. We propose a quantum-key-distribution (QKD) key provisioning scheme by applying auxiliary graph for end-to-end security service in optical networks. Simulation demonstrates the good performance in terms of security level and key provisioning latency.

Room 6F

14:00–16:00
Th3E • Coherent Optical Access Networks
Presider: Dora van Veen; Nokia Corporation, USA

Th3E.1 • 14:00 Invited
Coherent Optics for Access From P2P to P2MP, L. Alberto Campos[1], Zhensheng Jia[1], Mu Xu[1], Haipeng Zhang[1]; [1]*CableLabs, USA*. Coherent optics is being re-designed to future-proof access networks using P2P and P2MP systems. Coherent optics' higher speeds and link budgets, provide significant deployment flexibility. Coherent optics architecture, standards, and service implications benefits are discussed.

Th3E.2 • 14:30 Top-Scored
Intelligent Burst Receiving Control in 100G Coherent PON With 4×25G TFDM Upstream Transmission, Mu Xu[1], Zhensheng Jia[1], Haipeng Zhang[1], L. Alberto Campos[1], Curtis Knittle[1]; [1]*CableLabs, USA*. We proposed novel burst-receiving technologies, including power rebalancing and sub-channel recognition, in a 100G coherent PON with 4×25G-TFDM sub-channels. Superior burst-receiver performance is achieved over 80-km fiber with -39.2-dBm sensitivity and 2.4-GHz sub-channel frequency-detuning tolerance

Room 7AB

14:00–16:00
Th3F • Advanced Modulation Formats
Presider: Hussam Batshon; NEC Laboratories America Inc., USA

Th3F.1 • 14:00 Tutorial
Probabilistic Constellation Shaping: an Implementation Perspective, Junho Cho[1]; [1]*Nokia Bell Labs, USA*. This tutorial reviews recent advances in probabilistic constellation shaping (PCS) with particular focus on implementation perspectives. We analyze the complexity of several known shaping methods and discuss performance and complexity tradeoffs in different application scenarios.

Junho Cho received the B.S., M.S., and Ph.D. degrees in Electrical Engineering and Computer Science from Seoul National University, Seoul, Korea. He is currently a Distinguished Technical Staff at Nokia Bell Labs in Murray Hill, NJ, USA, with interests in DSP, FEC, PCS, and nonlinear optical fiber communications.

Room 8

14:00–16:00
Th3G • Sensing and Radar Applications

Th3G.1 • 14:00 Invited
Employing Fiber Sensing and on-Premise AI Solutions for Cable Safety Protection Over Telecom Infrastructure, Ting Wang[1]; [1]*NEC Laboratories America Inc., USA*. We review the distributed-fiber-sensing field trial results over deployed telecom networks. With local AI processing, real-time detection, and localization of abnormal events with cable damage threat assessment are realized for cable self-protection. © 2021

Th3G.2 • 14:30
Photonics-Based Multiband Radar Fusion With Millimeter-Level Range Resolution, Xin Zhu[1], Guanqun Sun[1], Fangzheng Zhang[1]; [1]*Nanjing Univ Aeronautics & Astronautics, China*. Photonics-based multiband radar fusion is demonstrated in which three photonics-based radars with a 2-GHz bandwidth are successfully fused to have an 18-GHz bandwidth response. Based on this technique, millimeter-level range resolution radar imaging is achieved.

Show Floor Programming

TS6 • Next Generation Opto-Electronic Devices – Measurement Challenges
Presented by Anritsu Company
14:45–15:15, *Theater II*

Room 3

Th3A • Energy Efficient Subsystems for the Data Center—Continued

Th3A.3 • 14:45
Demonstration of WDM-Enabled Ultralow-Energy Photonic Edge Computing, Alexander J. Sludds[1], Ryan Hamerly[1,2], Saumil Bandyopadhyay[1], Zhizhen Zhong[1], Zaijun Chen[1], Liane Bernstein[1], Manya Ghobadi[1], Dirk R. Englund[1]; *[1]MIT, USA; [2]NTT Research, USA.* We present experimental demonstrations of ultra-low power edge computing enables by wavelength division multiplexed optical links and time-integrating optical receivers. Initial experimentation demonstrations show <10fJ of optical energy per multiplication.

Th3A.4 • 15:00 Invited
Energy Efficient OEO Conversion and its Applications to Photonic Integrated System, Akihiko Shinya[2,1], Kengo Nozaki[2,1], Shota Kita[2,1], Tohru Ishihara[4], Shinji Matsuo[2,3], Masaya Notomi[2,1]; *[1]NTT Basic Research Labs, Japan; [2]NTT Nanophotonics Center, Japan; [3]NTT Device Technology Labs, Japan; [4]Nagoya Univ., Japan.* We describe nanophotonics-based opto-electric devices and their femtofarad integration. The combination of these devices and optical interference units has a potential to provide energyefficient and ultra-low latency optical information processing.

Th3A.5 • 15:30 Invited
Driving Down Link Energy and Driving up Link Density in GPU Networks, Benjamin G. Lee[1]; *[1]NVIDIA Corporation, USA.* GPU-accelerated computing systems, which power the AI revolution, rely on increasing amounts of off-chip I/O. To continue scaling, very dense integration of ultra-efficient optical transceivers alongside next-generation processor die will be needed.

Room 6C

Th3B • Photonic Signal Processing—Continued

in Montreal, Qc, Canada. His research interests include ultrafast photonics, optical signal processing, all-fiber and integrated-waveguide (silicon-photonic) technologies, fiber-optic telecommunications, all-optical (classical and quantum) computing, and broadband microwave signal generation and processing. Prof. Azaña's scientific outcome has been recognized with several awards and distinctions, including the 2008 IEEE-Photonics Society Young Investigator Award, the 2009 IEEE-MTT Society Microwave Prize, and the 2020 Canada Brockhouse Prize.

Th3B.3 • 15:30
All-Fiber Oise-Mitigating Sampling of Temporal Waveforms Enabling Broadband Operation and High Passive Amplification, Manuel P. Fernández[1,2], Saket Kaushal[1], Laureano A. Bulus-Rossini[2], Pablo A. Costanzo-Caso[2], Jose Azaña[1]; *[1]Institut National de la Recherche Scientifique (INRS) - Énergie Matériaux Télécommunications, Canada; [2]Laboratorio de investigación aplicada en telecomunicaciones (CNEA) & Instituto Balseiro (UNCuyo-CNEA) & CONICET, Argentina.* We propose an all-fiber design concept for Talbot-based denoising passive enhancement of temporal waveforms using four-wave-mixing, and demonstrate about an order-of-magnitude improvement in the operation bandwidth × amplification factor (>150 GHz) versus previous electro-optic designs.

Room 6D

Th3C • Si Photonics—Continued

Th3C.4 • 14:45
110 Gbit/s NRZ and 160 Gbit/s PAM-4 GeSi Electro-Absorption Modulator, Xiao Hu[1,2], Dingyi Wu[1], Yuguang Zhang[1,2], Hongguang Zhang[1], Daigao Chen[1,2], Min Liu[1], Jia Liu[1], Lei Wang[1,2], Xi Xiao[1,2], Shaohua Yu[2]; *[1]NOEIC, China; [2]CICT, China.* A pure Ge electro-absorption modulator operating at 1600 nm wavelength with electro-optic bandwidth beyond 67 GHz is reported. The 110 Gbit/s NRZ and 160 Gbit/s PAM-4 modulation clear openings of eye diagrams are demonstrated.

Th3C.5 • 15:00 Invited
Considerations for Silicon Photonics Process Technologies in a Commercial Foundry Environment, Edward Preisler[1]; *[1]Tower Semiconductor, USA.* Aspects of silicon photonics process technologies intended for high volume production in a traditional silicon electronics-driven foundry environment are discussed. Both technological and economical challenges are described in detail.

Th3C.6 • 15:30 Invited
Highlights of 10-Years of Research in a Japanese Si Photonics Project, Yasuhiko Arakawa[1], Takahiro Nakamura[2], Kazuhiko Kurata[3]; *[1]Univ. of Tokyo, Japan; [2]Photonics Electronics Technology Research Association, Japan; [3]AIOCORE Co., Ltd, Japan.* We discuss the development of a large-scale national project in Japan on silicon photonics technology, focusing on the optical I/O core, a 5mm square chip that integrates key photonic devices such as quantum dot lasers.

Room 6E

Th3D • Quantum Networking and Resiliency—Continued

Th3D.3 • 14:45 Top-Scored
A Dynamic Multi-Protocol Entanglement Distribution Quantum Network, Rui Wang[1], Obada Alia[1], Marcus Clark[1], Sima Bahrani[1], Siddarth Joshi[1], Djeylan Aktas[1], George Kanellos[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]Ruder Boskovic Inst., Croatia.* We implement a six-user quantum communication network utilising a quantum-enabled ROADM for flexible and on-demand allocation of entanglement across different users. This allows dynamic networking for multiple quantum protocols.

Th3D.4 • 15:00
Microservice-Based Unsupervised Anomaly Detection Loop for Optical Networks, Carlos Natalino[1], Carlos Manso[2], Lluis Gifre[2], Raul Muñoz[2], Ricard Vilalta[2], Marija Furdek[1], Paolo Monti[1]; *[1]Chalmers Univ. of Technology, Sweden; [2]Centre Tecnologic de Telecomunicacions de Catalunya (CTTC/CERCA), Spain.* Unsupervised learning (UL) is a technique to detect previously unseen anomalies without needing labeled datasets. We propose the integration of a scalable UL-based inference component in the monitoring loop of an SDN-controlled optical network.

Th3D.5 • 15:15
Autonomous and Generalized Soft Failure Detection Based on Digital Residual Spectrum in Optical Networks, Kaixuan Sun[1], Yu Zhenming[1], Hongyu Huang[1], Jing Zhang[2], Kun Xu[1]; *[1]Beijing Univ. of Posts and Telecomm, China; [2]Univ. of Electronic Science and Technology, China.* We propose and experimentally demonstrate an autonomous and generalized soft failure detection scheme using Auto-Encoder and digital residual spectrum. False negative rate (FNR) for five transmission systems is below 3.87% with the same trained model.

16:00–16:30 Coffee Break

16:30–18:30 Postdeadline Papers *(Rooms 6C, 6D, 6E, 6F)*

Room 6F

Th3E • Coherent Optical Access Networks—Continued

Th3E.3 • 14:45 Top-Scored
200-Gb/s/λ Coherent TDM-PON With Wide Dynamic Range of >30-dB Based on Local Oscillator Power Adjustment, Guoqiang Li[1], Sizhe Xing[1], Zhongya Li[1], Junwen Zhang[1], Nan Chi[1]; [1]*Fudan Univ., China.* We experimentally demonstrate the 200-Gb/s/λ PDM-16QAM coherent TDM-PON data transmission with wide dynamic-range based on the local-oscillator power adjustment for continuous and burst-mode signals, achieving >30-dB dynamic-range and 37-dB power budget over 50-km SSMF transmission.

Th3E.4 • 15:00
Experimental Demonstration of 200 Gb/s/λ Coherent PON With a Low-Complexity Receiver and a Multi-Purpose Neural Network, Dongxu Zhang[1], Xiaofeng Hu[1], Xiaoan Huang[1], Kaibin Zhang[1]; [1]*Bell Labs, Shanghai, Nokia Shanghai Bell, China.* We experimentally evaluate a single-BPD-based polarization-insensitive coherent receiver for 200 Gb/s/λ PON. A neural network is used as a joint equalizer and Alamouti decoder. A 29 dB power budget is achieved with 20 km transmission.

Th3E.5 • 15:15
Experimental Demonstration of 100/200-Gb/s/λ PON Downstream Transmission Using Simplified Coherent Receivers, Md Saifuddin Faruk[1], Xiang Li[1], Seb Savory[1]; [1]*Univ. of Cambridge, UK.* We demonstrate 100- and 200-Gb/s/λ line-rate PON downstream transmission considering Alamouti-coded 16QAM signal with a single-polarization heterodyne receiver. The power budget is experimentally evaluated for both single-ended and balanced detection considering 25 km reach.

Th3E.6 • 15:30
Low-Cost Asymmetric Point-to-Multipoint Coherent Architecture for Access Networks, Yunyun Fan[1], Mengfan Fu[1], Xiaomin Liu[1], Yicheng Xu[1], Lilin Yi[1], Weisheng Hu[1], Qunbi Zhuge[1]; [1]*Shanghai Jiao Tong Univ., China.* We propose a low-cost asymmetric point-to-multipoint coherent architecture for access networks. In this architecture, the coherent transmitters for the unlink are greatly simplified and the tolerance to laser frequency offset is significantly improved.

Room 7AB

Th3F • Advanced Modulation Formats—Continued

Th3F.2 • 15:00
Mitigating Nonlinear Interference by Limiting Energy Variations in Sphere Shaping, Yunus Can Gültekin[1], Alex Alvarado[1], Olga Vassilieva[2], Inwoong Kim[2], Paparao Palacharla[2], Chigo M. Okonkwo[1], Frans M. Willems[1]; [1]*Eindhoven Univ. of Technology, Netherlands;* [2]*Fujitsu Network Communications Inc., USA.* Band-trellis enumerative sphere shaping is proposed to decrease the energy variations in channel input sequences. Against sphere shaping, 0.74 dB SNR gain and up to 9% increase in data rates are demonstrated for single-span systems.

Th3F.3 • 15:15
Eigenvalue-Domain Neural Network Receiver for 4096-ary Eigenvalue-Modulated Signal, Hiroyuki Takeuchi[1], Ken Mishina[1], Yuhei Terashi[1], Daisuke Hisano[1], Yuki Yoshida[2,1], Akihiro Maruta[1]; [1]*Osaka Univ., Japan;* [2]*National Inst. of Information and Communications Technology (NICT), Japan.* Demodulation scheme based on multilabel eigenvalue-domain neural network for a 4096-ary eigenvalue-modulated signal is demonstrated experimentally. Successful demodulation with a 2.5 dB power margin compared with multiclass single-label classification is achieved at 10.7 Gb/s.

Th3F.4 • 15:30 Invited
Shaped Four-Dimensional Modulation Formats for Optical Fiber Communication Systems, Bin Chen[1,2], Gabriele Liga[2], Yi Lei[1,2], Wei Ling[1], Zhengyan Huan[1], Xuwei Xue[3], Alex Alvarado[2]; [1]*Hefei Univ. of Technology, China;* [2]*Eindhoven Univ. of Technology, Netherlands;* [3]*Beijing Univ. of Posts and Telecommunications, China.* We review the design of multidimensional modulations by maximizing generalized mutual information and compare the maximum transmission reach of recently introduced 4D formats. A model-based optimization for nonlinear-tolerant 4D modulations is also discussed.

Room 8

Th3G • Sensing and Radar Applications—Continued

Th3G.3 • 14:45
LIDAR-Assisted Channel Modelling for LiFi, Sreelal Maravanchery Mana[1], Kerolos Gabra Kamel Gabra[1], Sepideh Mohammadi Kouhini[1], Malte Hinrichs[1], Dominic Schulz[1], Ronald Freund[1], Volker Jungnickel[1]; [1]*Fraunhofer HHI, Germany.* We present fast and accurate modelling of LiFi channels using data from LIDAR scans. Line-of-sight, first and residual reflections are modelled in the frequency-domain and using the integrating-sphere method. Model and measurement show good agreement.

Th3G.4 • 15:00
Integrated 1.58 cm Range Resolution Radar and 60 Gbit/s 50m Wireless Communication Based-on Photonic in Terahertz Band, Yanyi Wang[1], Weiping Li[1], Junjie Ding[1], Jiao Zhang[2], Feng Wang[1], Chen Wang[1], Li Zhao[1], Cuiwei Liu[1], Wen Zhou[1], Jianguo Yu[3], Mingzheng Lei[2], Min Zhu[2], Feng Zhao[4], Jianjun Yu[1]; [1]*Fudan Univ., China;* [2]*Purple Mountain Laboratories, Nanjing,, China;* [3]*Beijing Univ. of Posts and Telecommunications, China;* [4]*School of Electronic Engineering, Xi'an Univ. of Posts and Telecommunications, China.* A novel photonics-based THz band high-resolution radar sensing, and a long-distance communication system integrated architecture was proposed and experimentally demonstrated. To the best of our knowledge, 60 Gbit/s THz signals at 340 GHz band were delivered over 50 m wireless distance with an integrated 1.58 cm resolution radar for the first time.

16:00–16:30 Coffee Break

16:30–18:30 Postdeadline Papers *(Rooms 6C, 6D, 6E, 6F)*

Show Floor Programming

TS6 • Next Generation Opto-Electronic Devices – Measurement Challenges
Presented by Anritsu Company
14:45–15:15, *Theater II*

Key to Authors and Presiders

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