2018 OPTICAL INTERCONNECTS

7th ANNUAL IEEE PHOTONICS SOCIETY
OPTICAL INTERCONNECTS CONFERENCE

#oi2018

4-6 June

HILTON SANTA FE HISTORIC PLAZA
SANTA FE, NEW MEXICO, USA

CONFERENCE PROGRAM

GENERAL CO-CHAIRS
Ali Ghiasi, Ghiasi Quantum LLC, USA
Clint Schow, U. of California - Santa Barbara, USA

PROGRAM CO-CHAIRS
Stephane Lessard, Ericsson, Sweden
Chen Sun, Ayar Labs, USA

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Optical Interconnects Conference 2018
Program-at-a-Glance

All sessions are in Mesa Ballroom	Monday, 4 June	Tuesday, 5 June	Wednesday, 6 June
8:00 am – 8:30 am	**Breakfast/Coffee Break – Canyon Ballroom**		
8:30 am – 10:00 am	**MA:** Opening Remarks & Next Generation Optical Interconnects **Session Chair:** C. Schow	**TuA:** Silicon Photonics Volume Manufacturing **Session Chair:** A. Ghiasi	**WA:** Next Generation Hyperscale Data Centers I **Session Chair:** A. Ghiasi
10:00 am-10:15 am	**Coffee Break/Exhibits – Canyon Ballroom**		
10:15 am – 11:45 am	**MB:** Advance Silicon Photonics Devices I **Session Chair:** H. Turk	**TuB:** Silicon Photonics Devices II **Session Chair:** T. Takahara	**WB:** Next Generation Hyperscale Data Centers II **Session Chair:** B. Taylor
11:45 am – 1:30 pm	**Lunch Break** (ON OWN)		
1:30 pm – 3:15 pm	**MC:** Advance Optical Co-Packaging **Session Chair:** T. Schrans	**TuC:** Interconnects and Fabrics **Session Chair:** A. Seyedi	**WC:** Advance Communication I **Session Chair:** F. McCormick
3:15 pm – 3:45 pm	**Coffee Break/Exhibits – Canyon Ballroom**		
3:45 pm - 6:00 pm	**MD:** Workshop on Co-packaged Optics **Session Chair:** C. Sun	**TuD:** Workshop on 100G Signaling: Enabling Next Generation Interconnects **Session Chair:** S. Lessard	3:45 pm-5:00 pm **WD:** Advance Communication II **Session Chair:** J. Bovington
6:00 pm – 7:00 pm	**Welcome Reception – Canyon Ballroom**	**Registration - Canyon Ballroom Foyer** **Monday, 4 June** 7:00 am – 5:30 pm **Tuesday, 5 June** 7:30 am – 5:00 pm **Wednesday, 6 June** 8:00 am – 3:00 pm	

Final Program

MONDAY, 4 JUNE 2018

8:00 am–8:30 am **Canyon Ballroom**

Breakfast

8:30 am–10:00 am **Mesa Ballroom**
Session MA **Opening Remarks and Next Generation Optical Interconnects**
Session Chair Clint Schow, *University of California–Santa Barbara, CA, USA*

8:45 am–9:30 am ***(Plenary)***

MA.1 The ARPA-E ENLITENED Program: Will Co-Packaged Integrated Photonic Interconnects Transform Future Data-Centers?, Michael Haney, *ARPA, MD, USA*

Under the ARPA-E ENLITENED program, integrated photonic technologies are being developed to enable new networking architectures that overcome the approaching communications limits in high-density computing systems. The overall objective is to provide transformative energy efficiency enhancements in data centers. Program goals and status are reviewed.

9:30 am–10:00 am ***(Invited)***

MA.2 High Speed, Low Energy, Low Latency, and Low Cost Optical Interconnect for Servers and Data Centers, Daniel Kuchta, *IBM T.J. Watson Research Center, Yorktown Heights, NY, USA*

The Ethernet Standards have gone in a direction of higher speeds but without regards to energy, latency, and cost. This talk will focus on an ARPA-E project, MOTION, which aims to produce a low energy 16 × 56 Gb/s NRZ optical transciever mounted of the first level package.

10:00 am–10:15 am **Canyon Ballroom**

Coffee Break / Exhibits

10:15 am–11:45 am **Mesa Ballroom**
Session MB **Advance Silicon Photonics Devices I**
Session Chair Harris Turk, *US Government, USA*

10:15 am–10:30 am

MB.1 Impact of Backscattering on Microring-Based Silicon Photonic Links, Meisam Bahadori, Sébastien Rumley, Qixiang Cheng, and Keren Bergman, *Columbia University, New York, NY, USA*

The first quantitative analysis of optical power penalty due to the backscattering of silicon add-drop ring resonators is presented. Simulated results based on experimentally retrieved data show the attributing power penalty from fabricated microrings is as high as 4.5 dB for 10 Gbps OOK links.

10:30 am–10:45 am

MB.2 Improving Microresonators Reliability in Silicon Photonic Integrated Circuits, Mahdi Nikdast, *Colorado State University, CO, USA,* Gabriela Nicolescu, *Polytechnique Montréal, Canada,* and Odile Liboiron-Ladouceur, *McGill University, Montréal, Canada*

Exploring microresonators (MRs) design space, we demonstrate a design method (DeEPeR) to enhance MRs reliability in silicon photonic integrated circuits (PICs) under fabrication process variations. DeEPeR is validated through fabricating several MRs. Moreover, simulation results indicate considerable optical signal-to-noise ratio improvements in PICs using DeEPeR.

10:45 am–11:00 am

MB.3 A Stable Ultrahigh Extinction Silicon Photonic Amplitude Modulator, Hong Cai, Sheng Liu, Andrew Pomerene, Douglas C. Trotter, Andrew L. Starbuck, Christina Dallo, Dana Hood, Christopher T. DeRose, and Anthony L. Lentine, *Sandia National Laboratories, Albuquerque, NM, USA*

We demonstrate the ultrahigh extinction operation of a silicon photonic (SiP) amplitude modulator (AM) employing a cascaded Mach-Zehnder interferometer. By carrying out optimization sweeps without significantly degrading the extinction, the SiP AM is robust to environment changes and maintained >52 dB extinction for >6 hrs.

11:00 am–11:15 am

MB.4 Thermal Effect on Semi-Conductor and Metal Heaters in FP-Based Modulator Using Thermal Simulation, M. Atif, *Technische Universität Berlin, Berlin, Germany and Sicoya GmbH, Berlin, Germany and GC University, Lahore, Pakistan,* S. Mahdi, *Technische Universität Berlin, Berlin, Germany,* S. Kupijai, C. Theiss, H. Rhee, A. Al-Saadi, *Sicoya GmbH, Berlin, Germany,* M. Henniges, D. Selicke, *Technische Universität Berlin, Berlin, Germany and Sicoya GmbH, Berlin, Germany,* M. Vitali, L. Yan, D. Bronzi, *Sicoya GmbH, Berlin, Germany,* U. Woggon, *Technische Universität Berlin, Berlin, Germany,* and S. Meister, *Sicoya GmbH, Berlin, Germany*

In this paper, a comparison of semi-conductor and metal heaters have been presented. The thermo-optic influence is determined by using thermal simulation in Fabry-Pérot based modulator. Heaters were used to stabilize shifted spectrum by controlling temperature. High efficiency 0.67 K/mW of Si-heaters is computed.

11:15 am–11:45 am *(Invited)*

MB.5 Energy-Efficient Microsecond Silicon Photonic Switches, Ming Wu, *University of California, Berkeley, USA*

Large-scale (128 × 128) silicon photonic switches with microsecond response time and low energy consumption (<1mW) are made possible by integrating micro-electro-mechanical-system (MEMS) actuators with silicon photonics. In this talk, we will describe the principle and performance of such switches and discuss their applications in data centers.

11:45 am–1:30 pm

Lunch Break (on own)

1:30 pm–3:15 pm **Mesa Ballroom**

Session MC **Advance Optical Co-Packaging**

Session Chair Thomas Schrans, *Rockley Photonics, CA, USA*

1:30 pm–2:00 pm ***(Invited)***

MC.1 The PhotonicPlug – Scaling Up Silicon Photonics Packaging, Hesham Taha, *Teramount Ltd., Jerusalem, Israel*

The PhotonicPlug technology enables scalable silicon photonics packaging for datacom, telecom, on-board-optics and 2.5D interposer applications. It allows passive alignment of optics, including single mode fiber, to silicon photonic channels with flip-chip packaging machines and supports high-volume and low cost packaging through standard CMOS flows

2:00 pm–2:15 pm

MC.2 Glass Tube Ferrule for Solder-Reflow-Compatible Embedded Optoelectronic Interconnections, James S. Sutherland, Douglas L. Butler, Jeffery S. Clark, Clifford G. Sutton, Robin M. Force, Alexander L. Cuno, Karl Heise, Lars Brusberg, Alan F. Evans, *Corning Research & Development Corporation, Corning, NY, USA,* and Michael de Jong, *Corning Optical Communications, Keller, TX, USA*

A glass-tube-based MT-style fiber array ferrule and connector packaging are presented that provide a compact solder-reflow-compatible interface to PIC (Photonic Integrated Circuit) edge waveguides. Mate/demate experiments demonstrated IL (insertion loss) values across eight fiber array channels of less than 1.5 dB without index matching fluid.

2:15 pm–2:45 pm ***(Invited)***

MC.3 Transfer Printing for Silicon Photonics Transceivers and Interposers, G. Roelkens, J. Zhang, A. De Groote, J. Juvert, N. Ye, S. Kumari, J. Goyvaerts, G. Muliuk, S. Uvin, G. Chen, B. Haq, *Ghent University – imec, Ghent, Belgium,* B. Snyder, J. Van Campenhout, *imec, Leuven, Belgium,* D. Van Thourhout, *Ghent University – imec, Ghent, Belgium,* A. J. Trindade, C.A. Bower, *X-Celeprint Limited, Cork, Ireland,* J. O'Callaghan, R. Loi, B. Roycroft, and B. Corbett, *University College Cork, Cork, Ireland*

We present transfer printing as an enabling technology to realize heterogeneous PICs. The approach enables a cost-effective and intimate integration of III-V lasers on advanced high-speed Si PICs. It also enables the integration of III-V and silicon-based opto-electronic components on a passive Si/SiN interposer.

2:45 pm–3:15 pm ***(Invited)***

MC.4 Large-Scale, Automated, High-Throughput Photonic Packaging, Tymon Barwicz, *IBM T.J. Watson Research Center, Yorktown Heights, NY, USA,* Ted W. Lichoulas, *AFL Telecommunications, Duncan, SC, USA,* Yves Martin, Yoichi Taira, *IBM T.J. Watson Research Center, Yorktown Heights, NY, USA,* Shotaro Takenobu, *Asahi Glass Co., Yokohama, Japan,* Alexander Janta-Polczynski, *IBM Bromont, Quebec, Canada,* Eddie L. Kimbrell, *AFL Telecommunications, Duncan, SC, USA*, Jae-Woong Nah, *IBM T.J. Watson Research Center, Yorktown Heights, NY, USA,* Elaine Cyr, Richard Langlois, *IBM Bromont, Quebec, Canada,* Bo Peng, *IBM T.J. Watson Research Center, Yorktown Heights, NY, USA,* Robert Leidy, *GlobalFoundries, Vermont, USA,* Hidetoshi Numata, *IBM Research – Tokyo, Kawasaki, Japan,* Swetha Kamlapurkar, Sebastian Engelmann, *IBM T.J. Watson Research Center, Yorktown Heights, NY, USA,* Paul Fortier, and Nicolas Boyer, *IBM Bromont, Quebec, Canada*

Silicon photonic chip fabrication exhibits a stark contrast in scalability and cost-efficiency to photonic packaging. We address this challenge by moving photonic packaging complexity from assembly to wafer and, by the same token, enabling photonic packaging in standard microelectronic assembly lines.

3:15 pm–3:45 pm **Canyon Ballroom**

Coffee Break / Exhibits

3:45 pm–6:00 pm **Mesa Ballroom**

Session MD **Workshop on Co-Packaged Optics**

Session Chair Chen Sun, *Ayar Labs, CA, USA*

Speakers
Katharine Schmitdke, *Facebook, USA*
Tymon Barwicz, *IBM, USA*
Frank Flens, *Finisar, USA*
Koichi Takemerura, *PETRA, Japan*
Peter De Dobbelaere, *Luxtera, USA*
Kobi Hasharoni, *DustPhotonics, Israel*
Thomas Liljeberg, *Intel, USA*

6:00 pm–7:00 pm **Canyon Ballrom**

Welcome Reception

TUESDAY, 5 JUNE 2018

8:00 am–8:30 am **Canyon Ballroom**

Breakfast

8:30 am–10:00 am **Mesa Ballroom**

Session TuA **Silicon Photonics Volume Manufacturing**

Session Chair Ali Ghiasi, *Ghiasi Quantum, CA, USA*

8:30 am–9:15 am ***(Plenary)***

TuA.1 Advanced Silicon Photonics for High-Speed Interconnect, Peter De Dobbelaere, *Luxtera, CA, USA*

9:15 am–9:45 am ***(Invited)***

TuA.2 Versatile Silicon Photonic Platform for Datacom and Computercom Applications, Karim Hassan, Quentin Wilmart, Laeticia Adelmini, Vincent Reboud, Corrado Sciancalepore, Daivid Fowler, Stéphane Malhouitre, Yvain Thonnart, Olivier Castany, Stéphanie Garcia, Stéphane Brision, Viviane Muffato, Olivier Lemonnier, Karen Ribaud, Philippe Grosse, Benoit Charbonnier, Stéphane Bernabe, Ségolène Olivier, Bertrand Szelag, and Christophe Kopp, *CEA - LETI, Grenoble, France*

We present the LETI CMOS silicon photonics platform and its technological add-ons to tackle current silicon photonic and emergent applications. Core and add-on process modules as EIC hybridization, multiple photonic layers, CMOS process compatible laser sources are described to provide a versatile photonic integration scheme.

9:45 am–10:00 am

TuA.3 Direct Frequency Locking of Lasers to RF Oscillators, Zhe Xuan, Lixiong Du, and Firooz Aflatouni, *University of Pennsylvania, Philadelphia, PA, USA*

A hybrid-integrated frequency-locked loop is presented where an opto-electronic oscillator with a dispersive optical delay line is used to directly frequency lock a semiconductor laser to an RF synthesized source. A tracking range of 4.1pm at a total power consumption of 33mW is achieved.

10:00 am–10:15 am **Canyon Ballroom**

Coffee Break / Exhibits

10:15 am–11:45 am **Mesa Ballroom**

Session TuB **Advance Silicon Photonics Devices II**

Session Chair Tomoo Takahara, *Fujitsu, Tokyo, Japan*

10:15 am–10:45 am ***(Invited)***

TuB.1 Silicon Photonic Components for 400 Gb/s Transceivers, Yuliya Akulova, *Intel, Santa Clara, CA, USA*

We will review recent advances in silicon photonic components towards higher channel count and baud rate enabling cost-effective 400 Gb/s transceivers and establishing manufacturing platform for further scaling of datacenter optical interconnects to Tb/s.

10:45 am–11:00 am

TuB.2 Advanced Control for Crosstalk Minimization in MZI-Based Silicon Photonic Switches, Yishen Huang, Qixiang Cheng, and Keren Bergman, *Columbia University, New York, NY, USA*

Key drivers of crosstalk in MZI switch elements are identified in terms of phase error, electro-absorption loss, and coupler variations. An advanced control method is introduced that coordinates thermo-optic and electro-optic phase shifters to simultaneously mitigate these factors and improve crosstalk limit beyond equalized push-pull.

11:00 am–11:15 am

TuB.3 Enhancing SOI Waveguide Nonlinearities via Microring Resonators, Thomas Ferreira de Lima, Hsuan-Tung Peng, Mitchell A. Nahmias, Siamak Abbaslou, Chaoran Huang, Alexander N. Tait, Bhavin J. Shastri, and Paul R. Prucnal, *Princeton University, Princeton, NJ, USA*

Silicon photonics offers a suite of weak nonlinearities that can be exploited to engineer all-optical devices. Here, we study how microring resonators (MRRs) harness these nonlinearities, with a theoretical model and experimental validation. Free-carrier effects will practically always dominate over Kerr for MRR-loaded devices.

11:15 am–11:30 am

TuB.4 A Microring-Based Time-Division Demultiplexer with Differential Signaling, Ming Gong, Francis Smith, and Hui Wu, *University of Rochester, Rochester, NY, USA*

We propose a new electronic-photonic integrated circuit for time-division demultiplexing based on time-interleaved sampling by microring couplers. The quasi-differential circuit design overcomes the issue of input signal feedthrough due to the extinction ratio limitation of microrings.

11:30 am–11:45 am

TuB.5 Highly Efficient Polarization Rotation in Laterally Tapered 1D PhC Si Nanowire, Md Rezwanul H Khandokar, *University of Melbourne, Parkville, Australia,* Masuduzzaman Bakaul, *University of Melbourne, Parkville, Australia and Monash University Malaysia, Selangor, Malaysia,* Md Asaduzzaman, Stan Skafidas, and Thas Nirmalathas, *University of Melbourne, Parkville, Australia*

New structural designs by introducing 1D-PhC structure and novel approach of lateral tapering are proposed in Si nanowire polarization rotator. This shows rotator length of <7 μm with more than 90% efficiency and high operational bandwidth of >700 nm which covers long and short haul telecommunication bands.

11:45 am–1:30 pm

Lunch Break (on own)

1:30 pm–3:15 pm **Mesa Ballroom**

Session TuC **Silicon Photonics Interconnects and Fabrics**

Session Chair Ashkan Seyedi, *Hewlett Packard Enterprise, CA, USA*

1:30 pm–2:00 pm ***(Invited)***

TuC.1 PINE: An Energy Efficient Flexibly Interconnected Photonic Data Center Architecture for Extreme Scalability, Keren Bergman, *Columbia University, New York, NY, USA,* John Shalf, George Michelogiannakis, *Lawrence Berkeley National Laboratory, Berkeley, CA, USA,* Sebastien Rumley, *Columbia University, New York, NY, USA,* Larry Dennison, *NVIDIA,* and Monia Ghobadi, *Microsoft Research*

Cost and complexity of existing data-movement solutions prevent designing datacenter racks tailored to specific applications. We introduce the PINE concept (Photonically Interconnected datacenter Elements), in which compute, memory or storage modules can be flexibly combined thru one-model-fits-all embedded photonic connectivity and prevent stranded resources.

2:00 pm–2:15 pm

TuC.2 Wavelength Locking of Multicast Signals Using Photo-Conductive Effect in Silicon Photonic Platform, Alexander Gazman, Ziyi Zhu, Meisam Bahadori, and Keren Bergman, *Columbia University, New York, NY, USA*

We develop an automated wavelength locking of microring resonators for routing optical signals in unicast and multicast modes. The locking algorithm utilizes the photo-conductive effect of the integrated microheaters for tapless monitoring of the optical power coupled to the microring.

2:15 pm–2:30 pm

TuC.3 Microring-Based Si/SiN Dual-Layer Switch Fabric, Qixiang Cheng, Liang Yuan Dai, Meisam Bahadori, *Columbia University, New York, NY, USA,* Padraic Morrissey, *University College Cork, Cork, Ireland,* Robert Polster, Sebastien Rumley, *Columbia University, New York, NY, USA,* Peter O'Brien, *University College Cork, Cork, Ireland,* and Keren Bergman, *Columbia University, New York, NY, USA*

The first microring-based Si/SiN dual-layer switch fabric is fabricated, packaged and characterized. The 4 × 4 thermally-actuated switch fabric implements the switch-and-select architecture in an ultra-compact footprint. It leverages the Si/SiN dual-layer structure achieving a crossing-free design, showing great potential for ultra-low loss and crosstalk switching applications.

2:30 pm–2:45 pm

TuC.4 Characterization of Low Loss Photonic Waveguides Using Arrayed Waveguide Structure, Nicholas Boynton, Michael Gehl, Christina Dallo, Andrew Pomerene, Andrew Starbuck, Dana Hood, Douglas Trotter, Anthony Lentine, and Christopher T. DeRose, *Sandia National Laboratories, Albuquerque, NM, USA*

We present a new method of accurately characterizing waveguide loss using an arrayed waveguide grating measured in a swept wavelength interferometer. Using this method we can extract the waveguide propagation loss which is independent of insertion loss with an uncertainty of less than 0.1 dB/cm.

2:45 pm–3:00 pm

TuC.5 Self-Organized Lightwave Network (SOLNET) Formed by Two-Photon Photochemistry for 3-D Integrated Optical Interconnects, Tetsuzo Yoshimura, Shunya Yasuda, Hideaki Yamaura, and Yusuke Yamada, *Tokyo University of Technology, Tokyo, Japan*

Two-photon SOLNET, which enhances the self-aligned optical coupling capability in 3-D optical wiring, is found by FDTD simulations to exhibit lateral misalignment tolerances more than 3 μm between 600 nm-wide waveguides and [3 μm-600 nm] mode size conversion functions. Two-photon R-SOLNET is experimentally demonstrated.

3:00 pm–3:15 pm

TuC.6 Cross-Layer Optimization for High-Radix Integrated Optical Switches in Data Centers, Zhifei Wang, Peng Yang, *Hong Kong University of Science and Technology, Hong Kong,* Yi-Shing Chang, *Intel Corp., Santa Clara, CA, USA,* Jiang Xu, Xuanqi Chen, Zhehui Wang and Luan H. K. Duong, *Hong Kong University of Science and Technology, Hong Kong*

This work proposes a cross-layer framework to optimize high-radix optical switches and facilitate rapid initial system design explorations and evaluations. Case studies on 64-port switches show the framework can reduce as much as 93% laser energy consumption with optimized device parameters.

3:15 pm–3:45 pm **Canyon Ballroom**

Coffee Break / Exhibits

3:45 pm–6:00 pm **Mesa Ballroom**

Session TuD **Workshop on 100 G Signaling: Enabling Next Generation Interconnects**

Session Chair Stephen Lessard, *Ericson, Sweden*

Speakers
Andreas Bechtolsheim, *Arista, USA*
Chris Cole, *Finisar, USA*
Mark Nowell, *Cisco, USA*
Tom Palkert, *Molex, USA*
Nathan Tarcy, *TE Connectivity, USA*
Jeff Twombly, *Credo Semiconductors, USA*
Brad Booth, *Microsoft, USA*

WEDNESDAY, 6 JUNE 2018

8:00 am–8:30 am **Canyon Ballroom**

Breakfast

8:30 am–10:00 am **Mesa Ballroom**

Session WA **Next Generation Hyperscale Data Centers I**

Session Chair Ali Ghiasi, *Ghiasi Quantum, CA, USA*

8:30 am–9:15 am ***(Plenary)***

WA.1 The Road to 400G Optics, Andreas Bechtolsheim, *Arista Networks, Santa Clara, CA, USA*

This talk will discuss the impact of silicon interface speed transitions from 25 Gbps to 50 Gbps and to 100 Gbps on the packaging options for 400G optics, including the OSFP, QSFP-DD and COBO optics module form factors.

9:15 am–9:45 am ***(Invited)***

WA.2 Requirements for Next Generation Data Center, Hans-Juergen Schmidtke, *Facebook, Cambridge, MA, USA*

9:45 am–10:00 am

WA.3 Technical Feasibility of New 200 Gb/s and 400 Gb/s Links for Data Centers, Yi Sun, Robert Lingle, Jr., *OFS Fitel, LLC, Norcross, GA, USA*

The technical feasibility of new 200 G and 400 G PHYs over fewer MMF fiber pairs is demonstrated from the literature, for application in cloud and large enterprise data centers.

10:00 am–10:15 am **Canyon Ballroom**

Coffee Break / Exhibits

10:15 am–11:45 am **Mesa Ballroom**

Session WB **Next Generation Hyperscale Data Centers II**

Session Chair Brian Taylor, *Facebook, Cambridge, MA, USA*

10:15 am–10:45 am ***(Invited)***

WB.1 Requirements for Next Generation Networks in High Performance Computing, Robert Senger, *IBM TJ Watson Research Center, Yorktown Heights, NY, USA*

We begin by overviewing current challenges building high-performance, scalable networks, and then discuss desirable network attributes for next generation high-performance workloads. We examine promising ideas and directions for addressing these challenges and attributes, in the areas of technology, topologies, and support for processor offloading.

10:45 am–11:15 am ***(Invited)***

WB.2 Integrated Silicon Photonics for Future Data Center Applications, Drew Alduino, *Intel Corp., Santa Clara, CA, USA*

11:15 am–11:45 am ***(Invited)***

WB.3 Reconfigurable Integrated Photonics Based on Optical Phase Change Materials, Tian Gu, *Massachusetts Institute of Technology, Cambridge, MA, USA*

We present novel photonic circuit architectures and device designs based on optical phase change materials. Ge-Sb-Se-Te integrated Si-photonics exhibit significantly improved switching performance over state-of-the-art GST-based approaches. The technology is scalable to non-blocking matrix switches with arbitrary network complexity, enabling high-performance reconfigurable photonics circuits.

11:45 am–1:30 pm

Lunch Break (on own)

1:30 pm–3:15 pm **Mesa Ballroom**

Session WC **Advance Communication I**

Session Chair Frederick (Rick) McCormick, *Sandia National Labs, Albuquerque, NM, USA*

1:30 pm–2:00 pm ***(Invited)***

WC.1 DSP-Free Coherent Interconnects for Data Center Networks, Joseph Kahn, Anujit Shastri, and Jose Krause, *Stanford University, Stanford, CA, USA*

We review low-power DSP-free coherent receiver architectures for dual-polarization quadrature phase-shift keying (DP-QPSK). They exhibit performance comparable to their DSP-based counterparts in short-reach links, while consuming an estimated power of ~4 W for 200 Gbit/s DP-QPSK in 90-nm CMOS.

2:00 pm–2:15 pm

WC.2 Clock and Data Recovery in High-Speed PAM-4 Transmission Systems, Nebojsa Stojanovic, Fotini Karinou, Cristian Prodaniuc, Zhang Qiang, Zhang Liang, and Jinlong Wei, *Huawei Technologies Duesseldorf GmbH, Munich, Germany*

We propose a novel clock and data recovery method for high baud rate four-level pulse amplitude modulation format receivers without any digital signal processing. The new phase detector operates with a single sample per symbol and uses only high-speed logical circuits.

2:15 pm–2:30 pm

WC.3 Opto-Electrical Hybrid Equalization for VCSEL-MMF Based Links, Chenyu Liang, Wenjia Zhang, and Zuyuan He, *Shanghai Jiao Tong University, Shanghai, China*

In this paper, opto-electrical hybrid equalization for VCSEL-MMF based links is proposed to enhance 56-Gb/s PAM-4 transmission over 300-m MMF. Three order of magnitude BER improvement has been achieved by applying the proposed approach, with the greatly reduced complexity needed for electrical equalization.

2:30 pm–2:45 pm

WC.4 Forward Error Correction-Free Low Latency Direct Detection DWDM Optical 100 Gb/s Transmission in a Pluggable Form Factor for Network Edge Interconnect Application, S. N. ElAhmadi, S. ElAhmadi, and A. Puc, *Menara Networks, Dallas, TX, USA*

Low power pluggable CFP form factor is proposed and experimentally demonstrated over 200 km of standard G.652 fiber. Optical duo-binary (ODB) modulation and distributed Raman amplification are used to achieve error-free, non-repeatered, 100 Gb/s transmission. By avoiding extensive signal processing system features very low latency.

2:45 pm–3:15 pm *(Invited)*

WC.5 100G VCSELs, Stephen Ralph, *Georgia Tech, USA*

3:15 pm–3:45 pm **Canyon Ballroom**

Coffee Break / Exhibits

3:45 pm–5:00 pm **Mesa Ballroom**

Session WD **Advance Communication II**

Session Chair Jock Bovington, *Cisco, CA, USA*

3:45 pm–4:15 pm *(Invited)*

WD.1 Recent Advances of PAM4 Signaling for Data Center Optics, Frank Chang, *Inphi, CA, USA*

4:15 pm–4:30 pm

WD.2 A Pair of Integrated Optoelectronic Chips for Optical Interconnects, Kai Liu, Yongqing Huang, Xiaofeng Duan, Qi Wang, Qi Wei, Xiaomin Ren, and Shiwei Cai, *Beijing University of Posts and Telecommunications, Beijing, China*

In this paper, a pair of integrated optoelectronic chips based on VCSEL and PIN-PD is proposed for optical interconnects. One of the chips emits light at 848.1nm and receives light at 805.3 nm, while the other one emits light at 805.3.1 nm and receives light at 848.1 nm.

4:30 pm–5:00 pm *(Invited)*

WD.3 Transmission and Switching Technologies for 5G Transport Networks, Fabio Cavaliere, Luca Giorgi, *Ericsson Research, Pisa, Italy,* and Luca Potì, *CNIT, Pisa, Italy*

5G is requiring higher capacity and performance to the optical transport network while demanding lower cost and energy consumption. This work illustrates new technologies (novel modulation formats, photonic integrated circuits) for cost effective high speed transmission and switching in 5G fronthaul and backhaul networks.

END OF PROGRAM