

# Final Program

MONDAY, 5 JUNE 2017

8:00 am–8:30 am

Canyon Ballroom

Breakfast

9:00 am–9:45 am

Mesa Ballroom

Session MA: Welcome & Plenary I

Session Chair: Dominic Goodwill, *Huawei Technologies, Canada*

9:00 am–9:45 am

MA1 Silicon Photonics and the Future of Optical Connectivity in the Data Center  
(Plenary)

Presider: Thomas Liljeberg, *Intel Corp.*

The bandwidth growth inside data centers has driven significant innovations in networking and optical connectivity. We'll review recent advances in silicon photonics, discuss where silicon photonics is deployed in the data center of today, and how it will be transforming future data centers.

9:45 am–10:15 am

Canyon Ballroom

Coffee Break/Exhibits

10:15 am–11:45 am

Mesa Ballroom

Session MB: Silicon Photonics

Session Chair: Frederick McCormick, *Sandia National Laboratories, USA*

10:15 am –10:45 am

MB1: Use of 3D Technology for Silicon Photonics (Invited)

Presider: Sylvie Menezo  
*CEA-LETI*

10:45 am–11:00 am

MB2 Intermodulation Crosstalk of Graphene-Enabled Electro-Optic Microring Modulators for DWDM Interconnects

Presiders: Nathan C. Abrams, Meisam Bahadori, Christopher T. Phare, Michal Lipson, Keren Bergman  
*Columbia University, New York, NY, USA*

The intermodulation crosstalk of graphene modulators integrated on silicon nitride is experimentally characterized for the first time on 1 Gb/s signals. We show that 25 GHz channel spacings are supported with <0.1 dB penalty for DWDM applications.

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**11:00 am–11:15 am**

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**MB3: A Two-Segment Optical DAC 40 Gb/s PAM4 Silicon Microring Resonator Modulator Transmitter in 65nm CMOS**

**Presiders:** Ashkan Roshan-Zamir, Binhao Wang, Shashank Telaprolu, Kunzhi Yu  
*Texas A&M University, College Station, TX, USA*

Cheng Li, M. Ashkan Seyedi, Marco Fiorentino, Raymond Beausoleil  
*Hewlett-Packard Enterprise, Palo Alto, CA, USA*

Samuel Palermo  
*Texas A&M University, College Station, TX, USA*

A two-segment silicon photonic microring modulator implements an optical DAC for PAM4 modulation. Independent level and edge-rate control is achieved using segmented MSB/LSB pulsed-cascode drivers. The 65nm CMOS transmitter achieves 40Gb/s operation at 4.38mW/Gb/s while driving each microring modulator segment with 4.4Vppd swing.

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**11:15 am–11:30 am**

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**MB4: Comparison of DAC-less PAM4 Modulation in Segmented Ring Resonator and Dual Cascaded Ring Resonator**

**Presiders:** Anthony H. K. Park, Ajith S. Ramani, Lukas Chrostowski, Sudip Shekhar  
*University of British Columbia, Vancouver, BC, Canada*

We compare the performance of 25 Gb/s PAM4 modulation in segmented ring and dual cascaded ring resonators driven by CMOS drivers designed in 65nm process. With optimized frequency detuning, the segmented ring modulator is found to achieve larger eye opening with lower power consumption.

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**11:30 am–11:45 am**

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**MB5: 29-GHz Small-signal Modulation Bandwidth for Directly Current-modulated 980-nm Oxide-aperture VCSELs**

**Presiders:** Ricardo Rosales  
*Technische Universität Berlin, Berlin, Germany*

Philip Moser  
*Stanford University, Stanford, CA, USA*

James A. Lott  
*Technische Universität Berlin, Berlin, Germany*

An epitaxial design with a half-lambda optical cavity surrounded by only two oxide-current apertures as small as 2-micrometer in diameter leads to highly confined optical fields and carriers and to a record 29.3-GHz small-signal modulation bandwidth at room temperature for 980-nm vertical-cavity surface-emitting lasers.

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**11:45 am–1:15 pm**

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**Lunch Break (ON OWN)**

**1:15 pm–3:15 pm**

**Mesa Ballroom**

**Session MC:** Advance Devices

**Session Chair:** Stephane Lessard, *Erickson, USA*

**1:15 pm–1:45 pm**

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**MC1:** Photonic Integration in Commercial Manufacturing Lines (*Invited*)

**Presider:** Ajey Jacob  
*Global Foundries*

**1:45 pm–2:00 pm**

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**MC2:** Characterization of Systematic Process Variation in a Silicon Photonic Platform

**Presiders:** Nicholas Boynton  
*Sandia National Laboratories, Albuquerque, NM, USA*  
*and*  
*University of New Mexico, Albuquerque, NM, USA*

Andrew Pomerene, Andrew Starbuck, Anthony Lentine, Christopher T. DeRose  
*Sandia National Laboratories, Albuquerque, NM, USA*

We present quantitative analysis of the correlation of resonant wavelength variation with process variables, and find that 50% of the resonant wavelength variation for microrings is due to systematic process conditions. We also discuss the improvement of device uniformity by mitigating these systematic variations.

**2:00 pm–2:15 pm**

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**MC3:** Scalable and Broadband Silicon Photonics Chip to Fiber Optical Interface Using Polymer Waveguides

**Presiders:** Antonio La Porta, Roger Dangel, Daniel Jubin, Norbert Meier, Folkert Horst,  
Bert Jan Offrein  
*IBM Research - Zurich, Rüschlikon, Switzerland*

We present a silicon photonics optical I/O interfacing solution based on adiabatic optical coupling between silicon and polymer waveguides working for both O- and C-band. In the O-band, a fiber-to-chip coupling loss < 4 dB was found, with a PDL < 0.5 dB.

**2:15 pm–2:30 pm**

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**MC4:** Substrate Removal for Ultra Efficient Silicon Heater-Modulators

**Presiders:** Nicholas J. D. Martinez, Christopher T. DeRose, Robert Jarecki, Andrew L. Starbuck,  
Andrew T. Pomerene, Douglas C. Trotter, Anthony L. Lentine  
*Sandia National Laboratories, Albuquerque, NM, USA*

We present results of ultra efficient (2.16 nm/mW) thermally tunable modulators with n-type heaters and Si substrate removed. To our knowledge, this is the most efficient thermally tunable modulator at 1550nm. We include results of externally heated modulators with commensurate enhancements through substrate removal.

## 2:30 pm–2:45 pm

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### **MC5: The Benefit of Mid-board Optic and Other Flyover Technology**

**Presiders:** Fred Coppinger, David Langsam, Adam Page, Marc Verdiell  
*Samtec Inc., New Albany, IN, USA*

We experimentally study the performance difference between a mid-board optic solution, a copper flyover to a QSFP cage solution and a Direct Attached Copper solution using a Xilinx VCU118 evaluation board. We show that the mid-board optic solution provides the highest quality eye diagram.

## 2:45 pm–3:15 pm

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### **MC6: Hybrid Optical Engines for On-board Optical Applications (*Invited*)**

**Presider:** Bardia Pezeshki  
*Kaiam Corp.*

## 3:45 pm–5:45 pm

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### **WORKSHOP I: On-board and Co-Packaged Optics**

**Presiders:** Ilya Lyubomirsky  
*Inphi*  
Alex Wright-Gladstein  
*Ayer Lab*  
CJ Lee  
*Cisco*  
Jim A. Tatum  
*Finisar*  
Rob Stone  
*Broadcom*  
Brad Booth  
*Microsoft*

Despite improved efficiencies, the power consumed by data center networking hardware is growing rapidly in proportion to increasing network capacity. Networking is expected to contribute a significant fraction of the overall power budget when data center networks transition to 400G interfaces. New approaches are needed to further improve efficiency and reduce energy per bit. This workshop will explore the potential benefits of moving optics closer to the switch ASIC to eliminate power hungry SerDes, and thus reduce overall power consumption. The workshop will try to answer the questions: Can on-board optics provide a solution in the near term or do we need co-packaged optics to gain a significant benefit? What are the engineering and techno-economic tradeoffs? Is fully integrated optics still a dream or reality?

## 5:45 pm–7:15 pm

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**Canyon Ballroom**

**Welcome Reception**

## TUESDAY, 6 JUNE 2017

8:00 am–8:30 am

Canyon Ballroom

Breakfast

8:30 am–9:45 am

Mesa Ballroom

Session TuA: Plenary II

Session Chair: Benjamin Lee, *IBM Research, USA*

8:30 am–9:15 am

**TuA1: Attojoule Optoelectronics – Saving More Energy with Optics (Plenary)**

**Presider:** David A. B. Miller  
*Stanford University, Stanford, CA, USA*

Energy in short interconnects inside machines dominates scaling of information processing and communication. Low-energy integrated optoelectronics can eliminate much energy in links themselves and, with space-multiplexing in 2D arrays, could eliminate link circuit energies, allowing 10–100 fJ/bit for all links from 1cm to 10m.

9:15 am–9:30 am

**TuA2: Programmable Optical Power Distribution in Silicon Photonic Platform**

**Presiders:** Alexander Gazman, Meisam Bahadori, Ziyi Zhu, Keren Bergman  
*Columbia University, New York, NY, USA*

We demonstrate a reconfigurable, software-controlled, C-band optical power distribution system leveraging a 1x7 cascaded microring-based silicon photonic device. The thermo-optic effect and the spectral response of each ring is characterized and utilized in FPGA-based control plane algorithm to achieve precise power distribution profiles.

9:30 am–9:45 am

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**TuA3: Integrated Fresnel Zone Plate in the SOI Backend for Improved Laser to Chip Coupling Efficiency**

**Presiders:** Marvin Henniges  
*Sicoya GmbH, Berlin, Germany*  
and  
*Technische Universität Berlin, Berlin, Germany*  
Stefan Meister, Hanjo Rhee, Christoph Theiss  
*Sicoya GmbH, Berlin, Germany*  
Hendirk Robers  
*Technische Universität Berlin, Berlin, Germany*  
Moritz Grehn  
*Sicoya GmbH, Berlin, Germany*  
David Stolarek, Lars Zimmermann  
*IHP, Frankfurt (Oder), Germany*  
Ulrike Woggon  
*Technische Universität Berlin, Berlin, Germany*

A zone plate, etched into the backend of a silicon-on-insulator chip, was designed to improve the optical coupling efficiency between grating couplers and non-perpendicular light sources with an elliptical beam profile. Measurements of a highly divergent light source showed efficiency improvements up to 8.7dB.

9:45 am–10:15 am

Canyon Ballroom

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Coffee Break/Exhibits

10:15 am–11:45 am

Mesa Ballroom

**Session TuB: Next Generation Data Centers**

**Session Chair: TBD**

10:15 am–10:45 am

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**TuB1: Roadmap to Optical I/O (Invited)**

**Presider:** Brad Booth  
*Microsoft*

10:45 am–11:00 am

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**TuB2: Application Regime and Distortion Metric for Multivariate RF Photonics**

**Presiders:** Alexander N. Tait, Thomas Ferreira de Lima, Matthew P. Chang, Mitchell A. Nahmias, Bhavin J. Shastri, Paul R. Prucnal  
*Princeton University, Princeton, NJ, USA*

Photonic weight banks employing multivariate statistical techniques could extend performance limits of multi-antenna radio systems. We characterize the aggregate bandwidth penalty imposed by a silicon microring weight bank and assess application regimes for multivariate RF photonics.

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**11:00 am–11:15 am**

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**TuB3: Flexible On-chip Frequency Comb Generation Using a SOI Dual-drive MZM**

**Presiders:** Jiachuan Lin, Hassan Sepehrian, Leslie A. Rusch, Wei Shi  
*Université Laval, Québec, Canada*

We demonstrate comb generation on 220-nm silicon-on-insulator, enabled by a dual-drive Mach-Zehnder modulator, by which 7 comb lines with 7dB flatness and 5-lines with 3dB flatness have been achieved. This provides a promising solution for flexible multicarrier transmitters on silicon.

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**11:15 am–11:45 am**

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**TuB4: Microprocessor with Photonics I/O (Invited)**

**Presenter:** Chen Sun  
*Ayer Lab*

In this work, we provide an overview of the technology and architecture of a microprocessor memory system with optical I/O. Zero-change photonics integration enabled the processor chip to be fabricated in a commercial electronics CMOS foundry.

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**11:45 am–1:15 pm**

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**Lunch Break (ON OWN)**

**1:15 pm–3:15 pm****Mesa Ballroom****Session TuC: High Speed Communication I**

**Session Chair:** Samuel Palermo, *Texas A&M University, USA*

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**1:15 pm–1:45 pm**

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**TuC1: DSP Solutions for Next Generation Intra and Inter-data Center Connectivity (Invited)**

**Presenter:** Sudeep Bhoja  
*Inphi*

We review DSP solutions for 100G & 400G intra-data center and data center interconnect applications. We review modulation and FEC techniques including fundamental Shannon limits for both copper and optics. Practical implementation challenges including power, performance and area that can be achieved in advanced CMOS.

## 1:45 pm–2:00 pm

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**TuC2: Real-Time 100 Gb/s NRZ-OOK Transmission with a Silicon Photonics GeSi Electro-Absorption Modulator**

**Presiders:** Jochem Verbist, Michiel Verplaetse  
*Ghent University – IMEC, Ghent, Belgium*

S. Ashwyn Srinivasan  
*Ghent University – IMEC, Ghent, Belgium*  
and  
*IMEC, Leuven, Belgium*

Peter De Heyn  
*IMEC, Leuven, Belgium*

Timothy De Keulenaer, Renato Vaernewyck, Ramses Pierco, Arno Vyncke  
*Ghent University – IMEC, Ghent, Belgium*  
and  
*Ghent University – BiFast, Gent, Belgium*

Peter Verheyen, Sathishkumar Balakrishnan, Guy Leplage, Marianna Pantouvaki,  
Philippe Absil  
*IMEC, Leuven, Belgium*

Xin Yin, Gunther Roelkens, Guy Torfs  
*Ghent University – IMEC, Ghent, Belgium*

Joris Van Campenhout  
*IMEC, Leuven, Belgium*

Johan Bauwelinck  
*Ghent University – IMEC, Ghent, Belgium*

We demonstrate single-wavelength, serial and real-time 100 Gb/s NRZ-OOK transmission over 500 m SSMF with a GeSi EAM implemented on a silicon photonics platform. The device was driven with 2 V<sub>pp</sub> without 50 $\Omega$  termination, allowing a low-complexity solution for 400 GbE short-reach optical interconnects.

## 2:00 pm–2:15 pm

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**TuC3: 56 Gb/s Direct Modulation of an InP-on-Si DFB Laser Diode**

**Presiders:** Amin Abbasi, Bart Moeneclaey, Jochem Verbist, Xin Yin, Johan Bauwelinck,  
Gunther Roelkens, Geert Morthier  
*Ghent University – IMEC, Ghent, Belgium*

We demonstrate 56 Gb/s direct modulation of a high bandwidth heterogeneously integrated InP/Si DFB laser, and transmission over 2 km of non-zero dispersion shifted single mode fiber. The high bandwidth of the laser is achieved by exploiting the photon-photon resonance effect.



## 2:15 pm–2:45 pm

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**TuC4:       Towards Efficient 100 Gb/s Serial Rate Optical Interconnects:  
a Duobinary Way *(Invited)***

**Presiders:** Xin Yin, Michiel Verplaetse, Laurens Breyne, J. Van Kerrebrouck,  
Timothy De Keulenaer, Arno Vyncke, Ramses Pierco, Renato Vaernewyck  
*Ghent University, Gent-Zwijnaarde, Belgium*

Silvia Spiga, Markus-Christian Amann  
*TUM, München, Germany*

Jiaja Chen  
*KTH, Stockholm, Sweden*

Geert Van Steenberge, Guy Torfs, Johan Bauwelinck  
*Ghent University, Gent-Zwijnaarde, Belgium*

Recent advances in integrated opto-electronic devices and frontend circuits have made it possible to efficiently transmit very high data rates over optical links for HPC/datacenter applications. This paper reviews our current progress towards serial 100-Gb/s optical interconnects, with emphasis on electrical duobinary (EDB) modulation.

## 2:45 pm–3:15 pm

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**TuC5:       100G transition: Electrical & Optical, Challenges & Opportunities *(Invited)***

**Presider:** Francesco Caggioni  
*MACOM*

The demand for BW is increasing at an unbelievable pace, the Chip, System and Optics industries are trying to converge on the next generation signaling rate to cater to this surge in BW demand. IEEE 802.3 is already working on 100G signaling for 100GBASE-DR1 and 400GBASE-DR4 & OIF PLL group has started to work on CEI-112G-PAM4-VSR. MACOM has envisioned this transition early and has had the opportunity to “play” with this technology in the lab for over a year. In this presentation we’ll touch on some of the experiments conducted so far.

**WORKSHOP II: High Speed  $\geq$  100 Gb/s Electrical and Optical Interconnect**

**Presiders:** Ali Ghiasi  
*Ghiasi Quantum LLC*  
Sudeep Bhoja  
*Inphi*  
Michael Sorna  
*Global Foundries*  
Haoli Qian  
*Credo*  
Jeffery Lee  
*Nokia Bell Lab*  
Azita Emami  
*Caltech*

IEEE P802.3 standard and OIF are currently defining chip-to-module, chip-to-chip, and backplane signaling based on 50Gb/s/lane PAM4 signaling. IEEE P802.3 standards currently are defining single lamda 100 Gb/s optical links based on PAM4 signaling. The 50 Gb/s electrical IO allows doubling the BW of a 128 lane switch from 3.2 Tb to 6.4 TB and allow doubling the BW of a 256 lane switch from 6.4 Tb to 12.8 Tb. The switch IO bitrate has been doubling approximately every 3 years. Assuming the current trend continues, we will have switches based on 100 Gb/s/lane in 2019. Switches with native 100 Gb/s IO expect to offer seamless interface to pluggable optical modules or an OBO (on board optics), but supporting conventional backplane at 100 Gb/s may not be feasible and instead eco-system may need to convert to copper cable or optical backplanes. What are the key challenges to transition to 100 Gb/s electrical and optical ecosystems and is the industry investing enough for such a major transition that is expected to occur in next 3 years? What are the practical solutions beyond 100 Gb/s? Is the right solution 200 Gb/s with higher Baudrate, stronger FEC, and/or higher order modulation, or a co-packaged PIC with WDM to increase the IO BW?

# WEDNESDAY, 7 JUNE 2017

8:00 am–8:30 am

Canyon Ballroom

Breakfast

8:30 am–9:45 am

Mesa Ballroom

Session WA: Energy Efficiency

Session Chair: Tomoo Takahara, *Fujitsu, Japan*

8:30 am–9:00 am

**WA1: Datacenter Optical Interconnects: Requirements and Challenges (*Invited*)**

**Presider:** Chongjin Xie  
*Alibaba Group, San Mateo, CA, USA*

From a service provider's point of view, we review the requirements on and status of datacenter optical interconnects and discuss the challenges for future datacenter networks, including both intra- and inter-datacenter optical interconnect technologies.

9:00 am–9:15 am

**WA2: Scalability of Microring-Based Crossbar for All-to-All Optical Interconnects**

**Presider:** Xian Xiao, Roberto Proietti, S. J. Ben Yoo  
*University of California, Davis, Davis, CA, USA*

We investigate the scalability of all-to-all crossbar switch with microring resonators. State-of-the-art  $-18.1$  dB crosstalk in resonators cannot support a  $4\times 4$  switch fabric while below  $-40$  dB crosstalk is necessary for  $32\times 32$  switch fabrics.

9:15 am–9:30 am

**WA3: Highly Scalable, Low-Crosstalk Architecture for Ring-Based Optical Space Switch Fabrics**

**Presiders:** Qixiang Cheng, Meisam Bahadori, Sébastien Rumley, Keren Bergman  
*Columbia University, New York, NY, USA*

A ring-based switch architecture that combines the Clos network with populated switch-and-select stages is proposed, achieving significantly reduced crosstalk compared to other non-blocking architectures. Detailed physical-layer simulation results show a  $128\times 128$  switch exhibits a power-penalty of 18dB, improving  $>10$ dB compared to the Benes switch.

**9:30 am–9:45 am**

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**WA4: Accelerated Out-of-Band Arbitration of a Microring-Based Silicon Photonic System**

**Presiders:** David M. Calhoun, Erik F. Anderson, Maarten H. N. Hattink, Sébastien Rumley, Keren Bergman  
*Columbia University, New York, NY, USA*

We present an architecture towards accelerating compute element operations on a fully arbitrated silicon photonic (SiP) system. An 8×8 SiP network is controlled in a distributed fashion, with connectivity consisting of two 10Gbps wavelength division multiplexed data links that are arbitrated out-of-band.

**9:45 am–10:15 am**

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**Canyon Ballroom**

**Coffee Break/Exhibits**

**10:15 am–11:45 am**

**Mesa Ballroom**

**Session WB: High Speed Communication II**

**Session Chair:** Mike Peng Li, *Altera, USA*

**10:15 am–10:45 am**

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**WB1: Silicon Photonics for Nx56G NRZ Optical Interconnects (*Invited*)**

**Presider:** Joris Van Campenhout  
*IMEC*

**10:45 am–11:00 am**

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**WB2: A 48-Gb/s Software Defined Optical Transceiver Using Multi-tone PAM/CAP Modulation**

**Presiders:** Fan Yang, Wenjia Zhang, Zuyuan He  
*Shanghai Jiao Tong University, Shanghai, China*

A 48-Gb/s software defined optical transceiver based on the multi-tone PAM/CAP signalling is proposed and experimentally demonstrated over 10-km SSMF. BER below 7% FEC threshold is achieved with equalization, which is better than direct PAM4 transmission.

**11:00 am–11:15 am**

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**WB3: Machine Learning of SVM Classification Utilizing Complete Binary Tree Structure for PAM-4/8 Optical Interconnection**

**Presiders:** Guoyao Chen, Lin Sun  
*Shanghai Jiao Tong University, Shanghai, China*  
Ke Xu  
*Harbin Institute of Technology, Shenzhen, China*  
Jiangbing Du, Zuyuan He  
*Shanghai Jiao Tong University, Shanghai, China*

A machine learning method of effective nonlinear decision frame for PAM-N system based on SVM using CBT structure is demonstrated in this work. The simulations results indicate improved performance by the method enhances the power sensitivity by 2-dB and 6-dB in 100-Gbps PAM-4/8 respectively.

**11:15 am–11:45 am**

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**WB4: High-Capacity PAM4 and DMT for Short Reach Interconnects (*Invited*)**

**Presider:** Jeffrey Lee

An overview of PAM4 and DMT modulation in short-reach, optical intensity-modulated and direct-detection channel is presented and impairments limiting the performance, such as clipping distortion, quantization noise, and thermal noise are introduced and discussed.

**11:45 am–1:15 pm**

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**Lunch Break (ON OWN)**

**1:15 pm–3:00 pm**

**Mesa Ballroom**

**Session WC: VCSEL and Advance Communication**

**Session Chair:** Harris Turk, *Department of Defense, USA*

**1:15 pm–1:45 pm**

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**WC1: VCSEL Based SWDM Links for Data Centers (*Invited*)**

**Presiders:** Chris Kocot, Anna Tatarczak, Jim A. Tatum  
*Finisar Corp., Sunnyvale, CA, USA*

We review several techniques for expanding the carrying capacity of MMF data links using SWDM and selective modal launch. Our approach utilizing four SWDM VCSELs and novel diffractive optical components enables 100 GbE transmission in a single 300 m OM3 MMF lane.

### 1:45 pm–2:00 pm

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**WC2: 30 Gbit/s 1.7 pJ/bit Common-Cathode Tunable 850-nm-VCSEL Driver in 28 nm Digital CMOS**

**Presiders:** Laszlo Szilagyi, Guido Belfiore, Ronny Henker, Frank Ellinger  
*Technische Universität Dresden, Dresden, Germany*

A common-cathode VCSEL driver implemented in 28-nm digital CMOS, assembled with a commercial VCSEL is presented. Electro-optical measurements show 30-Gbit/s operation with 1.7-pJ/bit from 2.9-V supply. When operated at 15-Gbit/s the power can be reduced while maintaining the modulation amplitude. Power/datarate tunability is demonstrated.

### 2:00 pm–2:30 pm

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**WC3: VCSEL Modulation Capacity: Continued Improvements or Physical Limits?**  
*(Invited)*

**Presiders:** Anders Larsson, Johan S. Gustavsson, Erik Haglund, Emanuel P. Haglund, Tamas Lengyel, Ewa Simpanen, Mehdi Jahed  
*Chalmers University of Technology, Gothenburg, Sweden*

The need for higher capacity interconnects raises the question whether the speed of VCSELs can be improved or whether physical limits have been reached. The presentation will address this, also in the context of other performance parameters and techniques for improving VCSEL-based interconnect capacity.

### 2:30 pm–2:45 pm

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**WC4: High Capacity SWDM PAM4 Transmissions over NG-WBMMF at Extended Reach**

**Presiders:** Yi Sun  
*OFS Fitel, LLC, Norcross, GA, USA*  
Frank Chang  
*Inphi Corp., Westlake Village, CA, USA*  
Kristine Scott, Robert Lingle Jr.  
*OFS Fitel, LLC, Norcross, GA, USA*  
Timo Gray, Jim A. Tatum  
*Finisar Corp., Allen, TX, USA*  
Sudeep Bhoja  
*Inphi Corp., Westlake Village, CA, USA*

42.5Gbps PAM4 transmission over 100 to 600 m NG-WBMMF at 850, 880, 910, 940 and 976 nm using PAM4 CMOS-IC chipset with real-time digital signal processing is investigated. The dispersion power penalty shows an inverse correlation with the overall bandwidth of the transmission links.

2:45 pm–3:00 pm

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**WC5: Proposal of Isolator-free Optical Interconnect Using Low-noise Graded-index Plastic Optical Fiber for Pluggable 4K/8K Optical Interface**

**Presiders:** Azusa Inoue, Yasuhiro Koike  
*Keio University, Yokohama, Japan*

We demonstrate that error-free data transmission can be easily obtained without optical isolators and/or precise fiber alignments by using a low-noise graded-index plastic optical fiber (GI POF) with microscopic core heterogeneities. The novel GI POF is paving the way for consumer-friendly 4K/8K optical interface.