PhoxTroT NEWSLETTER

Number 4

Photonics for High-Performance, Low-Cost & Low-Energy Data Centers, High Performance Computing Systems: Terabit/s Optical Interconnect Technologies for On-Board, Board-to-Board, Rack-to-Rack Data Links

September 2014

ECOC 2014 – Special Edition

Dear Readers,

Because last year's European Conference and Exhibition on Optical Communication (ECOC) was a great success, we wanted to present our fourth Newsletter in dedication to ECOC once again. This year's ECOC takes place from 21st to 25th September 2014 in Cannes and of course partners from PhoxTroT will be there, showing their greatest achievements made throughout the last year of the project. ECOC 2014 will again be a great possibility for presenting our progress concluding the second year of PhoxTroT. You can find us at the following conferences, symposia and workshop. We are looking forward to meet you and discuss our results.

@Conference:

Mo.3.4.5 15:00 *Terabit/s Optical Transmission Using Chip-Scale Frequency Comb Source* [invited], Christian Koos (KIT)

Mo.4.5.4 17:*00* *10 GBd SOH Modulator Directly Driven by an FPGA without Electrical Amplification*, Stefan Wolf (KIT)

Mo.4.5.5 17:15 *Ultra-Short Silicon-Organic Hybrid (SOH) Modulator for Bidirectional Polarization-Independent Operation*, Philipp Schindler (KIT)

We.1.6.5 09:45 *Ultra-Dense, Single-Wavelength DFT-Spread OFDM PON with Laserless 1 Gb/s ONU at only 300 MBd per Spectral Group*, Philipp Schindler (KIT)

We.2.1.2 11:45 *The Cool Future of Optics CoolBit [invited*], Jeroen Duis (TE)

We.2.4.5 12:00 *100-Channel WDM Rx-Type PIC on InP for Use of Low-Costand Low Power Consumption Electronics*, Moritz Baier (Fraunhofer HHI)

We.3.1.2 15:00 *From Silicon-Organic Hybrid to Plasmonic Modulation*, Juerg Leuthold (ETH Zurich)

We.3.1.3 15:30 *40 GBd 16QAM Modulation at 160 Gbit/s in a Silicon-Organic Hybrid (SOH) Modulator*, Matthias Lauermann (KIT)

@Workshop:

Sun WS5 pt.2 *Physical layer & component perspective*, Philipp Schindler (KIT)

@Panel Discussion:

Sun Ronald Broeke (CEO Bright Photonics)

@Exhibition

Stands 244, 273 Fraunhofer HHI - Detectors/receivers (photodiodes)

Stand 297 Vertilas GmbH - VCSELs

Stand 522 TE Connectivity - Active Optical Cables

Stand 379 Seagate / Fraunhofer / Anritsu – Joint Live demo "Planar Multimode Glass Waveguide Backplane and Connector Platform"

@ Special Symposium

Tu.3.5.3 14:45 *Low-loss Telecom Wavelength Board-Level Optical Interconnects in Thin Glass Panels by Ion-Exchange Waveguide Technology*, Lars Brusberg (Fraunhofer IZM)
Tu.3.5.6 15:*30* *Advances in Standardisation of Optical Circuit Board Fabrication and Measurement Processes*, Marika Immonen (TTM Technologies)

2ND SYMPOSIUM ON OPTICAL INTERCONNECT IN DATA CENTER NETWORKS

Tu.4.5 – 23rd September @ Redaction 1

Don't miss the Symposium organized by PhoxTroT

The state of the art in high-performance, low-energy, low cost and small-size optical interconnect technologies across the different hierarchical levels of the Data Centre.

Organizer

Richard Pitwon (Seagate)
Tolga Tekin (Fraunhofer IZM/TU Berlin)

Co-organizers

Nikos Pleros (AUTH/CERTH)
Dimitris Apostolopoulos (ICCS/NTUA)
Emmanouel Varvarigos (CTI 'Diophantus')
Carlos Lee (EPIC)

Tu.3.5 chair: Richard Pitwon, Seagate
Tu.3.5.1 14:00 *Optical Interconnects for Disaggregated Resources in Future Datacenters,* Jonas Weiss (IBM Research)
Tu.3.5.2 14:*30* *High Bandwidth Multimode Polymer Interconnects for On-Board Applications,* Richard Penty (University of Cambridge)
Tu.3.5.3 14:45 *Low-loss Telecom Wavelength Board-Level Optical Interconnects in Thin Glass Panels by Ion-Exchange Waveguide Technology*, Lars Brusberg (Fraunhofer IZM)
Tu.3.5.4 15:00 *Optical interconnect for mid-board and backplane with polymer waveguide for high speed data transmission*, Mayank Singh (Sumitomo Bakelite)
Tu.3.5.5 15:15 *GI-Core Polymer Optical Waveguide for Triggering the Migration of Optical Interconnects from Inter-Rack to PCBs,* Takaaki Ishigure (Faculty of Science and Technology, Keio University)
Tu.3.5.6 15:30 *Advances in Standardisation of Optical Circuit Board Fabrication and Measurement Processes,* Marika Immonen (TTM Technologies)

Tu.4.5 chair: Dimitrios Apostolopoulos (National Technical University of Athens)
Tu.4.5.1 16:15 *Advanced Modulation Formats in Data Centre Communications,* Michael Wale (Oclaro Technology Ltd)
Tu.4.5.2 16:30 *VCSEL-based parallel-optical modules for >100 Gb/S applications,* Hideyuki Nasu (Furukawa Electric, Co.Ltd)
Tu.4.5.3 16:45 *Photonic Crystal Cavities fabricated using DUV lithography,* William Whelan-Curtin (University of St Andrew)
Tu.4.5.4 17:00 *Research Activities on Silicon Photonics in AIST and Japanese National Projects*, Masahiko Mori (National Institute of Advanced Science and Technology)
Tu.4.5.5 17:15 *HAMR Performance and Integration Challenges,* Mark Gubbins (Seagate)

TE Connectivity
More Data = More Energy Consumption

Jeroen Duis from TE Connectivity will be presenting at: We.2.1.2 11:45 *The Cool Future of Optics CoolBit [invited], Jeroen Duis (TE)*

The emergence of faster data rates to keep pace with the demands for data poses a number of technical challenges. While this is not a new or radical thought, the radical conversation on how to combat these challenges specifically when it comes to the resources, like energy is imperative to fuel this data deluge. Among the problems that became apparent even at 10 Gb/s is the power consumption of copper-interconnect signals within systems and the problem is compounded at 25 Gb/s data rates. Power consumed by the networking equipment alone significantly contributes to the overall energy consumption problem of data centers that is estimated at 30 Billion watts worldwide[(1)].

The energy use of data centers is already staggeringly large and estimated to be more than 2% of total U.S. electricity consumption. Networking equipment consumes about 50% of a typical data center's energy. Air movement and cooling equipment consume about 37%, transformers and uninterruptible power supplies account for 10% and lighting and other items take another 3%[(2)].

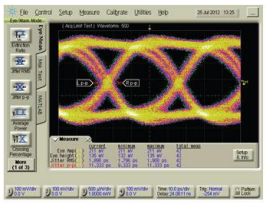
Less power dissipation results in less power needed in the conversion to drive the optics; Emerson[(3)] shows that a 1 Watt reduction at the server component level (processor, memory, hard disk, etc.) results in an additional 1.84-Watt savings in the power supply, power distribution system, UPS system, cooling system and building entrance switchgear and medium voltage transformer.

CDFP 400Gb/s Bidirectional communication consuming less than 6W per end

Active optical cable assemblies (AOCs) embed the high-speed optics (Coolbit optical engines) behind two transceiver ends and deliver an electrical interconnection to the other system electronics. This design enables very-high-speed and high-aggregate data rate links at costs significantly below those of separate transceivers and fibers. AOCs offer the benefits of optical with the ease-of-use of copper. The CDFP supports 400 Gb/s bidirectional data transport in a 16x25 Gb/s configuration. It is a front/rear panel pluggable module that consumes less than 6 Watts per end with all signal integrity features enabled.

With core networking doubling every 18 months or so and server I/O density doubling approximately every 24 months[(4)], delaying the inevitable transition to higher-speed data transmission capability could prove costly for many companies.

That is why TE is exploring the limits of photonics integration with several EU FP7 projects like the PhoxTroT Consortium. Here the transition will be made to Silicon Photonics while reusing the reliable and efficient VCSEL technology as light source and looking abroad for new wafer level integrated light sources for the future. With WDM & advanced modulations schemes the aim of the project is to reach a final aggregated bandwidth of 1,28 Tb/s through one single interconnect. To keep up with the requirements the power efficiency has to be at least 2 times lower than the current power consumption and with silicon photonics the promise is that this will be even better looking to several papers that report 50 fJ/b power consumption. TE will investigate how the different building blocks can be integrated most effectively and use the developed building blocks in the future products.



Eye Diagram of 25.78 Gb/s datatransmission using OM3 Fiber

Outlook TE is ready and can provide end-to-end communication solutions for optimized performance at increasingly higher data rates at all level of interconnection (Rack to Rack, Board to Board and on board) now and in the future.

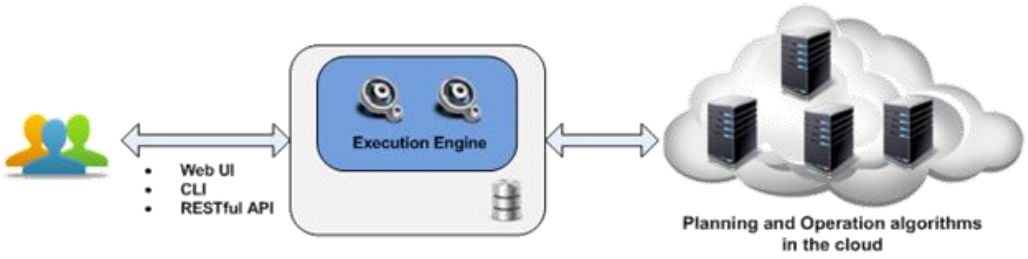
References: [1] New York Times - Data Centers Waste Vast Amounts of Energy Belying Industry Image; [2] EPA Creates Energy Star Spec for Data Center Storage Equipment; [3] Emerson Network Power: White paper : "Energy Logic: Reducing Data Center Energy Consumption by Creating Savings that Cascade Across Systems"; [4] IEEE802.org

One of us:

Emmanouel (Manos) Varvarigos

Manos received a Diploma in Electrical and Computer Engineering from the National Technical University of Athens in 1988, and the M.S. and Ph.D. degrees in Electrical Engineering and Computer Science from the Massachusetts Institute of Technology in 1990 and 1992, respectively. He has held faculty positions at the University of California, Santa Barbara (1992-1998, as an Assistant and later an Associate Professor) and Delft University of Technology, the Netherlands (1998-2000, as an Associate Professor). He has also worked at Bell Communications Research, and has consulted with several companies in the US and in Europe. In 2000 he became a Professor of Computer Engineering and Informatics (CEID) at the University of Patras, Greece, where he is leading the Communication Networks Lab. He is also the Scientific Director of the School Network and Network Technologies Sector at the Computer Technology Institute (CTI), which has a major role in the development of network technologies and telematic services in Greece, and is responsible for the development and operation of the Greek School Network, the largest public network in Greece. He was also the recipient of the 1st national prize in mathematics and a member of the Greek team for the Mathematics Olympiad. Manos has participated in more than 25 EU-funded research projects in the areas of optical networking and grid and cloud computing and in many national research projects. He has over 250 publications in international journals and conferences. His research activities are in the areas of network algorithms and protocols, optical networking, optical interconnects, resource management, VLSI layouts, and grid and cloud computing. His team has developed the Mantis tool for the planning and operation of fixed- and flex-grid optical networks and the OpenRSM tool for the remote management of systems. He likes reading, playing chess, collecting maps, and sitting at French cafes.

MANTIS: Optical Network Planning and Operation Tool



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