Technology Workshop
"Optical Interconnect in Data Centers"

The event is organized by **EPIC** and the EU project **PhoxTroT** with the support of **IEEE CPMT German Chapter** and **ECO**.

EPIC
European Photonics Industry Consortium
www.epic-assoc.com

PhoxTroT
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
www.phoxtrot.eu

IEEE
CPMT
IEEE COMPONENTS, PACKAGING AND MANUFACTURING TECHNOLOGY SOCIETY
http://cpmt.ieee.org

ECO
EUROPEAN CLUSTER IN OPTICAL INTERCONNECTS
www.ecoic.eu

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The workshop is focused on high-performance, low-energy and cost and small-size optical interconnects across the different hierarchy levels in data center and high-performance computing systems: on-board, board-to-board and rack-to-rack. At the end of the workshop a summary and conclusions will be prepared.

SESSION 1: DATA CENTERS

The projected increase in capacity, processing power and bandwidth density in data centre environments must be addressed by the migration of high density optical interconnect into the data communication enclosures. The conversion point between electrical to optical interconnects will move ever closer to the on-board processing complexes, whether these be CPUs, data storage controllers, FPGAs, routers or switches. This migration is already strongly reflected in the research, development and strategic activities of mainstream organisations in the data centre and broader ICT space and the emergence of a new technology eco-system.

This workshop will therefore consider the optical technologies required to support the migration of short reach optical interconnect into ICT systems and the resulting architectural advancements that can be opened up in data centre environments.
Proposed discussion topics:

• Prevailing interconnect and architectural trends in data centres (e.g. disaggregation)
• Technologies supporting migration of optical connectivity into the storage, server and HPC enclosures
• Demonstration of system embedded photonics in ICT systems
• Barriers to commercial adoption of system embedded optical interconnect technologies

SESSION 2: COMPONENTS

The penetration of optical technologies into short-range interconnect systems calls for a new generation of optical components that will optimally blend low-loss, low-power, low-footprint, high-speed and low-cost characteristics across the complete chain of functional systems required at all-levels of interconnect hierarchy. As the need for migrating into optical interconnects continuously grows, research on photonic components strives to come up with a clear "winning" solution for all different hierarchical levels drawing from a broad technology portfolio like polymers, glass, silicon photonics, plasmonics, III-Vs, 3D integration and photonic/electronic packaging. This workshop intends to provide a broader view of progress into respective components technologies in the effort to highlight the perspectives opened in the interconnect area and to identify the most promising roadmap.

Talks and discussion are envisaged to cover the following topics:
• transmitters/receivers for optical interconnects
• VCSELs
• low-loss waveguide platforms for rack-to-rack, board-to-board, on-board and on-chip interconnects
• switches and modulators
• chip-to-board and board-to-board coupling
• optoelectronic hybrid and monolithic integration
• optoelectronic device testing, packaging and reliability
• optical signal processing and optical memories

SESSION 3: SYSTEMS

The increasing deployment of optical technologies for rack-to rack communication in current generation data centre and HPC systems, has so far lead to faster and greener system implementations, but is not sufficient to sustain performance trends and contain energy consumption. Photonics have started to migrate into all levels of the interconnect hierarchy, from rack-to-rack and board-to-board to chip-to-chip and intra-chip data links, in order to meet the rapidly growing demand on digital information transmission, capture, storage and processing.

Motivated by recent breakthroughs and emerging technologies in short reach optical interconnect and the evolution of data centre architectures, this workshop aims to highlight the latest achievements on optical system solutions and architectures, that are placing photonics among the key enabling technologies of datacom and computercom evolution. In more detail, this workshop covers the following topics:
- Rack-to-rack, board-to-board, on-board and on-chip optical data links
- Optical interconnection interfaces
- Parallel optics for optical interconnection
- Signal processing subsystems/systems
- Routing solutions for different interconnection hierarchy levels
- Advanced modulation formats within the various optical interconnection layers
- Energy consumption"

SESSION 4: ARCHITECTURE

High performance computing (HPC) and datacenter (DC) systems are being built out of increasing numbers of processors. To obtain high system efficiency, computation versus communication performance needs to be balanced and given the aggressive rate of increase in compute density it is of paramount importance to avoid having the interconnection network become the bottleneck.

To address this problem research on novel photonic subsystems and components has been carried out as a means of bringing the abundant capacity that all-optical technology can offer closer to the computation elements. "Matching and mixing" the photonic building blocks that are built to interconnect the computation and storage resources becomes a very taxing problem. Indeed, to take advantage of the new features and improved performance of the novel photonic building blocks that are emerging we need to reconsider a number of issues, such as the types of topologies used at different system levels (on-board, board-to-board, rack-to-rack), how the different levels are interfaced, the mapping of topologies to the packaging hierarchy, specialized protocols for all-optical interconnects, the mapping of applications on the system hierarchy, just to name a few.

Session 4 of the workshop will look into HPC and DC systems from a high perspective, focusing on application requirements and interconnect architectures at different levels. Discussion topics are (but not limited to):
- Application and system networking requirements at different levels of the HPC and DC system
- Interconnect architectures based on photonic building blocks and all-optical technologies
  - Performance Evaluation: theoretical studies and simulations
  - Methodologies to evaluate different topologies and architectures
  - Technoeconomic studies
- Protocols and algorithms for photonic and all-optical interconnects

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Registration and Fee
- Speakers: 125 EUR + VAT / Participants: 125 EUR + VAT
- Agenda, hotel, and other logistics information will be sent directly to the participants
- www.epic-assoc.com/events

Organizing Committee
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- Klaus-Dieter Lang, IEEE/CPMT

SESSION 5: ROUTE TO ADOPTION

The route to adoption of new optical interconnect technologies at different communication tiers within data centres and other application spaces is determined by key driving factors including cost and performance, but of equal importance is the availability of a complete value chain to support such technologies.

The migration of optical connectivity into data centre subsystems is already being driven by an emerging commercial technology eco-system and widespread global research and development activities. Furthermore, recognition by international standards bodies of these emerging technologies is an important prerequisite to commercial adoption.

Proper awareness of and interaction between these commercial, research and standards activities will be crucial in ensuring a rapid technology transition to embedded photonics within data centres.

This session covers the following topics:
- Route to adoption of optical interconnect technologies in data centre systems
- Migration of optical technologies into data communication systems
- International standards for optical interconnect technologies
- Next generation data communication protocols in data centres
- Test and measurement methods and equipment for future embedded optical interconnect

Confirmed SPEAKERS and SESSION CHAIRS

- Avinash Karanth Kodi, Ohio University
- Bert Offrein, IBM
- David Selviah, University College London
- Dieter Bimberg, TU Berlin
- Dimitris Apostolopoulos, NTUA
- Elad Mentovich, Mellanox
- Emmanouel Varvarigos, CTI
- Felix Betschon, vario-optics ag
- Hideyuki Nasu, Furukawa
- Jeroen Duis, TE
- Kostas Katrinis, IBM Dublin
- Lars Brusberg, Fraunhofer IZM
- Marika Immonen, TTM Mail
- Marc Duranton
- Nikos Pleros, CERTH
- Richard Penty, University of Cambridge
- Richard Pitwon, Xyratex
- Simon Jones, Dow Corning
- Takehiro Hayashi, Hat Lab
- Tolga Tekin, TU Berlin
- Manabu Yasukawa, Synergy Optsystems
- Mayank Singh, Sumitomo Bakelite

- Muhannad Bakir, Georgia Tech
- Takashi Shimizu, Fujitsu
- Ulrich Fischer-Hilchert, Harz University
- William Whelan-Curtin, University of St Andrews