PSC2018
Limassol, Cyprus

Photonics in Switching and Computing

19 - 21 September, 2018

Workshop:

Fast Switching Technologies and architectural considerations for Data Center Networks

Date: Wednesday, 19th of September

Duration: 14:00 - 18:00

Chairman:	Dimitrios Klonidis	Athens Information Technology
Speakers:	Dominique Chiaroni	Nokia Bell Labs
	Ken-ichi Sato	Nagoya University
	Guilhem de Valicourt	IPG Photonics
	Dan Marom	HUJI University
	Salah Ibrahim	NTT
	George Zervas	UCL
	Hideaki Furukawa	NICT
	Kostas Tokas	NTUA
	Nicola Calabreta	TU/e

Workshop Program

14:00 – 14:10 Intro and welcome

14:10 – 14:40 Towards low TCO/Bit network smart fabrics: an incremental path to build 5G solutions and beyond (Tutorial).

Dominique Chiaroni **Nokia BL**

The cloudification of the network, creating new opportunities of markets in the access space motivated by new needs coming from the IoT and the Industry 4.0, has raised new challenges to provide low TCO/bit and low latency systems. In this presentation we will first describe the context, to identify the directions to follow to support the emergence of new applications. After a description of use cases, we will position the optical switching technology in this new space, and we will identify the key criteria of selection to make this technology successful. Finally we will illustrate some smart systems having the potential to fulfill the requirements of the 5G, in different market spaces: Xhaul and Backhaul, Access Aggregation, Datacom but also vertical markets including V2X.

14:40 – 15:00 Photonic integrated circuits for optical switching applications

Guilhem de Valicourt **IPG Photonics**

We review the recent achievements done in optical slot switched technology using silicon-based photonic integrated circuits. Monolithic integrated slot-blocker and slot-dropper devices are presented as well as a dual-hybrid cavity laser for fast wavelength switching.

15:00 – 15:20 Design of fast MEMS switches

Dan Marom **HUJI**

We describe a design for a silicon photonics waveguide switch based on MEMS in-plane actuation offering low-loss, low polarization dependence, sub-1 microsec switching at low voltage swings, and simple edge coupling. The switching mechanism is enabled by sub-1 micron physical actuation of a relatively thick silicon strip waveguide of 3 micron width and height.

15:20 – 15:40 Role of optical circuit switching and realization technologies for datacenter applications

Ken-ichi Sato **Nagoya University**

We discuss the way to create large-scale optical circuit switches that can be cost-effective and power efficient for intra data center networks. Our recent technology developments are also presented.

Break

16:00 – 16:20 Burst-Mode Enabled Optical DC Networks: Packet Switching and Beyond

Salah Ibrahim and Toshikazu Hashimoto **NTT**

Employing optical switching in Data Center (DC) Networks can overcome the present problematic mismatch between optical transmission and electrical switching. However unlike conventional optical networks, DC networks should support any-to-any connection among a very large number of network nodes in a dynamic fashion. To address these requirements, we present a new approach for realizing ultra-dynamic optical networks based on novel exploitation of burst-mode technologies and wavelength resources.

16:20 – 16:40 Data Center landscape beyond Moore's Law: Challenges and solutions towards deterministic nanosecond optical networking

George Zervas, Joshua Benjamin, Paris Andreades **UCL**

The Data Centers evolve to address current limitations and the Moore's Law slow down. We give an insight on how the computing infrastructure is evolving. We describe the challenges and opportunities for networking disruption avoiding the shortcomings of the past. Our recent developments towards nanosecond speed optical networking are then reported.

16:40 – 17:00 SDM-based fast optical switching technologies for dynamic data center optical networks

Hideaki Furukawa, Jose M. D. Mendinueta, Ruben S. Luis, and Naoya Wada **NICT**

We make use of spatial division multiplexing (SDM) over multi-core optical fibers and newly develop high-speed spatial optical switch systems for data-center optical network providing dynamic bandwidth allocation.

17:00 – 17:20 The NEPHELE project: Real time demonstration of an optical datacentre network integrating fast optical switching in slotted (TDMA) operation

Kostas Tokas, Christos Spatharakis, Ioannis Patronas, Angelos Kyriakos, Dionysios Reisis and Hercules Avramopoulos **NTUA**

We present the real time operation of the NEPHELE network, which relies on an optical data-plane architecture operating in a slotted mode, controlled with an SDN overlay for dynamic allocation of network resources. Successful end-to-end communication is demonstrated in various communication scenarios.

17:20 – 17:40 Photonic integrated WDM nanoseconds fast optical switches for scalable and low latency optical networks

Nicola Calabreta TU/e

We present a modular photonic integrated WDM cross-connect switch that exploits SOA technology for loss-less and nanoseconds wavelength, space, and time switching operation. A scalable and low latency data center network architecture will be presented based on distributed and parallel WDM cross-connect switches in combination with an efficient and distributed optical flow control.

17:40 – 18:00 Panel discussion

Open discussion among presenters with the participation of the audience. Indicative topics to be addressed:

- Evaluation of the most promising marketable solutions for the next generation of DCs
- Identification of long term research directions on the topic.
- Key technology requirements (i.e. research targets) for reduced cost/bit.
- Identification of other related research topics (e.g. specialized network architectures or scheduling approaches) to affect or further enhance the penetration of fast switching in future DCNs

Presenters' Bios

Dominique Chiaroni graduated in Mechanics (IUT d'Aix-en-Provence), in Thermal Sciences & Physics (Master and Bachelor at the University of Corsica), and in Optics and Microwaves (Engineer diploma obtained in 1990 from Telecom SudParis). He was engaged in 1990 by Alcatel CIT to work on optical switching technologies and related systems and networks. Since 2000, he focused mainly his efforts in the identification of pragmatic directions for the design of hybrid systems and networks. Currently working in the Network Energy program in Bell Labs France he has actively contributed to many European and National projects with the following responsibilities: project leader of the RNRT ECOFRAME (2007-2010), work-package leader of the FP7 ALPHA European project (2007-2011), responsible for Bell Labs France for the NTT-ALU strategic collaboration (2008-2011). Distinguished member of the Alcatel-Lucent Technical Academy in 2003, ALTA Chapter Chair since 2005, he actively participated to different missions: steering committees, chapter working groups, organization of three major workshops, organization of local events for the benefit of the company. Chair or co-chair of International conference or workshops he is also a regular member of the technical committees of many International Conferences or National jury of PHDs. He is author and co-author of more than 200 publications and patents including numerous invited papers and Tutorials, and contributions in books.

Ken-ichi Sato is currently a Professor at the Graduate School of Engineering, Nagoya University, and also an NTT R&D Fellow. He has been a leading researcher in the field of telecommunications for more than 35 years and authored/co-authored more than 500 research publications in international journals and conferences. He holds 50 granted patents. He served on numerous committees of international conferences including OFC 2016 General Chair and as the President of the Institute of Electronics, Information and Communication Engineers (IEICE) of Japan during 2016-2017.

Guilhem de Valicourt received the BSc and MSc degree in applied physics from the National Institute of applied Sciences (INSA), Toulouse, France, in 2008 and a MSc degree from Essex University, U.K, the same year. In 2008, he joined Alcatel-Thales-CEA III-V lab where he was working on design, fabrication, and characterization of RSOA and DFB lasers for microwave photonic systems and next generation of optical access networks toward the Ph.D. In 2011 he joined Alcatel-Lucent in France as a research engineer on optical communication systems and in 2014, he moved to Bell Labs, Nokia, NJ, USA, where his main research interests were focused on design and characterization of advanced photonic integrated circuits (PIC) in InP, silicon and hybrid III-V on silicon platform for optical packet transport and switching, datacenters and access networks. Since 2017, he is leading the activities on silicon photonics based PIC at IPG Photonics, NJ, USA. He has authored or co-authored more than 100 scientific papers in journals and international conferences, 4 book chapters and holds more than 25 patents. He received the 2011 "Best project" award from Alcatel-Lucent Bootcamp, the 2012 Marconi Young Scholar award, 2015 Harm Dorren Commemoration Award and was a finalist for the ParisTech Ph.D. prize in 2012.

Dan M. Marom is a Full Professor in the Applied Physics Department at Hebrew University, Israel, heading the Photonic Devices Group and currently serving as the Department Chair. He received the B.Sc. Degree in Mechanical Engineering and the M.Sc. Degree in Electrical Engineering, both from Tel-Aviv University, Israel, in 1989 and 1995, respectively, and was awarded a Ph.D. in Electrical Engineering from the University of California, San Diego (UCSD), in 2000. From 2000 until 2005, he was a Member of the Technical Staff at Bell Laboratories, Lucent Technologies, where he invented and headed the research and development effort of MEMS based wavelength-selective switching solutions for optical networks. Since 2005, he has been with the Applied Physics Department, Hebrew University of Jerusalem, Israel, where he leads a research group pursuing his research interests in creating photonic devices and sub-systems for switching and manipulating optical signals, in guided-wave and free-space optics solutions using light modulating devices, nonlinear optics, and compound materials.

Salah Ibrahim received the B.Sc. and M.Sc. degrees in electronics and communications engineering from Cairo University, Giza, Egypt, in 2000 and 2004, respectively, and the Ph.D. degree in electronics engineering from the University of Tokyo, Tokyo, Japan, in 2009. During 2009 and 2010, he was a Postdoc Research Scientist at the University of California, Davis, Davis, CA, USA. Since 2011, he has been with NTT Labs, Atsugi, Japan, where he is currently a Senior Researcher at NTT device technology labs.

Georgios Zervas is currently a Senior Lecturer in Optical and High-Performance Networks at University College London. He received his MEng degree in Electronic and Telecommunication Systems Engineering with distinction and PhD degree in optical networks from the University of Essex in 2003 and 2009 respectively. Following this, he held the positions of Research Associate and subsequently Research Fellow as a member of High-Performance Networks group at the University of Essex. He was appointed Lecturer in 2011. Following this, he held the positions of Lecturer and Senior Lecturer at University of Bristol until 2016 when he joined the Optical Networks Group at UCL. He also held the position of visiting Associate Professor at Keio University, Tokyo for 6 months.

Hideaki Furukawa received the Dr. Eng. degree from Osaka University, Osaka Japan, in 2005. Since 2005, he has been with National Institute of Information and Communications Technology (NICT), Tokyo Japan.

Konstantinos Tokas obtained his Diploma in Electrical and Computer Engineering from National Technical University of Athens, in 2015. His thesis was carried out at the Photonics Communications Research Laboratory (PCRL) and concerned high-speed optical interconnects using advanced modulation schemes. He is currently a member and PhD candidate of PCRL and his research activities include among others optical datacenter network sub-systems and architectures. He speaks fluently English and Spanish.

Nicola Calabretta is an Assistant Professor in Electro-Optical Communication Systems and Senior Research Fellow at Eindhoven University of Technology (TU/e). His expertise is in telecommunications engineering, electrical engineering and optical engineering. Nicola's research focuses on optical signal processing for highly spectral efficient multi-level modulation formats, high-speed electronics for processing of novel labeling techniques, FPGA implementation of scheduling algorithms for low latency control of large port optical switches, optical interconnects, photonic integrated wavelength selector with flexible bandwidth, photonic integrated optical switches and c optical nodes for metro networks. Applications of the group's work on fast optical switches include performance enhancement for optical metro/access networks and data center networks.

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