



33rd European Conference and Exhibition on Optical Communication

**FINAL
PROGRAM**

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International Congress Centrum ICC Berlin, Germany

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Welcome Address by ECOC 2007 Chairs



Hans-Joachim Grallert



Andreas Kirstädter



Andreas Gladisch



Klaus Petermann

We would like to welcome you to Berlin! In 2007 Berlin will be the European capital of optical communications. After 1992, the European Conference and Exhibition on Optical Communications will be held again in Berlin on September 16 to 20, 2007. This 33rd edition will provide another record number of participants and – what's more important – milestones in scientific and technical progress on materials, devices, and systems for applications in photonic networks. Since 1992 almost everything has changed in optical communications and in Berlin as well. That is because optical communications have now become a well established technology world-wide and Berlin has dramatically renewed itself.

From student to expert level, from academia to industry, ECOC's special symposia, tutorials, invited and contributed papers will analyse the impact and role of photonic technology in present and future telecommunication networks. Additionally a large exhibition will provide and display the latest (and future) components, products, systems, and services of optical communications.

The technical programme committee has been expanded by one additional sub-committee which will deal with broadband access, local area and home networks. This change reflects the growing importance of optical technologies in LAN and home networks. Generally speaking, the six sub-committees have received more than 750 papers from which 282 high quality papers have been accepted for oral and 140 for poster presentation. New fiber-based components, modulation schemes for efficient high speed transmission, 100 Gbps Ethernet and broadband access will be key issues this year.

We look forward to seeing you in Berlin this September.

General Co-Chairs

Hans-Joachim Grallert
Heinrich-Hertz-Institut, Berlin

Andreas Kirstädter
Nokia Siemens Networks
GmbH & Co. KG, Munich

Technical Program Co-Chairs

Andreas Gladisch
T-Systems International
GmbH, Berlin

Klaus Petermann
Technical University
Berlin

ECOC 2007 Conference General Chairs

Andreas Kirstädter, Nokia Siemens Networks GmbH & Co. KG, Germany
Hans - Joachim Grallert, Fraunhofer Heinrich Hertz Institute, Germany

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Andreas Kirstädter, Nokia Siemens Networks GmbH & Co. KG, Munich, Germany
Peter Neu, VDE, Frankfurt, Germany
Klaus Petermann, Berlin University of Technology, Berlin, Germany
Manfred Rocks, T-Systems International GmbH, Berlin/Darmstadt, Germany
Rupert Rompel, VDE, Frankfurt, Germany
Volker Schanz, ITG within VDE, Frankfurt, Germany
Herwig Zech, Nokia Siemens Networks GmbH & Co. KG, Munich, Germany

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Jean-Luc Beylat, Alcatel-Lucent, France
Pierluigi Franco Pirelli, Broadband Solutions, Italy
Hans - Joachim Grallert, Fraunhofer Heinrich Hertz Institute, Germany
Palle Jeppesen, COM-Technical University of Denmark, Denmark
Ursi Keller, ETH Zurich, Switzerland
Djan Khoe, COBRA - TU Eindhoven, The Netherlands
Andreas Kirstädter, Nokia Siemens Networks GmbH & Co. KG, Munich, Germany
David Payne, ORC - University of Southampton, UK
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Carlo Giacomo Sameda, Università di Padova, Italy
Will Stewart, UK
Peter Van Daele, IBBT - Ghent University, Belgium
Wsewolod Warzanskyj, Telefonica I+D, Spain

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Richard Linke, IEEE/LEOS, USA
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John D. Love, Australian National University, Australia
Hideo Kuwahara, Fujitsu, Japan

Technical Programme Co-Chairs

Klaus Petermann, Berlin University of Technology, Berlin
 Andreas Gladisch, T-Systems International GmbH, Berlin

TPC Members

Sub-Committee 1 - Fibres, Fibre Devices and Amplifiers

Alain Barthelemy, IRCOM, France
 Tim Birks, University of Bath, UK
 Evgeny Dianov, Russian Academy of Science, Russia
 Andrea Galtarossa, Universita' di Padova, Italy
 Lars Grüner-Nielsen, OFS, Denmark
 Sailing He, Zhejiang University, China
 Hervé Lefèvre, iXCore S.A.S., France
 Patrice Megret, Faculté Polytechnique de Mons, Belgium
 Shu Namiki, National Institute of Advanced Industrial Science and Technology, Japan
 Daniel Nolan, Corning, USA
 David Richardson, Optoelectronics Research Center, UK
 Dag Roar Hjelme, Optomed, Norway
 Christian Schaeffer, Technische Universität Dresden, Germany
 Lidia Terruzzi, Prysmian, Italy

Sub-Committee 2 - Waveguide and Optoelectronic Devices

Roel Baets, Ghent University-IMEC, Belgium
 Liam Barry, Dublin City University, Ireland
 Joe Campbell, University of Virginia, USA
 Chris Doerr, Alcatel-Lucent, Bell Labs, USA
 Alfred Driessen, University of Twente, The Netherlands
 Guang-Hua Duan, Alcatel Thales III-V Lab, France
 Gadi Eisenstein, Technion, Israel
 Piero Gambini, Avago Technologies, Italy
 Bozena Jaskorzynska, KTH, Royal Institute of Technology, Sweden
 Naoto Kobayashi, National Institute of Advanced Industrial Science and Technology, Japan
 Thomas Krauss, University of St. Andrews, UK
 Christian Lermiaux, Université de Technologie de Troyes, France
 Juerg Leuthold, Universität Karlsruhe, Germany
 Norbert Lichtenstein, Bookham, Switzerland
 Hanne Ludvigsen, Helsinki University of Technology, Finland
 Yi Luo, Tsinghua University, China
 Edmond Murphy, JDS Uniphase, USA
 Yoshiaki Nakano, University of Tokyo, Japan
 Edwin Pun, City University of HongKong, Hong Kong

Sub-Committee 3 - Subsystems and Network Elements for Optical Networks

Sébastien Bigo, Alcatel-Lucent, France
 José Capmany, Universidad Politécnica de Valencia, Spain
 John Cartledge, Queens' University, Kingston, Ontario, Canada
 Ernesto Ciaramella, Scuola Superiore S. Anna, Pisa, Italy
 Harm Dorren, Eindhoven University of Technology, The Netherlands
 Andrew Ellis, University of Cork UCC, Ireland
 Yaohui Jin, Shanghai Jiaotong University, China
 Mario Martinelli, CORECOM, Italy
 Masataka Nakazawa, University of Tohoku, Japan
 Werner Rosenkranz, University of Kiel, Germany

William Shieh, University of Melbourne, Australia
Mark Shtauf, Tel Aviv University, Israel
Alan Willner, University of Southern California, USA

Sub-Committee 4 - Transmission Systems

Peter Andrekson, Chalmers University of Technology, Sweden
Polina Bayvel, University College London, UK
Huug De Waardt, Eindhoven University of Technology, The Netherlands
Nick Doran IAT, Swansea University, UK
Joerg-Peter Elbers
Rene-Jean Essiambre, Alcatel-Lucent, USA
Kazuo Hagimoto, NTT, Japan
Paul Harper, Aston University, UK
Qingya Hua, Huawei Technologies, China
Michel Joindot, ENSSAT, France
Carsten Gudmann Jorgensen, OFS Fitel, Denmark
Peter Krummrich, Universität Dortmund, Germany
Christophe Peucheret, COM, Technical University of Denmark, Denmark
Alfredo Viglienzoni, Ericsson, Italy

Sub-Committee 5 - Backbone and Core Networks

Keren Bergman, Columbia University, USA
Piet Demeester, Ghent University-IMEC, Belgium
Gert J. Eilenberger, Alcatel-Lucent, Germany
Jean-Pierre Hamaide, Alcatel-Lucent Research & Innovation, France
Eugenio Iannone, Pirelli Labs, Italy
Gabriel Junyent, Universidad Politécnic de Catalonia, Spain
Andrew Lord, BT, UK
Fabio Neri, Politecnico di Torino, Italy
Ken-ichi Sato, University of Nagoya, Japan
Jan Späth, Ericsson, Germany
Masatoshi Suzuki, KDDI Labs, Japan
Ioannis Tomkos, Athens Information Technology Center, Greece
Yong Hyub Won, Information & Communications University, Korea

Sub-Committee 6 - Access Networks and LAN

Giancarlo De Marchis, TelCon srl, Italy
Nikolaus Gieschen, T-Systems, Germany
Madeleine Glick, Intel, UK
Stephane Gosselin, France Telecom R&D/CORE, France
Chinlon Lin, The Chinese University of Hong Kong, Hong Kong
Jesús Felipe Lobo, Telefonica S.A., Spain
Xing-Zhi Qiu, Ghent University-INTEC Design, Belgium
Kees van Bochove, KPN Royal Dutch Telecom, The Netherlands
Gerlas van den Hoven, GENEXIS, Eindhoven, The Netherlands
Godehard Walf, Fraunhofer-Heinrich-Hertz-Institute, Germany
Winston Way, Opvista Irvine, USA
Naoto Yoshimoto, NTT, Japan

Symposia

BAT Symposium - September 17, 14:00 - 18:00

Symposium on Broadband Access Technologies

Organiser: *Thomas P. Pearsall, EPIC, France*

Co-Chair: *Stéphane Gosselin, France Telecom*

Co-Chair: *Alfredo Viglienzoni, Ericsson Communications, Italy*

Summary:

This symposium focuses on the exploration and demonstration of novel optical networks and networking aspects for broadband access and metro-access networks. The speakers will cover specifically FTTx, PON and WDM-PON network solutions as well as local area networks. Presentations will cover issues important to successful commercial mass deployments, field trials, business planning, and applications of optical fibre communication technology in public, private and enterprise networks.

(see detailed program on page 16 and 18)

POF Symposium - September 18, 14:00 - 18:00

Polymer Optical Fibers - Effective Solutions for Automotive, Sensors, Home Networking and Interconnection

Co-Chair: *Olaf Ziemann, POF-AC Nürnberg, Germany*

Co-Chair: *Yasuhiro Koike, Keio University, Japan*

Summary:

Polymer Optical Fibers (POF) are in wide use for automotive networks (like MOST in 40 different cars) and automation since a number of years now. New applications will be the use of POF in home networks, interconnection and sensors.

The driving force for the POF use in home networks is the continuous increase in the access network capacity. New technologies and applications like VDSL, FTTH and IP-TV require low cost networks with simple installation, high security and low space consumption.

The POF Symposium on the ECOC'2007 will show the newest developments in Polymer Fiber technology, as well as in transmission technology. Some examples are the transmission of 1 Gbps over 100 m SI-POF (Siemens) and 30 Gbps over GI-POF (Georgia Inst. of Techn.). Results of the European POF-ALL project will be presented. Invited speakers from Asia, Australia, North- and South America will show the status of POF sensors and the capabilities of microstructured POF.

(see detailed program on page 22 and 24)

Workshop 1 **Hall 4/5**
100 Gigabit Ethernet for Carrier-Class Transport Networks

Chairs: Marcus Duelk, Alcatel-Lucent, USA, Andreas Kirstädter, Nokia Siemens Networks, Germany

Workshop Objective:

High-Speed Ethernet is continuing to spread from the original LAN environment into telecom and cable MSO service providers' networks. Next-generation 100 Gbps Ethernet (100 GbE) is envisioned to be indeed not a typical network interface for desktops or servers but rather an infrastructure interface in data centers or provider aggregation and content delivery networks. However, the requirements in carrier Metro networks are very different to those found in local area networks. This workshop covers various aspects of 100 GbE in carrier-class transport networks and is divided into three sessions:

- Carrier Networks – covering architectures and requirements of carrier networks, including incumbent carriers and the transitioning of their networks from TDM to more data-aware IP/Ethernet networks, outlining the differences between Ethernet networks in the enterprise and provider world, the latter using network protocols like Q-in-Q, PBB-TE or MPLS
- 100G Carrier Ethernet Switches – covering aspects of how to build carrier-grade switches and routers and what the challenges are scaling them to Terabit-per-second capacity with 100 Gb/s line cards
- 100G Transport for WDM Carrier Networks – covering the transport requirements in provider networks like Optical Transport Network (G.709) versus Ethernet transport, parallel versus serial transport, and what the challenges and techniques are to realize high-speed serial WDM transport.

Workshop 2 **Hall 7**
Quantum Dots : The Ultimate Frontier

*Chairs: Dieter Bimberg, Technische Universität Berlin, Germany
 Marc Illegems, EPFL Lausanne, Switzerland
 Richard Penty, University of Cambridge, United-Kingdom*

Semiconductor Quantum Dots represent the ultimate step in size reduction in semiconductor devices, bringing novel functionalities and promises for dramatic improvements to a range of photonic active devices such as edge emitting and vertical cavity lasers, optical amplifiers and detectors.

Quantum dots consist of nanoscale clusters of semiconductor material embedded in a wider bandgap matrix. The extension of a QD in all three dimensions of space is ideally shorter than the de Broglie wavelength of a charge carrier. Such strong carrier localization leads to a discrete atom-like, instead of a continuous density of states for both electrons and holes, a paradigm change for a semiconductor structure. In addition, the strong confinement leads to high radiative efficiency by limiting the carrier diffusion to nonradiative centers.

The optical and electronic properties of QDs are to a large extent composition, size and geometry tunable. Novel photonic devices based either on either single or high densities of QDs have been developed using many different material combinations covering a wide range of wavelengths and fields of application. Among them are Single Photon Emitters for quantum information processing, ultrahigh speed VCSELs for Terabit/s communications, and high speed Semiconductor Optical Amplifiers for the 100 Gbit/s Ethernet.

This workshop is sponsored by the EU network **SANDIE**

Program

Chair: Marc Illegems, EPFL Lausanne

- | | |
|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| 09:00 - 09:10 | Opening
<i>Dieter Bimberg, TU Berlin</i> |
| 09:10 - 09:35 | Applications of Quantum Dot Semiconductor Optical Amplifiers at 1.3 μm
<i>Jörg Leuthold, Uni Karlsruhe</i> |
| 09:35 - 10:00 | Recent Progress in Quantum Dot Semiconductor Amplifiers at Long Wavelengths
<i>Tomoyuki Akiyama, Fujitsu Tokyo</i> |
| 10:00 - 10:25 | Quantum Dash Based Mode-Locked Lasers Emitting at 1.55 μm
<i>Abderrahim Ramdane, CNRS Marcoussis</i> |
| 10:25 - 10:50 | Progress and Challenges of GaInNasSb for Optical Communication
<i>James Harris, Uni Stanford</i> |
| 10:50 - 11:20 | Coffee break |
|
<i>Chair: Richard Penty, University Cambridge</i> | |
| 11:20 - 11:45 | High Speed VCSELs for Optical Interconnects
<i>Nikolai Ledentsov, TU Berlin</i> |
| 11:45 - 12:10 | Qubits, Quantum Repeaters and Cryptography
<i>Mark Fox, Uni Sheffield</i> |
| 12:10 - 12:35 | Quantum Dot Devices for Quantum Communication
<i>Andrew Shields, Toshiba Cambridge</i> |
| 12:35 - 13:00 | Single Photon Emitters and Detectors for Quantum Communication
<i>Andrea Fiore, EPFL Lausanne</i> |
| 13:00 | Closing |

Workshop 3 **Hall 8**
Global Interoperability in Multi-Domain and Multi-Layer ASON/GMPLS Networks

Jointly sponsored by the Optical Internetworking Forum (OIF, www.oiforum.com) and MUPBED (www.ist-mupbed.eu)

*Chairs: Hans-Martin Foisel, Deutsche Telekom, Germany
 Vishnu Shukla, Verizon, USA*

Carrier networks are challenged by continuous traffic growth, the evolution of high bandwidth demanding data applications and increasing customer requests for on-demand network bandwidth services. The goal of introduction of intelligent control plane mechanisms in -multi vendor and multi-domain network environments is two-fold: Simplification of service provisioning and management and the opportunities to introduce new end-to-end bandwidth-on-demand services. The most optimal solution for such services in the current heterogeneous environments is standard based implementations. To ensure this also on practical level, the Optical Internetworking Forum (OIF, www.oiforum.com) has organised and carried out several interoperability tests and evaluations of prototype implementations of its Implementation Agreements.

This workshop will cover main aspects and results of the OIF Worldwide Interoperability Demonstration 2007, on On-Demand Ethernet Services over multiple ASON/GMPLS Network Domains, with speakers from Asia, North America and Europe.

Closely related to this workshop will be the:

- Live demonstration of the interoperability results and the global test network at the OIF ECOC2007 exhibition, booth 17078
- Lab tours to Deutsche Telekom premises in Berlin, where a more detailed demonstration of the ASON/GMPLS functions of the OIF Worldwide Test Network and the MUPBED (www.ist-mupbed.eu) European scale test network will be shown, replicating the "look and feel" of a real carrier environment.

Program

09:00 - 09:05	Welcome and Introduction <i>Organisers</i>
09:05 - 09:35	OIF Worldwide Interoperability Demonstration 2007 – Ethernet On-Demand Services enabled by OIF UNI and E-NNI Functions <i>Jim Jones</i>
09:35 - 10:05	OIF Worldwide Interoperability Demonstration 2007 – Results and Findings of the Control Plane Interoperability Test <i>Jonathan Sadler</i>
10:05 - 10:35	OIF Worldwide Interoperability Demonstration 2007 – Consideration from a Carrier's Perspective <i>Vishnu Shukla</i>
10:35 - 11:00	Coffee Break
11:00 - 11:30	GMPLS – Current Status of Standardization Work <i>Tomohiro Otani</i>
11:30 - 12:00	ASON – Current Status of Standardization Work <i>Bernd Zeuner</i>
12:00 - 12:30	Application of ASON Multi-Domain Architecture to Internet2 <i>Lyndon Ong</i>
12:30 - 13:00	ASON/GMPLS based Interoperability and Interworking Solutions in the European MUP-BED Multi-Domain and Multi-Layer Test Network <i>Jan Spaeth</i>
13:00	End

Workshop 4 **Hall 9**
Future Internet Design

*Chairs: Phuoc Tran-Gia, Universität Würzburg, Germany
 Michael Dueser, T-Systems, Germany
 Michael Menth, Universität Würzburg, Germany*

This workshop brings together researchers in the area of future Internet design, also referred to as 'Clean Slate Design', and researchers in the area of optical communications, to raise mutual awareness, explore areas of joint interest, and stimulate discussion on the directions of future network research. The progress in the different fields of optical communications will continue to be a key driver for the architectural changes in any future network design. Both communities will need to closely cooperate to make the future Internet happen. The success story of optics – any chance to be continued in the 21st century?

Program

09:00 - 09:15	Welcome and Introduction <i>Organisers</i>
09:15 - 09:45	Network Design – What (not) to Expect from the Future Internet <i>Prof. A.Odlyzko</i>
09:45 - 10:15	Intelligent and Agile Optical Networking for the Future Internet <i>Prof. Ben Yoo</i>
10:15 - 10:45	Challenges in Experimental Testbed Design for the Future Internet <i>Anastasius Gavras</i>
10:45 - 11:15	Coffee Break
11:15 - 11:45	Scheduling in Optics is the Wrong Answer for Fine-Grained Resource Sharing <i>Bob Briscoe</i>
11:45 - 12:15	Future Internet Transport Layer – Heading towards a Post-TCP Era? <i>Michael Scharf</i>
12:15 - 12:45	Future Internet Design – The Operator's Vision <i>Fabrice Guillemin</i>
12:45 - 13:00	Wrap-Up and Closing

Sunday, September 16 – 14:00 - 18:00

Workshop 5 Hall 4/5 **Electronic signal processing for transmission impairment mitigation: future challenges**

*Chairs: Robert Killey, University College London, UK
 Jörg-Peter Elbers, Ericsson, DE*

Recent advances in high speed electronic signal processing technology have led to the development of low cost devices for impairment mitigation in metro and long-haul transmission systems. There are still a number of open questions concerning the future directions of electronic equalization (EE) technology. These include the identification of the best performing and lowest cost solutions (e.g. electronic predistortion, decision feedback equalization, maximum likelihood sequence estimation, subcarrier multiplexing, and coherent detection with EE), questions concerning the optimum combination of electronic and optical compensation techniques, the impact of fibre nonlinearity on the performance of WDM systems employing EE and the potential of electronic signal processing for systems operating at channel rates of 40 Gbit/s and above. This workshop will address these issues, assessing the future role of high speed electronic processing in the next generation of optical networks.

Program

Chair: R. I. Killey, University College London

- 14:00 - 14:10 **Overview on electronic distortion mitigation**
H. Bülow, Alcatel-Lucent
- 14:10 - 14:30 **Moderate complexity equalizers for long-haul reach**
N. Alic, University of California San Diego
- 14:30 - 14:50 **Recent progress and future challenges for MLSE optical receivers**
P. Poggiolini, Politecnico di Torino
- 14:50 - 15:10 **Performance improvement of direct detection receivers by means of electronic post processing**
H. Griesser, Ericsson
- 15:10 - 15:30 **Alternative concepts for predistortion in high bit-rate transmission systems**
R. H. Derksen, Siemens
- 15:30 - 16:00 Coffee Break**

Chair: J. -P. Elbers, Ericsson

- 16:00 - 16:20 **Coherent 40 Gbit/s transmission and prospects for 100 Gbit/s**
K. Roberts, Nortel Networks
- 16:20 - 16:40 **Realtime coherent QPSK transmission: comparison of two carrier phase recovery approaches**
S. Hoffmann, R. Peveling, O. Adamczyk, T. Pfau, R. Noé, University of Paderborn
- 16:40 - 17:00 **Compensation of chromatic dispersion using coherent modulation and demodulation**
P. M. Watts, S.J. Savory, Y. Benlachtar, R. Waegemans, V. Mikhailov, P. Bayvel, University College London
- 17:00 - 17:20 **Nonlinearity and its compensation in optical-OFDM systems**
A. J. Lowery, Monash University
- 17:20 - 17:40 **Coherent optical MIMO-OFDM for optical fibre communication systems**
W. Shieh, University of Melbourne
- 17:40 - 17:50 **Sensitivity and distortion tolerance of optical OFDM**
F. Buchali, Alcatel-Lucent
- 17:50 - 18:00 Discussion**

Workshop 6 Hall 7 **Silicon Photonics in Telecom/Datacom: from Basic Research to Industrial Deployment**

*Chairs: Roel Baets, Ghent University - IMEC, Belgium
 Tom Pearsall, European Photonics Industry Consortium (EPIC), France
 Graham Reed, University of Surrey, UK*

Silicon photonics is rapidly gaining importance as a generic technology platform for a wide range of applications in telecom, datacom and sensing. It allows to implement optoelectronic functions in or above silicon through the use of wafer-scale technologies normally used for advanced CMOS-processing. Thereby it offers the prospect of using an existing industrial technology base for the manufacturing of advanced photonic components at low cost. In recent years there has been a plethora of scientific breakthroughs in this field, including the demonstration of ultra-compact passive optical functions, high speed optical modulators and detectors, silicon and silicon-compatible lasers, all-optical signal processing functions, integration with CMOS-circuitry etc.

This workshop aims to provide insight in the potential of this technology for the field of telecom and datacom. Both short- and long-term perspectives will be covered by a number of distinguished experts. The issue of access to CMOS fabs for prototyping and manufacturing of photonic components will also be addressed. The workshop will end with a panel discussion in which the experts and the audience will discuss the prospects and the challenges for the years to come in this dynamic field.

The workshop is co-organized by the European Network of Excellence ePIXnet (www.epixnet.org)

Program

- 14.00-14:10 **Opening**
Roel Baets, Ghent University-IMEC
- 14:10 - 14:40 **Why Silicon Photonics matters**
Thomas Koch, Lehigh University
- 14:40 - 15:05 **What Silicon can do for Electro-optical Modulation and all-optical Functionality at very high Bitrate**
Michal Lipson, Cornell University
- 15:05 - 15:30 **Making a Business out of Silicon Photonics**
Jean-Louis Malinge, Kotura
- 15:30 - 15:55 **Towards Foundries for Silicon Photonics**
Pieter Dumon, Ghent University-IMEC
- 15:55 - 16:25 Coffee Break**
- 16:25 - 16:50 **The best of two Worlds: Hybrid III-V/Silicon Integration for advanced Sources and Detectors**
John Bowers, UC Santa Barbara
- 16:50 - 17:15 **Heterogeneous Integration of III-V Sources and Detectors with, Silicon Photonic Wires by Wafer-scale CMOS-compatible Processes**
Jean-Marc Fedeli, CEA-LETI
- 17:15 - 17:40 **Pirelli's Roadmap on Silicon Photonics**
Marco Romagnoli, S. Ghidini, Pirelli
- 17:40 - 18:00 Discussion**

Get Together Reception (ICC Roofgarden) 18:00 - 19:30

Workshop 7 **Hall 8**
Networks for IT: A new Opportunity for Optical Network Technologies

Jointly sponsored by e-Photon/ONE+ (www.e-photon-one.org) and PHOSPHORUS (www.ist-phosphorus.org)

Chair: Dimitra Simeonidou, University of Essex,
Co-chairs: Mario Pickavet, Ghent University - IBBT,
 Anna Tzanakaki, Athens Information Technology,
 Ioannis Tomkos, Athens Information Technology,

Networks increasingly deal with managing and adapting distributed computing and associated data management resources (PCs, servers, supercomputers, clusters) and storage systems. Due to potentially very high aggregated demands for networked IT, a paradigm shift in the optical network architecture may be needed to enable dynamic and distributed IT services at large scale. This workshop offers a unique opportunity for optical network researchers and practitioners to exchange ideas and experiences on problems, challenges, solutions and future research and development issues concerning the deployment of optical networks for providing IT services. In addition to invited paper presentations, the workshop provides an intimate setting for discussion and debate.

Program

Chair: Anna Tzanakaki

- 14:00 - 14:10 **Workshop opening**
Dimitra Simeonidou, University of Essex
- 14:10 - 14:35 **Orchestrating optimally IT and network resource allocations for stringent distributed applications over ultrahigh bit rate transmission networks**
Dominique Verchere, Alcatel-Lucent, France
- 14:35 - 15:00 **The PHOSPHORUS project – new face of bandwidth on demand services**
Artur Binczewski, PSNC, Poland
- 15:00 - 15:45 **EnLIGHTened and G-lambda: reserving inter-domain lambda and compute resources across US and Japan**
Tomohiro Kudoh, AIST, Japan, Gigi Karmous Edwards, MCNC, USA
- 15:45 - 16:10 Coffee Break**
- Chair:* Ioannis Tomkos
- 16:10 - 16:35 **New requirements coming from entertainment, media and digital content for optical networks and control planes**
Peter Tomsu, Cisco Systems, Europe
- 16:35 - 17:00 **Resource virtualization and service abstraction for network and non-network resources**
Piero Castoldi, SSSUP, Italy
- 17:00 - 17:25 **SIP-based service virtualization for future IT services and applications over high speed optical networks**
Franco Callegati, University of Bologna, Italy
- 17:25 - 17:50 **Task scheduling in optical grid networks; A 3TNET approach**
Wei Guo, Shanghai Jiao Tong University, China
- 17:50 - 18:00 **Closing remarks**
Mario Pickavet, Ghent University

Workshop 8 **Hall 9**
Operation Expenditures (OpEx) Studies

Chairs: Carmen Mas Machuca, Munich University of Technology
 Monika Jaeger, T-Systems
 Sofie Verbrugge, Ghent University - IBBT

This workshop brings together researchers in the area of OpEx modeling and evaluation. Network operators have realized the high impact that OpEx has on the overall cost of their networks. To date, most of the existing studies have been focused on the Capital Expenditures (CapEx) of a certain technology, which are related to the network dimensioning and design. But nowadays, the interest is focused on OpEx and different challenges have been encountered such as for example how to model the OpEx factors, which are the most relevant factors, which is the impact that new control and management capabilities have on OpEx.

Program

- 14:00 - 14:20 Welcome and Introduction**
M. Jaeger
- 14:20 - 14:40 **Enabler of Cost-Efficient Network Operation**
Alex Vukovic
- 14:40 - 15:00 **Extending operational models to perform micro optimizations**
K. Casier, L. Van Halewyck, S. Verbrugge, D. Colle, M. Pickavet, P. Demeester
- 15:00 - 15:20 **Modeling of OpEx in network and service life-cycles**
Carmen Mas, Oyvind Moe, Monika Jaeger
- 15:20 - 15:40 **Characterizing the CapEx and OpEx Tradeoffs in Next Generation Fiber-to-the-Home Networks**
Thomas Rand Nash, Richard Roth, Rajev J. Ram, Randolph Kirchain
- 15:40 - 16:10 Coffee Break**
- 16:10 - 16:30 **OPEX modeling – a regulatory perspective**
Gabriele Kulenkampff, Konrad Zoz
- 16:30 - 16:50 **Increasing cost transparency by using process oriented OpEx modeling methods and standardized process frameworks**
Nikolaus Konrad
- 16:50 - 17:10 **The MOD-OPEX tool: methods and case studies**
Bodo Jacobs, Sandra Priess
- 17:10 - 17:30 **OpEx Benefits of Digital Optical Networks**
Vijay Vusirikala, Serge Melle
- 17:30 - 18:00 Wrap-Up and Closing**

Workshop 9 **Hall 10**
High Data Rate Transmission (340 Gbit/s) on Legacy Networks Fibre Infrastructure with Significant PMD

Chairs: Peter Winzer, Alcatel Lucent
 Werner Weiershausen, Deutsche Telekom, T-Systems,

Realisation of PMD tolerant WDM systems is a major challenge since the development of first 40Gb/s systems end of the 90's. Today the worldwide deployment of 40Gb/s interfaces has reached a certain volume, not least driven by next generation IP routers, thus increasing the pressure on carriers and system manufacturers to realize 40Gb/s backbone transport. Since many network operators are using their legacy fibre infrastructure partly exhibiting significant PMD values, PMD tolerance is a key system parameter for the deployment of 40Gb/s based WDM. Inherently tolerant advanced modulation formats, parallel channel transmission schemes, as well as optical and electrical compensators, are competing for market shares. Furthermore, solutions based on coherent detection combined with equalizers are under development in many laboratories of universities, subsystem and system vendors. This workshop wants to draw a bow from the innovation in components and subsystems to the network aspects and operators' needs.

Sunday

Conference Opening and Plenary Session

10:00 - 10:15

Opening Ceremony

Hans-Joachim Grallert, *Heinrich-Hertz-Institute, Germany*

10:15 - 10:45

Internet Economics, Internet Evolution, and misleading Networking Myths

Andrew Odlyzko, *Director of the interdisciplinary Digital Technology Center and Interim Director of the Minnesota Supercomputing Institute, both at the University of Minnesota.*

Abstract: The evolution of the Internet will depend heavily on the interaction between what users want and what technology can deliver, and economics will play a major role. Unfortunately the networking community continues to be guided by a collection of misleading dogmas that impede proper direction of research, development, and deployment. The roles of voice communication, of content, and of streaming real-time transmission versus file transfers are widely misunderstood, which leads to plans that are likely to be seriously flawed.



Andrew Odlyzko prior to moving to Minnesota in 2001, he devoted 26 years to research and research management at Bell Labs and AT&T Labs. He has written over 150 technical papers and has three patents. He has managed projects in diverse areas, such as security, formal verification methods, parallel and distributed computation, and auction technology. In recent years he has also been working on electronic publishing, electronic commerce, and economics of data networks. All his recent papers as well as further information can be found on his home page at <http://www.dtc.umn.edu/~odlyzko>.

10:45 - 11:15

Broadband, the important Part of T-Coms Network

Wolfgang Schmitz, *Senior Executive Vice President, Technology Engineering Center Deutsche Telekom – T-Com*

Abstract: Competitive and regulatory environment within the classic telecom markets encourages especially incumbent carriers to offer next generation services (NG) which integrate the classic voice service with internet and video services. T-Com currently rolls out a fiber to the cabinet infrastructure which enables an access bandwidth of 50 Mbit/s or more with VDSL technology.

To cope with the requirements of the next generation services the network infrastructure passes through a fast conversion during the upcoming years. Development trend is generally from circuit oriented to packet oriented and towards higher data rates. In the backbone an IP over OTN architecture using a "wavelength" as smallest circuit oriented granularity is envisaged. Efficient transport technology using ROADM (Reconfigurable Optical Add Drop Multiplexer) and 40 G/100 G are currently the major challenges. Ethernet, partly transported over OTN (Optical Transport Network) / WDM (Wavelength Division Multiplex), is used as major aggregation technology.



Wolfgang Schmitz is SEVP at Deutsche Telekom. In this capacity, he heads the Technology Engineering Center (TEC) at T-Com. He has over 25 years of experience in technical processes in global telecommunications, which he expanded before the takeover of TEC in various areas of Deutsche Telekom. He is responsible for the technical refinement of the entire network-based infrastructure/transport platforms and the further development of all service platforms such as IP, traffic selector platform for DSL, PSTN/ISDN and the intelligent network for the T-Com area. Other important areas of work include technical innovations for NGN, high-speed DSL systems and the implementation of triple play (IPTV). He applies his extensive knowledge in his current position to help

shape Deutsche Telekom's strategies. He is a sought-after contact for the top management of all well-known telecommunications manufacturers. His great expertise also means he has direct contacts in the relevant research and development areas. Wolfgang Schmitz is married, has a degree in engineering (e-Technology) and lives near Darmstadt.

11:15 - 11:45

Challenges of Future Broadband Network

Stephan Scholz, Designated CTO and head of the Research, Technology and Platforms at Nokia Siemens Networks

Abstract: In 2015, we will live in a world where five billion people will be connected, mostly via broadband access. The Internet will be the pre-dominant source of content and applications – consumed by end-users expecting a high degree of mobility support for their services.

The popularity and quick adoption of bandwidth-hungry triple-play services requiring 25 to 100 Mb/s, drive the need for considerable capacity increase in the access, transport, and aggregation domains. At the same time, the overall market pressure to reduce the total cost of ownership calls for architecture renewal.

Examples of such renewal include: Fiber to the home or cabinet, reduced number of local and central offices with extended last mile, flat metro aggregation through Ethernet over optics, simplified transport service for fixed & mobile networks using L2 and L1 switching.



Stephan Scholz joined Siemens in 1990 after graduating from the Technische Universität München and the Max Planck Institute for High Energy Physics. Since 2003 he heads Carrier Development worldwide at Siemens and is responsible for all carrier products including softswitches, gateways and next generation applications like IPTV, and their respective network management.

Previous to this, he was Senior Vice President of Wireline Networks Carrier Convergence, Vice President of Product Management at Siemens Wireline Networks Carrier Switching Division, and held various sales, marketing and business management positions at Siemens Information Communication Networks, in the United States from 1997 to 1999.

11:45 - 12:15

Development and Prospect of Optical Network in China

Leping Wei, Chief Technology Officer of China Telecom Corporation

Abstract: The speech starts with overall profile of telecom industry in China. Then the speech summarizes major development directions of CTC's optical networks. Thirdly, the speech introduces three phases for ASON project and key issues for MAN development. Fourthly, the speech illustrates latest broadband access development and gives access bandwidth demand for the next 5 years in CTC's market. Finally, the speech presents evolution routs of FTTx in China.



Mr. **Leping Wei** graduated from the department of E.E. of Tsing Hua University in 1970 and received the M.S. of E.E. degree from China Academy of Post and Telecom. Science, Beijing, in 1981 in P.R.China. His research interests are optical fiber communication, SDH, access network, NGN/NGI and network evolution strategy. He has published over 100 papers and 8 books. Currently he holds the positions as Chief Technology Officer of China Telecom Corporation.

12:15 - 12:30

General Information on the Conference

Andreas Gladisch, T-Systems International GmbH, Germany

Lunch Break 12:30 - 14:00

Session 1.1 Hall 3
Symposium on Broadband Access Technologies

Chair: Thomas P. Pearsall, EPIC; Stéphane Gosselin, Telecom R&D/CORE, France, Alfredo Viglienzoni, Ericsson, Italy

14:00
Introduction
 Stéphane Gosselin

1.1.1 14:10
Design and Performance of Low-cost WDM-PON Access Networks
 Dong Jae Shin, Hong Seok Shin, Sung Bum Park, Dae Kwang Jung, Yunje Oh, Samsung Electronics, Korea
 ♦ Design and performance of low-cost wavelength division multiplexed-passive optical network. WDM-PON candidates are presented. The relative system costs of the candidates are also estimated.

1.1.2 14:35
Enabling Services in Broadband Access
 Peter Vetter, Francois Fredricx, Edith Gilon, Chris Hawinkel, Steven Van den Berghe, Alcatel-Lucent, Belgium
 ♦ The paper describes functions to enable services over a broadband access network. A service plane is introduced to embed such functions in the access network. Examples for multimedia delivery are given.

1.1.3 15:00
FTTC: The Concept for Implementing Broadband Access and the Experience of Deutsche Telekom
 Nikolaus Gieschen, T-Systems Enterprise Services GmbH, Germany
 ♦ In 2006 Deutsche Telekom initiated a full scale roll-out of VDSL-based broadband access technology providing the coverage of about 8 Mio. Customers with very high speed internet accesses by end of the year.

1.1.4 15:25
How Deep should Fibre go into the Access Network?
 Ton Koonen, Ng'oma Anthony, Gert-Jan Rijkenberg, Maria Garcia Larrode, Patryk Urban, Huug de Waardt, Henrie van den Boom, Jia Yang, Hejie Yang, COBRA, Eindhoven Univ. of Technology, The Netherlands
 ♦ Optical fibre access to the home provides the most powerful and future-proof solution for versatile broadband services delivery, in combination with flexible optical routing, wireless last links to the user, and converged optical in-building networks.

Session 1.2 Roofgarden
Silicon Photonics

Chair: Alfred Driessen, University of Twente, The Netherlands

1.2.1 14:00
Tutorial: Manipulating Light on a Silicon Chip
 Michal Lipson, Cornell University, USA
 ♦ Photonics on chip could enable a platform for monolithic integration of optics and microelectronics for applications of optical interconnects in which high data streams are required in a small footprint. Recent results in Si Nanophotonics have shown the ability to guide, filter, bend and split light on Silicon chips using nano-size structures.
 In this talk I will review the challenges and achievement in the field of Silicon Nanophotonics and present our recent results. Using highly confined photonic structures we have demonstrated ultra-compact passive and active silicon photonic components with very low loss. The highly confined photonic structures enhance the electro-optical and non-linearities properties of Silicon. We demonstrated several active components including all-optical and electro-optic low power switches and modulators on silicon.

1.2.2 15:00
Multi-Channel Dispersion Compensation by Optical Phase Conjugation in Silicon Waveguide
 Simon Ayotte, Haisheng Rong, Shengbo Xu, Mario Paniccia, Intel Corporation, USA; Oded Cohen, Intel Corporation, Israel; Intel Corporation, USA
 ♦ We experimentally demonstrate dispersion compensation using a silicon based optical phase conjugator for simultaneous transmission of 4 DWDM channels of 10 Gb/s optical data over 320 km of standard fiber with negligible power penalty.

1.2.3 15:15
Tunable, Fourth-Order Silicon Microring-Resonator Add-Drop Filters
 Milos Popovic, Tymon Barwicz, Marcus Dahlem, Fuwan Gan, Charles Holzwarth, Peter Rakich, Henry Smith, Erich Ippen, Franz Kärtner, Massachusetts Institute of Technology, USA
 ♦ We demonstrate the first tunable, high-order channel add-drop filters based on silicon microring resonators. They meet rigorous, telecom-grade spectral requirements for microphotonic R-OADMs, reconfigurable optical add-drop multiplexers. The design addresses 100GHz-spaced, 40GHz-wide channels over 16-32nm.

1.2.4 15:30
Integrated Si3N4/SiO2 Slot-Waveguide Microresonators
 Carlos Barrios, Rafael Casquel, Miguel Holgado, Universidad Politecnica de Madrid, Benito Sanchez, Amadeu Griol, Universidad Politecnica de Valencia, Spain; Kristinn Gylfason, Hans Sohlström, Royal Institute of Technology, Sweden
 ♦ We demonstrate slot-waveguide microring resonators and Fabry-Perot microcavities on Si₃N₄/SiO₂. Characterization indicates guiding and confinement in the waveguide nanometric-size low-index slot region at O-band, 1260-1370nm wavelengths. We measured propagation losses <20 dB/cm.

Session 1.3 Hall 4/5
High Speed Transmission

Chair: Peter Andrekson, Chalmers University of Technology, Sweden

1.3.1 14:00
Invited: High speed Transmission Technologies for 100Gbit/s-class Ethernet
 Itsuro Morita, Sander Jansen, KDDI R&D Laboratories, Japan
 ♦ The demand for high speed optical transmission systems for adapting to the next generation higher speed Ethernet is increasing. This paper reviews enabling technologies to increase the channel bit rate to 100 Gbit/s.

1.3.2 14:30
Impairment Tolerance of 111Gbit/s POLMUX-RZ-DQPSK using a reduced Complexity Coherent Receiver with a T-spaced Equaliser
 Thomas Duthel, Chris Fludger, Christoph Schullien, CoreOptics GmbH, Germany; Dirk van den Borne, Giok-Djan Khoe, Huug de Waardt, Eindhoven University of Technology, The Netherlands; Ernst-Dieter Schmidt, Erik de Man, Nokia Siemens Networks GmbH & Co KG, Germany; Torsten Wuth, Siemens PSE GmbH & Co KG, Germany
 ♦ The tolerance to narrow spectral filtering in presence of chromatic dispersion is investigated for 111Gbit/s POLMUX RZ-DQPSK. It is shown that the use of T-spaced equalisers is enabled by appropriate electrical filtering.

1.3.3 14:45
160 Gbit/s-900 km DPSK Transmission with Time-domain Optical Fourier Transformation
 Toshihiko Hirooka, Masatada Okazaki, Kou Osawa, Masataka Nakazawa, Tohoku University, Japan
 ♦ A straight-line 160 Gbit/s-900 km DPSK transmission was successfully demonstrated with time-domain optical Fourier transformation without employing polarization multiplexing or Raman amplification. The transmission performance was almost ASE limited due to in-line EDFAs.

1.3.4 15:00
160 Gb/s Error-Free Transmission through a 100-km Fibre Link with Mid-Span All-Optical SOA-Based Wavelength Conversion
 Javier Herrera Llorente, Eduward Tangdiongga, Huug de Waardt, Oded Raz, Giok-Djan Khoe, Ton Koonen, Harm J.S. Dorren, Eindhoven University of Technology, The Netherlands; Yong Liu, University of Electronic Science & Technology of China, P.R. China; Javier Marti, Francisco Ramos, Universidad Politecnica de Valencia, Spain
 ♦ 160 Gb/s error-free transmission with acceptable penalty levels is demonstrated through a 50-km fibre link followed by a high-speed all-optical SOA-based wavelength converter and subsequently followed by another 50-km fibre link.

1.3.5 15:15
1,200 km SMF, 100 km spans 280 Gbit/s Coherent WDM Transmission using Hybrid Raman/EDFA Amplification
 Tadhg Healy, Fatima Garcia-Gunning, Tyndall National Institute, University College Cork, Ireland; Erwan Pincemin, France Telecom R&D, Benjamin Cuenot, JDS Uniphase, France; Andrew Ellis, UCC, United Kingdom
 ♦ We report the world's first transmission of a 280Gbit/s Coherent WDM, 261Gbit/s capacity signal, over 1200km with 100km spans of SMF, a pattern length of 2³¹-1, and with hybrid Raman/EDFA amplification.

Session 1.4 **Hall 7**
Fiber Lasers and Amplifiers I

Chair: Evgeny Dianov, Fiber Optics Research Center of the Russian Academy of Sciences, Russia

1.4.1 **14:00**
Invited: High Control in High Power Fiber Lasers and Amplifiers

Yoonchan Jeong, J. N. Maran, S. Yoo, A. J. Boyland, J. K. Sahu, J. Nilsson ORC, University of Southampton, United Kingdom

◆ We discuss fundamental aspects and future prospects of high power fiber lasers and amplifiers with particular attention to high control of cladding-pumped, rare-earth-doped fiber sources in a multitude of regimes.

1.4.2 **14:30**
A $\lambda/4$ -shifted Distributed Feedback Semiconductor Fiber Ring Laser with an OSNR of 85 dB and a Linewidth of 7 kHz

Akihito Suzuki, Ho Thi Quynhanh, Masato Yoshida, Masataka Nakazawa, Tohoku University, Japan

◆ We newly propose a $\lambda/4$ -shifted DFB semiconductor fiber ring laser incorporating an ultranarrow band FBG in the cavity. Large performance improvements with an OSNR of 85 dB and a linewidth of 7 kHz are obtained.

1.4.3 **14:45**
Simultaneous Spatial and Spectral Transparency Using Ultralong Fibre Laser Transmission

Juan Diego Ania-Castanon, Vassilios Karalekas, Paul Harper, Sergei Turitsyn, Aston University, United Kingdom

◆ We propose and experimentally implement ultra-long laser links providing cross-domain transparency over space and frequency, applicable to communications and signal processing. Full transparency over a 20 nm window is demonstrated for a 20 km span

1.4.4 **15:00**
Impact of Nonlinear Spectral Broadening on the Efficiency of Ultra-Long Raman Fiber Laser Transmission Links

Vassilios Karalekas, Juan Diego Ania-Castanon, Paul Harper, Vladimir Mezentsev, Sergei Turitsyn, Aston University, United Kingdom; Sergey Babin, Evgenii Podivilov, Institute of Automation and Electrometry, Russia

◆ We study the impact of nonlinear spectral broadening in ultra-long Raman laser cavities up to a record length of 82 km, and its implications for the design of quasi-lossless spans for signal transmission and processing.

1.4.5 **15:15**
Ytterbium-doped 2D Solid Core Photonic Bandgap Fiber for Laser Operation at 980 nm

Laurent Bigot, Vincent Paturel, Géraud Bouwmans, Yves Quinquempoix, Université de Lille, France; Yves Jaouen, GET / Telecom Paris, France

◆ We report on the fabrication and characterization of an ytterbium-doped Solid Core Photonic Bandgap Fiber. The bandgap losses introduced on the wavelength range above 1000 nm are used to favour laser gain at 977 nm.

1.4.6 **15:30**
Acoustically Q-switched Single-frequency Fibre Laser

Martina Delgado-Pinar, Antonio Diez, Jose Luis Cruz, Miguel Andres, Universidad de Valencia, Spain

◆ We present an actively Q switched DFB fibre laser. An acoustic pulse traveling along a fibre grating written in Er-doped fibre generates a dynamic defect that makes the DFB laser to operate in pulsed regime.

Session 1.5 **Hall 9**
Fibers and Fiber Components

Chair: Shu Namiki, National Institute of Advanced Industrial Science and Technology, AIST, Japan

1.5.1 **14:00**
Invited: Recent Advances in Ultra-Compact Highly Nonlinear Fibers and Their Applications

Masanori Takahashi, Masateru Tadakuma, Jiro Hiroishi, Yu Mimura, Ryuichi Sugizaki, Takeshi Yagi, Furukawa Electric co., Ltd., Japan

◆ We review design and characteristics of recently reported down-sized highly nonlinear fibers, HNLFs and ultra-compact HNLF modules. Furthermore, not only down-sizing, new attractive application is realized by utilizing unique mechanical characteristics of down-sized HNLF.

1.5.2 **14:30**
Fiber Fuse Effect: New Results on the Fiber Damage Structure

Igor Bufetov, Artem Frolov, Alexey Shubin, Mikhail Likhachev, Sergej Lavrishchev, Evgeny Dianov, Fiber Optics Research Center of the Russian Academy of Sciences; Vladimir Khopin, Institute of Chemistry of High Purity Substances of RAS, Russia

◆ Interference of fiber modes in the process of optical discharge propagation along the fiber enables one to influence the parameters of the process and to produce sequences of bubbles with a period of ~10-1000µm.

1.5.3 **14:45**
Large Aeff NZ-DSF with Dispersion Slope of 0.02 ps/nm²/km by utilizing Restrict-Mode-Excitation Method

Katsunori Imamura, Kazunori Mukasa, Masateru Tadakuma, Ryuichi Sugizaki, Takeshi Yagi, Furukawa Electric co., Ltd., Japan

◆ Large Aeff NZ-DSFs with Aeff larger than 65 µm² and dispersion slope of 0.02 ps/nm²/km were successfully fabricated by utilizing Restrict Mode Excitation method. The pure single mode pulse transmission was experimentally confirmed.

1.5.4 **15:00**
Holographic Tailoring of Launch Profile for Modal Selection in a 50µm Core Diameter Multi-Mode Fibre

Poh Ling Neo, Jon Freeman, Timothy Wilkinson, University of Cambridge, United Kingdom

◆ A spatial light modulator with a closed-loop iterative algorithm is demonstrated to be capable of performing modal control in a multimode fibre, generating a beam-size reduction and expansion of 30% and 100% in full-width half-maximum.

1.5.5 **15:15**
Inscription of Zone Plate Pattern on the Optical Fiber End Surface using Femtosecond Laser Pulses

Jun Ki Kim, Hae Young Choi, Yongmin Jung, Byeongha Lee, Gwangju Institute of Science and Technology, Kyungwhan Oh, Yonsei University, Ik-Bu Sohn, Young-Chul Noh, Jongmin Lee, APRI -Precision Optics Lab, Korea

◆ We fabricated a compact fiber based zone plate on the coreless-silica-fiber, CSF segments of 200µm diameter by femtosecond laser. We investigated the focusing properties by launching a He-Ne laser beam into the optical fiber

1.5.6 **15:30**
All-optical Hilbert Transformer for Optical Single-side-band Modulation by using Sampled Fiber Bragg Grating based Optical Transversal Filter

Masanori Hanawa, Kazuhiko Nakamura, Katsumi Takano, Kiyoshi Nakagawa, Yamagata University, Japan

◆ The first implementation of an optical Hilbert transformer for optical single side-band modulation, by using sampled fiber Bragg grating, has been reported. The principle, design, and measured frequency/time responses have been shown.

Session 1.6 **Hall 10**
Optical Burst Switching

Chair: Ioannis Tomkos, AIT, Greece

1.6.1 **14:00**
Demonstration of a Fully Functional Optical Burst Switched Network with Application Layer Resource Reservation Capability

Georgios Zervas, Reza Nejabati, Yixuan Qin, Dimitra Simeonidou, Mike O'Mahony, University of Essex, United Kingdom; Aldo Campi, Franco Callegati, Università di Bologna, Italy; Martin Reed, University of Essex, United Kingdom; Siyuan Yu, University of Bristol, United Kingdom

◆ We demonstrate on-demand application layer resource reservation over a fully functional application-aware OBS test-bed. This is achieved by hardware implementation and integration of application layer Session Initiation Protocol, SIP and the OBS Just-In-Time, JIT signalling

1.6.2 **14:15**
Experimental Validation of Deflection Routing in a 3-Node Optical Burst Core Network with 40Gb/s Edge Nodes

Abdullah Al Amin, Mitsuru Takenaka, Takuo Tanemura, Katsuhiko Shimizu, Yoshiaki Nakano, University of Tokyo, Ryo Inohara, Kohsuke Nishimura, Masashi Usami, KDDI R&D Laboratories Inc., Japan; Yutaka Takita, Yutaka Kai, Hiroshi Onaka, Fujitsu Limited, Hisato Uetsuka, Hitachi Cable Ltd., Japan

◆ We demonstrate deflection routing for random burst collision in a 3-node optical burst switching network testbed. Using an Ether-frame capable burst edge node, layer 2 characterization was performed, with near-theoretical low frame error at 40Gb/s.

1.6.3 **14:30**
Experimental Demonstration of Interworking GMPLS with OBS Networks

Hongxiang Guo, Takehiro Tsuritani, Tomohiro Otani, Masatoshi Suzuki, KDDI R&D Laboratories Inc., Japan; Yawei Yin, Peiwei Huang, Zheng Guannan, Jian Wu, Jintong Lin, Beijing University of Posts and Telecommunications, P.R. China

◆ Dynamic interworking operation between GMPLS and OBS networks was successfully demonstrated for the first time by GMPLS extensions of a group-LSP and node capability advertisement. Data burst transmission over the create group-LSP was also verified.

1.6.4 **14:45**
A Fault-Tolerant OBS Node Architecture with Resilient Buffers

Jing Zhang, University of California - Davis, USA; Lei Song, University of California, Davis, USA; Biswanath Mukherjee, Dept. of Computer Science - Univ. of California Davis, USA

◆ We investigate a novel fault-tolerant node architecture using a resilient buffer, R-buffer in optical burst switching, OBS networks. Our study shows that most of the lost bursts can be restored quickly using the architecture.

1.6.5 **15:00**
Bandwidth-Efficient Optical Burst-Switched Networks based on Traffic Engineering in the Wavelength Domain and Delayed Burst Scheduling

João Pedro, Paulo Monteiro, Nokia Siemens Networks Portugal, João Pires, Instituto de Telecomunicações, Portugal

◆ This paper shows that simple JET-based OBS networks can be designed to achieve high bandwidth utilization efficiency by combining traffic engineering in the wavelength domain and delayed burst scheduling at the ingress nodes.

1.6.6 **15:15**
All-optical Latching Circuit controlled by a 2-bit All-optical Correlator

Jose M. Martinez Canet, Raquel Clavero Galindo, Javier Herrera Llorente, Francisco Ramos, Javier Marti, Universidad Politecnica de Valencia, Spain; Yong Liu, University of Electronic Science & Technology of China, P.R. China; Ton Koonen, Harm J.S. Dorren, COBRA, Eindhoven Univ. of Technology, The Netherlands

◆ The routing functionality by all-optically interconnecting semiconductor-based optical logic gates and flip-flops is demonstrated in the frame of an all-optical label swapping network. High extinction ratios are obtained at the output of the flip-flop.

1.6.7 **15:30**
AOLS Node with Sequential Address Generation and Label Recognition

Ruth Van Caenegem, Didier Colle, Mario Pickavet, Piet Demeester, Ghent University, Belgium

◆ This paper proposes an all-optical counter, which is built out of MZI switches. Due to the counter, all-optical labels can be checked sequentially. A dimensioning study shows how it improves the AOLS node's scalability.

Session 2.1 **Hall 3**
Symposium on Broadband Access Technologies (continued)

Chair: Thomas P. Pearsall, EPIC; Stéphane Gosselin, France Telecom R&D/CORE, France, Alfredo Viglienzoni, Ericsson, Italy

2.1.1 **16:10**

Deep-fiber Broadband Access Networks

Martin Hatas, Ericsson, Sweden

◆ This paper looks into two recent standards, GPON and VDSL2 as means of deploying large scale FTTx networks. Respective technologies and topologies are described together with lessons learned during several years of practical FTTx deployment.

2.1.2 **16:35**

Infrastructure and Challenges for Convergence of Radio, Fiber and ADSL Technologies

Yukio Horiuchi, KDDI R&D Laboratories, Inc., Japan

◆ This paper describes broadband fixed access networks and its services as well as an optical infrastructure for mobile phone networks. Challenges and convergence scenarios from fixed mobile and broadcasting converged perspectives are also discussed.

2.1.3 **17:00**

FTTH versus FTTC in optical Access Networks

Bruno Capelle, France Telecom, France

◆ Both for FTTH and FTTB deployments, this paper is focusing on the main strategic issues to be solved in the fibre access and the residential building installation and is suggesting some options what could be able to reduce operational costs for PON configurations.

2.1.4 **17:25**

Access Network Technologies: Deployments in Sweden

Claus Popp Larsen, Ericsson Telecom AB, Sweden

◆ Access-network technologies are discussed in the context of Swedish deployments. Sweden is characterised by a high penetration of FTTH. The most common technology is point-to-point Ethernet, either as an L2 or as an L3 solution.

End of Symposium 17:50

Session 2.2 **Roofgarden**

Chair: Masataka Nakazawa, Tohoku University, Japan

2.2.1 **16:15**

Tutorial: Forward Error Correction in Optical Communication Systems

Takashi Mizuochi, Mitsubishi Electric Corporation, Japan

◆ In this tutorial, the basics of forward error correction, FEC are explained, and the key terms related to FEC in optical communications are clarified, e.g. net coding gain, code rate, input BER, output BER, Q limit, and Shannon limit. We then review the history of FEC in optical communications. The various FECs reported to date are classified as belonging to three generations: RS, 255, 239 represents the first generation, concatenated codes are the second generation, and more powerful FEC based on soft-decision decoding is the third generation. The second generation FECs will be explained, and recently developed concatenated codes discussed. The third generation FECs are analyzed in detail, with emphasis on block turbo codes and low-density parity check codes for superior NCGs with soft decision decoding. The positive impacts on existing systems are also discussed. We will relate each generation of FEC to the Shannon limit, and discuss the ultimate NCG as a function of code rate. The additional useful functionalities obtained by employing FECs and the application of FEC to error monitoring for adaptive equalization will also be covered. Finally, this tutorial anticipates possible roles for optical technologies in future optical communication networks.

Session 2.3 **Hall 4/5**
High Capacity Systems

Chair: Paul Harper, Aston University, United Kingdom

2.3.1 **16:15**

Invited: 8x107 Gbit/s Serial Binary NRZ/VSB Transmission over 480 km SSMF with 1bit/s/Hz Spectral Efficiency and without Optical Equalizer

Karsten Schuh, Eugen Lach, Bernhard Junginger, Axel Klekamp, Gustav Veith, Alcatel-Lucent Research & Innovation, Germany

◆ We demonstrate error free 8x107 Gbit/s DWDM serial binary NRZ VSB transmission over 480 km SSMF without using an optical equalizer. A spectral efficiency of 1bit/s/Hz is achieved.

2.3.2 **16:45**

Unrepeated Transmission of 160 Gb/s RZ-DPSK over 240 km Dispersion Managed Fiber

Reinhold Ludwig, Carsten Schmidt-Langhorst, Colja Schubert, FhG Heinrich-Hertz-Institut, Germany; Stefan Weisser, Lutz Raddatz, Alcatel-Lucent, Germany

◆ The advantages of using RZ-DPSK in combination with Raman amplification and advanced forward-error-correction are shown in an OTDM-transmission experiment of a 160 Gb/s single-polarization signal over an unrepeated distance of 240 km.

2.3.3 **17:00**

Bi-directional unrepeated Transmission over 436 km using Third-order distributed Raman Amplification

E. Brandon, P. Bousselet, I. Brylski, N. Tranvouez, D. Mongardien, Alcatel-Lucent, France

◆ An error-free transmission experiment in bidirectional unrepeated configuration over 436 km is reported. Particular attention has been paid to Rayleigh backscattering and distributed Raman amplification, enabling us to cover 77 dB span loss.

2.3.4 **17:15**

Demonstration of a 960 Gb/s, 96 x 12.3 Gb/s Transpacific OADM Network in a Re-Circulating Single-Loop Transmission Experiment

Bamdad Bakhshi, Ekaterina Golovchenko, Stuart Abbott, Tyco Telecommunications, USA

◆ We present the first laboratory demonstration of transoceanic OADM-networks. Using a new method for study of networks in re-circulating single-loop transmission experiments, we demonstrate successful transpacific 96x12.3Gb/s DWDM-networking, including transmission over various OADM-branches.

2.3.5 **17:30**

70 x 10 Gbps, mixed RZ-OOK and RZ-DPSK Upgrade of a 7224 km conventional 32 x 10 Gbps designed System

Laurent du Mouza, Sebastien Dupont, Pierre Marmier, Vincent Letellier, Alcatel-Lucent Submarine Networks, Gabriel Charlet, Alcatel-Lucent Research and Innovation, France

◆ We report a laboratory transmission experiment demonstrating the upgradeability of a conventional 7224 km NZDSF link designed for 32 x 10 Gbps CRZ capacity by using a mix of 24 OOK-RZ and 46 RZ-DPSK 10 Gbps channels

2.3.6 **17:45**

Performance Assessment of DQPSK using Pseudo-Random Quaternary Sequences

Bernhard Spinnler, Nokia Siemens Networks, Germany; Changsong Xie, Siemens, Germany

◆ We present performance assessments of optical communications systems employing DQPSK modulation format and pseudo-random multi-level data sequences of various lengths. Differences to simulation results based on pseudo-random binary sequences will be pointed out and discussed.

Session 2.4 **Hall 7**
Fiber Lasers and Amplifiers II

Chair: Evgeny Dianov, Fiber Optics Research Center of the Russian Academy of Sciences, Russia

2.4.1 **16:15**

Invited: Large Effective Area Optical Fibres for Lasers and Amplifiers

Liang Dong, Jun Li, IMRA America, Inc.; Ann Arbor, Xiang Peng, Raydiance, Orlando, USA

◆ Built-in mode filtering in leakage channel fibres enables robust fundamental mode operation with effective area much larger than possible with conventional approaches. Recently effective area exceeding ~3000µm² and PM fibre have been demonstrated.

2.4.2 **16:45**

High Efficiency and High Output Power Fiber Optic Parametric Amplifier

Shoichiro Oda, Henrik Sunnerud, Peter Andrekson, Chalmers University of Technology, Sweden

◆ We demonstrate a nearly complete depletion of 99.92% and a high power conversion efficiency with a signal output power of 0.53 W in a fiber optic parametric amplifier with a pump power of 1 W.

2.4.3 **17:00**

Pump-to-Stokes relative Intensity Noise Transfer in Brillouin Amplifiers

Junhe Zhou, Lilin Yi, Philippe Gallion, GET/ENST, CNRS, France; Yves Jaouen, GET / Telecom Paris, France; Jianping Chen, Shanghai Jiao Tong University, P.R. China

◆ This paper proposes for the first time an analytical expression of the relative intensity noise, RIN transfer in Brillouin amplifiers. Theoretical modelling and experimental measurements have been performed in the case of narrow linewidth pump.

2.4.4 **17:15**

Stimulated Brillouin Amplification in a Tellurite Fiber as a potential System for Slow Light Generation

Guanshi Qin, Yasutake Ohishi, Toyota Technological Institute, Hideyuki Sotobayashi, Masahiro Tsuchiya, National Institute of Information and Communications Technology, Atsushi Mori, NTT Photonic Laboratories, Japan

◆ We demonstrated stimulated Brillouin amplification in a single mode non-doped tellurite fiber. Potential performance of a tellurite fiber for slow light generation is clarified on the base of Brillouin gain characteristics.

2.4.5 **17:30**

Combined Effect of Kerr and Raman Nonlinearities on Single-pump Optical Parametric Amplifiers.

Stuart Murdoch, John Harvey, Stephane Coen, Frederique Vanholsbeeck, Rainer Leonhardt, Gordon Wong, Andy Hsieh, University of Auckland, New Zealand

◆ We demonstrate both theoretically and experimentally the influence of the Raman susceptibility on single-pump parametric amplifiers. We discuss the implications of this result for the design of broadband optical parametric amplifiers.

2.4.6 **17:45**

Low Noise Fiber Raman Amplifiers using a Raman Ring Fiber Oscillator

Joon Tae Ahn, Hong-Seok Seo, Bong Je Park, ETRI, Korea

◆ We propose two fiber Raman amplifier schemes based on Raman ring fiber oscillator to reduce double Rayleigh scattering noise at high gains and successfully demonstrate their low noise characteristics by measuring bit-error-rate data at 10Gb/s.

Session 2.5 **Hall 9**
MUX/DEMUX and Waveguides

Chair: Hanne Ludvigsen, Helsinki University of Technology, Finland

2.5.1 **16:15**

Invited: 1-square-inch 100GHz 40ch VMUX/DEMUX based on Single-chip PLC Integration with 2.5%-Delta Silica-based Waveguides

Mikitaka Itoh, Kei Watanabe, Yusuke Nasu, Hiroshi Yamazaki, Shin Kamei, Ikuo Ogawa, Akimasa Kaneko, Yasuyuki Inoue, NTT Photonics Laboratories, Japan

◆ We developed a 1-square-inch 100GHz 40ch VMUX/DEMUX based on single-chip PLC integration and stacked PD integration techniques. The use of 2.5%-delta silica-based waveguides greatly reduced the chip size without degrading optical performance.

2.5.2 **16:45**

PLC-type Demultiplexer with a Spectral Modulation Function

Takuya Tanaka, Naoki Ooba, Shin Kamei, Yasuyuki Inoue, NTT Photonics laboratories, Masamichi Fujiwara, Hiro Suzuki, NTT Access Network Service Systems Laboratories, Japan

◆ We report a 100-GHz-spacing 48-channel PLC-type demultiplexer with a wavelength monitoring function composed of an MZI and two AWGs. Its transmission spectra can be shifted at a practical rate by modulating the MZI section.

2.5.3 **17:00**

Waveband Selective Switch Using Concatenated AWGs

Shoji Kakehashi, Hiroshi Hasegawa, Ken-Ichi Sato, Nagoya University, Japan; Osamu Moriwaki, Masayuki Okuno, NTT Electronics, Japan

◆ We propose a novel waveband-selective switch. The switch makes the best use of the waveband multi/demultiplexers that can be created by connecting concatenated Planar Lightwave Circuit AWGs and switches. Its performance is successfully demonstrated.

2.5.4 **17:15**

20GHz Channel Spacing InP-based Arrayed Waveguide Grating

Francisco Soares, Wei Jiang, Sang-Woo Seo, Jong Hwa Baek, Ronald Broeke, Jing Cao, Ben Yoo, University of California, Davis, USA; Fredrik Olsson, Royal Institute of Technology, Sweden; Sebastian Lourduoss, Royal Institute of Technology, USA

◆ We demonstrate a 10-channel InP-based Arrayed-Waveguide Grating, dimensions = 5.0x6.0 mm² with a 20-GHz channel spacing. The excess loss of the AWG is 5.5-6.3 dB, and the crosstalk level is below -15 dB.

2.5.5 **17:30**

Ultra-Wide-Band Low Loss and High Reliability Polymer Optical Waveguide

Shotaro Takenobu, Yasuhiro Kuwana, Kousuke Takayama, Yoshitomi Morizawa, Asahi Glass Co., Ltd, JAPAN

◆ We demonstrated polymer optical waveguide comparable propagation loss to silica and high reliability. Propagation loss was 0.022dB/cm at 1.55µm. Heat damp and high power tests gave very good results.

2.5.6 **17:45**

12.5Gbps/ch Transmission in Polymer Waveguide with 4-Channel Circular Graded-Index Cores

Takaaki Ishigure, Yusuke Takeyoshi, Keio University, Japan

◆ Multimode polymer waveguides with 4-channel circular graded-index cores are fabricated. Because of the parabolic index profile, very low-loss, 0.029dB/cm and high-bandwidth, 83Gbps are achieved, and a transmission of 12.5-Gbps for 3 m is demonstrated.

Session 3.1 **Hall 3**
Electronic Mitigation

Chair: Michel Joindot, ENSSAT / Université de Rennes 1, France

3.1.1 **8:30**
Invited: 40Gb/s Distortion Mitigation and DSP-Based Equalisation

Henning Bülow, Bernd Franz, Axel Klekamp, Fred Buchali, Alcatel-Lucent Deutschland AG, Germany;
♦ Different aspects of electronic distortion equalization at 40Gbit/s are highlighted: from the experimental assessment of analog equalizer circuits to the estimation of the digital processing effort in DSP based equalisation schemes.

3.1.2 **9:00**
Performance Improvements of Different Modulation Formats by Applying Adaptive Electronic Equalisation in 43 Gbit/s Systems

Bernd Franz, Axel Klekamp, Detlef Roesener, Fred Buchali, Henning Bülow, Alcatel-Lucent, Germany
♦ The system tolerance improvements by analog electronic equalisation have been experimentally evaluated for different 43 Gbit/s modulation formats, PSBT, DPSK, PSBT. Up to 70% higher DGD and 60% higher CD tolerance has been achieved.

3.1.3 **9:15**
Enlargement of PMD tolerance in 43 Gbit/s RZ-DQPSK signal using electrical dispersion compensation without adaptive control

Eiji Yoshida, Hiroto Kawakami, Eiichi Yamada, Kirokazu Kubota, Yuuzou Miyagawa, Yutaka Miyamoto, NTT Network Innovation Laboratories, Tomofumi Furuta, Toshihiro Itoh, Kimikazu Sano, Koichi Murata, NTT Photonics Laboratories, Japan
♦ We describe the enlargement of PMD tolerance using EDC without adaptive control numerically and demonstrate the effectiveness in a 43 Gbit/s RZ-DQPSK transmission experiment. The tolerance was extended to over 30 ps.

3.1.4 **9:30**
PMD Tolerance Enhancement by Adaptive Receiver for 43Gb/s DPSK NRZ- and RZ-Modulation

Axel Klekamp, Bernd Franz, Henning Bülow, Alcatel-Lucent, Germany
♦ We compared experimentally PMD tolerances of adaptively equalising 43Gb/s receiver for DPSK NRZ/RZ formats taking into account first and second order PMD. At 10-5 outage an improvement of PMD tolerance by 55% is found.

3.1.5 **9:45**
Performance of Electronic Pre-Distortion in 40-Gb/s Systems with Optical Dispersion Compensation for Different Modulation Formats and Transmission Fibres

Chongjin Xie, Bell Labs, Alcatel-Lucent, USA
♦ We show that the performance improvement obtained by electronic-pre-distortion in 40-Gb/s transmission systems with different fibres using in-line optical dispersion compensators is limited to about 3 dB by inter-channel cross-phase-modulation for both on-off-keying and differential-phase-shift-keying.

3.1.6 **10:00**
Performance of Electronic Predistortion Systems with 1 Sample/bit Processing using Optical Duobinary Format

Philip Watts, Polina Bayvel, Robert Killey, University College London, Madeleine Glick, Intel Research, United Kingdom
♦ We show that EPD using optical duobinary allows reduced sampling rates and increased dispersion tolerance. We report results of simulations of 10.7Gb/s transmission over 800km of SSMF with <2dB penalty using 1 sample/bit DACs.

Session 3.2 **Roofgarden**
Ethernet/OLS

Chair: Fabio Neri, Politecnico di Torino, Italy

3.2.1 **8:30**
Tutorial: The New Ethernet Landscape

Didier Colle, Ghent University, Belgium
♦ Ethernet is emerging as the technology that will enable high speed and low cost delivery of triple play and next-generation business services in metro network environments. This technology being referred as Carrier Grade Ethernet has evolved significantly from its LAN/best effort origins. The intent of this tutorial is to give an overview of these ethernet technologies in development and how they intend to meet the requirements of being a transport technology. The tutorial will address following topics:

1. The strengths and shortcomings of, legacy Ethernet for use as a transport technology
2. Survey of connectionless Carrier-grade Ethernet solutions: what are the connectionless solutions pushed forward in standard bodies, eg. PB, PBB, what are the pros and cons of these and for which applications/services are they well suited, e.g., TV broadcast, VPN, etc
3. Survey of Connection-oriented Carrier-grade Ethernet solutions: in analogy with the section on connectionless solutions, a pro/con study will be presented of connection-oriented ethernet technologies being development, eg. PBB-TE, ELS, VLAN XC, and their appropriateness for specific applications/services, e.g., internet access, IPv6, VPN, etc
4. Conclusion and sketch of a realistic scenario of a carrier-grade Ethernet based access/aggregation network using evolving technologies being discussed earlier.

3.2.2 **9:30**
Cost Reduction and Traffic Performance Improvement using Direct Forward Optical Layer Multicast in Optical Label Switching Nodes

Ni Yan, Aleida Alcaide, Jose Manuel Mendinueta, Eduard Tangdionga, Ton Koonen, COBRA, Eindhoven University of Technology, The Netherlands
♦ We propose a simpler, faster, more efficient and economical multicast concept for passive waveguide-based optical label switching nodes. We analyze its advantages in terms of cost and traffic performance in comparison with the recirculation approach.

3.2.3 **9:45**
A Novel Multiplexed Optical Code Label Processing with Huge Number of Address Entry for Scalable Optical Packet Switched Network

Nobuyuki Kataoka, Naoya Wada, Tetsuya Miyazaki, NICT, Ken'ichi Kitayama, Osaka University, Japan; Gabriella Cincotti, University of Roma Tre, Italy;
♦ We propose and demonstrate multiplexed optical-code-label processing, which enables to recognize multi labels per one packet on the same time and increase address entries. It cannot be done in electricity and other optical label processing.

3.2.4 **10:00**
All Optical Recognition of 36 SAC-Labels with 12.5 GHz minimum Bin Separation Using a Single Correlator for Optical Label Switching

Jose Bernardo Rosas-Fernandez, Ian White, University of Cambridge, United Kingdom; Walid Mathlouthi, Sophie LaRoche, Leslie Rusch, Laval University, Canada; Marco Presi, Scuola Superiore Sant'Anna University, Italy
♦ We demonstrate a 36-code spectral-amplitude-code family for optical-label recognition. A nonlinear device followed by a 12.5GHz channel AWG generates a control signal for all-optical switching of a 40Gbps payload among up to 36 ports.

Session 3.3 **Hall 4/5**
Radio over Fibre

Chair: Kees van Bochove, KPN Royal Dutch Telekom, The Netherlands

3.3.1 **8:30**
Simple ROF configuration to simultaneously realize optical millimeter-wave signal generation and source-free base station operation

Lin Chen, Jing He, Ying Li, Hong Wen, Yufeng Shao, Cheng Huang, Liliang Hu, Yazhi Pi, Ze Dong, Xiaoyan Lei, Shuangchun Wen, Hunan University, China
♦ We have proposed and experimentally demonstrated one novel and simple scheme to generate optical mm-wave signals and realize source-free base station operation by using directed modulation laser and optical filter techniques.

3.3.2 **8:45**
Simultaneous Generation and Delivery of Independent Wired and Wireless Services in Radio-over-Fiber Systems Using a Single Modulator

Zhensheng Jia, Gee-Kung Chang, Chowdhury Arshad, Georgia Institute of Technology, USA; Jianjun Yu, NEC Labs America, USA; Georgios Ellinas, University of Cyprus, USA
♦ We demonstrated a novel radio-over-fiber scheme to simultaneously provide 2.5Gbit/s wireless and 10Gbit/s wired data using a single modulator. It was successfully transmitted over 20km SMF-28 with <1.5dB power penalty for both services.

3.3.3 **9:00**
A cost-effective scheme to generate and de-multiplex multiple frequency millimeter-wave signals in a ROF network

Jianjun Yu, Ting Wang, NEC Laboratories America, USA; Gee-Kung Chang, Zhensheng Jia, Georgia Institute of Technology, USA
♦ A novel scheme to generate multiply frequency millimeter, mm-wave signals is achieved by imposing two RF carriers onto one optical carrier by employing only one external modulator.

3.3.4 **9:15**
High-frequency Radio over Fibre QPSK transmission through a 5 Km Multimode Fibre link

Ivana Gasulla, Jose Capmany, Universidad Politecnica de Valencia, Spain
♦ We report the experimental demonstration of Subcarrier multiplexed signals from 3 to 18 GHz through a 5 Km graded-index multimode fibre link. These are the highest values ever reported in terms of frequency and distance.

3.3.5 **9:30**
Dynamic Channel Allocation Experiment in DWDM Millimeter-wave Radio-on-Fiber Access Network

Juan Jose Vegas Olmos, Ken'ichi Kitayama, Osaka University, Toshiaki Kuri, NICT, Japan
♦ We demonstrate for the first time dynamic channel allocation capability of millimetre-wave band optical RoF signals in WDM access network using a supercontinuum multi-wavelength light source, arrayed-waveguide gratings and a reconfigurable optical crossconnect switch.

3.3.6 **9:45**
Dynamic capacity allocation for low-cost multicarrier multimode PON

Robert Taniman, Pieter-Tjerk de Boer, Bart Sikkes, University of Twente, Kees van Bochove, KPN Royal Dutch Telekom, The Netherlands
♦ A stable-matching-based multiuser multicarrier capacity allocation algorithm is proposed. It responds to ONU backlogs and dynamic subchannel gains. Benchmarked against Binary Linear Programming, it results in just 5% less allocated capacity, at much lower complexity.

3.3.7 **10:00**
Simplified Base Station Configuration for Fiber-Wireless Applications

Elaine Wong, Christina Lim, Ka-Lun Lee, ARC Centre of Ultra Broadband Information Networks, Australia; Angulugaha Prasanna, Thas Nirmalathas, University of Melbourne, Australia; Markus Ortsiefer, Christian Neumeyer, VERTILAS, GmbH, Germany
♦ We propose a technique to simplify base-station design using a VCSEL as an integrated reflector and transmitter for fiber-radio application. Results show IF-over fiber channels can be successful added and dropped from the fiber network.

Session 3.4 **Hall 7**
All-Optical Signal Processing

Chair: Naoto Kobayashi, National Institute of Advanced Industrial Science and Technology, Japan

3.4.1 **8:30**
Invited: Ultra-compact optical buffers on a silicon chip
 Yurii Vlasov, Fengnian Xia, Lidija Sekaric, William Green, Solomon Assefa, Michael Rooks, Sharee McNab, IBM TJ Watson Research Center, USA
 ♦ We will review the latest results on development of silicon nanophotonic devices for on-chip interconnects with the focus on ultracompact optical buffers.

3.4.2 **9:00**
10 Gb/s Optical Buffer Memory Using a Polarization Bistable VCSEL
 Takashi Mori, Yuuki Sato, Hitoshi Kawaguchi, CREST-JST, Nara Institute of Science and Technology, Japan
 ♦ Optical buffer memory was experimentally demonstrated at 10 Gb/s using a polarization bistable vertical-cavity surface-emitting laser. Fast switching operation was obtained by increasing the detuning frequency between the injection light and the lasing output.

3.4.3 **9:15**
A 160Gb/s to 10Gb/s DEMUX operation by Mach-Zehnder Interferometric Intersubband Ultrafast All-Optical Switch
 Ryoichi Akimoto, Takasi Simoyama, Hidemi Tsuchida, Shu Namiki, Lim Guan, Masanori Nagase, Teruo Mozume, Hiroshi Ishikawa, Toshifumi Hasama, National Institute of Advanced Industrial Science and Technology, Japan
 ♦ Mach-Zehnder interferometric ultrafast optical switching module utilizing novel TE cross-phase modulation caused by TM intersubband excitation in InGaAs/AlAs/AlAsSb coupled quantum wells was fabricated. A 160Gb/s to 10Gb/s DEMUX operation was demonstrated.

3.4.4 **9:30**
Sub-pJ and simultaneous multiple wavelength switching of an all-optical flip-flop based on a DFB-LD with integrated SOA
 Wouter D'Oosterlinck, Geert Morthier, Roel Baets, Ghent University - IMEC, Belgium
 ♦ Sub-pJ switching of a SOA and DFB laser diode based all-optical flip-flop is presented. Simultaneous switching of multiple wavelengths is demonstrated with switch times as low as 100ps and an ER over 15dB.

3.4.5 **9:45**
40Gb/s configurable photonic logic gates with XNOR, AND, NOR, OR and NOT functions employing a single SOA
 Jianji Dong, Xinliang Zhang, Jing Xu, Dexiu Huang, Huazhong University of Science and Technology, P.R. China
 ♦ We present 40Gb/s configurable logic gates with XNOR, AND, NOR, OR, and NOT functions based on FWM, XGM and T-XPM in single SOA. A detuning filter is employed to enhance the SOA modulation bandwidth.

3.4.6 **10:00**
Pattern Effect Removal Technique for Semiconductor Optical Amplifier-Based Wavelength Conversion
 Andrej Marculescu, Jin Wang, Jingshi Li, Philipp Vorreau, Wolfgang Freude, Juerg Leuthold, University of Karlsruhe, Germany; Shai Tsadok, Shalva Ben Ezra, Sagie Tsadka, Kailight Photonics, Israel
 ♦ A technique to overcome pattern effects due to slow recovery times in SOA based wavelength converters is presented. It uses the superposition of the outputs of red-shifted and blue-shifted filters having complementary pattern effects.

Session 3.5 **Hall 9**
Signal Monitoring

Chair: José Capmany Universidad Politécnica de Valencia, Spain

3.5.1 **8:30**
Invited: Multi-Impairment Monitoring for Photonic Networks
 Trevor B. Anderson, Sarah D. Dods, Ken Clarke, Justin Bedo, Adam Kowalczyk, NICTA, University of Melbourne, Australia
 ♦ As optical networks become more complex, the need to monitor more than just channel wavelength, power and OSNR becomes compelling. In this paper we describe an asynchronous sampling technique that can measure multiple simultaneous impairments.

3.5.2 **9:00**
Dither-free, Accurate, and Robust Phase Offset Monitor and Control Method for Optical DQPSK Demodulator
 Zhenning Tao, Akihiko Isomura, Takeshi Hoshida, Jens Rasmussen, Fujitsu Laboratories Limited, Japan
 ♦ A dither-free phase offset monitor and control method for an optical DQPSK demodulator is proposed. The phase offset is controlled with better than 1 degree accuracy and Q-penalty below 0.1 dB for 43 Gb/s.

3.5.3 **9:15**
Chromatic-Dispersion-Insensitive PMD Monitoring of 20-Gb/s DQPSK and 10-Gb/s DPSK Using DGD-Generated Polarization-Based Interferometer Filter
 Jeng-Yuan Yang, Lin Zhang, Bo Zhang, Xiaoxia Wu, Louis Christen, Alan Willner, Scott Nuccio, University of Southern California, USA; Liangshan Yan, General Photonics, USA
 ♦ We experimentally demonstrate a chromatic dispersion insensitive PMD monitoring technique using a polarization-based interferometer filter for phase-shift-keyed transmission systems. This technique can monitor 0-100ps of DGD, insensitive to 0-650 ps/nm chromatic dispersion.

3.5.4 **9:30**
Simple, Robust and Wide-Range Frequency Offset Monitor for Automatic Frequency Control in Digital Coherent Receiver
 Zhenning Tao, Huijian Zhang, Lei Li, Fujitsu R&D Center Ltd., P.R. China; Akihiko Isomura, Takeshi Hoshida, Jens Rasmussen, Fujitsu Laboratories Limited, Japan
 ♦ We demonstrate a simple, robust and +/-10 GHz range frequency offset monitor used for automatic local laser frequency control in optical digital coherent receiver. It can tolerate low OSNR, large distortion and unsynchronized clock.

3.5.5 **9:45**
Experimental Synchronization Monitoring of I/Q Misalignment and Pulse Carving Misalignment in 20-Gbit/s RZ-DQPSK Data Generation
 Xiaoxia Wu, Louis Christen, Bo Zhang, Jeng-Yuan Yang, Lin Zhang, Scott Nuccio, Alan Willner, University of Southern California, USA; Loukas Paraschis, Cisco Systems, USA
 ♦ We experimentally demonstrate the monitoring of I/Q data-stream misalignment and carver-misalignment for 20-Gbit/s RZ-DQPSK. We get 20dB dynamic range for data-misalignment and 6.3dB for carver-misalignment by measuring RF clock-tone and low-frequency power.

3.5.6 **10:00**
Chromatic dispersion and OSNR monitoring in a WDM 40Gbit/s system
 Lamia Baker-Meflah, Benn Thomsen, John Mitchell, Polina Bayvel, University College London, United Kingdom
 ♦ A technique based on spectral analysis after frequency down-conversion for multi-impairment monitoring in 40Gbit/s multi-channel systems is proposed and experimentally demonstrated. The use of electro-optic down-conversion makes it cost effective for multi-channel operation.

Session 3.6 **Hall 10**
Measurement and Sensing

Chair: Hervé Lefèvre, iXCore S.A.S., France

3.6.1 **8:30**
Invited: Millimeter Resolution Reflectometry Over Two Kilometers
 Brian Soller, Dawn Gifford, Mark Froggatt, Matt Wolfe, Stephen Kreger, Luna Technologies, USA
 ♦ Millimeter resolution optical frequency domain reflectometry measurements are achieved over 2 km of length. This level of spatial resolution over kilometer distances enables unprecedented link characterization in emerging short-haul applications such as avionics and FTTH.

3.6.2 **9:00**
Highly Sensitive Coherent Optical Frequency-domain Reflectometry Employing SSB-modulator with cm-level Spatial Resolution over 5 km
 Yusuke Koshikiya, Xinyu Fan, Fumihiko Ito, NTT Corporation, Japan
 ♦ We present OFDR employing an SSB-modulator and a narrow linewidth fibre-laser. We achieved cm-level resolution over 5 km measurement range and high sensitivity with a noise level 23 dB lower than the Rayleigh backscatter level.

3.6.3 **9:15**
Refractive Index Sensor Based on Whispering Gallery Modes Resonances of Thin Capillaries
 Vanessa Zamora, Antonio Diez, Miguel Andres, Benito Gimeno, Universidad de Valencia, Spain
 ♦ Whispering gallery modes resonances of thin capillaries shift as a function of the refractive index of the liquids that fill the inside, with very high sensitivity, and enable the measure of relatively high index values.

3.6.4 **9:30**
Experimental Investigation on Temperature and Strain Dependence of Brillouin Frequency Shifts in GeO₂-Doped Optical Fibers
 Weiwen Zou, Zuyuan He, Kazuo Hotate, The University of Tokyo, Japan
 ♦ The strain- or temperature-coefficient of Brillouin frequency shift is shown to be a quadratic function of draw-tension during fiber-fabrication. The coefficients decrease by 1.48 % and 1.61 % respectively for 1-mol% increase of GeO₂ concentration.

3.6.5 **9:45**
Novel Dispersion Compensating Module based Interrogator for Fiber Bragg Grating Sensors
 H.Y.Fu, H.L. Liu, H.Y. Tam, P.K.A. Wai, C. Lu, The Hong Kong Polytechnic University, Hong Kong
 ♦ We propose and demonstrate a novel interrogator for fiber Bragg grating, FBG sensors using a dispersion compensating module. High speed potential of this scheme has also been investigated.

3.6.6 **10:00**
Temperature-Insensitive Strain Measurement with PM-PCF based Sagnac Interferometer
 Xinyong Dong, H.Y Tam, The Hong Kong Polytechnic University, Hong Kong; Ping Shum, Nanyang Technological University, Singapore
 ♦ Temperature-insensitive strain measurement is realized by using a polarization-maintaining photonic crystal fibre, PM-PCF Sagnac interferometer. The achieved sensitivity is 0.23 pm/με. The measurement range, by stretching the PM-PCF only, is up to 32 mε.

Session 4.1 **Hall 3**
POF Symposium

Polymer Optical Fibers – Effective Solutions for Automotive, Sensors, Home Networking and Interconnection

Chair: *Olaf Ziemann, Polymer Optical Fiber Application Center Nuremberg, Germany*
Yasuhiro Koike, Keio University, Japan

Opening of the Symposium **14:00**

4.1.1 **14:15**
The Status of POF Technology

Yasuhiro Koike, Takaaki Ishigure, Keio University, Japan
 ♦ Plastic optical fibers, POFs have been established in unique datacom markets such as digital audio interfaces, factory automations and automotive LANs. Low-loss graded index POF has opened a new market of customer premises network in recent years. The status of POF technology is reviewed, and the concept of "Fiber-to-the-Display" for broadband society is proposed.

4.1.2 **14:45**
POF Sensors - applications in every day's life

Hans Poisel, Polymer Optical Fiber Application Center Nuremberg, Germany
 ♦ In this paper we will show some representative examples that demonstrate the capabilities of sensors based on polymer optical fibers and their real applications.

4.1.3 **15:15**
Experimental studies of bandwidth behaviour in Graded Index Microstructured Polymer Optical Fibres

Maryanne Large, University of Sydney, Australia
 ♦ GImPOF, Graded index microstructured polymer optical fibres differ from conventional GI POF not just in having a microstructure, but also in having a much larger index contrast. Previous theoretical results had suggested that their behaviour may be very different from conventional GI POF structures. In this talk the most comprehensive set of experimental data to date, characterising the bandwidth, differential mode delay and equilibrium length will be presented. The role of chromatic dispersion and experimental error will be explicitly considered. Finally, the results will be compared to those of competing multimode fibres.

Session 4.2 **Roofgarden**
OFDM I

Chair: *Nick Doran, IAT, Swansea University, United Kingdom*

4.2.1 **14:00**

Tutorial: Adaptation of Orthogonal Frequency Division Multiplexing, OFDM to Compensate Impairments in Optical Transmission Systems
Arthur Lowery, Monash University, Australia
 ♦ Orthogonal Frequency Division Multiplexing, OFDM is now the preferred technology for wideband radio communications because of its ability to efficiently equalize highly dispersive channels, but has, until recently, been of little interest to the optics community. In the last two years, several groups have adapted 'radio' OFDM to work efficiently over fiber channels, bringing the possibility of adaptive dispersion compensation of several thousand kilometers of standard fiber. This year, experimental systems have transmitted at data rates of 20 Gbit/s using direct detection and coherent receivers. Although the electronic signal processing has yet to be demonstrated in real time, theoretical studies have shown the computational cost is less than other dispersion compensation techniques; furthermore, OFDM scales well to higher data rates. Thus, OFDM is a serious contender for future long-haul systems, especially as it can rapidly adapt to switching events in all-optical networks. This tutorial aims to introduce OFDM concepts and place them in the framework of photonic engineering. After the many methods of modulating OFDM onto optical carriers are reviewed, the tutorial will explore new issues including OFDM's tolerance to fiber nonlinearity.

4.2.2 **15:00**
Maximum-Likelihood Phase Estimation for Coherent Optical OFDM

William Shieh, The University of Melbourne, Australia
 ♦ We present a robust and computation-efficient method of maximum-likelihood phase estimation. Both computer simulation and transmission experiment of coherent optical OFDM system show that maximum-likelihood decision- feedback following pilot-assisted phase estimation gives the optimal performance

4.2.3 **15:15**
Data Rate and Distance Scaling of CO-OFDM Systems

Markus Mayrock, Herbert Haunstein, Universitaet Erlangen-Nuernberg, Germany
 ♦ Simulations show the BER performance of a coherent optical OFDM system with different cyclic prefix lengths. We derive a design rule, which allows data rate and distance scaling while maintaining robustness to chromatic dispersion.

Session 4.3 **Hall 4/5**
SOA-based Signal Processing

Chair: *Harm J.S. Dorren, Eindhoven University of Technology, The Netherlands*

4.3.1 **14:00**

Invited: Integrated devices for all optical signal processing
Alistair Poustie, CIP, United Kingdom
 ♦ Hybrid integration of semiconductor optical amplifiers into practical all-optical signal processing modules is described. Recent advances in nonlinear SOAs and multiple array devices are highlighted, with applications from optical memory to sophisticated burst-mode optical regenerators.

4.3.2 **14:30**
Large Dynamic Range 32 x 32 Optimized non-blocking SOA based Switch for 2.56Tb/s Interconnect Applications

Eng Tin Aw, Adrian Wonfor, Richard Penty, Ian White, University of Cambridge, United Kingdom; Madeleine Glick, Intel Research, United Kingdom
 ♦ A practical non-blocking 32x32 SOA based switch is demonstrated at 80Gb/s per port with IPDR of >20dB. This switch uses an optimised design that requires only 3 SOA cascades whilst limiting the total SOA count.

4.3.3 **14:45**
100-Gbps Optical Packets with 8-bit RZ Pulse Patterns Generated by an Optical Pulse Synthesizer

Yosuke Tanaka, Ryo Kobe, Shinsuke Takeda, Tatsutoshi Shioda, Takashi Kurokawa, Tokyo University of Agriculture and Technology, Japan; Hiroyuki Tsuda, Keio University, Japan
 ♦ We successfully generated optical packets by the feedback control of an optical pulse synthesizer. Arbitrary 8-bit RZ pulse packets with a bit rate of 100 Gbps were experimentally demonstrated.

4.3.4 **15:00**
Demonstration of Chromatic Dispersion and Optical Noise insensitivity of a Quantum-Dash based Fabry-Perot Laser in All-optical Clock Recovery at 40 Gbit/s

Vincent Roncin, Sebastien Lobo, Laurent Bramerie, Jean-Claude Simon, ENSSAT / Université de Rennes 1, France; Alexandre Shen, Frédéric Van Dijk, Guang-Hua Duan, Alcatel Thales III-V Lab, France
 ♦ In this paper we propose BER measurements allowing to demonstrate the ultra-low sensitivity of an all-optical clock recovery based on a quantum-dash Fabry-Perot Laser to chromatic dispersion and optical noise on the injected data signal

4.3.5 **15:15**
Cascadability Assessment of an All Optical 3R Regenerator based on Synchronous Modulation using a Saturable Absorber and Optical Clock Recovery

Quang Trung Le, Laurent Bramerie, Vincent Roncin, Sebastien Lobo, Mathilde Gay, Michel Joindot, Jean-Claude Simon, ENSSAT / Université de Rennes 1; David Massoubre, Jean-Louis Oudar, LPN-CNRS; Alexandre Shen, Frédéric Van Dijk, Guang-Hua Duan, Alcatel Thales III-V Lab, France
 ♦ We report on the cascadability assessment of 3R regeneration based on optical synchronous modulation using cross saturation absorption in a quantum-well microcavity driven optically by the recovered clock from a self-pulsating laser device.

4.3.6 **15:30**
Analysis of the Spectral Efficiency of Filter-Assisted Wavelength Conversion for Polarity-Preserving Operation

Alessandro Marques de Melo, Klaus Petermann, Technical University of Berlin, Germany
 ♦ We investigated by means of numerical simulations the influence of the data duty-cycle on the efficiency of filter-assisted wavelength conversion. The data polarity is kept without the need of an additional notch filter.

Session 4.4 **Hall 7**
Modules and Techniques for Access

Chair: Naoto Yoshimoto, NTT Access Network Service Systems Laboratories, Japan

4.4.1 **14:00**
Invited: A Fast-Response and High-Sensitivity PIN-TIA Module with Wide Dynamic Range for 10G Burst-Mode Transmissions

Susumu Nishihara, Makoto Nakamura, Kazuyoshi Nishimura, Keiji Kishine, Shunji Kimura, Kazutoshi Kato, NTT Corporation, Japan
 ♦ 10G burst-mode PIN-TIA module has been developed with a new function of automatic offset compensation with instantaneous response of 10 ns, high sensitivity of -19.5 dBm, and wide dynamic range of 20.5 dB.

4.4.2 **14:30**
Development of GE-PON ONU PX-20 optical transceiver with wide temperature range from -20 to +85 degree C for outdoor operation

Satoshi Shirai, Naohiro Nomura, Masamichi Nogami, Tamon Omura, Junichi Nakagawa, Mitsubishi Electric Corporation, Japan
 ♦ We have developed PX-20 optical transceiver for GE-PON ONUs with wide temperature range covering -20 to +85 degrees, which is suitable for outdoor equipment. The transceiver successfully supports power budget of 29dB and 20km transmission.

4.4.3 **14:45**
Development of New Optical Access Network System Based on Optical Packet Switches

Takumi Nomura, NEC Communication Systems, Ltd., Japan; Hiromi Ueda, Toshinori Tsuboi, Hiroyuki Kasai, Tokyo University of Technology, Japan
 ♦ This paper presents the development of a downstream-side system for the Gigabit Ethernet-Optical Switched Access Network, GE-OSAN. We detail two of the technologies required by the system: optical packet switching and optical burst receiving.

4.4.4 **15:00**
Free-Space Optical Communication in a Swarm of Microrobots

Paolo Corradi, Arianna Menciassi, Cecilia Laschi, Paolo Dario, Scuola Superiore Sant'Anna, Italy; Leonardo Ranzani, Mario Martinelli, Politecnico di Milano, Italy; Oliver Scholz, Fraunhofer Institute for Biomedical Engineering, Germany; Angel Diéguez, University of Barcelona, Spain
 ♦ This paper presents the theoretical investigations, supported by experimental measurements, of the communication channel between miniaturized optical communication systems to be integrated into swarming microrobots, while trying to stress very low power consumption issues.

4.4.5 **15:15**
DWDM Achieved with Thermal Sources: a Future-proof PON Solution

Walid Mathlouthi, Julien Penon, Leslie Rusch, Laval University, Francesco Vacondio, Amirhossein Ghazisaeidi, Center of optics photonics and Lasers, Canada
 ♦ We achieve the promise of semiconductor amplifiers, SOAs to mitigate severe intensity noise of spectrum-sliced WDM, notwithstanding optical filtering at the receiver. Dense WDM capacity is demonstrated using a thermal source and a saturated SOA.

4.4.6 **15:30**
A PON System Providing Triple Play Service Based on a Single Dual-Parallel Mach-Zehnder Modulator

Qingjiang Chang, Yue Tian, Cishuo Yan, Xinyu Xu, Junming Gao, Yikai Su, Shanghai Jiao Tong University, P.R. China
 ♦ We propose and experimentally demonstrate a novel PON system providing triple play service with centralized light source using a single dual-parallel Mach-Zehnder modulator. Upstream data re-modulation based on downstream DPSK format is also achieved.

Session 4.5 **Hall 9**
Fiber Devices for System Applications

Chair: Christian Schaeffer, Technische Universitat Dresden, Germany

4.5.1 **14:00**
Simultaneous all-optical 2R regeneration of 4x10 Gbit/s Wavelength Division Multiplexed channels

Lionel Provost, Francesca Parmigiani, Periklis Petropoulos, David Richardson, ORC, University of Southampton, United Kingdom; Kazunori Mukasa, Masanori Takahashi, Jiro Hiroishi, Masateru Tadakuma, Furukawa Electric co., Ltd., Japan
 ♦ We demonstrate all-optical regeneration of four WDM channels in a single optical fibre by using polarization multiplexing in a bidirectional configuration. We observe no performance degradation arising from the presence of the multiple channels.

4.5.2 **14:15**
Timing jitter tolerant 640 Gb/s demultiplexing using a long-period fibre grating-based flat-top pulse shaper

Leif Oxenlowe, Michael Galili, Hans Christian Mulvad, Anders Clausen, Palle Jeppesen, Technical University of Denmark, Radan Slavik, ASCR, Czech Republic; Yongwoo Park, University of Quebec, Canada; Jose Azana, INRS, Canada
 ♦ A 400 fs flat-top pulse is used to demultiplex a 640 Gb/s data signal with a significant increase in jitter tolerance to 350 fs, and a substantial reduction in receiver sensitivity penalty

4.5.3 **14:30**
Phase-Preserving 2R-Regeneration of an 80-Gb/s RZ-DQPSK Signal by Using a Nonlinear Amplifying Loop Mirror

Kristian Cvecek, Klaus Sponkel, Christian Stephan, Georgy Onishchukov, Gerd Leuchs, University Erlangen-Nuremberg, Germany; Reinhold Ludwig, Colja Schubert, Fraunhofer Heinrich-Hertz-Institut, Germany; Bernhard Schmauss, University of Applied Sciences - Regensburg, Germany
 ♦ The performance of a nonlinear amplifying loop mirror as a 2R regenerator for an 80-Gb/s RZ-DQPSK has been investigated. A significant eye-opening improvement and a negative power penalty of 2.6 dB have been obtained.

4.5.4 **14:45**
Passive All-optical Clock Recovery demonstration at 42.66 Gbit/s with Bragg-gratings based Fabry-Perot Filter

Vincent Roncin, Julien Poët, Quang Trung Le, Sebastien Lobo, Laurent Bramerie, Jean-Claude Simon, ENSSAT / Université de Rennes 1, France; David Chevallier, Catherine Le rouzic, Laurent Lablonde, Benoit Cadier, IXFiber, France
 ♦ In this paper, we present the performance of an all-optical clock recovery device based on a passive Fabry-Perot band-pass filter made-up of Bragg Gratings and followed by an SOA for patterning effect reduction.

4.5.5 **15:00**
Optimization of SBS-Suppression for 320 Gbit/s DQPSK All-Optical Wavelength Conversion

Bernd Hüttl, Alexandre Gual i Coca, Carsten Schmidt-Langhorst, Reinhold Ludwig, Colja Schubert, Fraunhofer Heinrich-Hertz-Institut, Germany; Robert Elschner, Christian Bunge, Klaus Petermann, Technical University of Berlin
 ♦ We investigate single- and dual-tone phase modulation of the cw-pump for effective stimulated Brillouin scattering suppression in all-optical wavelength conversion based on FWM in highly-nonlinear fibre. The performance is evaluated in 320Gbit/s-DQPSK wavelength conversion experiments.

4.5.6 **15:15**
Comparison on Crosstalk Tolerance of RZ-DPSK and RZ-OOK Modulation Format in Fiber Optical Parametric Amplifier

Bill Ping Piu Kuo, Kenneth Wong, The University of Hong Kong
 ♦ We investigated crosstalk tolerance of RZ-DPSK and RZ-OOK modulation format in OPA with 100GHz channel spacing. Results show an average of 2.4dB improvement in Q factor by using RZ-DPSK format over RZ-OOK format.

4.5.7 **15:30**
Polarization Independent All-Optical Clock Recovery from Highly Distorted Data Signals

Franko Küppers, Qing Wang, University of Arizona, USA; Tuomo von Lerber, Perlos Corporation, Finland; Seppo Honkanen, Micronova, Finland
 ♦ A polarization independent multiwavelength all-optical clock recovery scheme based on a birefringent resonator is introduced. We verify proper operation of the method with data signals highly distorted by dispersion and fiber nonlinearity.

Session 4.6 **Hall 10**
Optical Network Applications

Chair : Gabriel Junyent, Universitat Politècnica de Catalunya, Spain

4.6.1 **14:00**
Invited: Large Scale Video Delivery Using Hybrid Packet/Circuit Multicasting: Experiences from Chinese Broadband Network Testbed, 3TNet

Yaohui Jin, Shanghai Jiaotong University, P.R. China
 ♦ To support large scale video delivery, we carried out a hybrid packet/circuit multicasting field trial with 26000 users. Each end user has 40 Mb/s guaranteed bandwidth. The results of 1040 concurrent users testing were reported.

4.6.2 **14:30**
On-demand uncompressed HDTV Transmission over a GMPLS controlled Service-Aware all-optical network

Ramon Casellas, Iván Martínez, Carolina Pinart, Raul Muñoz, Ricardo Martínez, Fermín Galán Márquez, Centre Tecnològic de Telecomunicacions de Catalunya, Gabriel Junyent, Universitat Politècnica de Catalunya, Spain
 ♦ An intelligent optical network needs to address the heterogeneous requirements that new services like on-demand, uncompressed HDTV transmission impose, jointly considering management, control and transport planes. Such a transmission was assessed over a GMPLS network

4.6.3 **14:45**
Demonstration and analysis of TV- and data transport in the OpMiGua hybrid circuit/packet switched network testbed

Steinar Bjornstad, Andreas Kimsas, NTNU, Norway; Martin Nord, Research Center COM, Technical University of Denmark, Denmark; Lars Eriksen, R&D Manager, Norway; Vegard Tuft, Dag Hjelme, Norvald Støl, Norwegian University of Science and Technology, Norway; Aasmund Sudbo, University of Oslo, UniK, Norway
 ♦ TV-broadcast contribution is an important, optical network application requiring absolute performance guarantees. We demonstrate the OpMiGua testbed for uncompressed IP-video streaming in the presence of standard IP data transport in the network.

4.6.4 **15:00**
Evaluation of Optical Grid Scheduling through Dimensioning

Chris Develder, Marc De Leenheer, Bart Dhoedt, Piet Demeester, Ghent University, Belgium
 ♦ Optical Grids promise cost and resource efficient delivery of, distributed services. We propose an optical Grid dimensioning methodology, and use it to evaluate the effect of Grid scheduling algorithms on the dimensions of such Grids.

4.6.5 **15:15**
Joint Resource Allocation in Optical Grids: Algorithms and Performance Study

Xin Liu, Wei Wei, Xiang Yu, Chunming Qiao, State University of New York at Buffalo, USA; Ting Wang, NEC Labs America/University of Virginia, USA
 ♦ This paper reports the first numerical study of the problem of jointly optimizing job assignment and light-path establishment, JALE. Several approaches are proposed to efficiently support distributed computing applications in wavelength-routed networks.

4.6.6 **15:30**
Demonstration of a Task-flow based Aircraft Collaborative Design Application in Optical Grid

Zhengyu Wang, Guo Wei, Zhenyu Sun, Yaohui Jin, Weiqiang Sun, Weisheng Hu, Xinhua Lin, Min-You Wu, Shanghai JiaoTong University, P.R. China; Chunming Qiao, State University of New York at Buffalo, USA
 ♦ One task-flow scheduler has been designed for a task-flow based Aircraft Collaborative Design Application in Optical Grid. The practical running of this application on an Optical Grid testbed has been demonstrated to prove its feasibility.

Session 5.1 **Hall 3**
POF Symposium (continued)

Chair: Olaf Ziemann, Polymer Optical Fiber Application Center Nuremberg, Germany Yasuhiro Koike, Keio University, Japan

5.1.1 **16:15**
Advanced Modulation Techniques for Polymer Optical Fiber Transmission
 Sebastian Randel, Jeffrey Lee, Siemens, Germany; Ton Koonen, Henrie van den Boom, Maria Garcia Larrode, Jia Yang, Ng'oma Anthony, Gert-Jan Rijckenberg, COBRA, Eindhoven Univ. of Technology, The Netherlands; Florian Breyer, Munich University of Technology, Germany
 ♦ Today polymer optical fibers, POF are used in a bunch of applications such as multimedia communications in automobiles and industrial automation. Recently they also entered the market for home networking. In this scenario next generation systems are commonly foreseen to consist of gigabit wireless technologies with small cell size complemented by a wired in-house backbone that feeds small scale antennas e.g. in each room. The POF has turned out to be a highly attractive candidate for this purpose as it offers unique features like an outer diameter of only about 1.5 mm, self-installation by the end user, as well as EMI immunity. This talk provides an overview on recent progress in advanced modulation techniques both for enabling Gigabit-Ethernet transmission over POF as well as high-capacity radio-over-POF at high microwave frequencies.

5.1.2 **16:45**
Status and recent results from the POF-ALL EU project: large-core plastic fibers for low cost, high-speed short reach applications
 Roberto Gaudino, Politecnico di Torino, Italy
 ♦ POF-ALL is a European STREP project, funded within the EU VI Framework Programme, under the IST call "Broadband for all". The project is meant to develop a low-cost solution based on large-core Plastic Optical Fiber, POF to make the delivery of broadband access to everyone possible. The project focuses on the last part of access networks towards the final user, a segment usually indicated as "edge network" and on in-building and in-house delivery of high-speed digital signal. A careful optimization of the enabling technologies, components, devices and protocols will end up in a real-life field test. This paper, besides describing the framework of the project, presents the most recent technical achievements. In particular, we show advanced transmission techniques over 1-mm large core POF, that allows us to achieve, using different technical solutions, 100 Mbit/s over 200 meters, and 1 Gbit/s over 100 meters.

5.1.3 **17:15**
100 Mbit/s - Gbit/s - 10 Gbit/s and beyond, the use of POF in home networking and interconnection
 Olaf Ziemann, Polymer Optical Fiber Application Center Nuremberg, Germany
 ♦ Fast Ethernet SI-POF systems are on the way to mass production now. Complete installation sets are available by Siemens e.g. But the POF technology offers much higher potential. Data rate of 1 Gbps can be realized by the use of PMMA-GI-POF, but also by multi carrier transmission on SI POF. Data rates of 10 Gbps and more, 30 Gbps has been demonstrated can be realized by PF GI POF or by parallel transmission over POF ribbons. The presentation will give an overview of the present available technology, possible applications and the advantages of POF technology in comparison to glass fibers and copper cables. The biggest application at this time is the use of POF in car networks. Much higher potential will have the use in home networks and in interconnection solutions.

Session 5.2 **Roofgarden**
OFDM II

Chair: Werner Rosenkranz, University of Kiel, Germany

5.2.1 **16:15**
Optimal Design for Coherent Optical OFDM Transmitter Employing Pre-distortion
 Yan Tang, William Shieh, The University of Melbourne, Keang-Po Ho, National Taiwan University, Taiwan
 ♦ A detailed analysis is presented on the optimal design for coherent optical OFDM transmitter employing predistortion. The optimal design shows 4-bit DAC resolution is sufficient and the excess loss for optical I/Q modulator is 5.0 dB.

5.2.2 **16:30**
10-Gb/s OFDM with conventional DFB lasers
 Sander Jansen, Itsuro Morita, Hideaki Tanaka, KDDI R&D Laboratories Inc., Japan
 ♦ We show that using RF-pilot tone phase noise compensation optical coherent 10-Gb/s OFDM, 12.5 Gb/s before coding can be realized with conventional DFB lasers.

5.2.3 **16:45**
Phase Noise on Coherent Optical OFDM Systems with 16-QAM and 64-QAM beyond 10 Gb/s
 Xingwen Yi, William Shieh, Yiran Ma, The University of Melbourne, Australia
 ♦ We present the experimental transmission results of coherent optical OFDM systems with 16-QAM and 64-QAM formats. Phase noise effects from laser linewidth and non-linear fibre transmission are investigated.

5.2.4 **17:00**
Optimization of an optical OFDM system by peak to average signal ratio reduction
 Fred Buchali, Alcatel-Lucent, Germany; Fabian Supper, University of Applied Sciences, Germany
 ♦ We studied the optimization of an O-OFDM system by reduction of peak to average signal ratios enabling the increase of average modulation. An improvement of 9dB for 2⁻¹, 14dB for 2¹⁵-1 pattern length is demonstrated.

5.2.5 **17:15**
PMD Tolerant Direct-Detection Optical OFDM System
 Markus Mayrock, Herbert Haunstein, Universitaet Erlangen-Nuernberg, Germany
 ♦ We show that PMD degrades the transmission performance of an optical OFDM system which is based on direct-detection and single side-band transmission. Maximum PMD tolerance can be achieved applying polarization diversity together with polarization control.

Session 5.3 **Hall 4/5**
Fiber based Signal Processing

Chair: Andrew Ellis, UCC, United Kingdom

5.3.1 **16:15**
Invited: All-optical 160 Gbit/s RZ data retiming system incorporating a pulse shaping fibre Bragg grating
 Francesca Parmigiani, Morten Ibsen, Periklis Petropoulos, David Richardson, University of Southampton, United Kingdom; Leif Oxenlowe, Michael Gallili, Darko Zibar, Anders Clausen, Palle Jeppesen, Technical University of Denmark, Denmark
 ♦ We characterize a 160Gbit/s retimer based on flat-topped pulses shaped using superstructured fibre Bragg grating. The benefit of using shaped rather than conventional forms in terms of timing jitter reduction are confirmed by bit-error-rate measurements.

5.3.2 **16:45**
320 Gbit/s Simultaneous Clock Recovery and Channel Identification
 Michael Gallili, Leif Oxenlowe, Anders Clausen, Palle Jeppesen, Technical University of Denmark, Denmark
 ♦ We report on a cross-phase modulation-based scheme for simultaneous channel identification and pre-scaled clock recovery for high-speed data transmission.

5.3.3 **17:00**
Multi-period NOLM design for ultrafast all-optical A/D conversion
 Yuji Miyoshi, Osaka University, Kensuke Ikeda, Central Research Institute of Electric Power Industry, Hideaki Tobioka, Takashi Inoue, Furukawa Electric Co., Ltd., Shu Namiki, National Institute of Advanced Industrial Science and Technology, AIST, Ken'ichi Kitayama, Osaka University, Japan
 ♦ Targeting 100-GS/s, 4-bit A/D conversion, design consideration of NOLM having multi-period transfer function is presented. A NOLM with nearly 4-period transfer function for 2-ps sampled pulses is experimentally demonstrated for the first time.

5.3.4 **17:15**
All-Optical RZ-DPSK WDM to RZ-DQPSK Phase Multiplexing using Four-Wave Mixing in Highly-Nonlinear Fiber
 Guo-Wei Lu, Kazi Abedin, Tetsuya Miyazaki, National Institute of Information and Communications Technology, NICT, Japan
 ♦ We experimentally demonstrate an all-optical phase multiplexing scheme using FWM in a highly-nonlinear fiber. Two 10-Gb/s RZ-DPSK WDM signals are phase-multiplexed into one 20-Gb/s RZ-DQPSK signal with a 1.6-dB negative power penalty.

5.3.5 **17:30**
Optical Add-Drop Multiplexer Based on Fiber Optic Parametric Amplification
 Henrik Sunnerud, Shoichiro Oda, Jiang Yang, Peter Andrekson, Chalmers University of Technology, Sweden; Takashi Nishitani, Osaka University, Japan
 ♦ We present a novel ultrafast FOPA-based all-optical add-drop TDM multiplexer. Both the drop and add functions were successfully evaluated with NRZ data at 10 Gb/s

5.3.6 **17:45**
Polarization Independent All-Optical 3R Regeneration of Optical Packets Based on the Kerr Effect and Offset Spectral Slicing
 Chris Ito, John Cartledge, Queen's University, Canada
 ♦ Polarization independent all-optical 3R packet regeneration is demonstrated at 10 Gb/s. With careful design, a remarkable property of cross-phase modulation yields excellent performance with no additional complexity compared to an implementation that requires polarization control.

Session 5.4 **Hall 7**
Modulation Techniques and Multiple Access

Chair: Godehard Walf, Fraunhofer-Institut für Nachrichtentechnik, Germany

5.4.1 **16:15**
Experimental Demonstration of a Novel OFDM-A Based 10Gb/s PON Architecture
 Dayou Qian, Junqiang Hu, Jianjun Yu, Philip Ji, Lei Xu, Ting Wang, Milorad Cvijetic, NEC Laboratories America, USA; Toshihiko Kusano, NEC Corporation, Japan
 ♦ This paper introduces a novel architecture for next generation PON based on the employment of OFDMA, with the first experimental demonstration of 10Gbps optical OFDMA transmission using Directly Modulated Laser in 2.5GHz channel bandwidth.

5.4.2 **16:30**
Low cost Multi-Band OFDM for remote modulation of colourless ONU in hybrid WDM/TDM-PON architecture
 Naveena Genay, T. Duong, A. Pizzinat, B. Charbonnier, P. Chanclou, France Telecom R&D, C. Kazmierski Alcatel Thales III-V Labs, France
 ♦ We demonstrate the use of OFDM for remote modulation of colourless ONU as a low cost solution for upstream transmission in a hybrid WDM/TDM-PON architecture. A comparison is performed between two potential solutions.

5.4.3 **16:45**
Demonstration of 3-λx8x10 Gbps WDM/DPSK-OCDMA using 31-chip, 640 Gchip/s SSFBG En/decoder for 10 G Flexible Access Network
 Xu Wang, Naoya Wada, National Institute of Information and Communications Technology, Ken'ichi Kitayama, Osaka University, Japan
 ♦ We demonstrate a high data-rate SSFBG-based WDM/OCDMA experiment, 3 wavelengths with 100 GHz spacing, 8 OCDMA, 10 Gbps/user using 31-chip, 640 Gchip/s en/decoders, DPSK modulation, time gating and FEC.

5.4.4 **17:00**
A novel bidirectional WDM/TDM-PON using DPSK downstream signals and a custom AWG
 Nicola Calabretta, Marco Presi, Roberto Proietti, Giampiero Contestabile, Ernesto Ciaramella, Scuola Superiore Sant'Anna University, Italy
 ♦ We demonstrate a novel SOA-based bidirectional WDM/TDM-PON architecture that exploits a custom-AWG for distribution and demodulation of all WDM-NRZ-DPSK downstream signals and a Reflective-SOA to re-modulate the 1Gbit/s upstream signal.

5.4.5 **17:15**
Demonstration of FTTx System with QPSK Offset Sideband Modulation
 David Krause, Jamie Gaudette, John Cartledge, Queen's University, Canada; Trevor Norman, Kim Roberts, Nortel Networks, Canada
 ♦ To alleviate the implications of bi-directional crosstalk in a simple in-line transceiver, 2.5 GSym/s QPSK offset sideband modulation and 1.25 Gb/s direct OOK modulation are used for downstream and upstream signalling, respectively.

5.4.6 **17:30**
Highly Spectral Efficiency Multi-User Optical Network Architecture using 1Gb/s 16QAM Subcarrier Multiplexing
 Jin Yong Ha, Adrian Wonfor, Richard Penty, Ian White, University of Cambridge, Pierpaolo Ghiggino, Ericsson, United Kingdom
 ♦ A proof-of-principal-demonstration of a 20-Gb/s multi-user optical network using SCM-16QAM for high spectral-efficiency is reported. A single wavelength 20-SCM channel simulation is performed, showing an EVM of less than 7% for the worst case channel.

5.4.7 **17:45**
Generation of 3.6 Gbps 16-QAM 39 GHz mm-wave carrier employing photonic vector modulation
 Rakesh Sambaraju, Valentin Polo, Juan Luis Corral, Javier Marti, Universidad Politecnica de Valencia, Miguel Angel Piqueras, Das Photonics S. L, Spain
 ♦ The experimental generation of a 3.6Gb/s-16QAM 39GHz carrier employing Photonic Vector Modulation is reported for the first time. The quadrature condition is introduced using an optical delay line. EVM is estimated from measured eye-diagrams.

Session 5.5 **Hall 9**
Photodiodes and Receivers

Chair: Joe Campbell, University of Virginia, USA

5.5.1 **16:15**
Invited: Ultrafast Waveguide-integrated pin-Photodiodes and Photonic Mixers from GHz to THz Range
 Heinz-Gunter Bach, Fraunhofer-Institut fuer Nachrichtentechnik, Germany
 ♦ Long-wavelength InP-based micro-pin photodiodes with 150 GHz bandwidth are demonstrated. ? Applying these diodes optically parallel-fed travelling wave photodetectors with high output power and photonic mixer sub-THz transmitter ICs will be demonstrated.

5.5.2 **16:45**
Thin Film InGaAs/InAlAs Photodetectors Integrated on a Silicon-on-Insulator Waveguide Substrate
 Joost Brouckaert, Gunther Roelkens, Dries Van Thourhout, Roel Baets, Ghent University - IMEC, Belgium
 ♦ We present compact and efficient InGaAs/InAlAs metal-semiconductor-metal photodetectors coupled with Silicon-on-Insulator waveguides. The responsivity of 25µm long detectors is 1.0A/W at a wavelength of 1.55µm. The dark current is 3.0nA at 5V bias.

5.5.3 **17:00**
10 GHz Balanced Photodetector with +17 dBm RF Output Power
 Andreas Belling, Hao Chen, Ning Duan, C. Campbell, University of Virginia, USA
 ♦ We report on a novel high-power balanced photodetector with 0.75 A/W responsivity and 870 mA-GHz saturation current-bandwidth product. The common mode rejection ratio is >30 dB.

5.5.4 **17:15**
3Gbps-per-Channel Highly-Parallel Silicon Receiver OEIC
 Robert Swoboda, Michael Foertsch, A3PICs Electronics Development GmbH, Austria; Horst Zimmermann, Vienna University of Technology, Austria
 ♦ An optoelectronic integrated circuit in 0.6µm BiCMOS containing 36 parallel receiver channels each with PIN photodiode and low-power amplifiers inclusive output drivers is presented. The sensitivity is -17.8dBm at 3Gbps in each channel for 850nm.

5.5.5 **17:30**
Multi-Channel Operation of a Receiver Photonic Integrated Circuit with an Integrated Semiconductor Optical Amplifier
 Radhakrishnan Nagarajan, Masaki Kato, Vince Dominic, Sheila Hurtt, Andrew Dentai, Jacco Pleumeekers, Peter Evans, Mark Missey, Ranjani Muthiah, Arnold Chen, Damien Lambert, Prashant Chavarkar, Atul Mathur, Johan Bäck, Infinera, USA
 ♦ We demonstrate multi-channel operation of a high speed, dense wavelength division multiplexed, DWDM, InP receiver photonic integrated circuits with on-chip semiconductor optical amplifiers.

5.5.6 **17:45**
Multi-Frequency Heterodyne System for All-Optical-Technology-Free Ultrafast Optical Waveform Measurement
 Takahide Sakamoto, Tetsuya Kawanishi, Masayuki Izutsu, National Institution of Information and Communications Technology, Japan
 ♦ A multi-frequency heterodyne system for ultrafast optical waveform measurement is proposed. Ultrafast waveform beyond photodiode bandwidth is downconverted to a slow-speed signal by photomixing with a locally generated ultra-flat comb. 80-GHz waveform was successfully measured.

Session 6.1 **Hall 3**
Photonic Crystal Fibers I

Chair: Dag Roar Hjelle, Optomed, Norway

6.1.1 **8:30**

Invited: Potential of hole-assisted fibres in optical access and in-house networks
 Toshio Kurashima, NTT, Japan
 ♦ Hole-assisted fibre, HAF has an extremely low bending loss characteristic compared with conventional fibre. We describe recent progress on optical wiring technologies based on HAF, which enables us to offer simple and economical FTTH installation.

6.1.2 **9:00**
Experimental demonstration of phase matching between two different photonic bandgaps in Hybrid Photonic Crystal Fibers

Arismar Sodré Junior, Cristiano Cordeiro, Hugo Hernández-Figueroa, Unicamp, Brazil; Jonathan Knight, University of Bath, United Kingdom
 ♦ We have experimentally demonstrated, for the first time, phase matching between 02 different photonic bandgaps of an optical fiber. It was got by launching femtosecond pulses near a zero-dispersion wavelength of Hybrid Photonic Crystal Fibers.

6.1.3 **9:15**
Nanoparticle-Doped Microstructured Polymer Optical Fibre

Helmut Yu, Alexander Argyros, Martijn van Eijkelenborg, University of Sydney, Geoff Barton, School of Chemical and Biomolecular Engineering, Australia; Christophe Barbe, Kim Finnie, Linggen Kong, Scott McNiven, Australian Nuclear Science and Technology Organisation, Australia; Francois Ladouceur, University of New South Wales, Australia
 ♦ A generic method has been developed which utilises functional nanoparticles as a universal dopant delivery system for embedding material into microstructured polymer optical fibres, mPOF. Doping experience with silica nanoparticles and quantum dots is presented.

6.1.4 **9:30**
Extending the Use of Polymers through Hollow-Core Polymer Fibres

Alexander Argyros, Jaryrd Pla, Leon Poladian, Andrew Docherty, University of Sydney, Australia
 ♦ We investigate kagome lattice hollow-core polymer fibres. The very low overlap between the core mode and the polymer is crucial to the guidance mechanism and allows polymer fibres to be used in the infrared.

6.1.5 **9:45**
Nano-Crystallized Glass Fibers with Second-Order Optical Nonlinearity

Naoki Iwafuchi, Takumi Fujiwara, Yoshiki Yamazaki, Hiroshi Mori Tohoku University, Takayuki Komatsu, Nagaoka University of Technology, Japan
 ♦ Second harmonic generation, SHG and propagation loss have been measured on nano-crystallized optical fibers from a tellurite based glass. Angular dependence of SHG intensity and low propagation loss, 0.15 dB/cm at 1.55 micrometer are reported.

6.1.6 **10:00**
All-optical switching in liquid-crystal filled lead silicate photonic crystal fiber using transverse coupling geometry

Hannu Hoffrén, Jesse Tuominen, Hanne Ludvigsen, Helsinki University of Technology, Finland
 ♦ Up to 25 dB extinction ratio is demonstrated in an all-optical switch based on liquid-crystal filled lead silicate photonic crystal fiber using transverse coupling geometry. An operating range of 600-1700 nm is achieved.

Session 6.2 **Roofgarden**
Advanced Modulation Formats

Chair: Peter Krummrich, University of Dortmund, Germany

6.2.1 **8:30**

Tutorial: Advanced Optical Modulation Formats
 Peter Winzer, Alcatel - Lucent, USA; Rene-Jean Essiambre, Alcatel - Lucent, USA
 ♦ Alongside technologies such as forward error correction, low-loss optical components, and low-noise optical amplification schemes, advanced optical modulation formats have become key to improving performance and increasing capacity of modern wavelength-division multiplexed, WDM fiber systems. In recent years, many well established radio-frequency, RF techniques for modulating, detecting, and digitally processing signals have been adopted and extended to optical transport applications. While several aspects of such adaptations have been successful, the migration process of RF techniques to optical communications faces several fundamental as well as technological limits that are specific to the fiber-optic communication channel. This tutorial reviews advanced optical modulation formats in the context of modern optically-routed WDM networks. We discuss generation, detection, and multiplexing options for intensity- and phase-modulated formats at bit rates from 10 to 100 Gb/s. We highlight the formats' resilience to key impairments found in optical networking, such as optical amplifier noise, chromatic dispersion, polarization-mode dispersion, concatenated optical filtering, and fiber nonlinearity.

6.2.2 **9:30**
Reduction of intra-channel four-wave mixing through pairwise or pulse-to-pulse alternate polarization of carrier-suppressed RZ signals

Johannes Fischer, Germany; Klaus Petermann, Technical University of Berlin, Germany
 ♦ It is shown that a combination of pairwise or pulse-to-pulse alternate polarization and 67% duty cycle carrier-suppressed return-to-zero, CSRZ achieves additional reduction of intra-channel four-wave mixing compared to bit-to-bit alternate polarization in 40 Gbit/s systems.

6.2.3 **9:45**
Study of precise optical modulation using Mach-Zehnder interferometers for advanced modulation formats

Tetsuya Kawanishi, Takahide Sakamoto, Akito Chiba, Masayuki Izutsu, National Institution of Information and Communications Technology, Japan
 ♦ We investigated impact of parasitic phase modulation at Mach-Zehnder modulators on advanced modulation formats, such as quadrature-amplitude-modulation. Phase error due to imbalance in a modulator can be compensated by using an optical frequency-shift-keying modulator.

6.2.4 **10:00**
Advanced Modulation Formats for Electronic Predistortion of Intra-channel Nonlinearities at 40 Gbit/s

Stephan Hellerbrand, Norbert Hanik, Munich University of Technology, Christian Weber, Klaus Petermann, Technical University Berlin, Germany
 ♦ The role of the target modulation format, at the receiver in electronically predistorted 40 Gbit/s transmission is studied by comparing various on-off-keying formats. Best performance is achieved for CS-RZ as the target format.

Session 6.3 **Hall 4/5**
Novel Integration Technology I

Chair: Piero Gambini, Avago Technologies, Italy

6.3.1 **8:30**

Invited: A Photonic Interconnect Layer on CMOS
 Dries Van Thourhout, Joris Van Campenhout, Roel Baets Ghent University-IMEC, Belgium; Pedro Rojo-Romeo, Philippe Regreny, Christian Seassal, Institut des Nanotechnologies de Lyon, France; Chrystelle Lagahe, Tracit Technologies, France; Xaveer Leijts, Pietro Binetti, Richard Notzel, Meint Smit, TUIe, The Netherlands; Lea Di Cioccio, Jean-Marc Fedeli, CEA-LETI, France
 ♦ We propose and demonstrate a photonic interconnect layer consisting of heterogeneous microdisk lasers and microdetectors integrated with a nanophotonic silicon waveguide circuit. The photonic layer is fabricated using waferscale processes and a die-to-wafer bonding process.

6.3.2 **9:00**
160 Gb/s optical time-division demultiplexing by four-wave mixing in a 5cm length ultra-high nonlinear As₂S₃ waveguide

Mark Pelusi, Fahid Ta'eed, Steve Madden, D Choi, Barry Luther-Davies, Centre for Ultrahigh bandwidth Devices for Optical Systems, CUDOS, Australia; Benjamin Eggleton, University of Physics, Australia
 ♦ An As₂S₃ waveguide with ultra-high optical Kerr nonlinearity ~ 2000 W⁻¹km⁻¹ demonstrates high-performance time-division demultiplexing of a 160Gb/s signal into its tributary 10Gb/s channels via four-wave mixing in just a 50mm length device.

6.3.3 **9:15**
Wavelength Converter with +5 dB Parametric Gain Using Direct-Bonded QPM-Zn:LiNbO₃ Ridge Waveguide

Takeshi Umeki, Masaki Asobe, Yoshiki Nishida, Osamu Tadanaga, Katsuaki Magari, Tsutomu Yanagawa, Hiroyuki Suzuki, NTT Photonics Laboratories, Japan
 ♦ We fabricate a 50-mm-long ZnO-doped quasi-phase-matched LiNbO₃ ridge waveguide by employing the direct bonding and dry etching techniques. We successfully achieve a parametric conversion gain of +5 dB by using a X₂ cascade scheme.

6.3.4 **9:30**
First Demonstration of PPLN+RSOA-based Tunable All-Optical NRZ-to-RZ Format Conversion

Jian Wang, Junqiang Sun, Qizhen Sun, Xinliang Zhang, Dexiu Huang, Huazhong University of Science and Technology, P.R. China; Martin Fejer, Stanford University, USA
 ♦ We experimentally demonstrate a novel scheme of all-optical NRZ-to-RZ format conversion at 10 Gb/s and 20 Gb/s using a PPLN and a RSOA. Tunable operation and single-to-dual channel conversion are successfully observed in the experiment.

6.3.5 **9:45**
Fabrication of 300-nm-period nanostructure in a bulk fused silica

Mykhaylo Dubov, Vladimir Mezentsev, Ian Bennion, David Nikogosyan, Aston University, United Kingdom
 ♦ We report on the first recording of a 300-nm-period structure in a permanently moving sample of a pure fused silica using the tightly-focused, 82 nJ, 267 nm, 300 fs, 1 kHz laser pulses.

6.3.6 **10:00**
Vertically Coupled GaInAsP/InP Microring Lasers Fabricated by Using Full Wafer Bonding

Helmut Heidrich, Michael Hamacher, Ute Troppenz, Fraunhofer Institute for Telecommunications, Germany; Dimitris Syvridis, Dimitris Alexandropoulos, Spiros Mikroulis, National and Kapodistrian Univ. of Athens, Greece; Kevin Williams, Chyng Wen Tee, University of Cambridge, United Kingdom; Viorel Dragoi, EV Group E. Thallner GmbH, Austria; Marin Alexa, Max Planck Institute of Microstructure Physics, Germany; Dana Cristea, Cristian Kusko, Mihai Kusko, National Institute for Research and Development in Microtechnologies, Romania
 ♦ We summarize results on the processing and characterization of current injected 1.55 μm single- and multi-microring lasers including vertical active/passive waveguide coupling. The devices were fabricated by GaInAsP/InP-GaAs full-wafer bonding using a BCB interface

Session 6.4 **Hall 7**
WDM PONs

Chair: Gerlas van den Hoven, GENEXIS, The Netherlands

6.4.1 **8:30**

Invited: High Temperature, Colourless Operation of a Reflective Semiconductor Optical Amplifier for 2.5Gbit/s upstream transmission in a WDM-PON
 Anna Borgesani, Ian Lealman, David Smith, Alistair Poustie, Richard Wyatt, CIP, United Kingdom
 ♦ Wide temperature range operation of a reflective SOA as a high-speed, colourless upstream modulator is demonstrated in a WDM-PON architecture. 2.5Gbit/s upstream transmission over 10km up to 80C is shown across the C-band.

6.4.2 **9:00**

Coherent Crosstalk-suppression in WDM Access Networks employing Reflective Semiconductor Optical Amplifier
 Patryk Urban, Ton Koonen, Giok-Djan Khoe, Huug de Waardt, Eindhoven University of Technology, The Netherlands
 ♦ Dithering the bias current of a Reflective SOA can effectively reduce coherent crosstalk, which can be a major limitation in WDM-PON performance using colourless RSOA-based ONUs. The power penalty was reduced from 5dB to 1dB.

6.4.3 **9:15**

Power Budget Improvement for Passive Outside Plant Long Reach High Density Access Network using High Bit Rate RSOA-ONUs
 Jose Lazaro, Victor Polo, Francesc Bonada, Josep Prat, Universitat Politècnica de Catalunya, UPC, Spain; philippe chanclou, France Telecom, Christophe Kazmierski, Alcatel-Thales III-V Lab, France
 ♦ New Remote Nodes design of Sardana network allows reaching >1000 ONUs along protected 100km and broadband to users by using thin-film filters, remote amplification, 1.25/2.5/5Gbps-capable RSOA-ONUs and 10Gbps down-stream.

6.4.4 **9:30**

Reflective ONUs by integration of Erbium Doped Waveguide Amplifiers
 Jose Lazaro, Victor Polo, Josep Prat, Universitat Politècnica de Catalunya, UPC, Spain; Karin Ennsner, CNIT, Italy; Giuseppe Della Valle, Stefano Taccheo, Politecnico di Milano, Italy
 ♦ We propose and discuss using erbium-doped-waveguide amplifier as gain element in ONT. We demonstrate that it can provide high gain, bidirectional operation and bit-rate transparency paving the way to 10Gbps symmetric PON.

6.4.5 **9:45**

Continuous-Wave Supercontinuum-Based Bidirectional Long Reach WDM-POM Incorporating FP-LD-based OLT and RSOA-based ONUs
 Ju Han Lee, Chul Han Kim, University of Seoul, Korea; Kwani Lee, Korea Institute of Science and Technology, Korea
 ♦ We experimentally demonstrate a long reach, 60km, bidirectional, colorless WDM-PON architecture based on uncooled, TO-can packaged RSOAs for upstream and FP-LDs for downstream, which are wavelength-locked by a spectrum-sliced, high-power, depolarised CW supercontinuum injection source

6.4.6 **10:00**

Transmission of Upstream Data and Broadcast Signals over a Single Wavelength in WDM-PON Using Light-Injected Optical Sources
 Ho Chul Ji, Ken'ichi Kitayama, Osaka University, Ikuo Yamashita, The Kansai Electric Power Company, Japan
 ♦ We propose and demonstrate the transmission of 122-Mb/s upstream data and broadcast signals over a single wavelength using mutually injection-locked Fabry-Perot laser diodes, MIL-FPLDs and a reflective semiconductor optical amplifier, RSOA .

Session 6.5 **Hall 9**
Transport Testbeds

Chair: Masatoshi Suzuki, KDDI R&D Laboratories, Japan

6.5.1 **8:30**

Invited: Experimental interconnection and interworking of the multi-domain, ASON-GMPLS and multi-layer, TDM-LSC NOBEL2 test-beds
 Raul Muñoz, Ricardo Martínez, Fermín Galán Márquez, Centre Tecnològic de Telecomunicacions de Catalunya, Spain; Robert Morro, Telecom Italoa, Italy; Hans Foisel, Sabine Szuppa, T-systems, Germany; Javier Jiménez, Oscar Gonzalez de Dios, Telefonica I+D, Spain; Hermann Dentler, Alcatel-Lucent, Germany; Eduard Escalona, Salvatore Spadaro, Fernando Agraz, Universitat Politècnica de Catalunya, Spain; Bela Berde, Alcatel Research & Innovation, France
 ♦ This paper presents the implemented interconnection of the test-beds involved in NOBEL2 project based on a star-hub router, and the proposed solution for ASON-GMPLS multi-domain multi-layer interworking among test-beds based on a centralized ASON-GMPLS proxy.

6.5.2 **9:00**

Implementation of Multilayer VPN Capabilities in SINET3
 Shigeo Urushidani, Jun Matsukata, Kensuke Fukuda, Yusheng Ji, Shunji Abe, Michihiro Koibuchi, Shigeki Yamada, National Institute of Informatics, Japan
 ♦ This paper describes the practical network design of an advanced hybrid network that accommodates a rich variety of packet and circuit services, especially the multilayer VPN and layer-1 BoD services.

6.5.3 **9:15**

Lambda Sharing Demonstration via Traffic-Driven Lambda-on-Demand
 Yukio Tsukishima, Akira Hirano, Naohide Nagatsu, Wataru Imajuku, Masahiko Jinno, Yoshinori Hibino, Yoshihiro Takigawa, Kazuo Hagimoto, NTT Network Innovation Laboratories, Japan; Xi Wang, Luc Renambot, Byungil Jeong, Jason Leigh, Tom DeFanti, Alan Verlo, University of Illinois at Chicago, USA
 ♦ This paper proposes GMPLS-capable Lambda-on-Demand to adjust the number of load-balanced end-to-end lambdas according to the traffic volume while successfully sharing lambda resources to connect between any two of three nodes for the first time.

6.5.4 **9:30**

OTN-overhead based Optical-Path Performance Management in the NMS of GMPLS-Controlled All-Optical Networks
 Takehiro Tsuritani, Masanori Miyazawa, Tomohiro Otani, KDDI R&D Laboratories, Inc., Japan
 ♦ OTN-overhead based optical-path performance management was successfully demonstrated in the network management system of GMPLS-controlled all-optical networks. Intentional bit error ratio, BER degradation was appropriately detected and isolated by tracing the BER along the optical-path.

6.5.5 **9:45**

Transpacific Ethernet Transport over GMPLS-based Three Administrative-Domain Photonic Networks
 Atsushi Taniguchi, Wataru Imajuku, NTT Network Innovation Laboratories, Shuichi Okamoto, Yasunori Sameshima, Yukihisa Okano, NICT, John Moore, MCNC, Tomohiro Otani, KDDI R&D Laboratories, Inc., Japan
 ♦ This paper describes the results of transpacific light path creation for an Ethernet transport service over GMPLS-controlled three administrative domain networks between the US and Japan.

6.5.6 **10:00**

Experimental Demonstration of an Optical Interconnection Network with Asynchronous Transmission
 Assaf Shacham, Caroline Lai, Keren Bergman, Columbia University, USA
 ♦ Asynchronous routing of optical packets experimentally demonstrated on a 4x4 3-stage interconnection network testbed, offering increased flexibility and efficiency. 6x10 Gb/s wavelength-striped packets with optically encoded addresses routed correctly. Error-free transmission is verified.

Session 6.6 **Hall 10**
Emerging Technologies

Chair: Sebastien Bigo, Alcatel-Lucent France Research & Innovation, France

6.6.1 **8:30**

Simultaneous Demodulation and Slow-light Delay of DPSK Signals at Flexible Bit-Rates using Bandwidth-Tunable SBS in Optical Fibre
 Lilin Yi, Yves Jaouen, Junhe Zhou, GET / Telecom Paris, Erwan Pincemin, France Telecom R&D, France; Weisheng Hu, Yikai Su, Shanghai jiao tong university, P.R. China
 ♦ Simultaneous demodulation and slow-light delay of 10-Gb/s and 2.5-Gb/s DPSK signals with excellent performance are demonstrated using bandwidth-tunable SBS in optical fibre. SBS demodulation presents much better delay performance compared with 1-bit-delay demodulation

6.6.2 **8:45**

10-Gb/s Slow-Light Performance Based on SBS Effect in Optical Fiber using NRZ and PSBT Modulation Formats
 Lilin Yi, Yves Jaouen, Renaud Gabet, GET / Telecom Paris, France; Weisheng Hu, Yikai Su, Shanghai jiao tong university, P.R. China; Sebastien Bigo, Alcatel-Lucent France Research & Innovation, France
 ♦ For the first time, we have demonstrated error-free slow-light via SBS in optical fiber for 10-Gb/s NRZ and PSBT formats. The PSBT signal sensitivity is 5.2dB better than the NRZ case for 35-ps delay

6.6.3 **9:00**

Demonstration of 4-bit Photonic Analog-to-digital Conversion Employing Self-frequency shift and SPM-induced Spectral Compression
 Takashi Nishitani, Tsuyoshi Konishi, Kazuyoshi Itoh, Osaka University, Japan
 ♦ We propose and demonstrate the photonic analog-to-digital conversion employing soliton self-frequency shift and SPM-induced spectral compression. From experimental results, we confirm that input 15-level analog signals are successfully converted into 4-bit digital signals.

6.6.4 **9:15**

Multiple-Tap Complex-coefficient Incoherent Microwave Photonics Filters using Phase-Shifted Fiber Bragg Gratings
 Mikel Sagues, Alayn Loayssa, Universidad Pública de Navarra; Raimundo Garcia-Olcina, Salvador Sales, Jose Capmany, Universidad Politecnica de Valencia, Spain
 ♦ We propose a novel scheme to implement multi-tap complex coefficient filters based on optical single-sideband modulation and narrow-band optical filtering. A four-tap filter is experimentally demonstrated to high-light enhanced tuning performance provided by complex coefficients.

6.6.5 **9:30**

Polarization stabilizer for polarization-division multiplexed optical systems
 Paolo Martelli, Maddalena Ferrario, Lucia Marazzi, Paola Parolari, Aldo Righetti, Rocco Siano, CoreCom, Pierpaolo Boffi, Silvia Pietralunga, Mario Martinelli, Politecnico di Milano, Italy
 ♦ The effectiveness of a magneto-optic polarization stabilizer in demultiplexing two polarization-division multiplexed channels is experimentally demonstrated. Bit-error rate measures are presented for RZ-OOK modulation format at 10 Gb/s.

6.6.6 **9:45**

Broadband Swept Optical Single-sideband Modulation Generation for Spectral Characterization of Optical Components
 Mikel Sagues, Garbiñe Beloki, Alayn Loayssa, Universidad Publica de Navarra, Spain
 ♦ We propose a technique for broadband optical single-sideband modulation generation for spectral measurement applications. We experimentally demonstrate an unwanted-sideband suppression over 35 dB in a broadband range from 50 MHz to 20 GHz.

6.6.7 **10:00**

A 10.3125-Gbit/s SiGe BiCMOS Burst-Mode Clock and Data Recovery Circuit with 160-bit Consecutive Identical Digit Tolerance
 Jun Terada, Kazuyoshi Nishimura, Minoru Togashi, Tomoaki Kawamura, Shunji Kimura, Yusuke Ontomo, NTT Corporation, Japan
 ♦ A burst-mode clock and data recovery, CDR circuit for 10 G-EPON OLT receivers is presented. The CDR employs a single-VCO architecture, which increases consecutive identical digit, CID tolerance. The developed CDR demonstrates 160-bit CID tolerance.

Session 7.1 **Hall 3**
Photonic Crystal Fibers II

Chair: Lidia Terruzzi, Prismsian, Italy

7.1.1 **10:45**
Raman Gain Suppression in All-solid Photonic Bandgap Fiber

Toshiki Taru, Sumitomo Electric Industries, Japan; Jing Hou, National University of Defense Technology, China
 Jonathan C. Knight, University of Bath, United Kingdom
 ♦ Raman gain suppression by the photonic bandgap structure in all-solid PBGF was proposed and demonstrated in order to apply it to the high power laser delivery without power depletion by Raman process in the fiber.

7.1.2 **11:00**
Low-Loss Dispersion-Shifted Solid-Core Photonic Bandgap Bragg Fiber

Mikhail Likhachev, Andrei Levchenko, Mikhail Bubnov, Fiber Optics Research Center of RAS, Russia; Sebastien Fevrier, Raphael Jamier, Georges Humbert, Xlim, France; Mikhail Salganskii, Vladimir Khopin, Institute of Chemistry of High Purity Substances of RAS, Russia; Aleksey Guryanov, Institute of Chemistry of High Purity Substances of RAS, Russia
 ♦ A Bragg fiber with the zero dispersion wavelength shifted towards 1µm has been proposed, fabricated and studied. Dispersion of 60ps²/nm km has been achieved at 1064nm with an optical loss of 1.1dB/m

7.1.3 **11:15**
Square Lattice Hollow Core Photonic Bandgap Fibres

Francesco Poletti, David Richardson, University of Southampton, United Kingdom
 ♦ We propose a novel photonic bandgap fibre, PBGF based on a square lattice cladding. The fibre presents a 20% wider bandgap than conventional triangular-lattice-based PBGFs and with a 9-cell core can be effectively single moded.

7.1.4 **11:30**
Guidance and polarization properties of an anisotropic microstructured fibre

Martina Delgado-Pinar, Antonio Díez, Salvador Torres-Peiró, Teresa Pinheiro-Ortega, Enrique Silvestre, Miguel Andres, Universidad de Valencia, Spain
 ♦ We present the fabrication of different microstructured fibres, in which anisotropy is created in the lattice of air-holes by enlarging four air-holes next to the silica core. Guiding properties of the polarization modes are reported.

7.1.5 **11:45**
Archimedean-like lattice microstructured optical fibers

Antoine Proulx, Steeve Morency, Claude Paré, INO, Canada
 ♦ We present a novel microstructured optical fiber design consisting of an Archimedean-like lattice of air holes surrounding a solid central core. We show that this cladding structure substantially improves the circularity of the fundamental mode.

7.1.6 **12:00**
Fundamental and higher-order mode confinement loss spectrum in realistic air-silica hollow-core Bragg fibers

Matteo Foroni, Federica Poli, Davide Passaro, Annamaria Cucinotta, Stefano Selli, University of Parma, Italy; Jesper Lægsgaard, Anders Bjarklev, COMoDTU, Technical University of Denmark
 ♦ Silica bridges in realistic air-silica hollow-core Bragg fibers are responsible of the surface mode presence, which interrupt the transmission window of the fundamental and the higher-order modes, narrowing the width useful for light guiding.

7.1.7 **12:15**
Highly efficient generation of cascaded Four-Wave Mixing products in a Hybrid Photonic Crystal Fiber

Arismar Sodré Junior, José Chavez Boggio, Hugo Hernández-Figueroa, Hugo Fragnito, Unicamp, Brazil; Jonathan Knight, University of Bath, United Kingdom
 ♦ We report on highly efficient generation of cascaded four-wave products over 110nm, covering C and L bands. It has been gotten by launching two lasers near one zero-dispersion wavelength of a Hybrid Photonic Crystal Fiber.

Session 7.2 **Roofgarden**
Coherent Systems I

Chair: Ernesto Ciaramella, Scuola Superiore Sant'Anna University, Italy

7.2.1 **10:45**
Invited: DSP-Enhanced Differential Direct-Detection for DQPSK and m-ary DPSK

Xiang Liu, Alcatel-Lucent, Bell Laboratories, USA
 ♦ We review the principle and progress of sampled self-coherent optical receiver based on differential-direct-detection and digital-signal-processing, showing promise of improving receiver sensitivity, receiving multi-level DPSK formats, reconstructing signal field, and digital compensation of transmission impairments.

7.2.2 **11:15**
Invited: Performance comparison of singly-polarized and polarisation-multiplexed coherent transmission at 10Gbauds under linear impairments

Gabriel Charlet, Renaudier Jérémie, Oriol Bertran Pardo, Haik Mardoayn, Sebastien Bigo, Alcatel-Lucent Research and Innovation, France; Massimiliano Salsi, University of Parma, Italy
 ♦ The tolerance to narrow filtering, PMD and chromatic dispersion has been measured with and without polarization multiplexing at 10Gbauds. Only a limited penalty is induced by polarization multiplexing, despite doubling of the channel rate.

7.2.3 **11:45**
Carrier phase estimation for coherent equalization of 43-Gb/s POLMUX-NRZ-DQPSK transmission with 10.7-Gb/s NRZ neighbours

Dirk van den Borne, Chris Fludger, Thomas Duthel, Christoph Schullen, CoreOptics GmbH, Germany; Torsten Wuth, Siemens PSE GmbH & Co KG, Germany; Ernst-Dieter Schmidt, Erich Gottwald, Nokia Siemens Networks GmbH & Co. KG, Germany; Giok-Djan Khoe, Huug de Waardt, Eindhoven University of Technology, The Netherlands
 ♦ We show the influence of 10.7-Gb/s NRZ neighbors on 43-Gb/s polarization-multiplexed NRZ-DQPSK transmission combined with digital coherent equalization. The impact of XPM induced phase noise is reduced with an optimized carrier phase estimation algorithm.

7.2.4 **12:00**
Measurement of Constellation Diagrams for 40-Gb/s DQPSK and 60-Gb/s 8ary-DPSK Using Sampled Orthogonal Differential Direct-Detection

Xiang Liu, Sethumadhavan Chandrasekhar, Alcatel-Lucent, Bell Laboratories, USA
 ♦ We demonstrate the reconstruction of constellation diagrams for 40-Gb/s DQPSK and 60-Gb/s 8ary-DPSK signals using orthogonal differential direct-detection and analog-to-digital conversion. The recovered differential-phase variance manifests various transmission impairments including noise and nonlinearity.

7.2.5 **12:15**
Simple Low-cost Homodyne PSK Receiver

Josep Fabrega, Josep Prat, Universitat Politècnica de Catalunya, Spain
 ♦ A novel phase shift keying, PSK receiver technique is proposed based on electronic-driven diversity and same optics than heterodyne. It achieves high tolerance to phase noise and feasible implementation with off-the-shelf electronic and optical components.

Session 7.3 **Hall 4/5**
Novel Integration Technology II

Chair: Christian Lermiaux, Université de Technologie de Troyes, France

7.3.1 **10:45**
Invited: Electronics and photonics: convergence on a silicon platform

Jurgen Michel, Lionel C. Kimerling, Massachusetts Institute of Technology, USA
 ♦ The complete integration of photonic devices into a CMOS process flow will enable low cost photonic functionality within electronic circuits. We will discuss challenges and opportunities for CMOS integrated photonic devices.

7.3.2 **11:15**
Fast Optical Clock Recovery and Signal Regeneration Applications of a Monolithic Mode Locked Laser with DBR Mirrors and an Optical Amplifier

Brian Koch, Jonathan Barton, Milan Maanovi?, Zhaoyang Hu, Henrik Poulsen, John Bowers, Daniel J. Blumenthal, University of California, USA
 ♦ We demonstrate optical packet clock recovery with locking in less than 700 ps, 25 bits using a novel device which is compatible with other monolithic components. Regenerative capabilities are analyzed using bit error rate tests

7.3.3 **11:30**
Mitigation of Signal Distortion in 42.7 Gb/s Duobinary Transmission Using a Single Chip Optical Equalizer

Vitaly Mikhailov, Robert Kille, Polina Bayvel, University College London, United Kingdom; Christopher Doerr, Larry Buhl, Bell Laboratories, Alcatel-Lucent, USA
 ♦ We experimentally investigated the ability of optical equalizers to mitigate signal distortion caused by chromatic dispersion, intrachannel fiber nonlinearities and cascaded filters in 42.7 Gb/s duobinary transmission

7.3.4 **11:45**
Silicon-on-Insulator, SOI Delay-Line Interferometer with Low Polarization-Dependent Frequency Shift for 40 Gbit/s DPSK Demodulation

Lars Zimmermann, Karsten Voigt, Georg Winzer, Torsten Mitze, Juergen Bruns, Klaus Petermann, Technical University of Berlin, Germany; Thomas Richter, Colja Schubert, Fraunhofer Heinrich-Hertz-Institut, Germany
 ♦ A 40 Gbit/s SOI rib-waveguide delay-&-add interferometer is presented. Across the C-band we demonstrate high uniformity, low loss, PDL, and PDFS, < 1 GHz. RZ & NRZ DPSK balanced-detection measurements at 40 Gbit/s are included.

7.3.5 **12:00**
5 Channel, 20Gbit/s per Channel Transmitter Photonic Integrated Circuit for 100GbE Application

Masaki Kato, Radhakrishnan Nagarajan, Jacco Pleumeekers, Peter Evans, Arnold Chen, Atul Mathur, Andrew Dentai, Sheila Hurtt, Damien Lambert, Prashant Chavarkar, Mark Missey, Johan Bäck, Ranjani Muthiah, Sanjeev Murthy, Infinera, USA
 ♦ We have developed a 100Gbit/s, 5channels x 20Gbit/s transmitter Photonic Integrated Circuit for 100GbE applications, and demonstrated 10km transmission in SMF-28 fiber for short reach applications.

7.3.6 **12:15**
Optical coupling of active components and polymer based optical waveguide boards

Norbert Keil, Fraunhofer Institute, Heinrich-Hertz-Institut, Germany
 ♦ Optical coupling between active components and polymer based optical waveguide boards are addressed. Using a waveguide chip as optical adapter the coupling loss between laser diodes and single-mode fibres can be reduced by some 6dB

Session 7.4 **Hall 7**
Access Systems

Chair: Kazuo Hagimoto, NTT, Japan

7.4.1 **10:45**
A Wideband Low-distorted ROSA for Video Distribution Service based on FM Conversion Scheme
 Kimikazu Sano, Toshihide Yoshimatsu, Satoshi Kodama, Makoto Nakamura, Miwa Mutoh, Satoshi Tsunashima, Koichi Murata NTT Corporation, Japan; Naohiko Yuki, NTT ANSL, Japan
 ♦ A receiver optical sub-assembly has been developed for video distribution service based on FM conversion scheme. The ROSA features a wide bandwidth of 0.05-10.5 GHz and a low duty-cycle-distortion of <1-%.

7.4.2 **11:00**
Experimental Equalization of Crosstalk in a 2 x 2 MIMO System Based on Mode Group Diversity Multiplexing in MMF Systems @ 10.7 Gb/s
 Stefan Schoellmann, Werner Rosenkranz, University of Kiel, Germany
 ♦ We investigate experimentally a 2 x 2 MIMO system based on Mode Group Diversity Multiplexing over MMF. We show that the interference between co propagating signals is strongly reduced by using equalization.

7.4.3 **11:15**
Transmission of 1.25 Gb/s per channel over 4.4 km Silica Multimode Fibre using QAM Subcarrier Multiplexing
 Jianming Zeng, Jeffrey Lee, Jia Yang, Henrie van den Boom, Ton Koonen, Eindhoven University of Technology, The Netherlands; Florian Breyer, Munich University of Technology, Germany; Sebastian Randel, Siemens, Germany
 ♦ By applying 16-, 32- and 64-QAM subcarrier modulation, 1.25Gb/s transmission per channel via a 4.4-km silica multimode fibre was experimentally demonstrated. The passband region of the fibre was deployed by the subcarrier channel.

7.4.4 **11:30**
All-Optical Envelope Detection for Wireless Photonic Communication
 Idefonso Tafur Monroy, Jorge Seoane, Palle Jeppesen, Technical University of Denmark
 ♦ We propose and experimentally demonstrate operation of an all-optical half-wave rectifier to implement all-optical envelope detection for photonic wireless communication. Down-conversion of a 38 GHz, 3.25 Gb/s ASK, radio frequency signal is successfully achieved

7.4.5 **11:45**
Novel demultiplexing and error-free transmission of 12-channel millimeter-wave-band signals in 25-GHz optical-frequency-interleaved DWDM radio-over-fiber System
 Toshiaki Kuri, NICT, Japan; Hiroyuki Toda, Doshisha University, Japan; Ken'ichi Kitayama, Osaka University, Japan
 ♦ We demonstrate a novel demultiplexing and error-free transmission of twelve-channel 60-GHz-band signals over 25-km plus 2-km standard single-mode fibers in optical-frequency-interleaved dense wavelength division multiplexed radio-over-fiber system with 25-GHz channel spacing.

7.4.6 **12:00**
Experimental Generation of FCC-Compliant UWB Pulse using FBGs
 Mohammad Abtahi, Julien Magné, Mehrdad Mirshafiei, Serge Doucet, Leslie Rusch, Sophie LaRochelle, Laval University, Canada
 ♦ A simple and robust technique for the generation of power-efficient, FCC-compliant UWB pulses is proposed and experimentally demonstrated. An FBG shapes the source spectrum and a length of SMF performs the frequency-to-time conversion.

Session 7.5 **Hall 9**
Network Design I

Chair: Andrew Lord, British Telecom, United Kingdom

7.5.1 **10:45**
Invited: IP over DWDM in core networks: near term and long term goals
 Ori Gerstel, Cisco Systems, USA
 ♦ We explain the IP over DWDM architecture, the applications driving it and its advantages and disadvantages. The talk will cover both near term values unique to this approach and its long term vision and goals.

7.5.2 **11:15**
Impact of router bypass using optical transport on control load during failure recovery
 Stefan Bodamer, Jan Späth, Ericsson, Germany; Dirk Reviol, T-Systems, Germany
 ♦ In IP backbone networks, router bypass using optical transport technology reduces network cost while increasing meshing of routers. This paper provides new results on the impact on the control load for a realistic network scenario.

7.5.3 **11:30**
Efficient Management of a Network's Excess Capacity: A Traffic-Engineering Approach
 Marwan Batayneh, Suman Sarkar, Smita Rai, Biswanath Mukherjee, University of California, Davis, USA
 ♦ We utilize a telecom network's Excess Capacity to improve its Quality-of-Service. Our Excess Capacity Management Scheme, ECMS significantly improves connection availabilities and utilization of network capacity when applied to an optical backbone mesh network

7.5.4 **11:45**
Traffic Driven Path Capacity Adjustment Utilizing Adaptive Digital Filter
 Shuto Yamamoto, Ipppei Shake, NTT, Japan; Tomohiko Kurahashi, Internet Initiative Japan Inc., Japan; Yukiyasu Tarui, Internet Multifeed Co., Japan
 ♦ This paper proposes a novel method for traffic driven path capacity adjustment. Simulations on the method are performed using an example of real traffic data in an Internet exchange, and its feasibility is experimentally confirmed.

7.5.5 **12:00**
Hierarchical Optical Path Network Design Considering Waveband Protection
 Yoshiyuki Yamada, Hiroshi Hasegawa, Ken-Ichi Sato, Nagoya University, Japan
 ♦ We propose a novel hierarchical optical path network design algorithm with consideration of waveband protection. The algorithm utilizes a waveband loop chain to attain dedicated protection. The numerical experiment shows 10-50% network cost reduction.

7.5.6 **12:15**
Outage and Capacity Based Path Selection in Optical Networks
 Jonathan Li, National ICT Australia, Australia; Kerry Hinton, ARC Special Center for Ultra-Broadband Information Networks, Australia; Peter Farrell, The University of Melbourne, Australia; Sarah Dods, NICTA, Australia; Milosh Ivanovich, Chief Technology Office, Telstra, Australia; Paul Fitzpatrick, Telstra Chief Technology Office, Australia
 ♦ We demonstrate a new method to determine the overall probability of successful path selection in all-optical networks, considering both blocking probability from traffic and wavelength utilisation and outage probability from multiple physical layer impairments.

Session 7.6 **Hall 10**
Performance improvement and monitoring in PONs

Chair: Nikolaus Gieschen, T-Systems Enterprise Services GmbH, Germany

7.6.1 **10:45**
Simple Approach to Enhance Bidirectional Transmission Performance of WDM-PONs with RSOAs
 Shu-Chuan Lin, San-Liang Lee, National Taiwan University of Science & Technology, Taiwan
 ♦ Inserting a FP etalon in the ONU of WDM-PON systems can provide performance improvement on 10G/1.25-Gbps downstream/upstream transmission by reshaping the low-ER downstream signals that reduce the intensity fluctuation of RSOA-remodulated upstream signals

7.6.2 **11:00**
Centralized Frequency Stabilization by Dithering Transmission Spectra of PLC-Type MZI-AWG for DWDM-PON
 Masamichi Fujiwara, Hiro Suzuki, Naoto Yoshimoto, Makoto Tsubokawa, NTT Access Network Service Systems Laboratories, Takuya Tanaka, Naoki Ooba, NTT Corporation,
 ♦ We propose centralized frequency stabilization for uplink signals in DWDM-PON. The key device, a PLC integrating two AWGs and a MZI, is developed and the precise frequency stabilization of this technique is experimentally confirmed.

7.6.3 **11:15**
Reduction of Signal-Induced Rayleigh Noise in a 10Gb/s WDM-PON using a Gain-Saturated SOA
 Eimear MacHale, Giuseppe Talli, University College Cork, Ireland; Chi Wai Chow, Photonic Systems Group, Tyndall National Institute, Ireland
 ♦ We demonstrate mitigation of signal-induced Rayleigh-beat-noise in a carrier-distributed WDM-PON using a gain-saturated SOA. The required signal-to-Rayleigh power was reduced by 11dB thereby enabling 10Gb/s error-free transmission in a 64 way-split, 20km reach PON.

7.6.4 **11:30**
Low-Cost Non-intrusive Fiber Monitoring in a PON Last Drop
 Jan Vandewege, Xing-Zhi Qiu, Wei Chen, Bert De Mulder, Johan Bauwelinck, Bart Baekelandt, Ghent University, Belgium
 ♦ Low-cost embedded negative step response OTDR performs PON last drop fiber plant monitoring from an ONU without need for additional optical components, without penalty on network link performance and without service interrupt

7.6.5 **11:45**
In-service Line Monitoring System using 1650 nm Brillouin OTDR for 8-branched PON Fibres with Individually Assigned BFSS
 Nazuki Honda, Noriyuki Araki, Yuji Azuma NTT Corporation, Japan
 ♦ We design an in-service line monitoring system using 1650 nm B-OTDR for measuring 8-branched PON fibres with individually assigned Brillouin frequency shifts, and obtain individual B-OTDR traces of 8-branched PON fibres.

7.6.6 **12:00**
Remotely Powered Optical Switch for Remote Subscriber Aggregation and OTDR Measurement in PON
 Roger Helkey, Michael Inbar, Olivier Jerphagnon, Volkan Kaman, Shifu Yuan, Jim Klingshirn, Nicholas Madamopoulos, John Bowers, Calient Networks, USA
 ♦ We present for the first time remote powering of a 3-D MEMS for optical switching using light over fibre. The low power switch with integrated optical splitters is suitable at non-powered remote PON distribution sites

7.6.7 **12:15**
Effect of PON Geographical Distribution on Monitoring by Optical Coding
 Habib Fathallah, Mohammad M. Rad, Leslie A. Rusch, Université Laval, Canada
 ♦ We derive the performance and critical design issues of optical-coding based centralized live PON monitoring technique allowing more than 512 clients. We consider PON geographical distribution models in our performance evaluation

Session 8.1 **Hall 3**
VCSEL and High-Speed Laser Modulations

Chair: Hans-Ulrich Pfeiffer, Bookham Zurich, Switzerland AG

8.1.1 **14:00**
Invited: Progress in 1.55 μm vertical cavity, VCSEL surface emitting lasers
 Markus Christian Amann, Technische Universität München, Markus Ortsiefer, VERTILAS GmbH, Germany
 ♦ We report on recent progress in long-wavelength VCSEL research. High-speed, 10 Gbit/s, high temperature and high power, >1 mW @ 85°C operation has been achieved with Buried Tunnel Junction, BTJ VCSELS at 1.55 μm emission wavelength.

8.1.2 **14:30**
MIXSELS - a new class of ultrafast semiconductor lasers
 Deran Maas, Aude-Reine Bellancourt, Benjamin Rudin, Matthias Golling, Heiko Unold, Thomas Südmeyer, Ursula Keller, ETH, Switzerland
 ♦ For the first time we have successfully demonstrated a novel concept of a passively modelocked vertical-external-cavity surface-emitting semiconductor laser with an integrated saturable absorber. This MIXSEL will be ultimately suitable for cost-effective high-volume wafer-scale fabrication.

8.1.3 **14:45**
1 x 12 VCSEL Array at 1.55 μm for High-Bandwidth at Metro-Range
 Werner Hofmann, Gerhard Böhm, Walter Schottky Institut, Markus-Christian Amann TU München, Markus Ortsiefer, VERTILAS GmbH, Germany; Elaine Wong, ARC CUBIN, National ICT Australia
 ♦ For a monolithically integrated 1x12 VCSEL array a per-channel bandwidth of 10 Gb/s over 20 km of standard single-mode fibre, SSMF is demonstrated. The emission wavelength is addressable by current-tuning without any bit-error-rate, BER penalty.

8.1.4 **15:00**
40 Gbit/s Directly Modulated Passive Feedback Laser with
 Jochen Kreissl, Ute Troppenz, Wolfgang Rehbein, Tom Gaertner, Peter Harde, Fraunhofer Institute for Telecommunications, Germany; Mindaugas Radziunas, Weierstrass Institute for Applied Analysis and Stochastics, Germany
 ♦ 40 Gbit/s open eyes are demonstrated for a passive feedback laser transmitter with complex coupled DFB section. The transmitter shows superior single mode emission in combination with chirp tuning capability and high reliability.

8.1.5 **15:15**
Un-cooled operation, 10°C to 85°C of a 10.7-Gbit/s 1.55-mm electro-absorption modulator integrated DFB laser for 40-km transmission
 Noriko Sasada, Kazuhiko Naoe, Yasushi Sakuma, Kaoru Okamoto, Ryu Washino, Daisuke Nakai, Katsuya Motoda, Opnext Japan, Inc., Japan; Shigeki Makino, Masahiro Aoki, Central Research Laboratory, Hitachi Ltd., Japan
 ♦ A modulated output-power more than +3.7 dBm, a dynamic extinction-ratio over 9.3 dB, and a power-penalty below 1.8 dB were achieved for 10.7-Gbit/s, 40-km transmission over a wide temperature range from 10°C to 85°C.

8.1.6 **15:30**
High-Power 10-Gb/s Semi-Cooled Operation of AlGaInAs Electroabsorption Modulator Integrated $\lambda/4$ -Shifted DFB Laser
 Kan Takada, Suguru Akiyama, Manabu Matsuda, Japan; Shigekazu Okumura, Mitsuru Ekawa, Tsuyoshi Yamamoto, Fujitsu Laboratories Ltd., Japan
 ♦ High-power 10-Gb/s semi-cooled operation was obtained for AlGaInAs electroabsorption modulator integrated AlGaInAs $\lambda/4$ -shifted DFB lasers. At 53°C, a 9.95-Gb/s 100-km transmission was achieved at average fiber output power of +3.0 dBm.

Session 8.2 **Roofgarden**
Slow Light

Chair : Patrice Mégret, Faculté Polytechnique de Mons, F.P.Ms, Belgium

8.2.1 **14:00**
Tutorial: Slow and fast light: state of the art and future perspectives
 Gadi Eisenstein, Technion Institute of Technology, Israel
 ♦ We describe the state of art in several slow and fast light technologies as well as their use in various communication and microwave related applications.

8.2.2 **15:00**
Soliton Self-frequency Shift based Slow Light in Optical Fiber up to 1600 Delay-to-pulse-width Ratio
 Takashi Kunihiro, Tomochika Kanou, Akihiro Maruta, Osaka University, Japan; Shoichiro Oda, Chalmers University of Technology
 ♦ We have proposed an all-optical tunable delay line using soliton self-frequency shift and filtering supercontinuum spectrum. A wide range tunability up to 1600 delay-to-pulse-width ratio for 0.45ps pulse was demonstrated for the first time.

8.2.3 **15:15**
Dispersionless Slow Light with 5-Pulse-Width Delay in a Long Fibre Bragg Grating
 Joe Mok, Martijn de Sterke, University of Sydney, Benjamin Eggleton, University of Physics, Australia Morten Ipsen, University of Southampton, United Kingdom
 ♦ We observe the excitation of gap solitons in a 30 cm fibre Bragg grating using 0.68 ns pulses, which emerge with a tunable delay of up to 3.2 ns, or almost 5 pulse widths, without broadening.

8.2.4 **15:30**
Variable-Bit-Rate, Continuously-Controllable Optical TDM using SBS-Based Slow Light Tunable Delay Line
 Bo Zhang, Lin Zhang, Irfan Fazal, Jeng-Yuan Yang, Alan Willner, University of Southern California, Lianshan Yan, General Photonics, USA
 ♦ We experimentally demonstrate continuously-tunable OTDM using SBS-based slow-light. Two 75-ps misaligned 2.5-Gb/s RZ channels are successfully multiplexed, resulting in 9-dB power-penalty reduction. Variable-bit-rate OTDM is demonstrated at three different bit-rates, all with error-free operation.

Session 8.3 **Hall 4/5**
Coherent Systems II

Chair: Carsten Gudmann Jorgensen, OFS Fitel, Denmark

8.3.1 **14:00**
Invited: Electrical PMD Compensation in 43-Gb/s POLMUX-NRZ-DQPSK enabled by Coherent Detection and Equalization
 Dirk van den Borne, Huug de Waardt, Giok-Djan Khoe, Eindhoven University of Technology, The Netherlands; Thomas Duthel, Chris Fludger, Christoph Schullien, CoreOptics GmbH, Ernst-Dieter Schmidt, Erich Gottwald, Nokia Siemens Networks GmbH & Co. KG, Torsten Wuth, Siemens PSE GmbH & Co KG, Germany
 ♦ PMD compensation using coherent equalization is demonstrated experimentally. Using 43-Gb/s polarization-multiplexed NRZ-DQPSK, we show compensation of practically arbitrary amounts of DGD, >200ps and CD with negligible penalty, even in the presence of PDL and SOPMD.

8.3.2 **14:30**
1, 000-km Polarization-Interleaved WDM Transmission of 20-Gbit/s QPSK Signals on the Frequency Grid with 12.5-GHz Channel Spacing using Digital Coherent Receiver
 Sang-Yuep Kim, Kazuro Kikuchi, University of Tokyo, Japan
 ♦ Polarization-interleaved 20-Gbit/s QPSK signals on the 12.5-GHz-spaced grid are transmitted over 1, 074 km. Using a digital coherent receiver to demultiplex such ultra-dense WDM QPSK signals, we achieve spectral efficiency as high as 1.6 bit/s/Hz.

8.3.3 **14:45**
Polarization-Multiplexed 2.8 Gbit/s Synchronous QPSK Transmission with Real-Time Digital Polarization Tracking
 Timo Pfau, Ralf Peveling, Florian Samson, Johannes Romoth, Sebastian Hoffmann, Suhas Bhandare, Selwan Ibrahim, David Sandel, Olaf Adamczyk, Mario Pormann, Reinhold Noé, University of Paderborn, Germany; Jerome Hauden, Nicolas Grossard, Photline Technologies, France; Y. Achiam, CeLight Israel
 ♦ This paper presents the implementation of an electronic polarization tracking algorithm which enables real-time polarization tracking multiplexed synchronous QPSK transmission with DFB lasers. The achieved BER at 2.8 Gbit/s is well below the FEC threshold.

8.3.4 **15:00**
Coherent RZ-8PSK Transmission at 30Gbit/s over 1200km Employing Homodyne Detection with Digital Carrier Phase Estimation
 Matthias Seimetz, Lutz Molle, Dirk Gross, Bodo Auth, Ronald Freund, Heinrich-Hertz Institut, Germany
 ♦ Coherent optical RZ-8PSK transmission over 1200km is experimentally demonstrated for the first time employing homodyne detection with 8-th power digital phase estimation. Accompanying simulations detail the theoretical system performance and potential of coherent 8PSK.

8.3.5 **15:15**
Carrier Phase Control for FWM Cross-talk Suppression in Dense WDM Transmission at Low-Dispersion Wavelength
 Etsushi Yamazaki, Fumikazu Inuzuka, Kazushige Yonenaga, Takashi Yamamoto, Atsushi Takada, NTT Corporation, Japan
 ♦ FWM crosstalk distortion can be suppressed by controlling the relative phase of WDM carriers. Calculation and experiments show that WDM carrier phase control suppresses the in-phase component of FWM lights and reduces signal degradation.

8.3.6 **15:30**
Pilot-carrier based linewidth-tolerant 8PSK self-homodyne using only one modulator
 Moriya Nakamura, Yukiyoichi Kamio, Tetsuya Miyazaki, National Institute of Information and Communications Technology, NICT, Japan
 ♦ Linewidth-tolerant 8PSK self-homodyne modulation/demodulation using a DFB-LD with a linewidth of 30 MHz and only one modulator, based on a polarization-multiplexed pilot-carrier technique at 10 Gsymbol/s and even at 1 Gsymbol/s were demonstrated.

Session 8.4 **Hall 7**
Long reach and high capacity PONs

Chair: Stéphane Gosselin, France Telecom R&D/CORE, France

8.4.1 **14:00**
Invited: Long-reach Access and Future Broadband Network Economics

Russel Davey, BT, United Kingdom
 ♦ Operator drivers for extending the reach of GPON and futureproofing GPON deployments by reserving wavelengths for future use will be discussed. Next generation PON options will be reviewed as will economic aspects.

8.4.2 **14:30**
Invited: 10/2.5Gbps Demonstration in Extra-Large PON Prototype

Michael Rasztovsits-Wiech, Andreas Stadler, Stefan Gianordoli, Siemens, Austria; Karl Kloppe, Nokia Siemens Networks, Germany
 ♦ We describe the concept, realization and tests of a full-functional prototype for a future extra-large passive optical network. 10Gbps downstream and 2.5Gbps burst-mode upstream traffic at 100km reach and 1:512 split was achieved.

8.4.3 **15:00**
Dynamic Bandwidth assignment for Multi-service access in long-reach GPON

Ching-Hung Chang, Pandelis Kourtessis, John Micheal Senior, University of Hertfordshire, United Kingdom; Noemi Merayo, University of Valladolid, Spain
 ♦ A novel, two-state bandwidth assignment MAC protocol is demonstrated to assign network resources in long-reach GPONs. Network modelling has displayed significant improvement in packet loss-rate and channel throughput in the presence of service level differentiation.

8.4.4 **15:15**
Flexible and Scalable High-Density Quad-play Packet-Switched Access Infrastructure based on WDM Routing and Dynamic TDM Access

Carlos Bock, Stuart Walker, University of Essex, United Kingdom Josep Prat, UPC, Spain
 ♦ We describe a 2.5 Gbps WDM/TDM PON architecture featuring quad-play connectivity to 8, 192 users. 256-times laser-sharing with dynamic bandwidth allocation can offer 60% throughput increase and 50% latency reduction compared to a conventional static network.

8.4.5 **15:30**
Seamless and Cost-effective Upgrade from G-PON to 10G-PON by Dual-rate Mixture PON System using Electrical Multiplexing

Satoshi Ide, Tetsuji Yamabana, Japan; Yoshio Sakai, Kazuyuki Mori, Fujitsu Laboratories Ltd., Japan
 ♦ We propose a dual-rate mixture PON system using electrical multiplexing on G-PON wavelengths. By introducing a downstream synch-protection mapping and an over-sampling algorithm, we comply with G-PON Class-B+ performance and demonstrate seamless upgrade of 10G-PON.

Session 8.5 **Hall 9**
Network Design II

Chair: Piet Demeester, Ghent University, Belgium

8.5.1 **14:00**
Invited: Optical Networks - The Road Ahead

Biswanath Mukherjee, University of California Davis, USA
 ♦ Progress on research and development in optical networks will be discussed in this talk. Some emerging important topics include hybrid optical-wireless access, long-reach broadband access, dynamic optical circuit switching, robust network design, Ethernet everywhere, etc.

8.5.2 **14:30**
Method for the Determination of a Quality-of-Transmission Estimator along the Lightpaths of Partially Transparent Networks

Florence Leplingard, Thierry Zami, Alcatel-Lucent, France
 ♦ We propose a method to determine an analytical expression of the transmission Q-factor along a light-path in a transparent network. We experimentally assess its accuracy on a SMF-based WDM transmission system at 10.7 Gbit/s.

8.5.3 **14:45**
MINCOD-MTD: A RWA Algorithm in Semi-Transparent Optical Networks

Eva Marin, Sergio Sanchez, Xavier Masip, Josep Solé, Technical University of Catalonia, Spain; Guido Maier, CoreCom, Italy; Walter Erangoli, Stefano Santoni, Pirelli Labs, Italy; Marco Quagliotti, Telecom Italia, Italy
 ♦ This paper proposes a new RWA algorithm that takes into consideration the Maximum Transmission Distance, MTD parameter to be applied to semi-transparent optical networks, achieving a considerable benefit in terms of blocking probability reduction.

8.5.4 **15:00**
RWA for Mitigating Power Excursion Effects in EDFA-based all-Optical Metro Networks

Filippo Cugini, Paolo Ghelfi, Antonella Bogoni, CNIT, Luca Valcarenghi, Piero Castoldi, Scuola Superiore Santa Anna, Italy; Rodolfo Di Muro, Bimal Nayyar, Ericsson, United Kingdom
 ♦ Two novel Routing and Wavelength Assignment, RWA policies are proposed for all-optical metro mesh networks. These RWA policies contribute to mitigate the excessive power excursions in network links without requiring additional network resources.

8.5.5 **15:15**
Dynamic control domains to achieve power stability in optically transparent mesh networks

Christopher White, Dan Kilper, Bell Laboratories, USA
 ♦ Simulation results show that the dynamic control domains method for scheduling network control events minimizes the interactions between channel power adjustments while simultaneously enabling multiple concurrent control adjustments in optically transparent mesh networks.

8.5.6 **15:30**
Paced TCP gives higher utilization with no buffers than with small buffers

Goutam Das, Rod Tucker, Christopher Leckie, University of Melbourne; Kerry Hinton, ARC Special Center for Ultra-Broadband Information Networks, Australia
 ♦ Using a new analytical model of TCP link utilization, we show that paced TCP achieves a better utilization when the bottleneck routers have no buffers rather than

Session 8.6 **Hall 10**
Quantum Dot Lasers and Amplifiers

Chair: Liam Barry, Dublin City University, Ireland

8.6.1 **14:00**
High Brightness Tapered Lasers based on Quantum Dots at 920 nm with Enhanced Temperature Stability of the Emission Wavelength for Uncooled Pump Applications

Wolfgang Kaiser, Universität Würzburg, Germany
 ♦ Low-aperture index-guided tapered lasers based on InGaAs-quantum dots are demonstrated with low temperature induced wavelength shift of 0.14 nm/K, P=900 mW suitable for integration in laser bars. Gain-guided lasers exhibit output powers of 3 W.

8.6.2 **14:15**
10Gb/s Transmission at 1.55µm with Directly Modulated Quantum Dash Laser and Constant Operation Parameters up to 85°C

Beatrice Dagens, Dalila Make, Odile Le Gouezigou, Francois Lelarge, Benjamin Rousseau, Alain Accard, Jean-Guy Provost, Francis Poingt, Jean Landreau, Olivier Drisse, Estelle Derouin, Frédéric Pommereau, Guang-Hua Duan, Alcatel Thales III-V Lab, France
 ♦ 10Gb/s transmission at 1.55µm up to 85°C is realised with a quantum dash directly modulated laser. The bias current and current swing are unchanged during operation, demonstrating a temperature independent modulated light source.

8.6.3 **14:30**
Dynamic Switching of High Powered Picosecond Pulses from a Quantum Dot Mode-locked Laser Diode using an Integrated Quantum Dot Switch

Hiabo Wang, Alastair Rae, Mark Thompson, Richard Penty, Ian White, University of Cambridge, United Kingdom; Alexey Kovsh, Innolume GmbH, Germany
 ♦ An integrated quantum-dot switch is presented exhibiting on-chip gain of 19dB and saturation powers in excess of 13dB. Dynamic switching of 10ps, 5ps and 1ps pulses is presented with peak powers in excess of 170mW.

8.6.4 **14:45**
Temperature dependence of Henry factor of Undoped and p-doped InAs/GaAs Quantum-Dot Lasers emitting at 1.3 µm

Ding-Yi Cong, Anthony Martinez, Kamel Merghem, Abderrahim Ramdane, CNRS/LPN & Institut National des Télécommunications, Jean-Guy Provost, Alcatel Thales III-V Lab, France; Marc Fischer, Nanoplus Nanosystems and Technologies GmbH, Igor Krestnikov, Alexey Kovsh, Innolume GmbH, Germany
 ♦ The temperature dependence of Henry factor aH of undoped and p-type doped InAs/GaAs QD lasers is reported for the 20-80 °C range. It is shown that aH of p-type doped devices is temperature insensitive.

8.6.5 **15:00**
Quantum Dot Semiconductor Optical Amplifier at 1.3µm for Ultra-Fast Cross-Gain Modulation

Thomas Vallatis, Christian Koos, Boris-Alexander Bolles, Rene Bonk, Wolfgang Freude, Juerg Leuthold, University of Karlsruhe, Matthias Laemmlin, Christian Meuer, Dieter Bimberg, Technical University of Berlin, Germany
 ♦ Measured gain and phase dynamics of InAs/GaAs quantum dot amplifiers reveal small alpha-factors. This enables ultra-fast cross-gain modulation which speeds up with increasing injection current and depends only weakly on the optical peak power.

8.6.6 **15:15**
Chirp reduction in quantum dot-like semiconductor optical amplifiers

Romain Brenot, Alcatel-Thales III-V Lab, France
 ♦ The chirp induced by saturated quantum dot SOA is carefully studied. It is demonstrated that circular dots allow for 50 km of transmission at 10 Gb/s, even upon saturation.

8.6.7 **15:30**
Direct observation of the coherent spectral hole in the noise spectrum of a saturated InAs/InP quantum dash amplifier operating near 1550 nm

Amir Capua, Visorlan Mikhelashvili, Gadi Eisenstein, Technion Institute of Technology, Israel; Johan Reithmaier, Kassel university, Andreas Somers, Alfred Forchel, Würzburg university, Germany; Michel Calligaro, Olivier Parillaud, Michel Krakowski, Alcatel - Thales 3-5 Lab, France
 ♦ We demonstrate a direct observation of the coherent noise spectral hole in a saturated quantum dash amplifier. Its width 500-600 GHz is determined by the response time and is responsible for high speed regeneration properties.

Poster Session Central Lobby

P001
Adapting the Slow Light spectrum in optical fibers for delay enhancement

Thomas Schneider, Ronny Henker, Markus Junker, Lauterbach Kai-Uwe, Hochschule für Telekommunikation, Leipzig, Germany
 ♦ A simple method for the adaptation of the slow light bandwidth of optical fibers is shown. With this method it is possible to change the bandwidth, gain and slope of Brillouin scattering in optical fibers.

P002
Design of ultimate gain-flattened broadband O, E, and S+C+L fiber amplifiers by a new fiber Raman gain medium

Guanshi Qin, Toyota Technological Institute, Japan
 ♦ By solving the inverse amplifier design problem, gain-flattened broadband O, ~17.5THz, E, ~15.1THz, and S+C+L, ~20.9THz fiber Raman amplifiers are designed by a new TeO₂-BaO-SrO-Nb₂O₅-P₂O₅-WO₃, TBSNWP tellurite fiber.

P003
Gain analysis for Tb³⁺-doped fluoride fiber in the 0.54 μm band

Yamashita Tatsuya, Yasutake Ohishi, Toyota Technological Institute, Japan
 ♦ We have investigated the amplification performance of Tb-doped fluoride fiber in the 0.54μm band based on the numerical analysis, and it has been demonstrated to have the highest gain of 8.3dB, for the first time.

P004
Optimized Superimposed Fiber Bragg Gratings to Reduce Birefringence Effects in WDM Applications

Victor Garcia-Muñoz, Miguel Preciado, Miguel Muriel, Universidad Politécnica de Madrid, Spain; Christophe Caucheteur, Sébastien Bette, Marc Wullpart, Patrice Mégret, Faculté Polytechnique de Mons, Belgium
 ♦ We experimentally demonstrate the reduction of Differential Group Delay and Polarization Dependent Loss in Superimposed Fiber Bragg Gratings when the fiber is rotated after each inscription, which is of great importance in WDM applications.

P005
Reconstruction of high-reflectance FBG from noisy data

Oleg Belai, Evgenii Podivilov, David Shapiro, Institute of Automation and Electrometry; Leonid Frumin, Novosibirsk State University, Russia
 ♦ The inverse scattering problem is studied for high-reflectance grating with noisy reflection data. An adaptive regularization procedure is proposed allowing to reconstruct FBG under strong noise.

P006
Broadband Dispersion Compensating Hole-Assisted Fibers

Kunimasa Saitoh, Shailendra Varshney, Masanori Koshiba, Hokkaido University, Japan
 ♦ Novel design of broadband dispersion compensating hole-assisted fibers is demonstrated. The proposed structure exhibits large negative dispersion coefficient around -550ps/nm/km at 1550nm with matched RDS. Further, its Raman amplification properties are investigated.

P007
Indirect technique of measuring Raman gain efficiency distribution based on OTDR

Masaharu Ohashi, Osaka Prefecture University; Ikuo Yamashita, The Kansai Electric Power Company, Japan
 ♦ An indirect technique is proposed for measuring Raman gain efficiency distribution by using OTDR. Raman gain efficiency is estimated easily from the relative-index difference and MFD, which can be measured by the bidirectional OTDR method.

P008
New Easily Assembled Mechanical Splicer for Direct Coated Optical Fibre Connection without Stripping and Cleaning

Hitoshi Son, Nippon Telegraph and Telephone Corporation, Japan
 ♦ We propose a new type of mechanical splicer that provides easy assembly. It has good performance with a low average insertion loss of 0.2 dB and a high return loss of over 46 dB.

P009
Fabrication of Rare-Earth Doped Fibers by Flash Vaporization Method

Borut Lenardic, Miha Kveder, Optacore d.o.o., Slovenia; Herve Guillon, Samuel Bonafant, Kermestran, France
 ♦ Highly rare-earth doped optical fiber preforms were produced using flash vaporization method for precursor delivery. TEOS and lanthanide precursors were used.

Poster Session Central Lobby

Preforms with fully consolidated core layers have been made and were drawn to fibers

P010
Spontaneous Brillouin Scattering Modelling and Measurement in Various Axisymmetric Optical Fibres

Vincent Lanticq, Stephane Fortier, EDF R&D; Yves Jaouen, Renaud Gabet, GET / Telecom Paris; Sylvie Deleplane-Lesoille, LCPC; Jean-Louis Auguste, Xlim, France
 ♦ We describe a computation method of spontaneous Brillouin scattering process using a simple original acoustic mode analysis. Numerical results have been compared with measured Brillouin spectra for two different commercially available fibres

P011
Multiwavelength Erbium-Doped Fiber Laser Based on a Nonlinear Hi-Bi Fiber Loop Mirror

Xinhuan Feng, H.Y Tam, Chao Lu, Ping-kong Alexander Wai, The Hong Kong Polytechnic University, Hong Kong; Dingyuan Tang, Nanyang Technological University, Singapore
 ♦ A novel multiwavelength erbium-doped fiber laser, EDFL based on a nonlinear high-birefringence fiber loop mirror, HiBi-FLM is proposed and demonstrated. Up to 50-wavelength lasing operation with wavelength spacing of 0.8 nm has been achieved.

P012
Theoretical Analysis and Primary Experimental Verification of Reflectometric Measurement of Polarization Mode Dispersion in an Optical Fiber Link with Polarization-Dependent Loss

Hui Dong, Tang Ming, Ping Shum, Nanyang Technological University, Singapore; Yandong Gong, Institute for Infocomm Research, Singapore
 ♦ We demonstrate theoretically and experimentally that the differential group delay and differential attenuation slope of an optical fiber with polarization-dependent loss can be explicitly obtained by reflectometric measurements in optical frequency and fiber length domains.

P013
Highly efficient, low-pedestal Gaussian pulse compression using dispersion-managed comb-like profiled fiber

Takashi Inoue, Yuki Taniguchi, Jiro Hiroishi, Takeshi Yagi, Yu Mimura, Furukawa Electric Co., Ltd., Japan
 ♦ We attain highly efficient, low-pedestal Gaussian pulse compression using comb-like profiled fiber, CPF characterized by normal-dispersion-HNLF. In experiment, input pulse having 2.6ps-FWHM is successfully compressed to 0.39ps-FWHM Gaussian pulse with peak-to-pedestal-ratio of 19.3dB by 3-step-CPF.

P014
5.7dB SBS suppression with a HNLf, module Comprised of 3 HNLfs having Different GeO2 Concentration

Masanori Takahashi, Masateru Tadokuma, Jiro Hiroishi, Takeshi Yagi, The Furukawa Electric Co., Ltd., Japan
 ♦ We demonstrated 5.7dB SBS suppression of a HNLf by controlling Brillouin gain spectrum with three HNLfs which have different GeO₂ concentration. FWM wavelength conversion efficiency is improved by 5.7dB comparing to conventional HNLfs.

P015
Dual-Mode Fibre, DMF capable of single- and multi-mode transmission

Hiromasa Tanobe, Ryo Nagase, Mamoru Kobayashi, NTT Photonics Labs., Japan; Yasuo Shibata, Osamu Moriwaki, Yoshihisa Sakai, NTT Corporation, Japan
 ♦ Single- and multimode optical signal transmission with DMF was demonstrated for the first time. This DMF also has a relatively low bending optical loss for simultaneous single- and multi-mode transmission.

P016
Widely tunable Wavelength Exchange in Anomalous-dispersion Regime

Wai Lam Fung, Henry Cheung, Kenneth Wong, University of Hong Kong
 ♦ We investigate the tunability of wavelength exchange using two pumps in the anomalous-dispersion region. Complete wavelength exchange is achieved with tuning range >15nm. Bit error rate of <10⁻⁹ is maintained with power penalties of ~2dB.

P017
Ultra-Fast Automatic Gain Control Amplifier with Unique and Simple Transient Control

Yoichi Oikawa, Noriyasu Shiga, Masamichi Shiga, Yoshiaki Horiuchi, Hiroshi Nagaeda, Trimatiz Limited, Japan; Susumu Oshio, Riso Kagaku Corporation, Japan
 ♦ We have developed the ultra-fast automatic gain control amplifier that has a feedforward controlled EDFA

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and a feedback controlled high-speed VOA. Sub-micro-second response time for 9-dB input fluctuation at 20-dB total gain is demonstrated.

P018
Negative Brillouin Gain and its Application to Distributed Fiber Sensing

Tsunee Horiguchi, Ryosuke Muroi, Yuki Miyamoto, Shibaura Institute of Technology, Japan
 ♦ Negative Brillouin gain in single-mode fibers has been temporally obtained at the resonant frequency. This negative gain combined with positive gain makes it possible to achieve higher spatial resolution in distributed Brillouin-based fiber sensing.

P019
Calculation of Raman Fiber Laser Spectra by a Combination of Shooting Method and Split-Step Fourier Transform Algorithm

Johannes Hagen, Rainer Engelbrecht, Alexander Siekiera, Bernhard Schmauss, University of Erlangen, Germany
 ♦ A numerical method for calculation of FWM spectral broadening in Raman fiber lasers is presented. It is based on the steady-state equations and the nonlinear Schroedinger equation. Numerical results are confirmed by measurements.

P020
Optical Properties of Highly Al₂O₃ and P₂O₅ Doped Silica Hosts for Large Mode Area Fiber Lasers and Amplifiers

Mikhail Likhachev, Kiril Zotov, Mikhail Bubnov, Fiber Optics Research Center of RAS, Russia; Denis Lipatov, Mikhail Yashkov, Aleksey Guryanov, Institute of Chemistry of High Purity Substances of RAS, Russia;
 ♦ Highly Al₂O₃ and P₂O₅-doped silica glass having a low refractive index has been studied. Compositions providing loss below 30dB/km and therefore suitable as hosts in LMA active fibers have been determined.

P021
Tunable Pulse Delay Using Spectral Filtering from a Nonlinearly Broadened Optical Spectrum and Group Velocity Dispersion in a Chirped Fiber Bragg Grating

Mable P. Fok, Chester Shu, The Chinese University of Hong Kong
 ♦ Optically-controlled variable delay up to 415 ps is demonstrated for 10-GHz pulses using self-phase and cross-phase modulations in a 32-cm bismuth-oxide highly nonlinear fiber followed by group velocity dispersion in a chirped fiber Bragg grating.

P022
Bismuth-Oxide Highly Nonlinear Fiber Based Dispersion Imbalanced Loop Mirror for RZ Signal Regeneration

Mable P. Fok, Chester Shu, The Chinese University of Hong Kong, Hong Kong
 ♦ We demonstrated a compact dispersion imbalanced loop mirror for RZ signal regeneration using a 32-cm bismuth-oxide highly-nonlinear fiber. BER measurement was performed with a 10-Gb/s 2²¹-1 PRBS. The receiver sensitivity was improved by 6 dB.

P023
Generation of new Frequencies by Pulse Splitting

Ayhan Demircan, Uwe Bandelow, Weierstrass Institut f. Angewandte Stochastik; Marcel Kroh, u2t photonics AG; Bernd Hüttl, Fraunhofer Heinrich-Hertz-Institut, Germany
 ♦ We present a pulse splitting mechanism by third-order dispersion in the normal dispersion regime, which leads to the excitation of new frequency components on the red side of the pulse spectrum.

P024
Supercontinuum generation with 532 nm quasi-continuum pulses in photonic crystal fibre tapers

Jaime Cascante-Vindas, Antonio Diez, Miguel Andres, Teresa Pinheiro-Ortega, Enrique Silvestre, Universidad de Valencia, Spain
 ♦ We report experimental results on supercontinuum generation in PCF tapers using quasi-continuous pump pulses of 7 ns duration at 532 nm. SC generation in normal and anomalous dispersion regimes are presented.

P025
Broadband SBS Slow Light using Simple Spectrally-Sliced Pumping

Bo Zhang, Lin Zhang, Alan Willner, University of Southern California, USA; Lianshan Yan, General Photonics, USA; Zhaoming Zhu, Daniel Gauthier, Duke University, USA
 ♦ We demonstrate broadband SBS slow-light using spectrally-sliced pumping. Both 2.5-Gb/s NRZ-OOK and NRZ-DPSK signals are delayed by maximum 170-

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ps with 4-dB power-penalty. Periodic spectrally-sliced multi-channel pumping scheme is proposed within a single slow-light medium.

P026
EDFA Dynamic Range Extension via Novel Digital Pump Drive

Douglas Butler, Avanex Inc., USA
◆ Pump laser threshold, L-I curve nonlinearity, kink and roll-off limitations are overcome via novel digital EDFA control. Pump power consumption, dissipation and output power are improved by enabling operation above traditional kink current.

P027
All-optical Broadband Tunable Wavelength Multicasting using a Pump-Modulated Wide-Band Fiber Optical Parametric Amplifier with High and Flat Gain

Guo-Wei Lu, Kazi Abedin, Tetsuya Miyazaki, National Institute of Information and Communications Technology, Japan
◆ We demonstrate an all-optical broadband wavelength multicasting scheme using a pump-modulated optical parametric amplifier. ≥ 11 -dB ER and ≥ 8 -dB eye-opening Q are obtained through a 64-nm bandwidth with high, 28 dB and flat, ~ 3 -dB variation gain.

P028
Compact Waveguide Array Connectors for Optical Backplane System

Seiki Hiramatsu, Mitsubishi Electric Corporation, Japan
◆ Novel backplane connectors are demonstrated. Using 3D-waveguide arrays with optical path redirection, multiple optical fibers can be simultaneously plugged into the backplane connector. Furthermore, modulation performance of a 10-Gbps/ch eye opening is successfully obtained.

P029
Extremely high reliability of guardring-free InAlAs avalanche photodiode

Eitaro Ishimura, Yagyu Eiji, Masaharu Nakaji, Susumu Ihara, Kiichi Yoshiara, Yasunori Tokuda, Takahide Ishikawa, Toshihiko Aoyagi, Mitsubishi electric corporation, Japan; Mitsubishi electric corporation, Japan
◆ The InAlAs avalanche photodiode with a guardring-free structure that reduces the bias voltage of the p-n junction of top surface exhibits a record high reliability of over 8000 hours at a high temperature of 200 °C.

P030
Investigation of Waveguide Mode Profile Using Low Coherent Interferometric Method

Zhipeng Wang, Ray Chen, University of Maryland Baltimore County, USA
◆ We demonstrate for the first time a waveguide mode profile characterization scheme in an AWG, utilizing low coherent interferometric measurement. The technique is very effective in characterizing input waveguide design in advanced AWG devices.

P031
Small volume, 0.6 cc surface mount 10-Gbit/s Mini Flat Mach-Zehnder modulator module

Ken Tsuzuki, Nobuhiro Kikuchi, Yasuo Shibata, Wataru Kobayashi, Hiroshi Yasaka, NTT Corporation, Japan
◆ We developed a small size InP Mach-Zehnder, MZ modulator module for use in a small form transponder, which is only 13.8x8.9x4.9 mm3 in size, 0.6 cc.

P032
Engineering spectral hole burning and carrier exhaustion mechanisms on the gain saturation behavior of quantum-dot optical amplifiers

Junggho Kim, Matthias Laemmlin, Christian Meuer, Sven Liebich, Dieter Bimberg, Technical University of Berlin, Gadi Eisenstein, Technion Institute of Technology, Israel
◆ We theoretically investigate how spectral hole burning and carrier-exhaustion affect the gain saturation spectra of a quantum-dot optical amplifier at various operation conditions and how they can be tuned to change the functionality.

P033
Extremely miniaturized bi-directional module with a single conventional 5.6mm TO-package and a single ball-lens.

Hiromi Nakanishi, Sumitomo Electric Industries, Ltd., Japan
◆ An extremely miniaturized bi-directional module with very low cost has been successfully developed by using a single conventional 5.6mm TO-package and a single ball-lens. It exhibited excellent performance by minimizing optical and electrical cross-talk.

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P034
First Demonstration of 40-Gbit/s Operation of a Semiconductor-Integrated Optical Digital-to-Analog Converter

Kengo Sawada, Hiroyuki Uenohara, Tokyo Institute of Technology, Japan
◆ We demonstrated the first operation of a 40-Gbit/s semiconductor-integrated optical digital-to-analog converter. Four-level signals were generated and a quarter dependence of phase on temperature and wavelength compared with that for 10-Gbit/s was verified.

P035
Serial and Hybrid Multicast Modes Based on an Active Vertical Coupler Optical Crosspoint Switch

Kornkamol Thakulsukanant, Siyuan Yu, University of Bristol, United Kingdom
◆ Serial and hybrid multicast modes using active vertical coupler optical crosspoint switch have been implemented. SNR deterioration of 0.225 dB per increase scale and good eye-diagrams opening are found for serial and hybrid multast, respectively.

P036
All-Optical 20 Gb/s Logic AND Gate with Tunable Single-Channel Output or Dual-Channel Outputs Using a PPLN waveguide

Jian Wang, Junqiang Sun, Qizhen Sun, Xinliang Zhang, Dexiu Huang, Huazhong University of Science and Technology, P.R. China; Martin Fejer, Stanford University, USA
◆ We propose and demonstrate at 20 Gb/s a novel logic AND gate using cascaded sum- and difference-frequency generation in a periodically poled LiNbO3 waveguide. Tunable single-channel output and dual-channel outputs are observed in the experiment.

P037
FROG Characterisation of a Turbo-Switch Wavelength Converter

Xuelin Yang, Rod Webb, Robert Manning, Photonic Systems Group, Tyndall National Institute, Ireland; Aisling Clarke, Robert Maher, Liam Barry, Dublin City University, Ireland
◆ The FROG technique is used to characterise output pulses from a Turbo-Switch wavelength converter in different configurations. Results show low chip on the output pulses, a vital requirement in high-speed optical transmission systems.

P038
A Highly Stable Evanescently-Coupled Hybrid Fiber Semiconductor Laser Design

Aireza Khalili, Xiao Hann Lim, Hopil Bae, James Harris, Stanford University, USA
◆ We present an evanescent coupling method between a semiconductor anti-resonant reflecting optical waveguide and a side-polished fiber. In particular, we have been able to demonstrate the first hybrid evanescently-coupled fiber semiconductor laser using this technology.

P039
All-Optical Data Processing Using Directional Monostability in Semiconductor Ring Laser

Siyuan Yu, Zhuoran Wang, University of Bristol; Sandor Furst, Marc Sorel, University of Glasgow, United Kingdom
◆ This paper describes all-optical data processing characteristics of an optical digital device based on the directional optical bistability and monostability in semiconductor ring laser. Experimental demonstration of all-optical monostable and data gating operations is reported.

P040
Nonreciprocal Microdisk Resonators Utilizing Magnetic Bubble Domains in Garnet Film for Ultra-Compact Optical Waveguide Isolators

Kunimasa Saitoh, Naoya Kono, Kuniaki Kakiyama, Masanori Koshiba, Hokkaido University, Japan
◆ The three-dimensional characteristics of magneto-optical microresonators are presented, leading to a guideline for the design of nonreciprocal circuits. This involves a demonstration of how the resonators with selected parameters are practical for miniaturized non-reciprocal circuits.

P041
10Gbps x 4ch Arrayed Optical Modules for Petascale Computing Systems using a Novel Assembly Technique

Koji Terada, Jun Matsui, Hiroyuki Nobuhara, Fujitsu Laboratories Ltd.
◆ We propose a novel assembly technique for compact and cost-effective arrayed optical modules. Using this technique, a 10Gbps x 4ch receiver module of compact size and high sensitivity has been successfully demonstrated.

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P042
Transient Behaviour of Nonlinear Optical Compensator Based on Vertical Micro-Cavity Saturable Absorber

Satoshi Suda, Fumio Koyama, Nobuhiko Nishiyama, Tokyo Institute of Technology, Japan; Catherine Caneau, Chung-En Zah, Corning Incorporated, USA
◆ We demonstrated the 25 ps transient response of a nonlinear-effect compensator based on a reverse-biased vertical cavity saturable absorber. The modelling and experiment on the transient behaviour of negative nonlinear phase-shift are presented.

P043
Passband-expandable tunable filter for optical network aggregation

Yasuki Sakurai, Changho Chong, Masaharu Okada, Yuji Hotta, Naoyuki Mekada, Santec corporation, Japan
◆ We demonstrate wavelength and bandwidth tunable optical filters with box-like passband shape. The wavelength tuning range is 40 nm and the 3dB-bandwidth varies from 0.2 nm to 6.0 nm.

P044
Small Helical Reflective Arrayed-Waveguide Grating with Integrated Loop Mirrors

Yuichiro Ikuma, Jiro Ito, Mitsuhiro Yasumoto, Daisuke Miyamoto, Hiroyuki Tsuda, Keio University, Japan
◆ We have fabricated a 25-GHz-spacing, 8-ch, compact helical reflective arrayed-waveguide grating with integrated loop mirrors. The loss, the polarization dependent loss, and the adjacent-channel crosstalk were 10.9dB, 0.1dB, and -8.2dB, respectively.

P045
Telecom Components for Terahertz Applications: LT InGaAs Photoconductors for Coherent Detection Close the Gap

Bernd Sartorius, Jutta Böttcher, Carsten Bornholdt, Harald Künzel, Helmut Roehle, Michael Schlak, Fraunhofer Institute HHL, Germany
◆ A THz system based on fibre connected compact InP-modules is proposed. The hereby missing key device, the photoconductor for coherent THz detection is developed. The functionality is demonstrated in a first THz experiment.

P046
All-Optical Flip-Flop and Digital Inverter Functions using a Monolithic Semiconductor Ring Laser

Guido Giuliani, University of Pavia, Italy; Siyuan Yu, Zhuoran Wang, Guohui Yuan, Bei Li, Muhammad Memon, University of Bristol; Sandor Furst, Marc Sorel, University of Glasgow, United Kingdom
◆ All-Optical digital functions are experimentally demonstrated using a monolithic semiconductor ring laser, SRL. The SRL can operate as Flip-Flop for digital memory applications, and as a digital inverter with potential for all-optical 2R regeneration

P047
Ultra-Wideband Photonic Millimeter-Wave Synthesizers with Coaxial, DC-110GHz and Rectangular Waveguide, 69-112GHz Output Ports

Mario Weiss, Andreas Stöhr, Andrei Malcoci, Dieter Jäger, University of Duisburg-Essen; Andreas Steffan, U2T photonics AG, Germany
◆ Two photonic millimeter-wave-synthesizers based upon optical heterodyning are presented: A photonic synthesizer with coaxial W1 output for operation from DC-110GHz and a synthesizer featuring a WR10 waveguide output for signal generation from 69-112GHz.

P048
A 100Gbps Flexible Optoelectronic Interconnection with Multi-Mode Optical Waveguide Circuits

Hiroshi Hamasaki, Hideto Furuyama, Hideo Numata, Chiaki Takubo, Hideki Shibata, Toshiba cooperation, semiconductor company, Japan
◆ We developed a 100 Gbps bandwidth, 12.5 Gbps/ch x 8 ch flexible optoelectronic interconnection with electrical circuits and 40 um core multi-mode optical waveguide circuits.

P049
Slow Light Waveguide Detector Slowing Light in Bragg Reflector Waveguide

Keisuke Kuroki, Go Hirano, Fumio Koyama, Kouichi Hasebe, Takahiro Sakaguchi, Nobuhiko Nishiyama, Tokyo Institute of Technology, Japan; Catherine Caneau, Chung-En Zah, Corning Incorporated, USA
◆ We demonstrate a slow-light waveguide detector, slowing light in a Bragg reflector waveguide. The length of the detector is as small as 20µm. A possibility of size-reduction and polarization-insensitive operations can be presented.

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P050
1 Gbit/s Full-Duplex Bidirectional Optical Data Transmission over 500 m of 50 μ m-Core Graded-Index Multimode Fiber with Novel Monolithically Integrated Transceiver Chips
Martin Stach, Fernando Rinaldi, Dietmar Wahl, Dieter Rimpf, Steffen Lorch, Rainer Michalzik, Ulm University, Germany
 ♦ We present bidirectional data transmission experiments in half- and full-duplex mode at 1 Gbit/s data rate over 500m graded-index multimode fiber with VCSELs and MSM photodiodes as parts of a GaAs-based monolithically integrated transceiver chip.

P051
Feedback effects on performance of DM and DFB lasers in RoF systems
Aleksandra Kaszubowska-Anandarajah, Liam Barry, Prince Anandarajah, Celine Guignard, Dublin City University, Ireland; Brian Kelly, James O’Gorman, Eblana Photonics, Ireland
 ♦ Impact of optical feedback on performance of Discrete-Mode and DFB lasers used as transmitters in RoF system is investigated. Results show that the DM laser is capable of handling 10dB more feedback than DFB laser.

P052
Injection Locked DBR Laser Diode module for Access Applications
Alexandre Shen, Fabrice Blache, Guang-Hua Duan, Francois Lelarge, Franck Mallécot, Jean-Guy Provost, Harry Gariah, Odile Le Gouezigou, Francis Pointng, Lionel Le Gouezigou, Frédéric Van Dijk, Benjamin Rousseau, Frédéric Pommerau, Alcatel-Thales III-V Lab, France; Philippe Chanclou, France Telecom, France
 ♦ A Distributed Bragg Reflector laser diode has been packaged and characterised in an injection locking configuration for access applications. A modulation Bandwidth of 5GHz and a chirp parameter as low as 1.2 have been demonstrated.

P053
Actively Mode-Locked Fabry-Perot Laser Diode Module for Sampling Applications
Alexandre Shen, Guang-Hua Duan, Franck Mallécot, Harry Gariah, Francois Lelarge, Fabrice Blache, Odile Le Gouezigou, Lionel Le Gouezigou, Frédéric Pommerau, Francis Pointng, Benjamin Rousseau, Somdatta Mitra, Alcatel-Thales III-V Lab, France
 ♦ We report on a Fabry-Perot laser diode packaged in a module compatible with active mode-locking. We obtained narrow pulses, 2ps with an ultra-low level jitter, <200fs at 17GHz, this is compatible with optical sampling applications.

P054
Pluggable inter-plane couplers for multilayer optical interconnections
Jurgen Van Erps, Christof Debaes, Hugo Thienpont, Vrije Universiteit Brussel, Nina Hendrickx, Peter Van Daele, Ghent University, Belgium
 ♦ We present pluggable inter-plane coupling components which can be used to route signals in board-level multilayer optical interconnections. The components are prototyped using Deep Proton Writing, but are compatible with low-cost mass fabrication.

P055
160Gb/s characterisation of gain and phase dynamics of a semiconductor optical amplifier
Giancarlo Gavioli, Benn Thomsen, Polina Bayvel, UCL, United Kingdom
 ♦ We report the first characterisation of nonlinear gain, phase and chirp dynamics of an SOA at 160Gb/s using a spectrogram measurement technique. Results are key for the design of 160Gb/s optical SOA-based wavelength converters

P056
Silicon-on-Insulator Modulators for Next-Generation 100 Gbit/s-Ethernet
Christian Koos, Jan Brosi, Wolfgang Freude, Juerg Leuthold, University of Karlsruhe, Michael Waldow, RWTH Aachen, Germany
 ♦ Novel SOI modulator schemes with unprecedented electrical bandwidth and compactness are proposed and investigated. We find that 100 Gbit/s modulation at 3V peak-to-peak voltage is possible with ultra-compact devices of less than 2mm length.

P057
Low-Penalty Transmission of High-Speed Data through a Cascade of Silicon Microring Resonator Drop Ports
Benjamin Lee, Aleksandr Biberman, Keren Bergman, Columbia University, USA; Nicolás Sherwood-Droz, Carl

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Poitras, Qianfan Xu, Michal Lipson, Cornell University,
 ♦ We demonstrate the propagation of 10-Gb/s optical data through a cascade of microring filter drop ports. The power penalty is measured through two and four resonator hops and compared with simulated values.

P058
Integrated Mux/Demux with 25/50GHz interleavers
Wei Chen, Infinera Corp., USA
 ♦ Pair of 50/25 GHz interleavers was integrated on a chip using high index waveguide technology. The cascaded MZ-based interleaver uses a polarization diversified scheme and achieved 25dB crosstalk and 18GHz 0.5dB bandwidth across C-band.

P059
All-optical NRZ-DPSK Clock Recovery Using Chirped Fibre Bragg Grating, CFBG Induced Clock Tone
Fu Songnian, Tang Ming, Wen-De Zhong, Xia Li, Ping Shum, Nanyang Technological University, Singapore; Yang Jing Wen, Institute for Infocomm Research, Singapore
 ♦ All-optical NRZ-DPSK clock recovery is demonstrated with the CFBG induced clock tone and SOA-based fibre ring laser. The 10 GHz clock is optically recovered with 17 dB extinction ratio and 540 fs root-mean-square timing jitter.

P060
Asynchronous optical performance monitoring of RZ-DQPSK signals using delay-tap sampling
Bartomiej Kozicki, Akihiro Maruta, Ken’ichi Kitayama, Osaka University, Japan
 ♦ We demonstrate optical performance monitoring of OSNR and chromatic dispersion in RZ-DQPSK signals using asynchronous delay-tap sampling. Our method provides precise qualitative estimation over a broad range of impairment levels and good degradation isolation.

P061
Low Cost and High Performance Fibre In-line Bi-directional Optical Subassembly for Fibre-to-the-Home
Hyunseo Kang, Jong Jin Lee, Seihyoung Lee, Kwonseob Lim, Shinyoung Yoon, Chong Hee Yu, Electronics and Telecommunications Research Institute, Korea
 ♦ We propose a novel fibre in-line bi-directional optical subassembly based on core-to-cladding mode coupling. We successfully demonstrated 10 km transmission using proposed BOSA which has 1.76GHz 3dB bandwidth, -23.6dBm sensitivity, and -86dB crosstalk.

P062
Low Timing Jitter Phase-Locked Loop for Versatile and Adaptive Synchronization in High Bit Rate Optical Sampling Systems
Erik Benkler, Harald Telle, Physikalisches-Bundesanstalt, Germany
 ♦ A novel scheme for synchronization of sampling pulse trains to optical data streams is presented. Besides generation of ordinary eye diagrams it facilitates waveform visualization of repetitive, including PRBS data words using word-synchronous sampling.

P063
Electronic Dispersion Compensation for 107Gb/s Coherent Detection with Multi-Level Modulation Formats
Christina Hebebrand, Werner Rosenkranz, University of Kiel, Germany
 ♦ We investigate the performance of electronic dispersion compensation for coherent detection with a zero-forcing equalizer approach, using the minimum mean-square error criterion, for RZ-QPSK, RZ-8PSK and Star-RZ-16QAM for the linear and nonlinear channel at 107Gb/s.

P064
Design Optimization of 40 Gb/s RZ-DQPSK Transceiver for High OSNR and PMD Tolerance under Fast Polarization Changes
Takeshi Hoshida, Tomoo Takahara, Yuichi Akiyama, Hiroki Ooi, Kentaro Nakamura, Yoshikazu Terayama, Noriaki Mizuguchi, Zhenning Tao, Jens Rasmussen, George Ishikawa, Takafumi Terahara, Hiroshi Onaka, Fujitsu Laboratories Limited, Japan; Daisuke Tanimura, Yokogawa Electric Corporation, Japan; Hirotohi Kodaka, Yokogawa Electric Corporation, Japan
 ♦ Full-band tunable, multi-rate, 43 and 44.6 Gb/s RZ-DQPSK transceiver with excellent balance of OSNR and PMD tolerances under fast, 1.6 rad/ms SOP change was realized and its manufacturability was confirmed through measurement on 100 modules.

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P065
Monitoring of DPSK/DQPSK Signals using 1-Bit Delayed Self-Homodyne Detection with Optical Phase Diversity
Kazunori Tanimura, Hiroshi Ohta, Yokogawa Electric Corporation, Japan
 ♦ We developed a method for analysing DPSK/DQPSK signals using 1-bit delayed self-homodyne detection. A clear difference in the 40-Gbit/s RZ-DQPSK signals was observed in the analytical distributions of transitional amplitude and phase variations.

P066
Experimental Synchronization/Multiplexing of Optical Data Packets using a Reconfigurable and Continuously-Tunable Optical Delay Based on Wavelength Conversion and Inter-channel Chromatic Dispersion
Irfan Fazal, Alan Willner, Bo Zhang, Omer Yilmaz, Scott Nuccio, University of Southern California, USA; Martin Fejer, Carsten Langrock, Stanford University, USA
 ♦ 10Gb/s Optical data packets are synchronized and multiplexed by using continuously-tunable all-optical delay line with 26.4ns tuning range. Delay reconfigurability is measured to be 276ps.

P067
Characterisation of an RZ-DQPSK transmitter using coherent detection
Chris Fludger, Thomas Duthel, Christoph Schullien, CoreOptics GmbH; Alexander Voss, Bernhard Schmauss, University of Erlangen, Germany
 ♦ We characterise the optical field from an RZ DQPSK transmitter using coherently detected constellation diagrams. We show the dependence on bias and phase offsets, as well as timing mismatch.

P068
A Parallel Equalizer for High-Speed Electronic Dispersion Compensation
Daniel Efinger, Joachim Speidel, University of Stuttgart, Germany
 ♦ A parallel architecture for linear transversal feed-forward, FFE and decision feedback equalizers, DFE is derived and applied to electronic dispersion compensation of a 40 Gbit/s intensity modulated optical transmission system with direct detection, IM/DD.

P069
A Fiber-Based All-Optical Regenerator for DQPSK Signals
Masayuki Matsumoto, Osaka University, Japan
 ♦ Analysis of an all-optical regenerator for DQPSK signals is presented. The phase regeneration is performed in the amplitude domain by use of fiber-based 2R regenerator. Reduction of phase noise is achievable by strong amplitude regeneration.

P070
Comparison of All-Optical XOR Gates at 42.6Gbit/s
Xuelin Yang, Robert Manning, Rod Webb, Photonic Systems Group, Arvind Mishra, Tyndall National Institute, University College Cork, Ireland; Graeme Maxwell, Alistair Poustie, Robert Harmon, Centre for Integrated Photonics, CIP Ltd, United Kingdom
 ♦ We report for the first time the 42.6Gbit/s bit-error-rate performance of two types of all-optical XOR gates based on semiconductor optical amplifiers. We compare a hybrid integrated Mach-Zehnder interferometer with a dual UNI arrangement.

P071
Optically Gain Clamped EDFAs in Dynamic Burst Switched Networks
Benjamin Puttnam, Benn Thomsen, Giancarlo Gavioli, Polina Bayvel, University College London, United Kingdom
 ♦ The impact of network size on optical feedback cavity design in optically gain clamped EDFAs for the suppression of power transients is investigated using a recirculation loop based dynamic optical network test-bed.

P072
Penalty Saturation of MLSE-Based Electronic Equalisation in Presence of DGD and Chromatic Dispersion
Alfons Schinabeck, Lucent Technologies Network Systems GmbH, Germany; Herbert Haunstein, University of Erlangen-Nuernberg; Wolfgang Sauer-Greff, Ralf Urbansky, University of Kaiserslautern, Germany
 ♦ The MLSE equaliser performance is investigated for large DGD and CD by theoretical bounds and 42.7Gb/s simulations. Due to penalty saturation the required OSNR at DGDs closely above bit duration is dominant.

P073

State-Complexity Reduction in MLSD Receivers for Direct-Detection Optical Communications

Michele Franceschini, Gianluigi Ferrari, Riccardo Raheli, University of Parma, Italy; Fausto Meli, Andrea Castoldi, Cisco Photonics, Italy

◆ We investigate the impact of state complexity reduction techniques on the performance of MLSD-based EDC. Our results show that simple state reduction techniques guarantee a good trade-off between complexity and robustness against uncompensated chromatic dispersion.

P074

Combined Impact of Raman and EDFA Transients on Long Haul Transmission System Performance

Stephan Pachnicke, Peter Krummrich, Edgar Voges, University of Dortmund, Erich Gottwald, Nokia Siemens Networks GmbH & Co. KG, Germany

◆ The combined impact of SRS and EDFA transients stemming from channel load changes is investigated. It is shown that the maximal power excursion deviates from the linear product of isolated SRS and amplifier gain transients.

P075

Spectrally Efficient OFDM-Transmission with Compatible Single-Sideband Modulation for Direct Detection

Matthias Schuster, Christian Bunge, Klaus Petermann, Technical University of Berlin, Bernhard Spinnler, Nokia Siemens Networks, Germany

◆ OFDM is suggested to overcome chromatic dispersion without explicit compensation. The use of the required single-sideband modulation in combination with direct detection, asks for advanced modulation techniques. An old idea is observed and discussed.

P076

Uncompensated WDM transmission of 10.7 Gbit/s directly detected DPSK over 300 km standard single-mode fibre and through 6 SOAs

John Downie, Jason Hurley, Michael Sauer, Srikanth Raghavan, Corning Incorporated, USA; Sergey Lobanov, Corning Incorporated, Russia

◆ We demonstrate uncompensated WDM transmission of 10.7 Gb/s DPSK signals demodulated with a narrow-band optical filter in the receiver over 300 km of standard single-mode fibre and through 6 SOAs using an MLSE-EDC receiver.

P077

Can SSMF handle ULH 40 Gb/s WDM transmission?

Erwan Pincemin, Antoine Tan, France Telecom R&D, Yves Jaouen, GET / Telecom Paris, Alessandro Tonello, Stefan Wabnitz, Université de Bourgogne, France; Juan Diego Ania-Castanon, Vladimir Mezentsev, Sergei Turitsyn, Aston University, United Kingdom; Kingdom; Lars Gruner Nielsen, OFS Fitel Denmark

◆ We compare the performance of SSMF and UltraWave fibers for ULH 40 Gb/s WDM transmissions, with both CSRZ-ASK and CSRZ-DPSK formats. We show that ULH distances can be reached on SSMF by using CSRZ-DPSK only.

P078

Improving the Transmission Performance for an Externally Modulated Baseband Single Sideband OFDM Signal Using Nonlinear Post-compensation and Differential Encoding Schemes

Wei-Ren Peng, National Chiao-Tung University, Taiwan; Sien Chi, Yuan Ze University, Taiwan

◆ We propose the nonlinear post-compensation and differential encoding schemes for an externally modulated optical baseband SSB OFDM signal. We show the tolerance to the chromatic dispersion could be effectively enlarged by the differential detection technique.

P079

Experimental Demonstration of PMD Compensation by LDPC-Coded Turbo Equalization

Ivan Djordjevic, University of Arizona, USA

◆ The possibility of PMD compensation by using LDPC-coded turbo equalization is demonstrated experimentally for NRZ systems operating at 10 Gb/s. Significant BER performance improvement over the optimum threshold receiver is obtained.

P080

Achieving Physical Layer Security/Privacy with Self-Wrapped OCDM Transmission

Yue-Kai Huang, Bernard Wu, Ivan Glesk, Konstantin Kravtsov, Evgenii Narimanov, Paul Prucnal, Princeton University, USA; Ting Wang, NEC Labs America/University of Virginia, USA

◆ We present a novel transmission system using self-wrapped WHTS OCDM signals to achieve enhanced transmission security. Distributed key is encoded and

time-spread to hide under noise in the network. BER of 10^{-4} is demonstrated experimentally.

P081

1310/1550 nm SMF-FSO-SMF Transmission without Intermediate O/E Conversion using Automatic Optical-Axis Alignment Method

Takeshi Tsujimura, NTT, Japan

◆ We designed bidirectional transmission system where SMF and FSO are directly connected without photo-electric devices. 1 Gbit/s transmissions at 1310 and 1550 nm were successfully achieved with 5-Hz vibration using automatic optical axis alignment method.

P082

PMD Mitigation for 42 x 43 Gb/s DPSK, NRZ and RZ by Distributed Polarisation Scrambling over 4820 km long NZDSF Fibre

Axel Klekamp, Henning Bülow, Alcatel-Lucent Deutschland AG, Germany; Sebastien Dupont, Philippe Plantady, Alcatel-Lucent Submarine Networks, Gabriel Charlet, Alcatel-Lucent Research and Innovation, France

◆ Simultaneous mitigation of 8ps mean DGD at 43Gb/s is demonstrated over 42 channels by use of 5 polarisation scramblers distributed over 4820km NZDSF straight line and UFEC with system margin. DPSK-NRZ and-RZ performance is compared.

P083

Experimental assessment of frequency-dependent crosstalk penalty with different 43 Gb/s modulation formats

Hans Bissessur, Christian Bastide, Alcatel-Lucent, France

◆ We experimentally analyse the crosstalk penalty versus the frequency location of the crosstalk, show that the classical crosstalk curves can be wrong by more than 6 dB, and compare different formats and filters.

P084

Numerical and Experimental Investigation of the Effect of Dispersion on Nonlinear Phase Noise in RZ-DPSK Systems

Leonardo Coelho, Norbert Hanik, Munich University of Technology, Lutz Molle, Dirk Gross, Ronald Freund, Christoph Caspar, Heinrich-Hertz Institut; Ernst-Dieter Schmidt, Nokia Siemens Networks GmbH & Co KG, Germany

◆ Using a novel Karhunen-Loève expansion method, we verify numerically and experimentally that the effect of dispersion can improve the performance of RZ-DPSK systems when nonlinear phase noise is the dominant impairment.

P085

Observation of Stimulated Brillouin Scattering in Ultrahigh-speed In-phase and Carrier-suppressed RZ OTDM Transmission

Toshihiko Hirooka, Kou Osawa, Masataka Nakazawa, Masatada Okazaki, Tohoku University, Japan; Hitoshi Murai, Oki Electric Industry, Japan

◆ We report that stimulated Brillouin scattering, SBS plays an important role in ultrahigh-speed bitwise phase-controlled OTDM transmission such as in-phase and carrier-suppressed RZ. SBS-induced performance limitation in a 160 Gbit/s-500 km transmission is described.

P086

640 Gbit/s DWDM transmission over PCF using orthogonal polarisation channel allocation

Kazuhide Nakajima, Kenji Kurokawa, Katsusuke Tajima, NTT Corporation, Japan

◆ Negligible input polarisation state dependence is experimentally confirmed in PCF transmission. 40 Gbit/s X 16 DWDM transmission over a 26 km long PCF is demonstrated using an orthogonal polarisation channel allocation for the first time.

P087

Novel Scheme for High-Bit-Rate Coherent-OFDM Transmission without PLL

Hadrien Louchet, Andre Richter, VPIsystems, Germany

◆ A novel architecture based on OFDM modulation and optical heterodyne detection that requires no electrical or optical phase-locked-loop is proposed. System performances are compared with those of a DQPSK system at a data-rate of 100-Gb/s.

P088

1-bit/s/Hz Spectral Efficiency OCDM Technique Based on Multi-frequency Homodyne Detection and Optical OFDM

Shin Kaneko, Hiro Suzuki, Noriki Miki, Hideaki Kimura, Makoto Tsubokawa, NTT, Japan

◆ We propose a novel OCDM technique that combines multi-frequency homodyne detection and optical OFDM to achieve 1-bit/s/Hz spectral efficiency without polari-

zation multiplexing. Numerical simulation results show the validity and performance of this technique.

P089

80-Gb/s 256-QAM Signals using Phase Noise and DGD-Tolerant Pilot-Carrier-Aided Homodyne Detection

Yukiyoishi Kamio, Moriya Nakamura, Tetsuya Miyazaki, National Institute of Information and Communications Technology, NICT, Japan

◆ We investigated DGD tolerance enhancement for 80-Gb/s signals up to 20 ps by employing pilot-carrier-aided self-homodyne detection with 10-Gsymbol/s 256-QAM, instead of 40-Gsymbol/s DQPSK, without using a narrow spectral linewidth light source.

P090

Fibre-independent Dispersion-Map Optimization for the Suppression of XPM and SPM in Fibre-Optical Transmission Systems

Mirosława Malach, Christian Bunge, Klaus Petermann, Technical University of Berlin, Germany

◆ We propose a procedure to optimize successively the dispersion map of a 10 Gb/s WDM NRZ system. The method is based on the evaluation of nonlinear phase shifts and accumulated dispersion along the transmission line.

P091

A Radio over Fiber System for Simultaneous Generation and Transmission of Multiband Signals

Qingjiang Chang, Yikai Su, Shanghai jiaotong university, P.R. China

◆ We propose and experimentally demonstrate a novel RoF system for simultaneous generation and transmission of baseband, micro-wave and millimeter-wave signals with a single wavelength using a dual-parallel Mach-Zehnder modulator and a single-drive Mach-Zehnder modulator.

P092

Nonlinear Phase Noise Separation Method for Simulation of ASK Optical Fibre Transmission Systems with Strong Signal-Noise Interaction

Evgeny Vanin, Gunnar Jacobsen, Anders Bertmson, Acreo AB, Sweden

◆ We propose a method that enables accurate ASK system modelling even when the detected optical field obeys non-Gaussian statistics with a substantial amount of nonlinear phase noise accumulated in the fibre due to signal-noise interaction.

P093

The Memory of Optimized Dispersion-Managed Periodic Optical Links

Paolo Serena, University of Parma, Italy; Alessandra Orlandini, University of Parma, Italy; Alberto Bononi, Universita di Parma, Italy

◆ We provide a new expression of the pseudo-random sequence length needed for reliable testing of DM periodic optical links with optimized pre- and post-compensation, and show that it scales linearly with bitrate.

P094

Impact of strong optical filtering on DQPSK modulation formats

Xiang Zhou, AT&T, Jianjun Yu, Ting Wang, NEC Labs America/University of Virginia, Guodong Zhang, AT&T Labs, USA

◆ We study the influence of strong optical filtering on DQPSK modulation formats and show that the performance can be significantly improved by using a delay-interferometer with larger free spectral range

P095

Impact of Nonlinearities on Optical OFDM with Direct Detection

Abdulmir Ali, Jochen Leibrich, Werner Rosenkranz, University of Kiel, Germany

◆ The impact of Kerr effect and modulator nonlinearity on optical OFDM transmission is studied for an uncompensated link of 8x80km of SSMF. Especially, the dependency on the number of OFDM subcarriers is considered.

P096

Do's and Don'ts for a more proper emulation of FWM in 10Gb/s WDM systems with low dispersion fiber

Emmanuel Seve, Jean-Christophe Antona, Thierry Zami, Alcatel-Lucent, France

◆ We numerically investigate simulation conditions to properly emulate the impact of FWM in WDM 10G systems based on low dispersion fiber, such as the stastistic impact of phase/time shifts between channel or combs of channels.

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P097
Transmission of WDM Multilevel 8x30 Gbit/s Single Polarization RZ-D8PSK with a Total Capacity of 240 Gbit/s
Jesper Jensen, Torger Tokle, Christophe Peucheret, Palle Jeppesen, Technical University of Denmark
 ♦ By combining differential 8-ary phase shift keying with wavelength division multiplexing, we present transmission of 8 channel multilevel modulation with 3 bits per symbol. We observed no error-floor down to BER = 10^{-10} .

P098
Theoretical Performance Limits of Optical DPSK Under Severe Chromatic Dispersion
Michele Franceschini, Giorgio Bongiorno, Gianluigi Ferrari, Riccardo Raheli, University of Parma, Italy
 ♦ We investigate the theoretical performance limits, in terms of information rate, of optical DPSK. In particular, we characterize the chromatic dispersion tolerance of DPSK. For comparison, the performance of MLSD is also considered.

P099
Performance of a 43Gb/s NRZ-DPSK Signal Over a 1440km Commercial 10Gb/s DWDM System, Under Varying DPSK Decoder FSR Values
Irene Leung, Cisco Systems Inc., Canada
 ♦ We investigate the performance of a 43Gb/s NRZ-DPSK signal over a 1440km commercial 10Gb/s DWDM Network. Utilizing DPSK decoder FSR values of 50GHz and 65GHz, we demonstrate the robustness of the signal to optical filtering.

P100
Cost and Performance Comparison in Data Vortex networks with and without shared traffic control
Qimin Yang, HMC, USA
 ♦ Data Vortex networks that operate with shared traffic control allow for lower cost and better system performance. The routing efficiency is improved especially under bursty traffic operations.

P101
Physical layer impairment, PLI-aware routing and wavelength assignment, RWA in dispersion-managed DWDM networks
Thomas Fischer, Nokia Siemens Networks, Germany
 ♦ A PLI-aware RWA algorithm with unique workflow is proposed for provisioning and rerouting in GMPLS-enabled transparent DWDM networks. Although fiber nonlinearities in dispersion-managed systems are captured, standard performance assessment is outpaced by orders of magnitude.

P102
Analysis of Wavelength Blocking in Large Metro Core Network Using Optical and Digital ROADM Transport Systems
Serge Melle, Infinera, Vijay Vusirikala, USA
 ♦ Network planning analysis indicates wavelength blocking in all-optical ROADM networks incurs additional OEO for wavelength conversion, and constrains service reconfiguration. Analyses show that digital ROADM systems provide flexibility

P103
Large-scale AWG Router, 15 nodes, 217 paths Providing Full-mesh and Non-uniform Transmission Capacities
Osamu Moriwaki, Kenya Suzuki, Koichi Takiguchi, Yoshihisa Sakai, NTT Corporation, Japan
 ♦ We developed an AWG router with non-uniform transmission capacities realizing the best wavelength utilization. The router has a cyclic routing table and its throughput is extended to about three times that of the previous one.

P104
ASON survivability testbed supporting p-cycles protection
Yu Deng, Shanguo Huang, Pei Zhang, Beijing University of Posts and Telecommunications, P.R. China; Wanyi Gu, Key Laboratory of Optical Communication and Lightwave Technologies, Ministry of Education, Beijing, P.R. China
 ♦ A distributed testbed SURBED, Survivability Testbed for Automatically Switched Optical Networks supporting p-cycles protection is proposed and demonstrated. Based on SURBED the performances of several traditional survival mechanisms and a p-cycles protection algorithm are evaluated.

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P105
Scalable all-optical packet-switching nodes: a dimensioning study
Ruth Van Caenegem, Didier Colle, Mario Pickavet, Piet Demeester, Ghent University - IMEC, Belgium
 ♦ All-optical Label Swapping suffers from bad scalability. This paper proposes a new AOLS node design based on wavelength striping. It compares the new design with the original AOLS node via a dimensioning study.

P106
Optical signal quality monitoring using fibre-Bragg-gratings-based correlators in optical packet-switched networks
Ruth Vilar, Francisco Ramos, Javier Marti, Universidad Politecnica de Valencia, Spain
 ♦ Novel technique based on the use of optical pulse correlation to assess the signal quality at optical domain with relaxed speed requirements is proposed. The method is compared to traditional techniques based on BER estimation

P107
High Performance SCM Optical Packet Switching Router for Optical Circuit, Burst and Variable Length Packet Processing
Gustavo Puerto, Beatriz Ortega, Alfonso Martinez Garcia, Maria Manzanedo, ITEAM Research Institute; Daniel Pastor, Jose Capmany, Universidad Politécnica de Valencia, Spain
 ♦ An optical subcarrier multiplexing packet switching router based on the label swapping paradigm supporting optical burst switching and optical circuit switching connections at 10 Gb/s on a single platform is presented.

P108
Strategies for the Migration from Opaque to Hybrid Networks
Annalisa Morea, Julien Poirrier, France Telecom, France
 ♦ Cost analyses usually compare fully opaque to fully hybrid networks. However no operator can afford migrating in one step its entire network. We address different migration strategies and identify the optimal levels of network transparency.

P109
Analysis of Closed Amplified Cycles in WSS ROADM based Mesh Optical Networks
David Dahan, Uri Mahlab, ECI telecom, Israel
 ♦ We report experimental and numerical stability analysis of closed amplified optical cycles formed by mesh network with WSS ROADM

P110
Link Management Protocol extensions for OMS protection in GMPLS-based optical ring networks
Luis Velasco, Salvatore Spadaro, Jaime Comellas, Gabriel Junyent, Universitat Politècnica de Catalunya, Spain
 ♦ In this paper we propose a mechanism to provide dedicated section protection in ring-based optical networks. It is based on extensions to GMPLS Link Management Protocol, LMP and its performance is experimentally evaluated.

P111
Planning of GMPLS Transport Networks With Conversion and Regeneration Capabilities
Nabil Naas, Hussein Mouftah, University of Ottawa, Canada
 ♦ We propose heuristics that are capable of planning large-sized GMPLS transport networks with conversion and regeneration capabilities in a reasonable amount of time. The planning problem objective is to minimize the total weighted port count.

P112
Novel Architectures of Asynchronous Optical Packet Switch
Jijia Chen, Lena Wosinska, Lars Thylén, Sailing He, The Royal Institute of Technology KTH/ICT, Sweden
 ♦ We propose two asynchronous optical packet switch architectures, with efficient contention resolution based on controllable optical buffers and tunable wavelength converters TWCs. Providing a few shared optical buffers significantly boosts the performance obtained by TWCs.

P113
Sub-Band-Patch-Through heuristic for cost efficient wavelength assignment in DWDM networks
Sascha Kallin, Nokia Siemens Networks GmbH & Co. KG, Marco Hoffmann, Siemens, Germany
 ♦ This paper discusses a heuristic for cost efficient wavelength assignment by saving mux/demux cards at nodes in an all-optical network while using the possibility

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ty to patch through wavelengths of a sub-band at intermediate nodes.

P114
Performance Comparison of OBS and OCS for VoD Applications
Wei Wei, Xin Liu, Xiang Yu, Chunming Qiao, University at Buffalo, SUNY; Ting Wang, NEC Laboratories America, USA
 ♦ We study the performance of video-on-demand, VoD applications under various network/traffic parameters in optical networks. The results show that optical burst switching, OBS is more suitable for supporting VoD applications than optical circuit-switching, OCS.

P115
Performance Comparison of Different Data Rate Adaptation Mechanisms
Martin Belzner, Herbert Haunstein, University of Erlangen-Nuremberg; Dieter Stoll, Lucent Technologies Network Systems GmbH, Germany
 ♦ Different data rate adaptation mechanism and their influence on network and traffic characteristics are visualized in radar plots in order to provide a fast and fair comparison of multiple parameters at the same time.

P116
The WONDER Testbed: Architecture and Experimental Demonstration
Roberto Gaudino, Vito De Feo, Fabio Neri, A. La Porta, R. Birke, S. M. Finocchietto, M. Petrana, A. Antonio, Politecnico di Torino, Italy
 ♦ We present the latest experimental results within the WONDER project, aiming at the demonstration of an advanced packet-based WDM architecture. Our results show the feasibility of all-optical networking using commercially available optoelectronic components.

P117
Multistage Interconnection Network Photonic Controller Exploiting a Cascaded SOA-based Ultrafast Module
Nicola Andriolli, Mirco Scaffardi, Gianluca Berrettini, Scuola Superiore Sant'Anna; Luca Poti, Consorzio Nazionale Interuniversitario per le Telecomunicazioni; Antonella Bogoni, CNIT, Italy
 ♦ In this paper we exploit cascades of a single SOA-based module working up to 160Gb/s to perform all-optical control and switching operations in a multistage Batcher-Banyan photonic interconnection network with intermediate contention manager.

P118
In-service measurement of the OSNR in ROADM-based Networks
Wolfgang Moench, JDSU Deutschland GmbH, Germany; Julia Larikova, Tellabs, USA
 ♦ Optical networks using ROADMs present a challenge for OSNR testing. We propose a new method for measuring the in-band OSNR based on a high resolution optical spectrum analyzer using a new optical polarization splitting method.

P119
Novel Wavelength Initialization of the Bragg-grating based Tunable External Cavity Laser for WDM-PON
Jie Hyun Lee, ETRI, Korea
 ♦ We propose a novel wavelength-initialization method for the Bragg-grating based tunable ECL. Using the proposed method, wavelengths can be initialized within 0.5nm, which is enough to be used in the WDM-PON with 200GHz wavelength spacing.

P120
Hybrid WDM/TDM-PON Using Remotely Pumped Optical Amplifier
Soo-Jin Park, KT Inc., Korea; Oh Jung-Mi, Sang-Geun Koo, Donghan Lee, Chungnam National University, Korea
 ♦ It was shown that the remote pumping scheme increases the optical loss budget up-to 24dB for the hybrid WDM/TDM-PON, where the coherent seed light injected R-SOA is used as the colourless transmitter.

P121
A Simple Configuration for WDM Full-Duplex Radio-Over-Fiber Systems
Jianqiang Li, Kun Xu, Jian Wu, Jintong Lin, Beijing University of Posts and Telecommunications, P.R. China
 ♦ A compact and functionality-centralized configuration is proposed for full-duplex millimeter-wave, mm-wave radio-over-fiber, ROF systems incorporating wavelength-division multiplexing, WDM.

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P122
A bidirectional Single Sideband Gigabit WDM-RoF System using Reflective SOA
Lee Dae Won, Won Yong-Yuk, Han Sang-Kook, Yonsei University, Korea
 ♦ We proposed a new bidirectional gigabit WDM-RoF system. CS transmits the 30GHz SSB wireless signal which is modulated 1.25Gb/s using a MZM and a FBG. BS transmits 1.25Gb/s wireless signal using a RSOA.

P123
VMAPS: a Versatile Medium Access Control and Processing System for an Optical WDM Metro Ring Network
Maria C. Yuang, Yu-Min Lin, National Chiao Tung University, Taiwan; Ya-Shian Wang, Chunghwa Telecom Co., Ltd., Taiwan
 ♦ We present the design/experimentation of a versatile medium-access control and processing system, VMAPS for optical packet-switched WDM networks. VMAPS achieves exceptional MAC performance and enables optical parallel headers to be modified via wavelength-to-time conversion.

P124
Reducing the Back Reflection-Induced Penalty by Using a Receiver with an Optimized Decision Level in a Wavelength-Reuse Single Fiber Bidirectional WDM-PON
Seung-Hyun Cho, ETRI, Korea
 ♦ We present the use of an optical receiver with an optimized decision-level for reducing the back reflection-induced degradation of an upstream transmission in a λ -reuse reuse single fiber bidirectional RSOA-based WDM PON.

P125
Future-Proof WDM-PONs with Bandwidth/Wavelength Upgradeable VCSEL arrays
Elaine Wong, ARC CUBIN, National ICT Australia, Werner Hofmann, Walter Schottky, Markus-Christian Amann, TU München, Germany
 ♦ The continual escalation of bandwidth demand in WDM-PONs is supported with VCSEL arrays that facilitate the migration of CWDM to DWDM operation from 2.5 Gb/s to 80 Gb/s without further investment into transmitter infrastructure.

P126
Using Sub-sampled Fiber Bragg Gratings to Achieve Laser Sources Compatible OCDMA En/decoders
Tao PU, Yuquan Li, Rong Wang, Jilin Zheng, Peng Chen, Yingxun Zhu, Lin Lu, Institute of Communication Engineering, Nanjing, P.R.China
 ♦ A novel sub-sampling technology is given, which can be used to manufacture multiple en/decoders for different wavelengths with one phase mask. The proposed method is experimentally proven to fit for WDM compatible OCDMA system

P127
An interoperable access network based on CWDM-routed PONs
Yuval Shachaf, Pandelis Kourtessis, John Micheal Senior, University of Hertfordshire, United Kingdom
 ♦ A dynamic access network architecture based on coarse-routed PONs is described. Modelling of a coarse-AWG OLT to support multiple RSOA-based ONUs has demonstrated error-free transmission in the presence of AWG polarisation-dependent wavelength shift and phase-errors.

P128
8-channel 200 GHz-Spacing Multi-Wavelength Lasers by Silica PLC Hybrid Integration
Su Hwan Oh, Electronics and Telecommunications Research Institute, Korea
 ♦ We successfully fabricated a very compact 8-channel 200 GHz-spacing multi-wavelength laser, MWL module for WDM-PON OLT source.

P129
A Method to Use Continuous Mode Receivers as Burst Mode Receivers for TDM-based Passive Optical Networks
Chang-Joon Chae, Thisara Jayasinghe, NICTA, Australia
 ♦ We propose a simple and effective method to drastically reduce the dynamic range requirement of the burst-mode receiver for TDM-based passive optical networks. Its feasibility is demonstrated with a 2.5Gb/s continuous mode receiver.

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P130
Wavelength Cross-Connect Switching System with Dynamic Capacity Control that uses PLC-based WSS
Atsushi Taniguchi, Akira Hirano, Takashi Goh, Akimasa Kaneko, Takayuki Mizuno, Yoshinori Hibino, NTT Network Innovation Laboratories, Japan
 ♦ We propose a wavelength cross-connect, WXC Switching System with dynamic capacity control that uses Planar-Lightwave-Circuit, PLC-based wavelength selective switch, WSS. The switching system can realize fast capacity control with simple end-to-end communication.

P131
Very high bit rates WDM transmission on a Free Space Optics System
Davide Massimiliano Forin, Giorgio Tosi Belleffi, Franco Curti, Natalia Corsi, Gabriella Cincotti, University of Roma, Valeria De Sanctis, Uniroma3, Italy; Antonio Teixeira, University of Aveiro, Portugal
 ♦ We report experiments on a fully transparent WDM-FSO system. Results demonstrate that this kind of system is able to bring the high bandwidth of the fiber in the last mile/last hundred of meters scenario.

P132
Local Area networking in a Multi-functional Repeater-based Optical Access Network
Nishaanthan Nadarajah, Chang-Joon Chae, NICTA, Australia; An Tran, Thas Nirmalathas, University of Melbourne, Australia
 ♦ A simpler and bandwidth efficient scheme for providing local area networking amongst the customers in a multi functional repeater-based optical access network is proposed and experimentally demonstrated.

P133
Home Network based on CWDM Broadcast and Select technology
Philippe Guignard, Hary Ramanitra, Laurent Guillo, France Telecom R&D, France
 ♦ We present a new scheme of multi-service home network based on single mode fibre, using CWDM technologies in association with a broadcast and select architecture. Results concerning the network dimensioning are reported.

P134
A Color-Free WDM-PON Employing Fabry-Pérot Laser Diodes Without a Seed Light Injection
Sil-Gu Mun, Korea Advanced Institute of Science and Technology, Korea
 ♦ We demonstrate a WDM-PON by employing a double-contact F-P LDs without a seed light injection. To avoid the high MPN at low frequency, we use BPSK as a modulation format at a low RIN window.

P135
Impact of Fiber Chromatic Dispersion on DS-OCDMA System
Ye Zhang, Tsinghua University, P.R. China
 ♦ A criterion, $f_{max}L_{max}D=10^2$, is proposed to judge the maximum fiber access distance, within which chromatic dispersion can be neglected. And it is verified by a 2x2 DS-OCDMA system at 127-chip 320-Gchip/s.

P136
Optical network architecture for UWB range extension beyond a single complex of cells
Mehmet Toygan, Manoj Thakur, Stuart Walker, University of Essex, United Kingdom
 ♦ We present an efficient scenario for deploying high-capacity optical access networks using Radio over Fibre technology. A wide range of interactive multimedia services are available to end-users by using latest-generation, ultra wideband signalling methodology.

P137
Spurious Free Dynamic Range of 1.3 μ m and 850 nm Directly Modulated High Speed VCSELs for Low Cost WLAN-over-Fibre Systems
David Yoo, Michael Sauer, Eric Sadowski, Catherine Caneau, Chung-En Zah, Frank Annunziata, Corning Incorporated, USA; Nobuhiko Nishiyama, Tokyo Institute of Technology, Japan
 ♦ The nonlinearity and RIN of 1.3 μ m/850nm VCSELs were evaluated at the 2.4/5.8GHz bands to investigate their viability for WLAN-over-fibre systems. More than 38km singlemode and 300m multimode reach can be achieved.

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P138
Analysis of backscattered optical signals in narrow spectrum remote feeding single-fibre links employing RSOAs
Juan José Martínez, Ignacio Garcés, Ángeles Losada, Alicia López, Asier Villafranca, University of Zaragoza, Spain
 ♦ We assess the bounds that Brillouin and Rayleigh backscattering impose to single fibre optical links that use narrow spectrum optical sources acting as feeders of RSOAs for upstream transmission.

P139
Mini-slot Transmission Scheme for a PON System with Local Customer Internetworking Capability
JaeGwan Kim, Information and Communications University, Korea
 ♦ We propose mini-slot transmission scheme for a PON where each customer can be switched to access or local mode dynamically. Simulation shows that throughput and delay are dependent on the speed of mode switching.

P140
Cost-Effective Wavelength-Shared Hybrid Passive Optical Network Upgrade Re-using Both Optical Network Units and Remote Node
Martin Bouda, Páparao Palacharla, Youichi Akasaka, Takao Naito, Fujitsu Laboratories of America, USA; Stephen Smith, Fujitsu Network Communications, USA
 ♦ We have proposed and demonstrated the cost-effectiveness of a Wavelength-Shared Hybrid PON architecture for upgrade of existing PON systems while re-using all equipment on customer premises and re-using the fiber plant including remote node.

Session 9.1 **Hall 3**
MLSE

Chair: William Shieh, University of Melbourne, Australia

9.1.1 **8:30**

Invited: Performance of MLSE in Optical Communication Systems

Theodor Kupfer, Stefan Langenbach, Nebojsa Stojanovic, Soeren Gehrke, James Whiteaway, CoreOptics GmbH, Germany

◆ We show the improvements maximum likelihood sequence estimation, MLSE brings for different transmission impairments in optical transmission systems. We consider MLSEs with 4 states and 16 states and show the impact of other parameter choices.

9.1.2 **9:00**

Robust Detection of 10.7-Gb/s DPSK Using Joint Decision Maximum Likelihood Sequence Estimation

Mohammad Alfiad, Dirk van den Borne, Ton Koonen, Huug de Waardt, Eindhoven University of Technology, The Netherlands; Fabian Hauske, University of the Federal Armed Forces, Munich, Germany; Antonio Napoli, Nokia Siemens Networks, Germany

◆ We experimentally apply Joint-Decision MLSE, JD-MLSE detection to 10.7-Gbit/s DPSK. We demonstrate that a JD-MLSE using the constructive and destructive components preserves the 3-dB OSNR advantage of DPSK over OOK in dispersion-limited optical systems

9.1.3 **9:15**
MLSE-EDC versus optical dispersion compensation in a single-channel SPM-limited 800 km link at 10 Gbit/s

Pierluigi Poggiolini, Gabriella Bosco, Monica Visintin, Politecnico di Torino, Italy; Seb Savory, Yannis Benlachtar, Robert Killely, Polina Bayvel, University College London, United Kingdom

◆ We investigate experimentally the effectiveness of MLSE-EDC for application with signals limited by self-phase modulation, by comparing the results with those obtained using different maps of optical dispersion compensation.

9.1.4 **9:30**
Investigation of the Use of Electronic Pre-Distortion and MLSE Equalization in Long-Haul Transmission

Yannis Benlachtar, Seb Savory, Polina Bayvel, Robert Killely, University College London, United Kingdom

◆ The performance of an 11Gps NRZ transmission system over 1600km utilizing electronic predistortion coupled with 2sample-per-bit 32-state MLSE equalization is studied. We show that MLSE reduces the OSNR penalty in the linear and nonlinear regime

9.1.5 **9:45**

Polarization-Diversity Turbo-Equalization of Polarization Mode Dispersion

Stephan Hellerbrand, Norbert Hanik, Munich University of Technology, Germany

◆ A novel method based on polarization diversity and iterative equalization is proposed to combat polarization mode dispersion, PMD. Simulation results are presented that show considerable gain over MLSE receivers without polarization diversity.

9.1.6 **10:00**

Limitations of MLSE-Viterbi receivers due to clocking errors

Hadrien Louchet, Andre Richter, VPIsystems, Germany

◆ Imperfections of clock recovery from highly distorted signals limit the utilization of electronic dispersion mitigation. We investigate the impact of clocking errors on the performance of MLSE-Viterbi equalization using static and adaptive channel estimation.

Session 9.2 **Roofgarden**
Semiconductor Lasers and Amplifiers

Chair: Yoshiaki Nakano, University of Tokyo, Japan

9.2.1 **8:30**

Invited: Hybrid III-V and IV lasers and amplifiers

John Bowers, University of California, USA

◆ Silicon evanescent lasers and amplifiers have been demonstrated utilizing low temperature wafer bonding technology. This approach enables the creation of high performance, small footprint active devices on silicon for photonic integrated circuits.

9.2.2 **9:00**

Tunable Distributed Amplification, TDA- DFB Laser Array Using Asymmetric Periodic Structure

Nobuhiro Nunoya, Hiroyuki Ishii, Yoshihiro Kawaguchi, Hiromi Oohashi, NTT Corporation, Japan

◆ We applied an asymmetric structure to a TDA-DFB laser to expand the tuning range. We achieved a 6.7 nm tuning range for a single laser and 36-channel operation with a 100-GHz grid for a 6-LD array.

9.2.3 **9:15**

Demonstration of C- and L-band external cavity wavelength tunable laser utilizing a wideband SOA with coupled quantum well active layer

Shinya Sudo, Kenji Mizutani, Takeshi Okamoto, Kiyotaka Tsuruoka, Kenji Sato, Koji Kudo, NEC Corporation, Japan

◆ We present a wideband gain chip for a C+L band tunable laser based on coupled QWs. Low threshold current density, over 13-dBm fiber coupled power, and high SMSR across 77-nm tuning range are demonstrated.

9.2.4 **9:30**

More than 40nm tuning DBR-MMI-SOA with only one Bragg current control, compatible with fast switching

Helene Debregeas-Sillard, Catherine Fortin, Frédéric Pommereau, Yaneck Gottesman, Olivier Drisse, Estelle Derouin, Nadine Lagay, Benjamin Rousseau, Florence Martin, Jean Landreau, Christophe Kazmierski, Alcatel-Thales III-V Lab, France

◆ Our new 3DBR-MMI-SOA covers 41nm tuning with only one simultaneous Bragg current, and is compatible with fast switching. Its short cavity and simple tuning mechanism provide large technological tolerances, simple control, and high industrial yield.

9.2.5 **9:45**

Polarization-Insensitive GalnNAs / GalnAs MQW-SOA with Low Noise Figure and Small Gain Tilt over 90-nm Bandwidth, 1510 - 1600 nm

Shinsuke Tanaka, Ayahito Uetake, Susumu Yamazaki, Ken Morito, Fujitsu limited, Japan; Mitsuru Ekawa, Fujitsu Laboratories Ltd., Japan

◆ We developed a polarization-insensitive GalnNAs/GalnAs MQW-SOA with a small gain tilt of < 1.2 dB in C-band. The reduced NF increased the effective gain bandwidth by 50 nm as compared with a GalnNAs strained-bulk SOA.

9.2.6 **10:00**

External cavity diffraction-coupled tapered laser diodes

Imen Hassiaoui, Nicolas Michel, Michel Krakowski, Michel Lecomte, Olivier Parillaud, Michel Calligaro, Alcatel Thales III-V lab, Jean Pierre Huignard, Thales Research & Technology, Gilbert Bourdet, Ecole Polytechnique, LULI, France

◆ We demonstrate the first operation of a corrected tapered laser diode array in an external Talbot cavity. The in-phase supermode is selected with a divergence of the central peak of 0.18° FWHM.

Session 9.3 **Hall 4/5**
Modulation Techniques

Chair: John Cartledge, Queen's University, Canada

9.3.1 **8:30**

Invited: 100 Gbit/s: ETDM generation and long haul transmission

Gregory Raybon, Peter Winzer, Alcatel-Lucent, USA

◆ We review the electronic generation and transmission of recently demonstrated serial transport technologies at 100 Gb/s, including binary, multi-level, and coherently detected polarization-multiplexed formats.

9.3.2 **9:00**

Electronic Mitigation Robustness to the combined effect of CD and second order PMD

Julien Poirrier, France Telecom RD, France; Henning Bülow, Alcatel-Lucent, Germany

◆ The robustness of electronic mitigation to Second Order PMD and CD is experimentally assessed. We quantify their combined impact and identify the, PMD, CD domain over which SOPMD impact can not be neglected anymore.

9.3.3 **9:15**

Experimental Demonstration of Reduced Complexity 43-Gb/s RZ-DQPSK Rate-Tunable Receiver

Louis Christen, Xiaoxia Wu, Alan Willner, Scott Nuccio, University of Southern California, USA; Loukas Paraschis, Cisco Systems, USA

◆ We demonstrate an alternative DQPSK rate-tunable receiver offering reduced complexity through sharing of hardware in the I/Q demodulation paths. Demodulation of 43-Gb/s and 21.5-Gb/s RZ-DQPSK is demonstrated without penalty relative to a traditional receiver.

9.3.4 **9:30**

Coherent Demodulation of Optical Quadrature Duobinary Signal with Spectral Efficiency of 4 bit/s/Hz per Polarization

Kazuro Kikuchi, Kazuhiro Katoh, University of Tokyo, Japan

◆ We demonstrate demodulation of a 20-Gbit/s optical quadrature duobinary signal using the digital coherent receiver. The spectral efficiency reaches 4 bit/s/Hz/polarization owing to the narrowband duobinary-coded signal and quadrature modulation.

9.3.5 **9:45**

Performance of 2.5 Gb/s and 10 Gb/s transient and adiabatic chirped directly modulated lasers using electronic dispersion compensation

Ioannis Papagiannakis, Alexios Birbas, University of Patras, Greece; Chunmin Xia, Werner Rosenkranz, University of Kiel, Germany; Dimitrios Klonidis, Ioannis Tomkos, AIT, Greece

◆ For the first time to our knowledge we study the efficiency of electronic dispersion compensation when transient and adiabatic chirped directly modulated lasers operating at 2.5 Gbps and 10 Gbps are used.

9.3.6 **10:00**

Suppressing dynamic instabilities in PMD compensators by dithering the polarization of the transmitted signal

Ernesto Ciaramella, Emma Matarazzo, Scuola Superiore Sant'Anna University, Italy

◆ Dynamical issues of practical PMD compensators can be eliminated by modulating the polarization of the transmitted signal. Low-depth modulation, dithering stabilizes the compensator whilst not introducing significant jitter nor eye closure.

Session 9.4 Hall 7
Transmission Impairments and Special Techniques

Chair: Polina Bayvel, University College London, United Kingdom

9.4.1 8:30
Compensation of Non-linear Phase-shift in Incoherent Multilevel Receiver with Digital Signal Processing

Nobuhiko Kikuchi, Kohei Mandai, Shinya Sasaki, Central Research Lab., Hitachi Ltd., Japan

◆ A simple cancellation technique of SPM-induced phase-shift in amplitude- and phase-modulated signalling is proposed and experimentally demonstrated in 100-km transmissions of 40-Gbit/s 16-level and 50-Gbit/s 32-level signals with >6.8 dB increase of input power.

9.4.2 8:45
Impact of WDM Channel Dynamics on Transmission Performance of 42.7-Gb/s DBPSK and DQPSK

Xiang Liu, Sethumadhavan Chandrasekhar, Alan Gnauck, Robert Jopson, Randy Giles, Alcatel-Lucent, Bell Laboratories, USA

◆ We investigate the impact of WDM channel dynamics on performances of 42.7-Gb/s DBPSK and DQPSK signals in a transparent optical link, and show their robustness against rapid and large power changes in other channels.

9.4.3 9:00
Mitigation of XGM and Add/Drop Induced Penalties in SOA-based Metro WDM Ring Networks

Tomasz Rogowski, Stefano Faralli, Gabriele Bolognini, Fabrizio Di Pasquale, Scuola Superiore Sant'Anna, Italy; Rodolfo Di Muro, Bimal Nayar, Ericsson, United Kingdom

◆ Performance of link-control techniques in SOA-based metro WDM-ring networks has been characterized in steady-state and dynamic conditions; such techniques in short-span networks provide XGM reduction, effective OSNR improvement and significant BER-transient reduction during Add/Drop.

9.4.4 9:15
Experimental Demonstration of Slow Light on RZ-DQPSK Signals

Bo Zhang, Lin Zhang, Scott Nuccio, Louis Christen, Teng Wu, Alan Willner, University of Southern California, USA; Lianshan Yan, General Photonics, USA

◆ We demonstrate 60-ps symbol-delay with error-free demodulation of both quadratures for 10-Gb/s RZ-DQPSK via a SBS-based slow-light medium. Simulation results propose the possibility to transmit very-high spectrally-efficient formats through a bandwidth-limited slow-light element.

9.4.5 9:30
Cascaded Long Period Fibre Grating-Based DPSK Demodulator with Optically Tunable Phase Shifter

Tae-Young Kim, Youngjoo Chung, Won-Taek Han, Chang-Soo Park, Gwangju Institute and Technology (GI-ST), South Korea; Masanori Hanawa, University of Yamaguchi, Japan

◆ DPSK demodulator based on cascaded long period fibre grating is proposed. The performance of the demodulator is demonstrated for a 10-Gb/s DPSK system, showing clear eye diagram as well as bit error free performance.

9.4.6 9:45
Dual-mode Time-bin Coding for Quantum Key Distribution Using Dual-drive Mach-Zehnder Modulator

Ken-ichiro Yoshino, Akihiro Tanaka, Yoshihiro Nambu, Akio Tajima, Akihisa Tomita, NEC Corporation, Japan

◆ We demonstrate a new method of coding for quantum key distribution using a dual-drive Mach-Zehnder modulator. This method allows users to switch between two coding modes merely by changing the driving sequence of the modulator.

9.4.7 10:00
Quantum key distribution over WDMs and optical switches to combine the quantum channel with synchronization channels

Andreas Poppe, Hannes Huebel, Foteinh Karinou, Bibiane Blauensteiner, University of Vienna, Austria

◆ We use standard CWDM-telecom equipment and optical switches to combine entangled photons with all needed signalling channels and perform QKD via a single optical fiber over a distance of 25km.

Session 9.5 Hall 9
Control Plane

Chair: Jan Späth, Ericsson, Germany

9.5.1 8:30
Invited: Generalized MPLS, GMPLS Recovery Mechanisms at IETF

Dimitri Papadimitriou, Alcatel-Lucent, Belgium

◆ A requirement for the development of a unified control plane for both optical/circuit and electronic/packet switching equipment is the support of data plane fault recovery. This paper describes the data path recovery mechanisms, i.e. protection and re-routing, defined as part of the GMPLS protocol suite, as defined by the IETF.

9.5.2 9:00
Multi-domain routing techniques in ASON networks

Guido Maier, Fabio Mizzotti, Achille Pattavina, Politecnico di Milano, Italy

◆ A pan-European ASON network has been simulated under dynamic traffic to compare the different multi-domain routing procedures allowed by the ASON Recommendations. Compared features are: network performance, blocking probability and scalability, amount of required routing-information.

9.5.3 9:15
A Novel Signaling Protocol for Fast Lightpath Setup in GMPLS/WDM Optical Networks

Chava Vijaya Saradhi, Create-net, Italy; Suresh Gollu, Mohan Gurusamy, National University of Singapore, Luying Zhou, Institute for Infocomm Research, Singapore

◆ We propose an efficient signaling protocol for GMPLS/WDM optical networks based on backward reservation protocol. The simulation results show that the proposed protocol reduces setup time, number of reservation conflicts, and the blocking probability.

9.5.4 9:30
GMPLS extensions to Encompass Shared Regenerators in Transparent Optical Networks

Filippo Cugini, CNIT, Nicola Sambo, Nicola Andriolli, Alessio Giorgetti, Piero Castoldi, Luca Valcarengi, Scuola Superiore Sant'Anna, Italy; Esther Le Rouzic, Julien Poirrier, France Telecom, R&D division, France

◆ GMPLS signaling extensions are proposed to encompass the presence of shared regenerators in transparent optical networks without routing protocol modifications. Low blocking probability is obtained with just two transparent set up attempts before using regenerators.

9.5.5 9:45
Advance Reservation Algorithm for Service Oriented Optical Networks

Eduard Escalona, Salvatore Spadaro, Jaume Comellas, Gabriel Junyent, Universitat Politècnica de Catalunya, Spain

◆ Advance Reservation and Immediate Reservation service provisioning requires complex algorithmic approaches to guarantee QoS. In this paper we propose and evaluate an algorithm which significantly decreases connection preemption rates.

9.5.6 10:00
Economics of Optical Control Plane Technology

Peter Kubat, Vishnu Shukla, Verizon Laboratories, USA

◆ A flexible model is developed to analyze the economic impact of control plane technology on NG Optical Transport Network. Initial economic assessment suggests that substantial revenue gains and operations savings can be expected.

Session 9.6 Hall 10
Multimode Fibre in Access Networks

Chair: Roberto Gaudino, Politecnico di Torino, IT

9.6.1 8:30
Invited: Multimode Fibers Optimized for High Speed, Short Reach Interconnects

Robert Lingle, OFS Labs, USA

◆ Laser-optimized multimode fibers with parallel and CWDM optics offer a path for extending the cost-effectiveness of 10Gbps links based on 850nm VCSELs to the 100Gb Ethernet space. Both fiber and system developments will be reviewed.

9.6.2 9:00
Small Core-Diameter Polymer-Clad Silica-Core Fiber for High-Speed Short-Reach Transmission

Kenji Okada, Fujikura Ltd., Japan

◆ Transmission characteristics of small core-diameter polymer-clad silica-core fibers are presented. Error-free transmission over 2.5 Gbps at 20 m link can be supported by the manufactured fiber with VCSEL excitation.

9.6.3 9:15
Optically Powered Video Camera Link

Gunnar Böttger, Michael Hübner, Christos Klamouris, Michael Dreschmann, Juergen Becker, Wolfgang Freude, Juerg Leuthold, Moritz Röger, University of Karlsruhe, Germany; Andreas Bett, Fraunhofer ISE, Germany

◆ We implemented an optically powered video camera connected to a base station at 200 m distance. Power and 100-Mbps data-channel are multiplexed at 810 nm and 1310 nm into a 62.5 μm multimode fiber.

9.6.4 9:30
Discrete Multi-Tone Modulation for Low-Cost and Robust 10-Gb/s Transmission over Polymer Optical Fibre

Jeffrey Lee, Jianming Zeng, Henrie van den Boom, Ton Koonen, University of Technology Eindhoven, The Netherlands; Florian Breyer, Munich University of Technology, Sebastian Randel, Siemens, Germany

◆ Utilizing a transmission bandwidth of 2 GHz, we demonstrate 10.6-Gb/s, 11.9-Gb/s including overhead transmission over 100 m of 120-μm core-diameter graded-index polymer optical fibre with discrete multi-tone modulation, achieving a spectral efficiency of 5.3 bit/s/Hz.

9.6.5 9:45
100Mb/s Transmissions over Short Reach SI-POF Links: Experimental Demonstration of Extended Reach Systems

Daniel Cárdenas, Roberto Gaudino, Politecnico di Torino, Antonino Nespolo, Stefano Carnatel, Silvio Abrate, Istituto Superiore Mario Boella, Italy

◆ We present record results for extended-reach 1-mm-SI-POF systems using equalization and 8-PAM to overcome POF bandwidth limitations. We experimentally demonstrate error-free transmission, 100Mbit/s over 200m links and reliable transmission after FEC over 275m links

9.6.6 10:00
1.25 Gbit/s Transmission over up to 100 m Standard 1 mm Step-Index Polymer Optical Fibre using FFE or DFE Equalisation schemes

Florian Breyer, Norbert Hanik, Munich University of Technology, Sebastian Randel, Siemens, Germany; Jeffrey Lee, University of Technology Eindhoven, The Netherlands

◆ 1.25 Gbit/s OOK-transmission over up to 100m SI-POF is demonstrated using digital symbol-spaced equalisers such as Feed-Forward-Equaliser, FFE and Decision-Feedback-Equaliser, DFE.

Session 10.1 **Hall 3**
Polarization Mode Dispersion

Chair: *Andrea Galtarossa, Universita' di Padova, Italy*

10.1.1 **10:45**
Location and temporal characterization of hinges in optical fiber links

Andrea Galtarossa, Daniele Grosso, Luca Palmieri, Luca Schenato, University of Padova, Italy
 ♦ A reflectometric technique for the location and characterization of hinges in PMD-affected optical fiber links is presented. Preliminary laboratory tests confirm the viability and effectiveness of the proposed method.

10.1.2 **11:00**
Fast measurement of local PMD with high spatial resolution using stimulated Brillouin scattering

Luc Thevenaz, Stella Foaleng Mafang, EPFL Swiss Federal Institute of Technology, Switzerland; Marc Nikles, Omnisens SA, Switzerland
 ♦ Local beat length with a 21.5cm spatial resolution is measured in one second along a single mode fiber using the polarisation dependence of stimulated Brillouin scattering, in a non-destructive and simple way.

10.1.3 **11:15**
Distributed Birefringence Measurement in Optical Fibers with Ultra-High Spatial Resolution by Brillouin Gain Analysis

Yoshinori Yamamoto, Sumitomo Electric Industries, Ltd., Japan
 ♦ Distributed birefringence measurement in optical fibers with ultra-high resolution of a few centimeters is proposed and demonstrated by Brillouin gain analysis with the optical correlation method. Local changes of polarization axes can also be detected.

10.1.4 **11:30**
The role of birefringence correlation in spun fiber PMD properties

Andrea Galtarossa, Luca Palmieri, Luca Schenato, University of Padova, Italy
 ♦ We show that the autocorrelation function of fiber birefringence may play a crucial role in the definition of spun fiber PMD properties, to the extend that for certain autocorrelation the spin may even increase PMD.

10.1.5 **11:45**
Novel Technique for PMD Measurements of Installed Fibers Using Random Polarization Scrambling and a Tunable OTDR

Hongxin Chen, Normand Cyr, Gregory Schinn, Bernard Ruchet, Michel Leclerc, EXFO Electro-Optical Engineering Inc., Canada
 ♦ A novel field-practical technique for single-end PMD measurement in an optical fiber, based on randomly-polarized launched and detected light pulses, is significantly less sensitive to cable movement and offers improved measurement precision.

10.1.6 **12:00**
The effect of polarization mode dispersion on gain and delay spectra of Raman assisted narrow band fiber parametric amplifiers

Gadi Eisenstein, Amnon Willinger, Evgeny Shumakher, Technion Institute of Technology,
 ♦ We describe the influence of birefringence on the spectral shapes of both gain and delay in a narrow band optical parametric amplifier, based on a novel vector model which accounts for most nonlinear interaction mechanisms.

10.1.7 **12:15**
Analysis of Birefringence Effect in Long Period Gratings through Measurements of Chromatic and Polarization Mode Dispersions

Sébastien Bette, Christophe Caucheteur, Marc Wuilpart, Patrice Mégret, Faculté Polytechnique de Mons, F.P.M.s, Belgium; Raimundo Garcia-Olcina, Salvador Sales, Jose Capmany, Universidad Politécnica de Valencia, Spain
 ♦ We model the relationship that exists between the chromatic dispersion and differential group delay in LPG. Our theory, confirmed by experimental results, gives a deeper knowledge of birefringent LPG properties which are complex to model.

Session 10.2 **Roofgarden**
Nonlinear Fiber Optics

Chair: *Lars Gruner Nielsen, OFS Fitel Denmark, Denmark*

10.2.1 **10:45**
Tutorial: Nonlinear Fiber Optics: New Fibers - New Opportunities

John Dudley, Université de Franche-Comté, France
 ♦ Research in nonlinear fiber optics is currently undergoing dramatic expansion, motivated by advances and developments in new classes of optical fiber and the ready availability of a wide range of optical pump sources.

This Tutorial will survey selected recent work in this field that has investigated novel nonlinear propagation effects in both photonic crystal and highly nonlinear optical fibers.

Topics of a fundamental nature that will be covered will include the physics of supercontinuum generation, the self-similar evolution of ultrashort pulses in optical fiber amplifiers, linear and nonlinear pulse compression, and recent predictions concerning carrier dynamical effects in optical nanowires. Emphasis will be placed on stability and coherence issues, particularly for applications around 1550 nm. A survey will also be given of recent applications of novel fibers in a systems context, the many applications of broadband supercontinuum generation, and the development of functional nonlinear photonic devices.

10.2.2 **11:45**
Enhance Kerr Non-linearity in Sub-wavelength Diameter As₂Se₃ Chalcogenide Fibre Tapers

Eric Magi, Libin Fu, Dong-il Yeom, Hong Nguyen, University of Sydney, Benjamin Eggleton, University of Physics, Australia
 ♦ We experimentally demonstrate enhanced Kerr non-linear effects in tapered highly non-linear As₂Se₃ chalcogenide fibre with 1.2 µm waist diameter. We observe enhanced non-linearity of 68.4 W⁻¹m⁻¹, which is 45, 000 times larger than standard silica single-mode fibre.

10.2.3 **12:00**
A low-threshold all-Fiber 1000nm-band supercontinuum source

Thibaut Sylvestre, FEMTO-ST Institute University of franche-comte, France
 ♦ We demonstrate a low-threshold all-fiber compact supercontinuum source with a nearly flat band from 1.1µm to 2.1µm based on a Q-switched fiber laser and a nonlinear dispersion-shifted fiber.

10.2.4 **12:15**
All-Optical Half-Adder by Using a Single-Stage Optical Parametric Amplifier

David Lai, Edmond Lin, Kenneth Wong, The University of Hong Kong
 ♦ An all-optical half-adder has been successfully demonstrated using cross gain modulation, XGM and four-wave mixing, FWM in an optical parametric amplifier, OPA on a highly-nonlinear dispersion-shifted fiber. Power penalty of less than 2dB was achieved.

Session 10.3 **Hall 4/5**
Modulators

Chair: *Guang-Hua Duan, Alcatel Thales III-V Lab, France*

10.3.1 **10:45**
Invited: 80-Gbit/s InP DQPSK modulator with an n-p-i-n structure

Nobuhiro Kikuchi, Hiroaki Sanjoh, Yasuo Shibata, Tomonari Sato, Ken Tsuzuki, Eiichi Yamada, Tadao Ishibashi, Hiroshi Yasaka, NTT Corporation, Japan
 ♦ We developed an InP DQPSK modulator with a newly designed n-p-i-n structure. Operation at 80 Gbit/s was achieved with a low driving voltage of 3 Vpp. The chip size is only 7.5 mm x 1.3 mm.

10.3.2 **11:15**
Demonstration of 10 Gb/s C+L band InP-based Mach-Zehnder Modulator

Mads Nielsen, Kiyotaka Tsuruoka, Tomoaki Kato, T. Morimoto, Shinya Sudo, Takeshi Okamoto, Kenji Mizutani, Kenji Sato, Koji Kudo, NEC Corporation, Japan
 ♦ We present a 10 Gb/s InP-based Mach-Zehnder Modulator with Ru-doped buried hetero-structure waveguides. C and L band operation is demonstrated, including transmission over 103 km of SMF for 1528-1600 nm.

10.3.3 **11:30**
Single MZI-based 1x4 DQPSK demodulator

Manabu Oguma, Yusuke Nasu, Hiroshi Takahashi, Hiroto Kawakami, Eiji Yoshida, NTT Corporation, Japan
 ♦ We present a newly developed planar lightwave circuit, PLC type 1x4 DQPSK demodulator, which has simply designed 90°-hybrid. We also demonstrate a low insertion loss and excellent 43 Gbps demodulation characteristics.

10.3.4 **11:45**
Low-drive-voltage and compact RZ-DQPSK LiNbO₃ Modulator

Masaki Sugiyama, Masaharu Doi, Tetsu Hasegawa, Takashi Shiraishi, Kazuhiro Tanaka, Fujitsu Laboratories Ltd., Japan
 ♦ Integrated RZ-DQPSK modulator was for the first time developed with small bend radius and low-loss U-turn optical waveguide. It achieved low-drive-voltage: 3.5V for DQPSK modulator and 1.5V for RZ pulse carrier.

10.3.5 **12:00**
Low chirp QPSK modulator integrated in poled Z-cut LiNbO₃ substrate for 2 x MultiGb/s transmission

Henri Porte, Jerome Hauden, Nicolas Grossard, Pascal Mollier, Photline Technologies, France; Selwan Ibrahim, Reinhold Noé, University of Paderborn, Germany
 ♦ We report a QPSK modulator realized in Zcut lithium niobate crystal. The chirp is cancelled out by ferroelectric domain inversion. The halfwave voltage of 4.7V is 1V smaller than the one of Xcut modulators

10.3.6 **12:15**
High modulation bandwidth reflective SOA for optical access networks

Romain Brenot, Alcatel-Thales III-V Lab, France
 ♦ We have demonstrated that the use of a two electrodes configuration drastically improves the modulation bandwidth of Reflective SOA from 2 to 6 GHz

Lunch Break 12:30 - 14:00

Post Deadline Sessions 14:00 - 15:45

Post-Deadline Session 1

Post-Deadline Session 2

Post-Deadline Session 3

Closing Session 15:45 - 16:00 – Hall 3

Session 10.4 **Hall 7**
40 Gbit/s Systems

Chair: *Christophe Peucheret, Technical University of Denmark, Denmark*

10.4.1 **10:45**
Invited: Digital Coherent Receivers for Uncompensated 42.8Gbit/s Transmission over High PMD Fibre
Seb Savory, Vitaly Mikhailov, Robert Killey, Polina Bayvel, University College London, United Kingdom
 ♦ We outline the principles behind digital coherent receivers and report simultaneous compensation of 53, 712ps/nm chromatic dispersion from 3200km of SMF and a mean DGD up to 186ps using 42.8Gbit/s PDM-QPSK with a digital coherent receiver

10.4.2 **11:15**
Investigation of single channel nonlinear impairments on 40Gb/s coherent Polarization Division Multiplexed QPSK in dispersion managed or digitally post compensated systems
Massimiliano Salsi, University of Parma, Italy; Renaudier Jérémie, Gabriel Charlet, Oriol Bertran Pardo, Patrice Tran, Sebastien Bigo, Alcatel-Lucent France Research & Innovation, France
 ♦ The nonlinear tolerance of 40Gb/s coherent PDM-QPSK is investigated. Inline dispersion managed systems show better performance than digitally post compensated systems, and can be further improved by 1dB with digital mitigation of nonlinear phase distortions.

10.4.3 **11:30**
Impact of Inter-Channel Nonlinearities on 10-Gbaud NRZ-DQPSK WDM Transmission over Raman Amplified NZDSF Spans
Chongjin Xie, Sethumadhavan Chandrasekhar, Xiang Liu, Bell Labs, Alcatel-Lucent, USA
 ♦ We show that inter-channel cross-phase modulation, XPM significantly reduces the performance of a 10-Gbaud differential-quadrature-phase-shift-keying, DQPSK WDM transmission system, and nonlinear polarization scattering causes further performance degradation when polarization division multiplexing is applied.

10.4.4 **11:45**
Dispersion Map Suitable for Hybrid 10 Gb/s NRZ and 40 Gb/s RZ-DQPSK Transmission over 50 GHz-Spaced Network with Low Dispersion Fibre
Kentarou Nakamura, Masahiro Yuki, Akira Miura, Takeshi Hoshida, Hiroki Ooi, George Ishikawa, Takafumi Terahara, Hiroshi Onaka, Fujitsu Laboratories Ltd., Japan; Olga Vassilieva, Fujitsu Laboratories of America, Inc., USA
 ♦ We propose a dispersion compensation strategy that enables smooth migration from low-initial cost, with 10Gb/s NRZ to high ultimate capacity, with 40Gb/s RZ-DQPSK for 50 GHz-spaced photonic networks, and demonstrate transmission reach beyond 1350 km.

10.4.5 **12:00**
Equalized 42.8 Gb/s Transmission Based on a 10Gb/s EML Transmitter
Nikola Alic, Evgeny Myslivets, James Coles, Robert Saperstein, Joshua Windmiller, Stojan Radic, Rui Jiang, University of California San Diego, USA; Paul Firth, Christopher Clarke, Bookham Technology plc, United Kingdom
 ♦ A low cost 10 Gb/s electro-absorption modulated laser was directly driven by 42.8Gb/s data stream and matched by electronic equalization performed at the receiver to achieve OC-768 transmission.

10.4.6 **12:15**
Chirp-Managed 42.8 Gbit/s Transmission over 20 km Standard SMF without DCF Using Directly Modulated Laser
Philip Ji, Jianjun Yu, Ting Wang, NEC Laboratories America, Inc., USA; Zhensheng Jia, Georgia Institute of Technology, USA; Xueyan Zheng, Daniel Mahgerefteh, Finisar Corp, USA
 ♦ We demonstrate transmission at 42.8 Gbit/s over 20 km of standard single mode fiber at 1550 nm with BER smaller than 1x10⁻³ without dispersion compensation using a directly modulated chirp managed laser.

Session 10.5 **Hall 9**
Optical Network Systems

Chair: *Ken-Ichi Sato, School of Engineering - Nagoya University, Japan*

10.5.1 **10:45**
Invited: Enhancing the Capacity beyond Terabit per second for Transparent Optical Transport Network
Yutaka Miyamoto, Akihide Sano, Hirohji Masuda, Eiji Yoshida, Shigeki Aisawa, NTT Network Innovation Laboratories, Japan
 ♦ We review the recent challenges facing high-capacity transport technologies. Novel modulation formats, multiplexing schemes, and distributed amplification are described that show the feasibility of an over 10-Tbps-class OTN with the channel rate over 100 Gbps.

10.5.2 **11:15**
Simple Node Architectures for Concatenation of ROADM Rings
Kiyo Ishii, Hiroshi Hasegawa, Ken-Ichi Sato, University of Nagoya, Japan
 ♦ We propose simplified node architectures for connecting two ROADM rings. The necessary switch scale can be reduced, 50-90% compared to the conventional approach. A novel optical switching node architecture and the MUX/DEMUX are demonstrated.

10.5.3 **11:30**
Architecture and Performance of a Bidirectional OXC Based on Reversible Optical Switches with Reduced Complexity
Yongmin Qi, Weisheng Hu, Yi Dong, Xinyu Xu, Hao He, Yaohui Jin, Guo Wei, Weiqiang Sun, Shilin Xiao, Yikai Su, Shanghai Jiao Tong University, P.R. China; Wen-De Zhong, Nanyang Technological University, Singapore
 ♦ By exploiting the symmetry of bidirectional wavelength-connections in WDM networks, we propose NxN bidirectional OXCs using one N/2xN/2 reversible optical switch to reduce the complexity of OXCs. The feasibility is demonstrated at 10 Gb/s.

10.5.4 **11:45**
Demonstration of Contention Resolution and 100 km Transmission for IP/10GbE over 80 Gbit/s, 8? x 10 Gbit/s Colored Optical Packet Switching Network using 160 Gbit/s Throughput Optical Packet
Hideaki Furukawa, Naoya Wada, Hiroaki Harai, Yoshinari Awaji, Makoto Naruse, Hideki Otsuki, Tetsuya Miyazaki, NICT, Katsuya Ikezawa, Akira Toyama, Naoki Itou, Hiroshi Shimizu, Yokogawa Electric Co., Hiroshi Fujinuma, Hatsushi Iizuka, NTT Electronics Co., Japan; Eddie Kong, Amonics Ltd., Hong Kong
 ♦ Contention resolution and 100 km transmission of 80, 8? x 10 Gbit/s colored-optical-packets encapsulating IP packets with packet-loss-rate of less than 10⁻⁶ have been demonstrated by IP/optical-packet converters, optical fiber-delay-line buffers, and transient-response-suppressed EDFAs.

10.5.5 **12:00**
100Gbit/s packet generation with spectral efficiency larger than 1bit/Hz/s by using optical carrier suppression and separation and vestigial sideband filtering techniques
Jianjun Yu, Lei Xu, Philip Ji, Ting Wang, NEC Labs America, Qimin Yang, HMC, Zhensheng Jia, Gee-Kung Chang, Georgia Institute of Technology, USA
 ♦ We have experimentally demonstrated how to generate 100Gbit/s packet signals with spectral efficiency higher than 1bit/Hz/s for the first time. The performances of transmission and label erasure have also been evaluated.

10.5.6 **12:15**
Demonstration of Modified Hadamard Codes for OCDM-based Confidentiality
Anjali Agarwal, Ronald Menendez, Paul Toliver, Janet Jackel, Shahab Etemad, Telcordia Technologies, USA
 ♦ We implement novel orthogonal codes using a complex monomial matrix transformation on the conventional Hadamard codes for a spectral phase-encoded OCDM system. The resulting exponentially larger code space is invaluable for potentially enhancing data confidentiality.

Session 10.6 **Hall 10**
Networks for Broadband Services

Chair: *Naoto Yoshimoto, NTT Access Network Service Systems Laboratories, Japan*

10.6.1 **10:45**
Invited: Optical networks for broadband fixed and mobile services
Masatoshi Suzuki, KDDI R&D Laboratories, Japan
 ♦ Optical network technologies from access to core for fixed and mobile broadband services are presented. Network management for multi-layer networks, resource management, and 100Gbit/s transport technologies for advanced high-quality network services are also presented.

10.6.2 **11:15**
End-to-end synchronous digital television distribution using IP multicast and RF overlay hybrid techniques
Ryo Inohara, Yukio Horiuchi, KDDI R&D Laboratories Inc., Japan
 ♦ Digital television signal distribution over IP and RF overlay GE-PON networks was successfully demonstrated. Extraordinary end-to-end synchronization with IP packet jitter suppression and precise clock-recovery for OFDM television signals is confirmed.

10.6.3 **11:30**
Temporal-Domain Diversity Reception with Improved Link Reliability for Optical Wireless Access Networks
Chi Hang Kwok, Richard Penty, Ian White, University of Cambridge, United Kingdom
 ♦ We experimentally demonstrate a simple temporal-domain diversity-reception scheme to enhance the reliability of optical wireless transmission links with atmospheric turbulence effects. Link outage probability for a 1.25-Gb/s link using Manchester encoding is reduced by >96%.

10.6.4 **11:45**
A Novel WDM-PON Using Simultaneously Generated DPSK and OOK Centralized Lightwaves for Future Multi-Services in Access Networks
Ming-Fang Huang, Hung-Chang Chien, Chowdhury Arshad, Zhensheng Jia, Georgia Tech, USA; Jianjun Yu, NEC Labs America, USA; Jyehong Chen, National Chung Cheng University, Taiwan; Sien Chi, Yuan Ze University, Taiwan; Gee-Kung Chang, Georgia Tech, USA
 ♦ We proposed and experimentally demonstrated a novel multi-services WDM-PON system by using centralized lightwave sources. The service provision with 10Gb/s OOK and DPSK downstream signals and 1.25Gb/s upstream data has been successfully realized.

10.6.5 **12:00**
A WDM-PON Architecture with Selective-Broadcast Overlay
Ning Deng, Chun-Kit Chan, Lian-Kuan Chen, Chinlon Lin, The Chinese University of Hong Kong
 ♦ We propose and demonstrate a novel WDM-PON architecture supporting both point-to-point service and selective broadcasting. For each channel, the same light source is utilized to carry the two downstream services and the upstream re-modulated data.

10.6.6 **12:15**
A Scalable All-optical VPN in Multiple PONs with a Two-stage TDM-WDM Architecture
Yue Tian, Tong Ye, Yikai Su, Shanghai Jiao Tong University, P.R. China; Lufeng Leng, New York City College of Technology, USA
 ♦ We demonstrate optical VPN among different PONs using ASK/FSK format. The scalability is enhanced by using a bidirectional amplifier at the OLT and the FSK format combined with low-loss FBG reflectors for VPN traffic.

Lunch Break 12:30 - 14:00

Post Deadline Sessions 14:00 - 15:45

Post-Deadline Session 4

Closing Session 15:45 - 16:00 – Hall 3

GENERAL INFORMATION

ECOC 2007 WEBSITE

www.ecoc2007.de

ECOC 2007 CONFERENCE VENUE

ICC International Congress Center
Messedamm 22
14055 Berlin
Germany

Phone: +49-(0)30-3038-3000
Fax: +49-(0)30-3038-3283
E-mail: central@messe-berlin.de
Homepage: www.messe-berlin.com

ECOC 2007 Conference Organisers

For detailed information please contact:

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Homepage: www.ecoc2007.de

ECOC 2007 Exhibition Organisers

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Fax: +44 (0)1322 616350
E-mail: beverley.lucas@nexusmedia.com
Homepage: www.ecocexhibition.com

On-Site Counter - Office Hours

The registration counter is located in the Foyer of the ICC.

Phone: +49-(0)30- 3038-82001
Fax: +49-(0)30- 3038-82002
E-mail: vde-conferences@vde.com

The registration desk on-site will be open as follows:

Saturday, Sep 15	16:00 h - 18:00 h
Sunday, Sep 16	08:00 h - 18:00 h
Monday, Sep 17	08:00 h - 18:00 h
Tuesday, Sep 18	08:00 h - 18:00 h
Wednesday, Sep 19	08:00 h - 18:00 h
Thursday, Sep 20	08:00 h - 16:00 h

CONFERENCE REGISTRATION ON-SITE

To register for ECOC 2007 please fill in the registration form layed out at the registration desk. Full cash payment or credit card information must accompany all registrations in order to be accepted.

REGISTRATION FEES

Member* (VDE, EUREL, IEEE)	<input type="checkbox"/>	EUR 695,-
Non-member	<input type="checkbox"/>	EUR 765,-
Student**	<input type="checkbox"/>	EUR 350,-
Workshop only	<input type="checkbox"/>	EUR 100,-
Additional Conference proceedings	<input type="checkbox"/>	EUR 70,-
Ticket for the Conference Dinner***	<input type="checkbox"/>	EUR 110,-
Ticket for the Historical Train***		free
Get Together on Sunday, Sept. 16		free
Welcome Reception on Monday, Sept. 17		free

* Participants applying for the membership fee must present their membership card at the registration counter.

** A student's certification form has to be endorsed by a supervisor or head of department and the student card must be presented at the registration counter.

Presenting authors, co-authors, committee members and session chairs are not exempted from paying registration fees.

*** Upon availability only. Tickets for the train are only possible in conjunction with the booking of the Conference Dinner Ticket

Regular Conference Registration and Student Registration

Include admission to all plenary and technical sessions, to the exhibition and Poster Sessions, the coffee-breaks, one Copy of the proceedings, the conference welcome reception on Monday, September 17 at the ICC.

The conference dinner on Wednesday, September 19, at the Technical Museum in Berlin, requires a separate registration and is not included in the registration fees.

Lunches are not included in the Conference registration fees. You can find a list of Restaurants on page 47.

PAYMENT

Payment for registration must be made in EURO. The conference fee has to be fully paid in advance.

The following methods of payment are accepted:

- By credit card authorisation
- Cash payment on-site in EURO (€)

BADGES

Delegates will receive badges and vouchers for the booked events. Participants are kindly requested to wear their badge throughout the conference, even at social events. Lost badges will not be replaced. A new registration will be mandatory.

CANCELLATION

In the case of cancellation after August 10, 2007 or no show no refund will be made. Proceedings and CD-ROM will be sent to the registrant after the Conference.

PROCEEDINGS

All accepted papers will be published in the printed and electronic proceedings and will be provided to the conference delegates.

The Post-Deadline proceedings including a CD-ROM and the printed copy will be given out to the delegates on the last day of the conference in return of the conference evaluation form which will be included in the conference back bags.

Additional proceedings will be on sale during the conference (upon availability) at EURO 70,- and 30,- for the Post-Deadline Papers.

BUSINESS CENTER

At the main Foyer at the ICC a business center is on service daily from 9:00 to 16:00 h. Phone, Fax, Internet Access, Printing Services are available at moderate rates.

INTERNET – WLAN

WLAN access will be provided in the ICC. A specific voucher with free access codes (sponsored by Deutsche Telekom) will be delivered as a part of the conference materials in the delegates conference bags.

HOTEL RESERVATION / Official Travel Agency

Hotel accommodation throughout Berlin may be booked through the official travel agency CTI Compass Tours, which is present at the registration counter on-site during the office hours.

CTI Compass Tours
Schicklerstraße 5-7
10179 Berlin / Germany
Phone +49-(0)30-201-0969
Fax +49-(0)30-204-4022
E-mail: berlin@compasstours.de
Homepage: www.compasstours.de

Further hotels of all rates are also available on the official web-site of Berlin at www.berlin.de/english/accommodation/index.html

HOTEL BOOKING CONDITIONS

Change of reservation and cancellation

Please make your reservations, changes and cancellations directly with CTI Compass Tours or your chosen hotel.

Payment

All payments related to accommodation have to be made directly at departure in the hotel. In any case a credit card is required for guaranteed booking, otherwise no booking confirmation will be returned.

MESSAGES

Messages for delegates may be sent to the registration counter on-site:

Phone: +49-(0)30-3038-82001
Fax: +49-(0)30-3038-82002
or by e-mail: vde-conferences@vde.com

All messages received will be displayed on a message board at the conference meeting point.

TRANSPORT

By air:

Berlin Airports (Tegel, Tempelhof and Schönefeld) allow direct access from all major national and international airports. Taxi to the ICC from the various airports to the city takes about 15 minutes (Tegel), 30 minutes (Tempelhof) or 60 Minutes (Schönefeld). Next airport to the conference site is Tegel.

By train:

From Frankfurt ≈ 4 hours
From Munich ≈ 6 hours
From Hamburg ≈ 2 hours
From Stuttgart ≈ 6 hours

For more information on the transport network system of Berlin please see www.bvg.de

Access by Car:

Autobahn (Highway) A 100/115/E51 exit "Dreieck Funkturm"

PARKING

Daily rate 7,50 EURO at the garage below the conference venue.

SOCIAL PROGRAM

- **Get Together Reception, Sunday 16, 18:00 - 19:30**

The ECOC Get Together Reception will take place at the ICC Berlin in the "Roofgarden"
Delegates of the Sunday Workshops and Conference Delegates are welcome to this reception.

- **Welcome Reception, Monday 17, 19:00 - 21:00**

The ECOC Welcome Reception will take place at the ICC Berlin in the Main Lobby.

The Welcome Reception is open to all ECOC conference delegates.

The Exhibitors or visitors of the exhibition can also buy tickets for a price of 15,- EUR to attend this event, and have the opportunity to meet and discuss with the conference delegates.

- **Conference Dinner, Wednesday 19, 19:30 - 23:00**

The Conference Dinner will take place in the famous German Museum of Technology (Deutsches Technikmuseum Berlin)

- Departure at 18:30 from the ICC with the Historical Train (since the capacity of the train and the Museum of Technology is limited, the access to the train and the Conference Dinner is only for the holders of the prebooked tickets). For those who do not have tickets for the Train, it is possible to take the U-Bahn No. 2 (Underground) from the U-Bahn Station Kaiserdamm (nearest U-Bahn station to the ICC) direction Pankow, and exit at "Gleis-dreieck", from there it is 3 min walk. This is free of charge for the delegates using the CongressCard-tickets (see page 46).

The German Museum of Technology in Berlin retraces the German Cultural history of transport, communication, production and energy techniques on more than 20,000 m². The Museum contains Exhibition on inland navigation and deep-sea shipping, one of the largest collections of rail transport in historic engine sheds, vintage car depot with 70 cars and motorbikes plus museum park with brewery and mills. Since 2005, the new permanent exhibition on aviation and space flight can also be visited.

Address: Trebbiner Straße 9, 10963 Berlin

Phone: 030/902 54-0, Fax 902 54-175

www.dtmb.de, info@dtmb.de

- **Sightseeing in Berlin: The Agency "Zeitreisen" proposes the following tours:**

1. Old and New Berlin: City Tour by bus
2. Videobustour: The Time Travel Shuttle
3. Boat-Trip: Berlin by the Water
4. Magic of the Backyards
5. Jewish Berlin: Yesterday and Today
6. Cooking Event: New Berlin Cuisine
7. City of Design
8. World Cultural Heritage: The Isle of Museums
9. Movies made in Berlin: The Cinema on Wheels

For reservation of these tours or for price information please contact directly the Agency:

Zeitreisen - Veranstaltungs- und Projektmanagement

Unter den Linden 40

10117 Berlin

Phone: +49-30/44024450

Fax: +49-30/44024448

E-mail: ak@zeit-reisen.de

Homepage: www.zeit-reisen.de

CongressCard Berlin

All delegates will receive a CongressCard including a transport ticket which offers 72 hours of free travel within the A, B, and C Berlin fare zones of the Berlin public transport networks (excluding tours and special lines).

The CongressCard offers you discounts on city tours, boat trips, museums, theaters, restaurants, wellness and selected shops or stores. The CongressCard is valid only together with your ticket for 3 successive days after the ticket has been validated.

DESTINATION BERLIN - CITY MAP

A selection of touristic and Cultural highlights in Berlin are listed on the city map inserted in the conference back bag. For individual questions please contact the travel agency CTI at the registration counter.

WEATHER

Moderate temperatures may be expected in September. But occasional rain is not uncommon during this period. Therefore a jacket or sweater and an umbrella is recommended especially for the evenings.

INSURANCE

The organisers may not be held responsible for any injury to participants or damage, theft and loss of personal belongings. Participants should therefore make their own insurance arrangements.

SHOPPING

Most shops are located in the area around the Friedrichstraße (Eastern part of Berlin) and Kurfürstendamm (Western part of Berlin). The elegant boulevards invite to shop and stroll through their boutiques and noble warehouses. You will find exquisite shops as well on the legendary avenue "Unter den Linden". Usually, shops are open from Monday to Saturday 9:00 h - 20:00 h. Shops are generally closed on Sunday.

CURRENCY

The official currency in Germany is the Euro (€). Usual credit cards (Mastercard, American Express, VISA) are accepted in hotels, department stores and restaurants. Currently (August 2007) the exchange rate is approx. 1 EURO = 1,36 U\$.

ELECTRICITY

Power supply is 230 V AC, 50 Hz.

EMERGENCY SERVICES

Police	call 110
Ambulance/ Fire Brigade	call 112

LUNCH SERVICES AND RESTAURANTS AROUND ICC

Small lunches or sandwiches are on sale from the booth in the foyer of ICC and the restaurants listed below:

Restaurants around the ICC Berlin

Romiosini am ICC (just over the railway bridge)
Greek Restaurant (approx. 5 min walk)

Neue Kantstr. 17, 14057 Berlin
Phone: 030 10 55 06

La Pergola (just over the railway bridge)
Pizzeria (approx. 6 min walk)

Neue Kantstr. 19, 14057 Berlin
Phone: 0321 24 30

Asado am ICC (in front of ICC, through the passerelle)
Argentinian Steakhaus (approx. 5 min walk)

Messedamm 10, 14057 Berlin
Phone: 0301 60 38

Panda (in front of ICC, through the passerelle)
Chinese Restaurant (approx. 5 min walk)

Messedamm 10, 14057 Berlin
Tel. 30 16 033

Bistro - Bredow
Internat. Cuisine (approx. 10-12 min walk)

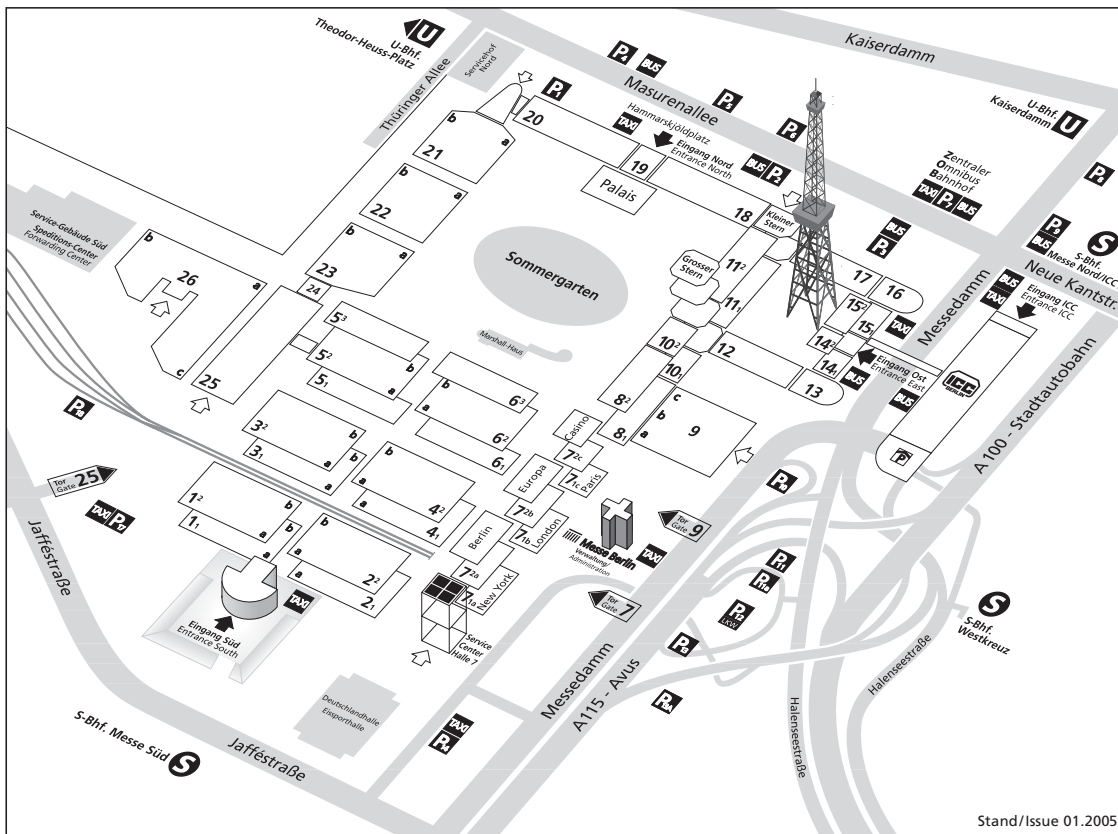
Kaiserdamm 80/81, 14057 Berlin
Phone: 030 39 54 60



SON DO - Chinese Restaurant
Vegetarian (approx. 10-12 min walk)

Kaiserdamm 32, 14057 Berlin
Phone: 0302 49 55

Döner Imbiss (over the railway bridge)
Near the ICC

Map of ICC Environments



-  Haupteingänge / Main entrances
-  Bedarfseingänge / Reserve entrances

NOTES

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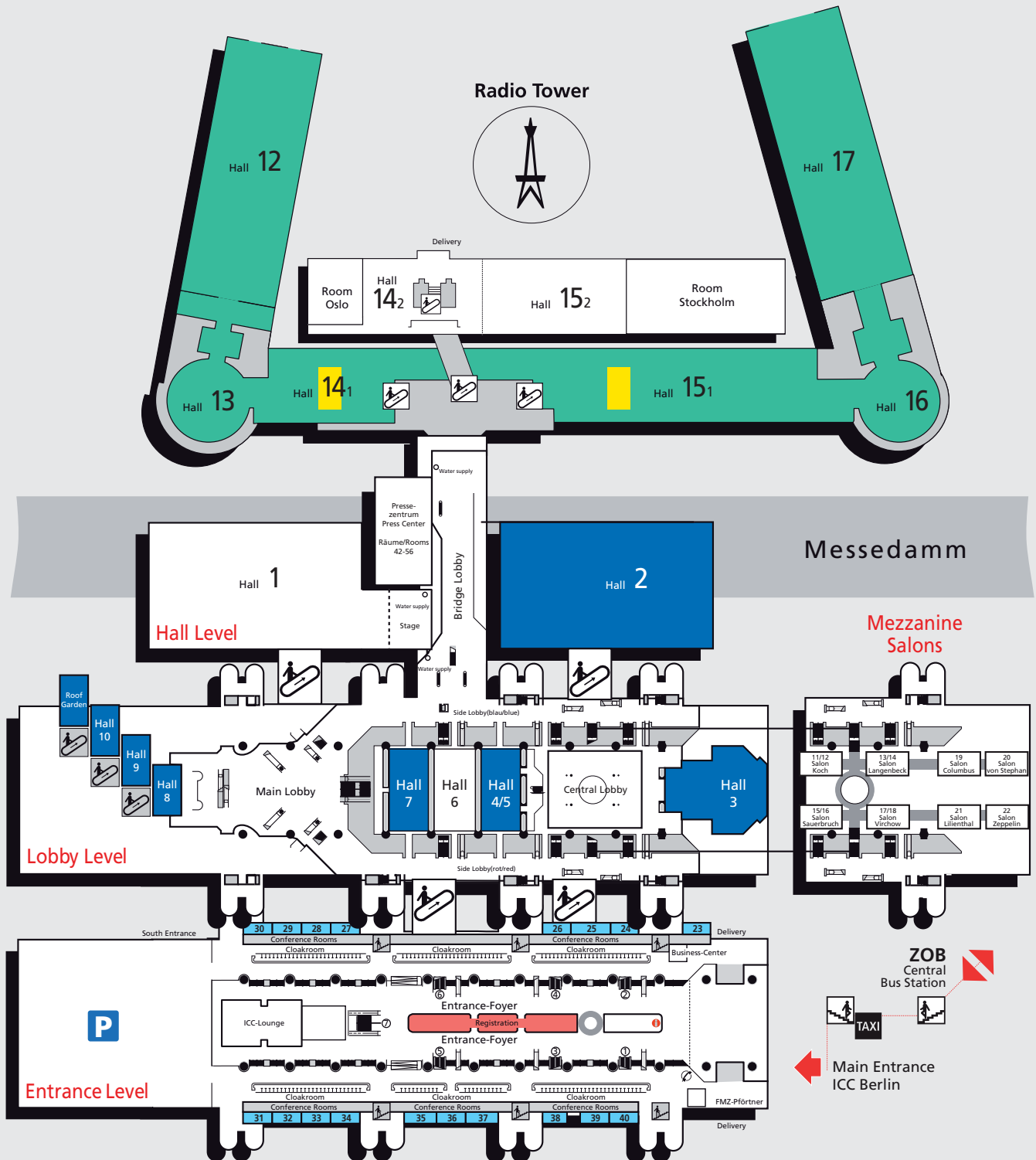
NOTES

Saturday, September 15							
16:00 - 18:00	Registration						
Sunday, September 16							
08:00 - 18:00	Registration						
	Hall 3	Roofgarden	Hall 4/5	Hall 7	Hall 8	Hall 9	Hall 10
09:00 - 13:00			Workshop 1 100 Gigabit Ethernet for Carrier-Class Transport Networks	Workshop 2 Quantum Dots : The Ultimate Frontier	Workshop 3 Global Interoperability in Multi-Domain and Multi-Layer ASON/GMPLS Networks	Workshop 4 Future Internet Design	
13:00 - 14:00	Lunch break						
14:00 - 18:00			Workshop 5 Electronic Signal Processing for Transmission Impairment Mitigation: Future Challenges	Workshop 6 Silicon Photonics in Telecom/Datacom: from Basic Research to Industrial Deployment	Workshop 7 Networks for IT: A new Opportunity for Optical Network Technologies	Workshop 8 Operation Expenditures (OpEx) Studies	Workshop 9 High Data Rate Transmission (40 Gbit/s) on Legacy Networks' Fibre Infrastructure with Significant PMD
18:00 - 19:30	Get Together Reception (ICC Roofgarden)						
Monday, September 17							
08:00 - 18:00	Registration						
10:00 - 12:30	Opening Ceremony and Plenary Session Hall 2						
12:30 - 14:00	Lunch break						
	Hall 3	Roofgarden	Hall 4/5	Hall 7	Hall 9	Hall 10	
14:00 - 15:45	Session 1.1 Symposium on Broadband Access Technologies	Session 1.2 Silicon Photonics	Session 1.3 High Speed Transmission	Session 1.4 Fiber Lasers and Amplifiers I		Session 1.5 Fibers and Fiber Components	Session 1.6 Optical Burst Switching
15:45 - 16:15	Coffee break (will be served in the Delegates Coffee Area at the Exhibition)						
16:15 - 18:00	Session 2.1 Symposium on Broadband Access Technologies	Session 2.2 Forward Error Correction in Optical Communication Systems	Session 2.3 High Capacity Systems	Session 2.4 Fiber Lasers and Amplifiers II		Session 2.5 MUX/DEMUX and Waveguides	
19:00 - 21:00	Welcome Reception (ICC Main Lobby)						
Tuesday, September 18							
08:00 - 18:00	Registration						
	Hall 3	Roofgarden	Hall 4/5	Hall 7	Hall 9	Hall 10	
08:30 - 10:15	Session 3.1 Electronic Mitigation	Session 3.2 Ethernet/OLS	Session 3.3 Radio over Fibre	Session 3.4 All-Optical Signal Processing		Session 3.5 Signal Monitoring	Session 3.6 Measurement and Sensing
10:15 - 10:45	Coffee break (will be served in the Delegates Coffee Area at the Exhibition)						
10:45 - 12:30	Exhibition only						
12:30 - 14:00	Lunch break						
14:00 - 15:45	Session 4.1 POF Symposium	Session 4.2 OFDM I	Session 4.3 SOA-based Signal Processing	Session 4.4 Modules and Techniques for Access		Session 4.5 Fiber Devices for System Applications	Session 4.6 Optical Network Applications
15:45 - 16:15	Coffee break (will be served in the Delegates Coffee Area at the Exhibition)						
16:15 - 18:00	Session 5.1 POF Symposium	Session 5.2 OFDM II	Session 5.3 Fiber based Signal Processing	Session 5.4 Modulation Techniques and Multiple Access		Session 5.5 Photodiodes and Receivers	
Wednesday, September 19							
08:00 - 18:00	Registration						
	Hall 3	Roofgarden	Hall 4/5	Hall 7	Hall 9	Hall 10	
08:30 - 10:15	Session 6.1 Photonic Crystal Fibers I	Session 6.2 Advanced Modulation Formats	Session 6.3 Novel Integration Technology I	Session 6.4 WDM PONs		Session 6.5 Transport Testbeds	Session 6.6 Emerging Technologies
10:15 - 10:45	Coffee break (will be served in the Delegates Coffee Area at the Exhibition)						
10:45 - 12:30	Session 7.1 Photonic Crystal Fibers II	Session 7.2 Coherent Systems I	Session 7.3 Novel Integration Technology II	Session 7.4 Access Systems		Session 7.5 Network Design I	Session 7.6 Performance Improvement and Monitoring in PONs
12:30 - 14:00	Lunch break						
14:00 - 15:45	Session 8.1 VCSL and High-Speed Laser Modulations	Session 8.2 Slow Light	Session 8.3 Coherent Systems II	Session 8.4 Long Reach and High Capacity PONs		Session 8.5 Network Design II	Session 8.6 Quantum Dot Lasers and Amplifiers
15:45 - 16:15	Coffee break (will be served in the Main Lobby)						
16:15 - 18:00	Poster Session Central Lobby						
18:30	Departure Historical Train (prebooked places only)						
19:30 - 23:00	Conference Dinner (German Museum of Technology)						
Thursday, September 20							
08:00 - 16:00	Registration						
	Hall 3	Roofgarden	Hall 4/5	Hall 7	Hall 9	Hall 10	
08:30 - 10:15	Session 9.1 MLSE	Session 9.2 Semiconductor Lasers and Amplifiers	Session 9.3 Modulation Techniques	Session 9.4 Transmission Impairments and special Techniques		Session 9.5 Control Plane	Session 9.6 Multimode Fibre in Access Networks
10:15 - 10:45	Coffee break (will be served in the Main Lobby)						
10:45 - 12:30	Session 10.1 Polarization Mode Dispersion	Session 10.2 Nonlinear Fiber Optics	Session 10.3 Modulators	Session 10.4 40 Gbit/s Systems		Session 10.5 Optical Network Systems	Session 10.6 Networks for Broadband Services
12:30 - 14:00	Lunch break						
	Hall 3	Roofgarden	Hall 4/5	Hall 7			
14:00 - 15:45	Post Deadline Session 1	Post Deadline Session 2	Post Deadline Session 3	Post Deadline Session 4			
15:45 - 16:00	Closing Session Hall 3						

ECOC 2007

33rd European Conference and Exhibition on Optical Communication

September 16–20, 2007, Berlin, Germany



Registration / Conference / Meeting Rooms / Exhibition / Catering