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# TABLE OF CONTENTS

Welcome Message ........................................................................................................... 5

ECOC 2007 Committees .................................................................................................. 6

Symposia ............................................................................................................................ 9
  - BAT Symposium ........................................................................................................... 9, 16, 18
  - POF symposium ........................................................................................................ 9, 22, 24

Workshops ......................................................................................................................... 10
  - WS 1: 100 Gigabit Ethernet for Carrier-Class Transport Networks ......................... 10
  - WS 2: Quantum Dots: The Ultimate Frontier .............................................................. 10
  - WS 3: Global Interoperability in Multi-Domain and Multi-Layer ASON/GMPLS Networks ........................................................................................................... 11
  - WS 4: Future Internet Design ...................................................................................... 11
  - WS 6: Silicon Photonics in Telecom/Datacom: from Basic Research to Industrial Deployment ................................................................................................. 12
  - WS 7: Networks for IT: A new Opportunity for Optical Network Technologies .................. 13
  - WS 8: Operation Expenditures (OpEx) Studies ............................................................ 13
  - WS 9: High Data Rate Transmission (340 Gbit/s) on Legacy Networks' Fibre Infrastructure with Significant PMD ........................................................................... 13

Plenary Session ................................................................................................................ 14

Tutorials ............................................................................................................................... 16, 18, 20, 22, 26, 30, 40

Regular Sessions .............................................................................................................. 16
  - Monday ......................................................................................................................... 16
  - Tuesday ......................................................................................................................... 20
  - Wednesday .................................................................................................................... 26
  - Thursday ....................................................................................................................... 38

Poster Session .................................................................................................................. 32

Post-Deadline Sessions ..................................................................................................... 40

General Information ......................................................................................................... 42

Registration Information .................................................................................................. 43

Payment and Cancellation ................................................................................................. 43

Social Program .................................................................................................................. 45

Program Overview ............................................................................................................ 51

Conference Venue Map .................................................................................................... rear cover side
Welcome Address by ECOC 2007 Chairs

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. 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 Kirstädtter
Nokia Siemens Networks GmbH & Co. KG, Munich

Andreas Gladisch
T-Systems International GmbH, Berlin

Klaus Petermann
Technical University Berlin

Technical Program Co-Chairs
ECOC 2007 Conference General Chairs
Andreas Kirstädtter, Nokia Siemens Networks GmbH & Co. KG, Germany
Hans - Joachim Grallert, Fraunhofer Heinrich Hertz Institute, Germany

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Hans - Joachim Grallert, Fraunhofer-Heinrich-Hertz-Institute, Berlin, Germany
Andreas Kirstädtter, 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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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 Kirstädtter, Nokia Siemens Networks GmbH & Co. KG, Munich, Germany
David Payne, ORC - University of Southampton, UK
Jean-Claude Simon, ENSSAT / University of Rennes1, France
Carlo Giacomo Someda, 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
Tetsuhiko Ikegami, Ministry of Education, Culture, Sports, Science & Technology (MEXT), Japan
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 Lerniaux, 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 Hong Kong, Hong Kong

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

Sébastien Bigo, Alcatel-Lucent, France
José Capmany, Universidad Politècnica de Valencia, Spain
John Cartledge, Queens’ University, Kingston, Ontario, Canada
Ernesto Ciarapella, 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 Martinei, CORECOM, Italy
Masataka Nakazawa, University of Tohoku, Japan
Werner Rosenkranz, University of Kiel, Germany
William Shieh, University of Melbourne, Australia
Mark Shtaif, 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 Politécnica de Catalunya, 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
Geras 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

**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

**Quantum Dots : The Ultimate Frontier**

**Chairs:** Dieter Bimberg, Technische Universität Berlin, Germany
Marc Ilegems, 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 is 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

### Program

**Chair:** Marc Ilegems, EPFL Lausanne

09:00 - 09:10 **Opening**
Dieter Bimberg, TU Berlin

09:10 - 09:35 **Applications of Quantum Dot Semiconductor Optical Amplifiers at 1.3 µm**
Jörg Leuthold, Uni Karlsruhe

09:35 - 10:00 **Recent Progress in Quantum Dot Semiconductor Amplifiers at Long Wavelengths**
Tomoyuki Akiyama, Fujitsu Tokyo

10:00 - 10:25 **Quantum Dash Based Mode-Locked Lasers Emitting at 1.55 µm**
Abderrahim Ramdane, CNRS Marcoussis

10:25 - 10:50 **Progress and Challenges of GainNasSb for Optical Communication**
James Harris, Uni Stanford

10:50 - 11:20 **Coffee break**

**Chair:** Richard Penty, University Cambridge

11:20 - 11:45 **High Speed VCSELs for Optical Interconnects**
Nikolai Ledentsov, TU Berlin

11:45 - 12:10 **Qubits, Quantum Repeaters and Cryptography**
Mark Fox, Uni Sheffield

12:10 - 12:35 **Quantum Dot Devices for Quantum Communication**
Andrew Shields, Toshiba Cambridge

12:35 - 13:00 **Single Photon Emitters and Detectors for Quantum Communication**
Andrea Fiore, EPFL Lausanne

13:00 **Closing**

**Lunch Break 13:00 - 14:00**
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
Organisers

09:05 - 09:35 OIF Worldwide Interoperability Demonstration 2007 – Ethernet On-Demand Services enabled by OIF UNI and E-NNI Functions
Jim Jones

09:35 - 10:05 OIF Worldwide Interoperability Demonstration 2007 – Results and Findings of the Control Plane Interoperability Test
Jonathan Sadler

10:05 - 10:35 OIF Worldwide Interoperability Demonstration 2007 – Consideration from a Carrier's Perspective
Vishnu Shukla

10:35 - 11:00 Coffee Break

11:00 - 11:30 GMPLS – Current Status of Standardization Work
Tomohiro Otani

11:30 - 12:00 ASON – Current Status of Standardization Work
Bernd Zeuner

12:00 - 12:30 Application of ASON Multi-Domain Architecture to Internet2
Lyndon Ong

12:30 - 13:00 ASON/GMPLS based Interoperability and Interworking Solutions in the European MUP-BED Multi-Domain and Multi-Layer Test Network
Jan Spaeth

13:00 End
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. Bulow, Alcatel-Lucent

14:10 - 14:30 Moderate complexity equalizers for long-haul reach
N. Alik, 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. Waegemanns, 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
Michael Lipson, Cornell University

15:05 - 15:30 Making a Business out of Silicon Photonics
Jean-Louis Malinge, Kotoru

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  
**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, Wei Guo, Shanghai Jiao Tong University, China

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, 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

<table>
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<tr>
<th>Time</th>
<th>Session</th>
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| 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 networks  
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  
**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

<table>
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<tr>
<th>Time</th>
<th>Session</th>
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</table>
| 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. Casler, L. Van Halsewyck, S. Verbrugge, D. Coils, M. Pickavet, P. Demeester |
| 15:00 - 15:20 | Modeling of OpEx in network and service lifecycles  
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  
**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, Germany

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.

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**Get Together Reception (ICC Rooftop)**  
18:00 - 19:30
Monday, September 17 – 10:00 - 12:30

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.
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.

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 routes 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.

General Information on the Conference

Andreas Gladisch, T-Systems International GmbH, Germany
In this talk I will review the challenges and achievements in the field of Nanophotonics and present our recent results. Using highly confined photonic structures we have demonstrated ultra-compact and passive as well as 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.

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.

Coffee Break 15:45 - 16:15
1.4.1 Invited: High Control in High Power Fiber Lasers and Amplifiers
Yocehan 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 A 1/4-shifted Distributed Feedback Semiconductor Fiber Ring Laser with an OSNR of 85 dB and a Linewidth of 7 kHz
K. Sahu, J. Nilsson ORC, University of Southampton, United Kingdom
We propose and experimentally implement ultra-long fiber 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.

1.4.3 Simultaneous Spatial and Spectral Transparency Using Ultralong Fiber Laser Transmission Links
Juan Diego Anita-Castanón, Vassilios Karakekas, Paul Harper, Sergei Tunitsyn, Aston University, United Kingdom
We report on the fabrication and characterization of an ytterbium-doped Solid Core Photonic Bandgap Fiber. The bandgap losses observed on the waveband range above 1000 nm are used to favour laser operation in pulsed regime.

1.4.4 Improvement of Nonlinear Spectral Broadening on the Efficiency of Ultra-Long Raman Fiber Laser Transmission Links
Vassilios Karakekas, Juan Diego Anita-Castanón, Paul Harper, Vladimir Mezentsev, Sergei Tunitsyn, Aston University, United Kingdom; Sergey Babin, Evgenii Podvilkov, Institute of Automation and Electrometry, Russia
We study the impact of nonlinear spectral broadening in Raman fiber amplifiers up to a record length of 82 km, and its implications for the design of signal-lossless spans for signal transmission and processing.

1.4.5 Ytterbium-doped 2D Solid Core Photonic Bandgap Fiber Laser Operation at 980 nm
Laurent Bigot,Vincent Pureur, Géraud Bouwmans, Yves Harper, Sergei Turitsyn, Aston University, United Kingdom; Sergey Babin, Evgenii Harper, Vladimir Mezentsev, Sergei Turitsyn, Aston University, United Kingdom; Evgeny Dianov, Fiber Optics Research Center of Russia, Russia
We demonstrate on-demand application layer reservation over a fully-functional application-layer 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 signaling.

1.4.6 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, Yoshito Nakami, University of Tokyo, Tokyo, Japan; Kousuke Nishimura, Masashii Suzuki, KDDI R&D Laboratories Inc., Japan; Yutaka Takita, Yutaka Kai, Hiroshi Onaka, Fujitsu Limited, Hisato Uetukka, Hitachi Cable Ltd., Japan
We demonstrate deflection routing for random burst collision in a 3-node optical burst switching network. Tested with a 4-channel burst capable edge node, layer 2 characteristics are confirmed, with near-theoretical low frame error at 40Gb/s.

1.5.1 Invited: Recent Advances in Ultra-Compact Highly Nonlinear Fibers and Their Applications
Masanori Takahashi, Masateru Tadakuma, Jiro Hiroishi, Yu Mimura, Yuzi Sugaki, Takeshi Yagi, Furukawa Electric co., Ltd., Japan
We review design and characteristics of recently reported down-sized highly nonlinear fibers, HNLF's and ultra-compact HNLF modules. Furthermore, not only down-sizing, new attraction, application, is realized by utilizing unique mechanical characteristics of down-sized HNLF.

1.5.2 Fiber Ring Laser with an OSNR of 85 dB and a Linewidth of 7 kHz
We propose a 1/4-shifted DBF 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.

1.5.3 Large Aeff NSDF with Dispersion Slope of 0.02 ps/nm/km by utilizing Restrict-Mode-Excitation Method
Katsunori Imamura, Kazunori Mukasa, Masateru Tadakuma, Ryuichi Sugaki, Takeshi Yagi, Furukawa Electric co., Ltd., Japan
We newly propose a 1/4-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.

1.5.4 Large Aeff NSF's with Aeff larger than 65 µm² and dispersion slope of 0.02 ps/nm/km were successfully fabricated by utilizing Restrict Mode Excitation method. The pure single mode pulse transmission was experimentally confirmed.

1.5.5 Holographic Tailoring of Launch Profile for Mode Selection in a 50µm Core Diameter Multi-Mode Fibre
Pong Ling Ng, Ron 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 from 20% to 10% in full-width half-maximum.

1.5.6 Optical Hilbert Transform for Optical Single-sideband Modulation by using Sampled Fiber Bragg Grating based Optical Transversal Filter
Masanori Takahashi, Masateru Tadakuma, Katsunori Mukasa, Yuzi Sugaki, Takeshi Yagi, Furukawa Electric co., Ltd., Japan
The first implementation of an optical Hilbert transform for optical single-sideband modulation, by using sampled fiber Bragg grating, has been reported. The principle, design, and measured frequency/time responses have been shown.

1.6.1 Invited: Demonstration of a Fully Functional Optical Burst Switched Network with Application Layer Resource Reservation Capability
Gennaro Curran, Rino Nebajati, Yiyan Qin, Dimitra Simeonidou, Mike O’Mahony, University of Essex, United Kingdom; Aldo Campi, Franco Callegati, University di Bologna, Italy; Martin Reed, University of Essex, United Kingdom; Sivam Yu, University of Birstol, United Kingdom
We demonstrate on-demand application layer reservation over a fully-functional application-layer OBS testbed. This is achieved by hardware implementation and integration of application layer Session Initiation Protocol, SIP and the OBS Just-In-Time, JIT signaling.

1.6.2 A Novel Fault-Tolerant OBS Node Architecture with Resilient Buffers
Jing Zhang, University of California - Davis, USA; Lei Song, University of California, Davis; 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.

1.6.3 Bandwidth-Efficient Optical Burst-Switched Networks based on Traffic Engineering in the Wavelength Domain and Delayed Burst Scheduling
Jairo Pedro, Paulo Monteiro, Nokia Siemens Networks Portugal, João Pires, Instituto de Telecomunicacões, 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.

1.6.4 All-optical Latching Circuit controlled by a 2-bit All-optical Correlator
Jose M. Martinez Carret, Raquel Calvero Galindo, Javier Herrera Llorente, Francisco Ramos, Javier Martí, Universidad Politecnica de Valencia, Spain; Yong Liu, University of Electronic Science & Technology of China, P.R. China; Tom Koonen, Harm J.S. Dorem, COBRA, Eindhoven Univ. of Technology, The Netherlands
The routing functionality by all-optically interconnecting semiconductor-bridge logic gates and flip-flops is demonstrated in the frame of an all-optical label swapping network. High extraction ratios are obtained at the output of the flip-flop.

1.6.5 All-optical Node with Sequential Address Generation and Label Recognition
Ruth Van Caenegem, Didier Colle, Mario Pickavet, Piet Demester, Ghent University, Belgium
This paper proposes an all-optical counter, which is built out of MDI switches. Due to the counter, all-optical labels can be checked sequentially. A dimensionality study shows how it improves the AOLS node’s scalability.
2.1.2 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.

2.1.3 Infrastructure and Challenges for Convergence of Radio, Fiber and ADSL Technologies
Yuuto 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 broadband converged perspectives are also discussed.

2.1.4 Access Network Technologies: Deployments in Sweden
Claus F. Larsen, Ericsson Telecom AB, Sweden
Access-network technologies are discussed in the context of Swedish deployments. Sweden is characterized 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 Tutorial: Forward Error Correction in Optical Communication Systems
Takashi Mizuo, 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 NCQs 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 NCQ 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.

2.2.2 High Capacity Systems
Chair: Paul Harper, Aston University, United Kingdom

2.3.1 Invited: 8x107 Gbit/s Serial Binary NRZ/VSB Transmission over 480 km SSMF with 1bit/s/Hz
title="Efficiency and without Optical Equalizer, Karsten Schul, Eugen Lach, Bernhard Junginger, Axel Klekamp, Gustav Veitl, 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 Unrepeatered Transmission of 160 Gb/s RZ-DPSK over 240 km Dispersion Managed Fiber
Dariusz Ledochowski, Carsten Schnitzler-Lenglein, Colja Schubert, FH Heinrich-Hertz-Institut, Germany; Stefan Weisser, Lutz Raadatz, 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 unrepeatered distance of 240 km.

2.3.3 Bi-directional unrepeatered Transmission over 436 km using Third-order distributed Raman Amplification
E. Branton, P. Bousselet, I. Brylski, N. Tranvouez, D. Mongardin, Alcatel-Lucent, France
An error-free transmission experiment in bidirectional unrepeatered configuration over 436 km is reported. Particular attention has been paid to Rayleigh backscattering and distributed Raman amplification, enabling us to cover 17 dB span loss.

2.3.4 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 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 Leteiller, 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 Performance Assessment of DQPSK using Pseudo-Random Quadrature Sequences
Benhard 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.
Welcome Reception (ICC Main Lobby) 19:00 - 21:00
9:00 9:45
3.2 Performance Improvements of Different Modulation Formats by Applying Adaptive Electronic Equalisation in 43 Gbit/s Systems
Bernd Franz, Axel Klekamp, Detlef Roesener, Fred Buschi, Henning Bölow, Alcatel-Lucent, Germany
● The system tolerance improvements by analog electronic equalisation have been experimentally evaluated for different 43 Gbit/s modulation formats, PSBt, DPSK, DSBS. Up to 70% higher DGD and 60% higher CD tolerance has been achieved.

9:15 9:50
3.3 Enhancement of PMD tolerance in 43 Gbit/s RZ-DQPSK signal using electrical dispersion compensa-
tion without adaptive control
Eiji Yoshida, Hiroto Kawakami, Eiichi Yamada, Kikoazu Kubota, Yuuzou Miyagawa, Yutaka Miyamoto, NTT Network Innovation Laboratories, Tomofumi Furuta, Yoshinori Itoh, Kimikazu Sano, Koichi Murata, NTT Photonics Laboratories, Japan
● We describe the enlargement of PMD tolerance using EDC without adaptive control numerically and demonstra-
tively the effectiveness in a 43 Gbit/s RZ-DQPSK transmission experiment. The tolerance was extended to over 30 ps.

9:30 10:05
3.4 PMD Tolerance Enhancement by Adaptive Receiver for 43Gbit/s DPSK NRZ- and RZ-Modulation
Axel Klekamp, Bernd Franz, Henning Bölow, Alcatel-Lucent, Germany
● We compared experimentally PMD tolerances of adaptively equalising 43Gbit/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.

9:45 10:20
3.5 Performance of Electronic Pre-Distortion in 40-Gb/s Systems with Optical Dispersion Compensation for Different Modulation Formats and Transmission Fibres
Changmin 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 interchannel cross-phase-modulation for both on-off-keying and differential-phase-shift-keying.

10:00 10:35
3.6 Performance of Electronic Pre-distortion 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 80km of SSMF with <2dB penalty using 1 sample/bit DACs.

10:30 11:05
3.7 Complete Base Station Configuration for Fiber-Wireless Applications
Elaine Wong, Christine, Ka-Lun Lee, ARC Centre of Ultra Broadband Information Networks, Australia; Angelikiaga Prasanna, Thas Nimalathas, University of Membourne, Australia; Markus Ortsteif, Christian Neureumy, VENTILAS, GmbH, Germany
● We propose a technique to simplify base-station design using a VCSIL as an integrated reflector and transmitter for fiber-radio application. Results show it over fiber channels can be successfully added and droped from the fiber network.
**Session 3.4**

**Hall 7**

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

3.4.1 Invited: Ultra-compact optical buffers on a silicon chip
Yuri Vlasov, Fenqin Xia, Lidija Sekaric, William Green, Solihun Rosela, Michael Rooks, Shane McNab, IBM TJ Watson Research Center, USA

- We will review the latest results on development of silicon nanophotonic devices for on-chip interconnect with the focus on ultra-compact optical buffers.

3.4.2 10 Gb/s Optical Buffer Memory Using a Polarization Bistable VCSEL
Takashi Morii, Yuuki Sato, Hitoshi Kawaguchi, QREST-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 laser output.

3.4.3 A 160 Gb/s to 10 Gb/s DEMUX operation by Mach-Zehnder Interferometric Intersubband Ultrafast All-Optical Switch
Ryoshi Akimoto, Takasi Simoyama, Hideomi Tsuchida, Shu Namiki, Lin Guan, Masanori Nagase, Teruo Muzume, Hiroshi Ishiakari, 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 160 Gb/s to 10 Gb/s DEMUX operation was demonstrated.

3.4.4 Sub-ps and simultaneous multiple wavelength switching of an all-optical flip-flop based on a DBR-LD with integrated SOA
Wouter D’Oosterlinck, Geert Morthier, Roel Baets, Ghent University - IMEC, Belgium

- A switching of a SOA and DBR 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 10dB.

3.4.5 400Gbps configurable photonic logic gates with XNOR, AND, NOR, OR and NOT functions employing a single SOA
Jiarui 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 PDM in single SOA. A detuning filter is employed to enhance the SOA modulation bandwidth.

3.4.6 Pattern Effect Removal Technique for Semiconductor Optical Amplifier-Based Wavelength Conversion
Andrej Marculescu, Jin Wang, Jingshi Li, Philipp Vormau, Wolfgang Freude, Jaeger Leuchtdiold, University of Karlsruhe, Germany; Shai Taodik, Shalva Ben Ezra, Sagie Taodik, 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 and blue-shifted filters having complementary pattern effects.

**Tuesday, September 18 – 8:30 - 10:15**

Coffee Break 10:15 - 10:45 • Exhibition only 10:45 - 12:30 • Lunch Break 12:30 - 14:00
Polymer Optical Fibers – Effective Solutions for Automotive, Sensors, Home Networking and Interconnection

Chair: Olaf Ziemann, Polymer Optical Fiber Application Center Nuremberg, Germany
Yasuhito Koiha, Keio University, Japan

Opening of the Symposium 14:00

4.1.1 The Status of POF Technology
Yasuhito Koiha, Takaaki Ishiguro, Keio University, Japan
Plastic optical fibers, POFs, have been established in unique datacom markets such as digital audio interfaces, factory automations and automotive LANs. Lossless 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 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 fibers and their real applications.

4.1.3 Experimental studies of bandwidth behaviour in Graded Index Microstructured Polymer Optical Fibres
Maryanne Large, University of Sydney, Australia
G-PoF, 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 rate of chromatic dispersion and experimental error will be explicitly considered. Finally, the results will be compared to those of competing multimode fibres.

4.1.4 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.

4.2.1 Maximum-Likelihood Phase Estimation for Coherent Optical OFDM
William Sheh, The University of Melbourne, Australia
We present a robust and computation-efficient method of maximum-likelihood phase estimation. Both computer simulation and transmission experiments of coherent optical OFDM system show that maximum-likelihood decision-feedback using pilot-assisted phase estimation gives the optimal performance.

4.2.2 Data Rate and Distance Scaling of CO-OFDM Systems
Markus Mayrock, Herbert Hausstein, Universitat 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.

4.2.3 Impairments in Optical Transmission Systems
Arthur Lowery, Monash University, Australia
Interference from nonlinearities has become a limiting factor for high-speed optical communication systems. This tutorial will introduce the most prominent of these nonlinearity effects and the current state of the art in mitigation techniques.

4.2.4 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.

4.2.5 Impairments in Optical Transmission Systems
Arthur Lowery, Monash University, Australia
Interference from nonlinearities has become a limiting factor for high-speed optical communication systems. This tutorial will introduce the most prominent of these nonlinearity effects and the current state of the art in mitigation techniques.

4.3.1 Cascadability Assessment of an All Optical 3R Regenerator based on Synchronous Modulation using a Saturable Absorber and Optical Clock Recovery
Guang-Hua Duan, Alcatel Thales III-V Lab, France
We report on the cascadability assessment of 3R all-optical regenerators. Arbitrary 8-bit RZ pulse packets with a bit rate of 100 Gbps were experimentally demonstrated.

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4.3.3 100-Gbps Optical Packets with 8-bit RZ Pulse Patterns Generated by an Optical Pulse Synthesizer
Arthur Lowery, Monash University, Australia
A practical non-blocking 32x32 SOA-based switch is demonstrated at 80Gbit/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.

4.3.4 Wavelength Conversion for Polarity-Preserving Regenerative 3R Operation
Hans Poisel, Polymer Optical Fiber Application Center Nuremberg, Germany
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.

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Tuesday, September 18 – 14:00 – 15:45
Session 4.4 Modules and Techniques for Access
Chair: Naoto Yoshimoto, NTT Access Network Service Systems Laboratories, Japan

4.4.1 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, Koji Kishine, Shunji Kimura, Kazutoshi Kato, NTT Corporation, Japan

- 10G burst-mode PIN-TIA module has been developed to enable 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 Development of GE-PON ONU PX-20 optical transceiver with wide temperature range from -20 to +85 degrees C for outdoor operation
Satoshi Shirai, Naohiro Nomura, Masamichi Nogami, Taman 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 Development of New Optical Access Network System Based on Optical Packet Switches
Takumi Nomura, NEC Communication Systems, Ltd.; Japan; Hiroki Ueda, Toshiba Tsusoi, Hiroiyuki 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 Free-Space Optical Communication in a Swarm of Microrobots
Paolo Corraldi, Arianna Menciassi, Cecilia Laschi, Paolo Dario, Scuola Superiore Sant'Anna, Italy; Leonardo Ranzani, Mario Martiradonna, Politecnico di Milano, Italy; Olivia Simoni, European Institute for Biomedical Engineering, Germany; Angel Déguez, 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 DWDM Achieved with Thermal Sources: A Future-proof PON Solution
Wald Mathiouth, Julien Peron, Leslie Rusch, Laval University; Giovanni Battista Landoni, Anhanshan 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 with wide temperature range from -20 to +85 degrees, which is suitable for outdoor equipment.
- The transceiver successfully supports power budget of 29dB and 20km transmission.

4.4.6 A PON System Providing Triple Play Service Based on a Single Dual-Parallel Mach-Zehnder Modulator
Qingjiang Chang, Yue Tan, Chishuo Yan, Xinwu Xu, Junming Gao, Yikai Su, Shanghai Jiao Tong University, 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.

4.5.1 Simultaneous all-optical 2R regeneration of 40-Gbit/s Wavelength Division Multiplexed signals
Loic Provost, Francesca Pampanini, Perihls Petropulos, David Richardson, ORC, University of Southampton, United Kingdom; Kazunori Mukasa, Masanori Takahashi, Jiro Hiroishi, Masateru Tadakuma, Furukawa Electric Co., Ltd., Japan

- We demonstrate 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 Timing jitter tolerant 640 Gb/s demultiplexing using a long-period grating-based flat-top pulse shaper
Leif Oxenløwe, Michael Galili, Hans Christian Mulvad, Anders Clausen, Palle Jepsen, Technical University of Denmark, Røn达尔 Slavik, ASC, Czech Republic; Yongwoon Park, Université Quebec, Canada; Jose Azana, INRS, Canada

- A 40fs 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 Phase-Preserving 2R-Regeneration of an 80-Gb/s RZ-DQPSK Signal by Using a Nonlinear Amplifying Loop Mirror
Kristian Cvecek, Klaus Sponsel, Christian Stepchan, Georg Ott, University of Erlangen-Nuremberg, Germany; Reinhold Ludwig, Coja Schubert, Fraunhofer Heinrich-Hertz-Instutut, Germany; Bernard Schmauss, University of Applied Science - 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 Passive All-Optical Clock Recovery demonstrated at 42.6Gbit/s with Bragg-gratings based Fabry-Perot Filter
Vincent Roncin, Julien Pollet, Quang Trung Le, Sebastien Lobo, Laurent Brahmier, Jean-Claude Simon, INRS/IT; France; David Chevalier, Catherine Le rouzie, Laurent Lablonde, Benoit Cadier, France

- In this paper, we present the performance of an all-optical clock recovery device based on a passive Fabry-Perot long-pass filter made-up of Bragg Gratings and followed by an SOA for patterning effect reduction.

4.5.5 Optimization of SBS-Suppression for 320 Gbit/s DQPSK All-Optical Wavelength Conversion
Bernd Knitt, Alexehandreu Diaz, Natascha Schmidl, Langhorn, Retnik Peter, Freiburg, Coja Schubert, Fraunhofer Heinrich-Hertz-Institut, Germany; Robert Eislicher, Christian Rendtel, Technical University of Berlin

- We investigate single- and dual-tone phase modula- tion of the cw-pump for effective stimulated Brillouin scattering suppression in all-optical wavelength conver- sion based on FWM in highly-nonlinear fibre. The per- formance is evaluated in 320Gbit/s DQPSK wavelength conversion experiments.

4.5.6 Comparison on Crosstalk Tolerance of RZ-DPSK and RZ-OOK Modulation Format in Fiber Optical Parametric Amplifier
Bil-Fing Yo, Xin Jin, 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 Polarization Independent All-Optical Clock Recovery from Highly Nonlinear Fiber
Franko Kuppers, Qiang Wang, University of Arizona, USA; Tuomo von Lerbee, PentaCorporation, Finland; Seppo Hovakarten, Micronova, Finland

- A polarization independent multiplexed all-optical clock recovery device based on a birefringent resonator is introduced. We verify proper operation of the method with data signals highly distorted by dispersion and fiber nonlinearity.

4.6.1 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 video multicast that new users with 2600 users. Each end user has 40 Mb’s guaranteed band- width. The results of 1040 concurrent users testing were reported.

4.6.2 On-demand uncompressed HDTV Transmission over a GMPLS controlled Service-Aware all-optical net- work
Ramón Casellas, Iván Martínez, Carolina Pinat, Raul Múllol, Ricardo Martínez, Fermín Galán Márquez, Centro Tecnológico de Telecomunicaciones de Catalunya, Gabriel Junyent, Universitat Politècnica de Catalunya, Spain

- An intelligent optical network needs to address the heterogeneous nature of services. In this talk, we present our on-demand, uncompressed HDTV transmission, jointly considering management, control and transport planes. Such a transmission was assessed over a GMPLS network.

4.6.3 Demonstration and analysis of TV and data trans- mission in the optiP gia hybrid circuit/packet switched network testbed
Steinar Bjostad, Andreas Kimsa, NTNU, Norway; Martin Nord, Research Center COM, Technical University of Denmark, Denmark; Lars Erikson, R&D Manager, Norway; Vegard Tuft, Dag Hjelme, Norvald Stol, Norwegian University of Science and Technology, Norway; Aasmund Suddso, Oslo University, UniK, Norway

- TV-broadcast contribution is an important, optical network application requiring absolute performance guarantees. We demonstrate the optiP gia tested for uncompressed IP-video streaming in the presence of standard IP data transport in the network.

4.6.4 Evaluation of Optical Grid Scheduling through Dimensioning
Christophe Navarre, Marc De Leenheer, Bart Dhoedt, Piet Dehne, Ghesa 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 dimensioning of such Grids.

4.6.5 Joint Resource Allocation in Optical Grids: Algorithms and Performance Study
Xi 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 lightpath establishment, JALE. Several approaches are proposed to efficiently support distributed computing applications in wavelength-routed networks.
Networks and interconnection solutions. Much higher potential will have the use in home communications and the advantages of POF technology in view of the present available technology, possible applications in automobiles and industrial automation. Recently 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 Mbit/s - Gbit/s - 10 Gbit/s and beyond, the use of POF can be expected in the near future. Fiber optic cables offer 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 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-km 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. 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.
<table>
<thead>
<tr>
<th>Session 5.4</th>
<th>Hall 7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modulation Techniques and Multiple Access</strong></td>
<td></td>
</tr>
<tr>
<td><strong>5.4.1</strong></td>
<td><strong>16:15</strong></td>
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<tr>
<td>Experimental Demonstration of a Novel OFDM-A Based 10Gb/s PON Architecture</td>
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<tr>
<td>Dayou Qian, Jianjun Hu, Jianjun Yu, Philij Ji, Lei Xu, Ting Wang, Milorad Cvijetic, NEC Laboratories America, USA; Toshifumi Kusano, NEC Corporation, Japan</td>
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<td>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.</td>
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<tr>
<td><strong>5.4.2</strong></td>
<td><strong>16:30</strong></td>
</tr>
<tr>
<td>Low cost Multi-Band OFDM for remote modulation of colourless ONU in hybrid WDM/TDM-PON architecture</td>
<td></td>
</tr>
<tr>
<td>Neavena Genay, T. Duong, A. Pizzina, B. Charbonnier, P. Charclou, France Telecom R&amp;D, C. Kazmierski, Alcatel Thales III-V Labs, France</td>
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<tr>
<td>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.</td>
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<tr>
<td><strong>5.4.3</strong></td>
<td><strong>16:45</strong></td>
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<tr>
<td>Demonstration of 3x4x8x10 Gbps WDM/DPSK-OCDMA using 31-chip, 640 Gchip/s SSFSG En/decoder for 10 G Flexible Access Network</td>
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<tr>
<td>Xu Wang, Naoya Wada, National Institute of Information and Communications Technology, Ken’ichi Kitayama, Osaka University, Japan</td>
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<td>We demonstrate a high data-rate SSFSG-based WDM/OCDMA experiment, with wavelengths and 100GHz spacing, 8 OCGMD, 10 Gbps/user using 31-chip, 640 Gchip/s en/decoders, DPSK modulation, time gating and FEC.</td>
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<tr>
<td><strong>5.4.4</strong></td>
<td><strong>17:00</strong></td>
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<tr>
<td>A novel bidirectional WDM/TDM-PON using DPSK downstream signals and a custom AWG</td>
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<tr>
<td>Nicola Calabretta, Marco Presi, Roberto Proietti, Giampiero Contestabile, Ernesto Ciaramella, Scuola Superiore Sant’Anna University, Italy</td>
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<tr>
<td>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 1Gb/s upstream signal.</td>
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<td><strong>5.4.5</strong></td>
<td><strong>17:15</strong></td>
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<tr>
<td>Demonstration of FTTH System with QPSK Offset Sideband Modulation</td>
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<tr>
<td>David Krause, Jamie Gaudette, John Cartledge, Queen’s University, Canada; Trevor Norman, Kim Roberts, Nortel Networks, Canada</td>
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<td>To alleviate the implications of bi-directional crosstalk in a simple in-line transceiver, 2.5 GSm/s DPSK offset sideband modulation and 1.25 Gb/s direct OOK modulation are used for downstream and upstream signalling, respectively.</td>
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<td><strong>5.4.6</strong></td>
<td><strong>17:30</strong></td>
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<tr>
<td>Highly Spectral Efficiency Multi-User Optical Network Architecture using 1Gb/s 16QAM Subcarrier Multiplexing</td>
<td></td>
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<tr>
<td>Jin Yong Ha, Adrian Wonfor, Richard Penty, Ian White, University of Cambridge, Pierpaolo Giugno, Ericsson, United Kingdom</td>
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<td>A proof-of-principal-demonstration of a 20-Gba/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.</td>
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<td><strong>5.4.7</strong></td>
<td><strong>17:45</strong></td>
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<tr>
<td>Generation of 3.6 Gbps 16-QAM 39 GHz mm-wave carrier employing photonic vector modulation</td>
<td></td>
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<tr>
<td>Rakesh Sambaram, Valentin Polo, Juan Luis Corral, Javier Marli, Universidad Politecnica de Valencia, Miguel Angel Piqueras, DAS Photonics S. L, Spain</td>
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<tr>
<td>The experimental generation of a 3.6Gbs/16-QAM 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.</td>
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<tr>
<th>Session 5.5</th>
<th>Hall 9</th>
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</thead>
<tbody>
<tr>
<td><strong>Photodiodes and Receivers</strong></td>
<td></td>
</tr>
<tr>
<td><strong>5.5.1</strong></td>
<td><strong>16:15</strong></td>
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<tr>
<td>Invited: Ultrafast Waveguide-integrated pin-Photodiodes and Photonic Mixers from GHz to THz Range</td>
<td></td>
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<tr>
<td>Heinz-Gunter Bach, Fraunhofer-Institut fuer Nachrichtentechnik, Germany</td>
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<td>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.</td>
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<tr>
<td><strong>5.5.2</strong></td>
<td><strong>16:45</strong></td>
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<tr>
<td>Thin Film InGaAs/InAlAs Photodiodes Integrated on a Silicon-on-Insulator Waveguide Substrate</td>
<td></td>
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<tr>
<td>Joost Brouckaert, Gunther Roeckers, Oves Van Thourhout, Roel Baets, Ghent University - IMEC, Belgium</td>
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<tr>
<td>We present compact and efficient InGaAs/InAlAs metal-semiconductor-metal photodetectors coupled with Silicon-on-Insulator waveguides. The responsivity of 25μm long detectors is 1.0G/μm at a wavelength of 1.55μm. The dark current is 3.0mA at 5V bias.</td>
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<tr>
<td><strong>5.5.3</strong></td>
<td><strong>17:00</strong></td>
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<tr>
<td>10 Gb/s Balanced Photodetector with +/-17 dBm RF Output Power</td>
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<tr>
<td>Andreas Bening, Hao Chen, Nian Duan, C. Campbell, University of Virginia, USA</td>
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<td>We report on a novel high-power balanced photodiode with 0.75 A/W responsivity and 870 mA-GHz saturation current-bandwidth product. The common mode rejection ratio is &gt;30 db.</td>
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<td><strong>5.5.4</strong></td>
<td><strong>17:15</strong></td>
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<td>3Gbps-per-Channel Highly-Parallel Silicon Receiver OEIC</td>
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<tr>
<td>Robert Swoboda, Michael Foerstch, ASICs Electronics Development GmbH, Austria; Horst Zimmermann, Vienna University of Technology, Austria</td>
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<td>An optoelectronic integrated circuit in 0.6um 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.</td>
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<td><strong>5.5.5</strong></td>
<td><strong>17:30</strong></td>
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<tr>
<td>Multi-Channel Operation of a Receiver Photonic Integrated Circuit with an Integrated Semiconductor Optical Amplifier</td>
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<td>Rashahvishvan Nagarajan, Masaki Kato, Vince Dominic, Sheila Hurt, Andrew Dentai, Jacc Julesmeers, Peter Evans, Mark Missey, Rangan Mutahir, Arnold Chen, Damien Lambert, Prashant Chavarkar, Atul Mathur, Johann Bak, Infinea, USA</td>
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<tr>
<td>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.</td>
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<td><strong>5.5.6</strong></td>
<td><strong>17:45</strong></td>
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<tr>
<td>Multi-Frequency Heterodyne System for All-Optical Technology-Free Ultrafast Optical Waveform Measurement</td>
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<tr>
<td>Takahide Sakamoto, Tetsuya Kawanishi, Masayuki Iizutsu, National Institution of Information and Communications Technology, Japan</td>
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<td>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.</td>
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Experimental demonstration of phase matching between two different photonic bandgaps in Hybrid Photonic Crystal Fibers

We report on the first recording of a 300-nm-period nanostructure in a bulk fused silica using the tightly-focused, 82 nJ, 267 nm, near-field 2π-rotation of high optical Kerr nonlinearity ~ 2000 W-1 km-1 demonstrates high-performance all-optical NRZ-to-RZ format conversion across technologies such as forward error correction, resilience to key impairments found in optical networks, and increasing capacity of modern wavelength-division multiplexing 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 network routing, such as optical amplifier noise, chromatic dispersion, polarization-mode dispersion, concatenated optical filtering, and fiber nonlinearity.

Advanced Modulation Formats for Electronic Preamplification

It is shown that a combination of pairwise or pulse-to-pulse alternate polarization of carrier-suppressed RZ signals involves high performance, and is crucial to the guidance mechanism, and allows optical fibers to be used in the infrared.

Coffee Break

Tutorial: Advanced Optical Modulation Formats

We have experimentally demonstrated, for the first time, phase matching between 0.02 different photonic bandgaps of an optical fiber. It was got by launching femtosecond pulses near a zero-dispersion wavelength of Hybrid Photonic Crystal Fibers.

Experimental demonstration of phase matching between two different photonic bandgaps in Hybrid Photonic Crystal Fibers

We investigate kagome lattice hollow-core polymer optical fibres from a tellurite based glass. Angular dependence have been measured on nano-crystallized optical silica nanoparticles and quantum dots is presented.

We report on the first recording of a 300-nm-period nanostructure in a bulk fused silica using the tightly-focused, 82 nJ, 267 nm, near-field 2π-rotation of high optical Kerr nonlinearity ~ 2000 W-1 km-1 demonstrates high-performance all-optical NRZ-to-RZ format conversion across technologies such as forward error correction, resilience to key impairments found in optical networks, and increasing capacity of modern wavelength-division multiplexing 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 network routing, such as optical amplifier noise, chromatic dispersion, polarization-mode dispersion, concatenated optical filtering, and fiber nonlinearity.

Advanced Modulation Formats

We have experimentally demonstrated, for the first time, phase matching between 0.02 different photonic bandgaps of an optical fiber. It was got by launching femtosecond pulses near a zero-dispersion wavelength of Hybrid Photonic Crystal Fibers.

Experimental demonstration of phase matching between two different photonic bandgaps in Hybrid Photonic Crystal Fibers

We investigate kagome lattice hollow-core polymer optical fibres from a tellurite based glass. Angular dependence have been measured on nano-crystallized optical silica nanoparticles and quantum dots is presented.

We report on the first recording of a 300-nm-period nanostructure in a bulk fused silica using the tightly-focused, 82 nJ, 267 nm, near-field 2π-rotation of high optical Kerr nonlinearity ~ 2000 W-1 km-1 demonstrates high-performance all-optical NRZ-to-RZ format conversion across technologies such as forward error correction, resilience to key impairments found in optical networks, and increasing capacity of modern wavelength-division multiplexing 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 network routing, such as optical amplifier noise, chromatic dispersion, polarization-mode dispersion, concatenated optical filtering, and fiber nonlinearity.

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**Session 6.4**

**WDM PONs**

Chair: Gerlas van den Hoven, GENEXIS, The Netherlands

6.4.1 8:30

*Intrinsic High Temperature, Colourlessness Operation of a Reflective Semiconductor Optical Amplifier for 2.5Gb/s upstream transmission in a WDM-PON*

Anna Kamei, Henk van Eijk, Alastair Poustie, Richard Wyatt, CIP, United Kingdom

- We have fabricated a reflective SOA laser as a high-speed, colourless upstream modulator that is demonstrated in a WDM-PON architecture. 2.5Gb/s upstream transmission over 10km up to 80km is shown across the C-band.

**Session 6.5**

**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*

Paul Muñoz, Ricardo Martínez, Fermin Galán Márquez, Centro Tecnolóxico de Telecomunicaciones de Catalunya, Spain; Robert Miro, Telecom Italia, Italy; Hans Foiel, Sabine Szuppa, T-systems, Germany; Javier Jiménez, Oscar González de Dios, Telefonica I+D, Spain; Hermann Dentler, Alcatel-Lucent, Germany; Eduard Escalonà, Salvatore Spadaro, Fernando Agraz, Universitat Politécnica de Catalunya, Spain; Berta 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.

**Session 6.6**

**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 Fibers*

Lii Y, Yves Jaouen, Junjie Zhou, GET / Telecom Paris, France; Weisheng Hu, Yikai Su, Shanghai jiao tong university, P.R. China

- We demonstrate 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*

Linh Y, Yves Jaouen, Renaud Gabet, GET / Telecom Paris, France; Westheng 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 SBS 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 Nohatai, Tsuyoshi Konishi, Kazuyoshi Itoh, Chuo university, Japan; Vo Duy Binh, Kansai 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 Coefficient Incoherent Microwave Photonics Filters using Phase-Shifted Fiber Bragg Gratings*

Mikel Sagues, Alayn Loayssa, Universidad Publica de Navarra; Raimundo Garcia-Olcina, Salvador Sales, Jose Campany, 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 multiplexing optical system*

Paolo Martoli, Maddalena Ferrara, Lucio Marazzi, Paola Pavanelli, Aldo Righetti, Rocio 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 multiplex signals 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, Garbire 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-Gb/s SiGe BiCMOS Burst-Mode Clock and Data Recovery Circuit with 160-bit Consecutive Identical Digit Tolerance*

Jun Terada, Kazuyoshi Nishimura, Minoru Tosoghi, Toshihito Nakaai, Shunsuke Kusunuma, Yutaka Otomo, NTT Corporation, Japan

- A 10.3125-Gb/s SiGe BiCMOS Burst-Mode Clock and Data Recovery Circuit with 160-bit Consecutive Identical Digit Tolerance. The CDR employs a single-VCO architecture, which increases convergence identical Digit Tolerance. The developed CDR demonstrates 160-bit CDR tolerance.
11:00 Low-Dissipation-Shifted Solid-Core Photonic Bandgap Fiber
Mikhail Likhachev, Andrei Bukhov, Nikolay Burakov, Institute of Chemistry of High Purity Substances of RAS, Russia; Roman Vedenko, Research Institute of Modern Photonics, Moscow, Russia
A novel photonic bandgap fibre, based on a square lattice cladding, is presented. The fibre consists of 30% air holes arranged in a square lattice surrounding a solid core. We show that the cladding structure significantly improves the circularity of the fundamental mode.

11:15 Archimedean-like lattice microstructured optical fibers
Antoine Proulx, Alexandre Laferriere, Université de Sherbrooke, 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 the cladding structure substantially improves the circularity of the fundamental mode.

11:45 Measurement of Constellation Diagrams for 40-Gb/s DQPSK and 60-Gb/s 8ary-DPSK Using Sampled Orthogonal Differential Direct-Detection
Xiang Liu, Zhaoyang Hu, John Bowers, Daniel J. Gauthier, Massachusetts Institute of Technology, USA
We demonstrate orthogonal differential direct-detection for DQPSK and m-ary 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.

12:00 Fundamental and higher-order mode confinement loss analysis in realistic air-silica hollow-core Bragg fibers
Matteo Foroni, Federica Poli, Davide Passaro,Università di Insubria, Como, Italy
Silica bridges in realistic air-silica hollow-core Bragg fibers are responsible of the surface mode presence, which affect the transmission window of the fundamental and the higher-order modes, narrowing the width useful for light guiding.

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 some optics than heterodyne. It achieves high tolerance to phase noise and feasible implementation with off-the-shelf electronic and optical components.

12:30 Fast Optical Clock Recovery and Signal Regeneration Applications of a Monolithic Mode Locked Laser with D3R Mirrors and an Optical Amplifier
Briath-Koch, Jonathan Barton, Milan Maurovi, Zhaoyang Hu, Henrik Poulsen, John Bowers, Daniel J. Gauthier, 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.

12:45 Silicon-on-Insulator, SOI Delay-Line Interferometer with Low Polarization-Dependent Frequency Shift for 40 Gbit/s DPSK Demodulation
Laura Zumr, Patrik Kovar, Georg Winzer, Torsten Mitze, Juergen Bruns, Klaus Petermann, Technical University of Berlin, Germany; Thomas Richter, Colin Schubert, Fraunhofer Heinrich-Hertz-Institut, Germany
We present a novel SOI interferometer, featuring reduced frequency shift and high uniformity, low loss, PDL, and PDFS, < 1 GHz. RZ & NRZ DPSK balanced-detection measurements at 40 Gbit/s are included.
A Wideband Low-distorted ROSA for Video Distribution Service based on FM Conversion Scheme

Kazuo Sano, Toshihide Yoshimatsu, Satoshi Kodama, Makoto Nakamura, Miwa Mutoh, Satoshi Tsunashima, Koki Murata NTT Corporation, Japan; Naohiko Yuki, NTT ANSL, Japan

We present a novel source optical sub-assembly that 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%.

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 Schmieder, 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.

Transmission of 1.25 Gb/s per channel over 4.4 km Silica Multimode Fibre using QAM Subcarrier Multiplexing

Jannying Zeng, Jeffrey Lee, Jia Yang, Hennie van den Boorn, Ton Koene, 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.

All-Optical Envelope Detection for Wireless Photonic Communication

Ilie Lu, Tatur 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.

Novel demultiplexing and error-free transmission of 12-channel millimeter-wave-band signals in 25-GHz optical-frequency-interleaved DWDM radio-over-fiber

Toshiaki Kuri, NICT, Japan; Hirofumi Toda, Doshisha University, Japan; Kenichi 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 waveband division multiplexed radio-over-fiber system with 25-GHz channel spacing.

Experimental Generation of FCC-Compliant UWB Signals

Mohammad Abtahi, Julien Magne, Mehrdad Mirshafiee, Serey Doucet, Leslie Rusch, Sophie LaRochelle, Université Laval, 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.

Invited: IP over DWDM in core networks: near term and long term goals

Oni 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.

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.

Efficient Management of a Network’s Excess Capacity: A Traffic-Engineering Approach

Marwan Batsyneh, Suman Sarkar, Smrita 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.

Traffic Driven Path Capacity Adjustment Utilizing Adaptive Digital Filter

Shuto Yamamoto, Ippei Shakte, NTT, Japan; Tomohiko Kunashii, Internet Initiative Japan Inc., Japan; Yuukiya 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.

Hierarchical Optical Path Network Design Considering Waveband Protection

Yoshuji Yamada, Hiroshi Hasegawa, Ken-ichi Sato, NTT Corporation, 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 desired protection. The numerical experiment shows 10-50% network cost reduction.

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.

Performance improvement and monitoring in PONs

Nikolaus Gieschen, T-Systems Enterprise Services GmbH, Germany

Simple Approach to Enhance Bidirectional Transmission Performance of WDM-PONs with RSOAs

Shi-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.

Centralized Frequency Stabilization by Dithering Transmission Spectra of PLC-Type MZI-AGW for DWDM-PON


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.

Reduction of Signal-Induced Rayleigh Noise in a 10Gb/s DWDM-PON using a Gain-Saturated SOA

Emair MacHale, Guglielmo Talli, University College Cork, Ireland; Oni Wolow, Photonic Systems Group, Trinity 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 11 dB thereby enabling 10Gb/s error-free transmission in a 64 way-split, 20km reach PON.

Low-Cost Non-intrusive Fiber Monitoring in a PON

Jian Yan, Jun Zhu, Xing-Zhi Qiu, Wei Chen, Bert De Mulder, Johan Bauweinck, Bert Baskeiland, Ghent University, Belgium

Low-cost embedded negative step response OTDR performs PON last fiber plant monitoring from an ONU without need for additional optical components, without penalty on network link performance and without service interrupt.

In-service Line Monitoring System using 1650 nm Brillouin OTDR for 8-branched PON Fibres with Individually Assigned BFs

Nazuki Honda, Naoyuki Nomura, Yui 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.

Remote Power-in-Optical Switch for Remote Subscriber Aggregation and OTDR Measurement in PON

Roger Hekty, Michael Inbar, Olivier Jerphagnon, Volkam Karam, Shih Yu Lin, Jim Khanishin, Nicholas Madamopoulos, John Bouwers, Calient Networks, USA

We present for the first time remote powering of a 0-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.

Effect of PON Geographical Distribution on Monitoring by Optical Coding

Habib Fathallah, Mohammad M. Mad, Leslie A. Rusch, Ulf Karlsson, Laval, Canada, University of.

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.
8.1. 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 Gb/s, high temperature and high power, >1 mW @ 85°C operation has been achieved with Buried Tunnel Junction, BTJ VCSELs at 1.55µm emission wavelength.

8.2. 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.

8.3. Polarization-Multiplexed 2.8 Gbit/s Synchronous QPSK Transmission with Real-Time Digital Polarization Tracking
Timó Rafa, Ralf Peveking, Florian Samson, Johannes Römmelt, Sebastian Hoffmann, Suhas Bhandare, Selvan Ibrahim, David Sandes, Olaf Adamczyk, Mario Porrmann, Reinhold Nolte, University of Paderborn, Germany; Jerome Hauduen, Nicolas Grossard, Photline Technologies, France; Y. Achiam, CeLiSight, Japan

This paper presents the implementation of an electro-optic polarization tracking algorithm which enables real-time polarization-multiplexed synchronous QPSK transmission with DFB lasers. The achieved BER at 2.8 Gb/s is well below the FEC threshold.

8.4. 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, Sweden

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.

8.5. Dispersionless Slow Light with 5-Pulse-Width Delay in a Long Fibre Bragg Grating
Joe Mok, Martin de Sterke, University of Sydney, Australia

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.

8.6. 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; Shigeokazu Oikuma, Mitsuhiro Ebawa, Tatsuya Yamamoto, Fujitsu Laboratories Ltd., Japan

We have demonstrated 15.9GHz-10Gb/s operation of an AlGaInAs electroabsorption modulator integrated GaAs laser with a 120G赫兹/4-150GHz electrical bandwidth. The laser demonstrated continuous-wave emission with a crystal temperature of 45°C.

8.7. Pilot-carrier based linewidth-tolerant 8PSK self-homodyne using only one modulator
Monika Nakamura, Yukinori Yamamoto, Tetsuya Matsushita, Tetsuya Kodama, NTT Corporation, Japan

We present a novel approach to linearly chirped wavelength-division multiplexing (LC-WDM) using only one modulator. The 10 Gb/s signal is transmitted with a 1.5 ps pulse width penalty.
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; Yusio 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 sync-protection mapping and an over-sampling algorithm, we comply with G-PON Class-B+ performance and demonstrate seamless upgrade of 10G-PON.

8.4.6 15:30
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=800 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 Degens, Dalila Make, Odile Le Gouezigué, François Lelarge, Benjamin Rousseau, Alain Accard, Jean-Guy Provost, François Poinot, Jean Landreau, Olivier Dhse, Estelle Derouin, Frédéric Pommeraye, Guang-Hua Duan, Alcatel Thales III-V Lab, France
10Gbs 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 modulation light source.
8.6.3 14:45
Dynamic Switching of High Powered Picosecond Pulses from a Quantum Dot Mode-locked Laser Diode using an Integrated Quantum Dot Switch
Habib Wang, Alastair Rae, Mark Thompson, Richard Penty, Ian White, University of Cambridge, United Kingdom; Alasey Kovsh, Innolume GmbH, Germany
An integrated quantum-dot switch is presented exhibiting chip-on-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 1.3μm
Ding-Yi Cong, Anthony Martinez, Kamel Mercheg, Abderrahim Ramdana, CNRS/LPN / Institut National des Télécommunications, Jean-Guy Provost, Alcatel Thales III-V Lab, France; Marc Fischer, Nanopuls Nanosystems and Technologies GmbH, Igor Krestnikov, IAlexey Kovsh, Innolume GmbH, Germany
The temperature dependence of Henry factor αH of undoped and p-type doped InAs/GaAs QD lasers is reported for the 20–80 °C range. It is shown that αH of p-type doped devices is temperature insensitive.
Wednesday, September 19  –  16:15 - 18:00

**P001 Adapting the Slow Light Spectrum in optical fibers for delay enhancement**

Thomas Schneider, Ronny Henker, Markus Junker, Lautenbach 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-flattening parameters of +2.8dB/40nm, E=+15.5THz, and S+C+L ~+20.9THz fiber Raman amplifiers are designed by a new TeO2-Sa3O-SrO-Nb2O5-P2O5-WO3, TSBWP tellurite glass fiber.

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

Narashita Tatsuya, Yosutake Ohishi, Toyota Technological Institute, Japan

We have investigated the amplification performance of Tb-doped fluoride fiber in the 0.54 µm 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**

Víctor García-Muñozm, Miguel Preciado, Miguel Muriel, Víctor García-Muñoz, Miguel Muriel, Universidade Politécnica de Madrid, Spain; Christophe Caussanel, Sébastien Belle, Marc-Walpier, Patrice Megret, 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-reflection FBG from noisy data**

Oleg Belaj, Evgeni Podivilov, David Shapiro, Institute of Automation and Electrometry; Leonid Frumin, Oleg Belai, Evgenii Podivilov, David Shapiro, Institute of Automation and Electrometry

An indirect technique is proposed for measuring the numerical analysis, and it has been demonstrated to have the highest gain of 8.3dB, for the first time.

**P006 Broadband Dispersion Compensating Holey-Assisted Fiber**

Kumina Saith, Shaleenda Varshney, Masanori Kishioka, Hokkaido University, Japan

A novel design of broadband dispersion compensating hole-assisted fibers is demonstrated. The proposed structure exhibits large negative dispersion coefficient around 400 ps/nm/km with matched RDS. Further, its Raman amplification properties are investigated.

**P007 New Easily Assembled Mechanical Splicer for Direct Coaxial Optical Fiber Connection without Stripping**

Hitoshi Son, Nippon Telegraph and Telephone Corporation

We propose a new type of mechanical splicer that provides easy assembly. It has good performance with a low 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**

Bohdan Mlyna, Milan Bajd, Optopace d.o.o., Slovenia: Herve Guillot, Samuel Bonnafous, Kestrem, France

Highly rare-earth doped optical fiber preforms were produced using flash vaporization method for precursor delivery, TEDS and lanthanide precursors were used.

**P010 Spontaneous Brillouin Scattering Modelling and Measurement in Various Asymmetric Optical Fibres**

Vincent Lantici, Stephanie Fortier, EDF R&D; Yves Jouveen, Renaud Gaget, GET / Telecom Panic; Sylvie Delpoine-Lessolle, LPCP; Jean-Louis Auguste, Xim, France

We describe a computation method of spontaneous Brillouin scattering process using the original acoustic mode analysis. Numerical results have been compared with measured Brillouin spectra for two different commercially available fibers.

**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, HBL-PLM 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-Dependent Loss in an Optic Fiber Link with Polarization-Dependent Loss**

Hui Tang, Ming Ting, Ping Shum, Nanyang Technological University, Singapore; Yandong Gong, Institute for Infocomm Research, Singapore

We 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 fiber and fiber length domains.

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

Takashi Inoue, Yuki Taniguchi, Hiroshi Hirotsu, Takeshi Yagi, Yu Mimura, Funakawa Electric Co., Ltd., Japan

We attain highly efficient, low-pedestal Gaussian pulse compression using comb-like profiled fiber, CPF characterized by normal-dispersion-HNL, in experiment, input pulse has 2.6ps-FWHM is successfully compressed to 0.38ps-FWHM Gaussian pulse with peak-to-pedestal-ratio of 19.3dB by 3-step-CPF.

**P014 5.7dB SBS suppression with a HNL module**

Masanori Takahashi, Masateru Tadakuma, Hiroshi Hirotsu, Takeshi Yagi, Yu Mimura, Funakawa Electric Co., Ltd., Japan

We demonstrated 5.7dB SBS suppression of a HNL by controlling Brillouin gain spectrum with three HNLs which have different GeO₄ concentration. FWM-induced pulse broadening in Raman fiber lasers is presented. It is shown that negative gain combined with positive gain makes it possible to achieve higher spatial resolution in distributed Brillouin-based fiber sensing.

**P018 Novel Brillouin Gain and its Application to Distributed Fiber Sensing**

Taeone Hongjii, 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 Singla, 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 experiments.

**P020 Optical Properties of Highly Al₂O₃ and PO₂-Doped Silicon-Hosts for Large Mode Area Fiber Lasers and Amplifiers**

Mahtu 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 PO₂-doped silica glass having a low refractive index has been demonstrated. We have fabricated fiber lasers 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, Hong Kong

Optically-controlled variable delay up to 415 ps is demonstrated for 10-GHz pulses using self-phase- and cross-phase modulation 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, 32-ps, bismuth-oxide highly nonlinear fiber followed by group velocity dispersion in a chirped fiber Bragg grating.

**P023 Generation of new Frequencies by Pulse Splitting**

Ayhan Demircan, Uwe Bandelow, Weierstrass Institut f. Angewandte Stochastik; Marcel Kroh, u²t photonics AG; Bernhard 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 Cancio-Castaneda, Antonio de valencia, Spain

We report experimental results on supercontinuum generation in PCF tapers using quasi-continuous pulse powers of 75 mJ 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; Zhongming Zhu, Daniel Gauthier, University of British Columbia, Canada

We demonstrate broadband SBS slow-light using spectrally-sliced pumping. Both 2.5-Gb/s NRZ-DQPSK and NRZ-DPSK signals are delayed by maximum 170-
We theoretically investigate how spectral hole burning and carrier interferometric measurement. The technique is very effective in characterizing input waveguide design in advanced AWG devices.

We demonstrate for the first time a waveguide mode characterization scheme in an AWG, utilizing low coherent interferometric measurement. The technique is very effective in characterizing input waveguide design in advanced AWG devices.

We developed a small size InP Mach-Zehnder, MZ modulator module for use in a small form transponder, which is only 13.8x9.4x4.9 mm3 in size, 0.6 cc. Small volume, 0.6 cc surface mount 10-Gbit/s Mini Flat Mach-Zehnder modulator module

We developed a 100 Gbps bandwidth, 12.5 Gbps/ch rectangular waveguide, 69-112GHz Output Ports Multi-Mode Optical Waveguide Circuits. Rectangular Waveguide, 69-112GHz Output Ports

We theoretically investigate how spectral hole burning and carrier-interference affect the gain saturation behaviors of quantum-dot optical amplifiers.

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P050 1 Gbit/s Full-Duplex Bidirectional Optical Data Transmission over 50 m of 50 µm-Core Graded-Index Multimode Fiber with Novel Monolithically Integrated Transceiver Chips

Christian Luch, Fabian Rinaldi, Dietmar Wöhr, Dieter Rimm, Steffen Lorch, Rainer Michaitak, Ulm University, Germany

We present bidirectional data transmission experiments in half- and full-duplex mode at 1 Gbit/s data rate over 500 km graded-index multimode fiber with VCSELs and MSM photodiodes as parts of a GaAlAs-based monolithically integrated transceiver chip.

P051 Feedback effects on performance of DM and DFB lasers in RoF systems

Alexandr Krastev, Jaspreet S. Grewal, Ralf Urbansky, University of Kaiserslautern, Germany;
Takeshi Hoshida, Tomoo Takahara, Yuichi Akiyama, Yokogawa Electric Corporation, Japan

We present feedback effects on performance of Discrete-Mode and DFB lasers used as transmitters in RoF system. The Discrete-Mode laser is capable of handling 10GB more feedback than DFB laser.

P052 Injection Locked DBR Laser Diode module for Access Applications

Alexandre Shen, Frédéric Blache, Guang-Hua Duan, François Lelarge, Franck Mallecôt, Henri Courtois, Le Lougeziguiz, Frédéric Van Dijk, Benjamin Rousseau, Frédéric Pommereau, Alcide-Thaís III-V Lab, France; Philippe Chanciot, France Telecom, France

A Distributed Bragg Reflect laser diode has been packaged and characterized 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 Mallecôt, Henri Courtois, Frédéric Lelarge, Frédéric Blache, Odile Le Lougeziguiz, Lionel Le Guéziez, Frédéric Pommereau, François Poingt, Benjamin Rousseau, Somadita Mitra, Alcide-Thaís III-V Lab, France

We report on a Fabry-Perot laser diode packaged in a module compatible with active mode-locking. We obtained nanosecond pulses with a near ultra-low line width <200fs at 17GHz, this is compatible with optical sampling applications.

P054 Pluggable inter-plane couplers for multilayer optical interconnections

Jürgen Van Erps, Christof Debaes, Hugo Thiopenot, 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 interconnections. The components are prototyped using Deep Proton Writing, but are compatible with low-cost mass fabrication.

P055 160Gbps' 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 non-linear gain, phase and chirp dynamics of an SOA at 160Gbps using a spectruman measurement technique. Results are key to understanding 400GbE's optical SOA-based wavelength converters

P056 Silicon-on-Insulator Modulators for Next-Generation 100 Gb/s Ethernet

Christian Koos, Jan Brosi, Wolfgang Freude, Jürg Leuthold,University of Karlsruhe, Michael Waldow, University of Erlangen, Germany; Wolfgang Sauerbrey, University of Erlangen, Germany

We present the first demonstration of silicon-on-insulator Mach-Zehnder interferometers with an included monolithically integrated DFB laser. We demonstrate a full-tranuble, ultra-high-speed data rate over 500m graded-index multimode fiber with VCSELs and MSM photodiodes as part of a GaAlAs-based monolithically integrated transceiver chip.

P057 Low-Penetration Transmission of High-Speed Data through a Cascade of Silicon Microring Resonator Drop Ports

Benjamin Lee, Alexandre Biberian, Keren Bergman, Columbia University, USA; Nicolas Sherwood-Oroz, Carl Kodaks, 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 25/50GbE Interleavers

Wolfgang Freude, Jürg Leuthold, Ortwin Döring, Jan Brosi, Michael Waldow, Wolfgang Sauerbrey, University of Erlangen, Germany

A pair of 50/25 GbE interleavers was integrated on a chip using high index waveguide technology. The cascaded MZ-based interleaver uses a polarization diversified scheme and achieved 25GbE crosstalk and 18GbE 0.5dB bandwidth across C-band.

P059 All-optical NRZ-DPSK Clock Recovery Using Chirped Fibre Bragg Grating, CFBG Induced Clock Tone

Fu Songian, Ting Ming, Wen-De Zhong, Xia Li, Ping Shang, 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 GbE clock is optically recovered with 17 dB extinction ratio and 540 fs root-square-time jitter.

P060 Asynchronous optical performance monitoring of RZ-DQPSK signals using delay-tap sampling

Benjamin Poinçot, Benjamin Rousseau, Somadita Mitra, Alcide Thaís III-V Lab, France; Philippe Chanciot, France Telecom, France

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, Sehyong Lee, Kwonseok 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 band width, -62dBm sensitivity, and -86dB crosstalk.

P062 Low Timing Jitter Phase-Locked Loop for Versatile and Adaptive Synchronization in High Bit Rate Optical Sampling Systems

Erik Benkerl, Harald Telle, Physikalisch-Technische 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 wave form visualization of repetitive, including PRBS data streams 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 107Gbps 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-DPSK, RZ-4PSK and 10RZ-16QAM for the linear and non-linear channel at 107Gbps.

P064 Design Optimization of 40 Gb/s RZ-DQPSK Transceiver for High OSNR and PMD Tolerance under Fast Polarization Changes

Takahiro Hoshida, Tomo Takeda, Yuchi Akizawa, Hiroki Ooi, Kento Nakanuma, Yoshikazu Terayama, Nonikai Mauychi, Zhenning Tao, Jens Rasmussen, Hiroshi Shikata, Takafumi Tanahara, Hiroshi Ono, Fujitsu Laboratories Limited, Japan; Daisuke Taninuma, Yokogawa Electric Corporation, Japan; Hiroshi Kodaka, Yokogawa Electric Corporation, Japan

A full-band tunable, multi-rate, 43 and 44.6 Gb/s RZ-DQPSK transceiver with excellent balance of OSNR and PMD tolerances with less than 12dBm S2P8 change was realized and its manufacturing was confirmed through measurement on 100 modules.

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 a 1-bit delayed self-homodyne detection. A clear difference in the DPSK/DQPSK signal was observed in the analytical distributions of transitional amplitude and phase variations.

P066 Experimental Synchronization/Multiplexing of Optical Data Packets using Continuously-Tunable Optical Delay Based on Wavelength Conversion and Inter-channel Chromatic Dispersion

Irfan Fazal, Alan Wilner, Bo Zhang, Omer Yilmaz, Scott Nuccio, University of Southern California, USA; Martin Feser, Carsten Langrock, Stanford University, USA

100Gb/s optical data packets are synchronized and multiplexed by using continuously-tunable all-optical delay line with 24-fm tuning range. Delay reconfigurability is measured to be 276ps.

P067 Characterisation of an RZ-DQPSK transmitter using coherent detection

Chris Fudiger, Thomas Duthen, Christoph Schullien, CoreOptics GmbH; Alexander Voss, Bernhard Schmauss, University of Erlangen, Germany

We characterise the electrical output of 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 Electrical Dispersion Compensation

Daniel Elfling, 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 DPSK Signals

Masayuki Matsumoto, Osaka University, Japan

Analysis of an all-optical regenerator for DPSK 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, Antrim College, Tandem National Institute, University College Cork, Ireland; Graeme Maxwell, Alastair Poustie, Robert Harmon, Centre for Integrated Photonics, University of Sunderland, County of Tyne and Wear, England

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 Gained Clamped EDFAs in Dynamic Burst Switched Networks

Benjamin Putnam, 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 testbed.

P072 Power Saturation of MLSE-Based Electronic Equalisation in Presence of DGD and Chromatic Dispersion

Allan Schmebeck, Lucent Technologies Network Systems GmbH, Germany; Herber Haustein, University of Erlangen-Nurnberg, Wolfgang Sauer-Greff, Ralf Urbansky, University of Kaiserslautern, Germany

The MLSE equalizer performance is investigated for large DGD and CD by changing both bounds and 42.7Gbps simulations. Due to penalty saturation the required OSNR at DGDs closely above bit duration is dominant.
Poster Session  
Central Lobby

**P073** State-Complexity Reduction in MLSR Receivers for Direct-Detection Optical Communications
Michele Franceschini, Gianluigi Ferrar, Riccardo Rahel, University of Parma, Italy; Fausto Melli, Andrea Castoldi, CNR-ISTI, Italy

- We investigate the state complexity reduction techniques on the performance of MLSR-based EDFA
- 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 Pachtner, Peter Krummicch, Edgar Yoges, University of Dortmund, Etich Goehwald, Nokia Siemens Networks GmbH & Co. KG, Germany

- The combined impact of SRS and EDFA transients stemming from different origins and effects 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
Malte-Schuster, Christian Bunge, Klaus Petermann, Technical University of Berlin, Bernhard Spinnder, Nokia Siemens Networks GmbH & Co. KG, Germany

- OFDM is suggested to overcome chromatic dispersion without explicit compensation. The use of the required single-sideband modulation in combination with state-of-the-art 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, Sirkhan Ragbahan, Corning Incorporated, USA; Stefan Lobanov, Corning Incorporated, Russia

- We demonstrate uncompensated WDM transmission of 10.7 Gbit/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 MSSE-EDC receiver.

**P077** Can SSFM handle ULH 40 Gb/s WDM transmission?
Erwan Pincemin, Antoine Tan, France Telecom R&D, Yves Jaouen, GET / Telecom Paris; and Differential Encoding Schemes

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

**P078** Improving the Transmission Performance for an Extended Wavelength-Independent Single Sideband OFDM Signal Using Nonlinear Post-compensation and Differential Encoding Schemes
Wen-Li Yang, 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 can be effectively recovered by the differential detection technique.

**P079** Experimental Demonstration of PMD Compensation by LDPC-Coded Turbo Equalization
Ivan Djordjevic, University of Arizona, USA

- We propose a procedure to optimize successively the dispersion map of a 10 Gb/s WDM N×2 system. The method is based on the evaluation of nonlinear phase changes and accumulated dispersion along the transmission line.

**P080** Experimental Demonstration of PMD Compensation for NRZ systems operating at 10 Gb/s
Wei-Ren Peng, National Chiao-Tung University, Taiwan; Toshihiko Hirooka, Kou Osawa, Masataka Nakazawa, Oki Electric Industry, Japan

- We provide 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.

**P081** The Memory of Optimized Dispersion-Managed Periodic Optical Links
Paolo Serina, University of Parma, Italy; Alessandra Orlandini, University of Parma, Italy; Alberto Bononi, Universita di Parma, Italy

- We investigate DGD tolerance enhancement for 80-Gb/s signals up to 20 ps by employing pilot-carrier-aided homodyne detection with a narrow spectral linewidth light source.

**P082** Novel Scheme for High-Bit-Rate Coherent-OFDM Transmission over Strong Signal-Noise Interaction
Abdulamir Ali, Jochen Leibrich, Werner Rosenkranz, Technical University of Kiel, Germany

- We propose a novel OCDM technique that combines multi-frequency homodyne detection and optical OFDM to achieve 1-bit/s/Hz spectral efficiency without polarization-multiplexing. Numerical simulations show the validity and performance of this technique.

**P083** Novel Nonlinearities on Optical OFDM with Direct Detection
Abdulamir Ali, Jochen Leibrich, Werner Rosenkranz, Technical University of Kiel, Germany

- We numerically investigate simulation conditions to properly emulate the impact of FWM in WDM 10Gb/s systems based on low dispersion fiber, such as the statistic impact of phase/time shifts between channel or comb channels.
<table>
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<tr>
<th>Poster Session</th>
<th>Central Lobby</th>
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<tbody>
<tr>
<td>P007 Transmission of WDM Multilevel 8x30Gb/s Single Polarization RZ-DFPSK with a Total Capacity of 240Gb/s</td>
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<tr>
<td>Jesper Jensen, Torger Tolke, Christophe Peucheret, Palref Jepsen, Technical University of Denmark</td>
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<td>∗ 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 = 10⁻³.</td>
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<td>P008 Theoretical Performance Limits of Optical DPSK Under High Chromatic Dispersion</td>
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<tr>
<td>Michele Franceschini, Giorgio Bongiorni, Gianluigi Ferrari, Riccardo Raheli, University of Parma, Italy</td>
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<td>∗ 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.</td>
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<td>P009 Performance of a 43Gb/s NRZ-DFPSK Signal Over a 1440km Commercial 10Gb/s DWDM System, Under Varying DPSK Decoder FSR Values</td>
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<tr>
<td>Irene Leung, Cisco Systems Inc., Canada</td>
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<td>∗ We investigate the performance of a 43Gb/s NRZ-DFPSK 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 in optical filtering.</td>
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<td>P100 Cost and Performance Comparison in Data Vortex networks with and without shared traffic control</td>
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<td>Qimin Yang, HMC, USA</td>
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<td>∗ 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.</td>
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<td>P101 Physical layer impairment, PLI-aware routing and wavelength assignment, RWA in dispersion-managed networks</td>
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<tr>
<td>Thomas Fischer, Nokia Siemens Networks, Germany</td>
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<td>∗ A PLI-aware RWA algorithm with unique workflow is proposed for provisioning and rerouting in GMPLS-enable-</td>
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<td>d transparent DWDM networks. Although fiber non-linerarities in dispersion-managed systems are captured, standard performance assessment is outpaced by orders of magnitude.</td>
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<td>P102 Analysis of Wavelength Blocking in Large Metro Core Network Using Optical and Digital ROADM Transceivers</td>
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<tr>
<td>Serge Melle, Infinera, Vijay Vusinikata, USA</td>
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<td>∗ Network planning analysis indicates wavelength blo-</td>
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<td>king in all-optical ROADM networks incurs additional overhead for wavelength conversion, and constrains service reconfiguration. Analyses show that digital ROADM systems provide flexibility.</td>
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<td>P103 Large-scale AWG Router, 15 nodes, 217 paths Providing Full-mesh and Non-uniform Transmission Capacities</td>
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<tr>
<td>Osamu Naiki, Morikawa, Kenya Suzuki, Koichi Takiguchi, Yoshisasa Sakai, NTT Corporation, Japan</td>
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<td>∗ We developed an AWG router with non-uniform trans-</td>
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<td>mission capacities realizing the best wavelength utiliza-</td>
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<td>tion. The router has a cyclic routing table and its throughput is extended to about three times that of the previous one.</td>
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<td>P104 ASON survivability testbed supporting p-cycles pro-</td>
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<td>tection</td>
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<td>Yu-Da Zhang, Shuangguo Huang, Pei Zhang, Beijing University of Posts and Telecommunications, P.R. China; Wanli Gu, Key Laboratory of Optical Communication and Lightwave Technologies, Ministry of Education, Beijing, P.R. China</td>
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<td>∗ A distributed testbed SURBBD, Survivability Testbed for emerging networks using optical packet switching, supporting p-cycles protection is proposed and demonstrated. Based on SURBBD the performances of several tradi-</td>
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<td>tional survivance mechanisms and a p-cycles protection algorithm are evaluated.</td>
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<td>P105 Scalable all-optical packet-switching nodes: a</td>
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<td>dimensioning study</td>
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<tr>
<td>Ruth Van Caenegem, Didier Colle, Marco Pickavet, Piet Demeester, Ghent University - IMEC, Belgium</td>
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<td>∗ All-optical, with new metrics and bad scalabili-</td>
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<td>ty. This paper proposes a new AOLS node design based on wavelength stripping. It compares the new design with the original AOLS node via a dimensioning study.</td>
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<td>P106 Optical signal quality monitoring using fibre-Bragg-</td>
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<td>gratings-based correlators in optical packet-switched networks</td>
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<tr>
<td>Ruth Vilar, Francisco Ramos, Javier Marti, Universidad Politecnica de Valencia, Spain</td>
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<td>∗ 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.</td>
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<td>P107 High Performance SC Optical Packet Switching Router for Optical Circuit, Burst and Variable Length Packet Processing</td>
<td></td>
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<tr>
<td>Gustavo Puerto, Beatriz Ortega, Alfonso Martinez Garcia, Maria Manzanedo, ITEAM Research Institute; Daniel Pastor, Jose Soriano, Universidad Politecnica de Valencia, Spain</td>
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<td>∗ An optical subcarrier multiplexing packet switching router based on the label swapping paradigm support-</td>
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<td>ing optical burst switching and optical circuit switching connections at 10Gb/s on a single platform is present-</td>
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<td>P108 Strategies for the Migration from Opaque to Hybrid Networks</td>
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<tr>
<td>Annalisa Morea, Julien Pointier, France Telecom, France</td>
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<td>∗ Cost analyses usually compare fully opaque to fully hybrid networks. However no operator can afford migrating in one step its entire network. We adddress different migration strategies and identify the optimal levels of network transparency.</td>
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<td>P109 Analysis of Closed Amplified Cycles in WSS ROADM based Mesh Optical Networks</td>
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<td>David Han, Ug Mahab, ECT Telecom, Israel</td>
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<td>∗ We report experimental and numerical stability analy-</td>
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<td>sis of closed amplified optical cycles formed by mesh network with WSS ROADM</td>
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<td>P110 Link Management Protocol extensions for OMS pro-</td>
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<td>tection in GMPLS-based optical ring networks</td>
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<td>Luis Velasco, Salvatore Spadaro, Jaume Comellas, Gustavo Puerto, Alfonso Marcos, Maria Manzanedo, ITEAM Research Institute; Daniel Pastor, Jose Soriano, Universidad Politecnica de Valencia, Spain</td>
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<td>∗ In this paper we propose a mechanism to provide dedicated section protection in ring-based optical net-</td>
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<td>works. It is based on extensions to GMPLS Link Management Protocol, LMP and its performance is experimentally evaluated.</td>
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<td>P111 Planning of GMPLS Transport Networks With Conversion and Regeneration Capabilities</td>
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<td>Nabij Naas, Hussein Mouftah, University of Ottawa, Canada</td>
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<td>∗ 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 cost weighted port count.</td>
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<td>P112 Novel Architectures of Asynchronous Optical Packet Switch</td>
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<td>Aipia Chen, Lena Woisinka, Lars Thviën, Sailing He, The Royal Institute of Technology KTH/ICT, Sweden</td>
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<td>∗ 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.</td>
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<td>P113 Sub-Band-Path-Through heuristic for cost efficient wavelength assignment in DWDM networks</td>
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<tr>
<td>Sascha Kallius, Nokia Siemens Networks GmbH &amp; Co. KG, Marco Hoffmann, Siemens, Germany</td>
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<td>∗ 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 possibili-</td>
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<td>ty to patch through wavelengths of a sub-band at inter-</td>
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<td>mediate nodes.</td>
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<td>P114 Performance Comparison of OBS and OCS for VoD Applications</td>
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<td>Wei Wei, Xin Lu, Xiang Yu, Chunming Qiao, University at Buffalo, SUNY: Ting Wang, NEC Laboratories America, USA</td>
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<td>∗ 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.</td>
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<td>P115 Performance Comparison of Different Data Rate Adaptive Packet Switching Mechanisms</td>
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<td>Martin Belzner, Herbert Haunstein, University of Erlangen-Nuremberg; Dieder Stoel, Lucent Technologies Network Systems GmbH, Germany</td>
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<td>∗ Different data rate adaptation mechanisms and their influence on network and traffic characteristics are visu-</td>
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<td>alized in radar plots in order to provide a fast and fair comparison of multiple parameters at the same time.</td>
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<td>P116 The WONDER Testbed: Architecture and Experimental Demonstration</td>
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<td>Roberto Cañudo, Vito De Feo, Fabio Neri, A. La Porta, R. Birke, S. M. Finocchietto, M. Petranà, A. Antonio, Politecnico di Torino, Italy</td>
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<td>∗ We present the latest experimental results within the WONDER project, aiming at the demonstration of an advanced packet-based WDN architecture. Our results show the feasibility of all-optical networking using commer-</td>
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<td>cially available optoelectronic components.</td>
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<td>P117 Multistage Interconnection Network Photonic Controller Exploiting a Cascaded SOA-based Ulfastrode</td>
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<td>Nicola Andriolli, Mirco Scaffardi, Gianluca Berretti,</td>
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<td>Scuola Superiore Sant'Anna; Luca Poli, Consorzio Nazionale Interuniversitario per le Telecomunicazioni; Antonella Bogoni, CNIT, Italy</td>
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<td>∗ In this paper we experimentally cascades of a SOA-</td>
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<td>based module working up to 1600Gb/s to perform all-</td>
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<td>optical control and switching operations in a multistage Batcher network. We demonstrate the connection network with intermediate contention manager.</td>
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<td>P118 In-service measurement of the OSNR in ROADM-based Networks</td>
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<td>Wolfgang Moenich, JDSU Deutschland GmbH, Germany; Julia Lankova, Tellabs, USA</td>
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<td>∗ Optical networks using ROADMs present a challenge for OSNR testing. We explore a new method for mea-</td>
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<td>sureing the in-band OSNR based on a high resolution optical spectrum analyzer using a new optical polariza-</td>
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<td>tion splitting method.</td>
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<td>P119 Novel Wavelength Initialization of the Bragg-grating based tunable External Cavity Laser for WDM-PON</td>
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<td>Je Hyeon Lee, ETRI, Korea</td>
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<td>∗ We present 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.</td>
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<td>P120 Hybrid WDM/TDM-PON Using Remotely Pumped Optical Amplifier</td>
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<td>Soon-Jin Park, KT Inc., Korea; Oh Jung-Mi, Sang-Geun Koo, Donghan Lee, Chungnam National University, Korea;</td>
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<td>∗ It was shown that the remote pumping scheme increases the os-</td>
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<td>al power budget up-to 24dB for the Hybrid WDM-TDM-PON, where the coherent seed light injected RSOA is used as the colourless transmitter.</td>
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<td>P121 A Simple Configuration for WDM Full-Duplex Radio-Over-Fiber Systems</td>
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<td>Ji-Woong Lee, Jun Su, Jang-Woo, Jin-Tung Lin, Beijing University of Posts and Telecommunications, P.R. China</td>
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<td>∗ A compact and functionality-centralized configuration is presented for full-duplex millimeter-wave, mm-wave radio-over-fiber, ROF systems incorporating wave-</td>
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<td>length-division multiplexing, WDM.</td>
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Poster Session

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 propose a new bidirectional gigabit WDM-ROF system. It transmits the 3Gbit/s SSB signal which is modulated at 1.2Gbit/s using a MEM and a FBG. The system transmits 25Gbit/s with a signal using a SOA.

P123 VMAPS: A Versatile Medium Access Control and Processing System for an Optical WDM Metro Ring Network Maria C. Yang, Yu-Min Lin, National Chiao Tung University, Taiwan; Ya-Shian Wang, Chunghua 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-Woo 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 wavelength-reuse single fiber bidirectional RSOA-based WDM PON.

P125 Future-Proof WDM-PONs with Bandwidth/Waveband Upgradable VCSEL arrays Elaine Wong, ARC CUBIN, National ICT Australia, Werner Hofmann, Walter Schoffitz, Markus-Christian Amann, TU Munich, Germany

The continuous escalation of bandwidth demand in WDM-PONs is supported with VCSEL arrays that facilitate the migration of CWDM to DWDM operation from 2.5 Gbit/s to 80 Gbit/s without further investment into transmitter infrastructure.

P126 Using Sub-sampled Fiber Bragg Grating to Achieve Laser Sources Compatible OCDMA En/decoders Tao Pu, Yuquan Li, Rong Wang, Jinlin Zheng, Peng Chen, Yingjun Zhu, Lin Lu, Institute of Communication Engineering, Nanjing, P.R.China

A novel sub-sampling technology is given, which can be used to multiplex multiple en/decoders at 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 Michael Senior, University of Hertfordshire, United Kingdom

A dynamic access network architecture based on coarse-routed PONs is described. Modelling of a coarse-routed PON presents a solution to support multiple RSOA-based ONUs, which have 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 with MLL 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, Thissara Jayasinghe, NICITA, 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 2.5Gbit/s continuous mode receiver.

Poster Session

P130 Wavelength Cross-Connect Switching System with Dynamic Capacity Control that uses PLC-based WSS. Atsushi Taniguchi, Akira Hirano, Takashi Goh, Akimasa Kaneko, Takuya Matsuura, Yuhinori 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 Forini, Giorgio Tosi Belletti, Franco Guri, Natalia Corsi, Gabriella Ciccotti, University of Roma, Valeria De Sanctis, Uninoima, Italy; Antonio Tiekera, 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/hundred of meters scenario.

P132 Local Area networking in a Multi-functional Repeater-based Optical Access Network Nishanthan Nadarajah, Chang-Joon Chae, NICITA, Australia; An Tran, Thais 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 networking 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-Perot Laser Diodes Without a Seed Light Injection Si-Gu Mun, Korea Advanced Institute of Science and Technology, Korea

We demonstrate a WDM-PON by employing a dual-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, Taiganghua University, P.R. China

A criterion, fmaxLmaxD=10^2, is proposed to judge the maximum fiber access distance, within which chromatic dispersion can be neglected. It is verified by 2×2 DS-OCDMA system at 127-chip 500-Gchip/s.

P136 Optical network architecture for UWB range extension beyond a single complex of cells Mehtem Toycan, 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 1.2 μm and 850 nm Directly Modulated High Speed VCSELs for Low Cost WLAN-over-Fibre Systems David Yao, Michael Sauer, Eric Sadowski, Catherine Canave, Chung-En Zih, Frank Annunziata, Coming Incorporated, USA; Nobuhiko Nishiyama, Tokyo Institute of Technology, Japan

The nonlinearity and RIN of 1.3μm/850nm VCSELs was evaluated at the 2.4/5.8GHz bands to investigate their viability for WLAN-over-fibre systems. More than 38dBm singlemode and 300μm multimode reach can be achieved.
Invited: Performance of MLSE in Optical Communication Systems
Theodor Kupfer, Stefan Langenbach, Nebojsa Stojanovic, Soeren Gehrze, James Whiteaway, CoreOptics GmbH, Germany

We show the improvements maximum likelihood sequence estimation, utilizing MLSE brings for different transmission impairments in optical transmission systems. We consider MLSE with 6 states and 16 states and show the impact of other parameter choices.

Plenary: 10:00 Hiroshi Nakano, University of Tokyo, Japan

Semiconductor Lasers and Amplifiers

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.

Tunable Distributed Amplification, TDA-DFB Laser Array Using Asymmetric Periodic Structure
Nobuhito Nuyona, Hencyuki Ishii, Yoshitaka Kawaguchi, Hiroshi 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-LO array.

Demonstration of C- and L-band external cavity wavelength tunable laser utilizing a wideband SOA with coupled quantum well active layer
Shinya Sudo, Kenji Matuzaki, 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 QWIs. Low threshold current deviation, over 13-Gbit/s fiber coupled power, and high SMR across 77-nm tuning range are demonstrated.

Coherent Demodulation of Optical Quadrature Duobinary Signal with Spectral Efficiency of 4 bit/s/Hz per Polarization
Kazuro Kikuchi, Kachohi Kato, 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.

Performance of 2.5 Gb/s and 10 Gb/s transparent and adiabatic chirped directly modulated lasers using electronic dispersion compensation
Ioannis Pagoniannis, Alexios Birbas, University of Patras, Greece; Churmin Xia, Werner Rosenkranz, University of Kiel, Germany; Demitrios Klonidis, Ioannis Tomkös, 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.

Suppressing dynamic instabilities in PDM compensators by dithering the polarization of the transmitted signal
Ernesto Caramella, Emma Matarazzo, Scuola Superiore Sant’Anna University, Italy

Dynamical issues of practical PMD compensators Gregory Raybou, 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.

Limitations of MLSE-EDC for application with signals limited by self-phase modulation, and high SMSR across 77-nm tuning range are demonstrated.

50 nm tuning of a 3DBR-MMI-SOA covers 41 nm tuning with 43-Gb/s and 21.5-Gb/s RZ-DQPSK is demonstrated without penalty relative to a traditional receiver.
9.6.2 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 Optically Powered Video Camera Link

Gunnar Böttger, Michael Hübers, Christos Klamous, Michael Dreschmann, Juergen Becker, Wolfgang Freude, Juerg Leuthold, Moni 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 Discrete Multi-Tone Modulation for Low-Cost and Robust 10-Gb/s Transmission over Polymer Optical Fibre

Jeffrey Lee, Jannen Zeng, Henrie van den Boom, Tim 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 fiber. A new low-cost, low-noise discrete multi-tone modulation, achieving a spectral efficiency of 5.3 bits/Hz.

9.6.5 100Mb/s Transmissions over Short Reach Si-POF Links: Experimental Demonstration of Extended Reach Systems

Daniel Cândea, Roberto Gaudino, Politecnico di Torino, Antonio Nespola, Stefano Camatel, 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 demonstrated error-free transmission, 100Mbit/s over 200m links and reliable transmission after FEC over 275m links.

9.6.6 1.25 Gbit/s Transmission over up to 100 m Standard 1 mm Step-Index Polymer Optical Fibre using FFE or DFE Equalization schemes

Florian Breyer, Norbert Hank, Munich University of Technology, Sebastian Randel, Siemens, Germany; Jeffery Lee, University of Technology Eindhoven, The Netherlands

A 1.25 Gbit/s OOK-transmission over up to 1000 m Si-POF is demonstrated using digital symbol-spaced equalisers such as Feed-Forward-Equaliser, FFE and Decision-Feedback-Equaliser, DFE.
Post-Deadline Session 1

Chair: Andrea Galtarossa, Universita' di Padova, Italy

10.1.1 Location and temporal characterization of hinges in optical fiber links
Andrea Galtarossa, Daniela Grossi, Luca Palmeni, 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 Fast measurement of local PMD with high spatial resolution using stimulated Brillouin scattering
Luc Thevenaz, Stella Foaengang 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 fibre using the polarization dependence of stimulated Brillouin scattering, in a non-destructive and simple way.

10.1.3 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 The role of birefringence correlation in spun fiber PMD propagation
Andrea Galtarossa, Luca Palmeni, 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 Novel Technique for PMD Measurements of Installed Fibers Using Random Polarization Scrambling and a Tunable OTDR
Horacio H. de N. Normand Cyr, Gregory Schirn, Bernard Ruchtel, 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 The effect of polarization mode dispersion on gain and delay spectra of Raman amplified Er-doped double-clad fibers
Gadi Eisenstein, Amnon Willinger, Evgeny Shumaker, Technion Institute of Technology, Israel

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 inter-action mechanisms.

10.1.7 Analysis of Birefringence Effect in Long Period Gratings through Measurements of Chromatic and Polarization Mode Dispersions
Sebastien Bette, Christophe Caucheteur, Marc Wulpert, Patrice Megret, Faculte Polytechnique de Mons, FRIBs, Belgium; Raimundo Garcia-Olcina, Salvador Sales, Jose Capmany, Universidad Politcnica 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.

10.1.8 Tutorial: Nonlinear Fiber Optics: New Fibers - New Opportunities
John Dudley, Universit de Franche-Comte, 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.

10.1.9 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.

Lunch Break 12:30 - 14:00

Post Deadline Sessions 2

Chair: Guang-Hua Duan, Alcatel Thales III-V Lab, France

10.3.1 Invited: 80-Gbit/s InP DQPSK modulator with an n-p-i structure
Norihito Klukhi, Hiroaki Sanjoh, Yasu Shibata, Tomonari Sato, Ken Tsuazki, Eichi Yamada, Tadakshi Ishihashi, Hiroshi Yasaki, NTT Corporation, Japan

We developed an InP DQPSK modulator with a newly designed n-p-i 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 Demonstration of 10 Gb/s C+L band InP-based Mach-Zehnder Modulator
Masakazu Ohnori, Kiyotaka Tsurumizu, Tomohiko Kato, T. Morimoto, Shinya Sudoh, Takeshi Okamoto, Kenji Matsuura, 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 1528-1610 nm.

10.3.3 Single MZI-based 1x4 DQPSK demodulator
Manabu Oguma, Tatsuke 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 Low-drive-voltage and compact RZ-DQPSK LiNbO3 Modulator
Masaki Sugiyama, Masaharu Ooi, Tetsu Hasegawa, Takeshi Nishida, 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 Low-chip QPSK modulator integrated in poled Z-cut LiNbO3 substrate for 2 x Multigbit/s transmission
Henri Porte, Jerome Hauden, Nicolas Grossard, Pascal Micon, Photoline Technologies, France; Salwan Ibrahim, Reinhold Noé, University of Paderborn, Germany

We report a QPSK modulator realized in Z-cut lithium niobate crystal. The chip 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 High modulation bandwidth reflective SOA for optical access networks
Romain Derout, Alcatel-Thales III-V Lab, France

We have demonstrated that the use of a two electro-dces configuration drastically improves the modulation bandwidth of Reflective SOA from 2 to 6 GHz.
Thursday, September 20 – 10:45 - 12:30

Session 10.4  40 Gbit/s Systems  Hall 7

Chair: Christophe Puechereu, Technical University of Denmark, Denmark

10.4.1  10:45
Invited: Digital Coherent Receivers for Uncompensated 42.8 Gbit/s Transmission over High PMD Fiber
Seb Savory, Vitaly Mikhalkov, Robert Killey, Polina Bayvel, University College London, United Kingdom

We outline the principles behind digital coherent receivers and report simultaneous compensation of 53, 7125 ps/nm chromatic dispersion from 3000 km of SMF and a mean DGD up to 168 ps using 42.8 Gbit/s PDM-QPSK with a digital coherent receiver.

10.4.2  11:15
Investigation of single channel nonlinear impairments on 40 Gbit/s coherent Polarization Division Multiplexed DQPSK in dispersion managed or digitally post compensated systems
Massimiliano Carbone, Parma, Italy; Renaudier Jeremie, Gabriel Charlet, Oriol Bertrand Pardo, Patrice Tran, Sebastien Bigo, Alcatel-Lucent France Research & Innovation, France

The nonlinearity tolerance of 40 Gbit/s coherent PDM-QPSK is investigated. Inline dispersion managed systems achieve 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-Gb/s NRZ-DQPSK WDM Transmission over Raman Amplified NZDSF Spans
Chunghie Xie, Sethumadhavan Chandrasekar, Xiang Liu, Bell Labs, Alcatel-Lucent, USA

We show that inter-channel cross-phase modulation, XPM significantly reduces the performance of a 10-Gb/s differential-quadrature-phase-shift-keying, DQPSK WDM transmission system, and nonlinear polarization scattering causes further performance degradation when polarization multiplexing is applied.

10.4.4  11:45
Dispersion Map Suitable for Hybrid 10 Gbit/s NRZ and 40 Gbit/s RZ-DQPSK Transmission over 50 GHz Spaced Network with Low Dispersion Fiber
Kostas Karkanis, Maria Nikopoulou, Maria Marra, Takeshi Hoshida, Hiroki Ota, George Ishikawa, Takafumi Teranaka, Hiroshi Onaka, Fujitsu Laboratories Ltd., Japan; Yoshiaki Otsubo, Fujitsu Laboratories of America, Inc., USA

We propose a dispersion compensation strategy that enables smooth migration from low-initial cost, with 100 Gbit/s NRZ to high ultimate capacity, with 40 Gbit/s RZ-DQPSK for 50 GHz spaced photonic networks, and demonstrate transmission reach beyond 1350 km.

10.4.5  12:00
Equalized 42.8 Gbit/s Transmission Based on a 100 Gbit/s EML Transmitter
Nikola Alic, Evgeny Myasyltsev, James Coles, Robert Sapenstorfer, Joshua Windmiller, Stotan Radi, Rui Jiang, University of California San Diego, USA; Paul Firth, Christopher Clarke, Bookham Technology plc, United Kingdom

A low cost 10 Gbit/s electro-absorption modulated laser was directly driven by 42.8 Gbit/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; Kueyong Zheng, Daniel Maggrehfeth, Finisar Corp, USA

We demonstrate transmission at 42.8 Gbit/s over 20 km standard single mode fiber with BER smaller than 1x10^-3 without dispersion compensation using a directly modulated chirp managed laser.

Session 10.5  10.6 Optical Network Systems  Hall 9

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, Akhide Sano, Hiroshi Masuda, Eiji Yoshida, Shigeki Aisawa, NTT Network Innovation Laboratories

We review the recent challenges facing high-capacity transport technologies. Novel modulation formats, multiple 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  11:00
Simple Node Architectures for Concatenation of ROADM Rings
Kyo ichi Hasegawa, Ken-Ichi Sato, University of Nagoya, Japan

We present simplified node architectures for connecting two ROADM rings. The necessary switch 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  11:15
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, Yanhu Jin, Guo Wei, Weiqiang Sun, Shilin Xian, Yikai Su, Shanghai Jiao Tong University, P.R. China; Wen-De Zhong, Nanyang Technological University, Singapore

By exploiting the symmetry of bidirectional wave-length-connections in WDM networks, we propose N×N bidirectional OXCs using one N×2xN/2 reversible optical switch to reduce the complexity of OXCs. The feasibility is demonstrated at 10 Gbit/s.

10.5.4  11:30
Demonstration of Contention Resolution and 100 km Transmission for IP/10Gbe over 80 bit/s, 87 x 10 Gbit/s Colored Optical Packet Switching Network using 160 Gbit/s Throughput Optical Packet Switching Network
Hideoke Furukawa, Naoya Wada, Hiroaki Harai, Yasunori Aikado, Makoto Naruse, Hideki Otsuki, Tetsuya Miyazaki, Naoki Kawanaka, Katuyoshi Sakurai, Akira Toyama, Naoki Itou, Hiroshi Shimizu, Yokogawa Electric Co., Hiroshi Fujimura, Hitachi, Ltd., NTT Electronics Co., Japan; Eddie Kong, Amonics ltd., Hong Kong

Contention resolution and 100 km transmission of 87 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-line and buffer, and transient-responsiveness-suppressed EDFA's.

10.5.5  11:45
100Gbit/s packet generation with spectral efficiency larger than 1bit/Hz/mi by using optical carrier suppression and separation and vestigial sideband filtering techniques
Jianjun Yu, Lei Xu, Philip Ji, Ting Wang, NEC Labs America, Inqin Yang, HMMC, Zhensheng Jia, Gue-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/mi for the first time. The performances of transmission and label erasure have also been evaluated.

10.5.6  12:00
Demonstration of Modified Hadamard Codes for OCDM-based Confidentiality
Arjyal Agrawal, Albert Menedez, Paul Tolver, 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 valuable for potentially enhancing data confidentiality.

10.5.7  12:15
A Novel WDM-PON Architecture with Selective-Broadcast Overlay
Ning Deng, Chun-Kit Chan, Luan-Kuan Chen, Chinnon Lin, The Chinese University of Hong Kong, Hong Kong

We propose and experimentally demonstrated a novel multi-services WDM-PON system by using centralized lightwave sources. The service provision with 10Gbit/s OOK and DPXK downstream signals and 1.25Gbps upstream data has been successfully realized.

Session 10.6  Networks for Broadband Services  Hall 10

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 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 Horuchi, KDDI R&D Laboratories, 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-Gbps link using Manchester encoding is reduced by >86%.

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; Gue-Kung Chang, Georgia Tech,

We propose and experimentally demonstrated a novel multi-services WDM-PON system by centralizing lightwave sources. The service provision with 10Gbit/s OOK and DPSK downstream signals and 1.25Gbps upstream data has been successfully realized.

Closing Session  15:45 - 16:00     –     Hall 3

Post Deadline Session 4
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:

VDE Conference Services
Ms. Hatice Altintas
Stresemannallee 15
60596 Frankfurt
Germany

Phone: +49-(0)69-63 08-477
Fax: +49-(0)69-96 31-5213
E-mail: vde-conferences@vde.com
Homepage: www.ecoc2007.de

ECOC 2007 Exhibition Organisers

Nexus Media Communications
Mrs. Beverley Lucas - Event Manager
Media House Azalea Drive
Swanley
BR8 8HU Kent
United Kingdom
Phone: +44 (0)1322 660070
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

<table>
<thead>
<tr>
<th>Category</th>
<th>Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member* (VDE, EUREL, IEEE)</td>
<td>€695-</td>
</tr>
<tr>
<td>Non-member</td>
<td>€765-</td>
</tr>
<tr>
<td>Student**</td>
<td>€350-</td>
</tr>
<tr>
<td>Workshop only</td>
<td>€100-</td>
</tr>
<tr>
<td>Additional Conference proceedings</td>
<td>€70-</td>
</tr>
<tr>
<td>Ticket for the Conference Dinner***</td>
<td>€110-</td>
</tr>
<tr>
<td>Ticket for the Historical Train***</td>
<td>free</td>
</tr>
<tr>
<td>Get Together on Sunday, Sept. 16</td>
<td>free</td>
</tr>
<tr>
<td>Welcome Reception on Monday, Sept. 17</td>
<td>free</td>
</tr>
</tbody>
</table>

* 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 delagates.
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
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
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)

La Pergola (just over the railway bridge)  
Pizzeria (approx. 6 min walk)

Asado am ICC (in front of ICC, through the passerelle)  
Argentinian Steakhaus (approx. 5 min walk)

Panda (in front of ICC, through the passerelle)  
Chinese Restaurant (approx. 5 min walk)

Bistro - Bredow  
Internat. Cuisine (approx. 10-12 min walk)

SON DO - Chinese Restaurant  
Vegetarian (approx. 10-12 min walk)

Döner Imbiss (over the railway bridge)  
Near the ICC

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**Map of ICC Environments**

- Haupteingänge / Main entrances
- Bedarfseingänge / Reserve entrances
ECOC 2007 Program Overview

**Saturday, September 15**
- 18:00 - 19:00: Registration

**Sunday, September 16**
- 18:00 - 19:00: Registration

### 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
  - Session 1.5: Fibers and Fiber Components

### Session 1.6
- Optical Burst Switching

### Session 2.1
- Forward Error Correction in High Capacity Systems
  - Session 2.2: Optical Communication Systems

### Session 2.3
- Session 2.4: Fiber Lasers and Amplifiers II

### Session 2.5
- MUX/DEMUX and Waveguides

### Session 3.1
- Electronic Mitigation
  - Session 3.2: Ethernet/DSL

### Session 3.3
- Radio over Fibre
  - Session 3.4: All-Optical Signal Processing

### Session 3.5
- Signal Monitoring
  - Session 3.6: Measurement and Sensing

### Session 4.1
- POF Symposium
  - Session 4.2: OFDM I

### Session 4.3
- SDA-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

### 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
- Photodetectors and Receivers

### Session 6.1
- Photonic Crystal Fibers I
  - Session 6.2: Advanced Modulation Formats

### Session 6.3
- Session 6.4: WDM-PON Networks

### Session 6.5
- Transport Testbeds
  - Session 6.6: Emerging Technologies

### Session 7.1
- Photonic Crystal Fibers II
  - Session 7.2: Coherent Systems I

### Session 7.3
- Session 7.4: Access Systems

### Session 7.5
- Network Design I
  - Session 7.6: Performance Improvement and Monitoring in PONs

### Session 8.1
- VCSEL and High-Speed Laser Modulations
  - Session 8.2: Slow Light

### Session 8.3
- Session 8.4: Long Reach and High Capacity PONs

### Session 8.5
- Network Design II
  - Session 8.6: Quantum Dot Lasers and Amplifiers

**Monday, September 17**
- 08:00 - 09:00: Opening Ceremony and Plenary Session

### Session 1.1
- Session 1.2: Silicon Photonics

### Session 1.3
- High-Speed Transmission

### Session 1.4
- Fiber Lasers and Amplifiers

### Session 1.5
- Fibers and Fiber Components

### Session 1.6
- Optical Burst Switching

### Session 2.1
- Forward Error Correction in High Capacity Systems

### Session 2.2
- Optical Communication Systems

### Session 2.3
- Session 2.4: Fiber Lasers and Amplifiers II

### Session 2.5
- MUX/DEMUX and Waveguides

### Session 3.1
- Electronic Mitigation

### Session 3.2
- Ethernet/DSL

### Session 3.3
- Radio over Fibre

### Session 3.4
- All-Optical Signal Processing

### Session 3.5
- Signal Monitoring

### Session 3.6
- Measurement and Sensing

### Session 4.1
- POF Symposium

### Session 4.2
- OFDM I

### Session 4.3
- SDA-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

### 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
- Photodetectors and Receivers

**Tuesday, September 18**
- 18:00 - 20:00: Departure Historical Train (prebooked places only)

**Wednesday, September 19**
- 18:00 - 19:00: Poster Session

**Thursday, September 20**
- 18:30 - 19:30: Conference Dinner (German Museum of Technology)
ECOC 2007
33rd European Conference and Exhibition on Optical Communication
September 16–20, 2007, Berlin, Germany

ICC Berlin
Internationales Congress Centrum Berlin

Registration / Conference / Meeting Rooms / Exhibition / Catering

ITG

VDE