OFC/NFOEC 2010 Archive

Technical Conference: March 21-25, 2010

Exposition: March 23-25, 2010

San Diego Convention Center, San Diego, California, USA

At OFC/NFOEC 2010, innovation and optimism in the industry were some of the key themes resonating with attendees and exhibitors. Technical presentations featured the latest breakthroughs in the drive for more capacity, as data transmission rates of more than 69 Tbits/s were reported, along with other key developments in wireless backhaul, datacom, passive optical networks, nonlinear fiber devices and much more.

On the show floor, companies from the systems, carrier and components sectors added an enhanced level of interest with mobile trailers, industry-first announcements and demos of 100G deployment, as the industry moves forward from 10G and 40G into a 100G reality. New this year, the Fiber Optic Switch and Technology Center featured two days of sessions exploring how advanced fiber connectivity and automated switching can help in provisioning, testing and monitoring various network architectures. Also new, the Optical Internetworking Forum presented a program on the building blocks for highly intelligent, reliable, interoperable networks, including insights into 100G, control plane and on-demand carrier services. At OFC/NFOEC's Market Watch and Service Provider Summit events, industry leaders presented on the state of the optical industry, photonic integration, wireless backhaul, carrier networks, super data centers and FTTx.

A series of events honoring Nobel Prize winner Charles Kao took place this year, after the 2010 conference was dedicated to the "Father of Fiber Optics." More than 40 years ago, Kao discovered a way to make light travel long distances down a glass fiber, spawning what would become a whole new field—optical fiber communication.

As a promising indicator that the industry is rebounding, attendance at OFC/NFOEC increased this year to 9,700 attendees. The more than 500 participating companies overwhelmingly reported strong leads and renewed interest from customers across the three exhibition days maintaining the show's standing as the world's largest optical communication event. Attendees were also treated to more than 700 technical presentations from leading research groups across the globe.

Next year, OFC/NFOEC moves north to Los Angeles, California. Mark your calendars for March 6 – 10, 2011 for what will continue to be the largest worldwide venue for doing business with the most important companies in the industry and for announcing the most cutting-edge optical communication research.

OFC/NFOEC 2010 to be Dedicated to Nobel Prize Winner and Industry Pioneer Charles Kao

This year's conference is being dedicated to Dr. Charles Kao, winner of the 2009 Nobel Prize for Physics. Dr. Kao will be honored at the OFC/NFOEC Plenary and Awards Session on March 23 with a special address by Tingye Li, retired AT&T research scientist and lightwave communications pioneer. A Special Symposium on Kao's life and the influence of his work will be held March 24. The OFC/NFOEC Exhibit Hall will feature a video tribute to Kao in its Video Theater.

2010 Agenda, Abstracts and Postdeadline Results

OFC and NFOEC Abstracts

Monday, March 22, 2010

Tuesday, March 23, 2010

Wednesday, March 24, 2010

Thursday, March 25, 2010

Agenda of Sessions and Key to Authors and Presiders

Agenda of Sessions

Key to Authors and Presiders

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Kyunghwan Oh, *Yonsei Univ., Korea*
David Richardson, *Univ. of Southampton, UK*
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Misha Sumetsky, *OFS Labs, USA*

B. Fiber and Waveguide Based Devices: Amplifiers, Lasers, Sensors, and Performance Monitors

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C. Optical Devices for Switching, Filtering, and Signal Compensation

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F. Transmission Subsystems and Network Elements

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3. Market Watch and Service Provider Summit

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Symposia Organizers

Beyond Telecom and Datacom: Optical Interconnects for the Computercom Era
Clint Schow, *IBM T. J. Watson Res. Ctr., USA*
Michael Tan, *Hewlett-Packard Labs, USA*

Symposium on Quantum Communications
Richard Hughes, *Los Alamos Natl. Lab, USA*
Thomas Chapuran, *Telcordia Technologies, USA*

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Atul Srivastava, *OneTerabit, USA*

2010 Invited Speakers

Category A. Fibers and Optical Propagation Effects

OMG1, **Recent Progress in Tellurite Fibers**, *Yasutake Ohishi, Guanshi Qin, Meisong Liao, Xin Yan, Takenobu Suzuki; Toyota Technological Inst., Japan*

OMG6, **Bi-Doped Fiber Lasers and Amplifiers for a Wavelength Range of 1300-1500 nm**, *Evgeny M. Dianov; Fiber Optics Res. Ctr., Russian Acad. of Sciences, Russian Federation*

OMO3, **High Power Fiber Lasers and Amplifiers for Applications in Telecommunications**, *George H. BuAbbud; IPG Photonics Corp., USA*

OMO6, **Ultimate Power Limits of Optical Fibers**, *Jay W. Dawson, Michael J. Messerly, Raymond J. Beach, Miroslav Y. Shverdin, Arun K. Sridharan, Paul H. Pax, John E. Heebner, Craig W. Siders, C. P. J. Barty; Lawrence Livermore Natl. Lab, USA*

OTuI1, **Next Generation Transmission Fiber for Coherent Systems**, *Rong Chen, Maurice O'Sullivan, Charles Ward, Serge Asselin, Michel Belanger; Nortel, Canada*

OWA2, **Nano-Engineered Optical Fibers and Applications**, *Ming-Jun Li, Pushkar Tandon, Dana C. Bookbinder, Daniel A. Nolan, Scott R. Bickham, Mark A. McDermott, Robert B. Desorcie, Jeffrey J. Englebert, Stephan L. Logunov, Valery Kozlov, James A. West; Corning, Inc., USA*

OWK5, **Actively Doped Solid Core Photonic Bandgap Fiber**, *Jes Broeng[1], Christina B. Olausson[1], Jens K. Lyngsø[1], Hiroki Maruyama[2], Ken-ichi Ueda[2]; [1]NKT Photonics, Denmark, [2]Inst. for Laser Science, Univ. of Electro-Communications, Japan*

Category B. Fiber and Waveguide-Based Devices: Amplifiers, Lasers, Sensors and Performance Monitors

OTuJ5, **Yb Fiber-Based Frequency Combs**, *Ingmar Hartl, Axel Ruehl, Martin Fermann; IMRA America, Inc., USA*

OWB1, **Polychromatic Sampling for High-Speed Real-Time Processing**, *Andreas O. J. Wiberg, Camille-Sophie Brès, Bill P. P. Kuo, José M. Chavez Boggio, Nikola Alic, Stojan Radic; Univ. of California at San Diego, USA*

OWL1, **New Prospects for Poled Fiber Technology in Frequency Doubling and Sensing**, *Simon Fleming,*
Honglin An, Andrew Michie; Univ. of Sydney, Australia

OThA7, **Astrophophotonics: A New Generation of Astronomical Instruments**, *Joss Bland-Hawthorn; Univ. of Sydney, Australia*

OThI3, **Linear and Nonlinear Semiconductor Optical Amplifiers**, *Juerg Leuthold; Univ. of Karlsruhe, Germany*

OThI4, **Burst-Mode Optical Amplifier**, *Yoshinari Awaji[1], Hideaki Furukawa[1], Benjamin J. Puttnam[1], Naoya Wada[1], Peter Chan[2], Ray Man[2]; [1]NICT, Japan, [2]Amonics Ltd., Hong Kong*

OThQ3, **Applications of Volume Bragg Gratings in High-Power Fiber Lasers**, *Fredrik Laurell, Pär Jelger, Valdas Pasiskevicius; Royal Inst. of Technology, Sweden*

OThQ6, **Slow Light Laser Oscillator**, *Yaakov Shevy, D. Shevy, R. Lee, D. Provenzano; Orbits Lightwave, Inc., USA*

Category C. Optical Devices for Switching, Filtering and Signal Compensation

OMH2, **Nanophotonic Devices by Dressed Photon Exchange**, *Motoichi Ohtsu; Univ. of Tokyo, Japan*

OMP1, **Photonic Crystal Slow Light Devices-Tunable Delay, Nonlinearity, Dynamic Tuning**, *Toshihiko Baba[1,2]; [1]Yokohama Natl. Univ., Japan, [2]CREST, Japan Science and Technology Agency, Japan*

OMP4, **Monolithically Integrated Phased-Array Switch for Optical Packet Switching and Interconnection**, *Yoshiaki Nakano, Takuo Tanemura, Ibrahim Murat Soganci; Univ. of Tokyo, Japan*

OWJ3, **Silicon Integrated Waveguide Devices for Filtering and Wavelength Demultiplexing**, *Folkert Horst; IBM Res.–Zurich, Switzerland*

OThB3, **Towards Silicon on Insulator DQPSK Demodulators**, *Lars Zimmermann[1,2], K. Voigt[2], G. Winzer[2], K. Petermann[2]; [1]IHP Microelectronics, Germany, [2]Technische Univ. Berlin, Germany*

OThJ1, **Endless Optical Polarization Control and PMD Compensation**, *Reinhold Noé, Benjamin Koch, Vitali Mirvoda, David Sandel; Univ. Paderborn, Germany*

OThR1, **System Requirements for WSS Filter Shape in Cascaded ROADM Networks**, *Fred Heismann; JDS Uniphase, USA*

Category D. Optoelectronic Devices

OMQ3, **High Performance "Green" VCSELs for Data Centers**, *Akihiko Kasukawa, K. Takaki, H. Shimizu, T. Kageyama, Y. Kawakita, N. Iwai, K. Hiraiwa, S. Imai, T. Takagi, N. Tsukiji, S. Kamiya, T. Ishikawa; Furukawa Electric Co., Ltd., Japan*

OWD2, **InP-Based Photonic Integration Circuits**, *Shinji Matsuo[1], Toru Segawa[1], Takaaki Kakitsuka[1], Yasuo Shibata[1], Akihiko Shinya[2], Masaya Notomi[2], Tomonari Sato[1], Yoshihiro Kawaguchi[1]; [1]NTT Photonics Labs, NTT Corp., Japan, [2]NTT Basic Res. Labs, NTT Corp., Japan*

OWD3, **Current View of Large Scale Photonic Integrated Circuits on Indium Phosphide**, *Charles Joyner, P. Evans, S. Corzine, M. Kato, M. Fisher, J. Gheorma, V. Dominic, P. Samra, A. Nilsson, J. Rahn, A. Dentai, P. Studenkov, M. Missey, D. Lambert, R. Muthiah, R. Salvatore, S. Murthy, E. Strzelecka, J. Pleumeekers, A. Chen, R. Schneider, R. Nagarajan, M. Ziari, J. Stewart, F. Kish, D. Welch; Infinera Corp., USA*

OWN6, **Remote Amplified Modulators: Key Components for 10 Gb/s WDM PON**, *Christophe Kazmierski; Alcatel-Thales III-V Lab, France*

OWU5, **High Performance Photonic Integrated Circuits for Coherent Fiber Communication**, *Chris Doerr; Bell Labs, Alcatel-Lucent, USA*

OThC1, **1060-nm VCSEL-Based Parallel-Optical Modules for Short Link Applications**, *Hideyuki Nasu, Yozo Ishikawa, Yoshinobu Nekado, Masakazu Yoshihara, Atsushi Izawa, Toshinori Uemura, Katsutoshi Takahashi; Furukawa Electric Co., Ltd., Japan*

OThC6, **High Speed Electronic Circuits for 100 Gb/s Transport Networks**, *Michael Möller[1,2]; [1]Saarland Univ., Germany, [2]MICRAM Microelectronic GmbH, Germany*

OThS3, **High-Speed Optical Transceiver and Systems for Optical Interconnects**, *Kurata Kazuhiko; NEC Corp., Japan*

OThS4, **High-Speed Optical/Electrical Devices and Their Integration for Highly-Efficient 100GbE**, *Toshiki Sugawara[1], Shigehisa Tanaka[1,2], Tatsuya Saito[1], Shinji Tsuji[1,2], Masahiro Aoki[1], Masato Shishikura[3], Hiroki Irie[3], Masanobu Okayasu[3]; [1]Hitachi, Ltd., Japan, [2]Optoelectroic Industry and Technology Development Association, Japan, [3]Opnext Japan, Inc., Japan*

Category E. Digital Transmission Systems

OMJ3, **Advanced Coherent Modulation Formats and Algorithms: Higher-Order Multi-Level Coding for High-Capacity System Based on 100Gbps Channel**, *Xiang Zhou[1], Jianjun Yu[2]; [1]AT&T Labs-Res., USA, [2]NEC Labs America, Inc., USA*

OMR5, **Data-Aided vs. Blind Single-Carrier Coherent Receivers**, *Maxim Kuschnerov[1], Kittipong Piyawanno[1], Bernhard Spinnler[2], Peter Kainzmaier[2], Mohammad S. Alfiad[3], Antonio Napoli[2], Berthold Lankl[1]; [1]Univ. of the Federal Armed Forces, Germany, [2]Nokia Siemens Networks GmbH & Co. KG, Germany, [3]Eindhoven Univ. of Technology, Netherlands*

OTuD3, **The Capabilities of the Undersea Telecommunications Industry**, *Neal Bergano; Tyco Telecommunications, USA*

OWE1, **Nonlinear Polarization Effects and Mitigation in Polarization Multiplexed Transmission**, *Chongjin Xie; Bell Labs, Alcatel-Lucent, USA*

OWE4, **Ultra-High Spectral Efficiency Transmission**, *Alan Gnauck, Peter J. Winzer; Bell Labs, Alcatel-Lucent, USA*

OThD1, **High Symbol Rate OFDM Transmission Technologies**, *Fatima C. Garcia Gunning[1], Selwan K. Ibrahim[1], Paola Frascella[1], Paul Gunning[2], Andrew D. Ellis[1]; [1]Tyndall Natl. Inst., Univ. College Cork, Ireland, [2]Futures Testbed, BT Innovate and Design, UK*

OThL1, **Soft Decision FEC for 100G Transport Systems**, *Kiyoshi Onohara, Yoshikuni Miyata, Takashi Sugihara, Kazuo Kubo, Hideo Yoshida, Takashi Mizuochi; Mitsubishi Electric Corp., Japan*

OThT1, **Advances in MLSD-Equalized Incoherent Transmission**, *Nikola Alic; Univ. of California at San Diego, USA*

OThT6, **56 GS/s ADC: Enabling 100GbE**, *Ian Dedic; Fujitsu Microelectronics Europe GmbH, UK*

Category F. Transmission Subsystems and Network Elements

OMS1, **Real-Time Prototypes for Digital Coherent Receivers**, *Chris Fludger[1], J. C. Geyer[2], T. Duthel[1], S. Wiese[1], C. Schulien[1]; [1]CoreOptics GmbH, Germany, [2]Univ. of Erlangen-Nuremberg, Germany*

OMS6, **Towards Real-Time Implementation of Optical OFDM Transmission**, *Qi Yang[1,2], Noriaki Kaneda[1], Xiang Liu[1], S. Chandrasekhar[1], William Shieh[2], Y. K. Chen[1]; [1]Bell Labs, Alcatel-Lucent, USA, [2]Univ. of Melbourne, Australia*

OTuE5, **Recent Progress on Nonlinear Compensation Technique in Digital Coherent Receiver**, *Takeshi Hoshida[1], Takahito Tanimura[2], Shoichiro Oda[2], Toshiki Tanaka[2], Hisao Nakashima[1], Zhenning Tao[3], Lei Li[3], Ling Liu[3], Weizhen Yan[3], Jens C. Rasmussen[1]; [1]Fujitsu Ltd., Japan, [2]Fujitsu Labs Ltd., Japan, [3]Fujitsu R&D Ctr., China*

OTuM5, **Next Generation Photonic Network Elements - Multigranularity Switching and Rate Flexible Transponders**, *Kazushige Yonenaga; NTT Network Innovation Labs, NTT Corp., Japan*

OThE3, **40G and 100G Deployment on 10G Infrastructure: Market Overview and Trends, Coherent Versus Conventional Technology**,*Jean-Paul Faure[1], Bruno Lavigne[1], Christine Bresson[1], Oriol Bertran-Pardo[2], Alberto Carrasco Colomer[3], Rafael Cantó[4]; [1]Alcatel-Lucent France, France, [2]Bell Labs, Alcatel-Lucent, France, [3]Telefonica Spain, Spain, [4]Telefonica I+D, Spain*

OThM7, **OFDM Spectral Efficiency Limits from Fiber and System Non-Linearities**, *Herbert F. Haunstein[1], Markus Mayrock[2]; [1]Alcatel-Lucent Deutschland AG, Germany, [2]Friedrich-Alexander Univ. Erlangen-Nuremberg, Germany*

Category G. Optical Processing and Analog Subsystems

OTuF1, **Wideband Wireless over Fibre Systems**, *Ian White, R. V. Penty, M. Crisp, S. Sabesan; Univ. of Cambridge, UK*

OTuF6, **Photonic Generation and Processing Technologies for Converged Ultra-High Speed Fiber-Wireless Systems**, *Zhensheng Jia[1], Jianjun Yu[2], Anjali Agarwal[1], Hung-Chang Chien[3], Arshad Chowdhury[3], Georgios Ellinas[4], Janet Jackel[1], Gee-Kung Chang[3]; [1]Telcordia Technologies, USA, [2]NEC Labs America, Inc., USA, [3]Georgia Tech, USA, [4]Univ. of Cyprus, Cyprus*

OTuN5, **Development of Photonic Switching Node Prototypes for Transparent Networks**, *Yoshiaki Nakano, Takuo Tanemura, Hideaki Imaizumi, Hiroyuki Morikawa; Univ. of Tokyo, Japan*

OThF5, **Linear Coherent Optical Receivers**, *Leif A. Johansson, Uppili Krishnamachari, Anand Ramaswamy, Jonathan Klamkin, Sasa Ristic, Hsu-Feng Chou, Larry A. Coldren, Mark Rodwell, John E. Bowers; Univ. of California at Santa Barbara, USA*

OThN3, **Optical Packet Add/Drop Systems**, *Dominique Chiaroni, G. Buforn, C. Simonneau, S. Etienne, J- C. Antona; Bell Labs, Alcatel-Lucent, France*

OThN6, **Optical Label Processing in Optical Packet Switched Networks**, *Nicola Calabretta, Harm Dorren; Eindhoven Univ. of Technology, Netherlands*

OThU1, **Performance of Microwave-Photonic Links**, *Thomas E. Darcie, Jinye Zhang; Univ. of Victoria, Canada*

OThU5, **High Frequency Photonic Analog-to-Digital Conversion Using Nonuniform Sampling**, *Michael L. Dennis, Patrick T. Callahan, Thomas R. Clark; Johns Hopkins Univ. Applied Physics Lab, USA*

OThV3, **Terabit/s Single-Carrier Transmission Systems Based on Coherent Time-Division Demultiplexing**, *Carsten Schmidt-Langhorst, Reinhold Ludwig, Lutz Molle, Dirk-Daniel Groß, Ronald Freund, Colja Schubert; Fraunhofer Heinrich-Hertz-Inst., Germany*

Category H. Core Networks

OTuG1, **Packet and Circuit Network Convergence with OpenFlow**, *Saurav Das[1], Guru Parulkar[1], Nick McKeown[1], Preeti Singh[2], Daniel Getachew[2], Lyndon Ong[2]; [1]Stanford Univ., USA, [2]Ciena Corp., USA*

OWH3, **Lessons Learned from CORONET**, *G. Clapp[1], R. Doverspike[2], R. Skoog[1], J. Strand[2], Ann Von Lehmen[1]; [1]Telcordia Technologies, USA, [2]AT&T Labs-Res., USA*

OWH6, **Architectural Trade-offs for Video Transport Networks**, *Didier Colle, Goutam Das, Mario Pickavet, Piet Demeester; Ghent Univ., Belgium*

OWR1, **Next Generation Transport Network Architecture**, *Ken-ichi Sato; Nagoya Univ., Japan*

OWY1, **Advanced Technologies for Next-Generation Fiber Networks**, *Milorad Cvijetic; NEC Corp., USA*

OWY4, **The Role of Arrayed Waveguide Gratings in Energy-Efficient Optical Switching Architectures**, *Edoardo Bonetto, Davide Cuda, Guido A. Gavilanes Castillo, Fabio Neri; Politecnico di Torino, Italy*

Category I. Access Networks

OTuO1, **Optical Access Solutions beyond 10GEPON/XGPON**, *Jörg-Peter Elbers; ADVA AG Optical Networking, Germany*

OTuO6, **Key Roles of Green Technology for Access Network Systems**, *Yoh Somemura; NTT Labs, Japan*

OWG3, **RSOA-Based 10G WDM PON Using FEC and MLSE Equalizers**, *Akira Agata, Y. Horiuchi; KDDI R&D Labs Inc., Japan*

OWQ1, **Integrated Optical and Wireless Access/Metro Networks**, *Chunming Qiao[1], Jianping Wang[2], Ting Wang[3]; [1]SUNY Buffalo, USA, [2]Computer Science Dept., City Univ. of Hong Kong, China, [3]NEC Labs America, Inc., USA*

OWQ6, **The Convergence of Wired and Wireless Services Delivery in Access and Home Networks**, *Mikhail Popov; Acreo Netlab, Sweden*

OWX1, **High-Speed Circuit Technology for 10Gb/s Optical Burst-Mode Transmission**, *Yusuke Ohtomo[1], Hideki Kamitsuna[2], Hiroaki Katsurai[1], Kazuyoshi Nishimura[1], Masafumi Nogawa[2], Makoto Nakamura[2], Susumu Nishihara[2], Takeshi Kurosaki[2], Tsuyoshi Ito[2], Akira Okada[2]; [1]NTT Microsystem Integration Labs, NTT Corp., Japan, [2]NTT Photonics Labs, NTT Corp., Japan*

OThG5, **Results from EU Project SARDANA on 10G Extended Reach WDM PONs**, *Josep Prat[1], Jose Lazaro[1], Philippe Chanclou[2], Risto Soila[3], Ana M. Gallardo[4], Antonio Teixeira[5], Giorgio M. TosiBeleffi[6], Ioannis Tomkos[7]; [1]Univ. Politècnica de Catalunya, Spain, [2]OrangeLabs, France Telecom, France, [3]Tellabs, France, [4]INTRACOM Telecom, France, [5]IT-Aveiro, Univ. de Aveiro, Portugal, [6]Mise Dip. Comm. ISCOM, Italy, [7]Athens Information Technology, Greece*

OThO3, **Ultra-Wideband Radio-over-Fiber Techniques and Networks**, *Benoît Charbonnier[1], Frédéric Lecoche[1], Mario Weiß[2], Andreas Stöhr[2], F. van Dijk[3], A. Enard[3], F. Blache[3], M. Goix[3], F. Mallecot[3], D. G. Moodie[4], A. Borghesani[4], C. W. Ford[4]; [1]France Télécom Res. and Development, France, [2]Univ. Duisburg-Essen, Germany, [3]Alcatel-Thales III-V Lab, France, [4]CIP Technologies, UK*

Category J. Network Experiments and Non-Telecom Applications

OWI1, **Design-Space Exploration for CMOS Photonic Processor Networks**, *Vladimir Stojanović[1], Ajay Joshi[2], Cristopher Batten[1], Yong-Jin Kwon[3], Scott Beamer[3], Sun Chen[1], Krste Asanović[3]; [1]MIT, USA, [2]Boston Univ., USA, [3]Univ. of California at Berkeley, USA*

OWI6, **Optical Flow Switching**, *Vincent Chan; Claude E. Shannon Communication and Network Group, Res. Lab of Electronics, MIT, USA*

OThH2, **Progress of Visible Light Communication**, *Shin-ichiro Haruyama; Keio Univ., Japan*

OThP3, **Photonic Terabit Routers: The IRIS Project**, *Jurgen Gripp[1], J. E. Simsarian[1], J. D. LeGrange[2], P. Bernasconi[1], D. T. Neilson[1]; [1]Bell Labs, Alcatel-Lucent, USA, [2]LGS Innovations, USA*

OThX2, **Low Power and High Density Optical Interconnects for Future Supercomputers**, *Petar K. Pepeljugoski[1], Jeffrey A. Kash[1], Fuad Doany[1], Daniel M. Kuchta[1], Laurent Schares[1], Clint Schow[1], Marc Taubenblatt[1], Bert Jan Offrein[2], Alan Benner[3]; [1]IBM T.J. Watson Res. Ctr., USA, [2]IBM Res. GmbH, Switzerland, [3]IBM Systems and Technology Group, USA*

NFOEC 1: Optical Networks and Services

NMB2, **Economics of 100G Transport**, *Ross Saunders, M. Traverso, T. Schmidt, C. Malouin; Opnext, Inc., USA*

NMB4, **Network Innovations Brought by Digital Coherent Receivers**, *Takeshi Hoshida[1], Hisao Nakashima[1], Takahito Tanimura[2], Shoichiro Oda[2], Zhenning Tao[3], Ling Liu[3], Weizhen Yan[3], Lei Li[3], Jens C. Rasmussen[1]; [1]Fujitsu Ltd., Japan, [2]Fujitsu Labs Ltd., Japan, [3]Fujitsu R&D Ctr., China*

NMD2, **Converged Networks; Their Pros and Cons**, *Munefumi Tsurusawa; KDDI R&D Labs Inc., Japan*

NTuA5, **The Impact of Peer-to-Peer Networking on User Behaviour and Network Design**, *Claus P. Larsen, Anders Gavler, Stéphane Junique; Acreo Netlab, Sweden*

NWB4, **Status of Next-Gen Access Networks in Europe**, *Bruno Capelle; France Telecom, France*

NFOEC 2: Network Technologies

NMC3, **Fiber Access Deployment Lessons**, *Vincent O'Byrne; Verizon Inc., USA*

NME2, **100G Coherent DWDM Transponder Module Enabling Seamless Upgrade of Long Haul Optical Transmission Systems**, *Ted Schmidt, Christian Malouin, Bo Zhang, Ross Saunders, Jin Hong, Roberto Marcoccia; Opnext Subsystems, Opnext, Inc., USA*

NME3, **100GBE Transmission, Appropriate Modulation Formats, Impact on Deployed Transport Networks**, *Marco Camera; Ericsson, Italy*

NTuB2, **Mapping and Transport Standard for OTU4**, *Mark Jones; Tellabs Inc., USA*

NTuC3, **Challenges of 40/100 Gbps Deployments in Long-Haul Transport Networks on Existing Fibre and System Infrastructure**, *Erwan Pincemin; France Telecom, France*

NThB2, **FiOS Cost Efficiency**, *Rajesh Yadav; Verizon Communications, USA*

NThF3, **AT&Ts Photonic Backbone Design Options**, *Kathy Tse; AT&T, USA*

2010 Market Watch

Tuesday, March 23–Thursday, March 25, 2010
OFC/NFOEC Exhibit Floor Theater

This three-day series of panel sessions engages the applications and business communities in the field of optical communications. Presentations and panel discussions feature esteemed guest speakers from industry, research and the investment communities.

The program will be located on the exhibit floor, so attendees can easily attend the sessions and tour the exhibit hall. Audience members are encouraged to participate in the question and answer segments that follow the presentations.

Market Watch Chair:
Karen Liu, *Vice President, Components and Video Technologies, Ovum, USA*

Market Watch Organizer:
Paul A. Bonenfant, *Communications Components Analyst, Vice President - Equity Research, Morgan Keegan & Co., USA*

Sponsored by:

Schedule-at-a-Glance

Panel descriptions and speakers are being confirmed so check this site often for program updates.

Tuesday:

12:00 p.m.–2:00 p.m.	Panel I: State of the Optical Industry Moderator: Richard Habel, *MSc, Chief Executive Officer, Habel Consulting, Canada*

3:00 p.m.–5:00 p.m.	Panel II: Implications of Wireless Network Evolution: Wireless Backhaul and Beyond Moderator: Dana Cooperson, *Vice President, Network Infrastructure, Ovum, USA*

Wednesday:

1:00 p.m.–3:00 p.m.	Panel III: Benefits and Tradeoffs of Photonic Integration—Functional or Hybrid? Moderator: Stan Lumish, *PhD, Department of Defense, USA*

Thursday:

10:00 a.m.– 12:00 p.m.	Panel IV: Packet Optical Migration—The Case for Multilayer Transport Equipment Moderator: Andrew Schmitt, *Directing Analyst, Optical, Infonetics Research, USA*
1:00 p.m.– 3:00 p.m.	Panel V: Reinventing Carrier Networks for 100G: Taking it to the Next Level Moderator: James King, *Executive Director, AT&T Laboratories, USA*

Panel I: State of the Optical Industry

Moderator: Richard Habel, *MSc, Chief Executive Officer, Habel Consulting, Canada*

The goal of this session is to provide views from carriers/service providers, equipment and component suppliers, VC/financiers, and market and equity researchers on industry health, consolidation, funding innovation, etc.

Speakers

State of the Optical Industry: Light at the End of the Tunnel?
Paul A. Bonenfant, *Communications Components Analyst, Vice President - Equity Research, Morgan Keegan & Co., USA*

As the industry emerges from the most pronounced downturn since the optical/Internet bubble burst in the early 2000's, investors seek signs of a sustained recovery–an end to sequential revenue declines, and earnings improvement from higher sales volumes vs. cost-cutting. Recent commentary from suppliers suggests demand for certain components exceeds supply. While some “double-ordering” is

inevitable, increased network deployment activity may be driving the up-tick, in addition to the typical dynamics associated with an inventory refresh (the "Bullwhip Effect"). Some argue that recent M&A activity (both public and private) has led to share shifts, but the problem of overcapacity remains. In this presentation, we will discuss topics of ongoing debate, including demand and deployment trends, consolidation (M&A, both public and private), innovation vs. near-term cash preservation, and whether the industry has reached (or is nearing) a state of sustained profitability.

Paul A. Bonenfant joined Morgan Keegan in January 2005 as Associate Analyst for Communications Equipment, and in February 2008 assumed the role of Senior Analyst for Communications Components. Prior to his move to Wall Street, Paul spent over 15 years in the telecommunications industry. He was Principal Network Architect at Mahi Networks, Chief Architect at (and a founding member of) optical networking start-up Photuris, and a business development manager for mergers and acquisitions in Lucent's Optical Networking Group. Before joining Lucent, he led requirements and standards development for optical transport systems at Bell Communications Research (Bellcore, now Telcordia Technologies). Paul received both his BS in engineering and applied science and his MS in electrical engineering from the California Institute of Technology.

The Optical Industry: 2010 and Beyond

Dana A. Cooperson, *Vice President, Network Infrastructure, Ovum, USA*

This presentation will provide an overall perspective on the optical industry, based on Ovum's ongoing component and systems research. Topics will include growth prospects and drivers, dependencies, and uncertainties.

Dana Cooperson is responsible for managing Ovum's networks research advisory and consulting services, which comprise broadband access, switching/routing, optical transport, mobile infrastructure, and carrier financials. Recent custom research projects have covered mobile network traffic management and optimization, test outsourcing in the mobile ecosystem, software product opportunities in ON, green networking, GPON opportunity analysis, EMEA and AP optical and carrier Ethernet opportunity analysis, and Ethernet services market entry planning.

Dana brings 15 years of telecoms vendor and service provider experience to her 11 years as an industry analyst. Prior to joining RHK/Ovum, Dana was a marketing manager for Tektronix, where she managed WDM/SONET/SDH test and measurement products. Before Tektronix, she managed MX3 and SONET products at Telco Systems. She began her career as a network engineer at NYNEX (now

Verizon Communications) in New York City. Dana was awarded an MS in management from MIT and a BS in engineering from Cornell University.

Optical Components: Fewer Players and More Opportunities
Andrew Schmitt, *Directing Analyst, Optical, Infonetics Research, USA*

This presentation will examine the results of the long awaited consolidation in the optical component business as well as highlight the most important trends in the equipment and component markets.

Andrew Schmitt (http://twitter.com/aschmitt) leads Infonetics Research's optical coverage, authoring quarterly market share and forecast reports, regular research notes, and service provider survey research. He covers the optical market from the carrier, equipment and components sides, tracking SONET/SDH, MSPP, crossconnects, WDM, ROADMs, packet optical transport, 10G, 40G, 100G+, metro and long haul optical, etc. He is also a consultant to startups, service providers, manufacturers and the investment community.

Prior to joining Infonetics, Andrew ran Vitesse Semiconductor's carrier chipset unit and headed Nyquist Capital, an investment advisory and consulting firm focused on the optical sector. He holds multiple patents, and earned his BS in electrical engineering at the University of California at Santa Barbara.

Transport Is More than Just Connectivity
Glenn Wellbrock, *Director of Optical Transport Network – Architecture and Design, Verizon Communications, USA*

Next-generation long haul transport systems must incorporate more than just 100G optics to be widely deployed. This talk will focus on the additional requirements and timelines needed to insure wide-scale deployment versus simply upgrading existing systems with higher capacity transponders.

Glenn Wellbrock is the Director of Optical Transport Network Architecture and Design at Verizon, where he is responsible for the development of new technologies for both the metro and long haul transport infrastructure. Previous positions include running the advanced technology lab, establishing evaluation criteria, and setting engineering guidelines for all backbone transport equipment as well as various positions within network operations. In addition to his 20+ years at Verizon (1984–2001 and 2004–present), Glenn was responsible for product aArchitecture within the United States-focused optical networks group at Marconi and product planning at Qplus Networks with a specific focus on developing alternative modulation

techniques.

Perspectives on the Worldwide Optical Fiber Marketplace

Brad M. Boersen, *Director, Business Strategy, Optical Fiber, Corning Inc., USA*

2010 represents the 40th anniversary of the invention of the first commercially viable low-loss optical fiber. Since that time, enough optical fiber has been deployed to make four round trips to the sun.
The worldwide market for optical fiber is now about 40% higher than at the peak of the internet bubble, and about 200% higher than at the 2003 post-internet bubble trough. This remarkable recovery and resilience has been driven by a) positive public policy, b) consumers appetite for bandwidth-consuming applications, and c) facilities-based competition.

Despite the 2008/2009 recession, the market for optical fiber in 2009 is expected to grow at least 15%. This growth was entirely driven by China, which grew more than expected and offset the expected (and experienced) declines in almost all other markets worldwide. These details and our view of 2010 market prospects will be discussed. In addition, our view of fiber market pricing dynamics, industry supply/demand, U.S. stimulus, and public policy trends may be reviewed.

Brad Boersen has 22 years of professional experience. Presently he is Director of Business Strategy & Analysis for Corning Inc.'s Optical Fiber business. Prior to joining the Optical Fiber business he worked in Corning's Optical Networking Devices business, and prior to Corning Brad worked for Eastman Kodak. Brad holds a B.S. degree in Chemical Engineering from Michigan State University and an M.S. in Engineering and Management from Massachusetts Institute of Technology.

Furthering Innovation in Optical Networks

Alan Lowe, *President and General Manager, Communications and Commercial Optical Products (CCOP) Business Segment, JDSU, USA*

Network providers want innovation when they invest in optical communications solutions, but this is not always what they are getting. When technology innovation does occur, it has often been the result of a single company or vendor taking the initiative.

As the industry continues to recover and higher capacity networks are required to meet increased bandwidth demands, leading market players will need to work more closely together and with customers to foster innovation from the outset. If this is

done well, the end user's needs for low cost, flexible and scalable solutions will be met in ways that are more beneficial to all parties involved.

Current examples and discussions about what future collaboration could look like will be covered during this presentation.

Alan Lowe is responsible for the JDSU's Communications and Commercial Optical Products business. Prior to joining JDSU in September 2007 as Senior Vice President of the Commercial Lasers business, Lowe was Senior Vice President of the Customer Solutions Group at Asyst Technologies, Inc., a leader in automating semiconductor and flat panel display fabs. From 2000 to 2003, he was President and Chief Executive Officer of Read-Rite Corporation, a manufacturer of thin-film recording heads for disk and tape drives. From 1989 to 2000, Lowe served in roles of increasing responsibility at Read-Rite, including President and Chief Operating Officer, and Senior Vice President, Customer Business Units. Prior to joining Read-Rite, he served in various sales positions with Microcom Corporation and IBM Corporation.

He is a member of the advisory board of ETM Inc., a privately held provider of tailored power subsystems. Lowe holds bachelor's degrees in computer science and business economics from the University of California at Santa Barbara, and also completed the Stanford Executive Program in 1994.

FTTH Deployment Worldwide—Status and Challenges of Massive Deployment

Étienne Gagnon, *Vice President, Product Management and Marketing, EXFO, Canada*

In today's networking world, offering more services—and therefore more bandwidth—to end users is the name of the game for wireless, wireline and cable TV operators. Bringing optical fiber further and further into the network is the commonly accepted approach by carriers around the world, whether they are investing in FTTH, FTTN or even 3G/4G networks. Although this represents a great potential for the optical communication industry in general, bringing fiber closer to the home is proving to be an unprecedented challenge from an optical technology standpoint. Having been at the forefront of the FTTH/FTTN wave since 2003, EXFO has built extensive expertise on this challenge. In this presentation, we will review the technical difficulties posed by early FTTH/FTTN deployments, and then take a look at today's challenges as these technologies are now massively being deployed throughout the world.

Étienne Gagnon was appointed Vice President of Product Management and

Marketing in May 2003, and in May 2007, he took on the responsibility of all our telecom business units—Optical, Transport and Datacom, Access, and Navtel. As such, he is responsible for EXFO's general marketing direction on both the product level and communications level. For nearly three years, before returning to EXFO in early 2003, Mr. Gagnon was Vice President of Sales and Marketing at TeraXion, an optical component manufacturer based in Quebec City.

Mr. Gagnon began his career as a design engineer for Bombardier/Canadair, where he worked on the Canadian Regional Jet project between 1990 and 1993. Later, he held the position of Business Development Manager for France Telecom in Hungary. In 1994, he joined EXFO's European office as a Regional Sales Manager, and in 1996, he was brought back to Quebec City to head the OSP marketing group. Mr. Gagnon then went on to become the director of our Outside Plant division in 1998, and remained in that function until he joined TeraXion in 2000.
Étienne Gagnon holds a Bachelor's degree in mechanical engineering from the University of Montreal's School of Engineering and a Master's degree in European business from the École nationale supérieure des télécommunications in France.

Panel II: Implications of Wireless Network Evolution: Wireless Backhaul and Beyond

Moderator: Dana Cooperson, *Vice President, Network Infrastructure, Ovum, USA*

The panel explores perspectives on optical architecture implications of wireless technology as mobile networks evolve from 2G to 3G to 4G. How will changing mobile network and service requirements affect ON requirements including media (air, copper, fiber), technology (DSL, Ethernet, PON, WDM), capacity, survivability, power and synchronization?

Speakers

Connectivity and Capacity Challenges in Wireless Backhaul
Reginald Wilcox, *Vice President, Optical Marketing and Product Management, Huawei Technologies, USA*

As wireless networks continue to evolve in feature, functionality, architecture and capacity, the backhaul transport network must follow in step to keep pace with this

transformation. From the backhaul perspective, this implies fundamental changes in capacity and connectivity. As 4G services rollout, individual cell sites are requiring capacity in excess of several hundred megabits per second. In addition, to achieve 3G coverage with 4G capacity, an order of magnitude increase in the number of cell sites will be necessary. To address these ongoing backhaul challenges, a service provider is well equipped to provide cost-effective solutions if all forms of communication media can be utilized. This presentation investigates back haul solutions over copper, fiber and microwave media with a focus on cost, service velocity, network availability and manageability. Benefits associated with integrating these media access onto a single platform will also be explored.

Mr. Wilcox is Huawei Technologies' Vice President of Optical Network Marketing and Product Management for North America. Prior to joining Huawei, Mr. Wilcox was an Executive Vice President responsible for operations at Menara Networks, a high-performance optical transceiver company. Mr. Wilcox also spent 19 years with Nortel, where he held a variety of positions including Vice President of Optical Development and President of Qtera Networks. In his tenure with Nortel, Mr. Wilcox played a pivotal role in Nortel's 10 Gb/s market success, its penetration into Metro DWDM and its transition to next generation transport systems.

Mr. Wilcox holds both a Bachelor's and Master's degree in electrical engineering from the University of Toronto located in Toronto, Canada.

Mobile Transport: the Business Case for Evolving Existing Backhaul to LTE
Matthew Smith, *Head of Optical Product Marketing, Business Unit Networks, Ericsson, USA*

With capacities on the radio access network (RAN) expanding fast through successive generations of HSPA and now LTE, some assert that the "bottleneck" is now in the backhaul. Surging bandwidth demand has not resulted in equally positive trends in average revenue per user, or ARPU. The race to higher-speed mobile broadband services is creating a business challenge that the backhaul network has an important role in solving.

We will explore how the backhaul network, with technologies that consist of broadband access, microwave, and Metro/optical, is responding to that challenge. The complicated migration from older SDH/SONET technology to an IP (MPLS)-based approach calls for rethinking the metro segment. Mobile backhaul requirements have led to important additions to the emerging packet optical transport segment, such as pseudowiring/circuit emulation and synchronization.

Let's examine together how to alleviate the backhaul challenges by raising capacities,

improving efficiencies and, most importantly, making the migration to IP to control cost. And, yes, many generations of existing installed backhaul equipment can now be upgraded to IP.

Matthew is Head of Optical Product Marketing at Ericsson and is responsible for all product and portfolio messaging and collateral, and related business analysis. Matthew has led the Optical marketing activities of Ericsson and formerly Marconi since 2005, and he has played an important part in the development and delivery of the marketing of Ericsson's Mobile Backhaul business solution.

After graduation from Loughborough University, Matthew joined Marconi in 2000 and held SDH, Ethernet, DXC and WDM marketing and product management roles. In his role as product line manager for Marconi's data and optical edge portfolio, Matthew was primarily focused on Ethernet technology, but also included a wide range of SDH edge equipment. Matthew worked on early introduction of NG-SDH technologies to the market place, such as GFP, LCAS and Layer 2 functionality, and he was heavily involved in the introduction of further product evolutions to Ethernet Transport. For most of his career, Matthew has focused on strategies for optical network migration to carrier Ethernet technologies, and helping operators to realize the cost and revenue generating opportunities those strategies provide.

Matthew is based in San Jose, California, at Ericsson's Silicon Valley campus.

Mobile Broadband Explosion and the Role for Microwave Backhaul
Stuart Little, *Director of Corporate Marketing, Harris Stratex Networks, USA*

The use of mobile broadband data is exploding. With the continued success of new smart phones and the imminent proliferation of connected netbooks, this situation can only get worse. Operators need to rapidly evolve their networks while preserving their existing revenue base. This presentation examines how next-generation microwave backhaul technologies can transform mobile networks and turn the mobile broadband explosion into a transformative opportunity for revenue growth.

Stuart Little has been involved in the wireless transmission industry on three continents for over 20 years, starting as a radio engineer with the Royal Australian Air Force (RAAF) and Amalgamated Wireless Australasia (AWA) in Australia. This was followed by positions in Technical Sales and Marketing in the United Kingdom with Nera AS and Digital Microwave Corporation (DMC).

Since 2000 Stuart has been based in California, holding positions in Product Management and Marketing with DMC (subsequently renamed Stratex Networks). In 2007 Stuart became responsible for global Corporate Marketing for Harris Stratex

Networks, the result of a merger that year between Stratex Networks and the Microwave Division of Harris Corporation, which formed the largest independent provider of microwave transmission systems in the world.

Backhaul Solutions—How Future-Proof Can They Be?

Oren Marmur, *Head of Optical Networking Line of Business, ECI Telecom Ltd., Israel*

As mobile networks evolve from the good old 2G networks towards 3G and beyond (eg, 3.5G, Wimax & LTE-based networks), backhauling infrastructure is transforming as well. The TDM, E1/T1-based backhauling is no longer enough, and Ethernet-based backhauling is becoming the ultimate answer for the high capacity backhauling requirements. This transformation raises many questions for operators, such as:

- How can we optimize the migration path to Ethernet-based backhauling, in terms of CAPEX?
- Should the TDM-based backhauling be totally replaced by Ethernet-based backhauling, or should it be done gradually?
- Two separate backhauling network (TDM and Ethernet) or a single network?

In this presentation we will discuss the solutions to perform an optimized transition, based on best practices—converged solutions for all backhauling requirements, transition management for the process and more.

Oren Marmur is the Head of the Optical Networking Line of Business at ECI Telecom, which includes end-to-end responsibility for all strategy, business, product management, development and sales support activities related to Optical Networking offering at ECI. Mr. Marmur has held this position since November 2007 and has over 17 years of experience in the telecom and optical industries.

Prior to joining ECI Mr. Marmur has been the founder of FlexLight Networks, a VC backed startup company that pioneered the GPON market and prior to that in several technical positions in the defense and telecom markets.

The 4G Backhaul Bottleneck: Wireless Customer Needs and Solutions
Ravi Potharlanka, *Chief Operating Officer, FiberTower, USA*

The presentation will provide an overview of how the evolution of wireless networks is presenting new and exciting challenges within backhaul part of the network. A synthesis of customer needs and key drivers will be presented. Next, an analysis of various solutions will be provided. Finally, the presentation will share perspectives on how the industry is expected to evolve as it solves the backhaul bottleneck.

Mr. Potharlanka has been the Chief Operating Officer (COO) of FiberTower since January 2008. Before becoming the COO, he served as co-President and SVP of Operations of FiberTower. Prior to that, he served as FiberTower's Vice President of Market Operations and Vice President of Strategic Partnerships between August 2001 and August 2003. From August 1997 to July 2001, Mr. Potharlanka served in various capacities at Teligent, Inc., a fixed wireless CLEC (or competitive local exchange carrier) company, most recently as Vice President of International Market Development. Prior to that, from August 1991 to December 1995, he served as Director of Product and Technology Development at Nextel Corporation and as Manager of Technology Development at Airtouch. Mr. Potharlanka holds a BE degree in electrical engineering from NIIT, Trichy (India), an MS degree in electrical engineering from the University of California at Davis, and an MBA degree from Harvard Business School.

Supporting 4G/Evolved Packet Core (EPC) Networks
Stuart Elby, *PhD, Vice President – Network Architecture, Verizon, USA*

4G radio access networks provide bandwidths 2.5–10X that of 3G networks. An even more fundamental change is the EPC architecture. All services including voice are treated as IP data applications, and all of these data sessions are anchored on the subscriber's "home" packet gateway. The resulting traffic flow and volume creates significant challenges for both the access and core network. Investments in optical packet technologies are needed to address these challenges.

Dr. Stuart Elby, Vice President of Network Architecture, is responsible for Verizon's network vision and evolution towards this target. Stuart is also responsible for the design and specification of Verizon's metro, regional, and long haul optical transport networks; VoIP and IMS networks; and emerging converged services platforms. Additionally, he is responsible for collaborative R&D activities with universities and government, and the Verizon Interoperability Forum.

Previously, Dr. Elby was a Research Associate at the NSF Center for Telecommunications Research at Columbia University performing R&D in all-

optical networks and developing ATM/WDM platforms. At a laser surgery start-up, he was responsible for FDA clinical trials and product development, and brought the first disposal plastic fiber-optic system to the medical market. In 1982, he worked at StorageTek, contributing to the development of the first commercial optical disk system.

Dr. Elby received a BS degree in optical engineering from the University of Rochester (New York) in 1982 and received a MSEE and PhD from Columbia University in 1989 and 1994, respectively.

Panel III: Benefits and Tradeoffs of Photonic Integration—Functional or Hybrid?

Moderator: Stan Lumish, *PhD, Department of Defense, USA*

The electronics industry has grown, thanks in large part to its ability to integrate more features and functions into smaller volumes at comparable costs. The photonics industry, on the other hand, has achieved rudimentary integration levels by comparison. This panel considers a number of issues related to this point. Is the lack of integration holding the industry back? What levels of integration have been achieved and what can be expected in the next five years? Is hybrid integration more valuable to the industry than functional integration? What are the critical metrics when considering functional versus hybrid integration? How do current solutions compare? Panel participants include leading photonic component suppliers and network equipment manufacturers, who use both types of solutions.

Speakers

Benefits and Trade-Offs of Integration—A Service Provider View
Laurel Clark, *Senior Architect, Network Architecture and Engineering, Level3 Communications, USA*

In the last decade, there's been a tremendous amount of innovation in the optical fiber communications space—bringing with it improvements in system scale, features and operational capabilities, while simultaneously providing significant cost reduction. As we look to the future, increased device integration seems to offer one of the best opportunities to continue on this path of realizing both cost compression and feature enhancements; equally important, higher levels of integration will be an essential tool for managing power and space constraints. We will discuss this view and how it fits into Level3's general approach to technology evaluation from a service provider's viewpoint—with the focus being on solutions that maximize competition and that will enable us to leverage market forces as much as possible.

Laurel Clark is a Senior Architect on the Core Architecture team at Level3 Communications, where she plays a key role in the evolution of Level3's core optical network and in the evaluation and selection of new optical layer technologies. Prior to joining Level3, she was Principal Consultant for Broadband Networks at Telcordia Technologies. Before that, Laurel held technical staff and management positions at AT&T in the Network Technology Development organization. Her career at AT&T included work on a variety of optical fiber and digital transmission technologies and participation in national and international standards development. She joined AT&T Bell Laboratories after receiving a BSEE from the University of Colorado at Boulder and a Masters of engineering from Cornell University.

Rapidly Changing Technology Is Driving the Direction of Integration on Optical Systems

Stephen Carlton, *Vice President, Planning and Product Management, Fujitsu Network Communications, USA*

Stephen will describe the different directions of integration and how these are offered on today's systems. The current state of technology imposes limitations on integration and constrains these directions. Real-world requirements for the next-generation systems are emerging and he will explain the impact on the direction of integration. Wrapping up he will share his vision of the future of optical systems.

Stephen Carlton is vice president of Planning and Product Management at Fujitsu Network Communications. In this role, Stephen is responsible for planning and writing of requirements for new product developments and also product line management of FLASHWAVE products.

Stephen joined Fujitsu in 1998 to assist planning of SONET system requirements. He eventually became Vice President, responsible for product line management and planning of SONET and WDM products developed by Fujitsu. Prior to joining Fujitsu, Stephen held various roles with Bell Northern Research (now Nortel) and Rockwell International (now Alcatel).

Stephen holds a Bachelor of Science degree in electronics from De Montfort University in Leicester, UK. He holds seven patents relevant to the field of transmission engineering.

Photonic Integrated Circuits Enable Next-Generation Networks
Stephen Grubb, *Infinera Fellow/Vice President Optical Systems Group, Infinera, USA*

Monolithic photonic integration provides a platform ideally suited for next-generation components operating at 40/100G speeds and chip capacities of 400 Gb/s and higher. Monolithic integration offers key advantages relative to hybrid integration in terms of reliability and manufacturability. We will present examples of next-generation, high-capacity PICs to highlight the dramatic advances in PIC technology and showcase next-generation PICs with hundreds of integrated optical components. The presentation will discuss how PICs simultaneously provide network scaling along multiple dimensions – capacity, cost, power, space and reliability. The presentation will also discuss the business and market impact of PICs at a system and network level and how they have enabled a new operational model for rapid and efficient service delivery.

Dr. Grubb is currently an Infinera Fellow and Vice President in the Optical Systems Group at Infinera. He has previously held positions at Corvis, SDL, and AT&T Bell Laboratories. He led R&D that was responsible for the first commercial deployment of Raman amplification in a network, and developed several novel high power fiber lasers and amplifiers. He received his PhD in chemical physics from Cornell University. Dr. Grubb has authored well over 100 publications and conference presentations and is an inventor on over 60 issued US patents.

System on a Stick—Smart Optical Transceivers with Built-In System Functions
Jianhui Zhou, *Chief Executive Officer, Broadway Networks, Inc., USA*

As service providers extend fiber to the customer premises to offer advanced bandwidth-intense services such as on-demand HDTV, the proliferation of protocols and technologies in the FTTx networks, e.g., Ethernet, PON, and WDM, often requires service providers to deploy multiple boxes in tandem for certain applications just to achieve protocol conversion and remote manageability.

The author presents here the concept of "system on a stick" and the smart optical transceivers that incorporate protocol conversion and optical-layer remote management into MSA-compliant pluggable transceivers. In addition to the traditional optical/electrical conversion and digital diagnostic and monitoring functions, these smart transceivers also provide system functions that are previously only achievable on the box-version equipment. The deployment of these smart transceivers in the FTTx networks has brought about many network-level benefits including simplified network architecture and enhanced manageability and serviceability. The author will talk about smart transceiver's working principles,

applications and deployment cases.

Dr. Jianhui Zhou is Chief Executive Officer of Broadway Networks, Inc., a company supplying innovative smart optical transceivers and cutting-edge optical subsystems to the FTTx market. Prior to joining Broadway in 2006, Dr. Zhou held various technical and managerial roles in a number of leading optical communications companies, including Senior R&D Manager at Lucent Technologies, where he received Bell Labs President's Gold Award; Director of Product Development and Vice President of Product Management at ONI Systems; Vice President and General Manager for China Operation at Ciena Corp.; and Entrepreneur-in-Residence at ComVentures.

Dr. Zhou received his PhD in applied physics from the California Institute of Technology, and BS and MS degrees in applied physics from the Beijing University of Posts and Telecommunications. He has published a number of refereed papers and conference presentations and received 5 US patents for inventions in the area of fiber amplifiers and optical communications systems.

Photonic Integration: Disruptive Change in Transport and Transmission
Alexander Schoenfelder, *Vice President, Product Line Management, Optical Communication Products, JDSU, USA*

Functional (monolithic) or hybrid photonic integration is vital to the success of solutions in both the transport and transmission areas of the network. Key benefits that functionally integrated products provide include:

- Smaller size
- Lower cost
- Higher power efficiency
- Improved performance.

Successful examples of products developed with a functionally integrated approach demonstrate at least a 50% reduction in size and power, and substantial cost savings.

During this session, panelists will discuss some of today's solutions and the key building blocks for integration. Monolithic integration is opportunistically applied where design compromises still allow, realizing the value of integration. Future solutions will emerge in the 40/100G transmission space and in new highly agile transport applications. Several examples of these solutions will be presented.

Alex Schoenfelder is Vice President of Product Line Management for all Optical Communication products at JDSU. Previously, he held the position of Vice President and General Manager of the Integrated Photonics and Transmission Module

Business at JDSU. Prior to joining JDSU, Alex held various Marketing and R&D management positions at SDL. Alex has more than 20 years experience in the optical communications industry. He received his PhD in electrical engineering and BS in physics from University in Karlsruhe, Germany.

InP-Based Photonic Integration: Driving Cost Reduction and Bandwidth Scaling

Andrew Carter, *Chief Technology Officer, Oclaro Inc., UK*

In the presentation, we will show how Oclaro's InP fabrication capability is enabling us to address both bandwidth scaling and cost reduction through integration. For these applications a relatively modest degree of (monolithic) integration is needed but with extremely high yield. This is achieved through the engineering approach of reusable building blocks and designs, integrated together through etch and regrowth techniques. In this way, there is no compromise in design when integrating, for example, modulators with tunable lasers. Where the cost/ performance and volumes are favorable, hybrid integration, using micro-optics or self alignment, is used in assembly, in conjunction with the appropriate level of monolithic integration in the InP chips. In the longer term, we anticipate increasing levels of monolithic photonic integration and are actively working with partners to link process, design and modelling together to facilitate a more rapid and predictable design cycle, as is the standard in the silicon industry.

Andy Carter received his doctorate in semiconductor physics from Oxford University in 1977 and moved directly into the field of photonics, joining the Caswell Research Centre in the UK, initially working for the Plessey Company, later for Marconi, Bookham and now Oclaro. He has been central in defining and executing research and development strategies in many aspects of photonic devices and systems, including active components for high speed systems, WDM technologies, tunable lasers and optoelectronic integration.

Andy has published or presented over 200 journal or conference papers, including invited papers at major photonic conferences. He is chief technology officer for Oclaro and a visiting professor in the Advanced Technology Institute of Surrey University.

Photonic Integration Technologies for the Next-Generation Optical Communication Systems

Hajime Shoji, *Department Head, Advanced Device Process R&D, Transmission Devices R&D Laboratories, Sumitomo Electric Industries, Ltd., Japan*

Key technologies for photonic integration based on III-V compound semiconductor

materials are described. Crystal growth and device technologies such as Butt-joint and selective area growth enabling in-plane bandgap control and integration of different functionalities are presented with the examples of actual devices applications. In addition, varieties of waveguide structure for photonic integration such as BH structures, high-mesa structures and couplers are introduced. Based on the existing technologies, future prospects for photonic integration will be presented: the kind of technology trend, timeline and possible applications. Potential issues of photonic integration will be also discussed together with expectations for breakthrough technologies.

Hajime Shoji received the BE, ME, and PhD degrees in electronic engineering from the University of Tokyo, Japan, in 1985, 1987, and 1990, respectively.

In 1990, he joined Fujitsu Laboratories Ltd., Atsugi, Japan, where he was engaged in the development of various types of semiconductor lasers. In 2003, he moved to the former Eudyna Devices Inc., Yamanashi, Japan, and he has been leading the development of LD products such as 10G EML-TOSA and full-band tunable lasers. In 2009, due to the reorganization of business in Sumitomo Electric Industries, Ltd. and Eudyna Devices Inc., he moved to Sumitomo Electric Industries, Ltd., Yamanashi, Japan. He is currently a Department Head of Transmission Devices R&D Laboratories, working on the development of advanced photonic and electronic devices.

Dr. Shoji is a member of the Institute of Electronics, Information and Communication Engineers (IEICE), the Japan Society of Applied Physics (JSAP) and the IEEE Photonics Society.

Photonic Integrated Circuits for Optical Access—A Market Reality if Technology Matches Economics

Valery Tolstikhin, *Founder and Chief Technology Officer, OneChip Photonics Inc., Canada*

Optical transceivers for access have emerged as the most massive photonics component market in telecom. Whereas in this market performance requirements may be not particularly challenging, cost efficiency and volume scalability expectations certainly are. An integrated photonics approach, in which optical waveguides are used as the device building platform and planar technologies as means to implement it, is a promising way to meet the challenge. Given that optical transceiver requires active (send/receive) along with passive (e.g. multiplex/demultiplex) functions, it would be further advantageous to use indium phosphide (InP) and related III-V semiconductors as a universal material system, which, uniquely, enables for a monolithic integration of the active and passive waveguide devices onto the same substrate, in a form of a photonic integrated circuit ***(PIC).***

In this presentation, the photonic integration's ability to reach and shape the market will be examined from the PIC economics and technology standpoints. As an example of approach that balances the two, OneChip's Multi-Guide Vertical Integration platform and related optical transceiver PICs for FTTH will be presented.

Valery Tolstikhin is a founder and Chief Technology Officer of OneChip Photonics Inc., a fables developer and manufacturer of optical transceivers for mass deployment, based on proprietary photonic integrated circuit technology. Headquartered in Ottawa, Canada and funded by venture capital, this company is at the leading edge of commercialization of the cost-efficient PICs for the ever-expanding optical access market.

Dr. Tolstikhin has been involved in the research, development and commercialization of advanced semiconductor devices for micro- and optoelectronics for more than 30 years. An industry veteran with a solid academic background and international credentials acquired through his work in Russia, Sweden, Netherlands and Canada, he has a long track of achievements as innovator, team builder and R&D organizer. Dr. Tolstikhin has authored more than 80 research papers and 8 patents in the areas of semiconductor devices and photonics, and has given numerous conference presentations in these areas. Dr. Tolstikhin earned his PhD in radio physics from Moscow Institute of Physics and Technology (1980) and his DSc in semiconductor physics from the Institute of Radio Engineering and Electronics of Russian Academy of Sciences (1993). Also, he is an adjunct professor at the University of Ottawa.

Panel IV: Packet Optical Migration—The Case for Multilayer Transport Equipment

Moderator: Andrew Schmitt, *Directing Analyst, Optical, Infonetics Research, USA*

This panel features discussion of the costs and benefits of converged packet optical transport, where optical equipment integrates optical, circuit, and packet transport and switching capabilities. We will look at the advances in component technology that make these systems possible as well as understand the advantages and drawbacks to deploying them in carrier networks.

Speakers

Delivering Next-Generation Services: How Packet Optical Networking and Connection-Oriented Ethernet Are Changing Metro Networking

Ralph Santitoro, *Director of Carrier Ethernet Marketing Development, Fujitsu Network Communications, Inc., USA*

Metro networks are evolving to meet the insatiable bandwidth demands of next-generation broadband data, video and wireless IP services with persistent deployments of TDM-based services. Central to this evolution is the deployment of Connection-Oriented Ethernet (COE) as the universal packet-based infrastructure upon which all IP services are delivered. In particular, packet optical networking—the integration of COE and Layer 1 networking—is showing unique value by enabling network operators to deliver COE over any existing fiber, PDH, copper or wavelength network asset. In this presentation I will discuss the key requirements for next-generation metro infrastructure networking and the central role of Connection-Oriented Ethernet in creating the new infrastructure. The presentation will include case study examples of how packet optical networking architectures are rapidly creating actual next-generation metro networks leveraging existing assets.

Ralph Santitoro, Director of Carrier Ethernet Market Development at Fujitsu Network Communications, provides thought leadership and market development of carrier Ethernet and packet optical networking solutions that accelerate the delivery of next-generation applications and services. Ralph is a founding member and director of the Metro Ethernet Forum, where he co-authored the industry's first Ethernet service specifications. He also wrote the forum's most popular papers on Ethernet services, with over 100,000 copies downloaded. He has published many articles and papers and frequently speaks at industry events on Ethernet Services, wholesale Access services, global Ethernet interconnect, Ethernet OAM, carrier Ethernet security and cell tower backhaul.

For over 25 years he has developed innovative telecom, computing and information security products and services at Fujitsu, IBM, Nortel, Turin Networks and three technology startups addressing enterprise, SMB, service provider and consumer markets.

Ralph holds a Bachelor of Engineering degree in electrical engineering and computer science from Stevens Institute of Technology in Hoboken, NJ.

Sub-Wavelength versus MPLS-Based Aggregation Solutions

Thomas Rasmussen, *Vice President of Product Line Management, TPACK A/S, Denmark*

Carriers are faced with the delicate issue of massively expanding the transport capacity in their networks while at the same time lowering the cost per bit. This presentation will highlight two potential strategies for solving this dilemma and show what the actual network equipment could look like. In both cases the traditional SONET/SDH is removed as transport layer and the typical CWDM is replaced by DWDM. The first option is to replace the SONET/SDH layer by electrical sub-wavelength tunnels (typically ODU0-tunnels) over OTN. This solution is simple to operate, but it has a relatively coarse granularity and does not allow differentiation among user traffic. The other option is to use MPLS/MPLS-TP tunnels (Label Switched Paths) over 10 Gigabit Ethernet over OTN. This solution is somewhat more complicated to manage, but it does allow for traffic management down to individual customer flow level.

Thomas Rasmussen has worked for TPACK since 2003, first as Senior Project Manager and since 2007 as VP of PLM.

Prior to joining TPACK Thomas has worked with erbium-doped fiber amplifiers and Sonet/SDH/DWDM telecommunications systems at the Technical University of Denmark and DSC Communications, and with optical components at ADC and Ibsen Photonics.

Thomas holds a Master's Degree in optical communications and a PhD degree in integrated optics from the Technical University of Denmark and has authored or co-authored more than 60 technical publications in international journals and presented at international conferences.

The Benefits of Packet Optical Integration

Bert Buescher, *Director of Product Management and Marketing for Optical Transport Solutions, Tellabs, USA*

Packet optical integration has the promise to provide carriers significant saving as networks (mobile, video and business services) scale to higher capacities. However, just integrating technologies together into a single network element does not necessary translate into a network cost savings. This presentation will explore metro/regional applications that may benefit from packet integrated with optical transport systems, technology enablers and network architectures. The benefits carriers are able to realize from integrated packet optical transport networks will be dependent on their PMO and paradigm chosen for deployment.

Bert Buescher is director of product management and marketing for Tellabs optical transport solutions. In this role, he is responsible for defining Tellabs' strategic direction and market introduction for global optical networking solutions including WDM, SONET/SDH and packet transport.

Previously at Tellabs, Buescher held various roles including positions in the office of the Chief Technical Officer, transport strategic planning and digital cross-connect product line management. Buescher has more than 15 years of experience in the communications and networking industry and has worked in various roles through his career including R&D, product line management and corporate strategy.

Buescher has a Bachelor of Science degree in electrical engineering and a Master of Business Administration degree from Purdue University.

Ethernet Transport—It's Time to Converge

Ori Aruj, *General Manager North America and Vice President of Marketing, Dune Networks, USA*

The Ethernet transport market is in the process of drastic change. The new requirements driven by telcos and carriers demand a transition of the transport market from TDM only to a converged network. The market is driving to transport systems that switch between TDM, OTN and data transparently. Thus, the need for a new type transport systems emerges—systems that can provide the control mechanism and reliability that TDM is well known for while driving scalability and performance the data world is known for. Best-of-breed silicon fabric technology is available to enable this convergence and provide scalable and smooth transition. It's time to converge!

Mr. Ori Aruj heads North American operations as well as worldwide marketing activities at Dune Networks. Prior to joining Dune, Ori headed product management, marketing and business development at Charlotte's Web Networks, a privately held company focused on developing core switching and routing equipment for next generation networks. Prior to moving to business roles at Charlotte's Web, Ori held a number of engineering leadership positions, heading routing protocols development and system integration. Ori started his career at Intel Corporation, where he held a number of engineering positions. Ori completed, *Summa Cum Laude*, his Bachelor's' degree in computer science at the Technion—Israel Institute of Technology. Ori holds an MBA from INSEAD, one of the world's top business schools.

Reducing Network Costs Using Integrated Multi-Technology Hardware and Multi-Layer Software

Steve West, *Co-Founder and Chief Technology Officer, Cyan Optics, Inc., USA*

Packet optical transport systems support packet, SONET, OTN and DWDM in integrated modular platforms. New component technology increases the capacity, improves the flexibility and reduces the complexity. Next-generation packet, OTN, and ROADM transport technologies operate alongside SONET and SDH. A changing mix of old and new services can be accommodated, which makes these platforms ideal for migrating to packet services and higher capacity transports. Integration reduces the number of network elements that must be managed and coordinated. Integration also reduces the need for patching and manual configuration. Multiple services and technologies are managed as layers with client-server relationships. Software coordinates all functions under a single management framework, further simplifying configuration and maintenance. The result is greatly reduced CAPEX and OPEX.

Steve West is responsible for product development and product management at Cyan. Cyan is his third communications systems start-up. He was previously a member of the founding team at Turin Networks, Inc., where he was responsible for product architecture. Steve was also an early employee at Advanced Fibre Communications Inc. (AFC), where as Director of Engineering he was responsible for development of international features.

Prior to arriving in the United States, Steve developed ASICs for use in tactical radio systems, telecommunications and deep-level mining blasting. Steve has an MSc (engineering) and BS. (engineering) (*Cum Laude*) from The University of the Witwatersrand in Johannesburg, South Africa.

Panel V: Reinventing Carrier Networks for 100G: Taking it to the Next Level

Moderator: James King, *Executive Director, AT&T Laboratories, USA*

With solid continued network growth, service providers are looking at increasing backbone speeds to 100G in order to increase the capacity of their photonic networks while decreasing the unit cost of transmission. System providers and component vendors are looking at these same trends with an eye toward bringing out products that will capture the revenue potential of this emerging market, even while they continue to develop and improve today's 40G solutions. But even with agreement about the market landscape, there remain many different strategies about how and when the industry will get to 100G. This session explores these different strategies and features leaders from companies in all three areas to share their views of how this new market will develop.

Speakers

Considerations for 100G Network Deployment

Mark Nowell, *Director of Engineering–Core Routing Business Unit, Cisco, Canada*

As carriers contemplate the transition to 100G, there are many drivers coming to play that influence their decisions. Overall network bandwidths continue to grow and the solutions available to address this growth are under evaluation. We will discuss how the technology trends, the system trends and the network architecture trends are all interwoven in the development of an optimum strategy for addressing the transition to 100G in the networks. Finally, some thoughts on the future beyond 100G will be presented.

Mark Nowell is a Director of Engineering in Cisco's Core Routing Business Unit. He is responsible for the architecture and platform engineering teams focused on delivering the next-generation core router products and platforms. Mark is also active within the industry standards and forums and acts as Chair of both the Ethernet Alliance's High Speed Ethernet Technical committee and the IEEE 802.3's 40GE single-mode fiber PMD Study Group. Mark previously worked at Hewlett-Packard.

Mark earned his BSc and MSc degrees at Queen's University in Kingston, Canada, and his PhD at Cambridge University in Cambridge, UK.

Enabling Technologies for 100G Deployment

Ed Cornejo, *Vice President, Market Development, Subsystems Division, Opnext, USA*

This presentation covers the enabling technologies for 100GbE client and 100G DWDM line side modules, with a brief reference to the standards and special interest groups that are driving the development of these modules. Also included is a high-level view of the key optical and electronic technologies needed to reduce cost and power consumption that will lead to smaller footprints. To enable smaller footprints we will need to do optoelectronic integration and use CMOS IC's wherever possible. Finally, we will describe the versatility of the 100G DWDM transmitters with coherent detection and how they can be adapted to different applications.

Mr. Cornejo is responsible for technical marketing of the Subsystems Division at Opnext, focusing on opportunities in the metro, regional, long haul and submarine markets. He is also a key member of Opnext's corporate product strategy and definition group working closely with other business units, advanced development and research teams defining Opnext's long-term vision and commitment. Prior to joining Opnext, Mr. Cornejo held a series of manufacturing, engineering and

marketing positions with AMP's Lytel Division and Lucent's Optoelectronics Group. He has 23 years experience in the optoelectronics field.

100G–Challenges and Solutions

Matthias Berger, *Department Head, High Speed Optics, ALU Optics Division, Alcatel-Lucent, Germany*

Driven by the proliferation of multimedia applications accessed by multiple end devices, network bandwidth continues to grow exponentially. This bandwidth increase drives the need for higher capacity line rates, without sacrificing spectral efficiency, maintaining comparable performance in terms of reach and dispersion tolerance, limiting significant increases in space and power, while at the same time allowing a transition to the higher capacity rates without a forklift upgrade of fiber plant or existing photonic line, all while providing the lowest TCO per transported bit. In order to achieve this goal, the application of different modulation schemes coupled with advanced digital signal processing and optical integration are required. With that, "conventional" modulation/detection will be replaced by advanced coherent detection utilizing higher level modulation formats. This will help to overcome not only major the fiber limitations but to remove optical distortion compensation.

Matthias Berger received his master's degree in communication technologies from the University of Ilmenau, Germany, in 1989 followed by a research assignment with focus on coherent transmission. He joined Philips Communications Industry working on high speed optical interface design. After joining Lucent Technologies he focused on WDM transmission and optical engineering. In 1999 he led the early 40G development activities first based on OOK followed by phase modulated solutions for different product applications. In his role as department head for high speed optics he became responsible for the introduction of digital signal processing applied to data rates at 40G and beyond.

Lessons from 40G—Applied to 100G

Bernhard Kubis, *Head R&D DWDM & Common, NWS Optical Networks, Nokia Siemens Networks GmbH & Co. KG, Germany*

The presentation will describe lessons learned from the introduction of 40G equipment to the market and how to apply them to upcoming 100G. Topics include:

- Experiences from product life cycle at 40G.
- Conclusions for 100G on technology choice, system concept.
- Impact of standardization.

- Supplier landscape, e.g. eco-system for 100G MSA.

Bernhard Kubis is head of R&D for the DWDM business in Nokia Siemens Networks. He brings more than 25 years of experience in optical networking R&D. He held different positions in R&D at Siemens Munich, Optisphere Inc. USA (a Siemens subsidiary) and Marconi Ondata GmbH in Backnang. He is also Member of the Board "Optical Networks" in VDE/ITG (Fachausschuss Optische Netze).

100GbE: How Datacenter Interconnects Drive Demand for Higher Speed
Bikash Koley, *Senior Network Architect, Google, USA*

This presentation focuses on the trade-offs associated with choices of various optical interconnect speeds and technologies to build data-center interconnect architectures. Such interconnects can be very short-distance or may span large geographical distances connecting several data-centers. The biggest drivers and sweet-spots for application of 100G+ technology in such applications are presented.

Bikash Koley is currently Senior Network Architect at Google, where he is focused on network infrastructure scaling, optimization and reliability. Prior to joining Google, Bikash was the Chief Technology Officer of Qstreams Networks, a company he co-founded. He also spent several years at Ciena Corporation in various technical roles developing DWDM and Ethernet technologies. He received a BTech from IIT, India and MS and PhD degrees from the University of Maryland at College Park, all in electrical engineering.

2010 Plenary

The OFC/NFOEC 2010 Plenary Session was held on Tuesday, March 23. Each plenary speaker presents for 30–40 minutes.

Brian Herlihy
President, SEACOM, Mauritius

Presentation: Broadband in Africa

Abstract: 17,000 km of undersea fiber optic cable is now linking South Africa to India and Europe via Mozambique, Tanzania, Kenya, Djibouti and Egypt. SEACOM is the first cable to provide broadband to countries in East Africa, the last region in the world to be connected to a submarine fiber optic network. SEACOM is a major catalyst in moving the dynamic African communications market from a voice-centric model to a

data-centric model based on broadband technologies. Mr. Herlihy will address the technical achievements that made possible these new milestones of connectivity.

Biography: Mr. Herlihy has extensive experience in mega-infrastructure projects in Africa spanning a number of disciplines including power generation, chemical processing plants, ports, and telecommunications. Mr. Herlihy has worked in Africa for eleven years before founding the SEACOM project in 2006. Mr. Herlihy has experience in project development, financing, and governmental liaison supported by a strong understanding of African economics.

An American citizen, his career began in the UK in 1994 in the health waste sector before joining the Bank of America as a Marketing Analyst in 1997. From 1999 to 2003, he worked on the Africa ONE project where he gained valuable African experience. In 2003 he was appointed Vice President of Development at Global Alumina, a large alumina refinery project in the Republic of Guinea before leaving to initiate SEACOM. As president, he is responsible for overseeing the full funding and implementation of the $600 million fibre optic undersea cable project.

He holds a MSc (Development Studies – African Economics) and BA (Economics and Philosophy) from the London School of Economics and Boston College respectively.

Philippe Keryer

Executive Vice President, President Carrier Product Group
Alcatel-Lucent, USA

Presentation: Beyond Today's Broadband Networks

Abstract: As end users and enterprises become further immersed in the Web and its ever-expanding possibilities, traffic is expected to grow exponentially over the next years, driven by the new generation web-based applications. Demand for bandwidth — both wired and wireless — is soaring, requiring increased capacities at submarine and terrestrial levels. As end users want seamless and always-on access to services, they also expect a quality of experience (QoE) greater than ever.

For carriers and service providers, this translates into a need to continuously scale the network across multiple dimensions while supporting the lowest total cost of ownership.

Philippe Keryer will talk about those key challenges and Alcatel-Lucent's vision on how current broadband networks have to evolve to a full IP multiservice network -"the Alcatel-Lucent's High Leverage Network™", with a focus on the key role optical transport innovations, technologies, and solutions have to play in this transformation.

Biography: Prior to his current role, Philippe Keryer was President of the Alcatel-Lucent Mobile Access Division, responsible for the GSM, UMTS and WiMAX radio access businesses.

Previous to that role he was President of the Alcatel-Lucent GSM/WiMAX Division.

Before Alcatel-Lucent he held several key positions at Alcatel including President of the Mobile Radio Division and President of Evolium™—a joint venture between Alcatel and Fujitsu. In addition, Philippe Keryer held various management positions at Alcatel in tendering, product management, marketing, and strategy.

He holds an engineering degree from Supélec and a "Mastère" from EDHEC, and is a board member of Alcatel Shanghai Bell and Alcatel-Lucent France. Philippe is a member of the Alcatel-Lucent Management Committee.

Hideo Miyahara

President, NICT, Japan

Presentation: Challenges for New Generation Networks

Abstract: In this talk, Dr. Miyahara will look back over the past five decades, during which the industry has witnessed dramatic technological changes in information and communication technologies (ICT). Dr. Miyahara will discuss the role ICT should be playing in our society over the next 50 years. Then, from the viewpoint of ICT, he will review the challenges the field will face in developing a new generation network (NWGN), which is envisioned as a post–IP network. In pursuing the NWGN program, Dr. Miyahara has come to believe that the industry needs collaborative research with specialists from various fields. He will introduce, as an example, the interdisciplinary research project currently being pursued by NICT and Osaka University.

Biography: Dr. Hideo Miyahara, born in Osaka, Japan in 1943, has been the president of the National Institute of Information and Communications Technology (NICT) of Japan since September 2007. He was the president of Osaka University from August 2003 to August 2007. He also was a Visiting Scientist at IBM Thomas J. Watson Research Center from 1983 to 1984.

Dr. Miyahara is a Life Fellow of the IEEE (Institute of Electrical and Electronics Engineers) and the Institute of Electronics, Information and Communication Engineers of Japan. His research interests include performance evaluation of computer communication networks and distributed multimedia systems.

Dr. Miyahara has received numerous awards, including the Institute of Electronics, Information and Communication Engineers Distinguished Achievement and Contributions Award in 2008, and the 6th Ericsson Telecommunications Award in 2002. He also received recognition from the Japanese Minister of Internal Affairs and Communications in 2003.

2010 Short Courses

General Information

Short Courses cover a broad range of topic areas at a variety of educational levels. The courses are taught by highly regarded industry experts on subjects such as 40 Gb/s transmission systems, optical transmission systems, photonic integrated circuits, and ROADM technologies.

Short Courses are an excellent opportunity to learn about new products, cutting-edge technology and vital information at the forefront of communications. Whether you choose a course designed for beginners or for more advanced instruction, the small size of each class gives you an excellent opportunity for personalized instruction. Short Courses are also an opportunity to earn Continuing Education Units (CEUs) and to meet one of the key requirements to maintaining your PE license.

Continuing Education Units (CEUs)

Demonstrate your commitment to continuing education and advancement in the optical communications field by earning CEUs. Certificates awarding CEUs are presented to all individuals who complete a Short Course, CEU form, and course evaluation. Forms will be available on-site.

Registration

Register for a Short Course and you also receive free admission to:

- OFC/NFOEC Exhibition
- Plenary Session
- Workshops
- Market Watch
- Service Provider Summit
- Exhibit Floor Activities

Each Short Course requires a separate fee. Paid registration includes admission to the course and one copy of the Short Course Notes. Advance registration is advisable. The number of seats in each course is limited, and on-site registration is not guaranteed. Register early to guarantee your seat!

Free Short Course Offer for Student Members

After the pre-registration deadline (March 4, 2010), student members of sponsoring organizations may register for free for select Short Courses not yet at capacity. Many Short Courses are in high demand—the best way to ensure admittance is to pre-register for the course before it reaches capacity. On-site registration is not guaranteed. Free student registration will

not be available for hands-on courses, full-day courses or courses that are filled before the pre-registration deadline.

To achieve the full value of attending a Short Course, students who take advantage of the free course offer are strongly encouraged to pre-purchase Short Course Notes for $15 at the time that they register for the course. Short Course Notes are a valuable take-home benefit of attending a course, and these notes will be available only to attendees of the course. (Paid attendees receive one copy of the notes.)

Register early to guarantee a space in a Short Course!

Visit the registration page after March 4 to sign up for a free Short Course and purchase the corresponding course notes. (If you are already registered for OFC/NFOEC, you will need to update your registration to select from the available Short Courses.)

2010 Tutorial Speakers

Category A. Fibers and Optical Propagation Effects

OTuA1, **Chalcogenide Fibers for Mid-Infrared Applications**, *Ishwar Aggarwal; NRL, USA*

Category B. Fiber and Waveguide-Based Devices: Amplifiers, Lasers, Sensors and Performance Monitors

OTuB5, **Silicon Nanophotonics**, *Dries Van Thourhout; Ghent Univ.–IMEC, Belgium*

OWL4, **Fibre Optic Sensors in Structural Health Monitoring**, *Jose Miguel Lopez Higuera; Photonics Engineering Group, Univ. of Cantabria, Spain*

Category C. Optical Devices for Switching, Filtering and Signal Compensation

OMH1, **Plasmonic Nanophotonic Devices**, *Harry Atwater; Caltech, USA*

OThB1, **Silica-Based Waveguide Technology for Phase Modulation 100Gb/s Coherent Receiver**, *Hiroshi Takahashi; NTT Photonics Labs, Japan*

Category D. Optoelectronic Devices

OWD1, **High Performance Photonic Integrated PIC**, *Larry A. Coldren; Univ. of California at Santa Barbara, USA*

OThK1, **Quantum Dot Devices**, *James Coleman; Univ. of Illinois, USA*

Category E. Digital Transmission Systems

OTuL1, **Nonlinearity Management and Compensation in Transmission Systems**, *Alexei Pilipetskii; Tyco Telecommunications, USA*

OThL4, **Algorithms for Coherent Detection**, *Michael Taylor; Optametra, LLC, USA*

Category F. Transmission Subsystems and Network Elements

OWO1, **OFDM for Adaptive Ultra High-Speed Optical Networks**, *William Shieh; Univ. of Melbourne, Australia*

Category G. Optical Processing and Analog Subsystems

OML5, **Long Haul Analog Links**, *Vincent J. Urick; NRL, USA*

OWW1, **All-Optical Processing with Highly Integrated InP-Based Subsystems**, *Alistair J. Poustie; Ctr. for Integrated Photonics, UK*

Category I. Access Networks

OWX4, **10G PON-Explained**, *Frank J. Effenberger; Huawei Technologies, USA*

Category J. Network Experiments and Non-Telecom Applications

OWM5, **Recent Progress on OTDM Terabit/s Transmission and Their Future**, *Toshihiko Hirooka; Tohoku Univ., Japan*

OThH1, **Green Networking**, *Bill St. Arnaud; Canarie Inc., Canada*

OThX1, **Optical Interconnects**, *David Miller; Stanford Univ., USA*

NFOEC 1: Optical Networks and Services

NThE1, **Mutli-Layer Traffic Engineering**, *Jonathan Sadler; Tellabs, USA*

NFOEC 2: Network Technologies

NWE1, **Operationalizing a Control Plane Network**, *Mike Reina; Telcordia Technologies, USA*

2010 Service Provider Summit

Wednesday, March 24, 2010
OFC/NFOEC Exhibit Floor Theater

The Service Provider Summit is open to all Conference and Show-Only Attendees! Join your colleagues for this dynamic program with topics and speakers of interest to CTOs, network architects, network designers and technologists within the service provider and carrier sector. The program includes panel discussions, a keynote presentation, exhibit time and networking time.

The program will be located on the exhibit floor, so attendees can easily attend the sessions and tour the exhibit hall. Audience members are encouraged to participate in the question and answer segments that follow the presentations.

Service Provider Summit Chair:
Karen Liu, *Vice President, Components and Video Technologies, Ovum, USA*

Service Provider Summit Organizer:
Myo Ohn, *Senior Director, Strategic Marketing and Business Development, Oclaro Inc., USA*

Schedule-at-a-Glance

Speakers are being confirmed so check this site often for program updates.

8:00 a.m.–8:30 a.m.	Continental Breakfast
8:30 a.m.–9:00 a.m.	Keynote Presentation: Building Very Large-Scale Computer Infrastructure Vijay Gill, *Senior Manager, Engineering and Architecture, Google, USA*
9:00 a.m.–10:30 a.m.	Panel I: The Rise of the "Super" Data Center and What it Means to the Network Moderator: Mike Sapien, *Principal Analyst, Ovum, USA*
10:30 a.m.–11:00 a.m.	Coffee Break
11:00 a.m.–12:30 p.m.	Panel II: FTTx—The Bright Spot in the Access Market Moderator: Christoph Pfistner, *Vice President, Product Marketing, NeoPhotonics, USA*
12:30 p.m.–5:00 p.m.	Lunch and Exhibit Time *(on your own)*

Keynote Presentation

Building Very Large-Scale Computer Infrastructure, Vijay Gill, *Senior Manager, Engineering and Architecture, Google, USA*

The talk focuses on Google's approach to building large-scale, warehouse-scaled computers (WSC), the drivers of connectivity between them, the data flows between WSCs and the software approach that enable very large-scale distributed computer applications. The network that connects the globally distributed WSCs is a critical part of infrastructure and we discuss why this is so.

Vijay Gill is Senior Manager, Engineering and Architecture, at Google. He is responsible for all network design, expansion and datacenter infrastructure for Google's production network, as well as participating in various industry organizations and advancing the company's efforts in the standards arena. Vijay has co-authored a variety of RFCs on traffic engineering, multihoming and routing. He has also given talks and presentations on network design, BGP scaling issues and

traffic engineering in forums such as NANOG and IETF. Vijay is also currently serving on the IETF Internet Architecture Board (IAB). Prior to joining Google, Vijay worked as Sr. Technical Manager for AOL Global Network Operations and was responsible for setting the technical direction and strategy for AOL production. Before AOL, Vijay worked as Manager of Architecture at MFN/Abovenet where he participated in revamping the global backbone, standardization of routing policy and product development. Earlier in his career, Vijay worked as a senior engineer at UUNET, participating in the MPLS and multicast engineering projects.

Panel I: The Rise of the "Super" Data Center and What it Means to the Network

Moderator: *Mike Sapien, Principal Analyst, Ovum, USA*

Ten years ago, carriers and data center operators were dumping data centers and the equipment sold for scrap, pulling the plug on hundreds of millions of dollars of investment. Presently every major carrier, internet player and services company is investing globally in huge data centers, thereby expanding their capacity and global reach. Moreover, the scope of data center operators have expanded to include large enterprises, application providers and hosting specialists beyond the traditional global carriers and internet/content players.

The investment is a critical part of their global expansion of new services and emerging convergence of data, voice, IT and internet-based services and over-hyped "cloud" services. At the same time, they must also invest in the increased network connectivity (including internet transit) to support the required interconnection between customers, carriers, networks and applications. What has changed?

Join us in this exciting session where executives from a variety of different data center service providers will present their views on why these data centers and investments are now strategic investments and a required part of their global network infrastructure. The individual presentations will be followed by a panel discussion and open Q&A session.

Speakers

Cloud Computing and Hosting Centers Intertwined with Network Service Providers
Joseph D. Houle, *Principal Technical Architect, AT&T Business Solutions, USA*

Providing cloud computing or hosting center services is a natural fit for AT&T. Just as we have been providing voice, TDM, DWDM, IP, and Ethernet bandwidth services for years, even decades, processing and storage services have been added to the portfolio. We will review the direction of the hosting and cloud computing market, AT&T's portfolio for this market and the network requirements needed to support this market.

Joseph Houle has been with AT&T for 25 years. He has extensive experience in data communication with a background in equipment design, service definition and network implementation. Joe is most recently working on the network capabilities to enable cloud computing. Previously Joe had focused on content delivery technologies including studies on the economics of Net Neutrality. Joe also contributed to early IPv6 service provider industry evolution plans and some preliminary Wi-Fi offers. Joe has an MS in computer science from Johns Hopkins University and a BS in IE/OR from Rutgers University.

Leveraging Carrier-Neutral Colocation to Deliver and Expand WAN Services

David R. Pickut, *P.E., Chief Technology Officer, Equinix, USA*

In the current capital-constrained market environment, the challenges of increasing network footprint and capabilities have increased significantly, especially for new markets. We discuss how carriers can leverage a carrier-neutral colocation provider to expand network reach and deliver additional service capabilities by accessing a large community of providers with complimentary offerings and reach, and how a carrier-neutral facility can maximize flexibility and ensure optimal use of capacity deployed. We highlight how to reduce operational costs via IP traffic peering, as well as the ability to increase reach for carrier ethernet and MPLS services via network-to-network interfaces (NNI). Also covered will be how to increase revenue potential and reduce time to market by using these providers. Finally, we discuss what features and services to look for when assessing carrier-neutral providers to ensure maximum operational reliability and future expansion potential.

Mr. Pickut has significant experience in engineering and management, with substantial focus on data centers, critical facilities and networks. Dave has worked in consulting engineering, computer equipment power systems manufacturing, IT management and data center operations. In his current capacity as Equinix CTO, he is responsible for research and evaluation of new technologies related to the Internet and network products/service, energy, power systems and cooling systems.

Mr. Pickut is a registered professional engineer with a Bachelor of Science degree in electrical engineering. He is a member of the IEEE Communications Society, the NFPA, AFCOM and the Uptime Institute.

Impact of Super Aggregators on the Internet

Stuart Elby, *PhD, Vice President – Network Architecture, Verizon, USA*

With the rise of "super" content aggregators over the last two years, the traffic topology of the Internet has undergone significant and disruptive change. Coincident with this change is a

dramatic increase in the volume of high bandwidth video content. Together these changes are challenging the Internet backbone provider community in several dimensions: resiliency, load balancing, bandwidth, and latency. Addressing these challenges will likely change the fabric of the Internet.

Dr. Stuart Elby, Vice President of Network Architecture, is responsible for Verizon's network vision and evolution towards this target. Stuart is also responsible for the design and specification of Verizon's metro, regional, and long haul optical transport networks; VoIP and IMS networks; and emerging converged services platforms. Additionally, he is responsible for collaborative R&D activities with universities and government, and the Verizon Interoperability Forum.

Previously, Dr. Elby was a Research Associate at the NSF Center for Telecommunications Research at Columbia University performing R&D in all-optical networks and developing ATM/WDM platforms. At a laser surgery start-up, he was responsible for FDA clinical trials and product development, and brought the first disposal plastic fiber-optic system to the medical market. In 1982, he worked at StorageTek, contributing to the development of the first commercial optical disk system.

Dr. Elby received a BS degree in optical engineering from the University of Rochester (New York) in 1982 and received a MSEE and PhD from Columbia University in 1989 and 1994, respectively.

Panel II: FTTx—The Bright Spot in the Access Market

Moderator: Christoph Pfistner, *Vice President, Product Marketing, NeoPhotonics, USA*

The FTTx market defies the economic downturn and keeps growing at a double digit rate while most other segments of the communications market experience limited growth. Both GPON and GEPON have become mainstream network architectures and video has established itself as the key bandwidth driver. Geographically China is gearing up to challenge Japan for the top position in terms of number of homes deployed, but all regions around the globe are experiencing significant growth as many governments have started to work on national broadband strategies. In the meantime the standards bodies are defining the next-generation access networks supporting bandwidth of 10G and beyond.

Join us in this exciting session where executives from different service providers will present their views on the evolving FTTx market. The individual presentations will be followed by a panel discussion and open Q&A session.

Speakers

Broadband Deployment Status in Europe
Bruno Capelle, *Access Networks Division, Broadband Deployment on Wired Networks, Orange Labs, France Telecom, France*

Abstract and biography not available at this time. Check back soon!

NTT's Efforts and Prospects for FTTH Deployment
Koji Sakuda, *Director, Access Network Service Systems Laboratories, NTT, Japan*

Mr. Koji Sakuda has been Director of NTT Access Network Service Systems Laboratories since 2007. He joined NTT in 1981. During his 28-year career at NTT, he has engaged in the development and commercialization of FTTH systems, and the planning and engineering of telecommunications facilities. In addition, he was involved in the promotion and management of broadband capability in regional areas of NTT East. Recently, he has formulated and driven the strategy for introducing NTT's research and development results to FTTH.

Verizon FiOS Deployment Five Years On
Vincent O'Byrne, *Director of Technology, Core-Network Technology Group, Verizon, USA*

Verizon has deployed PON systems since early 2004 and continues to expand its deployment, augmenting it with GPON in late 2007. This presentation looks at the current status of this deployment and what's under development within Verizon to meet customer's needs.

Vincent O'Byrne has over 25 years of experience in telecommunications in both the wireless and wireline arenas. Vincent is the Director of the FTTP Architecture and Design Group and his team is responsible for defining the access requirements for BPON and GPON as well as its evolution to meet the continued growth in demand and services. His present interests are in continuing to reduce the cost for FTTP and the possible deployment of next-generation technologies in the access space.

Vincent attended Kevin St. College of Technology in Dublin, received his BSc from Trinity College Dublin IRL, MSc from the University of Essex, UK, a PhD from the University from Wales, UK, and an MBA from Babson College, USA.

2010 Workshops and Panels

OFC/NFOEC Workshops provide opportunities to discuss and debate the latest technologies. Many workshops will be highly interactive, amongst both the speakers and the audience. The format of each session is determined by the organizers. In the past, many workshops have consisted of a series of short, contributed presentations (5 to 10 minutes) from people involved in the field followed by a panel discussion driven by questions from the audience.

The 2010 conference features workshops and panel discussions in current areas of interest in OFC and NFOEC categories alike. All OFC/NFOEC attendees are encouraged to participate. Workshops will be held on Sunday, March 21, 4:30 p.m.–7:30 p.m., and Monday, March 22, 8:00 a.m.–11:00 a.m. The workshops provide an interactive learning environment and are open to all conference registrants.

Workshops

Sunday, March 21, 4:30 p.m.–7:30 p.m.

Category B. Fiber and Waveguide-Based Devices: Amplifiers, Lasers, Sensors and Performance Monitors

OSuG, **Discipline-Hopping in Photonics: How Can Medical Sciences Benefit from Recent Advances in the Traditional OFC Technologies?** *Adrian Podoleanu[1], Morten Ibsen[2]; [1]Univ. of Kent at Canterbury, UK, [2]Univ. of Southampton, UK,* Fibers and fiber-laser based systems are rapidly invading the medical arena, and a number of avenues for enhanced functionality have emerged from improvements in these technologies in the recent past. With demands in medical-imaging applications for ever higher resolution and line-rates increasing at exponential rates, the need for careful use of the processing capabilities of signals to enhance performance and efficiency has become progressively more attractive.

This workshop aims to assist in, and explore paths for, opening up a more direct technical debate between two flourishing communities working on technologies related to medicine for diagnostic and treatment purposes. Topics to be addressed include:

1. Sources for diagnostics and treatments (e.g. swept wavelength, supercontinuum and high-power sources).
2. Optical configurations and specialised fibers (e.g. for OCT, confocal microscopy, multiphoton microscopy, endoscopy, etc).
3. Signal-processing (e.g. multiplexing-demultiplexing, phase-shifting interferometry).

Speakers:
Adrian Gh. Podoleanu, *Univ. of Kent, UK*
Morten Ibsen, *Univ. of Southampton, UK*
Zhongping Chen, *Univ. of California at Irvine, USA*
Robert Huber, *Ludwig-Maximilians-Univ. München, Germany*
Bahram Jalali, *Univ. of California at Los Angeles, USA*

Frederik D. Nielsen, *NKT Photonics A/S, Denmark*
William Yang, *BaySpec, Inc., USA*

Trends in Non-Invasive Optical Imaging Inspired by Traditional OFC Technologies, *Adrian Gh. Podoleanu; Univ. of Kent, UK,* Methods and devices initially developed by the fiber optic, sensing and fiber laser communities are now finding applications in high resolution non-invasive optical imaging. A short introduction will set the scene of the workshop presentations. Three avenues are identified in the modern low coherence interferometry and in the optical coherence tomography technologies which have taken inspiration from fiber optic sensing, fiber optic devices, fiber lasers and fiber optic communications: (i) optical sources, (ii) optical configurations and (iii) signal processing. Progress along these three avenues is characterised by the need to slice the tissue as fast as possible and as fine as possible. Novel fibers and improved optical and digital processing schemes continue to stimulate progress in endoscopy. In optical coherence tomography, the number of publications doubled every three years. In terms of speed, the line rate has increased by more than 6 orders of magnitude from 1991. In the last few years the emphasis has moved, from increasing the line rate, to increasing the speed in volume acquisition, therefore the speed is now quantified in number of voxels/s. Parallel processing and progress in fast ring lasers has lead to sub-second acquisition times of whole volumes of tissue of 1 GigaVoxels.

Please follow the link to find out more about Adrian Podoleanu.

Fiber Based Endoscopic OCT, MPM, and CARS Imaging, *Zhongping Chen; Beckman Laser Inst., Dept. of Biomedical Engineering, Univ. of California at Irvine, USA,* Optical coherence tomography (OCT), multiphoton microscopy (MPM), and coherent anti-stokes (CARS) imaging are imaging technologies that have found many biomedical applications. Several key advances in fiber based endoscopic OCT, MPM and CARS systems have directly resulted from technological innovations in the telecommunication field, including swept laser, fiber femtosecond laser, phase modulator, photonic crystal fiber, MEMS scanning device, etc. In this paper, I will review the principles behind these imaging techniques and highlight several recent technology advances in this exciting field.

Dr. Zhongping Chen is a Professor of Department of Biomedical Engineering and Director of Functional Optical Coherence Tomography Laboratory at University of California, Irvine. He is a Co-Founder of OCT Medical Imaging Inc. Dr. Chen received his BS degree in Applied Physics from Shanghai Jiao Tong University in 1982, his MS degree in Electrical Engineering from Cornell University in 1987, and his PhD degree in Applied Physics from Cornell University in 1993. Dr. Chen's research interests encompass the areas of biomedical photonics, microfabrication, biomaterials and biosensors. His research group has pioneered the development of functional optical coherence tomography, which simultaneously provides high resolution 3-D images of tissue structure, blood flow, and birefringence. He has published more than 100 peer-reviewed papers and review articles and holds a number of patents in the fields of biomaterials, biosensors, and biomedical imaging. Dr. Chen is a Fellow of the American Institute of Medical and Biological Engineering (AIMBE), a Fellow of SPIE, and a Fellow of the Optical Society of America.

Fourier Domain Mode Locked (FDML) Lasers: An All Telecom Components Light Source Providing Unprecedented Performance in Optical Coherence Tomography (OCT), *Robert Huber; Ludwig-Maximilians-Univ. München, Germany,* Fourier domain mode locking (FDML) is a new technique to realize very rapidly wavelength swept narrowband laser sources. With sweep rates up to 5 MHz, sweep bandwidths of 150nm and more and instantaneous linewidths as narrow as 0.02 nm, these sources offer unmatched performance in optical coherence tomography (OCT), a novel biomedical imaging modality. All passive and active optical elements in an FDML laser are readily available telecom components, resulting in an exemplary stability and reliability, which greatly helped to quickly push this new technology from a laboratory environment into clinical application. Recent developments, the current status and new improvements in FDML lasers will be reported. Efforts to extend the accessible wavelength range, to increase the instantaneous coherence length and to further push the sweep speed while maintaining low relative intensity noise will be discussed

Please follow the link to find out more about Robert Huber.

Taking Pictures with an Oscilloscope, *Bahram Jalali, Keisuke Goda, Kevin Tsia, Ata Mahjoubfar; Photonics Lab, Univ. of California at Los Angeles, USA,* We report an imaging method that overcomes the fundamental limitation between sensitivity and speed and offers frame rates that are 1,000 times faster than those of conventional CCDs. Our technique uses group velocity dispersion to map a 2-D pixel array into a 1-D serial analog data stream. It simultaneously achieves *optical image amplification* through stimulated Raman scattering in the dispersive medium. The optically serialized pixel stream resembles serial data in optical communication links, so a fiber optic receiver is used for image capture. Our system captures an entire 2-D image using a single-pixel photodetector and achieves, for the first time, net optical image amplification. This crucial capability overcomes the fundamental tradeoff between sensitivity and frame rate. It does so without the need for cooling - a costly and bulky solution; and without the need for high-intensity illumination – an approach that is even more undesirable as it can damage biological samples. We discuss the application of this fast and sensitive camera to early detection of cancer through identification of rogue diseased cells such as circulating tumor cells.

Bahram Jalali is a Professor of Electrical Engineering at UCLA, a Fellow of IEEE and of the Optical Society of America, and recipient of the R.W. Wood Prize from Optical Society of America. In 2005 he was elected into the Scientific American Top 50, and received the BrideGate 20 Award in 2001 for his contributions to the Southern California economy. Dr. Jalali serves on the Board of Trustees of the California Science Center and the Board of Columbia University School of Engineering and Applied Sciences. He has published over 350 journal and conference papers and holds 7 patents.

State of the art Supercontinuum Sources for Imaging, *Frederik D. Nielsen, Jeppe Johansen, Weidong Sheng, Carsten L. Thomsen, NKT Photonics A/S, Denmark,* New light sources have been pushed forward by OCT in the pursuit of speed and resolution throughout the history of the imaging modality. Amongst these sources are the high power fiber based Supercontinuum systems, which today offer unprecedented bandwidth and power compared to alternative light

sources. The Supercontinuum sources span both the visible and near infrared part of spectrum. Hence they cover all the wavelength windows of interest for most OCT applications. In addition, they provide turn-key operation and low cost of ownership especially in applications were high power and high resolution is needed. As with any light source various characteristics have to be taken into account as part of the OCT integration. In the case of Supercontinuum sources this in particular relates to spectral shape and intensity noise. In this talk we will elaborate on this topic and present the properties of state of the art Supercontinuum sources and routes towards imaging with an axial resolution close to 1 μm. Furthermore we will present some of the intrinsic noise properties of Supercontinuum sources, and consider their possible implications with regards to OCT.

Frederik Donbæk Nielsen joined NKT Photonics A/S as a research scientist 5 years ago. He received his MS degree from the University of Aalborg and PhD from Risoe National Laboratory/COM, Technical University of Denmark. He has for over 10 years been involved in development of laser sources and measurement systems, spanning laser velocimetry, optical coherence tomography and supercontinuum system development.

From the Telecom Boom and Bust Towards Pervasive Spectroscopy, *William Yang, BaySpec, Inc., USA,* Instrumentation professionals have long recognized great potential for NIR spectroscopic analyzers in many application areas ranging from lab analysis to portable field monitors. Until now, however, NIR process analytical instrumentation were too big, too expensive, too fragile, and so sophisticated they required highly trained operators for "real-world" application use. Recent advances in high volume telecom device manufacturing presents a disruptive new picture today. The state-of-the-art NIR spectrometer today borrows largely from the massive investments made in telecom grade components over the last ten years. These include: transmission holographic volume phase gratings, linear array image sensors, miniature lasers and light sources, and solid-state computer chips. Collectively, these are now assembled into ultra-compact, no moving parts, low power consumption, hermetic, reliability-tested spectral engines that can run on batteries in a handheld form factor. Today's spectral engines are designed to meet real-world challenges for best-in-class performance, long-term reliability, compact size, ultra-low power consumption at affordable prices. NIR spectrometers utilize telecom reliability-tested components and feature no moving parts for long term reliability and life-time calibration in the field. For the first time in instrumentation history an affordable, accurate and ruggedized spectral device is helping to fulfill the promise of NIR spectroscopy.

William Yang, PhD, is the President, CEO and co-founder of BaySpec, Inc. Dr. Yang received his BS and MS in Lasers and Optoelectronics from Tianjin University, and his PhD from the University of Waterloo in Laser Specroscopy. With over 20 years experience in applied spectroscopy, Dr Yang's industry experience covers semiconductor metrology, biomedical, ophthalmology, telecom and industrial spectroscopic device markets. Dr. Yang is a member of SPIE, OSA and the Society of American Photobiology.

Category C. Optical Devices for Switching, Filtering and Signal Compensation

OSuF, **Does Optical Dispersion Compensation Have a Future?** *Chris Doerr; Bell Labs, Alcatel-Lucent, USA,* Will the advent of intradyne coherent receivers, which can compensate fiber chromatic dispersion using digital signal processing, obviate the need for optical dispersion compensators (dispersion-compensating fiber, fiber Bragg gratings, etalons, etc.)? Electronic compensation is more flexible than optical compensation, however electronic compensation consumes significantly more power. For a single channel, electronic compensation is less expensive than optical compensation, but for a large number of channels optical compensation may have a lower overall cost. If optical dispersion compensators do survive, will they be mostly fixed or tunable? Single or multiple channel? Integrated or discrete? We will debate this issue from all sides.

If you would like to participate, please send an e-mail to Chris Doerr at crdoerr@alcatel-lucent.com. We will encourage the audience to ask tough questions, so be ready for a debate.

Speakers:
Martin Guy, *Teraxion, Canada*
Bengt Johansson, *Proximion, Sweden*
Robert Lingle, *OFS Labs, USA*
Daniel Mahgerefteh, *Finisar, USA*
Pavel Mamyshev, *Mintera Corp., USA*
Hiroshi Onaka, *Fujitsu, Japan*
Naoki Ooba, *NTT Photonics Labs, Japan*
Jeremie Renaudier, *Alcatel-Lucent, France*
Kim Roberts, *Ciena, Canada*
David Welch, *Infinera, USA*
Peter Wigley, *Oclaro, USA*

Category E. Digital Transmission Systems

OSuB, **Electronic 100GbE and Its Transport over OTN: Current Status and Future Developments**, *Peter Winzer[1], Yutaka Miyamoto[2]; [1]Bell Labs, Alcatel-Lucent, USA, [2]NTT Network Innovation Labs, NTT Corp., Japan,* After about 5 years of intense research and development, 100G transmission and switching is becoming a commercial reality. Standardization of 100G Ethernet (100GbE) by the IEEE will be finalized in 2010, and ITU-T based 100G Optical Transport Network (OTN) standardization of OTU4 digital framing is largely completed. At the same time, major component vendors and system integrators are nearing 100G product introduction, and data center operators as well as carriers are ready to roll out 100G technology. This workshop will focus on various aspects of 100GbE and its transport over OTN in the light of ongoing product development and deployment, including updates on the need for 100G technologies, 100G trials, 100G product development efforts, 100G standardization, and future directions for 100G optical networking, including a view towards 400(?) GbE.

Speakers:

Category 1: IEEE and ITU-T Standardization and Testbed Activities

Osamu Ishida, *NTT, Japan*

IEEE and ITU-T Standardization Activities in 100GbE and Its Transport

A new paradigm at 100 Gb/s where IEEE802.3 Ethernet drives ITU-T G.709 Optical Transport Network (OTN) will be highlighted. Their unique solutions for flexibility and scalability, such as the multi-lane architecture and the Generic Mapping Procedure (GMP), will be also reviewed.

Inder Monga, *ESnet (Energy Sciences Network), USA*

Challenges and Goals of 100Gbps Backbone Deployment

ESnet received ARRA (Stimulus) funding to build a prototype cross-country 100Gbps network, and to create a network testbed that researchers can use for several types of network experiments. This talk gives an overview of the goals and future plans for the ESnet 100Gbps Prototype Network and Testbed project. It also covers the challenges encountered to date.

Category 2: Carriers and other System Users

Peter Magill, *AT&T Research, USA*

To be Announced

Bert Basch, *Verizon, USA*

Verizon's 100G Roll-Out and What's Next

A brief review will be given of Verizon's activities related to the introduction of 100G in its networks and current plans for going forward.

Category 3: Transport Systems

Maurice O'Sullivan, *Nortel, Canada*

Need 100 GbE Transport? Get Coherent.

In anticipation of the general availability of short reach 100 GbE interfaces we describe a commercially available, 100 GbE compatible, coherent DWDM transceiver and look toward a future 400GbE or 1 TbE capable DWDM transport interface.

Matthias Berger, *Alcatel-Lucent, USA*

100G Status and Evolution- A System Integrators View

Driven by continuous growths in services and applications as well as strong support by international standards a transition of transport rates towards 100 Gbit/s can be expected in 2010 already. Transmission limitations can be overcome with coherent detection in combination with digital signal processing. A paradigm shift might be needed for a further increase in spectral efficiency while keeping a reasonable distance.

Hiroshi Onaka, *Fujitsu, Japan*

Challenges for Development of 100G Digital Coherent Transmission Systems

Digital coherent detection is very attractive technology, however, state-of-the-art VLSI and optical device technologies are required. This talk will clarify technological subjects of 100G digital coherent transmission systems.

Takashi Mizuochi, *Mitsubishi, Japan*
A Practical Perspective on Soft Decision FEC for 100Gbps and beyond
Soft decision FEC can be a great help for 100GbE transport. Conveniently, a digital coherent receiver has ADCs at its front-end. This makes it much easier to realize soft-decision decoding. "Triple-concatenation" improves not only coding gain but also power-saving.

Category 4: Switching and routing
Gary Nicholl, *Cisco, USA*
High Speed Client Interface Optics - The Limiting Factor for Next Generation Networks?
The talk addresses the current status of 100GbE and OTU4 client interfaces on routers and switches, and the (ominous) challenges ahead as the industry pushes to even higher speeds.

Ken Kutzler, *Alcatel-Lucent, USA*
To be Announced

Category F. Transmission Subsystems and Network Elements

OSuE, **How Can We Groom and Multiplex Data for Ultra-High-Speed Transmission?**
Klaus Grobe[1], Erwan Pincemin[2]; [1]ADVA AG Optical Networking, Germany, [2]France Telecom R&D, France, We propose to the invited speakers and audience to debate around the technologies and network elements required to switch, route, and aggregate/disaggregate efficiently ultra-high data rates carried by WDM channels implemented in the coming generations of metro/core transport networks running at 40 and 100 Gbps per wavelength and higher. In order to make the optical transport network as flexible as possible, it is important to implement network elements, such as colorless/directionless reconfigurable optical add-drop multiplexers (ROADM) able to switch or route efficiently wavelengths and circuits at various data rates but also able to realize grooming/de-grooming operations on the big optical pipes arriving and leaving the network nodes. As an attendee, you should bring your own ideas, solutions, and questions. Many aspects of this problem and its solutions can be discussed. Among them are:

- What is the optimum combination of the electrical and optical network elements' functionality balancing cost, performance, flexibility, simplicity, energy efficiency?
- In terms of optical wavelength switching and routing, is colorless/directionless ROADM the ultimate technology? Is it necessary to have flexible ROADM totally agnostic to the channel spacing and channel spectral occupancy? Are Optical Cross Connects (like those developed at the beginning of 2000s) necessary?
- Does grooming/de-grooming of ultra-high data rate (i.e. 100 Gbps) have to be necessarily electrical? If not, what could be the transmission and switching technologies able to do that optically?
- What does convergence of access, metro, and core networks involve for transmission and switching/routing technologies?

Speakers:
Cornelius Fürst, *ADVA, USA*

Ezra Ip, *NEC Labs America, USA*
Masahiko Jinno, *NTT, Japan*
David Neilson, *Alcatel-Lucent, USA*
Simon Poole, *Finisar, USA*
Bernhard Spinnler, *Nokia Siemens Networks, Netherlands*
Fritz-Joachim Westphal, *Deutsche Telekom, Germany*

Category G. Optical Processing and Analog Subsystems

OSuC, **Can Radio over Fiber Provide Last-Mile Connectivity?** *Thomas Clark[1], Alwyn J. Seeds[2]; [1]Applied Physics Lab, John Hopkins Univ., USA, [2]Univ. College London, UK*, Radio over fiber technology has the potential to significantly improve the availability, accessibility, reliability and affordability of wireless communication networks. The potential for the modulation transparent and mixed format interconnection of these cells using passive optical networks should allow for the efficient deployment of new radio cells and/or upgrading of existing wireless networks without incurring the excessive costs of new fiber plant or central station upgrades. This workshop seeks to address the networking and physical layer technology advances and challenges required to realize these benefits.

Most importantly, this workshop seeks to be a forum for launching community conversation about the various radio over fiber options and opportunities. To achieve this, the workshop will be organized with a limited number of planned speakers to introduce key topics in 8 minute presentations. The rest of the time will be kept open for spontaneous audience participation and debate with audience speakers limited to no more than 2 prepared slides.

Suggested Topics:

- Key applications and opportunities for RoF in PONs
- RoF devices and technologies
- Mixed format transport over PONs
- RoF system architectures

Category I. Access Networks

OSuD, **Beyond 10-Gb/s Passive Optical Networks – What's Next?** *Patrick Iannone[1], Ellsworth Burrows III[2]; [1]AT&T Labs, USA, [2]Alcatel-Lucent Technologies, USA*, In little more than a decade, several generations of standardized TDM PONs have been commercialized with line rates increasing from 155 Mb/s to the current generation of gigabit PONs (1.25 GB/s for the IEEE-standardized EPON and 2.5 Gb/s for the ITU-T-standardized GPON). The next generation of standardized 10-Gb/s TDM PONs are relatively well defined and should be commercially available soon.

This workshop explores optical access technology and architectural options beyond 10-Gb/s TDM PON. Many experts doubt that TDM PONs can remain cost effective as the line rate is increased, which leaves this space wide open for new technology entrants such as WDM PON, hybrid TDM-CWDM PON, code-division multiplexed (CDM) PON, orthogonal frequency-division multiplexed (OFDM) PON, etc. Naturally, the success of any of these approaches is dependent not only on the system performance, but on the ultimate cost and performance of the underlying components and subsystems, as well as the fit with future (as yet undefined) services.

To ensure lively discussion, we are returning to a more traditional workshop format. All speakers will be limited to 2 slides and 5 minutes per trip to the microphone. Attendees are encouraged to participate by presenting their own slides (same ground rules apply), asking questions, or commenting. The organizers will provide an old fashioned overhead projector with pens and transparencies for those who want to draw up slides on the spot. Pre-prepared slides should be on a USB stick. PON dissenters are also encouraged to attend and participate.

Category J. Network Experiments and Non-Telecom Applications

OSuA, **Dynamic Converged Optical Networking**, *Ioannis Tomkos; Athens Inst. of Telecomm, Greece,* One fundamental challenge at this point of optical networking evolution, is to develop novel unifying technologies and solutions that are controlled by an intelligent control and management plane and achieve convergence in multiple levels of the network operation (i.e. access / metro / core network segments, optical / wireless technology domains, optical / network / service layer integration, optical circuit / burst / packet switching paradigms, single / multiple domain networks), thus reaching an optical infrastructure that will enable optimum and efficient end-to-end service delivery with the required performance guarantees.

The workshop goal is to address solutions for achieving this converged framework with emphasis on experimental demonstrations. High level speakers representing both industry and academia will present their opinions and a panel discussion will follow.

Speakers:
Joe Berthold, *Ciena Corp.*
Milorad Cvijetic, *NEC America*
Stuart Elby, *Verizon*
Andreas Gladish, *Deutsche Telecom/T-Labs*
Akira Hirano, *NTT Network Innovation Labs*
Peter MaGill, *AT&T*
Biswanath Mukherjee, *Univ. of California at Davis*
Adel Saleh, *DARPA*
Masatoshi Suzuki, *KDDI*

Dynamic Converged Optical Networking: Setting the Scene, *Ioannis Tomkos; Athens Inst. of Telecomm, Greece.* An overview of the challenges associated with dynamic converged optical

networking will be presented. The different areas of convergence will be discussed and research activities targeting the development of relevant solutions will be outlined.

Network Resource Management for End-to-End QoS in Heterogeneous Networks, *Masatoshi Suzuki, KDDI R&D Labs, Japan.* A network resource management system to provide QoS guaranteed end-to-end path from heterogeneous access to core networks will be presented. In addition to MPLS and/or GMPLS light path in the core network, network resources in metro and access network can be reserved and end-to-end service with the required service quality can be provided. Experimental results will be presented.

Challenges and Opportunities of Converged Optical Networking, *Andreas Gladisch, Deutsche Telekom, Germany.* The constant growth of internet and increasing demands on bandwidth, flexibility and reliability results in a new quality of network architecture which combines packet and circuit functionalities. Besides these general trends there are topological factors, traffic structures, control plane functionalities and operational aspects that have to be considered to enable the take-off of the converged architecture. Finally there are cost requirements (CapEx and OpEx) factors which have to be fulfilled as well.

Optical Packet Transport, *Stuart Elby, Verizon, USA.* The integration of intelligent optical transport and packet switching promises to transform the network in terms of cost, flexibility, and new services opportunities. These benefits will be explored along with the technical challenges in realizing this vision.

Unified Application and Multilayer Network Management in Dynamic Converged Optical Networks , *Akira Hirano, NTT Network Innovation Labs, Japan*. NTT's activities toward the realization of a converged platform that can provide all kinds of network-related services will be presented. A common interface to virtualize heterogeneous resources including computing, visualizing, and networking resources to make the approach possible will be discussed. In addition, results from field trials that have been contacted for the evaluation of the platform focusing on multi-layer network management aspects, will be highlighted. Finally, we will introduce recent standardization activities within OGF, ETSI and ITU-T.

To Be Announced, *Peter MaGill, AT&T, USA*

Automating the Dynamic Converged Optical Network – Out to the Edge, Down to the Photonic Layer, *Joe Berthold, Ciena Corp., USA.* Large networks of optical transport switches provide automated connection setup, fast mesh restoration, and deliver 6-9s of service availability today. With the evolution to converged optical networking platforms, with their ability to switch packets, circuits and waves in a coordinated way, automation will be ever more necessary and more valuable. We will also see the scale of automated converged optical networks extend from the core to the edge of the optical domain, enabling the expansion of dynamic optical services to a larger community of end users.

End-to End Packetized Bandwidth Delivery in Converged Optical Networks, *Milorad Cvijetic, NEC Corp. of America, USA.* There is increasing need to deliver packetized carrier-grade bandwidth to different categories of end users. High bandwidth consumption and quality of

service criteria require optimized network architecture in both metro/core and access network segments. Herewith, we will discuss the architecture for converged optical networking assuming that 100 Gb transmission will be in its foundation.

Dynamic All-Optical Networking - From Chip-Scale to Global-Scale, *Adel Saleh, DARPA, USA.* It is argued that in networking applications ranging from chip-scale interconnects to global-scale communications, the cost and power consumption will be greatly reduced if the network is both all-optical and dynamic. The viability of optical circuit, burst and packet switching in these widely varied applications will also be discussed.

Network Convergence in the Future Internet, *Biswanath Mukherjee, Univ. of California at Davis, USA.*

The Future Internet is expected to demonstrate network convergence across multiple dimensions: convergence among access/metro/core network segments; convergence among optical and wireless technologies; and convergence among the physical, network, and services layers, including energy-conservation issues. Such an integrated converged network platform can support efficient end-to-end service delivery, so the Future Internet should combine different network technologies under a unified control and management framework. Important R&D problems across the above dimensions will be outlined.

A panel discussion will follow after the presentations. If you have specific questions for the speakers please e-mail them to the workshop chair in advance of the event at itom@ait.edu.gr.

NFOEC 1: Optical Networks and Services

NSuA, **Green Optical Networks: From Access to Core**, *Hans-Martin Foisel; Deutsche Telekom, Germany,* Broadband for all – the numerous initiatives of broadband network deployments around the globe are revealing a considerable downside of these activities: A significant increase of power consumption of the telecommunication equipment and attached customer gears! Continuing work as in the past is not an option!
In this workshop different views of carriers, vendors, R&D, standardisation bodies and initiatives on this new telecommunication challenge will be presented, covering:

- New network design and architectures – allocation of functions
- Evaluation of different technologies – from routers to optical network elements
- New approaches to in-house networks
- Content and processing power allocation – from customer end devices to carrier networks

Speakers include:

Jim Jones, *Alcatel-Lucent, USA*
Christoph Lange, *Deutsche Telekom, Germany*
John Rathke, *Verizon, USA*
Rodney Stuart Tucker, *Univ. of Melbourne, Australia*

Monday, March 22, 8:00 a.m.–11:00 a.m.

Category A. Fibers and Optical Propagation Effects

OME, **Micro/Nanofibers: Are They Here to Stay?** *Misha Sumetsky, OFS Labs, USA,*
Applications of optical micro/nanofibers attracted noticeable attention in recent years. Microfibers are used as means for connection to photonic devices (e.g., to microcavities and photonic crystals) as well as basic photonic elements including microfiber-based resonators, lasers, and sensors. Microfiber bends, loops, knots, coils, splices, and couplers have been demonstrated. On the other hand, there exist controversial opinions on the prospects for practical applications of micro/nanofibers. The goal of this workshop is to discuss and identify the opportunities of optical micro/nanofibers for commercial applications and fundamental science.

A lively discussion including positive, negative, and challenging opinions will be encouraged from all in attendance at this workshop. Bring slides on a USB stick if they will help you make a point.

Among the topics that you can discuss are the following:

1. What are the unique features of micro/nanofibers and how, if at all, do these features make them suitable for photonic devices?
2. What important problems have been solved by the use of micro/nanofibers?
3. What are the major challenges to future research or practical implementations of micro/nanofibers?
4. Is mass production of micro/nanofiber based devices a practical goal?
5. What are their relevant applications? Are they suitable building blocks for a photonic circuit? Are micro/nanofiber-based devices sufficiently robust for commercial applications? Are there better ways to achieve the same functionality?
6. Do micro/nanofiber photonics have a bright future, and if so, will that future be found in the pages of a journal, the balance sheet of a profitable business, or both?

Speakers:
G. Brambilla, *Univ. of Southampton*
N. Broderick, *Univ. of Southampton*
B. Eggleton, *Univ. of Sydney*
X. Fan, *Univ. of Missouri at Columbia*
K.P. Nayak, *Univ. of Electro-Communications*
A. Rauschenbeutel, *Johannes Gutenberg-Univ. Mainz*
M. Sumetsky, *OFS Labs*
J. Villatoro, *Inst. de Ciències Fotòniques*
F. Vollmer, *Harvard Wyss Inst.*

Category D. Optoelectronic Devices

OMC, **Which Optical Devices/Components Can Enable Future Advanced Modulation Formats?** *Liam Barry[1], Martin Schell[2]; [1]Dublin City Univ., Ireland, [2]Heinrich-Hertz-Inst. Fraunhofer, Germany,* New modulation formats are currently being proposed to enhance the performance and spectral efficiency of optical communications systems in core, metro, and access networks. These implementation of these advanced modulation formats such as QPSK, N-QAM, and OFDM in optically coherent communication systems requires specific photonic and optoelectronic devices and components that are suitable for such coherent photonic systems. These devices include low linewidth lasers, optical I-Q modulators, coherent optical receivers, etc. This workshop will explore the most suitable photonic and optoelectronic components for enabling practical and cost efficient coherent optical systems.

The workshop will discuss the various pro and cons of these devices and look to determine which components will be most suitable for the practical implementation of advanced modulation formats in core, metro, and access networks.

Speakers:
Chris Doerr, *Bell Labs, Alcatel-Lucent, USA*
Christophe Kasmierski, *Alcatel 3-5 Labs, France*
Martin Schell, *Heinrich Hertz Inst., Germany*
Huug de Waardt, *COBRA Inst., The Netherlands*
Dirk van den Borne, *Nokia Siemens, Germany*
David Welch, *Infinera, USA*
Hiroshi Yamazaki, *NTT, Japan*
S. Ben Yoo, *Univ. California at Davis, USA*

Category F. Transmission Subsystems and Network Elements

OMA, **1 TbE Transport – Why, When and How?** *Andrew Ellis[1], Seb Savory[2]; [1]Tyndall Natl. Inst., Ireland, [2]Univ. College London, UK,* Given the rapid growth of internet traffic it is predicted in some quarters that in the near future we will need transport systems with capacities approaching 1 Tb/s. This workshop will examine the motivation behind such predictions and discuss the potential requirements for transponders offering such capacities. The workshop will also cover technological choices that will enable 1 Tb/s through physical layer technologies and techniques, both electronic and optical, in addition to the opportunities and challenges of switching ultra-high capacity channels.

To facilitate the necessary debate, the workshop will be divided into three sessions, covering: the network requirements for 1-Tb/s transport, the enabling optical and electronic transmission technologies and finally the strategies for optical networking. In each session two speakers with opposing views will introduce the topic, following which the audience will be invited to make individual contributions. All speakers will be limited to one electronic slide, two overhead transparencies or two questions and strictly a maximum of 5 minutes per trip to the microphone. The organizers will provide an overhead projector with pens and transparencies for those who

want to draw up slides on the spot. Pre-prepared slides should be on a USB stick. Proponents and dissenters are equally encouraged to attend and participate. In the final 5 minutes of each of the three sessions the session co-chairs will attempt to summarize the discussion.

Category G. Optical Processing and Analog Subsystems

OMD, **Is All-Optical Processing Green?** *Javier Marti[1], Keith Williams[2]; [1]Univ. Politecnica de Valencia, Spain, [2]NRL, USA*, The tremendous growth of huge bandwidth consuming Internet applications (e.g. video & photograph up/downloading) is pushing on high-speed processing requirements in optical network nodes. Power consumption seriously limits scaling up electronics processing capabilities. Low power consumption intends to be an important driver to incorporate all-optical processing (AOP). However, a detailed comparison among different processing technologies based on high-speed all electronics, hybrid opto-electronics and all-optical in terms of power consumption has to be established for different processing functionalities in fiber optic networks.

The workshop addresses relevant key notes and further discussion on how AOP compares to all electrical processing and to hybrid opto-electronic processing in terms of power consumption efficiency. Figures of merit have to be defined to establish a fair comparison. Key visions on AOP's opportunities in both ultra-high speed network node equipments (routing, demultiplexing, etc) and high-performance computing will also be addressed.

Schedule

8:00 a.m.– 8:05 a.m.	**Introduction to the Workshop**
8:05 a.m.– 8:25 a.m.	**All Optical Processing in Green IT: Benchmarking From The Holistic Perspective** S.J. Ben Yoo, *Univ. of California at Davis, USA*
8:25 a.m.– 8:45 a.m.	**Energy Consumption in Optical and Electronic Signal Processing** Rod Tucker, *Univ. of Melbourne, Australia*
8:45 a.m.– 9:05 a.m.	**Optical-Path Technologies for Green Networks** Hiroshi Ishikawa, *AIST, Japan*
9:05 a.m.– 9:25 a.m.	**Optical Bypass in Packet Networks: An Opportunity to Reduce the Power Consumption of Systems While Offering High Network Efficiencies** Dominique Chiaroni, *Alcatel-Lucent, France*
9.25 a.m.–	**DISCUSSION PANEL**

9.35 a.m.	
9:35 a.m.– 9:45 a.m.	**BREAK**
9:45 a.m.– 10:05 a.m.	**Comparison of Electrical and Optical Switching for High Capacity, High Port Count Switches** John Bowers, *Univ. of California at Santa Barbara, USA*
10:05 a.m.– 10:25 a.m.	**Evaluation of Effectiveness in Power Consumption of Optical Packet Switches Realized in SOA Technology**, Vincenzo Eramo, *Univ. Rome La Sapienza, Italy*
10:25 a.m.– 10:45 a.m.	**To Be Announced**
10:45 a.m.– 11:00 a.m.	**DISCUSSION PANEL**

Category H. Core Networks

OMF, **Are All-Optical Networks Manageable?** *Dan Kilper; Bell Labs, Alcatel-Lucent, USA,* This workshop will probe difficult questions related to managing large optically-transparent networks. Using ROADM technologies, mesh networks are realized with many attributes different from traditional point-to-point transmission systems, e.g. planning tools are required to configure these systems with interest in using transmission impairments in routing decisions. Key questions to be addressed include:

- Can transparent networks be accurately planned?
- Is impairment aware routing useful? Is it even solvable?
- Can a network be too big? Should we go translucent?
- Can transients be controlled? Are they really a problem?

Interested participants are encouraged to send slides to the organizer: dkilper@alcatel-lucent.com or bring them to the workshop. Both invited and contributing participants are limited to 2 slides per topic. An open floor format will be used to encourage discussion.

Category I. Access Networks

OMB, **Beyond the Door Step: Can Fiber Also Invade the Home?** *Ton Koonen[1], Dalma Novak[2]; [1]Eindhoven Univ. of Technology, Netherlands, [2]Pharad, LLC, USA,* Fiber has become the predominant transmission medium in nearly all parts of telecommunication networks, starting

in long-haul international and national trunk lines, next in metropolitan networks, and now penetrating the access networks all the way towards our homes. But the battle for getting fiber into the home, beyond the doorstep, is still ahead. There are many established competitors, such as cat-5/7 cable, power line communication, wireless LAN and others. What can fiber offer more than they can? Capacity? Flexibility? Ease of installation? Upgradeability? Lower cost? How can fiber efficiently team up with other well-accepted technologies, such as wireless?

The workshop will facilitate lively discussion in this area among the participants. After introductions by speakers knowledgeable in various areas of in-home network technologies, the floor is yours. So please bring your ideas and let them be heard!

Presentations

OMB Optical Home Applications – Charbonnier
QoS in home-MP & PS – FITH – Popov

Schedule

8:00 a.m.	**Welcome, Introduction to the Workshop** Ton Koonen, *Eindhoven Univ. of Technology, Netherlands*
8:05 a.m.	**Fiber Use in The Home: Verizon's Perspective** Vincent O'Byrne, *Verizon, USA*
8:25 a.m.	**High-Speed In-Home Services: Plastic Optical Fiber for "Fiber-to-the-Display"** Yasuhiro Koike, *Keio Univ., Japan*
8:45 a.m.	**Optical Fiber Backbone to Serve Multiservice Home Network Requirements** Benoit Charbonnier, *France Télécom R&D, France*
9:05 a.m.	**Radio over Fiber for Picocellular Networks** Anthony Ng'oma, *Corning Inc., USA*
9:25 a.m.	**Break**
9:40 a.m.	**POF Technologies for In-home Networks** Roberto Gaudino, *Politecnico di Torino, Italy*
10:00 a.m.	**In-home Networks and Their Higher-Layer Aspects** Mikhail Popov, *ACREO, Sweden*
10:20 a.m.	**Are Fiber-Based In-home Networks Cost-Competitive?** Ton Koonen, *Eindhoven Univ. of Technology, The Netherlands*

10:40 a.m. **Input from the audience, Panel Discussion**

11:00 a.m. **Closure of the Workshop**

Fiber Use in The Home: Verizon's Perspective, *Vincent O'Byrne, Verizon, USA*
Dr. Vincent O'Byrne has over 25 years of experience in Telecommunications in both the wireless and wireline arenas. Vincent is the Director of the *FTTPArchitecture and Design* group in Verizon, and his team is responsible for defining the access requirements for BPON, GPON and next generation access technologies as well as their evolution to meet the continued growth in customer demand and services. His present interests are in continuing to reduce cost for FTTP and the possible deployment of next generation technologies in the access space.

He attended Kevin St. College of Technology in Dublin, received his BSc from Trinity College Dublin IRL, MSc from the University of Essex UK, a PhD from the University from Wales UK, and an MBA from Babson College US.

High-Speed In-Home Services: Plastic Optical Fiber for "Fiber-to-the-Display", *Yasuhiro Koike, Keio Univ., Japan*
Yasuhiro Koike received his MSc in applied chemistry in 1979, and his PhD in engineering in 1982 from the Graduate School of Engineering of Keio University, Tokyo, Japan. He was a visiting researcher in AT&T Bell Labs from 1989 to 1990. He became a professor in the Faculty of Science and Technology of Keio University in 1992. From 2003-2004, he also was a visiting professor at Tohoku University. He received an Honorary Doctorate at Eindhoven University of Technology in 2007, and he is an affiliate professor of the University of Washington since 2009.

Prof. Koike is General Chair of the POF Consortium since 1994. He led the "High-Speed POF Project" of the Kanagawa Academy of Science and Technology from 1995 to 1998, and was the project leader of the Plastic Optical Fiber Project of the Telecommunications Advancement Organisation of Japan from 1998 to 2001. He conducted the GigaHouse TownTM Project of Keio Engineering Foundation from 2002 to 2007. Since 2002, he is the research director of the Koike Photonics Polymer Project of ERATO, Japan Science and Technology Agency. He is a Member of the Science Council of Japan since 2006. His project "Face-to-Face Communication Business by Ultra High-Speed Plastic Optical Fiber and High-Definition Photonics Polymer" funded by the Cabinet of Japan will start in April 2010.

He was awarded "the International Engineering and Technology Award" of the Society of Plastics Engineers in 1994, the 42nd Fujihara Award in 2001 as the youngest prize winner, the Award of the Society of Polymer Science in 2003, Medal with Purple Ribbon from the Japanese government in 2006, was selected as "Nice Step Scientist" by National Institute of the Science and Technology Policy, Ministry of Education, Culture, Sports, Science and Technology in 2009, etc.

Optical Fiber Backbone to Serve Multiservice Home Network Requirements, *Benoit Charbonnier, France Télécom R&D, France*
Benoit Charbonnier was born in Versailles, France, in 1971. He received the Engineering degree and the PhD degree in 40-Gb/s soliton transmission from the École Nationale Supérieure des Télécommunications de Paris, Paris, France, in 1994 and 1997, respectively.

In 1997, he joined the Advanced Communications Group, Nortel Network, Harlow, UK, where he was engaged in 80-Gb/s long-haul transmission. In 2001, he joined Marconi Communications to develop an ultra-long-haul 10-Gb/s based transmission product. Since 2004, he has been a Research Engineer at France Télécom Research and Development, Lannion, France, where he is engaged in the study of next-generation optical access and in-building networks.

POF Technologies for In-home Networks, *Roberto Gaudino, Politecnico di Torino, Italy*
Roberto Gaudino, PhD, IEEE member, is currently Associate Professor in the Optical Communication Group at Politecnico di Torino, Italy, where he works on several research topics related to optical communications. Dr Gaudino's main research interest is in the metro and long-haul DWDM systems, fiber non-linearity, modeling of optical communication systems and on the experimental implementation of optical networks. He investigated on new optical modulation formats, such as Polarization or Phase Modulation, and on packet switched optical networks. Dr. Gaudino spent one year in 1997 at the Georgia Institute of Technology, Atlanta, as a visiting researcher in the OCPN group, where he worked in the realization of the MOSAIC optical network testbed. From 1998, he has been for two years with the team that coordinates the development of the commercial optical system simulation software OptSim. He is author or co-author of more than 100 papers in the field of Optical Fiber Transmission and Optical Networks, he is continuously involved in consulting for several companies of the optical sector and in professional continuing education.

He was the coordinator of the EU STREP project “POF-ALL” in 2006-2008, and he is currently the coordinator of its prosecution “POF-PLUS”, both on short-reach optical transmission over plastic optical fibers.

In-home Networks and Their Higher-Layer Aspects, *Mikhail Popov, ACREO, Sweden*
Mikhail Popov received the MSc degree (with honours) in Electrical Engineering in 1995 from St. Petersburg Electrotechnical University and the PhD degree in Electromagnetic Theory in 2002 from the Royal Institute of Technology (KTH), Stockholm, Sweden. Since 2001 he has been with Acreo as a research scientist and project manager. His current research interests include home networks, next-generation access networks, Ethernet, multi-layer networking as well as the general data and control plane issues in networks. Dr. Popov has authored and co-authored more than 50 papers on electromagnetic theory and optical communications. Currently, Dr. Popov is the co-ordinator for the European Large-Scale Integrating Project ALPHA "Architectures for

fLexible Photonic Home and Access networks“ from the EC Framework Programme 7 and the Chair of the Converged and Optical Networks cluster of the EC FP7 Future Networks projects.”

Radio over Fiber for Picocellular Networks, *Anthony Ng'oma, Corning Inc., USA*

Anthony Ng'oma (M'02) received his PhD degree in Optical Communications in 2005 and a Professional Doctorate in Engineering degree (PDEng) in Information and Communication Technology (ICT) in 2002, both from Eindhoven University of Technology, in The Netherlands.

He also has a M.Eng. degree and a BEng degree (with Merit) in Electrical Engineering and Electronics and Telecommunications, respectively, from the University of Zambia, Lusaka, Zambia.

He is currently a Senior Research Scientist within the Science and Technology Division at Corning Incorporated, Corning, NY. His current research interests include fiber-wireless systems for multi-Gbps wireless communication, access network technologies and in-home networking. From 2005 to 2007 he was a Post-Doctoral Researcher in the Electro-Optic Communications group at Eindhoven University of Technology. His previous research topics include low-cost fiber optic communication technologies for local-area networks and Polymer Optical Fiber (POF)-based fiber-wireless systems for millimeter wave applications. He has authored and co-authored more than 50 technical publications and two book chapters in the field of fiber-optic communication.

Dr. Ng'oma is a member of the IEEE Photonics Society, IEEE Communications Society, and the IEEE Microwave Theory and Techniques Society.

Are Fiber-Based In-home Networks Cost-Competitive? *Ton (A.M.J.) Koonen, Eindhoven Univ. of Technology, The Netherlands*

Ton (A.M.J.) Koonen (IEEE M’00–SM’01–F’07) since 1979 worked for more than 20 years in industrial applied research in broadband telecommunication systems, first as a member of technical staff at Philips Telecommunication Industry, and since 1987 as technical manager with Bell Laboratories (in AT&T Network Systems and in Lucent Technologies). He also was a part-time Professor at Twente University, Enschede, The Netherlands, from 1991 to 2000. Since 2001, he is a Full Professor at Eindhoven University of Technology in the Electro-optical Communication Systems Group at the COBRA Institute, where he is the Chairman of this group since 2004.

His current research interests include broadband communication technologies and networks, in particular fiber access and in-building networks, radio-over-fiber networks, and optical packet-switched networks. He has initiated and led several European and national R&D projects in these areas. Currently, he is involved in a number of access/in-home research projects in the Dutch IOP Generieke Communicatie programs, and in the European FP7 ICT program (amongst others ALPHA, POF-PLUS, and BONE). He is also the chairman of the recently established ICT

Innovation Platform ‘Duurzame ICT’ (sustainable ICT). He authored and co-authored more than 300 conference and journal publications.

Prof. Koonen is a Bell Laboratories Fellow since 1998, an IEEE Fellow since 2007, and an elected member of the IEEE LEOS Board of Governors since 2007. He received the ICTRegie Award 2009 for the most innovative joint research activities with Dutch ICT industry.

NFOEC 2: Network Technologies

NMA, **Network Technologies for Large Data Centers**, *Cedric Lam; Google Inc., USA*, Cloud computing has become a growing trend in future Internet communities. Instead of relying on localized data and applications programs stored on individual end-user computers, data centers equipped with massive parallel processors and centralized storage is time shared among network users as virtual machines. End user systems function as simple terminals with thin clients providing interface to data center facilities. A new data-center communication infrastructure is needed for cloud computing realization. Unlike in traditional backbone communications networks, where bit-rate-times-distance product is used as the performance metric, data center network connection performance measured by the bit-rate-times-port-count product. This workshop provides an interactive forum for technologists and data center operators to exchange ideas on requirements and innovations for data center network connections.

Speakers:
Frank Chang, *Vitesse Semiconductor, USA*
Dennis Abts, *Google, USA*
Loukas Paraschis, *Cisco, USA*
Arlon Martin, *Kotura, USA*
Donn Lee, *Facebook, USA*
Albert Greenburg, *Microsoft Corp., USA*

Panels

Tuesday, March 23, 4:30 p.m.–6:30 p.m.

NFOEC 2: Network Technologies

NTuD, **Integrated Packet/Sub-Wavelength Multiplexing for IP-over-DWDM Networks**, *Angela L. Chiu; AT&T Lab, USA*, Today's core IP/OL networks have wedded the router interface to the optical layer wavelength transmission rate (40Gb/s). However, the vast majority of router pairs do not have sufficient traffic to justify a full 40Gb/s link. The result is demultiplexing via intermediate routers using expensive router interfaces. This panel session explores network elements with integrated packet routing and sub-wavelength multiplexing as a more efficient

alternative. The panel will consist of experts from major service providers and equipment vendors. They will cover the following topics:

- Main economical drivers;
- Several main architectures and designs;
- Key elements in data plane, control plane, and management planes to realize the potential cost savings;
- Major challenges and potential roadblocks

Speakers:
Gagan Choudhury, *AT&T Labs*
Paulie Germano, *Google*
Ori Gerstel, *Cisco Systems*
Bruce Nelson, *Alcatel-Lucent*
Jack Oltman, *Ciena*
Glenn Wellbrock, *Verizon*

Wednesday, March 24, 3:30 p.m.–5:30 p.m.

NFOEC 1: Optical Networks and Services

NWD, **IP over DWDM**, *Roman Egorov; Verizon Labs, USA,* As network operators are starting to transform their infrastructure to support packet services, the optical networking industry is going through the phase where equipment vendors are starting to develop next generation platforms that integrate support for both TDM and packet transport. While the integration concept is generally agreed upon by the industry, its implementation is quite different depending on the background of a particular carrier or equipment vendor. Vendors, that traditionally developed hardware for photonic and TDM transport, view packet switch integration as a path forward. On the other hand, packet switch vendors perceive photonic integration on their interface cards as a step forward. The goal of this panel is to provide a view from carriers and equipment vendors on how this integration should proceed.

Speakers:
Glenn Wellbrock, *Verizon*
Zeljko Bulut, *Nokia-Siemens*
Bikash Koley, *Google*
David Boertjes, *Nortel*
Jeff Madox, *Cisco Systems*

Thursday, March 25, 1:00 p.m.–3:00 p.m.

NFOEC 1: Optical Networks and Services

NThD, **Next Gen PON Technologies: Capabilities and Deployment Challenges**, *Frank Effenberger; Huawei Technologies, USA,* As gigabit class PON technologies are becoming commonplace, we must now consider the next steps in PON technology. This panel will gather experts from major operators and technology companies to consider all the issues that arise from this consideration, including:

- Enhancements of current systems for wider splitting ratio or longer reach
- Time-lines for development, trial, and deployment of new technology
- Scenarios that are most likely to see NG-PON first
- Compatibility with existing systems (PON and otherwise)
- The practical management of rolling customers from one system to the other
- New applications or deployment styles that the technology makes possible
- Cost and business analysis

Speakers:
Bruno Capelle, *France Telecom*
Joseph Finn, *Verizon*
Jun-ichi Kani, *NTT*
Rod Tucker, *Univ. Melbourne*

NFOEC 2: Network Technologies

NThC, **Recent Advances in Optical Connectors**, *Ryo Nagase; Chiba Inst. of Technology, Japan,* Various optical fiber connectors have been developed during the 25 years since optical fiber communications systems were first put into practical use. Today, high performance and high power durable connectors are needed for trunk lines, extremely low cost connectors are required for home photonics, and small sized multi-fiber connectors are needed for on board optical wiring and parallel optical interconnection use for high speed signal transmission. The purpose of this panel is to discuss the latest technologies, recent issues related to various requirements, and the state of optical connector standardization.

The primary focus of the panel is to introduce recent trend of optical connector technologies such as new interface, standardization, endface cleanliness issue, and high-power reliability issue.

Speakers:
Ryo Nagase, *Chiba Inst. of Technology*
Shuichiro Asakawa, *NTT*
Tatiana Berdinskikh, *Celestica*
Matt Brown, *JDSU*
Takashi Shibuya, *NEC*

1. **Introductory Talk: Recent Technologies in Optical Connectors**, *Ryo Nagase, CIT*
2. **The Newest Connector - SF Connector**, *Shuichiro Asakawa, NTT*
3. **Importance for Endface Cleaning of PC Connectors**, *Tatiana Berdinskikh, Celestica*
4. **Recent Rerrule Endface Inspection Technologies**, *Matt Brown, JDSU*

5. **Optical Connectors and Plug-Style Optical Attenuators Against High Power**, *Takashi Shibuya, NEC*

Symposia

Charles Kao Symposium

Wednesday, March 24, 6:00 p.m.–8:00 p.m.
Room 6A

A celebration of the recent Nobel Prize awarded to Charles K. Kao *"for groundbreaking achievements concerning the transmission of light in fibers for optical communication"* and a celebration of the recognition bestowed, by extension, upon our field.

Introduction
Presider David Payne, *Univ. of Southampton*

Charles Kao and the Birth of Optical Fibers
Gwen Kao

The First Practical Optical Fibers
Peter Schultz, *Peter Schultz Consulting, LLC, formerly at Corning*
John B. MacChesney, *formerly at Bell Labs*
Tadashi Miyashita, *formerly at NTT*

Fiber and Systems
Andrew R. Chraplyvy, *Bell Labs, Alcatel-Lucent*

Conclusion
David Payne

Followed immediately by a reception in Room 6B sponsored by LaserFest.

Beyond Telecom and Datacom: Optical Interconnects for the Computercom Era

Organizers:
Clint Schow, *IBM T. J. Watson Res. Ctr., USA*
Michael Tan, *Hewlett Packard Labs, USA*

Performance gains in computer systems are increasingly achieved through interconnecting large numbers of parallel processor nodes. The resulting demands on communication bandwidth are extremely challenging, with the computer backplane or the telecom terminal backplane looming

as one of the primary bottlenecks to information transfer. Within the next decade, Exaflop-scale machines will be produced that incorporate well over 1 million optical interconnects. Traditional Datacom transceiver technology is too costly, bulky, and power hungry to support this scale of deployment. A new class of optimized short-reach, low-power and low-cost optical interconnects must therefore be developed to enable next-generation large-scale systems. This symposium will frame the Computercom interconnect challenge from several viewpoints. Speakers from system companies will detail the requirements of optical links for future systems. The capabilities of today's optical modules and prospects for scaling current devices and packaging into the future will be provided by speakers from Datacom transceiver companies. Finally, speakers from the research community will discuss the potential of emerging technologies that have not yet been fully developed or commercialized, but that offer the promise of enabling massive amounts of short-reach interconnect bandwidth at low-cost, with low-power consumption, a high area density, and potential for future scalability.

Monday, March 22, 1:30 p.m.–3:00 p.m.
Room 7

OMN, **Beyond Telecom and Datacom Symposium I**

Invited Speakers:

1:30 p.m.–2:00 p.m.
State of the Optical Transceiver Industry, *Vladimir G. Kozlov, LightCounting LLC, USA*

Ten years after the telecom bubble, optics is entering the spotlight again. Learning from mistakes of the past, it is important to set the right expectation and draw a line between hype and reality. Will the optics dominate 10G interface market? What is the future of 40G and 100G technologies? How active optical cables fit into this market?

Dr. Vladimir Kozlov is the founder and CEO of LightCounting, and optical transceiver market research company. Dr. Kozlov is also a co-founder of Fianium Inc. and Microtech Instruments Inc., which are focused on growing segments of the optoelectronics industry. Dr. Kozlov has more than 25 years of experience in optoelectronics and optical communications. He held a senior analyst position at RHK, Inc., where he conducted research on technology trends and market forecast for optical components, including lasers, detectors and transceivers. Dr. Kozlov also held product development and research staff positions at Lucent Technologies and Princeton University, working on innovative semiconductor laser devices and materials. Dr. Kozlov holds 3 US patents and has more than 50 publications in the area of optoelectronics, including more than 25 publications in referred scientific journals. He received an MSc (with honors) at Moscow State University in Russia and a PhD in Physics at Brown University in the United States.

2:00 p.m.–2:30 p.m.
Optics for Datacenters (and Servers), *Thomas Scheibe, Cisco, USA*

High-Speed Interconnects for the unified computer world. The session will discuss design options for general computer and grid environments, detail the implications of these designs for interconnects, and derive some recommendations for higher speed interconnects.

Thomas Scheibe joined Cisco in 1998 and is currently Director for datacenter systems in Cisco's System Architecture and Strategy Unit. During his time at Cisco he managed Cisco's transceiver portfolio and worked with customers in the cable and Metro Ethernet service provider space. Thomas represents Cisco on the Board of Directors of the Ethernet Alliance. Prior to Cisco, Thomas worked as a management consultant at McKinsey & Company. Thomas holds a MSEE from Technical University Chemnitz (Germany) and a MBA from Haas School of Business, UC Berkeley.

2:30 p.m.–3:00 p.m.
Optics for Volume Servers, *Terry Morris, Hewlett-Packard Co., USA*

Photonic interconnects provide a solution to the problems of power consumption and diminishing communication radius in volume servers, but cost considerations dictate a very different photonic infrastructure than is found in other applications.

Terry Morris is an HP Fellow with over 20 years experience developing high speed interconnections for computer systems ranging from GaAs supercomputers to high-volume blade servers. He currently holds over 30 US patents in the areas of interconnect, EMI containment, photonics, and packaging design.

Monday, March 22, 4:00 p.m.–5:30 p.m.
Room 7

OMV, **Beyond Telecom and Datacom Symposium II**

Invited Speakers:

4:00 p.m.–4:30 p.m.
Efficient Topologies for Large-Scale Cluster Networks, *Dennis Abts, Google, Inc., USA*

Increasing integrated-circuit pin bandwidth has motivated a corresponding increase in the degree or radix of interconnection networks and their routers. This paper describes the attened buttery, a cost-efficient topology for high-radix networks.

Dennis is a Member of Technical Staff at Google, Inc. where he is a Technical Lead for a next-generation large-scale cluster network. Prior to joining Google, he spent over 10 years at Cray Inc. where, as a Sr. Principal Engineer, he was involved in architecture and design of several large-scale multiprocessors and their high-performance interconnects including the Cray XT3, Cray XT4, Cray X1 and BlackWidow (Cray XT5). Dennis' research interests include parallel computer architecture, high-performance interconnection networks, memory system design, robust system design and fault tolerance. Dennis is a member of the IEEE, ACM, and IEEE

Computer Society. He holds a BS and MS in Computer Engineering and a PhD in Computer Science from the University of Minnesota.

4:30 p.m.–5:00 p.m.
The Transition to Chip Level Optical Interconnects, *Mike Haney, DARPA, USA*

The increasing bandwidth demands of computing chips have spawned significant research into chip-scale photonic interconnects. We review the DARPA-sponsored efforts at the inter- and intra-chip interconnect domains and highlight the key challenges to be addressed.

Dr. Haney is a professor in the Department of Electrical and Computer Engineering at the University of Delaware, where he is currently on leave while serving as a DARPA Program Manager. Previously, he was with George Mason University and was a co-founder of Applied Photonics, Inc. He received his BS from the University of Massachusetts in Physics, MS from the University of Illinois in Electrical Engineering, and PhD from the California Institute of Technology in Electrical Engineering. He is a fellow of the Optical Society of America.

Tuesday, March 23, 2:00 p.m.–3:30 p.m.
Room 7

OTuH, **Beyond Telecom and Datacom Symposium III**

Invited Speakers:

2:00 p.m.–2:30 p.m.
Optics for High-Performance Servers and Supercomputers, *Alan Benner, IBM Server Division, USA*

We report the optical interconnect for POWER7-IH systems, which provides high-BW, low-latency connectivity for 100,000s of high-performance CPU cores by leveraging dense transceiver and connector technologies to construct chip module optical IOs.

Dr. Benner is a Senior Technical Staff Member in IBM's Systems and Technology Group, doing architecture, design, and development of optical and electronic networks for servers and parallel systems. He received a B.S., Physics, in 1986 from Harvey Mudd College, and worked at AT&T Bell Laboratories' photonic networks and components group until 1988. He received a PhD at CU Boulder in 1992, studying nonlinear interactions between wavelength-multiplexed solitons, and has been with IBM since 1992. He has over 20 technical publications and patents issued in the US. and other countries, including books on Fibre Channel and specifications for InfiniBand.

3:00 p.m.–3:30 p.m.
Compact, High-Speed Hybrid Silicon Microring Lasers for Computer Interconnect, *John Bowers, Univ. of California at Santa Barbara, USA*

We investigate scaling of compact, low-threshold hybrid silicon microring lasers to meet the criteria of low power consumption, high-speed modulation and operation in elevated temperature for optical interconnect applications.

John Bowers holds the Fred Kavli Chair in Nanotechnology, and is the Director of the Institute for Energy Efficiency and a Professor in the Department of Electrical and Computer Engineering at UCSB. Dr. Bowers received his MS and PhD degrees from Stanford University and worked for AT&T Bell Laboratories and Honeywell before joining UC Santa Barbara. Dr. Bowers is a member of the National Academy of Engineering, a fellow of the IEEE, OSA and the American Physical Society, and a recipient of the OSA Holonyak Prize, the IEEE LEOS William Streifer Award and the South Coast Business and Technology Entrepreneur of the Year Award. He has published eight book chapters, 450 journal papers, 700 conference papers and has received 52 patents. He and coworkers received the EE Times Annual Creativity in Electronics (ACE) Award for Most Promising Technology for the hybrid silicon laser in 2007.

Tuesday, March 23, 4:30 p.m.–6:00 p.m.
Room 7

OTuP, **Beyond Telecom and Datacom Symposium IV**

Invited Speakers:

4:30 p.m.–5:00 p.m.
Transceivers and Optical Engines for Computer and Datacenter Interconnects, *Mitchell Fields, Avago Technologies, USA*

Technological and manufacturing advances are enabling optical solutions to meet demanding density, bandwidth, and cost metrics. We describe these solutions with respect to different system architectures and applications.

Mitchell Fields is presently Director of Strategic Marketing for the Fiber Optics Products Division of Avago Technologies. Previously, he was a field-applications engineer supporting top-tier customers with both MSA and proprietary optical designs. Mitch joined Avago in 2005 after five years at Sycamore Networks as an optical engineer and architect. From 1997 to 2000, Mitch was a staff scientist at MIT Lincoln Laboratory where he developed novel adaptive optics algorithms for the Airborne Laser Program. Mitch has degrees in mathematics and economics from SUNY Binghamton and a PhD in physics from Yale University.

5:30 p.m.–6:00 p.m.
Trends and Future Directions for Optical Interconnects in Datacenter and Computer Applications, *Katharine Schmidtke; Finisar Corp., USA*

The underlying technology trends that have enabled optics to displace copper in telecommunications, datacommunications, and datacenters are discussed. Future directions are outlined that will drive optical interconnects further into the fabric of computer systems.

Dr. Katharine Schmidtke has over twenty years experience in the field of optoelectronics. She received a PhD in non-linear optics at the Optoelectronics Research Center, Southampton University, UK, and received a NATO fellowship to conduct post doctoral research at Stanford University in the Center for Non-linear Optical Materials. Dr. Schmidtke has held various positions at New Focus, Inc. (now part of Oclaro, Inc.), JDSU, and Finisar Corp. Her roles and assignments in Europe and the US have ranged from DARPA funded research, through product management, to sales. She is currently Strategic Marketing Manager at Finisar Corp.

Symposium on Quantum Communications

Organizers:
Richard Hughes, *Los Alamos Natl. Lab, USA*
Thomas Chapuran, *Telcordia Technologies, USA*

Quantum communications using the transmission of single-photon states was invented 25 years ago. It is now an emerging technology for providing cryptographic services, especially key distribution, with security assurances rooted in laws of physics: passive monitoring of single-photon signals is not possible; and owing to the Heisenberg Uncertainty Principle active interception and retransmission introduces a disturbance, which the intended users can detect and defeat, within the assumptions of a security protocol. Because quantum communications are therefore not susceptible to an archival attack, they offer a potentially appealing alternative to public key-based methods of cryptographic key distribution, which are already retroactively vulnerable to future algorithmic attacks. Since the first experiments in 1991, quantum communications in optical fiber have seen remarkable progress in range, domains of use, and understanding of transmission impairments in a network environment. Large-scale demonstrations of quantum communications have taken place in the past year in several countries, and commercial standards activities are underway. The symposium will provide an overview of quantum communications in optical fiber networks, with presentations from the leading research groups around the world.

Tuesday, March 23, 2:00 p.m.–4:00 p.m.
Room 2

OTuC, **Quantum Communications Symposium I: Overview**

Tutorial Speaker:

2:00 p.m.-3:00 p.m.
Quantum Communications in Optical Fiber, *Wolfgang Tittel; Univ. of Calgary, Canada*

The possibility to use standard telecommunication fiber to transmit quantum data has been instrumental for the development of real-world quantum communication. I will introduce key primitives, and discuss their realization over deployed optical fiber.

Dr. Tittel is an Associate Professor and NSERC/GDC/iCORE Industrial Research Chair in Quantum Cryptography and Communication at the University of Calgary in Canada. He engaged in groundbreaking experiments in the field of quantum communication from the early stages on. The investigations were seminal in bringing quantum cryptography out of the laboratory and into the real world using a standard telecommunication fibre network. His current interests include practical quantum cryptography and quantum repeater technology. During his career, Dr. Tittel authored or co-authored over 50 articles in refereed journals, cited in total more than 4200 times.

Invited Speakers:

3:00 p.m.-3:30 p.m.
Single-Photon Avalanche Detectors for Quantum Communications, *Sergio Cova; Politechnico Milano, Italy*

QKD systems widely employ Single-Photon Avalanche Diodes (SPAD) and set strong demand for improved features and performance. The present state of this detector technology will be outlined, the main issues and prospect will be discussed.

Sergio Cova has been Electronics Professor at Politecnico di Milano since 1977. He has given contributions to research on detectors of optical and ionizing radiations, microelectronic devices and circuits, electronic and optoelectronic instrumentation systems. He pioneered the development of Single-Photon Avalanche Diodes (SPAD) and the extension of photon counting techniques to the infrared spectral range. He invented the Active-Quenching Circuit (AQC) that opened the way to the application of SPADs and developed it up to monolithic integrated form. In 2005 he co-founded the university spin-off company MPD Micro-Photon-Devices. He has authored over 200 papers and 4 US and EU patents.

3:30 p.m.-4:00 p.m.
Security of Quantum Key Distribution, *Norbert Lutkenhaus; Univ. of Waterloo, Canada*

Quantum Key Distribution offers the promise of secure communication with unprecedented security. Secure systems can be implemented by standard optical communication components - if done right. I report on the divide of right and wrong.

Norbert Lütkenhaus studied physics in Aachen and Munich. He obtained his PhD (quantum optics and quantum cryptography) under the supervision of Stephen Barnett (Strathclyde) in 1996. After postdoc positions in Innsbruck and the Helsinki he worked for MagiQ Technologies (New York) to initiate the commercial realisation of quantum key distribution (QKD). In 2001, he built up and lead a research group at the University of Erlangen-Nuremberg. He is a member of the Institute of Quantum Computing at Waterloo University. His main contributions are the security proof for practical QKD, optical quantum communication theory, and linear optics quantum information processing.

Tuesday, March 23, 4:30 p.m.–6:30 p.m.
Room 2

OTuK, **Quantum Communications Symposium II: Networking**

Invited Speakers:

4:30 p.m.-5:00 p.m.
Quantum Communications in Reconfigurable Optical Networks: DWDM QKD through a ROADM, *Nicholas Peters; Telcordia Technologies, USA*

We demonstrate coexistence of classical and quantum signals for quantum key distribution in a DWDM reconfigurable networking environment using a ROADM. We show how the limiting noise mechanism can depend on the link configuration.

Nicholas A. Peters is a Senior Scientist at Telcordia Technologies. Dr. Peters holds a BA Summa Cum Laude in Physics and Mathematics from Hillsdale College. He received MS and PhD degrees in Physics specializing in quantum information science and optics at the University of Illinois at Urbana-Champaign. His research expertise spans both fiber and free-space optics with emphasis on using single-photon interferometry and nonlinear optics for precision metrology, optical communications and quantum information applications. Dr. Peters is a member of the Optical Society of America and the American Physical Society.

5:15 p.m.-5:45 p.m.
Implementation of a High-Speed Quantum Key Distribution System for Metropolitan Networks, *Akihisa Tomita; NEC, Japan*

Requirement for a high-speed QKD system is described. It should be equipped with efficient receivers with high visibility, stable clock synchronization, and post processing hardware. Key generation rate will be further improved with WDM expansion.

Akihisa Tomita was born in Tokyo, Japan on October 18, 1959. He received BS and MS degrees in Physics in 1982, and 1984, and the PhD in electronics in 1998, all from the University of Tokyo, Japan. He joined NEC Corporation in 1984. He was a visiting researcher at AT&T Bell Laboratories, Holmdel, NJ from 1991 to 1992. Currently, he is leader of the Quantum Information Experiment Group of Quantum Computation and Information Project, ERATO-SORST, JST, and Senior Principal Researcher of NEC Corporation. He is currently involved in studies on photonic implementation of quantum information, in particular, quantum key distribution.

5:45 p.m.-6:15 p.m.
An Application-Oriented Hierarchical Quantum Cryptography Network Test Bed, *Zheng-fu Han; Univ. of Science and Technology, China*

A hierarchical metropolitan quantum-cryptography-network upon the inner-city commercial-telecom fiber cables is reported in this paper. The techniques of the quantum-router, optical-switch and trusted-relay are assembled here to divide the seven-user-network into a four-node-backbone-net, a two-user-subnet and a single-fiber-access-link.

Professor Zheng-fu Han was born in Anhui, China, in 1962. He got a bachelor's degree in physics from Anhui University in 1983, and master's degree from the University of Science and Technology of China (USTC) in 1990. From 1990 to 2000, he worked on Synchrotron Radiation applications. Now, he is header of the Optics and Optical Engineering Department of USTC, and deputy director of the Key Lab of Quantum Information of Chinese Academy of Science. For the past ten years he has focused on quantum key distribution (QKD) security analysis, single-photon detection, and QKD system, especially quantum key distribution networks.

Wednesday, March 24, 8:00 a.m.–10:00 a.m.
Room 2

OWC, **Quantum Communications Symposium III: Systems**

Invited Speakers:

8:30 a.m.-9:00 a.m.
Integrated Quantum Memory for Quantum Communication, *Wolfgang Tittel; Univ. of Calgary, Canada*

We present the first demonstration of a quantum memory protocol in a waveguiding media, which is promising for high-speed, electro-optic control of quantum state evolution during storage, as well as integration into future quantum networks.

Dr. Tittel is an Associate Professor and NSERC/GDC/iCORE Industrial Research Chair in Quantum Cryptography and Communication at the University of Calgary in Canada. He engaged in groundbreaking experiments in the field of quantum communication from the early stages on. The investigations were seminal in bringing quantum cryptography out of the laboratory and into the real world using a standard telecommunication fibre network. His current interests include practical quantum cryptography and quantum repeater technology. During his career, Dr. Tittel authored or co-authored over 50 articles in refereed journals, cited in total more than 4200 times.

9:30 a.m.-10:00 a.m.
Coherent State Quantum Key Distribution with Continuous-Wave Laser Beams, *Thomas Symul; Australian Natl. Univ., Australia*

In this talk, we present a status report on a coherent state quantum key distribution scheme that uses continuous-wave laser beams. The scheme does not require measurement basis switching and is intrinsically broadband.

Dr. Thomas Symul is an Australian Research Council Research Fellow leading the Quantum Communications activities of the Quantum Optics Group at the Australian National University. He received an engineering degree from Telecom ParisTech, and a PhD from the University of Paris VI. His contributions to the field of Quantum Information include studies of Quantum State Sharing, non-classical states and Quantum Cryptography. In 2006, Dr. Symul was awarded the Eureka prize for Scientific Research for his work on Quantum Key Distribution. He is a co-

founder of the company Quintessence Labs that seeks to commercialise a fibre based Quantum Key Distribution device.