OFC/NFOEC 2013 Archive

Technical Conference: March 17-21, 2013

Exposition: March 19-21, 2013

Anaheim Convention Center, Anaheim, CA, USA

After five days of sessions, workshops, panels, show floor activities, short courses and special events, the Optical Fiber Communication Conference and Exposition/National Fiber Optic Engineers Conference (OFC/NFOEC) wrapped up in Anaheim, Calif. yesterday.

The show featured more than 800 presentations, 550+ exhibitors and 12,000 attendees from around the world. Hot topics covered in technical sessions to post-deadline papers to show floor panels included software-defined networks, silicon photonics, 100G/400G network design, cloud and data center networking, and many others.

OFC/NFOEC's most well-attended program, the Plenary and Awards Session, featured three high-level speakers on three diverse topics. Caio Bonilha, president and CEO of Brazil's state-owned service provider Telebras discussed the country's efforts to establish a national broadband network amid varying challenges, such as deployment in and amongst the Amazon terrain.

Stanford's Nick McKeown, credited with co-inventing software-defined networking, gave insights into what exactly SDN and OpenFlow is and what it will mean for future networks.

ADVA Optical Networking CEO Brian Protiva gave a comprehensive look at the coming transformation of the network – from growth drivers and state of the industry to specific solutions needed to meet future challenges.

Hundreds of companies were on hand, showing their latest product offerings and services, and announcing the latest in areas such as 100G deployment, photonic integration, tunable SFP+ transceivers, data center interconnects, and new innovations on the client side .

The show floor theaters featured expanded programming this year to include topics on cloud services, silicon photonics, SDN and photonic start-ups. Market Watch explored key areas such as Metro 100G, packet optical convergence and optics in the data center.

The Service Provider Summit was headlined by Telx's Joe Weinman, who spoke on What Cloudonomics Means for the Network. Panels included Monetizing the Network – examining issues such as whether big data can help service providers in today's economy and Acquisition and Integration Strategies in the Service Provider Realm.

Technical sessions provided attendees with insights into the latest research being conducted at top institutions worldwide. Highlighted topics included a hybrid OpenFlow/PCE controller for more efficient

remote control of optical networks, a record-setting optical link that cuts supercomputer power consumption by more than half, a new technique for automatically assembling a multicore fiber, and a new distance record for 400 Gb/S data transmission.

The popular and uniquely formatted rump session covered whether silicon photonics will unlock a new future for optical chips, or whether hype has outpaced the technology.

Special symposia on enabling the cloud and convergence of wireless and optical networking offered attendees an even deeper look at the latest in those areas, while a special tribute symposium to optical communications pioneer Tingye Li explored his 40+ years of contributions that spanned the entire history of modern optical telecommunications.

Conference and show floor attendees alike agreed this year's event was alive and well – buzzing with the latest innovations and marketplace applications, while providing the top venue for researchers, engineers, business persons, entrepreneurs and others to meet, network and discuss the future of the optical communications field. Join us next year as we head to a new venue – San Francisco's Moscone Convention Center, 9-13 March 2014.

Download pages from the OFC/NFOEC Program Book!

Agenda of Sessions
Abstracts
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Update Sheet

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4. Market Watch and Service Provider Summit

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5. Fibers and Optical Propagation Effects

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

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7. Optical Devices for Switching, Filtering, and Interconnects

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9 . Digital Transmission Systems

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10. Transmission Subsystems and Network Element

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12. Core Network

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13. Access Network

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14. Optical Interconnection Networks for Datacom and Computercom

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Invited Speakers

Category 1. Optical Network Applications and Services (Invited)

Benefits of Multilayer Packet-Optical Transport, Chris Bowers; *Juniper, USA*

Carrier Strategies in Russia, Vitaly E. Shub; *TransTelecom, TTK, Russia*

Multi-Tenant Data Center and Cloud Networking Evolution, Nabil N. Bitar; *Verizon, USA*

Optics for Exascale: One Engineer's Perspective , Paul Coteus; *IBM, USA*

Path Computation Elements (PCEs): Applications and Status, Ramon Casellas; *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), Spain*

Surveys of Emerging Control Plane Initiatives, John Rathke; *Verizon, USA*

Transport Network Evolution for Advanced Services, Matthew Ma; *Tata Communications, USA*

Category 2. Network Technologies and Applications (Invited)

Advanced Modulation Formats for Free Space Laser Communications, Tom Wood; *LGS Innovations, USA*

Energy Awareness in the Design of Optical Core Networks, Andrea Bianco; *Politecnico de Torino, Italy*

Gridless Submarine Optical Networks, Brian Lavallée; *Ciena, Canada*

Near-term Opportunities for Terabit Transmission and Field Trials, T.J. Xia; *Verizon, USA*

Next-generation ROADM Architecture and Design, Roman Egorov; *Verizon, USA*

Strategic Vision for KDDI's Next Generation Packet Optical Transport Network, Masahiro Daikoku; *KDDI, Japan*

The "Growing Documentary" Project, Naohisa Ohta; *Keio University/KMD, Japan*

Toward Deeply Virtualized Elastic Optical Networks, Masahiko Jinno; *NTT, Japan*

Category 3. FTTx Technologies, Deployment and Applications (Invited)

[CANCELLED] Next Generation Applications and Services for Ultra-fast Broadband, Glenn Ricart; *US Ignite, USA*

Activities, Drivers, and Benefits of extending PON over other Media, Yuanqiu Luo; *Huawei, USA*

Cost and Performance Evaluation of WDM-based Access Networks, Andreas Gladisch; *Deutsche Telekom, Germany*

Cost Optimization in FTTP Environments, Roger Tobin; *Verizon, USA*

France Telecom's PON Deployment: Lessons Learned and Next Steps, Philippe Chanclou; *Orange Labs, France*

FTTdp: Complementing FTTH in Difficult Areas, Richard Goodson; *Adtran, USA*

FTTH Deployments in Latin America, Nelson Saito; *Furukawa Industrial SA Produtos Eletricos, Brazil*

ODN Intelligence: Automating Fiber Deployment and Operations, Osman Gebizlioglu; *Futurewei Technologies, USA*

Operation and Maintenance Work Using AR Technology for Optical Access Networks, Ikutaro Ogushi;*NTT Access Network Service Systems Labs., Japan*

Protection Schemes Beyond Currently Defined in FTTX, Takeshi Sakamoto; *NTT Access Network Service Systems Labs., Japan*

Category 5. Fibers and Optical Propagation Effects (Invited)

Development of Low Loss, Wide Bandwidth Hollow Core Photonic Bandgap Fibers , Marco Petrovich; *Univ. of Southampton, UK*

High-throughput Fiber Links for Computercom Interconnects, Benjamin Lee; *IBM, USA*

Multimaterial Functional Fibers, Alexander Stolyarov; *MIT, USA*

Nonlinear Performance of SDM Systems Designed with Multimode or Multicore Fibers, Govind Agrawal;*Univ. of Rochester, USA*

Rayleigh Backscattering Signatures of Optical Fibers: Their Properties and Applications, Mark E. Froggatt; *Luna Innovations, USA*

Recent Progress in Multi-core and Few-mode Fiber, Shoichiro Matsuo; *Fujikura, Japan*

Supermodes in Strongly-coupled Multi-core Fibers, Neng Bai; *CREOL, Univ. of Central Florida, USA*

Weakly-coupled Few-mode Fibers for Single-mode and Mode-division-multiplexed Transmissions, David Boivin; *Prysmian Group, France*

Category 6. Fiber and Waveguide Based Devices: Amplifiers, Lasers, Sensors, and Performance Monitors (Invited)

300-nm Broadband Chromium-Doped Fiber Amplifiers, Wood-Hi Cheng; *National Sun Yat-Sen Univ., Taiwan*

Amplifier Technologies for Unrepeatered Links, Submarine Transmissions, Hans Bissessur; *Alcatel-Lucent Submarine Networks, France*

Identification of High-PMD Sections along Installed Optical Cables with Long-range OFDR, Fumihiko Ito;*NTT Access Network Service Systems Labs., Japan*

Integration of Optical Fiber and Optoelectronic Devices, John V Badding; *Pennsylvania State Univ., USA*

Phase-sensitive Amplifiers for Low-noise Links, Carl Lundström; *Chalmers Univ., Sweden*

PPLN-based Phase-sensitive Amplifiers and Their Applications, Masaki Asobe; *NTT, Japan*

Practical Issues of the Tunable Dispersion Compensation using Parametric Wavelength Conversion, Ken Tanizawa; *AIST, Japan*

Waveguide Optics for Novel in situ Biomedical Imaging, David Sampson; *The Univ. of Western Australia, Australia*

Category 7. Optical Devices for Switching, Filtering, and Interconnects (Invited)

[CANCELLED] Quantum Effects in Graphene Plasmons, Javier García de Abajo; *IQFR-CSIC, Spain*

Chip and Board Scale Integrated Photonic Networks for Next-generation Computers, Vladimir Stojanovic; *MIT, USA*

Devices and Components for Space-Division Multiplexing in Few-Mode Fibers, Nicholas Fontaine; *Bell Labs, Alcatel-Lucent, USA*

Heterogeneous Integration of InP PDs on Silica-based PLCs, Mikitaka Itoh; *NTT, Japan*

Integrated Optical Beam Steerers, Karel Van Acoleyen; *Ghent Univ., Belgium*

Integration of Si Photonics into DRAM Process, Dongjae Shin; *Image Archit. Lab., South Korea*

Mid-Infrared Silicon Photonics, William Green; *IBM Thomas J. Watson Research Center, USA*

New Opportunities for Optical Phase-Locked Loops in Coherent Photonics, Larry Coldren; *University of California, Santa Barbara, USA*

Silicon Photonic Integrated Circuits for WDM Technology and Optical Switch, Long Chen; *Acacia, USA*

The Ge-on-Si Integrated Microphotonic Platform, Lionel Kimerling; *MIT, USA*

Category 8. Optoelectronic Devices (Invited)

40Gbit/s Germanium Waveguide Photodiode, Laurent Vivien; *Paris Sud, France*

Coherent Receiver PICs, Martin Schell; *HHI, Germany*

Compact and Power-efficient 100-Gbps CMOS-based Transceiver, Takashi Takemoto; *Hitachi, Japan*

High Density Optical Interconnects Integrated with Lasers, Optical Modulators and Photodetectors on a Single Silicon Chip, Yutaka Urino; *Photonics Electronics Technology Research Association (PETRA), Japan*

High Speed 850nm VCSELs for >40Gb/s Transmission, Johan Gustavsson; *Chalmers, Sweden*

III-V on Silicon Transmitters, Guang-Hua Duan; *III-V Lab, France*

III-V Quantum Dot Laser Growth on Silicon and Germanium, Huiyun Liu; *UCL, UK*

Thermal Management in Hybrid Silicon Lasers, Di Liang; *HP Labs, USA*

Ultra High-speed Uni-traveling Carrier Photodiodes, Cyril Renaud; *UCL,UK*

Category 9. Digital Transmission Systems (Invited)

Collaborative Signal Processing with FEC in Digital Coherent Systems, Takashi Sugihara; *Mitsubishi Electric, Japan*

GPU-based Parallelization of System Modeling, Stephan Pachnicke; *ADVA, Germany*

Higher-order Multilevel Signal Transmission using Coherent Receiver with Digital-Delay Detection, Nobuhiko Kikuchi; *Hitachi, Japan*

Large-capacity Transmission over a 19-core Fiber, Jun Sakaguchi; *NICT, Japan*

Nonlinearities in Space-division Multiplexed Transmission, Antonio Mecozzi; *Univ. L'Aquila, Italy*

Recent Progress in Space-division Multiplexed Transmission Technologies, Toshio Morioka; *TU Denmark, Denmark*

WDM Channel Capacity and its Dependence on Multichannel Adaptation Models, Erik Agrell; *Chalmers Univ., Sweden*

Category 10. Transmission Subsystems and Network Elements (Invited)

Advanced and Feasible Signal Processing Algorithm for Nonlinear Mitigation, Takeshi Hoshida; *Fujitsu, Japan*

Flexible Transceivers Using Adaptive Digital Signal Processing for Single Carrier and OFDM, David Plant; *McGill Univ., Canada*

Implementation of Coded Modulation and FEC, Deyuan Chang; *Huawei, China*

Pilot-Assisted Channel Estimation Methods for Coherent Receivers, Bernhard Spinnler; *Nokia Siemens Networks, Germany*

Real-time DSP for 100+Gb/s, Christian Rasmussen; *Acacia, USA*

ROADM Options in Optical Networks: Flexible Grid or Not?, Sheryl Woodward; *AT&T, USA*

Transmitter Synthesis for Advanced Modulation Formats Utilizing Silica-LiNbO3 Hybrid Integration Technology, Shinji Mino; *NTT, Japan*

Ultrahigh Spectral Efficiency Coherent Optical OFDM, Dayou Qian; *NEC Labs. America, USA*

Category 11. Optical Processing and Analog Subsystems (Invited

Coherent Optical and Radio Seamless Transmission Based on DSP-Aided Radio-over-Fiber Technology, Atsushi Kanno; *NICT, Japan*

Heterogeneous Photonic Integration for Microwave Photonic Applications, Greg Fish; *Aurrion, USA*

How to Design an Energy-efficient Fiber-Wireless Network, Leonid Kazovsky; *Stanford Univ., USA*

Periodically Poled Silicon (PePSi) for Efficient and Electronically-tuned Nonlinear Optics in Silicon, Bahram Jalali; *Univ. of California Los Angeles, USA*

Phase-modulated Radio-Over-Fiber Systems, Tom Murphy; *Univ. of Maryland, USA*

Phase-Sensitive Signal Processing using Semiconductor Optical Amplifiers, Andrew Ellis; *Aston Univ., UK*

Photonic Processing using Integrated Optical Filters, Christi Madsen; *Texas A&M, USA*

Progress in Photonic Analog-to-Digital Conversion, Franz Kaertner; *CFEL, Germany*

Category 12. Core Networks (Invited)

Can We use Flexible Transponders to Reduce Margins?, Jean-Luc Auge; *Orange Labs, France*

Cognitive Dynamic Optical Networks, Ignacio de Miguel; *Uni de Valladolid, Spain*

DT's Standardization Activities to Achieve Interoperability on 100G for Metro Applications, Rudiger Kunze; *Deutsche Telekom, Germany*

Dynamic Adaptive Virtual Optical Networks, Anna Tzanakaki; *AIT, Greece*

Flexgrid, SDM, Multi-fiber: Which is Best for Networks?, Jim Benson; *Nokia Siemens Network, USA*

Impact of Cloud, Datacenter, and IT on Transport Networks, Jeffrey He; *Huawei, China*

Software Defined Optical Networks Technology and Infrastructure: Enabling Software-Defined Optical Network Operations, Dimitra Simeonidou; *Univ. of Essex, UK*

Virtualization: What is It?, Clarence Filsfils; *Cisco, USA*

Category 13. Access Networks (Invited)

Advantages of Coherent Detection in Reflective PONs, Roberto Gaudino; *Politecnico di Torino, Italy*

Elastic and Green Optical Access based upon Coherent Interleaved Frequency Division Multiple Access (IFDMA), Ken-ichi Kitayama; *Osaka Univ., Japan*

Energy Efficient 10G-EPON System, Hiroaki Mukai; *Mitsubishi Electric Corp., Japan*

FSAN NG-PON2 Updates, Ronald Heron; *Alcatel-Lucent Canada, Canada*

Low Complexity FDM/FDMA Approach for Future PON, Benoit Charbonnier; *France Telecom Orange Labs, France*

Progress in Polymer-Based Components for Next-Generation PON Applications, Norbert Keil; *Fraunhofer Heinrich-Hertz Inst., Germany*

Category 14. Optical Networking, Technologies, and Applications for Datacom and Computercom (Invited)

A 10 µs Hybrid Optical-Circuit/Electrical-Packet Network for Datacenters, George Porter; *Univ. of California San Diego, USA*

A 50Tbps Optically-Cabled Infiniband Datacenter Switch, Ola Torudbakken; *Oracle, USA*

Architectural Implications of Silicon Photonics in High Performance Computing , Fabrizio Petrini; *IBM, USA*

Configurable Optical Interconnects for Scalable Datacenters, Mike Schlansker; *HP, USA*

High Bandwidth Optical Interconnection for Densely Integrated Server, Jun Matsui; *Fujitsu, Japan*

Network Energy Efficiency in the Data Center, Mike Bennett; *Lawrence Berkeley National Lab., USA*

Optical Interconnect for Volume Servers, Brad Booth; *Dell, USA*

The Role of Optical Interconnections in Data-center Architecture Evolution, Errol Roberts; *Cisco, USA*

Plenary Session

Caio Bonilha

President and CEO, Telebras, Brazil

Presentation: Telebras National Backbone: Deployment Challenges

Abstract: The aim of this presentation is to share the challenges faced by the Telebras team in the deployment of Brazil's 20,000 miles of national broadband backbone. Different issues related to engineering, legal, regulatory and relations with partners and suppliers will be discussed. Bonilha will show that the Telebras network is one of the pillars of the PNBL (Brazil's National Broadband Plan), which aims to significantly expand broadband density and support local telecom technology deployment, as well as act as a neutral network. The presentation will also cover the impact of IP capacity wholesale prices after one year of initial deployment and the growth of independent ISP market share.

Biography: Caio Bonilha Rodrigues is the president and CEO of Telebras, Brazil's federally-owned telecommunications service provider, and has more than 30 years of experience in telecommunications, wireless, data networks, network management, Internet and IT networking.

Prior to being appointed CEO in 2011, Bonilha held positions at Telebras as commercial and marketing director. Bonilha served as an advisor to and one of the architects of the PNBL—Brazil's National Broadband Program, which is being carried out by Telebras. Prior to joining Telebras, Bonilha was the founder and general manager of Brampton Telecom, a full-service telecommunications design and consulting firm specializing in optical backbones, mobile networks, broadband networks, Internet and CATV. Before that, Bonilha founded the engineering services company CelPlan. He has worked in a variety of other positions in the telecommunications field, including sales and marketing manager at Alcatel, regional director of Construtel, and engineering positions at CMW, Elebra, Telebras R&D, and CRT, where began his professional career.

Caio received his B.S. in electrical engineering from the UFRGS in 1978 and his Telecom Specialist from Unicamp in 1985. Since then, Bonilha has consulted on a variety of projects including the International Telegraph and Telephone Consultative Committee and the World Bank/ECLAC (Economic Commission for Latin America and the Caribbean). While working with a variety of countries, including Brazil, Argentina, Chile, Bolivia, Spain, Kenya, and Angola, Bonilha has shaped these projects with his expertise in optical technology, international leadership, and strategic business sense.

Nick McKeown

Professor of Electrical Engineering and Computer Science, Stanford University, USA

Presentation: Software-Defined Transport Networks

Biography: Nick McKeown has been a professor of electrical engineering and computer science at Stanford University since 1995. He grew up in the UK and received his B.Eng. from Leeds University in 1986. He moved to the U.S. in 1989 to do an M.S. and Ph.D. in electrical engineering and computer science at the University of California, Berkeley. His research group works on new Internet architectures, software-defined networks and how to make routers faster. He co-founded several companies based on technology started at Stanford. He is a

member of the National Academy of Engineering and recently received the Association for Computing Machinery Sigcomm "Lifetime Achievement" Award.

Brian Protiva

CEO, ADVA Optical Networking, Germany

Capitalizing on Network Transformation in the Age of Programmable, Multi-Layer Infrastructures

Abstract: Global demand for bandwidth continues to grow at a staggering pace while optical communications technology supports an ever increasing range of applications. This bandwidth growth and these new applications present inroads into new market verticals and sources of revenues, yet few systems or component providers in our industry are managing to demonstrate profitable growth. This presentation will highlight both key opportunities and challenges that arise when building multi-layer programmable infrastructures as solutions for carriers, ISPs and enterprise users, including next generation backhaul for LTE and LTE advanced networks.

Biography: Brian Protiva co-founded ADVA Optical Networking in 1994 and, as one of two managing directors, he focused on creating ADVA Optical Networking's marketing, sales and growth strategy. In 2001, Protiva was appointed CEO and set in motion the strategies that fuel the company's success today. Under his leadership, ADVA Optical Networking advanced to become the global market leader in Ethernet access devices and one of the top players in metro Wavelength Division Multiplexing (WDM) worldwide. To date, ADVA Optical Networking's innovative Optical+Ethernet solutions have been deployed at more than 10,000 enterprises and more than 250 carriers around the world. Revenues reached EUR 311 million in 2011, while employment climbed to 1,304 employees at year-end 2011. Prior to ADVA Optical Networking, Protiva was managing director at AMS Technologies (now the EGORA Group), which he joined in 1987 and where he focused on co-managing its subsidiaries. Protiva holds a bachelor of science in electrical engineering from Stanford University.

Market Watch Panel Sessions

OFC/NFOEC Exhibit Floor Theater

Market Watch—State of the Industry and Where it is Headed
Hear
Karen Liu, Ovum Inc., USA, Market Watch Chair
Samuel Liu, Juniper, Market Watch Organizer

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, *Principal Analyst, Components, Ovum Inc, USA*

Market Watch Organizer:

Samuel Liu, *Senior Product Line Manager, Juniper Networks, USA*

Schedule-at-a-Glance

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

Tuesday, 19 March 12:00 - 14:00	Panel I: State of the Industry Tom Fawcett, *Vice President of Product Line Managment, JDSU, USA*
Tuesday, 19 March 15:00 - 17:00	Panel II: High Speed Pluggable Optics for Data Center Tiejun J. Xia, *System Architect/DMTS, Verizon, USA*

Wednesday, 20 March 13:00 – 15:00	Panel III: Components looking for the “Booster Rocket” Karen Liu, *Principal Analyst of Components, Ovum, USA*
Thursday, 21 March 10:15 – 12:15	Panel IV: Metro 100G Applications Rafik Ward, Vice President of Marketing, Finisar, USA
Thursday, 21 March 13:00 – 15:00	Panel V: Packet Optical Convergence Melissa R. Handa, Executive Director – Telcordia, Ericsson, USA

Panel I: State of the Industry

Tuesday, March 19, 2013

12:00 – 14:00

Moderator:

Tom Fawcett, *Vice President of Product Line Managment, JDSU, USA*

Tom Fawcett is Vice President of Product Line Management at JDSU in the Communications and Commercial Optical Products Group. Prior to joining JDSU in 2006 Fawcett was Director of Marketing at Agilent/Avago Technologies in the Fiber Optic Products Group from 2000-2005. From 1991-2000 Fawcett held positions of increasing responsibility in Engineering and Product Line Management in the Fiber Optic Division of AMP/Tyco. Fawcett holds a bachelor’s degree in mechanical engineering from Clarkson University.

Panel Description:

A panel of industry experts will discuss the state of the optical networks industry in the current economic environment. Are we on the path to recovery from the economy downturn? Are there more M&A in the optical component side once the Opnext and Oclaro merger is complete? Is packet optical the direction to go? Can optical integration keep up with the pace of electronics development?

Speakers:

The Telecom Infrastructure Market in 2020: Where we are, Where we're headed, and Why

Dana Cooperson, *Vice President and Practice Leader of Network Infrastructure, Ovum, USA*

This talk will focus on connecting the dots in the infrastructure value chain, from buyers through systems and component vendors. Fundamental change in communications is underway; players must do much more than simply restructure and hope for the best. What are the fundamental drivers of change, and what structural and competitive shifts will they induce over the next seven years? What does this mean specifically for optical communications? We'll discuss the strategic and business implications of where we are and where we're headed.

Dana manages Ovum's network infrastructure advisory and consulting services, which comprise fixed access; mobile; IP services; optical transport; optical components; and carrier/vendor financials analysis. Her 30 years of telecoms experience include 14 years as an industry analyst and consultant, bolstered by 16 years in product management and network operations. Dana's custom

research projects have spanned strategic analysis of carrier opex; the future of telecom; mobile network traffic management and optimization; plus market entry opportunity analyses including GPON, Ethernet services, and non-carrier buyers of ON products. She began her career as a network engineer at NYNEX (now Verizon Communications). Her background provides a solid base for understanding her clients' challenges and opportunities. Dana holds an M.S. in Management from MIT and a B.S. in Engineering from Cornell University.

The State of the Industry: Renovation Required

Pat DiPietro, *Operating Partner, Marlin Partners, USA*

Optical/transport networks are at the start of a broad growth and change cycle driven by exploding growth of traffic from wireless, video, and cloud applications. As well, disruption in the equipment supplier base is creating opportunities for industry transformation. The industry is challenged to return to profitability. Where does everyone go from here? An industry consolidation opportunity is emerging: large OEMs divest of non-mobility assets, while many independents are sub-scale and narrow in scope prompting pressure to consolidate. Is this a good time for a new company and approach to the market? What makes one excited to be in this market right here, right now?

Mr. DiPietro is an Operating Partner focused on investment opportunities in the telecommunications and technology industries, with a specific focus on the optical, wireless, software, systems and semiconductor sectors. He brings over 20 years of operating and 12 years of venture capital investing experience. Mr. DiPietro has sat on the Board of numerous successful companies, including Sandvine, SiGe, Continuous Computing and BelAir Networks. Mr. DiPietro was Vice President of 3G Wireless at Nortel Networks and held senior managerial roles at various Nortel divisions and Bell Northern Research and launched several highly successful network products over his operating career. Additionally, he is the founder of The Ottawa Network, a non-for-profit start-up accelerator, has been a Board member of Invest Ottawa and has been an

angel investor in a number of technology start-ups. Mr. DiPietro earned a B.Sc. in Electrical Engineering from Queen's University, and has completed Masters in Telecommunications Management courses from Carleton University.

 **What will the Next Generation Metro Look Like?**
Eve Griliches, *Vice President of Optical Networking, ACG Research, USA*

This will be a discussion on how the metro is evolving to a data center interconnect architecture largely driven by content providers and carriers to get closer to the customer.

Ms. Griliches, has a reputation for delivering accurate and timely market information, leveraging advanced technology and staying focused on client care and customer service, spent five years at IDC as Program Director for the Telecommunications Equipment group. She provided in-depth insight and analysis on many of the key technologies in the telecom market. Ms. Griliches also provided critical business intelligence on emerging technology trends and their impact on the overall telecom market space. Ms. Griliches also has over 10 years of product management experience with a number of network equipment vendors. Those vendors include: Marconi (Ericsson), PhotonEx, Nortel Networks, Bay Networks, and Wellfleet. Additionally, she spent four years at Thinking Machines Corporation, one of the first parallel processing supercomputer companies.

 **Forecast for the Global Optical Networking Market: Critical Review**
Vladimir Kozlov, *Founder and Chief Analyst, LightCounting, USA*

LightCounting has established a reputation in the industry by publishing

conservative market forecasts, which have proven to be much more accurate than other more optimistic projections, at least so far. This presentation will review uncertainty of the forecast model and potential for upward and downward swings in the market. It will specifically address prospects for 100G technology in datacom and telecom markets, focusing on separating hype from reality.

Vladimir Kozlov is the founder and CEO of LIGHTCOUNTING an optical communications market research company. LightCounting was established in 2004 with an objective of providing in-depth coverage of market and technologies for high speed optoelectronic interfaces employed in communications. By now, the company employs a team of industry experts and offers comprehensive coverage of optical communications supply chain. Dr. Kozlov has more than 20 years of experience in optoelectronics, optical communications and market research. Dr. Kozlov held market analyst, product development and research staff positions at RHK Inc., Lucent Technologies and Princeton University. Dr. Kozlov holds several US patents and has numerous publications in the area of optoelectronics. He received M. Sc. at Moscow State University in Russia and Ph. D in Physics at Brown University in the United States.

The Path to Sustained Profitability

Subu Subrahmanyan, *Managing Director of Research Analyst, The Juda Group, USA*

The focus of this presentation will be on structural challenges to achieving sustained profitability in the optical component industry and opportunities to drive higher margins through a combination of innovation, scale and consolidation/pruning.

Natarajan 'Subu' Subrahmanyan, CFA is a Senior Managing Director and lead research analyst for communications equipment companies at The Juda Group, a division of Concept Capital Markets. Subu's research focuses on leading data and optical networking companies. He was featured on the Wall Street Journal's

Best of the Street Analyst List in 2007, and was named the best up-and-comer in telecom equipment in the 2001 Institutional Investor polls. Subu joined The Juda Group in January 2003 prior to which he was lead research analyst for data and optical networking companies at Goldman Sachs. He holds an MBA from the Owen School at Vanderbilt University and a B.S in Electrical and Electronics Engineering from Madras University.

Panel II: High Speed Pluggable Optics for Data Center

Tuesday, March 19, 2013
15:00 - 17:00

Moderator:

Tiejun J. Xia, *System Architect/DMTS*, *Verizon, USA*

Tiejun J. Xia is an expert of photonic technologies and optical communications in research, development, and technology innovations. He is Distinguished Member of Technical Staff with Verizon where his responsibility is optical network architecture and technology development. He is also an adjunct professor at Miami University, Ohio. Recently he served as Director for Network Technology Development at Chorum Technologies. Prior to Chorum, he worked with MCI for next generation optical transmission technologies. Before joining MCI, he was a research faculty member in the Department of Electrical Engineering at the University of Michigan. He is co-founder and current president of the Advanced Fiber Connectivity & Switching Forum. He was an adjunct professor at University of Texas at Dallas from 2005 through 2009. He has served on Technical Program Committees of OFC/NFOEC, APOC, ACP, and OECC. He is a senior member of IEEE and serves the executive board of IEEE Dallas Section. Dr. Xia holds his Ph.D. degree in Physics from CREOL (Center for Research and Education in Optics and Lasers) at the University of Central

Florida, M.S. degree from Zhejiang University, China, and B.S. degree from University of Science and Technology of China. He has published more than 100 technical papers, given numerous invited talks, and holds more than 60 granted or pending U.S. patents. In 2011, he was featured as “Verizon Innovator” on YouTube. In 2012, he was elected a Fellow of The Optical Society.

Panel Description:

Data centers and super data centers have experienced rapid development in recent years. Low-cost, high-speed pluggable optics, such as CXP, CFP, CFP2, CFP4, etc., are in high demand for intra-data center connections. Photonic integrated circuits and silicon photonics have attracted a lot of attention for highly integrated modules and devices. What is the latest industry status? When will 100G pluggable optics become dominant? What is the outlook for the next five years?

Speakers:

 **Adam Carter,** *General Manager for Transceiver Module Group, Cisco, USA*

Adam Carter has over 20 years experience in the optical communication market and is currently the Senior Director and General Manager of the Transceiver Module Group (TMG) at Cisco, a position he has held for the last four years. In March 2012 Cisco announced the acquisition of Lightwire, a privately held company developing Silicon Photonics for high bandwidth, low power, high density transceiver applications which now reports into TMGPrior to joining Cisco, Aam was Director of Marketing for the Fiber Optic Product Division at Avago Technologies, and before that held positions in Strategic Marketing, Product Management, Operations and Product Development for Agilent Technologies, Hewlett Packard and British Telecom & Dupont (BT&D).
Adam holds a BSc (Hons.) in Applied Physics from Portsmouth University and received a PhD from the University of Wales, Cardiff for his research on plasma etching of III-V semiconductor materials.

Datacom Transceivers: 100G and Beyond

Julie Eng, *Vice President of Engineering, Finisar, USA*

This talk will review optical component and transceiver technology for 100G and higher datacommunication links. In particular, the state-of-the-art in commercial VCSEL, DFB, and Silicon Photonics technology will be discussed and compared. Technology advances in parallel optics and longwave multi-channel optics required to support higher bandwidth density form factors such as CFP2, CFP4, QSFP, and board-mounted optical engines (BOAs) will be discussed. Technology development for 400G and higher bandwidth datacom transceivers will also be discussed.

Julie Sheridan Eng has served as Senior Vice President of Transceiver Engineering for Finisar Corporation since 2012, and for two years prior, held various senior management positions within the Finisar engineering organization. From 1995 to 2003, Dr. Eng was part of AT&T/Lucent/Agere, primarily leading Agere's optoelectronic transmitter, receiver, and transceiver design for datacom markets. Dr. Eng holds a B.A. degree (summa cum laude) in Physics from Bryn Mawr College and a BSEE degree with honors from the California Institute of Technology. She earned an MSEE and PhD in Electrical Engineering from Stanford University. She has published over a dozen papers and holds 7 patents.

100G Transceiver Trends for Data Centers and the Metro

Yves LeMaitre, *Chief Commercial Officer, Oclaro, USA*

We'll discuss recent developments for pluggable 100G transceivers for the line side and client side. We'll also review the move towards CFP2 and CFP4 and discuss the challenges around realizing next generation coherent pluggable

modules.

Yves LeMaitre has served as Oclaro's Chief Commercial Officer since July 2011. He previously served as Executive Vice President, Strategy and Corporate Development, at Oclaro from February 2011 to July 2011, and was Executive Vice President and General Manager of Oclaro's Advanced Photonic Solutions division from April 2009 to January 2011. Previously, Mr. LeMaitre served as Vice President of Telecommunications Sales and Corporate Marketing for the company from February 2008 to April 2009. From May 2005 to December 2007, Mr. LeMaitre was with Avanex, most recently serving as Chief Marketing Officer in charge of worldwide sales and marketing. Previously, Mr. LeMaitre was President and Chief Executive Officer of Lightconnect, a leading supplier of optical MEMS components and modules. In addition, he worked for Alcatel and its joint venture with Sprint International in a variety of general management, senior marketing and engineering positions in the United States, France, the Netherlands and Italy. Mr. LeMaitre earned a master's degree in mathematics and computer science from Nantes University in France. He also holds an engineering degree from Ecole Nationale Superieure des Telecommunications (ENST) in Paris.

 **The challenge of high speed optics interface for Core Router**

Sam Liu, *Senior Product Line Manager, Juniper, USA*

This talk will focus on three areas. The first is the trade off between 100G and 40G interface for data center applications. Secondly, how to support ultra high density for 10G interface. Finally, optics interface from client side to line side.

Samuel Liu is a Senior Product Line Manager at Juniper Networks who is responsible for packet optical solution and high speed optics product management. He has more than 15 years working experience on telecommunication and networking industry. Before Juniper, he worked on 100G and 40G optical transmission solutions as a Director of Product Line

Management at Stratalight Communications. Before that, he held various product line management, product marketing, product planning and system architect positions at Avanex, Huawei USA, Tellabs and several packet optical start-up companies. He has published tens of technical papers, and holds multiple US patents. Dr. Liu received his Ph.D. in Electrical Engineering at Illinois Institute of Technology. He received his B.E. in Optical Engineering at Zhejiang University, China.

High Performance Optical Engines using MEMS-based Hybrid Integration

Bardia Pezeshki, Founder and CEO, Kaiam, USA

The bandwidth demand for interconnects has exceeded practical single channel data rates, thus forcing the use of multi-lane approaches, such as CWDM or advanced modulation techniques. Such transceivers require multiple functions or subcomponents in a compact footprint, and some form of optical integration is necessary. The use of mature, generally available, and low-cost single element components such as EMLs, silica PLCs, and direct-mod DFBs, integrated in a hybrid fashion and optically aligned with MEMS, provides a simple and practical solution for high performance transceivers. We will specifically discuss the technology and market for 40Gb/s QSFP-LR4 and 100Gb/s ER and 80km applications.

Dr. Pezeshki is currently the founder and CEO of Kaiam. The company has developed a platform for hybrid PICs and supplies high performance multi-wavelength engines. Previous to Kaiam, he started Santur and drove the product development and commercialization of products such as the highly successful MEMs-based tunable laser and the 10x10Gb/s parallel transceiver. Prior to Santur, Dr. Pezeshki managed the Development group at SDL (now part of JDS Uniphase) and a similar group at IBM Research in Yorktown Heights. He obtained his Ph.D. from Stanford University and has approximately 30 patents and 100 peer reviewed publications and presentations.

High-speed Optics for Warehouse Scale Datacenter Connectivity

Vijay Vusirikala, *Network Architect, Google, USA*

In this talk, we will discuss the underlying bandwidth drivers for datacenter connectivity and emerging technology building blocks to address the needs of large datacenter operators. The talk will discuss scaling challenges and the promise of new technologies like silicon photonics for higher speed optics.

Vijay Vusirikala is currently Optical Network Architect at Google, where he is focused on solutions for scaling Google's optical network. Prior to Google, Vijay was at Infinera, Motorola and Sycamore Networks in senior marketing, business development and architecture roles working on optical networks and systems ranging from backbone core to access networks. Vijay has published extensively, spoken at numerous industry events, and holds several patents in optical devices and systems. He obtained a Ph.D from the University of Maryland, College Park in optoelectronic integration, and a BSEE from IIT, Madras in India.

Panel III: Components looking for the "Booster Rocket"

Wednesday, March 20, 2013
13:00 - 15:00

Moderator:

Karen Liu, *Principal Analyst of Components, Ovum, USA*

Karen Liu is responsible for market analysis of new telecoms technologies. Recent report topics include 40 Gbps/100 Gbps interfaces, ROADM architectures, datacenter communications needs and industry profitability. In her decade as an analyst, she has also worked on a broad range of custom advisory

projects and exploratory reports on emerging technologies such as ATCA platforms, tunable lasers, Wifi hotspots, home networking, and IPTV solutions. Projects included strategic advice, competitive analysis, new product market sizing, and industry structure analysis. She is a frequent industry speaker. Prior to joining Ovum, Karen architected DWDM networking products at Tellabs and IBM. The experience gave her an appreciation for the interaction between enabling component technology and advances in networks and systems architecture. Karen received a PhD in applied physics from Stanford University in the field of fiber optics, and a BSE in mechanical engineering from Princeton University.

Panel Description:

The burden of supporting faster traffic at lower cost ultimately rests on advances in component technology. Current technologies have done a great job getting us to amazing data rates already but the market is calling for further acceleration which will require lighting another “rocket stage”. As data rates push to 100G and beyond, the market is being forced to consider dramatically new approaches to increase per lane speeds while keeping costs down. Is the key integration? Is it more electronics processing? Is it volume consolidation?

Speakers:

Robert Blum, *Product Marketing Director of Photonic Components, Oclaro, USA*

Robert Blum is Director of Product Marketing for Oclaro’s Photonic Components Business Unit. Before joining Oclaro he was product line manager for optical transmission components at JDS Uniphase Corporation, and held various engineering and marketing management roles at Gemfire Corporation, all in California. Robert holds doctorate and masters degrees in Physics from Hamburg-Harburg University of Technology and Darmstadt University of Technology, respectively. He has studied and done research at Ecole Polytechnique Fédérale in Lausanne, Switzerland, Deutsche Telekom’s Research and Technology Labs in Darmstadt, Germany, and Stanford University, California.

Brad Boersen, *Director of Business Strategy & Analysis - Optical Fiber, Corning Inc., USA*

Brad Boersen has 25 years of professional experience. Presently he is Director of Business Strategy & Analysis for Corning Incorporated'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 BS degree in Chemical Engineering from Michigan State University and an MS in Engineering and Management from Massachusetts Institute of Technology.

 **Ben Hua**, *Vice President of Research & Development, O-NET Communication Limited, USA*

Ben Hua is Vice President of R&D O-Net Communications Limited, responsible for corporate R&D as well as new product introduction activities. Before joining He has worked in this industry for over 18 years for a number of companies, including JDSU and E-TEK Dynamics, Inc., holding various engineering and marketing management roles. Ben Hua holds Ph.D. in Physics and had conducted postdoctoral research in Telecommunication Research Labs at the University of Albert in Edmonton, Canada.

 **David Li**, *CTO, Hisense, USA*

David Li is the co-founder and CTO of Ligent Photonics and Hisense Broadband Multimedia Technologies. He received his bachelor degree from Shandong University and the MSEE from Beijing University of Aeronautics and Astronautics. He got the Doctor of Engineering degree from University of Electronic Science and Technology of China and the Ph.D. from University of Houston, respectively. Prior to joining Hisense-Ligent in 2002, he held a variety of positions as professor, principal design engineer, technical supervisor, and director of engineering in UESTC, CUHK, Texas Center for Superconductivity, Epsilon Lambda Electronics, and Molex Fiber Optics. He has been involved in the design and manufacturing of the high-speed electrical, optical modules and subsystems for more than 20 years. Since 2000, David has been participating the IEEE802.3 and FSAN meetings actively. Following the standard activities, he lead his team developed the innovative EPON ONU/OLT with accurate monitoring functions, GPON ONU/OLT modules, 10G-EPON symmetric and asymmetric modules, NG-PON1 modules, and WDM-PON modules, which have been all widely deployed around the world.

 **Osa Mok**, *Chief Marketing Officer, Innolight Technology Corp, USA*

Mr. Mok is an international marketing executive in the Telecommunications Industry with thirty years of

experience both in Fortune 500 and start-up companies. He joined Hambrecht and Quist (now JP Morgan Chase) in the early 1980's as a Communications Technology Analyst. From 1985 to 1992, he was Director of International Marketing for GTE (now Verizon). He won outstanding sales achievement awards and received several President's quality awards for distinguished management achievements. From 1993 to 1999, he worked as an International Business Development Executive assisting several Fortune 500 companies to develop telecommunications businesses in Asia and South America. Mr. Mok co-founded Pine Photonics in April 2000. He grew the company significantly despite a severe industry downturn and sold the company to Opnext in 2003. In 2008, Mr. Mok co-founded Innolight Technology Corporation. In just 4 years, Innolight has successfully developed businesses in all major continents and is now the leader in 10G/40G/100G optical transceivers in China. Throughout his career, Mr. Mok has accomplished key strategic sales, established business alliances and joint ventures, secured equity financing, and executed several mergers and acquisitions. Mr. Mok received a MBA degree from University of Santa Clara, and a M.S. from Texas A&M University.

 **Stefan Rochus**, *Vice President of Marketing and Business Development, CyOptics, USA*

Stefan M. Rochus, Vice President Marketing and Business Development, CyOptics Inc., USA Stefan M. Rochus, Ph.D., has been Vice President of Marketing and Business Development at CyOptics Inc. since 2005. From 2003 to 2005, he served as Marketing Director for Triquint's Optoelectronics Division. From 2000 to 2003, Dr. Rochus was Product Line Director for Lucent Technologies' and later Agere Systems' EDFA, Pump laser and Passives businesses. He also managed Lucent Technologies' European Optoelectronics Sales and Marketing Operations from 1997 to 2000. Dr. Rochus holds a M.Sc. degree in Electrical Engineering from the University of Braunschweig, Germany and a Ph.D. degree from the University of Munich, Germany.

Panel IV: Metro 100G Applications

Thursday, March 21, 2013
10:15 – 12:15

Moderator:

Rafik Ward, *Vice President of Marketing, Finisar, USA*

Rafik Ward joined Finisar in 2003. Throughout his career at Finisar, Mr. Ward has held a variety of progressive roles including Product Marketing, Product Line Management and Senior Director of Marketing. In 2008, Rafik was promoted to Vice President of Marketing at Finisar, the position he currently holds, where his responsibilities include Product Management, Strategic Marketing and Corporate Communications. Prior to Finisar, he served in various engineering and marketing positions at West Bay Semiconductor, Aegis Lightwave, and Ballard Power Systems. He holds an MBA degree from MIT Sloan School of Management and a B.A.Sc. in Mechanical Engineering from the University of British Columbia.

Panel Description:

100G transport has been emerging as a long haul transport new normal approach. Verizon announced the massive metro 100G development will start from 2013. What will happen for the metro 100G? Is the standard PM-QPSK will extend from LH to metro? How about 16QAM? Is there a room for direct detection based metro 100G solution?

Speakers:

Interoperable Coherent 100G engine, A Key Enabler of Network Function Virtualization in Metro Space

Shamim Akhtar, *Senior Director of Architecture & Technology Strategy, Comcast, USA*

This talk is going to cover the higher layer network element virtualization and

application localization trend as the moving force to trigger the need for Metro bandwidth elasticity & scale. In additiona it will cover the advent of DSP and PIC integration would yield an interoperable 100G, a table stake and line system aware flex speed innovation beyond 100G.

Shamim Akhtar, Sr. Director Network Architecture & Technology Strategy is responsible for driving the network technology platform and architecture roadmap for Comcast's truly converged national IP/Optical backbone, Metro, Edge and Access network. His technology & operations leadership has brought tremendous momentum in the area of vendor agnostic network scaling to support Triple play residential, MEF based business services and Mobile backhaul services over one converged IP/Optical network. Shamim is a frequent speaker in packet optical core and access space. He is instrumental in aligning system level thought process in scaling speeds beyond 100G to 1Tbps in North America by collaborating with carriers, technology partners and research organizations. He is a Co-founder of Docsis provisioning of EPON/10GEPON for scaling access bandwidth in commercial space. Shamim is an IIT Graduate with working knowledge of MSO/Carrier network in North America, Europe and APAC through his prior experience in Philips, VPISystems and Internet Photonics/Ciena.

Metro 100G – Does one solution fit it all?

Jörg-Peter Elbers, *Vice President Advanced Technology, ADVA*, Germany

Power consumption, footprint and cost are of paramount importance for the adoption of 100G technologies in the metro space. This talk will discuss applications and technical approaches, analyzing whether a single solution can address the diverse set of requirements.

Jörg-Peter Elbers is Vice President Advanced Technology at ADVA Optical Networking in Munich, Germany, and is globally responsible for technology strategy, new product concepts, standardization, and research. Current

advanced technology activities include software-defined networking, beyond 100G transmission and next-generation optical access. Prior to joining ADVA in 2007, Jörg-Peter was Director of Technology in the Optical Product Unit of Marconi (now Ericsson). From 1999 to 2001, he worked at Siemens AG, last as Director of Network Architecture in Siemens Optical Networks. He holds a Dr.-Ing. and Dipl.-Ing. degree in electrical engineering from the Technical University of Dortmund, Germany.

 **Jean-Paul Faure**, *Product Line Manager for Data Center Connect (DCC), Alcatel-Lucent, USA*

Jean-Paul Faure is a Product Line Manager (PLM) for Data Center Connect (DCC) in the Optical Networking Division at Alcatel-Lucent. He joined the Alcatel Corporate Research Center in 1999 to work on optical switching technologies and flexible networks. He later joined the Alcatel Optical Networking Division contributing to the development of multi-reach transmission platforms and GMPLS applications. In 2007, he became PLM for WDM terrestrial solutions, with a focus on ultra-high bit rate transmission, and was involved in the Coherent 100Gb/s market introduction, several early field trials, and customer deployments. He is now a PLM for the DCC solution. Member of the Alcatel-Lucent Technical Academy, he received the “Bell Labs President’s Award” in 2010 for his involvement in the 100Gb/s Coherent innovation program and demonstrated business impact. He is the author and co-author of 12 patents and several international publications. Jean-Paul Faure obtained a Masters Degree in Physics from University of Paris-XI Orsay, and a PhD. in applied Physics from University of Paris-VI in 1998.

 **Evolution of Packet Optical Convergence in Metro**

Jun Shi, *Senior Director of PLM, Juniper, USA*

100G coherent technology is becoming a catalyst to drive multilayer network

convergence across boundaries in Core, however Metro may arguably face more dynamics on its evolution path due to legacy 10G/40G transport infrastructure and various applications. It's a multi-dimension challenge to sort out how to invest efficiently on migration of legacy infrastructure and application, convergence between different network layers, and multilayer coordination, etc. An open ecosystem is needed for the industry to collaboratively work together and drive the market transition. This topic will focus how to drive packet optical convergence in Metro network by building up an open ecosystem.

Jun Shi is a Senior Director of Product Line Management at Juniper Networks, with responsibility for PTX product line and Packet Optical Solution. He has more than 15 years of experience in Networking Industry. Prior to joining Juniper, Jun worked for Cisco for 13 years, holding various positions from Sales Engineer, Software Engineer, Technical Marketing Engineer to Senior Product Marketing Manager. During his 5 years of PLM role there, he fathered CRS Thin Core product line and CRS3 140G, and led the next generation Core product development. Before Cisco, he worked for China Telecom. Jun holds a MS degree in Electrical Engineering and double CCIE in SP and R&S.

Ubiquitous Deployment of 100G throughout the Metro Network

Malcolm Toynbee, *Group Product Manager, Tellabs, USA*

It is well accepted within our industry today that 100G will be the first choice for the long haul transport network but what is it going to take to make that same belief come true for metro networks? Historically mass adoption of higher data rates within the metro transport network have only happened when costs closely align with the service need (revenue source). Today we have products that meet the technology need but potentially go beyond the minimum viable performance required. This disconnect usually results in a first cost hurdle that cannot always be overcome for all end customers. We need to take 100G technology down the same path we did with 10G, from discrete optics designs, to MSA based solutions, to small form factor pluggable. This means great strides in the reduction of size, power consumption and cost.

Malcolm Toynbee is Global Marketing Director for Tellabs packet optical solutions. In this role, he is responsible for promoting Tellabs' strategic direction and commercial market management for packet optical networking solutions including OTN, SONET/SDH, and Packet Optical transport. Before joining Tellabs, Toynbee held various R&D, product management and strategy roles at JDS Uniphase, Sycamore Networks and Scientific-Atlanta (now Cisco). He has more than 15 years of experience in the telecommunications and networking industry. Malcolm Toynbee has a bachelor's degree in Electrical Engineering from the University of New Brunswick and an MBA from Lake Forest Graduate School of Management.

 **Extending 100G into the Metro**

Glenn Wellbrock, *Director of Backbone Network Architecture, Verizon Business, USA*

This presentation outlines how 100G is used today in metro networks and what is needed for this technology to become the default solution in this very cost-conscious application space.

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 & 2004-present), Glenn was responsible for Product Architecture within the USA focused optical networks group at Marconi and Product Planning at Qplus Networks with a specific focus on developing alternative modulation techniques.

Panel V: Packet Optical Convergence

Thursday, March 21, 2013
13:00 - 15:00

Moderator:

Melissa R. Handa, *Executive Director - Telcordia, Ericsson, USA*

Melissa Handa is the lead for Telcordia's Network and Product Integrity Services Business Unit. As Executive Director, Melissa leads her team which specializes in requirements development, standards consulting, product analysis, product testing, risk assessments and deployment support. Melissa also serves as the Network and Product Integrity Quality Manager and manages the quality reviews that Telcordia provides for various equipment manufacturers. Melissa has a wide range of technical and managerial experience in the field of telecommunications that enables her to effectively understand client's technological and business needs.

Panel Description:

After 10G non start and 40G test water for IPoWDM, packet optical is coming back with 100G using coherent solution. What will be the major benefit for packet optical convergence? Are there clear paths specified by standards? Router companies are adding integrated optics on routers while transport companies are adding MPLS/packet features on transport equipment. Is there a clear market?

Speakers:

 **The Simplest Packet-Optical Convergence**

Jeff Cox, *Senior Director of Network Architecture, Microsoft, USA*

Packet-Optical Convergence" means many different things to those in the industry. The term has grown and morphed into including all manner of technologies, protocols, systems, and network designs leading to great market confusion over what is important. Microsoft is interested in those forms of packet-optical convergence that promise to deliver the most cost-effective bandwidth possible over large distances with a multi-vendor inter-operable solution. As such, Microsoft is focused on future implementation of packet-optical convergence that offer relatively simple implementations.

Jeffrey L. Cox is the Sr. Director Network Architecture leading the Architecture, Testing and Standards

(ATS) team in the Global Network Services (GNS) group of Microsoft's Online Services Division (OSD). The ATS team focuses on developing future end-to-end network infrastructure architectures supporting all of Microsoft's online and cloud services. Jeff has accumulated almost 30 years of experience in architecting, designing, and operating large scale network infrastructures and in the development of hardware systems in the packet switching and optical transmission space.

Software Defined Packet-Optical Core is the Future

Bikash Koley, *Principal Architect and Manager of Network Architecture, Google, USA*

Bikash Koley is the Principal Architect and manager of the Network Architecture team at Google. Bikash is responsible for scaling optimization and automation of the network layer of Google's cloud infrastructure. Bikash also oversees the network technology road-map at Google in order to support all the present and future Google services. Prior to Google, Bikash was the CTO 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.
Bikash is a frequent speaker in conferences and industry forums and is an active participant in various networking standard bodies. Bikash has received 8 patents related to various optical and networking 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.

IP and Optical Transport Network Integration Transformation – A Vision or Reality

Lieven Levrau, *Product Line Director, ip/OPTICS, UK*

Service providers continuously strive to balance two conflicting goals, reducing the cost of reliably transporting high volumes of traffic while extracting appropriate value from innovative new services. Collapsing redundant functionality in network layers enables the reduction of network elements in the data path and reduces cost and operational complexity to a fundamental set of transport. Closer integration of IP & optical transport stands to provide efficiencies in power and rack space, simplified network planning and fault management, and fewer points of failure. For the service provider, this results in higher efficiency and robustness with lower complexity and at a lower cost of operation. Ultimately the transport infrastructure can gracefully and cost-effectively scale to address continued traffic growth. This presentation will outline the key considerations for optimizing the core network by setting out a IP optical integration framework.

Lieven Levrau received an Mater in Science degree in Applied Physics engineering (Photonics) from the University of Brussels in 1994 and he has studied Avionics at the University of Ghent. He has participated in several European and national research projects such as NOBEL, Dynamo and GSN. His current research interests are focused on design issues related to multi-layer network control architectures for core and metro networks, and security for cloud, and grid computing. He is an IEEE member and Alcatel-Lucent Technical Academy (ALTA08) member. In his currently role as Product Line Manager within the IP Division, he is responsible for the IP and Optical integration and is one of the driving forces behind the Converged Backbone Transformation (CBT). Lieven is active in the IETF, in the MPLS-TP and CCAMP. His current interests are in network virtualization related issues, security and multi layer optical packet and transport networks.

The Value of Packet and Optical Transport Convergence for the Next-Generation Internet
Loukas Paraschis, *Senior Solution Architect, Cisco, USA*

As a new generation of coherent DWDM systems, with more than 2 b/s/Hz spectral efficiency, is offering the much need scaling the existing fiber infrastructure, albeit at a significantly higher proportion, typically more than 50%, of the total transport network cost, the convergence of IP/MPLS with flexible DWDM promises the most cost-efficient IPNGN evolution in open interoperable transport architectures that combine advancements in photonics, routing, traffic-engineering, multi-layer control-plane and software-defined-network automation, to improve operation, provisioning, and restoration, and to optimize network utilization.

Loukas Paraschis is senior solution architect in cisco's Americas next generation network group, primarily responsible for the evolution of core routing and optical transport network architectures, technologies, business models, and market development efforts in Service Providers, large Enterprise, and Public Sector infrastructure. Prior to his current role, Loukas worked as an R&D engineer, product manager, technical leader, and more recently Business Development Manager for cisco's optical networking and core routing. He has (co)authored more than 50 related peer-reviewed publications, invited, and tutorial presentations, two book chapters, and two patents, and was an IEEE Photonics Distinguished Lecturer. Loukas received his Ph.D. from Stanford University, is a senior member of IEEE, and a Fellow of OSA.

Converged Core: The Benefits of an Innovative Architecture

Hans-Juergen Schmidtke, *Chief Architect for Converged Supercore, Juniper, USA*

Data and telecommunications networks experience a continuous demand in data growth while challenged with the economic reality of high operational complexity and capital expenditures. New revenue generating service offerings that can be deployed fast and seamlessly are important for the success of a wide range of telecommunication companies and content service providers. Novel network architectures that describe ways to forward, control and manage networks while integrating technologies such as routing & switching and OTN/DWDM are essential to form a packet-optical solution. IP/MPLS and OTN/DWDM based designs and migration scenarios will be discussed.

Hans-Juergen Schmidtke is Chief Architect for Converged Supercore at Juniper Networks located in Sunnyvale, Calif. In this role he is responsible for the architecture of the IP Converged Core and the Optical & Transport strategy and implementation of all Juniper's optical and transport related technologies. In his career he was Head of the Fixed Network Operator Business in North America for Nokia Siemens Networks located in Mountain View, Calif. Over the years at Nokia Siemens Networks and Siemens Communications, Inc., he has held positions in product management and general management in both Germany and the US. Dr. Schmidtke worked on various aspects of optical physics from advanced research, to product development, to real-world large-scale deployments. He studied physics at the University of Dusseldorf and at the Max-Planck Institute of Quantum Optics, and received his PhD from the University of Wurzburg. Dr. Schmidtke is member of IEEE, OSA and the German Physical Society.

Service Provider Summit

The Service Provider Summit is open to all Conference Attendees and Exhibits Pass Plus 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, *Principal Analyst, Components, Ovum Inc, USA*

Service Provider Summit Organizer:
Steve Plote, *Solution Sales Director, Tellabs, USA*

Wednesday, March 20, 2013

8:30–9:00 a.m.	**Keynote: What Cloudonomics Means for the Network**
9:00–10:30 a.m.	**Panel I: Monetizing the Network – Achieving Value out of the Infrastructure** Mark Lum, Co-Founder Market Lead, Layer123, UK
11:00 a.m.–12:30 p.m.	**Panel II: Acquisition and Integration Strategies – Consolidation in the Service Provider Realm** Stephen Hardy, Editorial Director/Associate Publisher, Lightwave Magazine, USA

Keynote Presentation

Wednesday, March 20, 2013

8:30 – 9:00

Joe Weinman, Senior Vice President, Cloud Services & Strategy, *Telx, USA*
Abstract: The economics of the cloud—Cloudonomics—help achieve a variety of business results: cost reduction and business agility, but also customer intimacy, product leadership, operational excellence, and accelerated innovation. To achieve these, emerging architectures such as hybrid clouds are driving new network technologies, next generation distributed fabrics, and increasingly intelligent and optimizing network services.

Biography: Joe Weinman is responsible for leading Telx's fast-growing cloud services business

development and strategy. He joined Telx® with over 30 years of experience in executive leadership positions at AT&T, Hewlett-Packard, and Bell Laboratories, in areas such as corporate strategy, business development, product management, operations, and R&D. Named a “Top 10 Cloud Computing Leader” by TechTarget, Weinman is a frequent keynote speaker, blogger and the founder of Cloudonomics—a rigorous, multidisciplinary approach to valuing the cloud—and the author of *Cloudonomics: The Business Value of Cloud Computing*, available from booksellers worldwide in ebook and hardcover editions. He has been awarded 16 U.S. and international patents in diverse fields and has been showcased in numerous global broadcasts, print and online publications. He has a Bachelors and Masters in Computer Science from Cornell University and UW-Madison respectively, and has completed Executive Education at the International Institute for Management Development in Lausanne.

Panel I: Monetizing the Network - Achieving Value out of the Infrastructure

Wednesday, March 20, 2013
9:00 - 10:30

Moderator:

Mark Lum, *Co-Founder Market Lead, Layer123, UK*

Mark Lum is Co-Founder and Market Lead at Layer123, a new venture knowledge exchange company. His expertise is founded in Optical, Carrier Ethernet, Mobile, Metro, FTTx and Storage networks and services, with experience spanning WDM, OTN, SDH/SONET, ATM, MPLS and Ethernet technologies. Mark studied Natural and Electrical Sciences at Cambridge University and was awarded his MSc in Telecommunication Systems while working in the Harlow R&D labs of ITT-STL, developing the very first multi-Gigabit optical systems. He has a broad industry experience, having worked at Tektronix as market development manager, Nortel Networks as portfolio manager, RHK as market research director and as an independent consulting analyst. Mark has also taken an active role in global standardisation, having led Tektronix' program at ITU and ETSI, contributing as technical editor for several standards and as ITU-T Rapporteur. With many papers published on carrier network evolution, he is a well-known and frequently-requested speaker and chair at industry conferences.

Panel Description:

There is no build it and they will come economic revival happening in the Networks. Capital $$s are still very tight and Service Providers need to squeeze as much revenue as possible from their assets and will

only invest in new infrastructure that will deliver revenue payback in a short window. It is one thing to raise prices on Commodity services like DSL, FiOS, and Smart Phone Data plans; but, do these changes attract customers or drive them away? Analytics can make a lot of user information available to the Service Providers. How much of it and what type is useful to the SPs? Can it help target new revenue sources and enable better services and user experience yet still protect the privacy of subscribers? Are Big Data Analytics a curse or a Goldmine? What are the Service Providers doing to try and obtain more revenues out of their infrastructure? Is the strategy working?

Speakers:

Service-Oriented Adaptive Packet-Optical Transportation
Walter Chen, *Network Planner III: IP Development & Engineering, Sprint, USA*

As service providers under increasing pressure to support the explosive Internet and mobile data traffic growth, the core transport network has always been a cost and needs to be designed and controlled as cost effectively as possible. On the other hand, the rapid development of mobile technology and applications also demand a core network that allows rapid new service enablement that in general implies higher cost. We discuss from service providers' perspective some of the important technical requirements of a service-oriented integrated packet-optical transport network which could potentially meet both of the above seemingly conflicting objectives.

Walter Chen is a principal network engineer in IP Design and Development at Sprint, responsible for SprintLink IP core network strategies, architecture, capacity forecast and planning, and has similar responsibility for Sprint's new Next Generation Wireless WAN core network. He is also responsible or partially responsible for the Sprint wireline network capital unit cost models, including both IP and transport. He holds a PhD in Astrophysics from The Johns Hopkins University, and worked at NASA Goddard Space Flight Center before joining the telecom industry in 1999. He introduced more rigorous numerical methodology into core network capacity forecasting and planning, used network planning tools such as Cariden MATE and WANDL IPMPLSView in both network topology optimization and green-field network design and modeling.

Leveraging new network capability to improve service economics
Per Larsson, *Executive Network Architect, TDC, Denmark*

All parts of the network must play their full role in supporting today's requirements for on-demand and scalable capacity, while aiming for high resource utilisation at lowest cost. It was always thus – this is the long-standing job of network infrastructure – but users' demands continue unabated, are stronger than ever, and change still quicker. New capabilities in flexible optical networking, from zero-touch photonics and coherent DSP to high-capacity OTN switching and converged packet infrastructure, open the door for new services and new operating models. Network control plane stands ready for the next evolution: what further operational intelligence is needed, how can applications be more closely coupled, and what benefits will new concepts like Transport SDN bring to the table? This talk, with one foot firmly in today's network context, will explore the possibilities, applicable use cases and likely benefits for Carriers of these new capabilities.

Per Larsson joined TDC in 2001, and currently holds a position as executive network architect at TDC Capacity & planning department, with focus on optical & transmission, mainly DWDM and SDH platforms. Per started his work in carrier networks in the mid 80's, with a focus on the transmission technologies of the day: X.25, Frame Relay and ATM. Planning, building and network operation/management were the main topics. His experience has been gained at TietoEnator, Telecom Finland, Sonera, Tele1 Europe and Songnetworks. Since 1997 he focused on optical & transmission platforms, primarily DWDM and SDH networking. Particularly the main topics of development, planning, network operation/management and cost analysis, in both international and regional areas. With his broad experience, Per is today active in the development and planning of TDC's Optical & transmission networks in the Scandinavian and European region.

Chris McReynolds, *Vice President of Global Transport Products, Level3, USA*

Chris McReynolds has been with Level 3 for 6 years. He started in the corporate strategy group exploring wireless backhaul, international expansion, content distribution network optimization, and video creation & distribution supply chains. Since then he has managed various products and services, and currently is Vice President of Core Networks Services responsible for Global Transport and Ethernet Services. He attended Stanford University obtaining a B.S. and M.S. in engineering and has an M.B.A from the Leeds School of Business.

Panel II: Acquisition and Integration Strategies - Consolidation in the Service Provider Realm

Wednesday, March 20, 2013
11:00 - 12:30

Moderator:

Stephen Hardy, *Editorial Director/Associate Publisher, Lightwave Magazine, USA*

Stephen Hardy is editorial director and associate publisher of *Lightwave*, part of the Technology Group of PennWell Corp. Stephen is responsible for establishing and executing *Lightwave's* editorial strategy across the brand's Web site, email newsletters, events, e-zine, and other information products. He has covered the fiber-optics space for more than a dozen years, and communications and technology for more than 25 years. During his tenure, *Lightwave* has received awards from *Folio:* and the American Society of Business Press Editors (ASBPE) for editorial excellence. Prior to joining *Lightwave* and PennWell in 1997, Stephen worked for *Telecommunications* magazine and the *Journal of Electronic Defense*.

Panel Description:

Does today's macroeconomic environment make consolidation among service providers more likely to occur or less? This panel will examine the prospects for such mergers and acquisitions and offer their insights on what makes a successful acquisition from the viewpoints of both the buyer and the seller. The financial aspects of M&A also will be discussed.

Speakers:

Clint Heiden, *President, Sidera Networks, USA*

Clint Heiden is President of Sidera Networks. Prior to joining Sidera Networks in 2011, he was President of PAETEC Fiber Services and National Accounts, where he led all efforts related to the company's fiber operations and strategy for retaining and growing its largest accounts. Mr. Heiden brings an entrepreneurial approach to business that is backed by nearly twenty years of executive experience within the telecom and Internet industries. Mr. Heiden has held executive positions for companies such as Cable & Wireless America, Qwest, UUNET, Intellifiber and InterCon Systems. Mr. Heiden holds a B.B.A. in Computer Information Systems from James Madison University

 **Randy Nicklas**, *CTO, XO Communications, USA*

Acquisition Strategies and Integration - Consolidation in the Service Provider Realm
Joe Stockhausen, *Vice President of Infrastructure Management, Zayo, USA*

Joseph M. Stockhausen is a senior telecommunications industry executive with more than 20 years of leadership experience in facilities based, metropolitan telecommunication systems. Most recently serving as Director, Fiber/Backhaul Implementation Services for ExteNet, a wireless service provider, Mr. Stockhausen brings an added value to Blue Crane as we endeavor to meet customer demand for cost effective bandwidth through innovative deployment of technology. He was SVP of Network Infrastructure Support Services, for the Metropolitan Network Services Group of Level 3 Communications, Inc. The Metropolitan Network Services Group was responsible for the expansion and maintenance of the 100+ metropolitan fiber based networks. Joseph Stockhausen came to Level 3 through the company's acquisition of Looking Glass Networks, Inc., where he was a co-founder of the company and the Vice President of Network Development. Mr. Stockhausen's early career included network development, financial analyses and accounting positions with WorldCom, Metropolitan Fiber Systems, Telesphere Communications and MT & Company. He holds a BS in Accounting from the University of Illinois.

OFC/NFOEC Press Releases

Below is a comprehensive listing of news releases from OFC/NFOEC 2013.. Should you have any questions, please email media@ofcconference.org.

Title	Date
OFC/NFOEC 2013 Concludes, Featuring Week of Latest Developments in SDN, Silicon Photonics, Network Optimization and More	22 March 2013
OFC/NFOEC Features New Research in Low-Power Supercomputing, Long-Distance 400G Data Transmission, Simplified Multicore Fiber Manufacturing	12 March 2013
OFC/NFOEC 2013 to Host World-Class Optical Communications Exposition Featuring 550+ Companies, Industry and Business Programming on Show Floor	11 March 2013
New Flex-Grid System Prevents Optical Network 'Traffic Jams'	7 March 2013
OFC/NFOEC 2013 to Feature Breakthrough Research, Technology-focused Programming at the World's Leading Optical Communications Event	4 March 2013
OSA Foundation Announces 2013 Corning Student Paper Competition Finalists	21 February 2013
Optical Communications Pioneer Tingye Li to be Honored at OFC/NFOEC 2013	31 January 2013
ADVA Optical Networking CEO Brian Protiva to Address Network	6 December 2012

Transformation at OFC/NFOEC 2013 Plenary Session	
James Coleman Wins 2013 John Tyndall Award	30 November 2012
Communications Technology Leaders Set to Deliver Keynote Talks at OFC/NFOEC 2013	12 October 2012
OFC/NFOEC Named One of Fastest Growing Trade Shows by TSNN	2 July 2012

Exhibitor News

Many prominent industry corporations unveil innovative new products and research at OFC. Below is a comprehensive list of news from OFC/NFOEC 2013 Exhibitors..

Please contact Angela Stark, OFC/NFOEC's Communications Director, at 202.416.1443 or via email at media@ofcconference.org with any questions.

Company	Title	Date
AppliedMicro	AppliedMicro Announces Key Technology for Rapidly Expanding OTN Market	21 March 2013
M/A COM Technology Solutions, Inc.	M/A-COM Technology Solutions Announces Industry's Lowest Power EML Driver	20 March 2013
Light Brigade, Inc., The	The Light Brigade, Fujikura Asia and ITE	20 March 2013

	College West Collaborate to Develop FTTH-Ready Workforce	
Light Brigade, Inc., The	The Light Brigade® Launches New Fiber Optics 1-2-3 Course and Manual for 2013	20 March 2013
Light Brigade, Inc., The	The Light Brigade® Incorporates Latest Standards in Fiber Optic Safety Training DVD	20 March 2013
OE Solutions	OE Solutions Announces Cooled Single Channel Transceiver	20 March 2013
Fraunhofer IPMS	Liquid Crystals Enable Light Guiding	20 March 2013
Kaiam Corporation	Kaiam Acquires GC Holdings, Inc. (Gemfire) and Raises Financing to Commercialize Photonic Systems-in-Package for Data Center Applications	19 March 2013
Anritsu Company	Anritsu MP1800A BERT Part of High-speed Demonstrations of Mindspeed CDR Retimers	19 March 2013
EFFDON Networks Ltd.	Effdon to present world-first 80km single-fiber 100G CFP module	19 March 2013
Kotura	Silicon Photonics Innovator Kotura Establishes Fabless Semiconductor Model	19 March 2013

	and Strengthens Key Component Supply Chain	
Kotura	Kotura Rolls Out 100G Silicon Photonics Chips with WDM in Dense QSFP Package	19 March 2013
Anritsu Company	Anritsu to Showcase Solutions for Testing High-speed Data Transmissions	19 March 2013
Sumitomo Electric Device Innovations U.S.A., Inc	Sumitomo Electric to Demonstrate Industry's First 25G EDR Technology Using Anritsu MP1800A BERT During OFC/NFOEC	19 March 2013
Teledyne LeCroy Corporation	Teledyne LeCroy to Debut New Optical Modulation Analyzer Solution at OFC/NFOEC 2013	19 March 2013
Go!Foton	Go!Foton and Samsung Jointly Announce the Invisia™ Indoor Living Unit (ILU) Solutions for FTTH deployment in MDUs	19 March 2013
OE Solutions	OE Solutions announces a full portfolio of 10G PON transceivers	19 March 2013
Photon Kinetics, Inc.	Photon Kinetics and Genia Photonics Announce 850 nm Fiber Laser for High Resolution Differential Mode Delay Measurements	19 March 2013

NTT Advanced Technology Corporation	Compact Optical Switch, CSW series switches the optical paths in the physical layer without interrupting network services	18 March 2013
NTT Advanced Technology Corporation	New Medical Light Source using NTT's Communication Laser Technology	18 March 2013
NTT Advanced Technology Corporation	Introducing Our Latest Product in Optical Connector Cleaners, the "NEOCLEAN -M" for Multi-Core Optical Connectors	18 March 2013
OneChip Photonics	OneChip Photonics Announces Relationship with IQE to Produce High-Volume InP PICs	13 March 2013
OneChip Photonics	OneChip Photonics Announces New Family of Photonic Integrated Circuit (PIC)-Based 100Gbps Optical Interconnect Solutions for Data Center Interconnect Applications	13 March 2013
Menara Networks	Menara Networks Announces New Full C-Band Tunable OTN XFP with Enhanced Forward Error Correction and Ethernet Monitoring Based on Menara's Latest OTN Processor Built on IBM 65 nm CMOS Process	18 March 2013
Go!Foton	Go!Foton introduces PEACOC™, an ultra-	18 March 2013

	high density Fiber Patch panel with Enhanced Access for Compact Optical Connectors	
Schott North America	New Schott TO Plus® Header Clocks in at 28 Gb/S, Almost Doubling Previous Data Transfer Speeds	18 March 2013
Schott North America	SCHOTT Introduces New Fiber Optic Communications Capabilities at the Optical Fiber Communication Conference and Exposition	18 March 2013
CALIENT Technologies	CALIENT Technologies and Plexxi Partner to Bring Software-Defined Networking to Large-Scale Data Center Networks	18 March 2013
3SPGroup	EXFO Launches IQS-2800 ITLA Tunable Laser Source	18 March 2013
3SPGroup	Tektronix Real-Time Oscilloscopes to Achieve 70 GHz Performance	18 March 2013
Proximion AB	Proximion Launches First 16-port Flexible-Grid Optical Layer Monitor	18 March 2013
Proximion AB	Proximion Launches DCM for ULH Coherent Links	18 March 2013
3SPGroup	Sumitomo Electric to Showcase Devices for Coherent Communications at OFC/NFOEC 2013	18 March 2013
3SPGroup	Sumitomo Electric to Showcase Optical Mux/Dmux Integrated TOSA/ROSA for	18 March 2013

100GLR4 at OFC/NFOEC 2013

Sumitomo Electric Device Innovations U.S.A., Inc	Sumitomo Electric to Showcase AOC Leadership at OFC/NFOEC 2013	18 March 2013
AppliedMicro	AppliedMicro Announces Key Technology for Rapidly Expanding OTN Market	18 March 2013
Nokia Siemens Networks, US, LLC	Coriant Sets New Course And Vision For Optical Networks	18 March 2013
OE Solutions	Successful interworking of Smart SFP™ demonstrated at EANTC	18 March 2013
NeoPhotonics	NeoPhotonics Announces New micro-ITLA for Coherent Networks at 100G and Beyond	18 March 2013
MoSys, Inc.	MoSys Announces 100G Multi-Mode Gearbox PHY for Networking and Communications Line Cards and Modules	18 March 2013
New Ridge Technologies	World's Best Endless Rotating Half-Waveplate	17 March 2013
General Photonics Corp.	General Photonics Introduces 200-Series Instruments at OFC	17 March 2013
NeoPhotonics	NeoPhotonics Announces New Variable Power Intradyne Coherent Receiver for 100G Networks	17 March 2013
OpTek Systems, Inc.	OpTek Systems Partners with Connected Fibers for LaserCleaveTM Distribution	17 March 2013
General Photonics Corp.	General Photonics Introduces New Polarization Synthesizer/Analyzer at OFC	15 March 2013

Menara Networks	Menara Networks Announces Metro 100G DWDM Breakthrough with Tunable DWDM CFP Transceiver with Integrated OTN and FEC Capabilities for Metro and Data Center Interconnection at OFC/NFOEC 2013	15 March 2013
Menara Networks	Menara Networks Awarded Contract to Build New DWDM Network in Iraq	15 March 2013
PhoeniX Software	Aspic 3 available now!	15 March 2013
Emcore Corporation	EMCORE to Host Live Demonstration of its micro-ITLA for 40/100/400 Gigabit Coherent Applications at OFC/NFOEC 2013	14 March 2013
Oclaro, Inc.	Oclaro Launches the Industry's First Commercially- Available Dual-Chip Uncooled Pump Lasers for ROADMs	14 March 2013
Oclaro, Inc.	Oclaro Unveils New Customizable Add/Drop Routing Platform for Next Generation Networks	14 March 2013
Oclaro, Inc.	Oclaro Achieves Key Milestone in Indium Phosphide Tunable Transmitter Development for 100G Coherent CFP2	14 March 2013
TE Connectivity	TE Connectivity Showcases Networking Solutions to Enable Terabit Speeds at OFC/NFOEC 2013	14 March 2013
Yenista Optics	Yenista Optics opens Support Center in China	14 March 2013
Luceo Technologies GmbH	PARALLEX® platform system fulfills all needs for BER component and transceiver	14 March 2013

	testing	
EXFO	EXFO Launches MXS-9100 MEMS Matrix Optical Switch	14 March 2013
M/A COM Technology Solutions, Inc.	M/A-COM Technology Solutions Showcases New Products at OFC/NFOEC Show, 2013	13 March 2013
Pilot Photonics	PILOT PHOTONICS DEMONSTRATES OPTICAL COMB SOLUTION AT OFC/NFOEC 2013	13 March 2013
OneChip Photonics	OneChip Photonics Announces Foundry Relationship with Global Communication Semiconductors (GCS)	13 March 2013
Emcore Corporation	EMCORE Commences Volume Production of micro-ITLA Tunable Laser for 40/100/400 Gigabit Coherent Applications	13 March 2013
AppliedMicro	AppliedMicro Fuels Deployment of 100G OTN and Data Center Networks	13 March 2013
Kaiam Corporation	KAIAM CORPORATION DEMONSTRATES 40KM, 40GB/S QSFP+ TRANSCEIVER WITH INTEGRATED OPTICAL ENGINES AT OFC/NFOEC 2013	12 March 2013
Fibotec Fiberoptics GmbH	dB-Meter	12 March 2013
TE Connectivity	TE Connectivity's NG4access Value-Added Modules (VAMs) to be Unveiled at OFC/NFOEC	12 March 2013
Southern Photonics	Southern Photonics Announces Rebrand	11 March 2013

	as Coherent Solutions Ahead of OFC/NFOEC	
GigaCom Benelux BVBA	GIGACOM Introduces the World's First Semi-Automated Optical Distribution Frame at OFC/NFOEC	7 March 2013
AppliedMicro	AppliedMicro Receives ZTE Supplier of the Year Award for 10 to 100 Gbps Connectivity Solutions	4 March 2013
Yenista Optics	Yenista Optics launches Tunable Lasers from 1240 to 1700 nm	1 March 2013
3SPGroup	EXFO Launches Revolutionary Test Module for 100G Field Deployment	14 February 2013
Luceo Technologies GmbH	Frost & Sullivan Recognizes LUCEO Technologies for its Price Performance Value Leadership in the BERT Market	13 February 2013
OPTOKON/SUNCALL AMERICA	OPTOKON Presents Expanded Hand Held Test and Measurement Instrument Portfolio at OFC/NFOEC 2013, Booth 3309	11 February 2013
NeoPhotonics	NeoPhotonics Boosts 100G Capabilities with Acquisition of LAPIS Semiconductor Optical Components Unit	22 January 2013
JiangSu UNIKIT Optical Technologies Co., Ltd.	Specialist of fiber optic connection	18 January 2013
EXFO	EXFO Adds WDM Investigator to Its FTB-5240S/BP to Reduce Troubleshooting Time and OPEX in DWDM Networks	16 January 2013
Fibercore Limited	Fibercore Announces New Chairman	10 December

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 a number of subjects.

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.

Certificates of Attendance are available for those who complete the online course evaluation you will receive after the course. If you have questions, please contact shortcourses@ofcconference.org with your name and course number.

Short Courses by Topic

Category 1. Optical Network Applications and Services

SC102 WDM in Long-Haul Transmission Systems

Neal S. Bergano; *TE SubCom, USA*

SC171 Introduction to Optical Control Plane Concepts, Technologies and Practices

Greg Bernstein; *Grotto Networking, USA*

SC176 Metro Network: The Transition to Ethernet

Loudon Blair; *Ciena Corp., USA*

Sold Out SC203 100 Gb/s and Beyond Transmission Systems, Design and Design Trade-offs

Benny Mikkelsen[1], Martin Birk[2]; *[1]Acacia Communications, USA, [2]AT&T Labs, USA*

SC243 Next Generation Transport Networks: The Evolution from Circuits to Packets

Ori Gerstel; *Cisco Systems, USA*

New time!

SC261 ROADM Technologies and Network Applications

Thomas Strasser; *Nistica Inc., USA*

SC264 Introduction to Ethernet Technologies

Jeffrey Cox; *Microsoft, USA*

SC327 Modeling and Design of Fiber-Optic Communication Systems

René-Jean Essiambre; *Bell Labs, Alcatel-Lucent, USA*

SC328 New Developments in Optical Transport Networking (OTN)

Stephen Trowbridge; *Alcatel-Lucent, USA*

SC356 40G/100G Ethernet Technologies and Applications

Osamu Ishida; *NTT Electronics, Japan*

SC371 Multi-layer Control Plane Technologies - Managing Hybrid Networks

Lou Berger[1], Wes Doonan[2]; *[1]Labn Consulting, USA, [2]Adva Optical, USA*

New Course! SC386 The Evolution of Network Architecture Towards Cloud-centric Applications

Loukas Paraschis; *Cisco Systems, Inc., USA*

New Course! SC389 Network Optimization

Dominic Schupke; *Nokia Siemens Networks, Germany*

New Course! SC401 Software Defined Networking and OpenFlow

Saurav Das; *Big Switch Networks, USA*

Category 2. Network Technologies and Applications

Sold Out SC101 Hands-on Workshop on Fiber Optic Measurements and Component Testing

Caroline Connolly[1], Chris Heisler[1], Joseph Bos [2], Tony Nicholson[3]; *[1]OptoTest Corp., USA, [2]Luna Technologies, USA, [3]Connected Fibers, USA*

SC176 Metro Network: The Transition to Ethernet

Loudon Blair; *Ciena Corp., USA*

SC185 Hands-on Polishing, Inspection and Testing of Connectors

Jerry Renville[1], Steve Baldo[2], Neal Wagman[3]; *[1]Light Brigade Inc., USA, [2]Seikoh Giken Co. Ltd., USA, [3]Norland Products, USA*

Sold Out SC187 Hands-on Basic Fiber Optics for the Absolute Beginner

Dennis Horwitz; *Micronor Inc., USA*

Sold Out SC203 100 Gb/s and Beyond Transmission Systems, Design and Design Trade-offs

Benny Mikkelsen[1], Martin Birk[2]; *[1]Acacia Communications, USA, [2]AT&T Labs, USA*

SC210 Hands-on Polarization-Related Measurements

Danny Peterson[1], Tasshi Dennis[2], Brian Teipen[3], Christine Tremblay[4]; *[1]Verizon Business, USA, [2]NIST, USA, [3]ADVA Optical Networking, USA, [4]Ecole de Technologie Superieure, Univ. du Quebec, Canada*

SC264 Introduction to Ethernet Technologies

Jeffrey Cox; *Microsoft, USA*

SC266 Quantum Cryptography and Quantum Information

Richard Hughes[1], Thomas Chapuran[2]; *[1]Los Alamos Natl. Lab, USA, [2]Applied Communication Sciences, USA*

SC291 Hands-on Fiber Optics for Engineers Designing for Military, Aerospace, Shipboard and Industrial Harsh Environmental Applications

Dennis Horwitz; *Micronor Inc., USA*

SC312 Parametric Optical Processing and Systems

Stojan Radic; *UCSD, USA*

SC314 Hands-on Fiber Characterization for the Engineering of Long Haul and Metro Deployments

Daniel Peterson[1], Christine Tremblay[2]; *[1]Verizon, USA, [2]École de technologie supérieure, Université. du Québec, Canada*

SC347 Reliability and Qualification of Fiber-Optic Components

David Maack; *Corning, USA*

SC360 Hands-On Fiber Optic Terminations and Measurements with Emphasis on MTP Connectorized Ribbon Fiber

Caroline Connolly[1], Chris Heisler[1], Loïc Cherel[2], Mike Hughes[3], Tom Mitcheltree[3], Jim Frazer[4], Jill Christie[4]; [1]OptoTest Corp., USA, [2]Data-Pixel SAS, France, [3]USConec Ltd., USA, [4]Domaille Engineering, USA

SC384 Background Concepts of Optical Communication Systems

Alan Willner; *Univ. of Southern California, USA*

New Course! SC387 Network Securities

David Dumas; *Verizon Communications, Inc., USA*

New Course! SC388 Wireless Backhaul

Stu Benington; *Tellabs, Inc, USA*

New Course! SC401 Software Defined Networking and OpenFlow

Saurav Das; *Big Switch Networks, USA*

Category 3. FTTx Technologies, Deployment, and Applications

Sold Out SC101 Hands-on Workshop on Fiber Optic Measurements and Component Testing

Caroline Connolly[1], Chris Heisler[1], Joseph Bos [2], Tony Nicholson[3]; *[1]OptoTest Corp., USA, [2]Luna Technologies, USA, [3]Connected Fibers, USA*

SC114 Passive Optical Networks (PONs) Technologies

Frank J. Effenberger*; Futurewei Technologies, USA*

Sold Out SC187 Hands-on Basic Fiber Optics for the Absolute Beginner

Dennis Horwitz; *Micronor Inc., USA*

SC243 Next Generation Transport Networks: The Evolution from Circuits to Packets

Ori Gerstel; *Cisco Systems, USA*

New time!

SC264 Introduction to Ethernet Technologies

Jeffrey Cox; *Microsoft, USA*

SC267 Silicon Microphotonics: Technology Elements and the Roadmap to Implementation

Lionel Kimerling; *MIT, USA*

SC347 Reliability and Qualification of Fiber-Optic Components

David Maack; *Corning, USA*

Category 5. Fibers and Optical Propagation Effect

SC208 Optical Fiber Design for Telecommunications and Specialty Applications

David J. DiGiovanni; *OFS Labs, USA*

SC210 Hands-on Polarization-Related Measurements

Danny Peterson[1], Tasshi Dennis[2], Brian Teipen[3], Christine Tremblay[4]; *[1]Verizon Business, USA, [2]NIST, USA, [3]ADVA Optical Networking, USA, [4]Ecole de Technologie Superieure, Univ. du Quebec, Canada*

SC288 Fundamentals of Polarization, PDL, and PMD

Nick Frigo; *US Naval Academy, USA*

SC289 Basics of Optical Communication Systems and WDM

Gerd Keiser; *PhotonicsComm Solutions Inc., USA*

SC360 Hands-On Fiber Optic Terminations and Measurements with Emphasis on MTP Connectorized Ribbon Fiber

Caroline Connolly[1], Chris Heisler[1], Loïc Cherel[2], Mike Hughes[3], Tom Mitcheltree[3], Jim Frazer[4], Jill Christie[4]; [1]OptoTest Corp., USA, [2]Data-Pixel SAS, France, [3]USConec Ltd., USA, [4]Domaille Engineering, USA

SC373 Specialty Fiber Splicing and Interconnection

Andrew Yablon; *Interfiber Analysis, USA*

Category 6. Fiber and Waveguide-Based Devices: Amplifiers, Lasers, Sensors, and Performance Monitors

SC208 Optical Fiber Design for Telecommunications and Specialty Applications

David J. DiGiovanni; *OFS Labs, USA*

SC267 Silicon Microphotonics: Technology Elements and the Roadmap to Implementation

Lionel Kimerling; *MIT, USA*

SC384 Background Concepts of Optical Communication Systems

Alan Willner; *Univ. of Southern California, USA*

Category 7. Optical Devices for Switching, Filtering, and Interconnects

SC265 Passive Optical Components and Filtering Technologies

Bruce Nyman[1], Christi Madsen[2]; *[1]TE SubCom, USA, [2]Texas A&M Univ., USA*

SC384 Background Concepts of Optical Communication Systems

Alan Willner; *Univ. of Southern California, USA*

Category 8. Optoelectronic Devices

SC177 High-Speed Semiconductor Lasers and Modulators

John Bowers; *Univ. of California at Santa Barbara, USA*

SC182 Biomedical Optical Diagnostics and Sensing

Thomas Huser*; Univ. of Bielefeld, Germany, Univ. of California at Davis, USA*

SC289 Basics of Optical Communication Systems and WDM

Gerd Keiser; *PhotonicsComm Solutions Inc., USA*

SC325 Highly Integrated Monolithic Photonic Integrated Circuits

Chris Doerr; *Acacia Communications, USA*

Category 9. Digital Transmission Systems

SC102 WDM in Long-Haul Transmission Systems

Neal S. Bergano; *TE SubCom, USA*

Sold Out SC203 100 Gb/s and Beyond Transmission Systems, Design and Design Trade-offs

Benny Mikkelsen[1], Martin Birk[2]; *[1]Acacia Communications, USA, [2]AT&T Labs, USA*

SC289 Basics of Optical Communication Systems and WDM

Gerd Keiser; *PhotonicsComm Solutions Inc., USA*

SC314 Hands-on Fiber Characterization for the Engineering of Long Haul and Metro Deployments

Daniel Peterson[1], Christine Tremblay[2]; *[1]Verizon, USA, [2]École de technologie supérieure, Université. du Québec, Canada*

SC327 Modeling and Design of Fiber-Optic Communication Systems

René-Jean Essiambre; *Bell Labs, Alcatel-Lucent, USA*

SC369 Test and Measurement of Complex Modulated Optical Signals

Bernd Nebendahl, Oliver Funke; *Agilent Technologies, Germany*

SC372 Energy-Efficiency Networking

Rod S. Tucker, Kerry Hinton; *Univ. Melbourne, Australia*

SC384 Background Concepts of Optical Communication Systems

Alan Willner; *Univ. of Southern California, USA*

New Course! SC390 Introduction to Forward Error Correction

Frank Kschischang; *University of Toronto, Canada*

Companion to SC391

New Course! SC391 FEC Technology and Applications in Optical Communications

Takashi Mizuochi, Yoshikuni Miyata; *Mitsubishi Electric Corporation, Japan*

Companion to SC390

Sold Out New Course! SC392 Coherent Optical Systems 1

Maurice O'Sullivan; Ciena, Canada

Companion to SC393

Sold Out **New Course! SC393 Coherent Optical Systems 2**

Maurice O'Sullivan; *Ciena, Canada*

Companion to SC392

Category 10. Transmission Subsystems and Network Elements

Sold Out **SC101 Hands-on Workshop on Fiber Optic Measurements and Component Testing**

Caroline Connolly[1], Chris Heisler[1], Joseph Bos [2], Tony Nicholson[3]; *[1]OptoTest Corp., USA, [2]Luna Technologies, USA, [3]Connected Fibers, USA*

SC105 Modulation Formats and Receiver Concepts for Optical Transmission Systems

Peter Winzer, Chandrasekhar Sethumadhavan, Xiang Liu; *Bell Labs, Alcatel-Lucent, USA*

SC205 Integrated Electronic Circuits and Signal Processing for Fiber Optics

Y. K. Chens, Noriaki Kaneda; *Bell Labs, Alcatel Lucent, USA*

SC239 Short-Reach Optical Interconnects

Steve Joiner; *Finisar, USA*

SC259 Electronic and Optical Impairment Mitigation

Chris Fludger[1], Seb Savory[2]; [1]CoreOptics GmbH, Germany, [2]Univ. College London, United Kingdom

SC289 Basics of Optical Communication Systems and WDM

Gerd Keiser; *PhotonicsComm Solutions Inc., USA*

SC341 OFDM for Optical Communications

Sander L. Jansen[1], Dirk van den Borne[2]; *[1]ADVA Optical Networking, USA [2]Juniper Networks, Germany*

SC360 Hands-On Fiber Optic Terminations and Measurements with Emphasis on MTP Connectorized Ribbon Fiber

Caroline Connolly[1], Chris Heisler[1], Loïc Cherel[2], Mike Hughes[3], Tom Mitcheltree[3], Jim Frazer[4], Jill Christie[4]; [1]OptoTest Corp., USA, [2]Data-Pixel SAS, France, [3]USConec Ltd., USA, [4]Domaille Engineering, USA

SC384 **Background Concepts of Optical Communication Systems**

Alan Willner; *Univ. of Southern California, USA*

New Course! SC395 Hands On: Basic Modeling and Design of Coherent Fiber-Optic Communication Systems

Erich Gottwald, Harald Rohde; *Nokia Siemens Networks, Germany*

All attendees must bring their own laptop, with Matlab installed, in order to participate in this course.

Category 11. Optical Processing and Analog Subsystems

SC160 Microwave Photonics

Keith Williams; *Naval Research Lab, USA*

SC217 Hybrid Fiber Radio: The Application of Photonic Links in Wireless Communications

Dalma Novak; *Pharad, LLC, USA*

SC384 Background Concepts of Optical Communication Systems

Alan Willner; *Univ. of Southern California, USA*

Category 12. Core Networks

SC171 Introduction to Optical Control Plane Concepts, Technologies and Practices

Greg Bernstein; *Grotto Networking, USA*

SC216 An Introduction to Optical Network Design and Planning

Jane M. Simmons; *Monarch Network Architects, USA*

SC243 Next Generation Transport Networks: The Evolution from Circuits to Packets

Ori Gerstel; *Cisco Systems, USA*

New time!

SC261 ROADM Technologies and Network Applications

Thomas Strasser; *Nistica Inc., USA*

SC264 Introduction to Ethernet Technologies

Jeffrey Cox; *Microsoft, USA*

SC327 Modeling and Design of Fiber-Optic Communication Systems

René-Jean Essiambre; *Bell Labs, Alcatel-Lucent, USA*

SC328 New Developments in Optical Transport Networking (OTN)

Stephen Trowbridge; *Alcatel-Lucent, USA*

SC372 Energy-Efficiency Networking

Rod S. Tucker, Kerry Hinton; *Univ. Melbourne, Australia*

SC384 Background Concepts of Optical Communication Systems

Alan Willner; *Univ. of Southern California, USA*

New Course! SC386 The Evolution of Network Architecture Towards Cloud-centric Applications

Loukas Paraschis; *Cisco Systems, Inc., USA*

New Course! SC389 Network Optimization

Dominic Schupke; *Nokia Siemens Networks, Germany*

New Course! SC401 Software Defined Networking and OpenFlow

Saurav Das; *Big Switch Networks, USA*

Category 13. Access Networks

SC114 Passive Optical Networks (PONs) Technologies

Frank J. Effenberger*; Futurewei Technologies, USA*

SC217 Hybrid Fiber Radio: The Application of Photonic Links in Wireless Communications

Dalma Novak; *Pharad, LLC, USA*

SC264 Introduction to Ethernet Technologies

Jeffrey Cox; *Microsoft, USA*

SC267 Silicon Microphotonics: Technology Elements and the Roadmap to Implementation

Lionel Kimerling; *MIT, USA*

SC372 Energy-Efficiency Networking

Rod S. Tucker, Kerry Hinton; *Univ. Melbourne, Australia*

SC384 Background Concepts of Optical Communication Systems

Alan Willner; *Univ. of Southern California, USA*

New Course! SC387 Network Securities

David Dumas; *Verizon Communications, Inc., USA*

Category 14. Optical Interconnection Networks for Datacom and Computercom

Sold Out SC187 Hands-on Basic Fiber Optics for the Absolute Beginner

Dennis Horwitz; *Micronor Inc., USA*

SC267 Silicon Microphotonics: Technology Elements and the Roadmap to Implementation

Lionel Kimerling; *MIT, USA*

SC291 Hands-on Fiber Optics for Engineers Designing for Military, Aerospace, Shipboard and Industrial Harsh Environmental Applications

Dennis Horwitz; *Micronor Inc., USA*

SC356 40G/100G Ethernet Technologies and Applications

Osamu Ishida; *NTT Electronics, Japan*

SC357 Computercom Interconnects: Circuits and Equalization Methods for Short Reach Power-Efficient Optical and Electrical Links

Alexander Rylyakov; *IBM T.J. Watson Research Center, USA*

SC358 Data Center Cabling: Transitioning from Copper to Fiber

Lisa Huff; *DataCenterStocks.com, USA, Discerning Analytics, LLC, USA*

SC359 Datacenter Networking 101

Cedric Lam, Hong Liu; *Google, USA*

SC371 Multi-layer Control Plane Technologies - Managing Hybrid Networks

Lou Berger[1], Wes Doonan[2]; *[1]Labn Consulting, USA, [2]Adva Optical, USA*

SC374 Cloud Computing and Dynamic Networks

George H. Clapp[1], Douglas M. Freimuth[2]; *[1]AT&T Labs, USA, [2]IBM Research, USA*

SC384 Background Concepts of Optical Communication Systems

Alan Willner; *Univ. of Southern California, USA*

New Course! SC385 Fundamentals of Super Computing

Kamesh Madduri; *Pennsylvania State Univ., USA*

New Course! SC386 The Evolution of Network Architecture Towards Cloud-centric Applications

Loukas Paraschis; *Cisco Systems, Inc., USA*

New Course! SC401 Software Defined Networking and OpenFlow

Saurav Das; *Big Switch Networks, USA*

Short Courses by Time

Sunday, 17 March

Time	Code	Title
9:00 - 12:00	**SC171**	**Introduction to Optical Control Plane Concepts, Technologies and Practices**
9:00 - 12:00	**SC177**	**High-Speed Semiconductor Lasers and Modulators**
9:00 - 12:00	**SC265**	**Passive Optical Components and Filtering Technologies**
9:00 - 12:00	**SC289**	**Basics of Optical Communication Systems and WDM**

9:00 - 12:00	**SC328**	**New Developments in Optical Transport Networking (OTN)**
9:00 - 12:00	**SC359**	**Datacenter Networking 101**
9:00 - 12:00	**SC384**	**Background Concepts of Optical Communication Systems**
9:00 - 12:00	**SC401**	**New Course! Software Defined Networking and OpenFlow**
9:00 - 13:00	**SC105**	**Modulation Formats and Receiver Concepts for Optical Transmission Systems**
9:00 - 13:00	**SC182**	**Biomedical Optical Diagnostics and Sensing**
9:00 - 13:00	**SC288**	**Fundamentals of Polarization, PDL, and PMD**
9:00 - 13:00	**SC325**	**Highly Integrated Monolithic Photonic Integrated Circuits**
9:00 - 16:30	**SC264**	**Introduction to Ethernet Technologies**
13:00 - 16:00	**SC114**	**Passive Optical Networks (PONs) Technologies**
13:00 - 16:00	**SC203**	**Sold Out *100 Gb/s and Beyond Transmission Systems, Design and Design Trade-offs***
13:00 - 16:00	**SC216**	**An Introduction to Optical Network Design and Planning**
13:00 - 16:00	**SC243**	**Next Generation Transport Networks: The Evolution from Circuits to Packets**

New time!

13:00 - 16:00	**SC358**	**Data Center Cabling: Transitioning from Copper to Fiber**
13:00 - 16:00	**SC371**	**Multi-layer Control Plane Technologies - Managing Hybrid Networks**
13:00 - 16:00	**SC385**	**New Course! Fundamentals of Super Computing**
13:00 - 16:00	**SC386**	**New Course! The Evolution of Network Architecture Towards Cloud-centric Applications**
17:00 - 20:00	**SC205**	**Integrated Electronic Circuits and Signal Processing for Fiber Optics**
17:00 - 20:00	**SC217**	**Hybrid Fiber Radio: The Application of Photonic Links in Wireless Communications**
17:00 - 20:00	**SC243***	**Next Generation Transport Networks: The Evolution from Circuits to Packets (See note about new time below)** **THIS COURSE HAS BEEN MOVED TO A NEW TIME: SUNDAY, 17 MARCH 2013 FROM 13:00-16:00.*
17:00 - 20:00	**SC259**	***Electronic and Optical Impairment Mitigation***
17:00 - 20:00	**SC267**	***Silicon Microphotonics: Technology Elements and the Roadmap to Implementation***
17:00 - 20:00	**SC341**	***OFDM for Optical Communications***
17:00 - 20:00	**SC372**	***Energy-Efficiency Networking***

17:00 - 20:00	**SC387**	***New Course! Network Securities***
17:00 - 20:00	**SC388**	***New Course! Wireless Backhaul***
17:00 - 20:00	**SC389**	***New Course! Network Optimization***

Monday, 18 March

Time	Code	Title
8:30 - 12:30	**SC101**	**Sold Out Hands-on Workshop on Fiber Optic Measurements and Component Testing**
8:30 - 12:30	**SC102**	**WDM in Long-Haul Transmission Systems**
8:30 - 12:30	**SC210**	**Hands-on Polarization-Related Measurements**
8:30 - 12:30	**SC239**	**Short-Reach Optical Interconnects**
8:30 - 12:30	**SC347**	**Reliability and Qualification of Fiber-Optic Components**
9:00 - 12:00	**SC176**	**Metro Network: The Transition to Ethernet**
9:00 - 12:00	**SC208**	**Optical Fiber Design for Telecommunications and Specialty Applications**
9:00 - 12:00	**SC356**	**40G/100G Ethernet Technologies and Applications**
9:00 - 12:00	**SC357**	**Computercom Interconnects: Circuits and Equalization Methods for Short Reach Power-**

		Efficient Optical and Electrical Links
9:00 - 12:00	**SC390**	**New Course! Introduction to Forward Error Correction** *Companion to SC391*
9:00 - 12:00	**SC392**	**Sold OutNew Course! Coherent Optical Systems 1** *Companion to SC393*
13:00 - 17:30	**SC187**	**Sold Out Hands-on Basic Fiber Optics for the Absolute Beginner**
13:30 - 16:30	**SC261**	**ROADM Technologies and Network Applications**
13:30 - 16:30	**SC312**	**Parametric Optical Processing and Systems**
13:30 - 16:30	**SC327**	**Modeling and Design of Fiber-Optic Communication Systems**
13:30 - 16:30	**SC369**	**Test and Measurement of Complex Modulated Optical Signals**
13:30 - 16:30	**SC373**	**Specialty Fiber Splicing and Interconnection**
13:30 - 16:30	**SC391**	**New Course! FEC Technology and Applications in Optical Communications** *Companion to SC390*
13:30 - 16:30	**SC393**	**Sold Out New Course! Coherent Optical Systems 2** *Companion to SC392*
13:30 - 17:30	**SC160**	**Microwave Photonics**

13:30 - 17:30	**SC185**	**Hands-on Polishing, Inspection and Testing of Connectors**
13:30 - 17:30	**SC360**	**Hands-On Fiber Optic Terminations and Measurements with Emphasis on MTP Connectorized Ribbon Fiber**

Tuesday, 19 March

Time	Code	Title
8:00 - 12:00	**SC314**	**Hands-on Fiber Characterization for the Engineering of Long Haul and Metro Deployments**
8:00 - 12:00	**SC395**	**New Course! Hands On: Basic Modeling and Design of Coherent Fiber-Optic Communication Systems** *All attendees must bring their own laptop, with Matlab installed, in order to participate in this course.*
8:00 - 12:30	**SC291**	**Hands-on Fiber Optics for Engineers Designing for Military, Aerospace, Shipboard and Industrial Harsh Environmental Applications**
9:00 - 12:00	**SC266**	**Quantum Cryptography and Quantum Information**
9:00 - 12:00	**SC374**	**Cloud Computing and Dynamic Networks**

Short Course Descriptions

SC101 Hands-on Workshop on Fiber Optic Measurements and Component Testing

Monday, 18 March 2013

8:30 - 12:30

Instructor: Caroline Connolly[1], Chris Heisler[1], Joseph Bos [2], Tony Nicholson[3]; *[1]OptoTest Corp., USA, [2]Luna Technologies, USA, [3]Connected Fibers, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

This Short Course focuses on the practical aspects of working with fiber optic components and instrumentation used to make optical performance characterization measurements. Four fully equipped stations are available for hands-on participation.

Rotation 1) Basic Component Testing—test and measurement techniques and latest issues involving single-mode and multimode fiber, cable and connectors including insertion loss, return loss, and visual fault location.

Rotation 2) Launch condition effects on multimode fibers. Launch conditions will be demonstrated and measured via near field, far field, and encircled flux methods. Includes demonstration and hands-on measurements with launch condition analyzer.

Rotation 3) Optical Time Domain Reflectometer (OTDR) and Fiber Link Characterization—understanding the measurements involved in characterizing a fiber link for high speed communications. Includes a demonstration of an OTDR for testing and troubleshooting of networks. By analyzing the backscatter and link length, attenuation and reflections can be analyzed. Anomalies such as connectors, splices, and breaks can be evaluated. As speeds increase, measurements such as Chromatic and Polarization-Mode Dispersion become necessary.

Rotation 4) Component test and characterization measurements such as CD, PMD, GD, Jones-Matrix Eigenvectors will be measured. Test instruments such as the optical vector analyzer, tunable lasers, and optical power meters are used to measure PDL using the All-States-Method and the Mueller-Stokes-Method. Experiments will help participants visualize polarization-dependent behaviors of fiber optic components.

Industry trends will be related in each rotation such as encircled flux requirements, high density connectivity, phase related measurements important to the design and manufacture of optical components.

Benefits:

This course should enable you to:

- Explain the fundamental optical differences and applications of single-mode fiber (SMF) vs. multimode fiber (MMF), including the different fiber types and fiber sizes.
- Identify the different connector types and understand their specific performance features (i.e., E2000, FC, LC, Mil-Styles, MTP, SC, ST, etc.) plus the various end-face options (i.e. Expanded Beam, UPC and APC).
- Test connectors, cable assemblies, and fiber links for insertion loss (IL) and return loss (RL), while also understanding how these measurements can be affected by wavelength and launch conditions.
- Explain characterization measurements on passive optical components.
- Measure spectral performance attributes using an optical vector analyzer (OVA).
- Measure polarization-dependent loss (PDL) and polarization mode dispersion (PMD) of fiber optic components.
- Test and troubleshoot fiber links and component assemblies using OTDR techniques.
- Measure and understand performance parameters of passive optical network components.

Audience:

This course is valuable to technicians, engineers, and managers interested in measurement and characterization of fiber optic components. Some familiarity with fiber optic test cables and equipment is assumed. Class size is limited to 16.

Instructor Biography:

 Caroline Connolly is a Sales Director at OptoTest Corp. and has been involved with fiber optic test and measurements technologies and cable assemblies for more than 12 years. Her experience covers all areas of physical layer optical testing ranging from laboratory to field applications. Before joining OptoTest, she worked in various key sales positions at Rifocs Corp. Connolly holds a bachelor's degree in business management from the University of Phoenix.

Chris Heisler has been in the fiber optics industry for over 4 years. For this duration he has worked at OptoTest Corp. as an Applications and Test Engineer where he has studied and researched fiber optic cable measurements with a focus on launch condition measurements and the various standards governing these measurements. Chris attended California Polytechnics San Luis Obispo where he received a B.S. in electrical engineering and is currently pursuing his master's degree.

Joe Bos is Lead Optical Engineer, Luna Technologies and has been with Luna Innovations since 2008. During his time at Luna, he has contributed to various aspects of Luna's optical test and measurement and fiber sensing instruments including research, development, manufacturing test, and customer support. Joe earned his B.S. in physics from Western Michigan University in 2006 and his M.S. in optics from the Institute of Optics at the University of Rochester in 2008. Prior to joining Luna, Joe's research endeavors included thin film coatings, tunable pulsed dye lasers, PIN photodiode characterization and nuclear mass spectrometry.

 Tony Nicholson is currently the Director of Technology at Connected Fibers, a company focused on selling manufacturing and test equipment, components, consumables, and tools for optical cable assembly fabrication. Since 1984, Mr. Nicholson has worked in various positions for companies manufacturing and developing test equipment primarily for the fiber optic industry. For the last 16 years he has been involved in the manufacture, sales, and support of interferometers for the fiber optic connector market and was on the technical advisory panel for the TIA during the draft of the first FOTP for measuring fiber optic connectors.

SC102 WDM in Long-Haul Transmission Systems

Monday, 18 March 2013
8:30 - 12:30

Instructor: Neal S. Bergano; *TE SubCom, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
Wavelength division multiplexing (WDM) technology used in long-haul transmission systems has steadily progressed over the past few years. Newly installed state-of-the-art transoceanic systems now have terabit/s maximum capacity, while being flexible enough to have an initial deployed capacity at a fraction of the maximum. The steady capacity growth of these long-haul fiber-optic cable systems has resulted from many improvements in WDM transmission techniques and an increased understanding of WDM optical propagation. Important strides have been made in areas of new single-mode fibers, gain equalization, modulation formats, error correcting codes and coherent transponders that have made possible the demonstration of multi-terrabit capacities over transoceanic distances in laboratory experiments. Next-generation systems and future upgrades of existing systems will benefit from these new concepts emerging from system research.

This course will review the important issues regarding the use of WDM in long-haul transmission systems. Included will be an introduction to long-haul undersea transmission systems, the amplified transmission line, dispersion/nonlinear management, transmission formats, measures of system performance, forward error correction, the importance of polarization effects, experimental techniques and results, a transmission line design example and future trends including coherent transponders.

Benefits:
This course should enable you to:

Explain the tradeoffs made in the design of an amplifier chain.

Summarize the tradeoffs made in the selection of dispersion maps.

Identify the methods used to measure system performance, such as Q-factor.

Identify the important polarization effects in long-haul transmission systems.

Compare the different methods of performing long-haul transmission experiments.

Discuss circulating loop experiments.

Discuss the future trends in long-haul transmission systems.

Gain insight into the optical propagation of data signals over long distances.

Audience:
This course is intended for the student who wants an understanding of how information is transmitted over long distances using fiber optic transmission lines. This includes new entrants into the fiber optic field with an engineering background, engineers with fiber optics exposure, people in the fiber optic telecommunications industry, and fiber optic research and development management.

Instructor Biography:

Neal S. Bergano received the B.S. degree in electrical engineering from the Polytechnic Institute of New York, New York, and the M.S. degree in electrical engineering and computer science from the Massachusetts Institute of Technology, Cambridge, in 1981 and 1983, respectively. In 1981, he joined the technical staff of Bell Labs' undersea systems division. In 1992, he was named a Distinguished Member of the Technical Staff of AT&T Bell Labs, where he became an AT&T Technology Consultant in 1996 and AT&T Technology Leader in 1997. He is currently the Managing Director of the System Research and Network Development, TE Subsea Communications LLC, Eatontown, NJ. He holds 31 U.S. patents in the area of optical fiber transmission systems. His main research has been devoted to the understanding of how to improve the performance and transmission capacity of long-haul optical fiber systems, including the use of wavelength division multiplexing in optical-amplifier-based systems.

Mr. Bergano is a Fellow of the IEEE, the OSA, AT&T, and TE Connectivity. He served on the Board of Directors for the OSA from 2009 to 2011, and served on the Board of Governors for the IEEE Lasers and Electro-Optics Society from 1999 to 2001. He is a long-time volunteer and supporter of the OFC/NFOEC meeting, which includes General Chair and Technical Chair in 1999 and 1997, Chair of the steering committee from 2000 to 2002, and is currently the Chair of OFC/NFOEC's long-range planning committee. He is the recipient of the 2002 John Tyndall Award, for outstanding technical contributions to and technical leadership in the advancement of global undersea fiber-optic communication systems.

SC105 Modulation Formats and Receiver Concepts for Optical Transmission Systems

Sunday, 17 March 2013

9:00 - 13:00

Instructor: Peter Winzer, Chandrasekhar Sethumadhavan, Xiang Liu; *Bell Labs, Alcatel-Lucent, USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

The ever-increasing traffic demands in carrier networks, driven by emerging data-centric services and applications, have led to intense research and development in the area of high-capacity (several 10 Tbit/s), high-speed (beyond 100 Gb/s per wavelength) optical transport networks. In order to enable such high capacities and speeds over appreciable transmission distances (>1000 km), spectrally efficient yet impairment-tolerant transmission technologies have moved into the focus of optical communications research and have led to considerable innovation in modulation and detection strategies. This course gives an overview of modulation formats and multiplexing techniques for optical networking applications, both from a conceptually fundamental and from a state-of-the-art technological point of view. The discussed modulation formats include intensity modulation, phase modulation, and quadrature amplitude modulation; multiplexing techniques include wavelength division multiplexing, polarization multiplexing, subcarrier multiplexing, and orthogonal frequency division multiplexing (OFDM), and also introduce spatial multiplexing as the next research frontier, heavily discussed at the conference. The course covers optical receiver design and optimization principles, both for direct-detection and coherent (intradyne) receivers, including a discussion of the underlying digital electronic signal processing and coding techniques. Finally, the course highlights the interplay of modulation format, receiver design, and the wide variety of transmission impairments found in optically routed long-haul networks and points to latest research trends in optical modulation and multiplexing.

Benefits:

This course should enable you to:

- Identify key objectives of high-capacity and high-speed optically routed network design.
- Describe the basic concepts behind all kinds of optical modulation and multiplexing techniques.
- Generate advanced optical modulation formats using state-of-the-art opto-electronic components.
- Explain the concepts behind optical receiver design, including direct and coherent detection as well as related digital signal processing techniques. Recognize the interplay between modulation format, receiver design, and transmission impairments.
- Get an insight into future trends in research and product commercialization of advanced modulation and multiplexing techniques and receiver concepts.

Audience:

This advanced-beginner course is intended for a diverse audience including lightwave system researchers

and engineers as well as opto-electronic subsystem designers. Some basic knowledge of optical modulation and detection technologies will help in better understanding the course but is not a prerequisite. Past attendees will find substantial updates to this course, which we continuously adapt to reflect the latest trends in research as well as in product development, and may hence find it useful to attend again.

Instructor Biography:

 Peter J. Winzer received his doctorate in electrical engineering/communications engineering from the Vienna University of Technology, Vienna, Austria, in 1998. His academic work, largely supported by the European Space Agency (ESA), was related to the analysis and modeling of space-borne Doppler wind lidar and highly sensitive free-space optical communication systems. [no new paragraph. – Please delete preceding empty line and make everything one paragraph.] In this context, he specialized in optical modulation formats and high-sensitivity receivers using coherent and direct detection. He continued to pursue this field of research after joining Bell Labs in 2000, where he focused on Raman amplification, optical modulation formats, advanced receiver concepts, as well as digital signal processing and multiplexing techniques for high-speed fiber-optic communication systems. Dr. Winzer is a Fellow of the OSA and of the IEEE.

 Sethumadhavan Chandrasekhar received a doctorate in physics from the University of Bombay, Bombay, India, in 1985. He joined Bell Labs, Lucent Technologies (formerly AT&T Bell Labs), Holmdel, New Jersey, in 1986. He has worked on III-V compound semiconductor devices such as photodetectors, heterojunction phototransistors, bipolar transitors (HBTs) and high-speed optoelectronic integrated circuits (OEICs), advanced receive-side digital signal processing, novel modulation formats, and high-speed DWDM optical networking systems. His current interests include coherent optical orthogonal frequency division multiplexed systems for high spectral efficiency transport and networking beyond 100Gb/s, multi-carrier superchannels, and software-defined transponders for efficient end-to-end optical networking. He is a Fellow of the IEEE and of the OSA.

 Xiang Liu is a Distinguished Member of Technical Staff at Bell Labs, Alcatel-Lucent. He received

his Ph.D. degree in applied physics from Cornell University. Since joining Bell Labs in 2000, Xiang has been primarily working on high-speed optical communication technologies including advanced modulation formats, coherent detection schemes, and fiber nonlinearity mitigation. Dr. Liu has authored/coauthored more than 200 journal and conference papers, and holds over 35 US patents. He is a Fellow of the OSA and an Associated Editor of Optics Express.

SC114 Passive Optical Networks (PONs) Technologies

Sunday, 17 March 2013
13:00 - 16:00

Instructor: Frank J. Effenberger*; Futurewei Technologies, USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
PON systems have become the preeminent technology for broadband optical access networks. Over 50 million lines of PON-based access have been deployed around the world. However, there are multiple network types deployed today, and proposals for future systems are even more diverse. For this reason, it is important to understand the architectures and technologies that are used in PON, including their unique capabilities and trade-offs.

At the highest level, this short course reviews the major architectural variants of PON systems, including TDMA, WDMA, OFDMA, and hybrids of these. The commercially important implementations of these technologies will also be described, and their major application areas (FTTHome, FTTbuilding, etc.) will be described. The status of commercial deployments and interoperability of the equipment will be reviewed.

Additionally, the economic drivers for the entire PON value chain will be reviewed, including the factors that triggered deployments of the past, and what may cause evolutionary steps to the next generation. The incorporation of the PON technology into the larger broadband network will also be covered, including the larger network architecture, management, and regulatory framework.

Benefits:
This course should enable you to:

- Understand and discuss the capabilities and advantages of different PON technologies.

- Be able to describe the practical limitations of real-world G-PON and EPON systems for broadband access.
- To know the motivations behind the Full-Service-Access-Network initiative and the related IEEE P802.3 and P1904 projects.
- Understand the commercial issues surrounding fiber access, and how PON works to address these.
- Have an overview of the possible future evolution paths that PON technology may take.

Audience:

This course is intended for engineers, network planners and product designers involved with broadband access and a need to understand passive optical networks.

Instructor Biography:

After completing his doctoral work in 1995, Dr. Effenberger took a position with Bellcore (now Telcordia) where he analyzed all types of access network technologies, focusing on those that employed passive optical networks. He witnessed the early development of the FSAN initiative and the development of the APON standard. In 2000, he moved to Quantum Bridge Communications (now a part of Motorola), where he managed system engineering in their PON division. This work supported the development and standardization of advanced optical access systems based on B-PON and G-PON technologies. In 2006, he became director of FTTx in the advanced technology department of Futurewei Technologies. He remains heavily involved in the standards work, and is a leading contributor to the major PON standards in the ITU. He is now the rapporteur of Q2/15, which is the group charged with standardization of all optical access systems. In 2011, Frank was named to be one of the first Huawei Fellows, and was promoted to be Vice president of access networks research in Futurewei.

SC160 Microwave Photonics

Monday, 18 March 2013

13:30 - 17:30

Instructor: Keith Williams; *Naval Research Lab, USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

There has been significant progress in photonic components and technology applicable to microwave (analog) systems; several unique microwave functions have been implemented in the photonic domain. Along with or because of these technical advancements, there has been a slow, but expanding acceptance of photonics for microwave systems. This updated/revised Short Course will review some of the current capabilities and limitations of photonics as divided into four areas. They are: techniques and devices for generating microwave-modulated light, techniques and devices for detection, RF transmission links (distinguished from digital transmission systems), and microwave signal processing (including time-delay beamforming, downconverting, filtering and photonic analog-to-digital conversion). Emphasis will be placed on relating device operation to basic photonic subsystem performance and relating the photonic link and functions to comparable microwave techniques (e.g., link loss, noise figure, dynamic range and phase error). More recent technology advancements will also be incorporated.

Benefits:

This course should enable you to:

- Explain limitations of photonics and photonic devices for microwave systems.
- Identify promising technologies for analog system improvements.
- Discuss and relate analog and digital fiber optic system differences.
- Design optical systems for microwave applications.
- Identify and compare RF systems which may benefit from utilizing RF Photonics.

Audience:

The course attendee should have a basic understanding of lasers, photodetectors, and fiber optics. A bachelor's degree in engineering or the physical sciences or an equivalent level of experience would be necessary to understand the system design and application-need aspects of the course.

Instructor Biography:

Keith J. Williams received his B.S.E.E. degree from the University of Nebraska and the M.S. and Ph.D. degrees from the University of Maryland. His doctoral research was conducted on microwave p-i-n photodetector nonlinearities. Since 2000, he has been the head of the Photonics Technology Branch of the Naval Research Lab, Washington, D.C., where his research interests include microwave-optical devices, microwave fiber-optic links and systems and high current photodiodes.

SC171 Introduction to Optical Control Plane Concepts, Technologies and Practices

Sunday, 17 March 2013
9:00 - 12:00

Instructor: Greg Bernstein; *Grotto Networking, USA*
Level: Beginner (no background or minimal training is necessary to understand course material)
Description:
The optical control plane is a suite of distributed processing capabilities that allow optical networks to react faster to changing demands and changes in network equipment availability. In addition, the optical control plane automates previously manual tasks reducing errors and making network resource status more readily available for provisioning and planning purposes.

This course introduces optical control plane concepts, technologies, and practices. Three key factors have pushed the deployment of control plane technologies into optical transport networks. First, optical transport networks have grown in capacity (DWDM) and number of elements deployed. Second, to remain competitive carriers need to dynamically allocate expensive or limited optical resources to their customers in a timely manner. Third, element management systems from different equipment vendors tend not to interoperate. These factors and others have led to the emergence of the optical control plane and its deployment in carrier's network as a key supplement to existing management systems.

Key concepts in the optical control plane to be covered include: neighbor discovery, link verification, rapid provisioning, dissemination of reachability information, dissemination of topology and resource status information, and path computation.

We will review the key standards for the optical control plane from the IETF, ITU, and the OIF. Included in this course are the latest emerging standards on wavelength switched optical networks (WSONs) being developed at the IETF. Examples from both TDM-based optical networks and transparent optical networks consisting of ROADMs will be given. Deployment options and additional restoration (beyond linear and ring) functionality will also be discussed.

Benefits:

This course should enable you to:

- Compare and contrast the use of these new control plane based standards with Element Management System (EMS) based approaches.
- List the key organizations involved in determining optical control plane standards or agreements and their relationships.
- Describe the differences and similarities in the control of TDM and transparent optical networks.
- Describe the protocols used in the optical control plane in terms of their heritage and functionality.
- Describe the purpose of neighbor discovery and its relation to network inventory.
- Explain the use of link state route protocols as applied to optical networks.
- Discuss the differences between datagram and optical routing with regard to service impact and standardization.
- Summarize and justify the functionality provided by the basic components of the optical control plane.

Audience:

This course is an introductory course on optical control plane standards. As such it assumes familiarity with SDH/SONET and WDM technology. Its emphasis will be on explaining the various control plane protocols to those with minimal prior experience in the areas of signaling or routing.

Instructor Biography:

Dr. Bernstein is currently Chief Consultant at Grotto Networking and is active in network standardization, network design, network equipment design, and network research for a variety of customers. He has been involved with standards development at the IETF, OIF, ITU-T, and ANSI Committee T1. Previously he was a Senior Director at Ciena Corp. after directing all software development at Lightera Networks (acquired by Ciena) where his team applied signaling and routing techniques to the control of networks of Lightera optical switches (now the Ciena CoreDirector). He is the lead author of the book *Optical Network Control: Architecture, Protocols, and Standards*, published by Addision-Wesley in 2004, and has written many articles and papers on the control of optical networks. He received his Ph.D., M.S. and B.S. degrees in electrical engineering and computer science from the University of California at Berkeley.

SC176 Metro Network: The Transition to Ethernet

Monday, 18 March 2013
9:00 - 12:00

Instructor: Loudon Blair; *Ciena Corp., USA*
Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)
Description:
Metro networks are being stretched by new broadband services that are forcing the capacity of customer access links to increase by two to three orders of magnitude. Because service revenues are not growing in proportion to bandwidth, new network solutions are needed to dramatically lower the cost per unit bandwidth of the network infrastructure. Consequently, service providers almost universally are migrating from SONET/SDH to Ethernet for both equipment interfaces and the creation of a new packet transport layer. In this course, we consider the motivation for new service offerings for both residential and business environments and we analyze how these new services are changing the magnitude and pattern of traffic flows across the metro area. We then explore traffic projections at several key points in the metro network and estimate the required capacity of networking switches and transmission systems that will result

from different service-mix scenarios. We will examine the mix of networking technologies that can be employed in the metro to yield a highly functional yet economic network solution. This will include an introduction to Carrier Ethernet and different implementation approaches to achieving carrier-grade performance as well as how Carrier Ethernet will operate in conjunction with other key network technologies including IP/MPLS, OTN and DWDM. With the anticipated dramatic growth in network capacity, the optical networking layer will play an increasingly important role in the metro network, both in enabling capacity scaling and in network reconfiguration. We discuss how the convergence of Carrier Ethernet and optical technologies is leading to the development of new packet-optical transport and switching systems. Applications of how packet-optical systems may be used in metro networks are explored using use cases.

Benefits:

This course should enable you to:

- Describe how new services are changing metro network traffic characteristics.
- Describe the impact that these new services will have on metro network traffic patterns and network equipment capacity in both aggregation and core metro networks.
- Describe the meaning of Carrier Ethernet and discuss different implementation approaches.
- Describe the key networking technologies used to build next generation metro networks, including DWDM, OTN, and IP/MPLS.
- Discuss the role of Carrier Ethernet in new metro architectures and how it operates in combination with other key technologies.
- Describe how packet and optical technologies are converging to form packet-optical transport and switching systems.
- Discuss how packet-optical systems may be used in different metro application scenarios, including new cloud network architectures.

Audience:

This course is intended for network architects and planners from service providers, engineering and marketing staff to network equipment providers, technologists with an interest in the evolution of networks, industry analysts, and financial analysts.

Instructor Biography:

Loudon Blair is Senior Director of Network Architecture at Ciena. Since joining the company in 1997, he has performed several roles in the development of Ciena's optical networking products. He has also worked at Iridium, BT and Hitachi. He has been a long-term contributor to OFC/NFOEC and was general co-chair for OFC/NFOEC in 2008.

SC176 Metro Network: The Transition to Ethernet

Monday, 18 March 2013

9:00 - 12:00

Instructor: Loudon Blair; *Ciena Corp., USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

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technologies is leading to the development of new packet-optical transport and switching systems. Applications of how packet-optical systems may be used in metro networks are explored using use cases.

Benefits:

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- Describe how new services are changing metro network traffic characteristics.
- Describe the impact that these new services will have on metro network traffic patterns and network equipment capacity in both aggregation and core metro networks.
- Describe the meaning of Carrier Ethernet and discuss different implementation approaches.
- Describe the key networking technologies used to build next generation metro networks, including DWDM, OTN, and IP/MPLS.
- Discuss the role of Carrier Ethernet in new metro architectures and how it operates in combination with other key technologies.
- Describe how packet and optical technologies are converging to form packet-optical transport and switching systems.
- Discuss how packet-optical systems may be used in different metro application scenarios, including new cloud network architectures.

Audience:

This course is intended for network architects and planners from service providers, engineering and marketing staff to network equipment providers, technologists with an interest in the evolution of networks, industry analysts, and financial analysts.

Instructor Biography:

Loudon Blair is Senior Director of Network Architecture at Ciena. Since joining the company in 1997, he has performed several roles in the development of Ciena's optical networking products. He has also worked at Iridium, BT and Hitachi. He has been a long-term contributor to OFC/NFOEC and was general co-chair for OFC/NFOEC in 2008.

SC177 High-Speed Semiconductor Lasers and Modulators

Sunday, 17 March 2013
9:00 - 12:00

Instructor: John Bowers; *Univ. of California at Santa Barbara, USA*

Level: Intermediate (prior knowledge of topic is necessary to appreciate course material)

Description:
Amplitude and phase modulation of light for transmission at 10, 40 and 100 Gbit/s is a critical problem for fiber-optic networks. We will review the basic concepts of optical modulators, with emphasis on electroabsorption modulators. The fundamental physics and design of modulators will be reviewed. The microwave characteristics of semiconductor lasers, important for high-speed digital and analog applications, are presented. From the rate equations for electron and photon dynamics in the laser we derive fundamental limits to laser bandwidth. These limits include resonance limits, damping, transport effects and device parasitics. Methods to increase the bandwidth are illustrated with examples from literature, along with results showing the current state of the art. Finally, analog and large-signal modulation issues important for applications in communication systems are covered, including ringing, chirp, intensity noise and distortion.

Benefits:
This course should enable you to:

- Compare different technologies.
- Make informed decisions on the design of optical transmitters and their incorporation into optical networks.
- Explain the performance of high-speed transmitters.

Audience:

Attendees should have some knowledge of semiconductor and device physics. A basic knowledge of laser operation is also needed.

Instructor Biography:

John E. Bowers is Director of the Institute for Energy Efficiency and the Kavli Professor of Nanotechnology in the Departments of Electrical and Computer Engineering and Materials at the University of California at Santa Barbara. He received his master's and doctorate degrees from Stanford University. He previously worked for Bell Labs and Honeywell. He is a member of the National Academy of Engineering and a Fellow of the IEEE, OSA and American Physical Society. He is a recipient of the IEEE/LEOS William Streifer Award and the OSA Holonyak Award. He has published nine book chapters, 500 journal papers, 700 conference papers and has received 52 patents.

SC182 Biomedical Optical Diagnostics and Sensing

Sunday, 17 March 2013
9:00 - 13:00

Instructor: Thomas Huser*; Univ. of Bielefeld, Germany, Univ. of California at Davis, USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

This course will teach you how advanced optical technologies and fiber optics are utilized in biomedical applications. The course starts with a short introduction to the basics of the life sciences, followed by an introduction to the basic properties of photons and the spectroscopic properties of biological materials, i.e. absorbance, reflectance, polarization, fluorescence, and light scattering. Modern optical imaging and sensing techniques, based on fluorescence, vibrational and nonlinear concepts, their extensions to fiber optics, and their biomedical applications will be discussed.

Benefits:

This course should enable you to:

- Determine how fundamental fiber-optics concepts best fit in with biomedical sensing applications
- List biological processes and show how they are related to diseases.
- Describe the composition of typical mammalian cells and how they can be imaged and analyzed *in vivo*.
- Define the best optical tools for the study of biological processes.
- Provide assistance in the design, construction and application of optical techniques to biological systems.
- Suggest and specify techniques that specifically highlight parts of interest within biological cells by employing optical tags.
- Read optical spectroscopic signatures of cells and discuss them in a meaningful way.

Audience:

This course in intended for technicians in industrial, academic and government laboratories; graduate students; managers in biotech and optical industries; postdoctoral fellows; optics researchers or teachers interested in the life sciences.

Instructor Biography:

Thomas Huser is an Adjunct Professor in the Department of Internal Medicine and the NSF Center for Biophotonics Science and Technology (CBST) at the University of California at Davis. He is also a Professor of Physics at the University of Bielefeld, Germany. Until November 2005, he was a Group Leader for biophotonics and nanospectroscopy at Lawrence Livermore National Lab (LLNL). He obtained his doctorate in physics from the University of Basel, Switzerland, where he worked on near-field optical microscopy. At the University of California at Davis and the University of Bielefeld he applies fluorescence and Raman spectroscopy to biological and medical problems at the single molecule to single cell level.

SC185 Hands-on Polishing, Inspection and Testing of Connectors

Monday, 18 March 2013
13:30 - 17:30

Instructor: Jerry Renville[1], Steve Baldo[2], Neal Wagman[3]; *[1]Light Brigade Inc., USA, [2]Seikoh Giken Co. Ltd., USA, [3]Norland Products, USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
This course consists of three stand-alone segments that are supervised by fiber-optic experts specializing in each particular discipline. Each segment includes both knowledge and hands-on components. The first segment, Fiber-optic Polishing, focuses on mass-production termination techniques that work with fiber optic connectors including SC, LC, and multifiber connector types with UPC and APC polishes. Learn how to achieve low insertion loss, low reflectance, optimum end-face geometry and improved production yields. The second segment, Fiber-optic End-face Inspection, explains the principles of microscopy and interferometry as they relate to the inspection and testing of fiber-optic plugs and termini. Hands-on demonstrations will show how microscopes and interferometers help to control the polishing process by checking for damage and measuring end-face geometry. The third segment, Connectorization Testing, reviews the test equipment used for attenuation and reflection testing after the polishing process is complete. The assemblies manufactured in the course are used in the testing to allow the course attendee to follow the production from assembly through testing processes.

Benefits:
This course will enable you to:

- Measure optical attenuation measurements and expected variations at 1310/1550/1625nm.
- Measure optical return loss and define its relationship to connector polishes, polishing procedures and test methods.
- Identify contaminants, their cause, and how to resolve contamination issues with a variety of cleaning products.
- Identify and discuss the fundamentals of the polishing processes and their impact on attenuation and reflection.
- Identify and determine how to adjust variables that affect end-face geometry.
- Measure scratches using automatic analysis equipment.

- Apply the criteria for pass/fail in quality assurance programs and applications.
- Determine how the immediate feedback from the interferometer will help control the manufacturing process, creating higher performance terminations and increased production yields.

Audience:

This course is applicable to those involved with fiber optic terminations from the novice to production engineers and managers involved with laboratory, manufacturing, and field disciplines. A basic knowledge of fiber optics is expected.

Instructor Biography:

Neal Wagman Jerry Renville

Since 1987, The Light Brigade (TLB) has instructed more than 42,000 attendees in its classes on fiber optic design, maintenance and testing, including topics such as OSP, networking, FTTx, DWDM and PMD/CD. Since 1990 TLB has provided a variety of special events at the OFC/NFOEC and CLEO conferences.

Norland Products Inc. has been manufacturing novel products to meet critical customer needs for more than 40 years. One of its specialties is 3-D interferometric testing and inspection of fiber-optic connectors. As the leader in this area, it has been actively involved in providing the optimum methods to achieve higher quality and cost savings.

Seikoh Giken (SG) provides high performance interconnectivity solutions for network systems and chip level applications. For networks and testing, Seikoh Giken provides premium patchcords (SMF and PMF), adaptors and attenuators. For manufacturers, SG manufactures ferrules, tunable connectors, polishing equipment, and films and photonic packaging technologies.

SC187 Hands-on Basic Fiber Optics for the Absolute Beginner

Monday, 18 March 2013
13:00 - 17:30

Instructor: Dennis Horwitz; *Micronor Inc., USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
This Short Course provides a very practical introduction to fiber optics with extensive show-and-tell and hands-on experiments to help better understand the concepts and industry trends by both seeing and doing. It has proven a popular and useful course to not just engineers but also purchasing, manufacturing, program management, sales, marketing, and management. The course provides a practical overview to the essential concepts behind fiber optics, including: single-mode, multi-mode, core, cladding, numerical aperture, attenuation, dB, dBm, dispersion, bandwidth, SONET, DWDM, and GbE. We also will discuss the broad range of applications from commercial telecommunications to military and aerospace, from medical to geophysical, and more. Mixed in with the various topics are hands-on test and measurement experiments to help better understand fiber optics and its nuances: visual fault location, optical power, attenuation, insertion loss, return loss, and optical time-domain reflectometry. The hands-on experiments help to introduce the participant to popular fiber optic standards used throughout various industries, including TIA fiber optic test procedures (FOTPs) and optical fiber system test procedures (OFSTPs). The participant will also come to understand some of the many variations in testing, the meaning of the results, and important tips when working with fiber.

Benefits:
This course should enable you to:

- Explain the fundamental optical differences and applications of single-mode fiber (SMF) vs. multimode fiber (MMF), including the different fiber types and fiber sizes.
- Identify the different connector types and understand their specific performance features (e.g. E2000, FC, LC, MIL styles, MTP, SC, ST, etc.) plus the various end-face options (i.e., Expanded Beam, NC, PC, SPC, UPC, and APC).
- Test connectors and cable assemblies for insertion loss (IL) and return loss (RL).
- Measure attenuation differences and bend loss effects in single-mode and multi-mode fiber links.

- Explain the differences between standard OTDRs and high resolution, short haul OTDRs, as well as their applications.
- Apply proper handling and cleaning techniques.
- Explain DWDM concepts and trends in telecommunications as well as Gigabit Ethernet technology driving LAN/WAN applications.
- Explain limitations of COTS components vs. requirements of harsh/hazardous environments.

Audience:

The course is the ideal introduction to fiber optics and is geared toward the engineer or manager just making the transition into fiber optic technology. Every two participants will share a test and troubleshooting set consisting of a visual fault locator (VFL), optical power meter (OPM), LED source, laser source, connector cleaning tools, and a variety of test cables to simulate different test scenarios.

Instructor Biography:

Dennis Horwitz received his M.S.E.E. from the University of California at Los Angles and has more than 30 years experience in research and development, product development, sales, and marketing of fiber optic test equipment and components. He was co-founder of two successful start-ups in fiber optic test and measurement: Photodyne Inc. (1979-1990, sold to 3M) and Rifocs Corp. (1990-2003, sold to Textron). He is actively involved in fiber optic standards development (ARINC, ISA, SAE, and TIA) and has been an OFC/NFOEC Short Course instructor for more than 10 years. He is currently Vice President for Sales/Marketing for Micronor Inc., which has developed and commercialized the first totally passive fiber optic rotary encoder for motion control applications.

SC203 100 Gb/s and Beyond Transmission Systems, Design and Design Trade-offs

Sunday, 17 March 2013

13:00 - 16:00

Instructor: Benny Mikkelsen[1], Martin Birk[2]; *[1]Acacia Communications, USA, [2]AT&T Labs, USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

While in the past, higher bitrates were mainly driven by Service Provider's backbone networks, an interesting trend is appearing, where mobile users and data centers in rural areas are requesting high data rates at 100Gb/s outside core networks. This trend in turn has a large influence on the Transmission Systems, Hardware, Software and Design.

The first part of this course provides an overview of the drivers and applications of 100G transmission systems in backbone, regional and metro networks. It describes the requirements and expectations carriers will have to cost, power consumption, footprint, reliability, optical performance, and interoperability. We present practical design issues of 100G line-cards, and we critically review the availability and performance of the key building blocks. In particular, we discuss the technologies needed to implement different modulation formats, and the corresponding trade-off between complexity/cost of line-card implementations and the achievable fiber transmission distance. We will also look at future bitrates and technologies beyond 100Gb/s.

Benefits:

- Identify key requirements and drivers for 100 Gbit/s applications.
- Describe the availability and performance of 100 Gbit/s key building blocks.
- Discuss 100 Gbit/s transmission limitations.
- Describe lessons learned from 100 Gbit/s field trials.
- Summarize 100 Gbit/s standards activities.

Audience:

The course is intended for engineers and technical managers who want an up-to-date overview of 100G transmission systems, including applications, line-card designs, and fiber transmission limitations. It will be significantly updated in 2013, and past attendees may find it useful to take the course again. The course requires some understanding of basic optical transmission systems.

Instructor Biography:

Benny Mikkelsen is co-founder and CTO at Acacia Communications, where he is responsible for the design of 100 Gbit/s optical transport products. Before Acacia, he co-founded Mintera and earlier was with Bell Labs, Lucent Technologies, where his research included ultra high-speed optical transmission. He holds master's and doctorate degrees in electrical engineering from the Technical University of Denmark.

 Martin Birk received his master's and doctorate degrees from Germany's University of Ulm in 1994 and 1999, respectively. Since 1999, he has been with AT&T Labs in New Jersey, working on high-speed optical transmission at data rates of 40Gbit/s and above.

SC205 Integrated Electronic Circuits and Signal Processing for Fiber Optics

Sunday, 17 March 2013
17:00 - 20:00

Instructor: Y. K. Chens, Noriaki Kaneda; *Bell Labs, Alcatel Lucent, USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
High speed electronics at 10-, 40-, 100-Gbit/s and beyond is a critical enabler for fiber-optic networks. We will review the basic functions of high speed lightwave circuits in optical terminals, with emphasis on physical layer transceiver electronics. The basic functions and architectures of these circuits will be reviewed. The high speed IC technologies and their implementation of these important high bit-rate digital and analog applications will be presented. The presentation materials include receiver front-ends including trans-impedance amplifiers and limiting amplifiers, clock-data recovery circuits including phase locked loop and digital phase detectors, SERDES such as electrical time-domain multiplexers, de-multiplexers and transmitter circuit such as driver amplifiers. Methods to enhance the performance and bandwidth are illustrated with examples from literature, along with results showing the current state of the art. A low-cost electronics solution such as FFE, DFE electronic front-end to equalize and mitigate optic fiber transmission impairments will be illustrated. The basic requirement, characteristics, and circuit

topologies of emerging data converters technologies (ADC, DAC) for optical communications will be reviewed. As an increasingly important electronic component in today's optical communication, the course will cover the topics on digital signal processing for coherent optical transmission. The basic architectures, algorithms, and implementation techniques of digital signal processing in optical communication will be reviewed. The techniques for transmission mitigation and intradyne detection will be presented on single carrier and multi-carrier modulation formats with examples.

Benefits:

This course should enable you to:

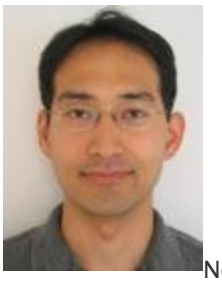
- Describe the functions and performance of high-speed electronics for optic fiber terminals.
- Evaluate the design and implementation of physical layer electronic circuits.
- Describe commonly used circuit architectures.
- Compare the merits among different IC technologies.
- Justify advanced electronic equalization techniques.
- Compare implementation complexity of various DSP techniques for optical transmission.

Audience:

This course is intended for engineers, scientists or managers who must make or understand the choice of electronic circuits for optical transmission products or evaluate electronic solutions used in purchased products.

Instructor Biography:

Young-Kai Chen is a director of high speed electronics and optoelectronics research department at Bell Labs, Alcatel-Lucent. He received his doctorate in electrical engineering from Cornell University. He worked for General Electric Co. before joining Bell Labs. He is a Fellow of IEEE, a member of the National Academy of Engineering, and a recipient of the IEEE David Sarnoff Award. He has published three book chapters, more than 100 journal papers and more than 150 conference papers, and he has received 15 patents.

 Noriaki Kaneda is member of technical staff at Bell laboratories, Alcatel-Lucent, Murray Hill, NJ. His Ph.D academic work included microwave photonics at the University of California, Los Angeles. Since he joined Lucent Technologies in 2000, he has worked on various topics regarding optical data formats including direct detection DPSK, digital coherent QPSK, coherent optical OFDM for the high bit rate optical transmission systems. His current research interest consists of high-speed digital signal processing in optical transmission systems.

SC208 Optical Fiber Design for Telecommunications and Specialty Applications

Monday, 18 March 2013
9:00 - 12:00

Instructor: David J. DiGiovanni; *OFS Labs, USA*

Level: None

Description:
Optical fiber design remains a robust field for innovation in both telecom and nontelecom applications. As worldwide bandwidth demand continues to grow, new fiber types and fiber-based components can increase speed, reduce cost and improve the bandwidth of communications networks. In addition, application-specific fiber can enable or benefit a wide array of functions such as simply transporting light between two points, amplifying light, processing signals, sensing environmental characteristics and even transporting particles. The tools available in adapting fiber to particular uses, whether for high speed communications or other applications, include a range of materials and dopants (glasses, polymers), the mechanics of the fiber (size, coatings, microstructure), waveguiding properties (index profile), and various fiber-based devices such as gratings and amplifiers. These tools have been used to establish an industry that continues to expand as photonics penetrates more and more industries and applications.

This short course will discuss the many ways in which optical fiber design can be used in a wide range of applications and will review an array of current fiber technologies. We will consider the role and

capabilities of materials, structures and waveguide design for both fiber and fiber-based photonic components. The focus will be on understanding the capabilities of fiber design and engineering with the goal of demonstrating the many opportunities available with novel optical fibers. Specific attention will be on the impact of transmission fiber design and properties for high-speed optical communication such as >40Gb/s transmission and coherent detection; designs for optical amplification and dispersion compensation; and the design of waveguides to produce effects such as enhanced nonlinearity and bandgap operation.

Benefits:

At the end of this course, participants will be able to:

- Understand how certain fiber attributes, like attenuation, modal area and dispersion can impact current and next-generation high speed communications technologies
- Describe the wide array of optical fibers available and discuss how their designs have been engineered for particular applications
- Compare the benefits of different materials in fiber design, including different glass dopants.
- Design simple fibers for various applications, such as amplifiers, dispersion compensators, sensors and component pigtails
- Determine whether particular applications can benefit from modified or novel optical fiber.
- Understand the potential offered by fiber engineering which may be exploited to improve existing applications or create new functions.

Audience:

This course is intended for the technical community seeking to understand the potential of optical fiber and waveguide design. Basic understanding of optical fiber properties is desirable though not required. The course will provide an understanding of the operating principles of fiber while also exploring the limits of waveguide and materials engineering. Specific designs for high speed transmission, optical amplification and dispersion compensation will be studied, among others.

Instructor Biography:

D.J. DiGiovanni received several engineering and mathematics degrees from Brown University, including a PhD in 1987. He joined Bell Laboratories in the Optical Fiber Research department in 1990 and has worked on various phenomena related to optical fibers for erbium-doped amplifiers, high power amplifiers and

lasers and Raman amplification. He is now president of OFS Laboratories and continues to explore designs, fabrication and applications of specialty and transmission optical fibers and devices.

SC210 Hands-on Polarization-Related Measurements

Monday, 18 March 2013
8:30 - 12:30

Instructor: Danny Peterson[1], Tasshi Dennis[2], Brian Teipen[3], Christine Tremblay[4]; *[1]Verizon Business, USA, [2]NIST, USA, [3]ADVA Optical Networking, USA, [4]Ecole de Technologie Superieure, Univ. du Quebec, Canada*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
In this Short Course you will measure the polarization-related parameters that are important to high-speed fiber optic communications. The course begins with a brief review of key polarization concepts and a short description of the course equipment and setups. The participants then divide into small groups and rotate among four lab stations. In Lab 1, you will control and measure the state and degree of polarization. You will also measure polarization cross-talk on polarization-maintaining fiber and create a polarization reference frame for absolute polarization measurements. Equipment for this lab includes a polarimeter, a DOP meter, various polarization controllers, and a polarization extinction ratio meter. Tasshi Dennis is the instructor. In Lab 2, you will measure the polarization dependent loss (PDL) of optical components (including filters) using the all-states and Mueller matrix PDL methods. You will also measure and correct for the polarization dependence of optical power meters and OSAs. Equipment for this lab includes a swept Mueller matrix setup, polarization controllers and scramblers, a PDL meter, an OSA and an optical power meter. Christine Tremblay is the instructor. In Lab 3, you will measure the polarization mode dispersion (PMD) of transmission paths with combinations of high-PMD fibers. The measurement methods used in this lab include Interferometry, wavelength scanning, polarization-OTDR, and Jones Matrix Eigenanalysis (JME). Danny Peterson is the instructor. In Lab 4, participants will explore the impact of first- and second-order PMD on a 100+ Gigabit/s dual-polarization QPSK channel. Equipment for this lab includes a 100 Gigabit Ethernet optical transponder, PMD source, polarization scrambler, polarimeter, and optical modulation analyzer. Brian Teipen is the instructor.

Benefits:

This course should enable you to:

- Operate a wide variety of polarization-related test equipment.
- Measure polarization dependent loss (PDL) using all-states and Mueller methods
- Measure polarization-mode dispersion (PMD) using Interferometric and JME methods
- Demonstrate the effect of PMD on high-speed digital signals and describe the technical difficulties associated with PMD compensation.
- Determine the outage probability in optical fiber transmission systems due to PMD-induced degradation.
- Measure polarization cross talk “in-line” and at the end of a polarization-maintaining (PM) fiber.
- Achieve optimum performance in PM fiber applications.
- Measure the polarization dependent response (PDR) of everyday test equipment and describe how to overcome PDRs by means of high-speed polarization scrambling.
- Describe/Measure the system-level effects of polarization-related impairments on optical channels.

Audience:

This course is ideal for engineers, technicians and managers involved with optical fiber, components, and/or 8G Fibre Channel, 10G SONET/SDH, or 10G/40G/100G Ethernet transmission interfaces.

Instructor Biography:


Tasshi Dennis received the Ph.D. in electrical engineering from Rice University. He is a staff scientist at NIST in the Optoelectronics Division working on high speed optical measurements. He is an OSA member.


Daniel Peterson is a distinguished member of the technical staff at Verizon. He is an internal

advisor on optical technologies for Verizon's ULH network. He received a Ph.D. in electrical engineering from the University of Texas at Dallas. He is a senior member of IEEE.

 Christine Tremblay, Ph.D., is a professor at the École de technologie supérieure, Université du Québec, where she set up the Laboratoire de technologies de réseaux, an advanced optical layer testbed for research on high- speed transmission technologies and network design, and established courses on optical communications. She is a member of OSA and IEEE.

 Brian T. Teipen, Ph.D., researches advanced optical transport techniques for ADVA Optical Networking. Brian received the Bachelor of Science degree in physics at Indiana University in 1995, and his doctorate degree in electrical engineering at The University of Texas at Dallas in 2000. He is an IEEE and OSA member.

SC217 Hybrid Fiber Radio: The Application of Photonic Links in Wireless Communications

Sunday, 17 March 2013
17:00 - 20:00

Instructor: Dalma Novak; *Pharad, LLC, USA*

Level: Intermediate (prior knowledge of topic is necessary to appreciate course material)

Description:
The use of photonic links for the transport and distribution of radio signals in wireless networks is becoming ever increasingly pervasive. Applications where such hybrid technology is employed include backhaul solutions for mobile networks; indoor distributed antenna systems; as well as integrated fixed and mobile broadband and ultrabroadband networks capable of providing users with very high bandwidth services.
This short course presents an overview of the application of photonic links in wireless communication networks. The associated system architectures and signal transport technologies that enable the

implementation of integrated wireless and wireline (optical) networks will be discussed. The various technical challenges and issues that must be addressed for the successful integration of these networks, which encompass very different requirements and specifications, will also be presented. Topics to be covered include:

- Integrated optical/wireless network architectures
- Requirements and challenges for the development of hybrid fiber radio systems
- Relevant technologies and implementation approaches

Benefits:

This course should enable participants to:

- Understand the motivation for the integration of wireless communication systems with optical fiber networks;
- Identify the technical challenges related to the application of photonics and optical networking concepts to wireless communications;
- Understand and compare physical layer technologies that enable the integration of wireless and optical networks;
- Identify technologies that can improve the performance of integrated optical and wireless networks;
- Establish the trade-offs with alternative integrated network architectures

Audience:

This is an intermediate course for people working in telecommunication related areas who wish to broaden their knowledge and learn how optical networks are being integrated with wireless communications or find out the current status of this multidisciplinary field.

Instructor Biography:

Dalma Novak is Vice-President at Pharad, LLC who are developing advanced RF-over-fiber and antenna products. She received her PhD in Electrical Engineering in 1992. From 1992 – 2004 she was a faculty member in the Department of Electrical and Electronic Engineering at The University of Melbourne,

Australia. Previously Dr. Novak held positions at Dorsal Networks and Corvis Corporation. Dr. Novak is a Fellow of the IEEE and has published over 250 papers in the area of hybrid fiber radio technologies.

SC239 Short-Reach Optical Interconnects

Monday, 18 March 2013
8:30 - 12:30

Instructor: Steve Joiner; *Finisar, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
This course will present an overview of short-reach optical interconnect technology, from traditional LED-based Ethernet transceivers all the way to high-density multichannel solutions now being investigated for multi-Terabit/s optical backplanes. Material will include applications and standards, basic component technologies (e.g. optoelectronics, IC's, optics, packaging, connectors), the basics of optical link analysis (e.g. power budgets, eye-diagrams, link penalties), and a survey of high-bandwidth, short-reach optical interconnect solutions including serial, parallel optics and coarse WDM.

Benefits:
This course should enable you to:

- Determine the suitability of optical interconnects for system applications.
- Compare technology options for short-reach optical interconnects.
- Compute a simple optical power budget.
- Identify the components best suited for a given optical interconnect application.
- Explain short-reach optical interconnect technology to system engineers and management.

Audience:
This introductory course is intended for an audience with at least some technical background in engineering, physics or related disciplines, and is ideally suited for engineers from related fields in optics, electronics, networking or computing systems who want to learn more about short-reach optical interconnects. Marketing or business development professionals seeking a deeper understanding of the technology may also consider taking this course.

Instructor Biography:

Steve Joiner has been developing products for emerging fiber-optic communication applications for 25 years. Steve currently works with Finisar Corp. Prior to joining Finisar, Steve was Director of Marketing for pluggable transceivers at Bookham. Steve works with both customers and standards bodies to create the best application of technology to meet market needs. Steve joined Hewlett-Packard in 1978, working in III-V devices, fiber-optic cable fabrication, fiber-optic transceiver development, and standards development. He was Program Manager for HP's first 1300-nm LED transceiver for the ESCON and FDDI markets. Later, he was responsible for all fiber-optic product development, then moved into technology planning and pre-competitive collaboration. In 1999 he joined the newly-formed Agilent Technologies Corporate Laboratory, where he managed the Network Architecture and Technology Department. He has chaired numerous standards committees, participating in the development of several multi-source agreements for fiber-optic packaging. Steve earned his B.A., M.A., and Ph.D. degrees in physics from Rice University in Houston.

SC243 Next Generation Transport Networks: The Evolution from Circuits to Packets

Sunday, 17 March 2013
13:00 - 16:00

New time!

Instructor: Ori Gerstel; *Cisco Systems, USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
Transport networking technologies are experiencing one of the most significant evolutionary pressures in recent history. While previous phases in the evolution of the transport layer were driven by operations considerations (SONET/SDH) and bandwidth growth (WDM), the current phase is driven by fundamental shifts in services from circuits to packets. Services like VoIP and VoD have a profound impact on how the network is architected and managed. The challenge is compounded by an order-of-magnitude increase in bandwidth demands from the end-user and by the large number of unknowns, both from a service type perspective and bandwidth sizing and distribution perspective. As a result, service providers and equipment vendors alike are struggling with the best long-term architecture to the new transport layer

and with the need for a smooth migration path form their legacy systems to that long-term solution. This course attempts to add clarity to the new requirements for the transport layer and the different technologies that are being considered to address these requirements. The course starts with a review of new services that must be supported by the transport layer, including Metro Ethernet services, storage services, and triple play services (mainly Internet/VOIP/VoD). We then proceed to discuss the current transport technologies, such as legacy IP, Ethernet, SONET/SDH and DWDM, and their drawbacks for the new offered services. Each legacy technology has been extended recently in support of the new demands. In particular, Carrier-class IP, MPLS-TP, Metro Ethernet, PBB-TE, OTN, and automated DWDM systems are being considered. We will clarify the innovation and capabilities that make these technologies more appropriate and how they can be combined into effective network architectures.

Benefits:

This course should enable you to:

- Understand transport technologies from L3 to L0: IP, MPLS, Ethernet, TDM, and WDM.
- Describe new enterprise services: point to point and point to multi-point Ethernet and Storage services.
- Understand how video and cloud affect the service provider network
- Understand next-gen SONET and the evolution of OTN.
- Compare MPLS, Ethernet, PBB-TE, MPLS-TP.
- Describe access and core networking from a transport perspective.
- Understand the interplay between the IP layer and the underlying transport technology.

Audience:

This course is intended for the general OFC/NFOEC audience, including network planners, architects, product line managers, and other professionals, as well as researchers working on electrical and optical technologies for the carrier's transport layer.

Instructor Biography:

Ori Gerstel (F'08) is a Principal Engineer at Cisco. His main role is to identify and define architectural capabilities that stem from IP and optical networks integration. Prior to that, he was in charge of Cisco's advanced optical technology team and is the key inventor of some of the advanced capabilities of Cisco's DWDM product. Before joining Cisco in 2002, he was a Senior Systems Architect for Nortel's photonic crossconnect. Before joining Xros/Nortel, Gerstel was the Systems and Software Architect for the Optical Networking Group at Tellabs, where he architected the first commercial mesh DWDM system.

Previously, he performed early optical networking research at IBM Research. He authored more than 80 papers for international conferences and journals and over 35 patents. He served on the program committee of various conferences and journals and is an invited speaker to many panels, tutorials and courses. Ori is Editor-in-Chief for the main journal on optical networking (JOCN) and on the steering committee of OFC. Ori holds a Ph.D. from Technion-Israel Institute of Technology, Israel.

SC259 Electronic and Optical Impairment Mitigation

Sunday, 17 March 2013
17:00 - 20:00

Instructor: Chris Fludger[1], Seb Savory[2]; [1]CoreOptics GmbH, Germany, [2]Univ. College London, United Kingdom

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
As the channel bit-rate has increased from 10 Gbit/s to 100 Gbit/s, chromatic dispersion (CD) and polarization mode dispersion (PMD) have become visible as limiting properties of optical network links, and have been subsequently mitigated using optical and electrical innovation. Next generation transmission equipment needs to meet the challenges of being cost-effective, flexible, spectrally efficient and highly tolerant to impairments in the channel. This course compares and contrasts electronic equalization and optical compensation techniques.

The effect of noise, dispersion, non-linear distortion, and filtering on optical transmission will be discussed. Electronic compensators using feed-forward or decision feedback equalizers, or Maximum-Likelihood Sequence Estimators will be explained, and their effectiveness with direct-detection or coherent receivers will be compared. Signal filtering and shaping, along with future trends and challenges will be discussed. Electronic techniques will be contrasted against and compared to optical compensation devices.

Benefits:

This course should enable you to:

- Describe the principle noise and distortion sources in an optical transmission system.
- Explain the requirement for dynamic impairment mitigation devices;
- Explain the importance of understanding the optical distortion in order to design an effective mitigator;
- Explain the major options for electronic equalisers and optical compensators and their advantages and disadvantages.
- Describe the building blocks and operation of electronic equalizers;
- Explain analogue and digital electronic signal processing;
- Explain the difference between electronic equalizers that operate on the optical field, and those that use the directly detected signal;
- Quantify the performance of the different PMD and CD compensators.
- Describe optical and electrical options for spectral shaping and filtering.

Audience:

This course is intended for individuals having a basic knowledge of digital lightwave transmission systems. It will be of value for industrial professionals (system designers, managers) who need to assess the different options of electronic and optical impairment mitigators, as well as for researchers who are new to the field.

Instructor Biography:

 Chris Fludger has received master's and doctorate degrees in electronics engineering from Cambridge University, UK. At Nortel Networks he has worked on electronic signal processing, advanced Modulation techniques and Raman amplification. He is currently working at Cisco Optical, developing next generation optical transceivers.

 Seb Savory received master's and doctorate degrees in engineering from Cambridge University, UK, and the MSc(Maths) degree from the Open University, UK. He is a lecturer at University College London, where his research is focused on digital coherent receivers. Previously he was at Nortel, where he worked on PMD compensation, coherent detection and DSP.

SC261 ROADM Technologies and Network Applications

Monday, 18 March 2013
13:30 - 16:30

Instructor: Thomas Strasser; *Nistica Inc., USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
In the past few years optical transmission platforms around the world have aggressively adopted Reconfigurable Optical Add-Drop Multiplexer (ROADM) technology. This technology is now firmly integrated into the product lines and roadmaps of transport systems and carriers with deployment of more than $1 billion of ROADM transport in the last year. This represents a groundbreaking commercial technology transformation of transparent optical routing displacing electrical grooming equipment for the first time on such a wide scale. Despite the commercial success, substantial confusion has surrounded this technology. This is largely because (a) the ROADM market is poorly defined since it may mean a subsystem or a system, neither of which have market-accepted minimum functionalities; (b) the lack of a clear market definition has been exploited to promote competing technologies driven by different commercial interests; and (c) there continues to be technology innovation that improves flexibility of these systems. This course will give a historical perspective of how this technology evolved, the numerous network benefits derived, and how those benefits depend on the functionality of the technology employed. Finally, the course will describe how these technologies are being integrated into WDM systems and what types of networks most fully leverage the new capabilities to provide network value.

Benefits:
This course should enable you to:

- Describe the network level benefits of ROADM systems.
- Define the different ROADM technology approaches competing in the market.
- Summarize the functionality differences between competing ROADM technologies, including which are most likely to succeed in the long term and why.
- Compare the incremental cost of a ROADM to the network level savings it enables.
- Discuss the types of networks that most fully benefit from ROADM technology and why.
- Explain the contradictory statements made about ROADM in trade literature.

Audience:

Anyone interested in more fully understanding the functionalities and benefits of ROADMs, including students, researchers, engineers, managers, and executives involved in ROADM development, network design, network planning, and network operations.

Instructor Biography:

Thomas A. Strasser received a doctorate from Cornell University designing periodic guided-wave devices and worked for three years at Eastman Kodak Research Labs and seven years at Bell Labs in Murray Hill, New Jersey. At Bell Labs his group invented and developed manufacturing for enabling technologies in the next-generation transmission platforms of AT&T and Lucent Technologies. He served for five years as the chief technologist defining the ROADM-based platform of Photuris and its subsequent acquirer, Mahi Networks. He is currently CTO of Nistica Inc., developing next-generation optical technologies. Strasser was the OFC/NFOEC 2006 General Co-chair and the OFC 2004 Technical Program Co-chair. He has contributed 40 patents and more than 100 presentations and publications in the field of optics and communication devices.

SC264 Introduction to Ethernet Technologies

Sunday, 17 March 2013
9:00 - 16:30

Instructor: Jeffrey Cox; *Microsoft, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

This course will begin by covering the history of Ethernet in the IEEE 802.3 standards and its evolution through present-day implementations. All major commercially successful variants will be reviewed at the physical layer, including coax (thin and thick-wire), twisted-pair, fiber (multi and single-mode), 10/100Mb and 1/10/40/100Gb implementations. Discussion topics will include media, topologies, framing, coding and media access control. The material will then introduce the data-link layer by covering learning bridges, spanning-tree, VLANs, trunking and flow-control. This information will be leveraged to illustrate how larger "switched" Ethernet networks are sometimes built. Issues related to scaling switched networks and "when to route" will be addressed ("Layer 2" vs. "Layer 3" networks). Extending Ethernet beyond the LAN into metropolitan and long haul networks will be explored. Different transport, protection and restoration mechanisms will be examined including Ethernet over SONET, GFP, DWDM and "native" transport. Finally, we will cover techniques for building extremely large-scale Ethernet-based networks that integrate Layer 2 switching, Layer 3 routing and optical transport.

Benefits:

This course should enable you to:

- Define Ethernet's place in the IEEE 802 standards.
- Identify the various Ethernet frame types.
- Explain how Learning Bridges function including the Spanning Tree protocol.
- Describe VLANs, Trunking and Flow Control.
- Describe Ethernet's various physical-layer implementations.
- Describe the various options for transporting Ethernet beyond the LAN environment.
- Discuss issues relating to protection and restoration in Ethernet environments.

Audience:

This course provides introductory-level information on Ethernet technologies and their related protocols. Individuals attending this course must understand basic networking/computing terminology and concepts. The material will delve into the "bits and bytes" of Ethernet protocols and is aimed at anyone

who wishes to understand Ethernet, how it works, and its applications. No prior knowledge of Ethernet is required.

Instructor Biography:

Jeffrey L. Cox has accumulated more than 25 years of experience in designing, deploying and supporting large-scale enterprise and carrier data networks. From 1985 to 1992, he designed and supported a large multi-protocol network infrastructure at Texas A&M University. During the mid 1990s, he built enterprise networks for various large corporations including Texas Instruments. He joined Level (3) Communications in 1998 and was responsible for the global architecture of the company's MPLS backbone and other packet infrastructures. In 2000, he started Celion Networks, building optical DWDM transport equipment targeted at transporting enterprise data traffic. He also held network architecture and research roles at JPMC, BT, and Juniper Networks. Jeff currently is a Principal Network Architect at Microsoft.

SC265 Passive Optical Components and Filtering Technologies

Sunday, 17 March 2013
9:00 - 12:00

Instructor: Bruce Nyman[1], Christi Madsen[2]; *[1]TE SubCom, USA, [2]Texas A&M Univ., USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
Today's WDM networks rely on subsystems, such as ROADMs and erbium-doped fiber amplifiers, and incorporate many types of passive components. For example, a typical optical amplifier will contain an isolator, a pump and signal multiplexer, optical taps, and a gain flattening filter. In this Short Course, we will discuss the passive components found in a typical WDM system. For each one, students will be able to identify the system requirements on device performance and assess the technology options for meeting those requirements. While passive devices may be simple in function, choosing and specifying them can be challenging. Performance issues such as insertion loss, return loss, polarization-dependent loss,

polarization mode dispersion, and chromatic dispersion are important, as are temperature and wavelength dependencies. Component fabrication techniques, including fused fiber, dielectric filters, planar waveguide, and fiber Bragg gratings are surveyed, with an emphasis on their relative strengths and weaknesses. For effective specification and system design, accurate measurements are critical. An understanding of the various measurement methods and issues will be provided. A fundamental understanding of optical filters will be addressed in the course. We take a signal processing approach, which allows us to compare the properties of such diverse filters as waveguide grating routers, Fabry-Perot etalons, ring resonators, and thin-film filters. The source of chromatic dispersion in filters and its relationship to their magnitude response will be discussed. Optical filter applications will be presented, including signal conditioning applications such as tunable dispersion compensation, as well as optical sensing applications.

Benefits:

This course should enable you to:

- Identify the device requirements and technology options of the passive components in a WDM system.
- Compare filter choices for applications, such as chromatic dispersion compensation and monitoring.
- Define specifications for passive components to meet system requirements.
- Understand the various measurement methods and important parameters.
- Explain the basic commonality and differences between optical filter types.
- Identify the trade-offs to obtain a more idealized, dispersionless, boxlike spectral response.

Audience:

This course is for those who need an introduction into the various types of optical components and filters used in WDM systems, including practitioners and technical managers responsible for system design, integration, and testing, as well as those who need to deliver and verify components for WDM systems.

Instructor Biography:

Bruce Nyman is currently with TE SubCom where he develops next-generation undersea systems. From 2005 to 2009 he was with Princeton Lightwave as Vice President of System Solutions. Previously, he developed optical amplifiers and measurement equipment at JDS Uniphase and optically amplified

undersea systems at Bell Labs. He received his doctorate from Columbia University and is a fellow of the IEEE.

 Christi Madsen is a professor at Texas A&M University, focusing on photonic processing for optical communications and sensing. Previously, she was a Distinguished MTS with Bell Labs. She is an OSA Fellow, coauthored *Optical Filter Design and Analysis: A Signal Processing Approach,* holds 30 patents, and has published numerous papers.

SC266 Quantum Cryptography and Quantum Information

Tuesday, 19 March 2013
9:00 - 12:00

Instructor: Richard Hughes[1], Thomas Chapuran[2]; *[1]Los Alamos Natl. Lab, USA, [2]Applied Communication Sciences, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
This course will describe the new and rapidly expanding field of quantum communications, which promises to revolutionize some aspects of communication networks. It will provide a view of an early application of quantum information and quantum communications, namely quantum cryptography and why it may be of interest for the OFC/NFOEC community. After a brief motivation as to "what is cryptography" and "What are the limitations with conventional cryptography," the course will provide a high-level view of quantum cryptography and quantum key distribution. The course will provide a brief history of quantum cryptography from its inception to the present time and will walk through detailed examples of how the BB-84 QKD protocol works. The course will then turn to the realities of real-world light sources and photon detectors. The course will include both fiber and free space environments and will identify and summarize some of the major efforts worldwide in this area. Finally the course will describe recent “quantum hacking” research results, and will discuss how recent QKD network testbed results set the stage for quantum information systems for the future.

Benefits:

This course should enable you to:

- Identify benefits of quantum key distribution techniques.
- Determine free-space and fiber based applications.
- Describe single photon sources and compute their expected characteristics.
- Describe concepts of quantum entanglement.
- Determine appropriate networking applications for quantum communications.

Audience:

The audience may include optical networking and optoelectronic technology researchers with an interest in quantum communications, managers of research groups, and engineers who want a glimpse of a new and forward-looking technology. An undergraduate-level understanding of quantum mechanics is helpful.

Instructor Biography:

Richard J. Hughes is a Laboratory Fellow at the Los Alamos National Lab. He is co-principal investigator of projects in both free-space and optical fiber based quantum key distribution and holds two US patents in these areas. He obtained his doctorate from the University of Liverpool and has held positions at Oxford University, Queens College Oxford, Caltech, CERN, and the University of Oslo. His awards include the Los Alamos Distinguished Performance Award, Los Alamos Fellow's Prize, co-winner of an R&D Development 100 Award for "Free Space Quantum Cryptography," and co-winner of the European Union's Descartes Prize. He is an APS Fellow and has authored more than 150 scientific papers.

Thomas E. Chapuran is a Senior Scientist at Applied Communication Sciences. He has served as co-principal investigator and Telcordia technical lead in experimental investigations of the

compatibility of quantum key distribution with optical networking. He holds a doctorate in physics from the University of Illinois, and served on the faculty at the University of Pennsylvania. His research interests include quantum communications, quantum computing, optical network architectures, broadband access, and signaling and control for next-generation networks. He received Telcordia CEO Awards in 2000 and 2001 and has authored numerous papers in the fields of telecommunications and physics.

SC267 Silicon Microphotonics: Technology Elements and the Roadmap to Implementation

Sunday, 17 March 2013
17:00 - 20:00

Instructor: Lionel Kimerling; *MIT, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
The optical components industry stands at the threshold of a major expansion that will restructure its business processes and sustain its profitability for the next three decades. This growth will establish a cost-effective platform for the partitioning of electronic and photonic functionality to extend the processing power of integrated circuits and the performance of optical communications networks. The traditional dimensional shrink approach to the scaling of microprocessor technology is encountering barriers in materials and power dissipation that dictate more distributed architectures. Before 2015 the performance requirements for this short link interconnection will cross the 10Mb/s.km threshold that dictates optical carrier utilization. This business direction will ignite a major change in leadership of the industry from information transmission (telecom) to information processing (computing, imaging); and it will open significant new markets with high-volume applications. Silicon microphotonics is a platform for the large-scale integration of CMOS electronics with photonic components. This course will evaluate the most promising silicon optical components and the path to electronic-photonic integration. The subjects will be presented in two parts: 1) Context: a review of the recently released Communications Technology Roadmap by the Industry Consortium of the MIT Microphotonics Center; and 2) Technology: case studies in High Index Contrast design for silicon-based waveguide, filter, photodetector, modulator, and laser devices. The objective of the course is to present an overview of the silicon microphotonic platform drivers and barriers in design, fabrication, packaging, and test.

Benefits:

This course should enable you to:

- Identify trends in the optical components industry.
- Explain the power of a standard platform.
- Discuss the benefits of electronic-photonic integration.
- Evaluate the latest silicon photonic devices.
- Summarize the findings of the Communications Technology Roadmap.

Audience:

This course is for executives and technologists in the optical components industry to include planners, engineers, and scientists participating in the optical components technology supply chain.

Instructor Biography:

Lionel Kimerling is the Thomas Lord Professor of Materials Science and Engineering at MIT. He was head of materials physics research at Bell Labs until 1990, when he joined MIT. He is currently Director of the MIT Materials Processing Center and its affiliate, the MIT Microphotonics Center, which he co-founded with 30 faculty members in 1997. Among his industry responsibilities were long-term reliability of semiconductor lasers, development of the first 1MB DRAM chip, and defect diagnostics and control for silicon IC manufacturing. His group's research has focused on silicon microphotonics, environmentally benign IC manufacturing, and solar electricity.

SC288 Fundamentals of Polarization, PDL, and PMD

Sunday, 17 March 2013
9:00 - 13:00

Instructor: Nick Frigo; *US Naval Academy, USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

While polarization is one of the fundamental characteristics of light, it is only the advent of high-speed, long-haul transmission systems that has made polarization imperfections of the optical medium an important issue. This course begins with illustrations of wave propagation for different states of polarization (linear, circular, elliptical) and we introduce the common formalisms with interactive examples, showing the relationships between the Jones and Poincare/Stokes representations. Birefringence, a polarization-dependence for the speed of light in a medium, is introduced using these formalisms, emphasizing pictorial descriptions of the analytic methods. This permits us to quickly touch on special topics such as perturbations, polarization-maintaining fibers (PMF), polarization controllers, polarizers, polarization-dependent loss (PDL), splicing losses, and measurement issues. An in-class demo summarizes the main topics. After a brief review of phase and group velocity, we consider systems of concatenated birefringent fibers to introduce polarization mode dispersion (PMD), showing several ways of approaching the phenomenon and emphasizing pictorial representations. While the course is on fundamentals, in the last section we briefly address some of the ways in which PMD can impair transmission and several approaches to compensation and mitigation.

Benefits:

After taking this course you should be able to:

- Describe the major representations of polarization states
- Perform simple calculations of polarization evolution in birefringent media.
- Explain the mechanisms underlying PMF and estimate splice tolerances
- Discuss polarization-dependent loss sources and effects
- Explain the physical origin of PMD
- Describe the dominant effects of PMD on transmission systems

Audience:

The course is intended for engineers, technicians, and managers who would like a fundamental survey of polarization effects in devices or systems. The participant should have a basic understanding of waves and the use of complex numbers to describe their phases. A basic understanding of how matrices multiply column vectors is necessary to follow the Jones formalism, and is highly recommended.

Instructor Biography:

Nicholas Frigo received a bachelor's degree from Claremont-McKenna College, and a Ph.D degree from Cornell University, both in Physics. He has worked at the Naval Research Laboratory, at Litton Industries, at AT&T Bell Laboratories, and at AT&T Research in optical propagation and polarization effects in fibers, fiber optic sensors, and optical networks. Since 2005 he has been teaching in the Physics Department at the US Naval Academy in Annapolis, MD.

SC289 Basics of Optical Communication Systems and WDM

Sunday, 17 March 2013
9:00 - 12:00

Instructor: Gerd Keiser; *PhotonicsComm Solutions Inc., USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
The course covers the basic functions and operational characteristics of commercially available optical fibers, LED and laser transmitters, optical receivers, and specialized passive and active photonics components needed for designing modern optical fiber communication links. It explains distortion effects on optical signals, defines bit error rate and optical receiver sensitivity, and describes the impact of these factors on the fidelity of lightwave signal transmission. The course also defines wavelength division multiplexing (WDM) concepts, components, and applications. The topics include characteristics of various WDM components, WDM link design examples, and implementation of WDM-based metro and fiber-to-the-premises (FTTP) networks.

Benefits:
This course should enable you to:

- Describe the functions and operations of key components in fiber optic links.
- Summarize technology trade-offs for implementing different types of fiber optic systems.
- Compare different component types for optical fiber link designs.
- Explain signal distortion processes and their effects on information transmission fidelity.
- Discuss wavelength division multiplexing (WDM) concepts and components.
- Describe WDM applications to long-distance, metro, and FTTP networks.

Audience:

This basic course is intended for engineers who are new entrants to the fiber optic communications field, component and product design and test engineers, technical trainers, technical sales and marketing personnel, consultants, telecommunications managers, and anyone who needs an introductory knowledge of optical fiber communications.

Instructor Biography:

Gerd Keiser was involved with telecom technologies at Honeywell, GTE, and General Dynamics. Recently he was an NSC Chair Professor at the National Taiwan University of Science and Technology. Currently he is the principal educator and consultant at PhotonicsComm Solutions. He is an IEEE Fellow, a SPIE Fellow, an OSA member, an associate editor of *Optical Fiber Technology*, and the author of four books. His interests are in the general areas of optical fiber networking technology and biophotonics.

SC291 Hands-on Fiber Optics for Engineers Designing for Military, Aerospace, Shipboard and Industrial Harsh Environmental Applications

Tuesday, 19 March 2013
8:00 - 12:30

Instructor: Dennis Horwitz; *Micronor Inc., USA*

Level: Intermediate (prior knowledge of topic is necessary to appreciate course material)

Description:

This Short Course provides a very practical and interactive experience for the engineer involved in designing fiber optic components and systems for deployment in harsh environments. Whether military, aerospace, or industrial in nature, a harsh environment application encompasses one or more attributes (temperature, vibration, shock, etc.) that exceeds the "benign environment" baseline associated with commercial telecom/datacom oriented BELLCORE or IEC standards. (The military design might also refer to these commercial products as COTS—commercial off the shelf—which largely dominates the OFC/NFOEC exhibition floor.) The course takes the engineer through a quick, practical overview of fiber optics and then demonstrates a 10-step methodology for designing a fiber optic system for a harsh environment application. At each step the application as well as misapplication of COTS technology will be discussed, including lessons learned from similar programs. From soup to nuts, the course takes the participants through a generic system design and offer guidelines and background to assist decision making at each step: defining the system architecture and lifecycle requirements; choosing the right fiber, cable, and connectors; designing the cable plant; selecting active/passive components; establishing proper installation practices, performing system testing, and certification; developing proper maintenance /restoration methodology; establishing training standards; and evaluating system reliability. Throughout the course, the participants will also perform some hands-on fiber optic test and measurement experiments to best understand the nuances of working with optical fiber, interpreting test standards, and basic troubleshooting techniques. Opportunity will also be provided for open discussion of experiences and problems faced by the participants—to show how the course's materials and 10-step methodology can be applied.

Benefits:

This course should enable you to:

- Explain the difference between MIL-SPEC and COTS/BELLCORE as applied to fiber optic components selected for Harsh Environment applications.
- Determine the relevant environmental, operational, maintenance, reliability, and lifecycle requirements of the application for proper system design and planning.
- Explain pro/cons of DWDM versus GbE, FC, and other optical transmission techniques.
- Explain the fundamental differences and applications of single-mode fiber (SMF) versus multimode fiber (MMF), including the different fiber types and fiber sizes.
- Identify the different optical connector and cable types and understand their specific advantages/disadvantages plus suitability for various applications.

- Operate basic fiber optic test and troubleshooting equipment plus measure attenuation and return loss of optical cable plant cable to understand issues associated with launch condition and installation.
- Discuss lessons learned from a variety of military, aerospace, and industrial programs.
- Understand basic reliability and failure mode issues specific to fiber optic applications.

Audience:

The course is intended for engineers, technicians, or program managers who are involved in the design and deployment of fiber optic systems intended for harsh environment applications—whether military, aerospace, or industrial. At least a few years experience and basic understanding of fiber optics and harsh environment attributes is necessary to understand the course material.

Instructor Biography:

Dennis Horwitz received his M.S.E.E. from the University of California at Los Angles and has more than 30 years experience in research and development, product development, sales, and marketing of fiber optic test equipment and components. He was co-founder of two successful start-ups in fiber optic test and measurement: Photodyne Inc. (1979-1990, sold to 3M) and Rifocs Corp. (1990-2003, sold to Textron). He is actively involved in fiber optic standards development (ARINC, ISA, SAE, and TIA) and has been an OFC/NFOEC Short Course instructor for more than 10 years. He is currently Vice President for Sales/Marketing for Micronor Inc., which has developed and commercialized the first totally passive fiber optic rotary encoder for motion control applications.

SC312 Parametric Optical Processing and Systems

Monday, 18 March 2013
13:30 - 16:30

Instructor: Stojan Radic; *UCSD, USA*

Level: None

Description:

The course will introduce the basics of parametric signal processing and its application in communication and sensing. The course is structured in three segments and will cover:

1. parametric physics in lumped and distributed platforms,
2. device design in time and spectral domains and
3. digital, analog and coherent applications.

Performance, impairments and physical limits of parametric amplification, band conversion, signal regeneration, coherent sampling and conjugation will be described in detail. The course will introduce wideband device synthesis and outline fundamental and practical performance limits. Emerging applications that include tunable sources, coherent sampling, analog-to-digital conversion, reconfigurable delays, and low-latency spectral monitoring will be covered. Finally, the parametric processor role in sensing systems such as distant-band LIDAR will conclude the course.

Benefits:

This course should enable you to:

1. Design the basic parametric amplifier using conventional, off-the shelf elements.
2. Design and test single- and multiple-band converter.
3. Construct coherent parametric processor.
4. Design and construct high-rate multiplexer, demultiplexer.
5. Design and construct scalable multicaster blocks.
6. Introduce parametric module into general purpose instruments in communication, sensing and measurements.
7. Design, construct and characterize high-rate analog-to-digital converter.
8. Explain advantages and disadvantages between translated and band-specific sensing and communication systems.

Audience:

Recommended audience includes researchers interested in ultrafast signal processing, high performance amplification, band conversion and general parametric technology. The course requires only basic fiber course background and will support attendance from junior graduate students and up. The course will

cover topics in communications, sensing, metrology and general laser design and welcomes attendance from diverse backgrounds.

Instructor Biography:

Stojan Radic is a Professor of Electrical Engineering at University of California. He graduated from The Institute of Optics, served as a Senior Scientist at Corning until 1998, when he joined Bell Laboratories. He was a Committee Chair at the Optical Amplifier Conference, Optical Fiber Communications Conference and a Program Chair of Coherent Optical Technologies and Applications Conference. He serves as an Associate Editor for Optics Express and is an OSA Fellow.

SC314 Hands-on Fiber Characterization for the Engineering of Long Haul and Metro Deployments

Tuesday, 19 March 2013
8:00 - 12:00

Instructor: Daniel Peterson[1], Christine Tremblay[2]; *[1]Verizon, USA, [2]École de technologie supérieure, Université. du Québec, Canada*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
In this hands-on course you will measure all of the necessary fiber parameters for qualifying and engineering the optical fiber links of long haul and metro networks at a specified bit rate. The course will begin with a review of the basics of loss, reflectance, chromatic dispersion and polarization mode dispersion in optical fiber links, as well as the challenges in moving from 10G to 40G and 100G bit rates. Bit-rate dependent loss and dispersion limits will be calculated for fiber qualification purposes. Descriptions of the course equipment and experimental setups will follow. The participants will then divide into small groups and rotate among four lab stations. In Lab 1, participants will measure loss and

optical return loss in optical fiber links using power meters and optical time-domain reflectometers (OTDR). In Lab 2, participants will measure the chromatic dispersion in optical fiber links using two different measurement techniques. The first one is the time-of-flight method and the second is the phase-shift method. Christine Tremblay is the instructor. In Lab 3, participants will measure the polarization mode dispersion (PMD) in optical links with combinations of high-PMD fibers using different measurement techniques: the interferometric method, the fixed analyzer method, the Stokes parameter evaluation method and the random-scrambling tunable POTDR method. Daniel Peterson is the instructor. The course will conclude with a review of the pros and cons for each method as well as an analysis of measurements results. Please note that the PMD portion of SC314 and SC210 overlaps in content.

Benefits:

This course should enable you to:

- Learn about transmission limits as a function of bit rate and application.
- Gain the knowledge to make decisions on when specific fiber testing is necessary dependent on the application.
- Measure polarization-mode dispersion (PMD) using Interferometric and JME methods.
- Measure chromatic dispersion (CD) using both time-of-flight (TOF) and phase-shift methods, and discuss CD compensation in mixed-fiber type mesh environments.
- Discuss the effect of PMD and chromatic dispersion on high-speed digital signals.
- Discuss the outage probability in optical fiber transmission systems due to PMD-induced degradation.
- Measure loss and characterize splices using optical time-domain reflectometry (OTDR).
- Describe the system-level effects of polarization-related impairments on long-haul optical transmission.

Audience:

This course is intended for engineers, technicians and managers involved with optical fiber, components or systems, including those that operate at or above 10 Gb/s.

Instructor Biography:

 Daniel Peterson is a distinguished member of the technical staff at Verizon. He has directed the characterization of the ULH network fiber. He is an internal advisor on optical technologies and is responsible for specifying new optical fiber and characterization of older fiber for Verizon's ULH network. Peterson is also an adjunct professor at the University of Texas at Dallas. He received a Ph.D. (electrical engineering) from the University of Texas at Dallas.

 Christine Tremblay is a professor at the École de technologie supérieure, Université du Québec. She set up the *Laboratoire de technologies de réseaux*, an advanced optical layer testbed for research on high-speed transmission, measurements and network design, and established courses on optical communications. She also held senior R&D and technology management positions at Nortel, EXFO and INO. She received a Ph.D. (optoelectronics) from the École Polytechnique de Montréal. She is a member of OSA and IEEE.

SC325 Highly Integrated Monolithic Photonic Integrated Circuits

Sunday, 17 March 2013
9:00 - 13:00

Instructor: Chris Doerr; *Acacia Communications, USA*
Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
This course will discuss monolithic photonic integrated circuits (PICs) in InP, silicon, and related materials for optical communications. The course will start with optical waveguide fundamentals and move toward state-of-the-art devices comprising many elements monolithically integrated. Higher layers of PIC design will be stressed. A significant portion is devoted to PICs for advanced modulation formats and coherent detection.

Benefits:
This course should enable you to:

- Design optical waveguide structures.

- Simulate optical waveguide structures.
- Design complex photonic integrated circuits.
- Simulate photonic integrated circuits.
- Understand some of the device physics.
- Predict future abilities and costs of photonic integrated circuits.
- Debug problems in photonic integrated circuits.

Audience:

This course is intended for anyone who has basic electromagnetics knowledge (e.g., know Maxwell's equations but do not have them memorized) and basic optical communications knowledge (e.g., know what optical fiber is but do not have to know what 16-QAM is) but wants to learn more about photonic integrated circuits.

Instructor Biography:

Christopher R. Doerr earned a B.S. in aeronautical engineering and a B.S., M.S., and Ph.D. in electrical engineering from the Massachusetts Institute of Technology. Since joining Bell Labs in 1995, Doerr's research has focused on integrated devices for optical communication. He received the OSA Engineering Excellence Award in 2002. He is a Fellow of IEEE and OSA. He was Editor-in-Chief of IEEE Photonics Technology Letters from 2006-2008. He was an Associate Editor for the Journal of Lightwave Technology from 2008-2011. He was awarded the IEEE William Streifer Scientific Achievement Award in 2009. He became a Bell Labs Fellow in 2011. He joined Acacia Communications in 2011.

SC327 Modeling and Design of Fiber-Optic Communication Systems

Monday, 18 March 2013
13:30 - 16:30

Instructor: René-Jean Essiambre; *Bell Labs, Alcatel-Lucent, USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

The broad objective of this course is to provide a working knowledge of the numerous techniques and tools used to design the transport layer of advanced fiber-optic communication systems, from metropolitan to ultra-long haul systems. The primary focus is on providing a comprehensive overview of how to model propagation over optical fibers, with emphasis on the various fiber nonlinear effects involving signal and noise, for both singly-polarized and polarization-division-multiplexed signals. This includes a description of the techniques suitable for modeling nonlinear propagation of various advanced modulation formats in optically routed networks. The course also provides a comparative description of various optical amplification technologies, such as erbium-doped and Raman amplification, for different types of transmission lines. A description of the tools used to characterize system performance is covered in this course, including evaluations of optical signal-to-noise ratio (OSNR) penalties and Q-factors. In addition, the course presents an introduction to the issues faced when configuring the physical layer of optical networks, including ring and mesh network topologies. Finally, the course concludes with an overview of the ultimate capacity of the "fiber channel" that helps participants understand technological limits associated with increasing the capacity of fiber-optic communication systems.

Benefits:

This course should enable you to:

- Develop a functional understanding of the basic building blocks of fiber-optic communication systems.
- Learn the basic elements of optical transmission modeling.
- Develop a detailed understanding of how to model nonlinear transmission over fibers, especially how to navigate through the numerous pitfalls of nonlinear transmission modeling.
- Choose a suitable technique for modeling specific systems, such as systems using advanced modulation formats.
- Compare the performance of various amplification technologies.
- Understand the basic technical issues faced when configuring optical networks with complex topologies.
- Estimate the ultimate limit to fiber capacity.

Audience:

This course is intended for engineers and scientists working on fiber-optic transmission as well as those working on components and subsystems interested in developing an expertise at the transmission level. The course also addresses academic researchers and graduate students with basic knowledge on optical or digital communication interested in developing a detailed knowledge of fiber-optic transmission modeling and in understanding system implications of advanced technologies.

Instructor Biography:

René-Jean Essiambre is a Distinguished Member of the Technical Staff at Bell Labs, Alcatel-Lucent. He received his doctorate from Université Laval and studied at the University of Rochester before joining Lucent Technologies (now Alcatel-Lucent) in 1997. Essiambre is contributing to the design of advanced optical transmission systems, especially in relation to the management of fiber nonlinearities. His interests include modulation formats, detection and optimization techniques for the design of optically routed networks to increase capacity, optical transparency, and functionality of wavelength-division multiplexed communication systems. He is a recipient of the 2005 Engineering Excellence Award from OSA, where he is a fellow.

SC328 New Developments in Optical Transport Networking (OTN)

Sunday, 17 March 2013
9:00 - 12:00

Instructor: Stephen Trowbridge; *Alcatel-Lucent, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

This course provides an introduction to revised ITU-T Recommendation G.709/Y.1331, *Interfaces for the Optical Transport Network (OTN)*, focusing on new interfaces and capabilities for OTN in the first major

revision of the standard since 2003. As DWDM networks have evolved, they have provided a common convergence layer for SONET/SDH, IP, and Ethernet traffic. The latest version of the standard helps move from a combination of point-to-point DWDM line systems and metro ROADM networks to a full, end-to-end managed network. The OTN hierarchy has been extended "at both ends," adding a new lower tier (ODU0) optimized for the transport of 1000GBASE-X (Gigabit Ethernet), and a new upper tier (ODU4) optimized for the transport of the new 100GBASE-R (100 Gigabit Ethernet) recently specified by the IEEE P802.3ba project. Mapping is specified for the new 40GBASE-R (40 Gigabit Ethernet) signal into existing 40G transport using the currently deployed ODU3. OTN is being deployed by many operators for their next generation network builds. This course will cover the basic concepts of G.709, with specific emphasis on the recently added interfaces and capabilities. You will learn how IP, Ethernet, and SONET/SDH traffic can be carried by an international standard based digital wrapper solution. You will develop an appreciation for the flexibility provided in the latest OTN standards to transport a wide variety of client signals and to efficiently manage bandwidth.

Benefits:

This course should enable you to:

- Understand the concepts that form the basis for an OTN based on G.709.
- Learn about the new interfaces provided in the latest revision of the standard.
- Apply the capabilities of the OTN standards to manage client signals and wavelengths.
- Understand the mapping mechanisms used by OTN to transport major client signals.
- Utilize the new flexibility of the latest standard for efficient bandwidth management.

Know where to look to find more information about G.709.

Audience:

This course is intended for anyone who designs, operates, or supports metro and/or long haul optical networks and who need to understand the new interfaces and capabilities in ITU-T Recommendation G.709 and how they can be used.

Instructor Biography:

Dr. Stephen J. Trowbridge is a Consulting Member of Technical Staff (CMTS) at Alcatel-Lucent. He received his B.S. (EE&CS), M.S. (CS), and Ph.D. (CS) from the University of Colorado, Boulder. He joined Bell Laboratories-AT&T (now Alcatel-Lucent) in September 1977. He has been active in optical networking standardization since 1995. He is vice-chair of ITU-T TSAG, chairman of ITU-T Working Party 3/15 (responsible for OTN standards including G.709), chairman of the ATIS COAST-OHI working group, and a was a member of the IEEE P802.3ba editorial team.

SC341 OFDM for Optical Communications

Sunday, 17 March 2013
17:00 - 20:00

Instructor: Sander L. Jansen[1], Dirk van den Borne[2]; *[1]ADVA Optical Networking, USA [2]Juniper Networks, Germany*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
In this short course we will discuss the ins and outs of optical OFDM for next-generation optical transmission systems. The course will describe the principles of OFDM, the signal processing algorithms that are required for generation and detection, as well the trade-off in digital signal processing complexity of the different as algorithms in various flavors of OFDM. The course will focus this year particularly on the different application scenarios of OFDM, ranging from short distance access networks to ultra long-haul transmission. In particular, focus will be placed on the role that OFDM can play in next-generation 400G/1T transport networks. In addition the course will touch on the requirements and challenges when using OFDM for multi-mode propagation.

We describe the most relevant techniques for the generation of OFDM (both analogue and digital), and explain in detail the modulation and detection techniques for an optical OFDM signal. In addition, implementation aspects of optical OFDM such as the compensation of transmitter and receiver

imperfections are addressed and the digital signal processing complexity trade-offs are explained.

The course should enable attendees to get a feel for the different concepts and implementations of optical OFDM and their application scenarios in different types of optical networks, including understanding the role that OFDM can play in optimizing the capacity of optical transport networks.

Benefits:

This course should enable you to:

- Describe the concept of orthogonal frequency division multiplexing (OFDM) and its implementation.
- List different flavors of optical OFDM and detail the advantages and disadvantages of each method to generate an OFDM signal.
- Appreciate the design trade-offs of the cyclic prefix, FFT-size, etc. with respect to for instance the dispersion tolerance and oversampling.
- Explain the multi-input, multi-output (MIMO) technique that is required to equalize a polarization division multiplexed (PDM) or a mode division multiplexed signal.
- Describe concepts such as IQ imbalance mitigation and phase noise compensation.
- Illustrate the advantage that OFDM can bring in the generation of super channels for next-generation 400G/1T transport networks as well as future mode-division multiplexed transmission.
- Explain the influence of fiber nonlinearity on OFDM and describe methods to optimize the nonlinear tolerance of optical OFDM.
- Discuss different applications for optical OFDM from access to long-haul transmission in next-generation optical transport.

Audience:

This course is intended for engineers, researchers and technical managers who like to gain a better understanding of optical OFDM and its applications in next-generation optical transport networks. Apart from the theory and concepts behind optical OFDM, the implementation and system design will be discussed in detail, such that the participants can obtain a good level of understanding for the different design trade-offs. Participants should have a basic knowledge in the field of fiber-optic transmission systems; no previous knowledge of OFDM is required. Past attendees of the course will find substantial updates and new information, and they are encouraged to attend again.

Instructor Biography:

 Sander L. Jansen received his Ph.D. degree (with highest honors) in EE from the Eindhoven, University of Technology. Subsequently, Dr. Jansen worked as a post-doc at KDDI R&D Laboratories in Japan where he specialized in optical orthogonal frequency division multiplexing (OFDM), a broadband multi-carrier modulation method, for long-haul transmission systems. Whereas OFDM is a common modulation format in wireless communication systems it was at the time of his post-doc new for the optical communication community. From 2008 to 2012 he was project manager at Nokia Siemens Networks in Germany. In this position he was responsible for the specification, technical evaluation and selection of optical components. In addition he investigated and evaluated modulation formats for next generation 100GbE transmission systems and was responsible for forward looking topics in collaboration with several universities. Currently, Dr. Jansen is Director of Product Line Management at ADVA Optical Networking, Germany.

Dr. Jansen authored and co-authored 10+ patents, one book chapter and more than 100 refereed papers and conference contributions. He is an associate editor for the *PTL* and has served as a committee member on various conferences. He has received several awards including the Young Investigator award from the IEEE Photonics Society *"for pioneering contributions in optical OFDM for fiber-optic transmission systems"*.

 Dirk van den Borne was born in Bladel, The Netherlands, on October 7, 1979. He received the M.Sc. and Ph.D. degrees in electric engineering from the Eindhoven University of Technology, The Netherlands, in 2004 and 2008, respectively.

During his master studies, he performed experimental work at Fuijtsu Laboratories Ltd., Kawasaki, Japan, and the Siemens AG, Munich, Germany. His Ph.D. research was conducted at Siemens AG (later Nokia Siemens Networks) in Munich in collaboration with the Eindhoven University of Technology. During his Ph.D. research he focused on improvements in long-haul transmission systems using robust optical modulation formats and electronic impairment mitigation. As part of his Ph.D. studies he succeeded in the first demonstration of 100-Gb/s transmission with coherent detection and digital signal processing, now the established standard for 100G transport. In 2008 he joined Nokia Siemens Networks, initially as a

system architect and later on as the R&D program manager responsible for the optical system performance of the DWDM portefolio. He was also responsible for setting up and coordination the European MODE-GAP project on multi-mode optical transmission systems during the initial phase of this project. In 2012 he joined Juniper networks, where he is now a senior architect for packet-optical transport.

He has spoken frequently at major industry events, authored and co-authored more than 100 peer-reviewed papers and conference contributions and holds several patents on optical communication. He received the telecommunication award from the royal Dutch engineering society (KIVI-NIRIA) and the IEEE/LEOS graduate student fellowship in 2007. He is a member of the technical program committee of the Optical Fiber Conference (OFC) and previously served on the technical program committees of the IEEE photonics conference and summer topicals conference.

SC347 Reliability and Qualification of Fiber-Optic Components

Monday, 18 March 2013
8:30 - 12:30

Instructor: David Maack; *Corning, USA*

Level: None

Description:
Reliability is one of the most important requirements for our modern telecommunication systems. It is one of a customer's first areas of intensive inquiry for a new supplier and potentially one of the biggest problems in deployed systems. An unreliable sub-component can easily bring down entire systems and, in the worst scenario, force recalls costing thousands of times the original components price leading to substantial financial liabilities and highly strained customer-vendor relationships. Qualification and reliability must both be performed for photonic components.

This course is a combination of two prior courses, "Reliability Methodologies for Fiber Optic Components" and "Qualification Programs for Fiber Optic Components" along with new material which tries to bridge the relationship and gap between qualification and reliability. When is it appropriate to rely on the qualification tests and when must expensive and time consuming reliability models be developed? This is a difficult balance that goes beyond just technical analysis; it involves risk taking, business decisions,

judgment and experience. Qualification programs are performed primarily to reduce the high costs of true reliability programs, and as such, act as a proxy for reliability.

Benefits:

This course will enable the attendee to:

- Learn the strategic and tactical differences between performance, qualification and reliability testing.
- Understand how and where reliability and qualification fit at the high level in organization structure and strategy
- Review the multitude of tools, roles and tactical functions that a reliability group performs particularly during product development
- Discuss and learn what constitutes a complete qualification program and get the author's interpretation of the "letter of the law" for the most popular standard
- See detailed charts comparing different qualification standards
- Appreciate what each of the qualification tests really test for and its limitations
- Determine why and when reliability testing and modeling needs to be done.
- Understand the limitation of both reliability modeling and qualification testing.
- Learn how to establish appropriate reliability tests and gather meaningful data.
- Apply the basics of reliability testing and modeling mathematics to determine the proper statistical distribution for a set of failure data.
- Calculate the reliability of a device using accelerated testing data with case studies for guidance.
- Find information on standards, components, reliability software and other reference materials.
- Read reliability and qualification reports and determine their adequacy.

Audience:

This course is intended for a general audience including non-technical persons with no particular background except an interest in or need for knowledge of reliability and qualification of fiber optic components. It is meant to impart valuable information to audiences of all levels.

Instructor Biography:

David Maack has more than 30 years of engineering and management experience in photonics with the last 15 years in qualification and reliability for passive and active fiber optic components. Currently, he is the reliability manager for the Components and Systems Group at Corning, Inc. in Corning, NY. He is the past chairman of the IEC TC86B Working Group 5 writing standards for passive fiber optic components, has participated in multiple Telcordia GR rewrites, and is the author of numerous papers. He has bachelor's degrees in physics and nuclear science along with a master's degree in business administration.

SC356 40G/100G Ethernet Technologies and Applications

Monday, 18 March 2013
9:00 - 12:00

Instructor: Osamu Ishida; *NTT Electronics, Japan*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
This short course provides an overview of the challenges, current solutions, and future trends in the highest speed Ethernet technologies and their applications.

The paradigm of the optical interface has shifted at 40 Gb/s both in terms of technology and application, from serial to multi-lane and from Telecom-driven to Datacom-driven, respectively. The course first reviews the historical trends, the evolution in Ethernet in terms of speed and applications, and the degree of penetration of Ethernet into WANs and SANs. The 40-Gb/s and 100-Gb/s Ethernet (IEEE802.3ba) Physical Layer architecture, technologies, and implementation with pluggable modules are discussed in detail to provide insight into current and future technology/standardization trends such as next-generation 100G and higher-speed Ethernet. Finally, the course highlights emerging 40G and 100G Ethernet usage cases both in telecom and datacom applications such as aggregated transport in Optical Transport Networks (OTNs) and a converged network interface for Fiber Channel over Ethernet (FCoE) in a cloud data center.

Benefits:

This course should enable you to:

- Summarize the evolution of Ethernet in terms of speed and applications.
- Identify key concepts behind the Ethernet Physical Layer technologies.
- Describe 40G and 100G Ethernet Physical Layer architecture and interfaces.
- Appreciate the 10G technologies leveraged with the lane distribution mechanism.
- Discuss the various form-factors of 40G and 100G pluggable transceiver modules.
- Derive insight into future trends regarding next-generation 100G and higher speed Ethernet.
- Compare technological options for wide- and storage-area-network applications.
- Explain 40G and 100G Ethernet accommodation in OTNs.
- Discuss data center Ethernet converged with fiber channel applications.

Audience:

This course is intended for engineers, researchers, and technical managers who would like to gain a better understanding of newly-standardized IEEE802.3ba 40G/100G Ethernet technologies and relevant usage cases both in telecom and datacom applications. No prior knowledge of Ethernet is required.

Instructor Biography:

Osamu Ishida is a project leader at NTT Electronics Co. (NEL), and leads several projects for 100G DSP/ASIC developments at NEL Electronics Device & Systems Group, Yokohama, Japan. He has over 20 years of experience at NTT Labs in research on high-speed Ethernet transport, WDM cross-connect, and coherent optical fiber communications. He has been involved with standards development of 10G/40G/100G Ethernet (*IEEE 802.3*) and the revision of OTN *(ITU-T G.709*). He is currently serving as Chair of the Technical Committee on Optical Communication Systems (OCS) in IEICE, Japan. Recently, he has served as a guest editor for *IEEE COM-M*. He is the author or coauthor of more than 50 journal and conference articles in English and a coeditor of the textbook *10 Gb/s Ethernet Technologies* published by

Impress Japan in 2005. He received his M.E. and B.E. degrees in electrical engineering from the University of Tokyo, Japan.

SC357 Computercom Interconnects: Circuits and Equalization Methods for Short Reach Power-Efficient Optical and Electrical Links

Monday, 18 March 2013
9:00 - 12:00

Instructor: Alexander Rylyakov; *IBM T.J. Watson Research Center, USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
Unlike telecom or datacom (where optics dominates), computercom interconnect applications is the area where optical and electrical I/O solutions are often in direct competition on all main performance parameters: reach, bandwidth, power efficiency, density and cost. To achieve the highest level of performance, both types of links require highly specialized front-end circuits and equalization methods.

The main focus of the course will be on circuits for VCSEL-based multi-mode optical links. All key circuit topologies and performance parameters will be compared to corresponding wireline transceiver solutions. For completeness, we will also briefly discuss circuits for Silicon Photonics applications.

We will start with outlining the basics of channel properties and communication techniques. We will then review the most common front-end I/O circuit topologies used in both optical and electrical short reach interconnects and compare their overall efficiencies. Typical transmitter and receiver architectures for both electrical and optical links will be presented, with discussion of basic functionality and performance requirements for each of the building blocks. We will outline the similarities as well as the differences between the key front-end components (e.g., VCSEL driver vs wireline driver vs Silicon Photonic modulator driver), and their effect on the overall link performance. The review will also include a brief discussion of the high-speed digital MUX/DEMUX (serializer/deserializer) circuits and the CDR (clock and data recovery) function. We will compare the most commonly used SiGe bipolar and CMOS technologies in terms of performance, power dissipation, area and cost. Several optical and electrical full link power efficiency examples will be presented and discussed.

Electrical links have to employ heavy-duty equalization techniques due to severe bandwidth limitations of

wireline channels, but optical solutions can also greatly benefit from equalization, even at short reach. We will discuss the most commonly used equalization methods:

- continuous-time linear equalizer (CTLE, often used on both sides of the link)
- feed-forward equalizer (FFE, typically employed in the transmitter pre-emphasis)
- decision-feedback equalizer (DFE, commonly present in the receiver)

High-level descriptions of several topologies of FFE transmitters and DFE receivers will be presented, together with a discussion of tradeoffs involved when selecting one equalizer over another, or using both. We will conclude with discussion of several recently published results demonstrating the dramatic benefits of equalization for optical links.

Benefits:

This course should enable you to:

- Outline overall transceiver architectures of typical wireline and optical short reach links
- Explain functionality and performance requirements of all key front-end I/O building blocks
- Evaluate and compare the efficiencies of wireline and optical short reach interconnects
- Compare SiGe bipolar and CMOS circuits for short reach optical and electrical links
- Understand and compare equalization techniques (CTLE, FFE, DFE)
- Discuss benefits and tradeoffs of equalization
- Make an educated choice between an optical and electrical solution for short reach interconnect

Audience:

This course is for anyone interested in learning the basic transmitter and receiver circuit architectures for both optical and electrical short reach interconnects. The course will help gain the insight into the main tradeoffs involved in choosing between the optical and electrical links, as well as the integrated circuit topologies and technologies used in the transceiver circuits. The overview of advanced equalization techniques will be also of interest to audience already familiar with the basics of short reach interconnect.

Instructor Biography:

Alexander Rylyakov received the M.S. degree in physics from Moscow Institute of Physics and Technology in 1989 and the Ph.D. degree in physics from State University of New York at Stony Brook in 1997, where he worked on the design and testing of superconductor integrated circuits based on Josephson junctions. In 1999 he joined the IBM T.J. Watson Research Center as a research staff member, working on the design and testing of high-speed digital and mixed-signal communication circuits for optical and channel-limited wireline communications. Many of those circuits, implemented in various generations of CMOS and SiGe bipolar, are now used in IBM products and several of them have established performance records in their respective technologies. Dr. Rylyakov's current research interests are in the areas of digital phase-locked loops for communication and microprocessor clocking, high-speed low power transceivers and equalization for wireline and optical communication, and integrated circuits for silicon photonics. He has published over 80 papers and has received 10 patents.

SC358 Data Center Cabling: Transitioning from Copper to Fiber

Sunday, 17 March 2013
13:00 - 16:00

Instructor: Lisa Huff; *DataCenterStocks.com, USA, Discerning Analytics, LLC, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
This short course is intended to help data center and network managers understand the value proposition of an all-optical data center. Topics that will be discussed include looking at basic data center network infrastructure design and hardware needs. The course was developed with the TIA-942, Telecommunications Infrastructure Standard for Data Centers in mind, but will also address the fact that many data centers really have not used this standard in practice. Networking standards such as IEEE 802.3, Fibre Channel, iSCSI and InfinBand will be reviewed along with their applicability to certain aspects of the data center. Technology roadmaps and data center networking trends such as the advent of Top-of-Rack (ToR) switching will be included as well as how to handle transitioning from lower to higher data rates within your data center. When it makes sense to implement fiber optics and what types of transceivers and cabling should be used for different scenarios will be presented. Other technologies such as Fibre Channel over Ethernet, RDMA (InfiniBand) over Converged Ethernet, IO virtualization and how virtualization and network consolidation will affect data rates will also be discussed. Detailed cost analysis of fiber versus copper in the data center will be presented considering not only equipment and infrastructure cost, but potential staff, port and cabling density, power and cooling costs. Also included

will be analysis of whether it matters what vertical market a data center supports – for example, does a financial sector data center have different requirements than a higher-education data center? Several real-world case studies will be presented.

Benefits:

This course should enable you to:

- Design data center networks in accordance with TIA-942
- Determine when a fiber-optic cabling solution would be appropriate
- Define Ethernet, Fibre Channel and InfiniBand technologies and their appropriate applications
- Compute how cost-effective your current network topology is
- Determine appropriate measures for upgrading network equipment to higher data rates
- Accurately and realistically compare copper and fiber technologies in the data center
- Identify different defined areas of a data center
- Determine appropriate technologies for your data center

Audience:

This course is valuable to engineers, technicians, networking professionals and managers interested in transitioning their networks and data centers from copper to fiber optics. Data center operators and facilities managers may also be interested in attending to understand some of the networking technologies contained in their data centers.

Instructor Biography:

 Lisa Huff is Chief Technology Analyst for DataCenterStocks.com and Principal Analyst at Discerning Analytics, LLC. Lisa is a Certified Data Center Professional (CDCP) and degreed electrical engineer with more than 25 years experience in the electronics industry. She has held various industry marketing and engineering positions at Berk-Tek, A Nexans Company, Communications Industry Researchers, FCI and Tyco Electronics. Her expertise is in data centers, data communications cabling and connectivity, networking equipment and optical components. Lisa writes for two blogs: DataCenterStocks and Optical Components. She has presented at several industry conferences and has produced more than 20 publications and her most recent market research can be found at Discerning Analytics Web site.

SC359 Datacenter Networking 101

Sunday, 17 March 2013
9:00 - 12:00

Instructor: Cedric Lam, Hong Liu; *Google, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
This introductory course starts with a review of the network transformations resulted from the rise of Internet computing applications. We then review the architectural structures of warehouse-scale computers (WSCs) and the networking technologies used to implement WSC datacenters. This course covers both intra-datacenter and inter-datacenter networks, the challenges facing datacenter operators in the next 3 to 4 years, the need for energy efficient datacenter networking technologies, and the desirable optical networking technologies to sustain the growth of Internet computing applications.

Benefits:
This course should enable you to:

- Define warehouse-scale computer (WSC) and describe its structure
- Describe the engineering principles and philosophies behind scalable mega-datacenter infrastructures
- Compare different datacenter cluster topologies and switching technologies.
- Compare the differences and similarities between traditional telecommunication networks and booming data-communication networks
- Identify the challenges for intra-datacenter and inter-datacenter communications
- Select suitable optoelectronic interconnect technologies
- Explain the roles of optics in transmission, multiplexing and switching
- Identify designs to realize energy efficient data networks

Audience:
This course is beneficial to optoelectronic engineers, fiber optic transceiver designers and optical transmission engineers who would like to understand the requirements of datacenter networking. It also benefits network engineers with the knowledge of high-speed optical communication technologies used to realize various datacenter network applications. For network planners and architects, this course provides outlooks in optical network technology developments in the next 3 to 4 years.

Instructor Biography:

Cedric F. Lam is currently Optical Network Architect at Google. Before joining Google, he worked at OpVista Inc. as chief system architect, responsible for the development of an ultra-dense WDM transport system with integrated ROADM functionality. Prior to OpVista, Cedric was senior technical staff member at AT&T Labs-Research. His research covers broadband optical transport and access networks architectures, optical signal modulation and transmission, passive optical network, HFC, etc. His current focus is in FTTH and optical networking technologies for data center applications. Cedric received B.Eng. in Electrical and Electronic Engineering from the University of Hong Kong with First Class Honors and PhD. in Electrical Engineering from UCLA.

Hong Liu is a Member of Technical Staff at Google Platform Advanced Technology, where she is involved in the system architecture and interconnection for large-scale computing platforms. Her research interests include interconnection networks, high speed signaling, photonic integrated circuit, and optical metro design. Prior to joining Google, Hong was a Member of Technical Staff at Juniper Networks, where she was principally involved in the architecture and design of high-end physical interface cards, network routers, and multi-chassis switches, including Juniper's flagship core router T640, edge routers M7i/M10i/M120, world's first OC768 line card and world's very first switch-matrix TX640. Hong received her Ph.D. in Electrical Engineering from Stanford University.

SC360 Hands-On Fiber Optic Terminations and Measurements with Emphasis on MTP Connectorized Ribbon Fiber

Monday, 18 March 2013
13:30 - 17:30

Instructor: Caroline Connolly[1], Chris Heisler[1], Loïc Cherel[2], Mike Hughes[3], Tom Mitcheltree[3], Jim Frazer[4], Jill Christie[4]; [1]OptoTest Corp., USA, [2]Data-Pixel SAS, France, [3]USConec Ltd., USA, [4]Domaille Engineering, USA

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
In a practical, hands-on setting the student will learn about industry standard inspection, measurement, and qualification methods and will solidify the measurement concepts with hands-on practice. With three

fully equipped stations, we will discuss care and cleaning of fiber optic cable assemblies as well as the trends to high density connectivity and inspection. Students will use equipment during the class to measure insertion loss, return loss, and to measure and analyze interferometric results on simplex and multifiber connectors.

Students will learn the basic concepts of an interferometer and how these measurements are performed. A hands-on demonstration of making measurements on a single- and multifiber connector will be provided with reference to TIA and IEC standards. The main measurement parameters for fiber geometry will be discussed for single and multifiber terminations. The influence of each parameter on performance and long term reliability of the connector will be explained in detail.

Benefits:

This course should enable you to:

- Identify fiber types such as simplex, duplex, and ribbon fiber and their practical applications
- Classify connectors and components that are used in networks and other long haul applications.
- Use several cleaning methods and recognize contamination versus scratches using various inspection methods.
- Measure insertion loss and return loss on terminated cable assemblies for single-mode and multimode simplex and ribbon fibers.
- Measure and analyze geometric data using an interferometer for simplex and ribbon fibers comparing achieved and expected results.

Audience:

Those in positions from technicians and engineers to managers interested in connector trends and measurements will find this class valuable. Familiarity with fiber optic testing and equipment is beneficial but not necessary.

Instructor Biography:

Caroline Connolly is a Sales Director at OptoTest Corp. and has been involved with fiber optic test and measurements technologies and cable assemblies for more than 12 years. Her experience covers all

areas of physical layer optical testing ranging from laboratory to field applications. Before joining OptoTest, she worked in various key sales positions at Rifocs Corp. Connolly holds a bachelor's degree in business management from the University of Phoenix.

Chris Heisler has been in the fiber optics industry for over 4 years. For this duration he has worked at OptoTest Corp. as an Applications and Test Engineer where he has studied and researched fiber optic cable measurements with a focus on launch condition measurements and the various standards governing these measurements. Chris attended California Polytechnics San Luis Obispo where he received a B.S. in electrical engineering and is currently pursuing his master's degree.

 Loïc Cherel is the CEO and founder of Data-Pixel SAS, a leading manufacturer of interferometry and inspection systems dedicated to the field of fiber optics.
Mr. Cherel is a contributing expert to the IEC standardization organization (86B, WG4 & WG6). In particular, he is the editor of some of the IEC standards related to single and multifiber geometry measurements using interferometers.

 Mike Hughes is the Product Manager for multifiber connectivity products at US Conec Ltd. He has held engineering and commercial positions in MT ferrule technology for over 9 years and has over 17 years of experience in copper and fiber optic connectors and cabling products. Mike is a US National Committee contributing expert to IEC SC86B, WG4, and WG6. Mike holds a Bachelor of Science degree in mechanical engineering from North Carolina State University and a Master of Business Administration degree from Wake Forest University.

Tom Mitcheltree is the Product Manager at US Conec Ltd for fiber optic connector cleaning tools. He has over 11 years of experience in manufacturing fiber optic systems for Telecommunications and Enterprise applications. Tom has been instrumental in implementing fiber optic cleaning and inspection solutions for high fiber count designs. He is a US National Committee contributing expert to IEC SC86B, WG4 & WG6, and co-author of IPC 8497-1. Tom holds a Bachelor of Science degree from Westminster College.

 Jill Christie is the Sr. Product Manager responsible for product strategy, new product development and global sales for the Fiber Optic Polishing division of Domaille Engineering.
Jill is a leader and innovator with a passion to build products and services for the fiber optic polishing market. She holds a Degree in electronics and has been with Domaille since 2000. In that time, her leadership, drive, and persistence have translated into many new products. She is widely recognized as a leading technical resource for fiber optic polishing.

 Jim Frazer is the President of Domaille Engineering and has overall responsibility for the strategic direction of the organization and its profitable growth. As President, Jim championed using engineering solutions to drive innovation across the company's businesses. Under his leadership, Domaille has moved closer to customers around the world, resulting in greater partnering, collaboration, and solution development.

SC369 Test and Measurement of Complex Modulated Optical Signals

Monday, 18 March 2013
13:30 - 16:30

Instructor: Bernd Nebendahl, Oliver Funke; *Agilent Technologies, Germany*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
Device bandwidth constraints and typical 50 GHz channel spacing force system designers to consider combined phase and amplitude modulation as a method to increase channel information capacity. Test and measurement of the transmitters and receivers used in these complex modulation systems requires techniques that are vastly different than those used for the simple amplitude modulation based systems that have dominated optical communications. This course will give an overview of the basics of complex modulation. For test and measurement there will be an emphasis on systems based on polarization diverse coherent receivers with their signals being sampled in real time. A significant part of the course will describe how various distortions of the constellation diagram can be traced back to transmitter or

receiver issues in order to help students identify issues of these subsystems. Parameters that quantify the signal quality of a complex modulated signal are introduced that allow rating the performance and identifying problems of a transmitter for complex modulated signals. The definition of the error-vector-magnitude (EVM) and its relationship to BER, SNR, and Q-factor will be explained. Methods to quantify the uncertainty of a test system and to validate its performance will be presented.

Benefits:

Attendees of this course will be able to:

- Compare the quality of various transmitters through the use of EVM measurements
- Determine the relationships between EVM, BER, and Q-factor
- Compare the different techniques used for complex modulation analysis and determine which provide optimum results for a given measurement scenario
- Relate details of constellation diagrams to specific device and/or measurement system impairments
- Identify the root causes of measurement degradation and uncertainty
- Develop test strategies to validate the accuracy of test results

Audience:

This short course is intended for engineers who start to work or already have experience in manufacturing and development of transmitters, links and receivers operating with complex modulated signals. Attendees should be aware of basic concepts of optical transmission and polarization of light. Research and manufacturing managers as well as technical buyers will get a profound background in order to make optimal decision for their test and measurement needs. Students will extend their knowledge in complex signal analysis to setup optimal test concepts.

Instructor Biography:

Oliver Funke

Product Manager, Agilent Technologies

 Oliver joined Agilent Technologies in 1992 (formerly Hewlett Packard) as Engineer of the Optical Communication Measurement Division. Oliver has worked in various R&D projects, including low noise OTDR receiver, optical power meter, coherent optical all parameter test and lightwave component analyzer in various positions from engineer to project lead. In 2006 he joined product marketing. He is now responsible as Product Manager for coherent transmission test. Oliver has a degree in Communication Theory from the Technical University in Munich.

 Bernd Nebendahl

Project Lead, Agilent Technologies

Bernd joined Agilent Technologies in 2000 as Engineer of the Optical Communication Measurement Division. Bernd has worked in various R&D projects, including tunable external cavity lasers, optical attenuators, coherent optical all parameter testers, distributed temperature sensing and the optical modulation analyzer in positions from optics designer to project lead. He currently focuses on all topics around coherent transmission. Bernd received a diploma and a PhD in physics, both from University of Stuttgart.

SC371 Multi-layer Control Plane Technologies - Managing Hybrid Networks

Sunday, 17 March 2013

13:00 - 16:00

Instructor: Lou Berger[1], Wes Doonan[2]; *[1]Labn Consulting, USA, [2]Adva Optical, USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

Network services and switching technologies have traditionally been deployed and operated along a *per-layer* approach, where network equipment supports only a single switching technology and management of each set of equipment is independent. More recently there has been a trend to integrate multiple switching technologies into the same network equipment and to integrated operation support tools and technologies. Such *hybrid networks* incorporate different and distinct classes, or *multiple-layers*, of transport services and switching. Examples of hybrid-network technologies include integrated packet-optical transport platforms, and OTN equipment that can simultaneously switch at ODUk multiplexing levels. Networks constructed with such network equipment present a unique set of deployment and control challenges. Integration between transport technologies involves adaptation in both data and control planes, and in order to efficiently manage these adaptations, a clear and consistent operational framework is required. In the context of the control plane, multi-layer integration enables opportunities for dynamic cross-layer interactions as well increased resource optimization.

This course will provide participants with an understanding of existing GMPLS-based control plane standards, techniques and mechanisms for operating hybrid networks. This course will review the relevant control plane concepts and standards. Both single-layer and multi-layer perspectives will be presented. The course will also identify specific concepts, tools and mechanisms which can be used by network operators to efficiently and functionally control a hybrid network controlled by a standards-based control plane. Such topics as dynamic forwarding adjacencies, dynamic service activation, virtual links, virtual nodes, and remote path computation will be covered. Use of these technologies in context of emerging network virtualization applications is also outlined. Examples of how these techniques can be deployed within optical hybrid network topologies are also discussed, along with the advantages and consequences of each.

Benefits:

This course should enable participants to:

- Identify and describe the primary operational support functions provided by a GMPLS-based control plane in a transport network
- Discuss and compare different control-plane based approaches for the integrated control of a multi-layer transport network.

- Determine how the capabilities of a specific control-plane implementation may be leveraged in a particular transport network.
- Begin the design of multi-layer transport network control systems employing single-layer or multi-layer control plane techniques and mechanisms.
- Initiate designs for the use of new network virtualization capabilities enabled by advanced control plane features.

Audience:

This course is intended for network engineers and network managers who are looking to gain an understanding of how a dynamic control plane can be leveraged in their current and planned transport networks. Much of this course will also be of interest to those looking for a high-level introduction to a GMPLS-based control plane. Basic familiarity with WDM and other transport network technologies is assumed. No familiarity with control plane routing or signaling is required.

Instructor Biography:

Louis Berger is a recognized industry expert in software and protocol control technology for telecommunication switching equipment. He has been designing, building and deploying IP infrastructure and other telecommunications products and technology for the last 25 years. Mr. Berger is currently a principal in LabN Consulting, LLC which he founded in 1999, where he provides consulting services in the areas of IP based control plane, GMPLS and MPLS. Prior to rejoining LabN, Mr. Berger was the Vice President of Protocol Development at Movaz Networks. Earlier Mr. Berger worked for FORE Systems and BBN. Since 1989, Mr. Berger has been an active contributor in the IETF where he has authored several RFCs and Internet-Drafts in the areas of GMPLS, MPLS, MPLS-TP, Quality of Service signaling and Routing. He coined the term GMPLS, pioneered it as a technology, and was the editor of the GMPLS signaling protocol specifications. He currently serves as the IETF CCAMP Working Group co-chair.

 Wes Doonan is Senior Director for Control Plane R&D at ADVA Optical Networking. Wes leads the ongoing development and delivery of control plane technologies at ADVA, using IP-based protocols and mechanisms to manage carrier-class transport networks. He has previously spoken at Internet2 JointTechs events, Supercomputing, TERENA, the MPLS & Ethernet World Congress, ECOC, IEEE HotInterconnects and various CENIC events. Wes has also served as industry advisor to various funded research activities, including the DRAGON, PHOSPHORUS, GEYSERS and OFELIA network research projects. He holds a Bachelor of Science in Electrical and Computer Engineering from Carnegie Mellon University.

SC372 Energy-Efficiency Networking

Sunday, 17 March 2013
17:00 - 20:00

Instructor: Rod S. Tucker, Kerry Hinton; *Univ. Melbourne, Australia*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
This short course will provide an introduction and overview of energy efficiency in communications networks. The course will look at trends (past and future), challenges and opportunities presented by the evolution to energy-efficient telecommunications.

Course components are:

- Growth of ICT and its power consumption
- Sustainability implications of ICT growth
- Modelling network power consumption
    - Sales and inventory based models
    - Network-design-based model
    - Transaction-based model

        - Important parameters: PUE, peak vs average access speed, dimensioning for growth, redundancy, protection and replacement
    - Power consumption modelling of networks
        - Access networks: Wireless, PON, FTTN, HFC and Point-to-Point
        - Edge and Metro networks
        - Core networks: Terrestrial and submarine
    - Power consumption of equipment
        - IP Routers (edge and core)
        - Switches (Ethernet, MPLS and TDM)
        - Cross connect, add/drop multiplexer
        - Multi-layer switches (GMPLS)
        - Transmission systems
        - OLTs and ONUs
        - Equipment for cloud services
    - Equipment power consumption trends
        - Time evolution
        - Traffic load dependence
    - Bringing it all together
        - Future trends and directions
        - Identifying leverage points for improvements in energy efficiency
    - Improving energy efficiency using:
        - Architectures
        - Protocols
        - Technologies
    - What is attainable
        - Lower theoretical limits on power consumption
        - How close can we get to these limits?: Network control, management and monitoring
    - Overview of global activities in green networking
        - GreenTouch
        - Carbon Trust
        - GreenGrid
        - GeSI
        - ITU, EU & others

Benefits:

This course should enable participants to:

- Compare networks from the perspective of energy efficiency.
- Compute an estimate of the energy efficiency of network equipment, designs and architectures (in Joules/bit).
- Explain the principles of energy efficiency in telecommunications networks
- Identify key factors and leverage points for improving the energy efficiency future network
- Describe the key determinants of network energy efficiency

Audience:

Telecommunications engineers, managers, policy makers, researchers and educators.
A basic knowledge of telecommunications networks and equipment will be advantageous. Little or no knowledge of energy efficiency issues in telecommunications networks is required.

Instructor Biography:

Rodney S. Tucker (M'76-SM'81-F'89) is a Laureate Professor at the University of Melbourne. He is Director of the University of Melbourne's Centre for Energy-Efficient Telecommunications (CEET). He is a Fellow of the Australian Academy of Science, a Fellow of the Australian Academy of Technological Sciences and Engineering, a Fellow of the Optical Society of America, and a Fellow of the IEEE. He is currently Vice-President, Publications of the IEEE Photonics Society.

Kerry Hinton received a PhD from the University of Newcastle Upon Tyne, U.K., in 1984. He worked at the Telstra Research Laboratories, Australia, for 21 years researching analytical and numerical modelling of optical systems, ASONs and monitoring in all-optical networks. In 2006, he joined the University of Melbourne, undertaking research into the energy efficiency of the Internet, communications technologies and networks as a member of the Centre for Energy Efficient Telecommunications (CEET).

SC373 Specialty Fiber Splicing and Interconnection

Monday, 18 March 2013

13:30 - 16:30

Instructor: Andrew Yablon; *Interfiber Analysis, USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:

The recent emergence of a diversity of optical fiber designs and applications has made optical fiber interconnection more challenging even as it has become more important. Effective interconnection of optical fibers is critical for all applications, including traditional telecom links, optical fiber sensors, and high-power fiber amplifiers and sources.

This course provides an introduction to all aspects of optical fiber interconnection, and compares the benefits and disadvantages of fusion splices, fiber connectors, and free space optics. Performance metrics and their measurement are introduced, including optical loss, reflectance, mode conversion, polarization crosstalk, and tensile strength. Special issues relevant to field deployment, factory production, and laboratory environments are all covered. An overview of equipment for fusion splicing as well as for fiber preparation and splice packaging is presented. Special fusion splicing strategies and fusion splice optimization are reviewed. Practical approaches for interconnection specialty fibers, including multimode, single-mode, dispersion managed, rare-earth-doped, large effective area, multi-core, high-power, polarization-maintaining, non-silica, and microstructured fibers are all discussed. Proof testing and long term mechanical reliability of fusion splices are addressed. A numerical approach for modeling fusion splicing is presented.

Benefits:

This course will enable you to:

- Improve the quality of your fusion splices
- Compare competing interconnection technologies
- Select equipment for optical fiber interconnection
- Estimate interconnection performance

- Test and measure optical fiber interconnections
- Avoid problems with splice reliability
- Evaluate and apply special fusion splicing strategies

Audience:

This course is intended for engineers and scientists who are concerned about the problem of optical fiber interconnection and are looking for practical solutions to their problems. This course presupposes a familiarity with contemporary optical fibers and their theory of operation.

Instructor Biography:

Andrew D. Yablon is President of Interfiber Analysis, an optical fiber test & measurement company. Dr. Yablon previously worked at Bell Labs, OFS Labs, and Vytran Corp and has consulted widely on optical fiber interconnection. He wrote the monograph *Optical Fiber Fusion Splicing*, is listed as an author on numerous peer-reviewed journal articles and conference publications, and holds 18 US Patents. He is a Senior Member of the OSA, was chair of the Optical Fiber Subcommittee for OFC/NFOEC 2010, and also teaches a fusion splicing course at SPIE Photonics West.

SC374 Cloud Computing and Dynamic Networks

Tuesday, 19 March 2013
9:00 - 12:00

Instructor: George H. Clapp[1], Douglas M. Freimuth[2]; *[1]AT&T Labs, USA, [2]IBM Research, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

Watch Preview of SC374—Cloud Computing & Dynamic networks by George Clapp, AT&T Research Labs, USA, OFC/NFOEC Subcommittee Chair

Cloud computing is playing an increasingly prominent role as providers offer more complete and robust services and as enterprises adopt the technology into their IT infrastructure. Cloud computing lowers the total cost of computing through large pools of resources that are shared across many clients and managed as a single entity. Virtualization is a key enabler that creates a logical version of a physical resource such as a computer or storage device and permits the resource to be allocated to different users as demands change. Networks are essential resources in cloud computing, just as essential as computers and storage devices, but unlike virtual computers and storage, cloud providers have treated their networks between data centers as static resources over which they had little control. This model is changing rapidly as new network technologies and services emerge. The optical control plane has enabled agile, intelligent and autonomous networks that can rapidly provision new services, and carriers are deploying them to offer dynamic services. The Research & Education community is also offering dynamic network services and integrating them into cloud computing for large scale experiments.

This course is an introduction to cloud computing and to the emerging dynamic network services. The course will describe cloud computing infrastructures and technologies such as virtualization and cover the different dynamic network technologies and services, describing how they can be virtualized and integrated into cloud computing. It will also describe sample cloud applications and how they can make use of the new services.

Benefits:

This course should enable you to:

- Identify and describe the key technologies that underlie cloud computing
- Describe the network within the data center and how it is virtualized and managed by the cloud provider
- Describe the key technologies that underlie dynamic network services
- Describe and compare the different dynamic network services either presently offered or under development by carriers and the Research & Education community
- Describe how the dynamic network services can be virtualized and integrated into cloud management systems
- Discuss sample cloud applications and how they can benefit from the dynamic network services

Audience:

This course is intended for planners and architects of both networks and data centers who are involved in designing networks both between and within data centers. The course will also be helpful to system vendors who wish to understand the emerging requirements of cloud and network service providers for

dynamic network services. The course is at an introductory level but some familiarity with data network architecture and protocols is assumed.

Instructor Biography:

 George H. Clapp is a telecommunications consultant who previously managed a research group in optical networking in Telcordia's Applied Research organization, focusing on the design and the control and management of optical networks. George previously managed data services at Ameritech, which was the first Regional Bell Operating Company to offer Internet Access in 1994 and created one of four Network Access Points (NAPs) for the National Science Foundation (NSF). George participated in the Internet Engineering Task Force (IETF), where he chaired working groups that defined the transport of IP over the data services of public carriers.

 Douglas M. Freimuth is a Senior Technical Staff Member in the Enterprise Networking group at the IBM T.J. Watson Research Center where he has focused on the research, design and development of server networking technologies. He is a co-author of the IO Virtualization (IOV) specifications in the PCI SIG. He has also participated in the Distributed Management Task Force (DMTF) for activities related to deployment of Virtual Machines and cloud networks. Doug has 60+ disclosures and patents in the domain of enterprise networking, and has also published related papers, developed products and contributed to open source.

SC384 Background Concepts of Optical Communication Systems

Sunday, 17 March 2013
9:00 - 12:00

Instructor: Alan Willner; *Univ. of Southern California, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
Optical communication systems have provided ever-increasing data transmission capacities, and there is a

set of core concepts that are fundamental to understanding many of the crucial technical areas. The OFC/NFOEC conference has numerous courses teaching advanced topics that require some basic prior knowledge of these core concepts. The intent of this short course is to provide key background information to enable attendees to subsequently take more advanced courses as well as to enhance the attendee's understanding of technical sessions throughout the conference.

An attendee will obtain an overview of the field that concentrates on a number of specific topics, including:

1. Introduction to optical systems (point-to-point links, reconfigurable networks, line/client, switching techniques)
2. Communications concepts (SNR, ISI, BER, PRBS, eye diagrams, link budget, data standards)
3. Channel multiplexing techniques (time, wavelength, subcarrier, space, polarization)
4. Fiber-based data-degrading effects (loss, chromatic dispersion, polarization-mode dispersion, polarization-dependent loss)
5. Amplifiers (EDFA and Raman, gain flattening, gain transients)
6. Nonlinear effects, dispersion management and fiber types
7. Modulation formats, capacity and data constellations (OOK, PSK, DPSK, QAM, OFDM)
8. Direct and coherent detection schemes
9. Mitigating data impairments: optical (tunable compensators) and electronic (DSP, FEC)
10. Basics of lightwave system modeling

Benefits:

This course should enable you to:

- Understand basic concepts of an optical communication system.
- Identify different types of modulation and multiplexing formats.
- Compute a simple optical power budget.
- Explain key differences between direct and coherent detection systems.
- Attend more advanced OFC short courses and understand better the conference technical sessions.

Audience:

This introductory course is intended for an audience with at least some technical background in engineering, physics or related disciplines, and is ideally suited for engineers who want to learn more

about optical fiber communication systems. The audience should gain valuable knowledge enabling them to take more advanced courses as well as understand better the conference technical sessions.

Instructor Biography:

Alan Willner (Ph.D., Columbia) worked at AT&T Bell Labs and Bellcore, and he is the Sample Chaired Professor of Engineering at USC. He received the Int'l Fellow of U.K. Royal Academy of Engineering, NSF Presidential Faculty Fellows Award from White House, Guggenheim Foundation Fellowship, Packard Foundation Fellowship, Fulbright Foundation Senior Scholars Award, OSA Forman Eng. Excellence Award, IEEE Photonics Society Eng. Achievement Award and Distinguished Lecturer Award, and Eddy Best Technical Paper Award from Pennwell. He is Fellow of AAAS, IEEE, OSA, and SPIE. He was co-chair of National Academies Committee on Optics and Photonics, president of IEEE Photonics Society, co-chair of OSA Science and Engineering Council, editor-in-chief of *Optics Letters, Journal of Lightwave Technology* and *IEEE JSTQE, and* CLEO general co-chair.

SC385 Fundamentals of Super Computing

New Course!

Sunday, 17 March 2013
13:00 - 16:00

Instructor:

Kamesh Madduri; *Pennsylvania State Univ., USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
An increasingly fast-paced, digital world has produced an ever-growing volume of petabyte-sized

datasets. At the same time, terabytes of new, unstructured data arrive daily. As the desire to ask more detailed questions about these massive streams has grown, parallel software and hardware have only recently begun to enable complex analytics for Big Data. Solving these problems at scale often raises new challenges because of sparsity and the lack of locality in the data, the need for additional research on scalable algorithms and development of frameworks for solving these problems on advanced memory technologies, multicore processors and accelerators, and high performance networks and petascale computers. This talk will highlight the importance of mapping Big Data applications to a variety of platforms for massive data analytics, and will compare and contrast the performance of complex queries on systems from Intel, NVIDIA, IBM, Cray, and Cloud/MapReduce platforms. Real-world examples in this tutorial include challenging problems such as detecting community structure in large social networks, improving the resilience of the electric power grid, and detecting and preventing disease in human populations.

Benefits:

- Understand how new optical technologies enable real-world applications
- Map data-intensive applications to high-performance networks and architectures
- Leverage big data analytics in decision-making
- Learn challenges and opportunities emerging in Big Data
- Describe innovative technologies on the horizon, such as hybrid memory, optical interconnects, multicore processors and accelerators, and petascale supercomputers.
- Compare big data technologies and solutions for real-world applications such as social network analysis, biological sciences, and cybersecurity.

Audience:

The goal of this short course is to provide an in-depth discussion of the opportunities and challenges in massive data analytics. Attendees will gain expertise at the mapping of algorithms to a variety of high-performance computing and data-intensive architectures. The presenter has a strong track record of presenting similar tutorials to academic and industrial audiences, and this material will be accessible by researchers, implementers, innovators, and executives.

Instructor Biography:

Kamesh Madduri is an assistant professor in the Computer Science and Engineering department at The Pennsylvania State University. He received his PhD in Computer Science from Georgia Institute of Technology's College of Computing in 2008, and was previously a Luis W. Alvarez postdoctoral fellow at Lawrence Berkeley National Laboratory. He is interested in all aspects of high-performance computing for solving informatics and scientific data analysis challenges, including the design of new scalable methods, parallel algorithm design, performance studies on emerging hardware platforms, and developing high-performance software systems. He was awarded the first Junior Scientist prize from the SIAM Activity group on Supercomputing (2010), an Outstanding Graduate Research Assistantship award from Georgia Tech's College of Computing (2008), and the NASA Graduate Student Researchers Program Fellowship (2006-08).

SC386 The Evolution of Network Architecture Towards Cloud-centric Applications

New Course!

Sunday, 17 March 2013
13:00 - 16:00

Instructor: Loukas Paraschis; *Cisco Systems, Inc., USA*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
This short course reviews the current and emerging “cloud-centric” network developments, and evaluates the functionality, characteristics, and the associated challenges in defining transport networks. We will study the the interplay among important and promising photonics technologies, and the convergence of IP and WDM network architectures that have increasingly become the best answer addressing the transport network needs.

The increasing availability of fast and reliable network connectivity has enabled applications to transition to an Internet based service delivery model, commonly referred to as “cloud computing”. The underlying infrastructure consists of data-centers of massive computing, and storage resources, and networking which is crucial in interconnecting, and optimizing the cost-performance, of the “cloud infrastructure”. As a result the interconnection of datacenters is one of the largest contributors to the increase of traffic demand in the traditional backbone transport networks. Consequently the structure of the Internet has started to change towards a flatter hierarchy and a denser interconnection with consequences for traditional optical transport, routing, traffic engineering, and security. We will first analyze the functional characteristics and challenges of these networks, and review the current and emerging applications that motivated these networks to scale leveraging IP, MPLS, and DWDM transport. We will particularly discuss how the new, high-bandwidth, predominantly video related, applications (including IPTV, video-on-demand, peer-to-peer, and videoconferencing), often with diverse quality-of-service requirements, are increasingly motivating a fundamental shift in services from circuits to packets, giving rise to the most significant evolution of transport networks in recent history. The course will then focuses on the current and future converged Packet and DWDM transport. We will identify the unique network requirements, design challenges, and desired future hardware and software features of these inter-data-center interconnection architectures, and their components. We will also review the significant advancements in optical technologies, system, standards, and the improvement in capital and operational cost, including bandwidth, density, or power. Finally, we will attempt to evaluate the interplay among the intra and inter data-center networking architectures, system design, and the enabling photonics technology and packaging innovations. Future network evolution, emerging standards, and related research topics are also being considered.

Benefits:

This short course will enhance the audience understanding of the interplay between network architectures, systems, and IP and photonics technology innovation in the actual evolution (past, current and future) of the public and private cloud-centric network infrastructure.

Audience:

This short course is intended for researchers (and students) in the fields of photonics technologies, and optical networking that wish to obtain an industry perspective, and also industry professionals that wish to have a network architecture and system level analysis of the networking evolution, with a particular focus on the implications of cloud-centric services.

Instructor Biography:

Loukas (Lucas) Paraschis is senior solution architect in cisco's Americas next generation network group, primarily responsible for the evolution of core routing and optical transport network architectures, technologies, business models, and market development efforts in Service Providers, large Enterprise, and Public Sector infrastructure. Prior to his current role, Loukas worked as an R&D engineer, product manager, technical leader, and business development manager for cisco's optical networking and core routing. He has been (co)author in next-generation transport networks of more than 50 related peerreviewed
publications, many invited, and tutorial presentations, two book chapters, two patents, and was an IEEE Photonics Distinguished Lecturer on this topic. Loukas received his Ph.D. from Stanford University, is a senior member of IEEE, and a Fellow of OSA.

SC387 Network Securities

New Course!

Sunday, 17 March 2013
17:00 - 20:00

Instructor: David Dumas; *Verizon Communications, Inc., USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
This course will address how to apply network security to an infrastructure (networks, systems, applications, and data) that requires protection. The course will start out with an overview of the state of network security and detail some of the latest threats from malware. An in-depth discussion of the necessary layers of defense to protect networks and systems will be take place. The layers include people, training, business continuity planning, physical security, policies and procedures, security operations, software/application/database security, network and communications security, management and procurement. Topics on security governance, laws and regulations of the land and security policies will be reviewed. Using secure protocols and secure management to devices will be addressed along with

examples. The use of encryption to protect data and traffic will be diagramed and the reasons to use encryption will be discussed along with key management. A brief overview of hardening operating systems and applications will be reviewed. The management and benefits of risk assessments and security standards will be explained and summarized as important frameworks for supporting product architectures, designs and development. Examples and lessons learned will be discussed throughout the class to add to the course content.

Benefits:

After taking this course, the attendee should be able to:

- Define some of the current threats to networks today
- Describe the layers of defense necessary for protecting networks and systems
- Summarize security governance and how laws, regulations and security policies fit into determining the selection of the appropriate controls
- Identify the uses of encryption for data integrity and data confidentiality
- Explain why hardening operating systems and applications is an important layer of defense
- List some of the security standards available today to protect networks and systems
- Discuss the importance of network security with your peers, management, developers, and family/friends

Audience:

No prior knowledge in network security is required to take this course. Anyone with an interest in network security should attend this new course. Whether you manage your home networks and systems or architect, design, and develop new products and services, this course is a must for you. It is intended for anyone that wants to learn more about network security basics and how they can be applied to the protection of networks and assets.

Instructor Biography:

David Dumas, CISSP, CISM, ISSA Distinguished Fellow
David is a Senior Network Security Engineer working directly for the Chief Network Security Officer of Verizon's Wireline Security Operations group. His current work involves outsourcing, offshoring, global cyber and privacy regulations, and a Verizon representative on outside security committees. David was the Director of Verizon's Network Security Architecture and Design group for 9 years.

He has 26 years in the security field and a background in computer science and security consulting. David is an author and presenter on the topic of securing networks.

SC388 Wireless Backhaul

New Course!

Sunday, 17 March 2013
17:00 - 20:00

Instructor: Stu Benington; *Tellabs, Inc, USA*

Level: Intermediate (prior knowledge of topic is necessary to appreciate course material)

Description:
Mobile broadband traffic is one of the major network drivers in the industry, and mobile service revenue continues to increase in importance to network operators' business models. It can even be said that mobility is becoming a feature rather than a discrete service offering as all forms of communication (voice, video and data) are becoming mobile to a large extent.

This presents operators with both a challenge and an opportunity. The challenge is to ensure that their networks can accommodate the requirements associated with a competitive mobility service offering as 2G and 3G networks evolve to 3G+ and 4G. At the same time, they must strike a balance between investing for the future and ensuring that their capital investment generates an appropriate ROI.

This course will explore the mobility service trends, the network requirements in accommodating them, the technologies that can and will be employed, and the associated incremental services that operators can add in ways that leverage these network investments. The area of particular focus will be Wireless Backhaul given its importance in effectively meeting the requirements that new mobile services will bring, and the quality of experience expectations that users will have.

The course will place an emphasis on the role of optical technology on wireless backhaul, and the benefits it brings in areas such as bandwidth requirements, latency, security, and potential for FMC extensions. It will also delve into the network topology changes as LTE and 4G become more prominent, and the implications for backhaul infrastructure.

Benefits:

This course will enable participants to do the following:

- Describe wireless backhaul architectures, technologies, and business issues
- Explain how services are changing the mobile telecommunications landscape and driving backhaul network requirements
- Determine the best methodology for optimal backhaul design

Audience:

This course is intended for technical participants (network design, architecture, optical technology, etc) who are looking to gain a better understanding of mobile infrastructure. It is also intended for management, marketing, and other non-engineering job functions who have some technical knowledge but are looking to deepen their knowledge in wireless backhaul and optical applications for mobility.

Instructor Biography:

Stuart Benington is director of portfolio strategy at Tellabs. In this role, he is responsible for identifying and targeting strategic application opportunities and for optimizing the Tellabs portfolio through product evolution and business development activity.

Prior to this role, Mr. Benington has held a variety of marketing, engineering and product planning positions across several Tellabs product groups, including Tellabs' Advanced Data Products, Optical Networks, and Managed Access Systems.

Mr. Benington has more than 20 years of experience in the telecom industry and holds a Bachelor of Science degree in economics and computer science from Purdue University and a Master of Business Administration degree from Northwestern University.

SC389 Network Optimization

New Course!

Sunday, 17 March 2013
17:00 - 20:00

Instructor: Dominic Schupke; *Nokia Siemens Networks, Germany*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
The course firstly summarizes network and traffic modeling for network optimization and planning. Necessary optimization fundamentals are then presented, including Linear Programming (LP), Mixed--Integer Programming (MIP), and heuristics. Representative approaches to solve routing, wavelength assignment, dimensioning, topology design, and resilience problems are covered in detail.

Benefits:

- Describe the process for optimizing a network using optimization software
- Formulate linear optimization models for network problems
- Explain the differences between the various modeling approaches
- Discuss the pros and cons of solving approaches (heuristics, branch--and--bound algorithms, ...)

- Identify key parameters influential in modeling complexity, solving time, and computation results

Audience:

The course requires only basic knowledge in mathematics (calculus and linear algebra), communication networks, and programming (recursions, iterations, …)

Instructor Biography:

Dominic Schupke is with Nokia Siemens Networks, Munich, Germany. He received his Dipl.--Ing. degree from RWTH Aachen in 1998 and his Dr.--Ing. degree from Munich University of Technology (TUM) in 2004. He has over 14 years experience in the area of transport networks, especially in their design and optimization. Since April 2009 he has instructed the course "Network Planning" at TUM.

SC390 Introduction to Forward Error Correction

New Course!

Monday, 18 March 2013
9:00 - 12:00

Companion to SC391

Instructor: Frank Kschischang; *University of Toronto, Canada*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:

Error-control coding, the technique of adding redundancy in controlled fashion to transmitted data so as to correct errors introduced by noise or other channel impairments, is a key component of modern optical communication systems. This course introduces basic concepts in coding and information theory: channel models and channel capacity (the Shannon limit), encoders and decoders (hard-decision and soft-decision), linear block codes and convolutional codes, code rate and overhead, Hamming distance, net

coding gain, generator matrices, parity-check matrices, syndromes, polynomials, and finite fields. Specific families and constructions of error-correcting codes will be described, including Hamming codes, Reed-Solomon codes, BCH codes, product codes, concatenated codes, turbo codes, and low-density parity-check codes. Techniques for combining coding with higher-order modulation (such as 16-QAM) will also be described. After completion of this course, students will be prepared for the more advanced course SC391: FEC Technology in Optical Communications.

Benefits:

This course should enable participants to:

- define the key parameters of an error-correcting code
- explain the system-level benefits provided by FEC
- convert between generator-matrix and parity-check-matrix descriptions of a code
- encode and decode a binary Hamming code
- carry out finite-field arithmetic
- encode a cyclic code using a generator polynomial
- decode a Reed-Solomon code using a Berlekamp-Welch-type algorithm
- combine two or more codes into a product-code or concatenation
- describe iterative decoding methods for low-density parity-check codes

Audience:

This course is intended for systems engineers, system operators and managers who need to understand the costs and benefits in applying physical-layer error-control coding in a communications link, and those who wish to prepare themselves for the more advanced course SC391. No previous background in information theory or algebra is assumed.

Instructor Biography:

Frank R. Kschischang is a Tier-I Canada Research Chair and Professor of Electrical and Computer Engineering at the University of Toronto, where he has been a faculty member teaching graduate courses in coding theory and information theory since 1991. Prof. Kschischang has received numerous awards both for his teaching and for his research, including the 2006 University of Toronto Faculty of Applied Science and Engineering Teaching Award and the 2010 IEEE Communications Society and Information Theory Society Joint Paper Award (for a paper on error-control in network coding). Prof. Kschischang served as the 2010 President of the IEEE Information Theory Society. Prof. Kschischang is an inventor of

“staircase codes,” a family of spatially-coupled product codes well-suited for applications in optical transport networks.

SC391 FEC Technology and Applications in Optical Communications

New Course!

Monday, 18 March 2013
13:30 - 16:30

Companion to SC390

Instructor: Takashi Mizuochi, Yoshikuni Miyata; *Mitsubishi Electric Corporation, Japan*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
This course describes the types of forward error correction (FEC) technique used for optical communications. The key terms related to FEC in optical communications are clarified, e.g. net coding gain, code rate, redundancy, interleaving, and Q limit. We then review the history of FEC in optical communications. The various types of FEC developed to date are classified as belonging to three generations: RS(255,239) represents the first generation, concatenated codes are the second generation, and more powerful FEC based on soft-decision decoding is the third generation. The second generation FECs will be explained, and recently developed concatenated codes discussed. The third generation FECs are analyzed in detail, with emphasis on low-density parity-check (LDPC) codes for superior NCGs with soft decision decoding. The positive impacts on existing systems are also discussed. We will relate each generation of FEC to the Shannon Limit, and discuss the ultimate NCG as a function of code rate. The circuit implementation of a Coherent DSP is discussed. The relationship between unwanted cycle slip and FEC performance is important. The additional useful functionalities obtained by employing FEC and the application of FEC to error monitoring for adaptive equalization will also be covered. Frame synchronization and error burst performance are also discussed. Finally, this course anticipates the possible roles for optical technologies in future optical communication networks.

Benefits:
This course should enable participants to:

- Explain key terms related to FEC in optical communications
- Describe the three generations of FEC
- Compare the net coding gain with the Shannon Limit
- Calculate the Q budget table based on the FEC's performance
- Measure the FEC's error correction capability
- Discuss how to use FEC in your own system
- Design a circuit implementation for Coherent DSP
- Discuss cycle slip, frame synchronization, and error-burst performance
- Discuss possible roles for optical technologies in future optical communications

Audience:

This course is intended for systems engineers, circuit-board designers, system operators and managers who need to understand and apply FECs to optical systems. Knowledge of information theory is not needed. If any members of the audience are interested in learning about the basic FEC theory and codes, SC390: "Introduction to Forward Error Correction" by Frank Kschischang is recommended.

Instructor Biography:

Takashi Mizuochi received a Ph.D. degree in electrical engineering from Osaka University, Japan. At Mitsubishi Electric Corporation, he has been engaged in research on coherent optical fiber communications, long-haul transmission systems, undersea WDM communication systems, FEC for transport systems, and electronic signal processing. He is currently R&D Senior Manager, Optical Communication Technology, at Mitsubishi Electric Corporation. He is serving as associate editor of IEEE JQE.

Yoshikuni Miyata received an M.E. degree in industrial and management systems engineering from Waseda University, Japan. At Mitsubishi Electric Corporation, he has been engaged in

research and development on error control coding methods for optical communications, wireless communications and data storage systems.

SC393 Coherent Optical Systems 2

New Course!

Monday, 18 March 2013
13:30 - 16:30

Companion to SC392

Instructor: Maurice O'Sullivan; *Ciena, Canada*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
This course examines implementation aspects of electric field transmitters; coherent receivers and the role of transmit and receive DSP for channel equalization and data recovery. Single and multicarrier implementations are presented. The dependence of performance upon the dispersion map and on composition of the wavelength division multiplexed (WDM) spectrum are addressed.

Benefits:
This course should enable you to:

- Learn standard implementations of single and multi-carrier electric field transmitters and coherent receivers
- Estimate Q and BER for BPSK, QPSK and 16 QAM modulations
- List or describe linear equalization functions performed by DSP
- Compare architectures of single and multicarrier coherent transceivers
- Anticipate relative performances of coherent phase modulated channels vs. dispersion map and WDM channel spectrum.

Audience:
This course is intended for those interested in the workings and estimates of performance of commercial and peri-commercial coherent solutions in a multi-span amplified WDM system. Some familiarity with Fourier Transforms and complex numbers is assumed.

Instructor Biography:

For more than 25 years Maurice O'Sullivan has contributed to the design and manufacture of optical fiber and, mostly, the highest capacity long line transmission equipment of its day with emphasis on layer 0. He holds a PhD in Physics from the University of Toronto

SC395 Hands On: Basic Modeling and Design of Coherent Fiber-Optic Communication Systems

New Course!

Tuesday, 19 March 2013
8:00 - 12:00

All attendees must bring their own laptop, with Matlab installed, in order to participate in this course.

Instructor: Erich Gottwald, Harald Rohde; *Nokia Siemens Networks, Germany*

Level: Advanced Beginner (basic understanding of topic is necessary to follow course material)

Description:
Within the course the building blocks for a simulation system for a coherent fiber optical communication system will be developed and implemented in a hands-on manner. The instructors will present the methodology and basic code skeletons which will then be used by the participants to implement a basic simulator in Matlab. After a general introduction into the modeling of optical transmission systems and into different modulation formats coherent specific topics like the modeling of a receiver, including both the optics and the signal processing part, will be covered. The target is a simulator which models a real system as much as possible, e.g. including effects due to limited bandwidths or phase distortions somewhere in the transmission chain. Due to the limited time, topics like nonlinear fiber transmission, PMD or EDFAs will not be covered.

As a communication system is simulated in order to analyze and to optimize it, virtual measurement instruments form an important part of a simulator. A number of virtual instruments like electrical spectrum analyzers, optical spectrum analyzers, constellation diagrams and eye diagram generators will be developed within the course.

The main part of the course will concentrate on the numerical simulation. However, a few topics in a coherent optical transmission system can also be covered analytically. An analytical model of the noise performance will be implemented and demonstrated in Excel.

As an example how a complete simulator can look like, the instructors will present their tool which is used for real live system development

Benefits:
This course should enable participants to design and program a simulator for a coherent optical transmission system, based on Matlab.

Audience:
This course is targeted for Researchers and students who want to learn how to build a simulation tool for coherent optical transmission systems. Familiarity with Matlab is a pre-requisite as well as a basic knowledge of transmission system related mathematics, e.g. Fourier transforms. Basic communication theory knowledge is also required.

The participants shall bring their own laptop computers, including a Matlab installation. Participants without a computer or without Matlab can follow the instructions and the tutoring part of the short course but might be idle during the hands on parts.

Instructor Biography:

Erich Gottwald joined Siemens Central Research Labs for Communication Technology in 1985 and worked on coherent optical transmission systems. With the up-coming of EDFAs he switched to WDM systems in 1991 and, as suitable commercial simulation tools were not available at that time,

developed a simulation tool for nonlinear fiber optical transmission systems which was the basis for dimensioning the first WDM 8/16 channel 10 Gb/s optical systems offered by Siemens in the late 90th. In the last years, together with Harald Rohde, he developed a very detailed simulation tool for the coherent system under development which includes every effect and impairment the instructors could think of.

Harald Rohde simulated photonic transmission system since he joined Siemens in 2001 after his PhD in physics. After using commercial simulation tools for many years, those tools turned out to be insufficient for the special needs of the development of a coherent optical access system so he started to implement own tools. Together with Erich Gottwald, he developed a very detailed simulation tool for the coherent system under development which includes every effect and impairment the instructors could think of.

SC401 Software Defined Networking and OpenFlow

New Course!

Sunday, 17 March 2013
9:00 - 12:00
Instructor: Saurav Das; *Big Switch Networks, USA*

Level: Beginner (no background or minimal training is necessary to understand course material)

Description:
Software Defined Networking has generated great levels of interest in the networking community, both in academia and (especially) in the industry. While some core ideas of SDN have been proposed separately in the past, their implications together are far-reaching. SDN promises to simplify the task of operating networks in part by decoupling and refactoring the relationship between networking hardware and the software that controls them; it provides greater control to the operator to customize and optimize their networks for the features they need and the services they provide; and finally it allows innovation to take place at a much faster rate, by helping the network evolve more rapidly in software (implemented outside-the-box), with possibly greater diversity of solutions generated by a larger pool of developers.
This course will attempt to cover a wide range of topics related to SDN and OpenFlow. It will start with a brief history and motivation behind the birth of OpenFlow at Stanford and its roots in related work in the past decade. From there we will distinguish between SDN and OpenFlow by presenting the SDN architecture and taking a deep-dive into the OpenFlow protocol. The majority of the time will be spent in discussing how SDN/OpenFlow networks work - topics covered will include discovery, connectivity, scalability, resilience, performance, interworking with legacy networks, and modes of operations.

Significantly, we will also discuss the benefits and use-cases of SDN/OpenFlow in different network segments such as the data-center, enterprise-campus and WANs. We will cover challenges and ongoing-research in SDN; as well as the role of the Open Networking Foundation (ONF), the primary industry forum for the advancement of SDN. Finally we will discuss the role of SDN and OpenFlow in transport networks and prior/current research in this area.

Like every good course (to break the monotony of presentation slides), there will be two "lab sessions". The sessions will cover live demonstrations of 'working code': the first will involve two open-source projects in the SDN space - Floodlight and Mininet - the former is the most popular OpenFlow controller in the open-source community and the latter is a popular and powerful tool that enables you to experiment with a 'network-in-a box'. The second session will give a glimpse at a commercial SDN controller.

Benefits:

- Define SDN architecturally
- Differentiate between SDN and OpenFlow
- Explain what OpenFlow really does, and compare/contrast between versions of OpenFlow
- Discuss the inner-workings of an OpenFlow/SDN network
- Identify SDN benefits
- List use-cases of SDN/OpenFlow
- Summarize research activities in SDN/OpenFlow
- Identify open-source tools and their use - Floodlight and Mininet

Audience:

This course is intended to be an introduction to a wide range of topics involving SDN and OpenFlow. As such it assumes a networking background but it is not strictly necessary.

Instructor Biography:

Saurav Das is currently a Member of Technical Staff at Big Switch Networks, a Silicon-Valley startup, born out of research in SDN and OpenFlow at Stanford. He has been involved with OpenFlow since 2008, when his PhD advisor Nick McKeown proposed it to him, while he was thinking about ways to make routers and transport NEs talk to each other. As a result, his research investigated a converged IP/MPLS/Optical network architecturally based on SDN/OpenFlow. Along the way, in collaboration with Ciena and Fujitsu, he prototyped and demonstrated the world's first OpenFlow controlled packet-optical network. He also demonstrated for the first time an MPLS service like Traffic-Engineering in an OpenFlow controlled network (without the IP/MPLS control plane); and was the first to suggest the deficiencies of the GMPLS control plane when compared to SDN/OpenFlow for multi-layer control. Before Stanford, he spent several years in the optical communications industry designing optical components and systems at Enablence. He holds a PhD in Electrical Engineering from Stanford University, and an MS in Optical Sciences from the University of Arizona, Tucson.

Rump Session

Silicon Photonics: Disruptive Technology or Research Curiosity?

Moderators: Dan Kuchta IBM Research, USA, and Michael Hochberg, Director OpSiS, USA

Why does almost every researcher who reports a very low energy per bit for a Silicon Photonics device neglect to include the laser power needed to generate that bit?Si photonics has been one of the hottest fields at OFC over the last few years. There have been many invited, contributed, and post-deadline papers that show devices and subsytems with promising attributes such as low power consumption, compact size, WDM capability, and monolithic integration. The dream is that Si Photonics can unlock a future of optical chips that integrate high-speed logic/memory with fast and ultra-low power photonic I/O on the same substrate. Yet there also seems to be a perception among some that the hype has outpaced the technology and the field suffers from a lack of complete scientific reporting in its publications with significant issues overlooked.

- Will lasers ever become efficient enough to meet the low energy expectations?

- How will we ever realize optical networks on a chip if the temperature stable devices are very large and the nanoscale devices are too temperature sensitive?
- Is the assumption that because it is silicon it will be reliable apply, and where are the reliability publications?
- Is there a path to reducing coupling losses on and off silicon to enable lower power operation with realistic link budgets?
- Optical Packaging is critical to the success of any optical component and it typically takes longer to develop packaging and packaging methodologies than to invent new devices. When will we start to see manufacturable packaging concepts supporting many channels and WDM?
- Why is the polarization sensitivity neglected so often?

These are just some of the critical aspects of Silicon Photonics that are not receiving enough attention. This rump session is an opportunity to air out some overlooked issues and discuss the potential impact of Si Photonics on optical networks from a pragmatic standpoint to re-align expectations with reality to move this potentially important technology forward.

The rump session will be a spontaneous discussion among the audience members. Other than a brief introduction to the issue, there will be no scheduled speakers. You can participate by attending and raising your hand to inform the moderator that you wish to speak or respond. A slide or two can be used to illustrate a point, but each speaker will be limited to a total of two minutes at the microphone. Conversation will flow most freely if your slide is on a plastic transparency, but we will accommodate digital slides on USB sticks and possibly slides transmitted over the wireless network. We will provide pens and transparencies for spontaneously written hand-drawn slides, which, after all, reflect the true spirit of a "rump" session. A laptop and projector will be available for digital slides. Also, Rump Session participants are invited to have their slides published on the OFC/NFOEC website after the session. If you are interested, then please contact Dan McDonold at dmcdonold@osa.org for more details.

2013 Tutorial Speakers

OFC/NFOEC tutorial presentations are one-hour instructional talks designed to provide reviews of important progress in research. Speakers are chosen through a highly selective nominations process to keep attendees at the forefront of optical communications.

Category 1. Optical Network Applications and Services (Tutorial)

MPLS Transport Profile (MPLS-TP): Overview and Status, Yoshinori Koike; *NTT, Japan*

Category 2. Network Technologies and Applications (Tutorial)

Energy Efficiency of Load-adaptively Operated Telecommunication Networks, Christoph Lange; *DT, Germany*

Category 3. FTTx Technologies, Deployment, and Applications (Tutorial)

NGPON2 Technology, Hirotaka Nakamura; *NTT Access Network Service Systems Labs., Japan*

Category 5. Fibers and Optical Propagation Effects (Tutorial)

Capacity Constraints, Carrier Economics, and the Limits of Fiber and Cable Design, Robert Lingle; *OFS, USA*
Chiral Fibers, Victor Kopp; *Chiral Photonics, USA*

Category 6. Fiber and Waveguide-Based Devices: Amplifiers, Lasers, Sensors, and Performance Monitors (Tutorial)

CANCELLED: Fiber Bragg Gratings in Industrial Sensing, Wolfgang Ecke; *IPHT, Germany*
Optical Amplifiers for Space Division Multiplexed Systems, David Richardson; *Univ. of Southampton, UK*

Category 7. Optical Devices for Switching, Filtering, and Interconnects (Tutorial)

Subwavelength Structures in Integrated Optics, Pavel Cheben; *National Research Council, Canada*

Category 8. Optoelectronic Devices (Tutorial)

Optoelectronic Components for Higher Order Modulation Formats, Nobuhiro Kikuchi; *NTT, Japan*

Category 9. Digital Transmission Systems (Tutorial)

Modeling of Non-Linear Propagation in Uncompensated Coherent Systems, Pierluigi Poggiolini; *Politecnico di Torino, Italy*

Space Division Multiplexed Transmission, Sebastian Randel; *Bell Labs, Alcatel-Lucent, USA*

Category10. Transmission Subsystems and Network Elements (Tutorial)

Advances in High-speed ADC, DAC, and DSP for Optical Transceivers, Charles Laperle; *Ciena, Canada*
Mode-Division Multiplexing Systems: Propagation Effects, Performance, and Complexity, Joseph Kahn; *Stanford Univ., USA, and Keang-Po. Ho; Silicon Image, USA*

Category 11. Optical Processing and Analog Subsystems (Tutorial)

Microwave Photonics: the Past and the Future, Keith Williams; *NRL, USA*
Optical Signal Processing, Alan Willner; *Univ. of Southern California, USA*

Category 12. Core Networks (Tutorial)

An Introduction to Routing and Wavelength Assignment Algorithms for Fixed and Flexgrid, Manos Varvarigos; *University of Patras, Greece*
PCE: What is It, How Does It Work and What are Its Limitations?, Raul Munoz; *CTTC, Spain*

Category 13. Access Networks (Tutorial)

Burst-mode Receiver Technology for Short Synchronization, Xing-zhi Qiu; *Ghent Univ., Belgium*
Home Area Networks, Ton Koonen; *Eindhoven Univ. of Technology, The Netherlands*
Real-time Digital Signal Processing for Future Optical Access Networks, Roger Giddings; *Bangor Univ., UK*

Category 14. Optical Interconnection Networks for Datacom and Computercom (Tutorial)

Optical Interconnection Networks for Datacom and Computercom, Casimer DeCusatis; *IBM, USA*

Workshops and Panels

OFC/NFOEC Workshops provide opportunities to discuss and debate the latest technologies. Workshop topics are controversial in nature and meant to 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 presentations (5 to 10 minutes) from people involved in the field followed by a panel discussion driven by questions from the audience.

The 2013 conference featured workshops in current areas of interest in optical communications. The workshops provide an interactive learning environment and are open to all conference registrants.

NFOEC Panel sessions provide interactive discussions focused on topics of interest to the industry. Panel discussions are comprised of industry panelists and represent a broad range of viewpoints and technology.

Like invited and tutorial speakers, workshop and panel topics and organizers are chosen through a highly selective nominations process.

Category 1. Optical Network Applications and Services

Workshop: SDN in Large Backbone Networks: Is There a Fit?
Organizer: *Ed Crabbe, Google, USA; and Christian Martin, Cisco, Switzerland*

Panel: Dynamic Network Services
Organizer: *John Strand; AT&T Labs, USA*

Panel: Network Security
Organizer: *Scott McNown: NSA, USA*

Panel: Optical Control Plane: Practice and Potential
Organizer: *Joe Berthold, Ciena, USA; and Jonathan Sadler, Tellabs, USA*

Category 2. Network Technologies and Applications

Workshop: Can Transport Equipment Cost Reductions Keep Pace with Carrier Internet Growth?
Organizer: *Robert Doverspike; AT&T, USA*

Panel: Optical Network Architecture and Technology for Financial Applications
Organizer: *Dion Leung, Tellabs, Singapore*

Panel: The Future of ROADM Technology: Deployment and Functionality
Organizer: *Tom Strasser; Nistica, USA*

Category 3. FTTx Technologies, Deployment, and Applications

Workshop: Post NG-PON2: Is it More About Capacity or Something Else?
Organizer: *Jun Shan Wey, Nokia Siemens Networks, USA; Thomas Pfeiffer, Alcatel-Lucent, Germany*

Panel: Cost Optimization for FTTX Builds
Organizer: Dave Russell; *Calix, USA*

Panel: PONS as Used by MSOs
Organizer: *Steve Condra; Cisco, USA*

Category 5. Fibers and Optical Propagation Effects

Workshop: Is the Technology There for SDM?
Organizer: *Kazi Abedin, OFS, USA; Anping Liu, Corning, USA; William Shieh, Univ. Melbourne, Australia; Masatoshi Suzuki, KDDI, Japan*

Category 6. Fiber and Waveguide-Based Devices: Amplifiers, Lasers, Sensors, and Performance Monitors

Workshop: Is the Technology There for SDM?
Organizer: *Kazi Abedin, OFS, USA; Anping Liu, Corning, USA; William Shieh, Univ. Melbourne, Australia; Masatoshi Suzuki, KDDI, Japan*

Category 7. Optical Devices for Switching, Filtering, and Interconnects

Workshop: What Is the Best Technology for Wavelength- and Space-division Cross Connects
Organizer: *Chris Doerr; Acacia Inc., USA; Roland Ryf, Bell Labs, Alcatel-Lucent, USA*

Category 8. Optoelectronic Devices

Workshop: Laser Sources for Silicon Photonics: Overcoming the Final Bottleneck
Organizer: *Liming Zhang, Alcatel-Lucent, USA; Jonathan Klamkin, Scuola Superiore Sant'Anna, Italy*

Category 9. Digital Transmission Systems

Workshop: If the technology for SDM exists, do we want to use it?
Organizer: Chongjin Xie, *Bell Labs, Alcatel-Lucent, USA*; Georgios Zervas, *Univ. of Bristol, UK*

Workshop: Paths to 3dB Additional Capacity/Performance Gain: How Far Can We Go and Is It Worth the Price?
Organizer: *Chris Fludger, Cisco Optical, Germany; Ezra Ip, NEC Labs, USA; and Gabriella Bosco, Politecnico di Torino, Italy*

Category 10. Transmission Subsystems and Network Elements

Workshop: Is the Technology There for SDM?
Organizer: *Kazi Abedin, OFS, USA; Anping Liu, Corning, USA; William Shieh, Univ. Melbourne, Australia; Masatoshi Suzuki, KDDI, Japan*

Workshop: Paths to 3dB Additional Capacity/Performance Gain: How Far Can We Go and Is It Worth the Price?
Organizer: *Chris Fludger, Cisco Optical, Germany; Ezra Ip, NEC Labs, USA; and Gabriella Bosco, Politecnico di Torino, Italy*

Category 11. Optical Processing and Analog Subsystems

Workshop: Does Analog Photonics Have a Role in a Digital World?
Organizer: *Paul Juodawlkis, MIT Lincoln Laboratory, USA; Michael Sauer, Corning Inc., USA*

Category 12. Core Networks

Workshop: If the technology for SDM exists, do we want to use it?
Organizer: Chongjin Xie, *Bell Labs, Alcatel-Lucent, USA*; Georgios Zervas, *Univ. of Bristol, UK*

Workshop: Will Flexgrid Networks be Worth the Investment for just 30% Improvement?
Organizer: *Akira Hirano, NTT, Japan; Hans-Juergen Schmidtke, Juniper, USA; Luis Velasco, Universitat Politecnica de Catalunya, Spain*

Category 13. Access Networks

Workshop: Can Access Networks Afford to be Wavelength Agile?
Organizer: *Klaus Grobe, ADVA, Germany; Michael Wale, Oclaro, UK*

Workshop: Post NG-PON2: Is it More About Capacity or Something Else?
Organizer: *Jun Shan Wey, Nokia Siemens Networks, USA; Thomas Pfeiffer, Alcatel-Lucent, Germany*

Category 14. Optical Interconnection Networks for Datacom and Computercom

Workshop: How Can Optics Address Bandwidth and Latency Bottlenecks in Data Centers?

Organizer: *Laurent Schares, IBM, USA; Loukas Paraschis, Cisco, USA; Ali Ghiasi, Broadcom, USA; George Papen, Univ. of California at San Diego, USA*

SDN in Large Backbone Networks: Is There a Fit?

Monday, March 18, 2013
9:00 AM - 12:00 PM

Event type: Workshop

Organizer: *Ed Crabbe, Google, USA; and Christian Martin, Cisco, Switzerland*

Description: Software Defined Networking has garnered a great deal of attention of late, having rapidly become one of this past year's most hyped networking technologies. By definition SDN's use cases are extremely, some would say frustratingly, broad, reflecting the inherent flexibility of the concept. This diversity can be problematic for both vendors attempting to create products to meet customer needs and potential users examining putative use cases in their own networks. This workshop will attempt to shed light on SDN's current and potential uses in large carrier networks, with a focus on the specific issues solved by the technology and on future deployment scenarios.

Speakers: Oscar González de Dios, *Telefonica, Spain*
Andreas Gladisch, *Deutsche Telekom, Germany*
Christos Kolias, *Orange, USA*
Ping Pan, *Infinera, USA*

Dynamic Network Services

Event type: Panel

Organizer: *John Strand; AT&T Labs, USA*

Description: "Dynamic Network Services" (DNS) are "bandwidth-on-demand" connections at data rates ranging from 50 Mbps to entire wavelengths at multiple Gbps. This panel will provide insights into current and prospective services, architectures, and standards from the perspectives of network service providers,

equipment vendors, clients, standards body participants, and researchers.

Topics will include:
• Dynamic switched Gb Ethernet and Optical Transport Network (OTN) services and architectures.
• Current commercial carrier offerings.
• Cloud computing applications of DNS.
• Current and upcoming equipment vendor offering targeting DNS services.

Speakers: Robert Doverspike; *AT&T Research Labs, USA*
Joe Berthold; *Ciena, USA*
Ori Gerstel; *Cisco, USA*
Inder Monga; *ESNet, USA*
Jerry Sobieski; *NORDUnet, USA*

Network Security

Event type: Panel

Organizer: *Scott McNown: NSA, USA*

Description: Awareness of the need for critical infrastructure protection, particularly for the communications sector, has been increasing. However, there has been relatively little discussion about the specifics of security for the transport network which underpins the bulk of this sector. While there is a sizable IT security industry, most security services are designed to operate at layers 3 and higher and may not be directly applicable to transport networks. A future network with dynamic network services and frequent resource optimization may result in more exposed interfaces and higher network complexity (both of which can increase vulnerabilities), while resource virtualization can help limit exposure. Potential topics to be considered include types of threats, technologies available to mitigate threats, the value proposition of security, and vendor/carrier/government perspectives.

Speakers: Bob Kimball, *Ciena, USA*
Martin Nuss, *Vitesse, USA*
Bill Semancik, *Department of Defense, USA*

Optical Control Plane: Practice and Potential

Event type: Panel

Organizer: *Joe Berthold, Ciena, USA; and Jonathan Sadler, Tellabs, USA*

Description: Distributed control systems for optical circuit-switched networks have been deployed in large-scale commercial applications for more than a decade. This panel will review how these systems are used in several representative networks, the value they bring, and the experience gained over the years. Collectively the industry has invested a great deal of time and effort towards achieving multi-domain networking. We will review these efforts, and discuss remaining challenges to interoperability across different administrative domains in a single operator network, different vendor domains, and ultimately different operator domains. Finally, the panel will discuss the role optical control planes may be expected to play in application driven networking.

Speakers:
Bruce Cortez, *AT&T, USA*
Matthew Ma, *Tata Communications, USA*
Jeff Mundt, *Verizon, USA*
Lyndon Ong, *Ciena, USA*
Jon Sadler, *Tellabs, USA*
Sriram Subramanian, *Ericsson, USA*

Can Transport Equipment Cost Reductions Keep Pace with Carrier Internet Growth?

Sunday, March 17, 2013
4:30 PM - 7:30 PM

Event type: Workshop

Organizer: *Robert Doverspike; AT&T, USA*

Description: Over the past decade telecommunications carriers (both commercial and government) have all faced the same dilemma: Traffic grows at a very high rate, yet associated revenues grow at a very low rate. Carriers have coped with this dilemma by taking advantage of unit-price reductions in switching/routers and transport

technologies, such as SONET/SDH, DWDM, coherent technology, and OTN. However, a decade ago, the technological maturity curve of transport technology was more advanced than that of switching. As a result, earlier network architectures attempted to use transport technology to bypass relatively more expensive switches and routers. In contrast, more recently the rate of unit price reductions of transport equipment have slowed, while those of switching equipment have caught up and, in fact, surpassed, much due to the wider deployment of Ethernet technology. Furthermore, carriers have employed their best network optimizers and architects to re-architect the network layers, better pack demand into limited capacity, and tap better subwavelength-rate multiplexing capabilities provided by the new OTN switches. Despite all these efforts, the need for carrier unit prices to mirror (and be inversely proportional to) traffic growth is facing its major bottleneck from transport equipment. What can the optical industry do about this? For example, the optical industry has recently focused significant resources into flexible grid technologies and space division multiplexing. But, are these the key technologies to really solve this dilemma? This workshop will present this problem from the point of view of carriers and then invite vendor participants to answer the challenge.

Speakers: Sheryl Woodward, *AT&T Labs Research, USA*
Tiejun Xia, *Verizon Communications, USA*
Joseph Berthold, *Ciena, USA*
Ori Gerstel/Loukas Paraschis, *Cisco, USA*
Paparao Palacharla, *Fujitsu, USA*
Madan Shastri, *Nokia Siemens/Americas, USA*

Optical Network Architecture and Technology for Financial Applications

Event type: Panel

Organizer: *Dion Leung, Tellabs, Singapore*

Description: Driven predominantly by the High Frequency Trading communities, the subject of low-latency network infrastructure has gained a lot of attention in the optical industry. Technological and commercial innovations have also been spurred by the financial services applications. On one end of the value chain, component vendors have been purposely building FPGAs to maximize market data processing performance; to the other end of the value chain, fiber providers are laying down new

dark fiber routes to obtain the shortest physical distance connecting major data centers and trading hub locations. This panel session is to explore, share and discuss some recent research and development activities, and future trend and business opportunities in this particular area.

Speakers: Richard Cosgrave, *Xilinx, UK*
Robert Keys, *BTI, USA*
Brian Lavallee, *Ciena, Canada*
Jim Sauer, *ADVA, USA*

The Future of ROADM Technology: Deployment and Functionality

Event type: Panel

Organizer: *Tom Strasser; Nistica, USA*

Description: Over the past 10 years ROADM technology has grown to dominate DWDM network deployments. This panel will discuss the future functionality of ROADM systems, including the Colorless, Directionless, Contentionless and Gridless features. This discussion will address the network applications and benefits of each of these features and what how current technology benefits from some of these features may come at a cost and performance penalty that limits their application in practical networks. This discussion should help the audience assess which features offer the most value within the limits of today's technologies and network architectures. Distinguished panelists from carriers, equipment manufacturers and ROADM subsystem vendors will address the ideal technologies for the near future.

Speakers: Shamim Akhtar, *Comcast, USA*
Ken Falta, *Finisar, USA*
Dario Falquier, *Nistica, USA*
Ron Johnson, *Cisco Systems, USA*
Glenn Wellbrock, *Verizon, USA*
Thierry Zami, *Alcatel Lucent, USA*

Post NG-PON2: Is it More About Capacity or Something Else?

Sunday, March 17, 2013
4:30 PM - 7:30 PM

Event type: Workshop

Organizer: *Jun Shan Wey, Nokia Siemens Networks, USA; Thomas Pfeiffer, Alcatel-Lucent, Germany*

Description:
NG-PON2 systems, on their way to be standardized in ITU-T, will offer 40 Gb/s aggregated bandwidth by 2015. How much more system capacity can we anticipate after that? Is it reasonable to ever increase the system bandwidth? While in long-haul networks the high level of traffic aggregation perfectly justifies continued capacity increase, the argument is different for access. Besides technical and cost reasons, there may be service and application related as well as business and operations related aspects, which motivate access technology to move into a substantially different direction in the long run.
Join us to hear about different drivers and innovative ideas from industry and academia experts, and to actively contribute to the discussion that will help in shaping the future of optical access networks.

Speakers: Frank Effenberger, *Futurewei Technologies, USA*
Guangquan Wang, *China Unicom, China*
Hideaki Kimura, *NTT Access Network Service Systems Labs., Japan*
Philippe Chanclou, *Orange Labs, France Telecom, France*
David Payne, *Trinity College Dublin, Ireland*
Eddie Drake, *The Walt Disney Studios, USA*
Josep Prat, *The Universitat Politecnica de Catalunya, Spain*
Daniel Sparacin, *Aurrion Inc., USA*
Ian Dedic, *Fujitsu Semiconductor Europe, UK*
Peter Vetter, *Bell Labs, Alcatel-Lucent, USA*
Rajesh Yadav, *Verizon Technology, USA*

Cost Optimization for FTTX Builds

Event type: Panel

Organizer: Dave Russell; *Calix, USA*

Description: The equipment costs for building FTTx networks have dropped dramatically over the past few years. But service providers have also achieved dramatic savings in construction, logistics, and service activation. This panel will feature leaders in FTTx who have done pioneering work in achieving efficiencies in their network deployments. Presenters will include a wide range of service providers, both large and small, with unique stories about how they achieved these cost breakthroughs.

Speakers:
Walt Donovan; *Dycom Industries Inc., USA*
Per-Anders Eriksson, *Ericsson, Inc, USA*
Hal Roberts; *Calix, USA*
Donny Smith; *J.D. Fail Engineering, USA*
Rajesh Yadav; *Verizon Technology, USA*

PONS as Used by MSOs

Event type: Panel

Organizer: *Steve Condra; Cisco, USA*

Description: PONs (Passive Optical Networks) have traditionally delivered high bandwidth through the Access Network but have also carried high costs for outside plant construction. Full feature interactive video has sometimes been cumbersome to enable all the features with a PON network. HFC and Coaxial cable has proven to be a very flexible robust architecture system but can that media continue to dominate the MSO market space in the Residential market? Commercial Services (high data bandwidth with minimal video requirements) have been ideal candidates for fiber based solutions and PON has played a role in MSO activities in the PON architecture space. The questions being posed in this Panel Discussion:

1. What is the future role of PON architectures with MSOs in both the Commercial Services space and the Residential market?
2. What is the timing for PON in the Residential market?

Speakers:

Tim Brophy, *Cisco, USA*
Eugene Dai, *Cox Communications, USA*
Craig Mathis, *Brighthouse Networks, USA*
Martin Mattingly, *Cisco, USA*
Rick Nowaczyk, *Comcast, USA*
David Piehler, *NeoPhotonics, USA*

Is the Technology There for SDM?

Sunday, March 17, 2013
4:30 PM - 7:30 PM

Event type: Workshop

Organizer: *Kazi Abedin, OFS, USA; Anping Liu, Corning, USA; William Shieh, Univ. Melbourne, Australia; Masatoshi Suzuki, KDDI, Japan*

Description: Space-division multiplexing (SDM) via multicore or multimode fiber is currently being actively explored to overcome capacity limit of single-mode fiber (SMF). The underlying SDM technologies from multicore/multimode fibers, to multi-core/mode compatible components, including couplers, splices, amplifiers, to the required electronic DSP power, are rapidly becoming a fertile ground for research and development. The central question to SDM technologies is not so much about their availability, but rather than their cost competitiveness in building out SDM based optical systems and networks against today's SMF counterpart. This workshop will bring together world-leading experts from industry and academia to highlight pertinent challenges, review the state-of-the-art research outcomes, and give insight on the future development, from component to system level in this exciting emerging field.

Speakers:
Few-mode Fibers: From Devices to Long-distance Transmission; *Siddharth Ramachandran, Boston Univ., USA*

Multicore Fiber Design; *Kunimasa Saitoh, Univ. of Hokkaido, Japan*

Multicore Fiber Cross Talk Measurement using OTDR; *Masataka Nakazawa, Tohoku Univ., Japan*

Scalable MMF Input/Output Couplers for Mode Multiplex Systems; *Henning Buelow, Bell Labs, Alcatel-Lucent, Germany*

Frequency-domain Equalization for MDM; Guifang Li, *Univ. of Central Florida, USA*

Comparison of SDM Concepts: Which One Is Best Suited to Avoid the Capacity Crunch? Peter Krummrich, *Dortmund Univ. of Technology, Germany*

SDM System Architecture and Requirement; *Sebastian Randel, Bell Labs, Alcatel-Lucent, USA*

Few-mode Fibers for Space Division Multiplexing; *Lars Gruner-Nielsen, OFS, Denmark*

Technologies for Multi-core Fibers; *Ming-Jun Li, Corning, USA*

Multicore EDFA for Space Division Multiplexing; *Yukihiro Tsuchida, Furukawa Electric, Japan*

MM Amplifier: What are the Design Challenges for Fibers Supporting Increasing Number of Guided Modes? *Shai-ful Alam, Univ. of Southampton, UK*

Laser Inscribed 3D Waveguide-based Spatial Multiplexors; Nicholas Psaila, *Optoscribe Ltd., Scotland*

What Is the Best Technology for Wavelength- and Space-division Cross Connects

Sunday, March 17, 2013
4:30 PM - 7:30 PM

Event type: Workshop

Organizer: *Chris Doerr; Acacia Inc., USA; Roland Ryf, Bell Labs, Alcatel-Lucent, USA*

Description: There is presently a large demand for optical wavelength and space switching, in the form of wavelength-selective switches and components designed to

make them colorless, directionless, and/or contentionless. The main technologies deployed are liquid crystal on silicon (LCOS) and micro-electro-mechanical systems (MEMS). However, LCOS and MEMS generally require bulk-optic packaging and have relatively low switching speeds, limiting their footprint, cost, and switching speed reductions. Planar lightwave circuits (PLCs) are used in some commercial optical add-drop multiplexers, but these are losing share to LCOS and MEMS. Why does photonic integration struggle so much in optical switching? Will coherent receiver technology, with its filtering and compensation capabilities, change the landscape? What technology will best support the increased port count required by space-division multiplexing? We will explore where optical cross connects are headed and how they might get there.

Speakers: Mark Feuer, *AT&T, USA*
Wendy Zhao, *Google, USA*
Michael Roelens, *Finisar, USA*
Shifu Yuan, *Calient, USA*
Shan Zong, *CoAdna, USA*
Nick Fontaine, *Alcatel-Lucent, USA*
Ton Koonen, *Technische Universiteit Eindhoven, Netherlands*
Joel Carpenter, *Univ. of Sydney, Australia*
Toshio Watanabe, *NTT, Japan*

Laser Sources for Silicon Photonics: Overcoming the Final Bottleneck

Sunday, March 17, 2013
4:30 PM - 7:30 PM

Event type: Workshop

Organizer: *Liming Zhang, Alcatel-Lucent, USA; Jonathan Klamkin, Scuola Superiore Sant'Anna, Italy*

Description: Silicon photonics has emerged as a viable photonics platform owing to the maturity of Silicon manufacturing and the demonstrated performance of CMOS-compatible photonic components. This technology is envisioned to propel optical interconnect applications that demand high-volume and low-cost production of

electronic-photonic integrated circuits, and will also impact other application areas including telecommunications, sensing, spectroscopy, and biology. Active and passive components including germanium photodiodes, pn junction modulators, and low-loss waveguides have been established as fundamental building blocks. However, it is unclear which on-chip laser source approach, if any, will predominate. Leading experts will present their opinions on the most promising integrated laser technologies for Silicon photonics and the remaining challenges for overcoming this final bottleneck.

Speakers: John Bowers, *Univ. of California, Santa Barbara, USA*
Connie Chang-Hasnain, *Univ. of California, Berkeley, USA*
Takanori Shimizu, *Photonics Electronics Tech. Research Association, Japan*
Richard Jones, *Intel, USA*
Huiyun Liu, *Univ. College London, UK*
Daniil Livshits, *Innolume, Germany*
Michael Mack, *Luxtera, USA*
Jurgen Michel, *MIT, USA*
Roberto Paiella, *Boston Univ., USA*
Gunther Roelkens, *Ghent Univ./IMEC, Belgium*

If the technology for SDM exists, do we want to use it?

Monday, March 18, 2013
9:00 AM - 12:00 PM

Event type: Workshop

Organizer: Chongjin Xie, *Bell Labs, Alcatel-Lucent, USA*; Georgios Zervas, *Univ. of Bristol, UK*

Description:
The capacity of current fiber-optic communication networks is approaching its limit. Design of cost and energy efficient next generation fiber-optic networks to sustain exponential traffic growth has become increasingly urgent. One potential technology for next generation fiber-optic networks is spatial-division multiplexing (SDM) based on multimode and multicore fibers. SDM has made significant progress mostly in terms of transmission and demonstrated great potential, but network-wide technical and economic challenges need to be addressed for service providers to adopt this technology. Is there a network-wide benefit on deploying multimode/multicore SDM as

opposed to multi-fiber or multi-band networks? If so, can existing nodes and network technologies and architectures scale to support SDM and yet provide flexible bandwidth services? Where do we expect to see the first SDM networks deployed? These questions will be discussed in this workshop.

Speakers: Explore benefits of SDM to networking service providers; Tiejun J. Xia, *Verizon, USA*

Why traffic demands will leave us no choice: Technology options for realizing long-haul SDM networks; Sebastien Randel, *Bell Labs, Alcatel Lucent, USA*

What will fibre-rich operators like BT do with SDM? Andrew Lord, *BT, UK*

Benefits of multi-core fiber technologies; Yoshinari Awaji, *NICT, Japan*

Role of SDM in capacity scaling – Where is the best fit – Datacenter, metro or long haul? Vijay Vusirikala, *Google, USA*

Towards multi-dimensional node architectures considering SDM; Dimitra Simeonidou, *Univ. of Bristol, UK*

Advantages and Issues on SDM-enhanced Optical Transport Network; Yutaka Miyamoto, *NTT, Japan*

Real-world SDM: A reality check on what it will take for SDM to displace single-mode fibre; Simon Poole, *Finisar, USA*

SDM: (when) will it be useful to carriers? Lynn Nelson, *AT&T, USA*

Paths to 3dB Additional Capacity/Performance Gain: How Far Can We Go and Is It Worth the Price?

Monday, March 18, 2013
9:00 AM – 12:00 PM

Event type: Workshop

Organizer: *Chris Fludger, Cisco Optical, Germany; Ezra Ip, NEC Labs, USA; and Gabriella Bosco, Politecnico di Torino, Italy*

Description:
As we approach the nonlinear Shannon limit, it is increasingly challenging to achieve another 3 dB of gain in transmission capacity or performance (e.g. reach). There are a few possible paths towards the realization of additional gain, e.g. multi-step nonlinear compensation and strong coding, but the cost-effectiveness of these paths is still questionable.
This workshop will examine the different paths and their potential to yield a further 3 dB performance gain. Are these new techniques worth implementing? Where would you invest your money? This workshop addresses the following topics:
1) **What would 3dB give me? An operator view of how he could use 3dB capacity / performance**
Glenn Wellbrock, *Verizon, USA*
2) **FEC & capacity limit? What's left for FEC and at what complexity**
Takashi Mizuochi, *Mitsubishi Electric Corp., Japan*
3) **Higher-order modulation formats – filling the gaps in the max distance vs capacity plot**
Magnus Karlsson, *Chalmers Univ., Sweden*
4) **Super-channel transmission – Nyquist-WDM /OFDM / Sub-Nyquist**
Juerg Leuthold, *Karlsruhe Inst. of Technology, Germany*
5) **Electrical mitigation of non-linearity – DSP = Doesn't Seem Possible**
Guifang Li, *Univ. of Central Florida, USA*
6) **Optical mitigation of non-linearity? Fibres/Raman/Spectral Inversion**
Pierluigi Poggiolini, *Politecnico di Torino, Italy*
7) **Disruptive technologies – phase sensitive amplifiers / Ultra-broadband amplifiers / SDM**
David Richardson, *Optical Research Centre, Univ. of Southampton, UK*

Does Analog Photonics Have a Role in a Digital World?

Monday, March 18, 2013
9:00 AM - 12:00 PM

Event type: Workshop

Organizer: *Paul Juodawlkis, MIT Lincoln Laboratory, USA; Michael Sauer, Corning Inc., USA*

Description: With the transition from analog to digital TV transmission and the increased use of optical fiber for wireless signal distribution and backhaul, the role of analog or microwave photonics in telecom networks has become more complex. Analog transmission, filtering and signal processing can reduce the digital signal processing requirements in spectrally efficient systems, potentially resulting in reduced power consumption. Alternatively, all-digital systems can reduce the need for specialized components and systems. This workshop will examine the changing role of analog photonics in the telecom infrastructure and in special-purpose links (e.g., military, radio astronomy), and explore how analog techniques and performance measures can be applied in the digital world.

Speakers:
Analog Photonics: Why Aren't More People Using It? Keith Williams, *U.S. Naval Research Lab., USA*

Can Analog Processing Help Digital Optical Networks? Peter Winzer, *Bell Labs, Acatel-Lucent, USA*

DSP-lite Coherent Transmission; Andrew Ellis, *Univ. of Aston, UK*

Digitised RF Transport in a World of Digital Optical Networks; Christina Lim, *Univ. of Melbourne, Australia*

Energy Efficient Optical/Wireless Networks; Leonid Kazovski, *Stanford Univ., USA*

Over 100Gb/s Wired and Wireless Seamless Transmission Based on Precise Analog and Digital EO/OE Device Technologies; Tetsuya Kawanishi, *National Institute of Information and Communications Technology (NiCT), Japan*

Trends in Analog and Digital Photonics for Future Military Systems; Paul Matthews, *Northrop Grumman Corp., USA*

If the technology for SDM exists, do we want to use it?

Monday, March 18, 2013
9:00 AM - 12:00 PM

Event type: Workshop

Organizer: Chongjin Xie, *Bell Labs, Alcatel-Lucent, USA*; Georgios Zervas, *Univ. of Bristol, UK*

Description:
The capacity of current fiber-optic communication networks is approaching its limit. Design of cost and energy efficient next generation fiber-optic networks to sustain exponential traffic growth has become increasingly urgent. One potential technology for next generation fiber-optic networks is spatial-division multiplexing (SDM) based on multimode and multicore fibers. SDM has made significant progress mostly in terms of transmission and demonstrated great potential, but network-wide technical and economic challenges need to be addressed for service providers to adopt this technology. Is there a network-wide benefit on deploying multimode/multicore SDM as opposed to multi-fiber or multi-band networks? If so, can existing nodes and network technologies and architectures scale to support SDM and yet provide flexible bandwidth services? Where do we expect to see the first SDM networks deployed? These questions will be discussed in this workshop.

Speakers: Explore benefits of SDM to networking service providers; Tiejun J. Xia, *Verizon, USA*

Why traffic demands will leave us no choice: Technology options for realizing long-haul SDM networks; Sebastien Randel, *Bell Labs, Alcatel Lucent, USA*

What will fibre-rich operators like BT do with SDM? Andrew Lord, *BT, UK*

Benefits of multi-core fiber technologies; Yoshinari Awaji, *NICT, Japan*

Role of SDM in capacity scaling - Where is the best fit - Datacenter, metro or long haul? Vijay Vusirikala, *Google, USA*

Towards multi-dimensional node architectures considering SDM; Dimitra Simeonidou, *Univ. of Bristol, UK*

Advantages and Issues on SDM-enhanced Optical Transport Network; Yutaka Miyamoto, *NTT, Japan*

Real-world SDM: A reality check on what it will take for SDM to displace single-mode fibre; Simon Poole, *Finisar, USA*

SDM: (when) will it be useful to carriers? Lynn Nelson, *AT&T, USA*

Will Flexgrid Networks be Worth the Investment for just 30% Improvement?

Sunday, March 17, 2013
4:30 PM - 7:30 PM

Event type: Workshop

Organizer: *Akira Hirano, NTT, Japan; Hans-Juergen Schmidtke, Juniper, USA; Luis Velasco, Universitat Politecnica de Catalunya, Spain*

Description: Once the fixed grid is broken down, many new benefits (higher spectral/power efficiency and more flexibility) are expected with tighter channel spacing, and properly sized spectrum for each bit rate and transmission distance.

Among the potential advantages are:
- Flexible modulation allow transmitting signals at 400 Gb/s and beyond with advanced DSP.
- The introduction of bandwidth variable or even multi-flow transponders reduces the required number of transponders.
- Multi-granular switching enables performing grooming directly at the optical layer, facilitating simplification and higher efficiency of multi-layer networks.

Meanwhile additional issues (transmission performance with flexible grid, control and

management, etc.) which should be treated will arise.

In this workshop we will review the main issues and try to demystify possible deployment scenarios of flexible grid network.

Speakers: Achim Autenrieth, *ADVA AG Optical Networking, Germany*
Steve Frisken, *Finisar, USA*
Oscar Gonzalez, *Telefonica, Spain*
Oliver Jahreis, *Juniper, Germany*
Scott Mountford, *AT&T, USA*
Vijay Vusirikala, *Google, USA*

Can Access Networks Afford to be Wavelength Agile?

Monday, March 18, 2013
9:00 AM - 12:00 PM

Event type: Workshop

Organizer: *Klaus Grobe, ADVA, Germany; Michael Wale, Oclaro, UK*

Description:
Next-generation access systems, in particular Passive Optical Networks (PONs), will employ multiple wavelengths. For operational reasons, wavelength-specific transceivers are inappropriate here. The choice of Optical Distribution Network (ODN) architecture is equally vital: whilst filtered schemes restrict the flexibility of bandwidth (wavelength) provisioning, they can offer advantages in terms of insertion loss, network integrity and security. The coupled challenges of low-cost wavelength-agnostic transceivers and wavelength-agile long-distance ODN architectures are of fundamental importance for future networks.
The workshop will provide a forum for these challenges, with special focus on:
- Cost-effective wavelength-agnostic transmitters
- Tunable filters
- ODN architecture and implementation
o Impact of wavelength agility on power budgets and reach
o Impact of wavelength / waveband filtering
o Migration from existing ODN

Speakers:
Robert Blum, *Oclaro, USA*
Dirk Breuer, *Deutsche Telekom, Germany*
Richard Duijn, *Genexis, The Netherlands*
Marco Fortazi, *Acreo, Sweden*
Cedric Lam, *Google, USA*
Denis Khotimsky, *ZTE, USA*
Robert Murano, *Photop Aegis, China*
Derek Nesset, *BT, UK*
David Piehler, *NeoPhotonics, USA*
David Smith, *Huawei/CIP, USA*

Post NG-PON2: Is it More About Capacity or Something Else?

Sunday, March 17, 2013
4:30 PM - 7:30 PM

Event type: Workshop

Organizer: *Jun Shan Wey, Nokia Siemens Networks, USA; Thomas Pfeiffer, Alcatel-Lucent, Germany*

Description:
NG-PON2 systems, on their way to be standardized in ITU-T, will offer 40 Gb/s aggregated bandwidth by 2015. How much more system capacity can we anticipate after that? Is it reasonable to ever increase the system bandwidth? While in long-haul networks the high level of traffic aggregation perfectly justifies continued capacity increase, the argument is different for access. Besides technical and cost reasons, there may be service and application related as well as business and operations related aspects, which motivate access technology to move into a substantially different direction in the long run.

Join us to hear about different drivers and innovative ideas from industry and academia experts, and to actively contribute to the discussion that will help in shaping the future of optical access networks.

Speakers: Frank Effenberger, *Futurewei Technologies, USA*

Guangquan Wang, *China Unicom, China*
Hideaki Kimura, *NTT Access Network Service Systems Labs., Japan*
Philippe Chanclou, *Orange Labs, France Telecom, France*
David Payne, *Trinity College Dublin, Ireland*
Eddie Drake, *The Walt Disney Studios, USA*
Josep Prat, *The Universitat Politecnica de Catalunya, Spain*
Daniel Sparacin, *Aurrion Inc., USA*
Ian Dedic, *Fujitsu Semiconductor Europe, UK*
Peter Vetter, *Bell Labs, Alcatel-Lucent, USA*
Rajesh Yadav, *Verizon Technology, USA*

How Can Optics Address Bandwidth and Latency Bottlenecks in Data Centers?

Monday, March 18, 2013
9:00 AM - 12:00 PM

Event type: Workshop

Organizer: *Laurent Schares, IBM, USA; Loukas Paraschis, Cisco, USA; Ali Ghiasi, Broadcom, USA; George Papen, Univ. of California at San Diego, USA*

Description: Data centers are to the cloud era what manufacturing plants have been to the industrial age. Large-scale applications need increasing amounts of communication bandwidth within data centers, where “east-west” traffic patterns have been dominating, and between data-centers for low-latency service delivery and distributed processing.

In this workshop, we invite leading experts to debate which emerging optical technologies and networking concepts will have the greatest impact in the design and operations of next-generation data centers. Datacenter operators and system OEMs will discuss how new optically-enabled architectures and (software-defined?) network multi-layer control planes could address potential bandwidth and latency bottlenecks.

Optical technology developers will debate in a second part how to best implement upcoming photonic building blocks into the data center network infrastructure. More

specifically, can bandwidth-density, power and cost requirements be met with pluggable transceivers in the 100-400 Gb/s era? With single switch bandwidth rapidly scaling to the multi-Tb/s range and approaching the bandwidth-density limit of standard rack-mount chassis, is there a need to place optics either on the switch/server boards or even in the package? Will future large datacenters employ a single on-board interconnect technology – such as VCSEL-based multimode or Silicon Photonics-based single mode fiber – or will there be an intermix of optical on-board or even higher density pluggable solutions?

Speakers: Mehdi Asghari, *Kotura, USA*
Andy Bechtolsheim, *Arista, USA*
Adam Carter, *Cisco, USA*
Marc Cohn, *Ciena, USA*
Chris Cole, *Finisar, USA*
Peter De Dobbelaere, *Luxtera, USA*
Mitch Fields, *Avago, USA*
Tom Issenhuth, *Microsoft, USA*
Ashok Krishnamoorthy, *Oracle, USA*
Marc Taubenblatt, *IBM, USA*

Special Symposia

Enabling the Cloud

Organizers: George Clapp, *AT&T Research Labs, USA*; Douglas Freimuth, *IBM, USA*

Cloud computing has emerged as a new paradigm that provides on-demand, efficient, secure, reliable and cost-effective computing and storage services. Technology is playing an increasingly prominent role as cloud providers offer more complete and robust services and as more enterprises enter the market. Networks among data centers and between clients and data centers are essential resources – just as essential as computers and storage devices – and the industry is adapting their networks to meet the particular challenges of cloud computing. This special symposium will provide in depth discussions of how networks can enable the cloud, focusing on new network technologies both within data centers and between data centers. The symposium consists of two technical sessions, one on data center networks and a second on network virtualization.

I. Data Center Networks

Monday, 18 March
13:30--15:30

The widespread adoption of cloud computing is placing new and difficult requirements on data center networks. Server virtualization has made workloads much more dynamic as Virtual Machines (VMs) can be added or deleted or moved from one server to another. Network state is no longer associated with the server but now resides in the VMs, and the network state can change as VMs migrate among servers. Issues of scale arise as the number of VMs within a data center grows to two or three orders of magnitude larger than the number of servers, and network security is a paramount concern as multiple – potentially competing – enterprises are served within a single data center. This session will discuss how industry participants are responding to these challenges by developing innovative network technologies and applying new approaches such as Software Defined Networks. Topics discussed will include:

- Alternative data center network technologies for cloud computing

- Standards initiatives
- New requirements for optical networking equipment and components
- Interaction of data center networks and wide area networks
- Management of data center networks

Speakers:

13:30--14:15

The Coming Decade of System Networking Discontinuities, Renato Recio; *IBM, USA*

Renato Recio works on System I/O and Network Architecture, Strategy, and Standards. For the past 15 years, he has played a leadership role in the strategy, architecture and design of future IBM system IO and Networks. He is currently responsible for IBM's System Networking product strategy, which includes the physical fabric, network virtualization and Software Defined Networking stack.

He has been a founding engineer and author of several IO and Network industry standards. He also has filed over 200 patents, of which over 100 have already issued. He has published dozens of refereed technical conference (e.g. IEEE and ACM) papers. He created and chairs the IEEE Data Center Converged And Virtual Ethernet Switching (DC CAVES) workshops (see www.i-teletraffic.org/itc22/workshops/dc-caves-workshop/).

Abstract

The traditional Data Center Networking (DCN) model is under a transitory period, where several emerging technologies may cause significant discontinuities and result in a new dominant model. Clients are seeking: optimized fabrics that are flat and converged, simpler network control and management, automated network virtualization services and a platform for which to run agile network services. This presentation will cover the client requirements that are influencing the demand side of

these new solutions, as well as some of the emerging technologies

14:15--14:40
The Programmable Cloud; John Manville, *Cisco, USA*

 John Manville is Senior Vice President of Cisco IT Global Infrastructure Services. In this role, Manville leads the strategy and operations for Cisco networks, data centers, middleware, and databases. These systems provide the technology infrastructure services for Cisco's global workforce of more than 65,000 people. His primary focus is on addressing critical business requirements while maintaining a balance of operational excellence and innovation. Among other achievements, Manville successfully led the transformation of Cisco's data center strategy, implementing Cisco's internal cloud data center services while significantly improving Cisco's resiliency posture, time to capability, and cost structure. In keeping with the philosophy that "Cisco is its first and best customer," Manville continues to showcase the real-world benefits of Cisco's technology solutions throughout its own network and data centers. This practice has contributed to the reduction of Cisco's carbon footprint through significant savings in power and increased asset utilization.

Since joining Cisco in 2007, Manville has played a key role in establishing Cisco IT as a trusted advisor to business partners, both internal and external to Cisco. He drives collaboration with external partners to integrate their technologies with Cisco's, demonstrating the value both provide as one integrated solution. Prior to Cisco, Manville held a variety of IT positions with some of Wall Street's most respected financial companies. With a career spanning North America and Europe, he began in the industry as a network engineer, designing packet switching networks for customers in the United Kingdom. Manville holds an electrical and electronic engineering degree from University College, London University, and an executive master's degree in technology management from the University of Pennsylvania.

Abstract

Trends such as social apps, cloud, and BYOD offer the opportunity to significantly improve customer experiences and increase worker productivity. Making the most of these trends, however, is going to require some new thinking about infrastructure. This presentation will explore how to build on your existing investments and create a programmable data center that will give you the agility and flexibility to keep up with today's on-demand world.

14:40--15:05

Network Services Interface: An Interface for Requesting Dynamic Inter-datacenter Network; Tomohiro Kudoh, *National Inst. of Advanced Industrial Science and Technology (AIST), Japan*

Tomohiro Kudoh received his Ph.D. degree from Keio University in 1992. He joined National Institute of Advanced Industrial Science and Technology (AIST) in 2002. He currently serves as the deputy director of Information Technology Research Institute, AIST. In the past few years his research has focused on network as an IT infrastructure. His recent work also includes the G-lambda project which aims to define an interface to manage network as a Grid resource. He is a co-chair of the OGF (Open Grid Forum) NSI (Network Services Interface) working group.

Abstract

The Network Services Interface Working Group in the Open Grid Forum has been working to define an open interface standard to enable interoperability between dynamic circuit services, which can be used for inter-datacenter networking.

15:05--15:30

Evolution of the Architecture and Technology of Data Centers towards Exascale and Beyond; Adel Saleh, *UCSB, USA*

 Dr. Saleh is a Research Professor, Electrical and Computer Engineering Department and Institute for Energy Efficiency, University of California Santa Barbara since October 2011, conducting research on optical networking and photonics technology for chip-scale to global-scale applications. From 2005 to 2011, he was a DARPA Program Manager; from 1999 to 2004, he held various leadership positions in the optical networking industry, including Corvis, the first company to commercialize core all-optical networks. From 1970 to 1999, he was with Bell Labs / AT&T Labs Research, conducting and leading research on optical and wireless networks. He served on the OFC Technical Committee, 1995 to 1998, and served as: Technical Co-Chair, 1999; General Co-Chair, 2001; Steering-Committee Member, 2001-2006. He has more than 100 publications and 25 patents, and holds a Ph.D. from MIT and a B.Sc. from Alexandria University, Egypt, both in Electrical Engineering. He is an IEEE Fellow and an OSA Fellow.

Abstract
The continual growth of data centers cannot be maintained through incremental advances in today's technologies and architectures. An alternative architecture based on reconfigurable WDM optical networking technology is presented for realizing future, exascale, elastic data centers.

II. Network Virtualization

Monday, 18 March
16:00--18:05

Cloud computing lowers the total cost of computing through large pools of resources that are shared across many clients and managed as a single entity. Virtualization is a key enabler that creates a logical version of a physical resource such as a computer or storage device and permits the resource to be allocated to different users as demands change. Cloud providers have traditionally treated their networks as static resources,

but this model is changing as academia and industry apply virtualization techniques to networks, enabling more dynamic and efficient use of network resources. This session will discuss the state-of-the-art in network virtualization, providing an overview of the technology and forecasts for its development. The speakers will discuss topics such as:

- Reference model, architectural principles and objectives
- Role of Software Defined Networks
- Network virtualization projects
- Challenges and future directions

Speakers:

16:00--16:25
Role of Optical Network Infrastructure Virtualization in Data Center Connectivity and Cloud Computing; Reza Nejabati; *Univ. of Bristol, UK*

 Reza Nejabati obtained his MSc with distinction in Telecommunication and Information Systems and PhD in Electronic Systems Engineering from the University of Essex. He is currently a lecturer in the Department of Electrical and Electronic Engineering, University of Bristol. He was a lecturer and prior to that an RCUK fellow, in the School of Computer Science and Electronic Engineering, University of Essex. He has over ten years of academic and industrial experience in the field of telecommunication and computer science. His current area of research is in the filed of disruptive new Internet technologies with focus on application of high-speed network technologies, design and control issues for software defined, service-oriented and programmable network, cross layer network design and architecture as well as network architecture and technologies for e-science and cloud computing.

Abstract
A Datacenter as a Service architecture utilizing coordinated virtualization of distributed datacenters and operator's optical network is proposed. Two Optical network

virtualization methods and a datacenter composition mechanism are introduced and their performance is evaluated.

16:25--16:50

WAN Virtualization: Looking Beyond Point-to-Point Circuits; Inder Monga, *Energy Sciences Network/Lawrence Berkeley Labs, USA*

Inder Monga serves as the Chief Technologist and Area Lead of network engineering, tools and research at Energy Sciences Network. Mr. Monga plays a key role in developing and deploying advanced networking services for collaborative and distributed "big-data" science. He has helped contribute to multiple standards in the distributed systems community with currently active roles as the co-chair of the Network Services Interface working group in the Open Grid Forum. He also drives a number of initiatives in the global research and education community and is the co-chair of the Next-Generation Architecture and Distributed Topology Exchange working group at Global Lambda Integrated Facility (GLIF) consortium. Mr. Monga's research interests include network virtualization, software-defined networking, energy efficiency and distributed computing. He currently holds 17 patents and has over 15 years of industry and research experience in telecommunications and data networking at Wellfleet Communications, Bay Networks, and Nortel. He earned his undergraduate degree in electrical/electronics engineering from Indian Institute of Technology in Kanpur, India, before graduate studies in Boston University's EECS Department.

Abstract

Meshes of point-to-point circuits have been the lingua franca for isolating WAN traffic between distributed sites. This talk describes a flexible switching-service abstraction that enables distributed science collaborations as well as enterprise cloud computing.

16:50--17:15

Extending Network Virtualization into the Optical Domain, Jörg-Peter Elbers; *ADVA Optical, Germany*


Jörg-Peter Elbers is Vice President Advanced Technology at ADVA Optical Networking in Munich, Germany, and is globally responsible for technology strategy, new product concepts, standardization, and research. Current advanced technology activities include software-defined networking, beyond 100G transmission and next-generation optical access. Prior to joining ADVA in 2007, Jörg-Peter was Director of Technology in the Optical Product Unit of Marconi (now Ericsson). From 1999 to 2001, he worked at Siemens AG, last as Director of Network Architecture in Siemens Optical Networks. He holds a Dr.-Ing. and Dipl.-Ing. degree in electrical engineering from the Technical University of Dortmund, Germany.

Abstract
After server and storage virtualization, network virtualization adds the missing piece to the cloud computing puzzle. This paper discusses prospects, challenges and solutions for extending network virtualization into the optical domain.

17:15--17:40
Network Functions Virtualization: Challenges, Vision and Action, Christos Kolias, *ETSI NFV, USA*


Christos Kolias is currently a senior research scientist at Orange Silicon Valley leading the Software-Defined Networking (SDN) project. He has lectured on OpenFlow/SDN at several events. Christos is a founding member of the “Network Functions Virtualization” (NfV) group. His technical areas of interest include flow-aware

routing, high-speed switching, wireless networks, network virtualization and intelligent networks. Before joining Orange, he worked at Google, Covad and Caspian Networks. He has been a visiting faculty member and a frequent lecturer at Stanford University, UCLA, and USC. He holds a Ph.D. in Computer Science from UCLA, where he worked on high-speed packet-switched networks under Professor L. Kleinrock.

Abstract
A number of the world's leading telecoms network operators have recently launched a specifications group called "Network functions Virtualization" (NfV). The group's mission is to to explore and expose the benefits, enablers and challenges for implementing, in software, network functions utilizing evolving standard IT virtualization technology and which could lead into consolidating many network equipment types. NfV has issued a call-for-action to the industry.

17:40--18:05
Network Virtualization & Software Defined Carrier Networks; Bruce Anthony, *IBM STG Wireless Systems, USA*


Bruce is a Distinguished Engineer and CTO for IBM's Mobile and Wireless Systems. Over his 30 year tenure with IBM he has lead the creation of new businesses around Networking technology like Thin Clients, Telecom Blade Servers, Mobile Network Optimization Systems and WiFi Acceleration technologies. He is currently responsible to define IBM's strategies and product roadmaps around the Servers, Storage and Networking needed to support Mobile Devices and Software based Carrier Networks.

Abstract
Software Defined Networking and Cloud Computing are transforming the landscape in Enterprise IT. This talk will provide a perspective on how these technologies can also transform Carrier Networks, the extensions that may be needed to deliver robust

network services and a view on new industry efforts like Network Function Virtualization to drive change.

Additional Sessions

In addition to the special symposium on cloud computing, there will be other sessions with particular focus on the cloud. A panel on “Dynamic Network Services” will discuss how bandwidth-on-demand services offered by public carriers can meet the special requirements of cloud computing and the Service Provider Summit will hold a keynote address entitled "The Impact of Cloudonomics on the Network" by Joe Weinman.

Convergence of Wireless and Optical Networking

Organizers: Kenneth Reichmann, *AT&T Labs-Research, USA*; Jörg-Peter Elbers, *ADVA Optical Networks, Germany*

The unprecedented growth in demand for wireless services has spurred a race among carriers to upgrade and build out their mobile and fixed broadband wireless networks. As both the number of wireless sites and the bandwidth per site continue to increase, the importance of well-engineered optical/wireless networks has become ever more apparent. This symposium will assess the convergence of optical and wireless networks from different angles, such as:

• What are key 4G/5G mobile technologies and could those concepts provide a blueprint for optical access?
• What are the requirements which heterogeneous mobile networks impose on optical backhaul networks?
• How much integration between wireless and optical networking is required?
• What is the optimum level of convergence between fixed and mobile networks?
• Can software-defined network technologies help to solve the bandwidth bottleneck in the backhaul?

I. Future Architectures

Tuesday, 19 March
14:00--16:00

Speakers:

14:00--14:30

Operator Perspective on Next-Generation Optical Access for High-Speed Mobile Backhaul; Naoto Yoshimoto, *NTT Labs, Japan*

Naoto Yoshimoto is Senior R&D Manager at NTT Laboratories. He received B.S., M.S., and Ph.D. degrees in electronics and information engineering from Hokkaido University, Japan, in 1986, 1988, and 2003, respectively. He joined NTT Laboratories in 1988, and engaged in the research and development of optical transmission systems and devices for broadband access systems. He is currently the director of Broadband Optical Access System project in NTT Access Network Service Systems Laboratories, and is engaged in the planning of next-generation optical access networks and architectures. In particular, he has recently been devoting effort to advanced research for optical-wireless convergence network technologies and resilient access networks. Dr. Yoshimoto is a member of the IEEE Communication Society and a senior member of the Institute of Electronics, and he has served the chair of technical sub-committee "Access Network" in OFC2012 and OECC2013. He is also the visiting professor of Hokkaido University since 2010.

Abstract

Deep-penetrated optical access using advanced photonic technologies will play an important role in the construction of multiple services platforms that can provide not only future small-cell based wireless services beyond 4G, but also M2M towards a big-data society.

14:30--15:00

A Small Cell Augmentation to a Wireless Network Leveraging Fiber-to-the-Node

Access Infrastructure for Backhaul and Power; Patrick Iannone, *AT&T Labs-Research, USA*

 Patrick Iannone (BS Columbia University 1984; PhD Princeton University 1994) has worked in optical access research since joining AT&T Bell Laboratories in 1985 (currently AT&T Labs). He holds 40 U.S. patents and has authored over 100 publications. He has served as IEEE-LEOS Meeting Chair, as an elected member of the IEEE-LEOS Board of Governors and has chaired technical subcommittees for the IEEE-LEOS Annual Meeting and the Optical Fiber Communication Conference (OFC). He has served as OFC Technical Program Co-Chair in 2004 and General Co-Chair in 2006, and is currently Chair of the OFC Steering Committee. Dr. Iannone is a Fellow of the IEEE.

Abstract
We describe an efficient fiber backhaul strategy for a small-cell network, which leverages facilities associated with an existing fiber-to-the node (FTTN) residential access network. Related optimization studies are also described.

15:00--15:30
Unified Access and Aggregation Network Allowing Fixed and Mobile Networks to Converge; Philippe Chanclou*, France Telecom R&D--Orange Lab, France*

 Philippe Chanclou received the Ph.D. and Habilitation degrees from Rennes University, France in 1999 and 2007, respectively. He joined the R&D facilities of France Telecom in 1996 where he worked on the research of active and passive

optical telecommunications functions for access networks. In 2000, he joined the University of ENST-Bretagne (now TELECOM Bretagne) as a senior lecturer where he was engaged in research on optical switching and optical devices using liquid crystal for telecommunications. During 2001 to 2003, he has participated to the foundation of Optogone Company. Since 2004, he joined France Telecom R&D - Orange Lab where he was engaged in research on the next generation optical access networks.

Abstract

A new concept for unified access and aggregation network architecture allowing fixed and mobile networks to converge is proposed based on the concepts of Next Generation POP combining structural and functional convergence.

15:30--16:00

Network Architectures for CPRI Backhauling; Mike Loomis, *Alcatel-Lucent, USA*

Mike Loomis is VP Technical Sales with Alcatel-Lucent and is responsible for technology strategy and solutions across the Alcatel-Lucent portfolio spanning from 4G LTE to IP Services. He has developed and deployed backhaul designs for 2G/3G and 4G LTE wireless backhaul including small cells. Previously he lead the IP Division consulting engineering organization. He has over 18 years of data networking experience beginning his career with Welfleet communications. He has also held a variety of product management positions in Ethernet Switching and Carrier Ethernet and Network Management portfolios. He holds a B.S. from Rensselear Polytechnic Institute and an MBA from the University of New Hampshire.

Abstract

Small cell deployments provide unique challenges to the underlying transport networks that provide connectivity between cell sites and back to the wireless core equipment. There are two fundamental types of small cells – All-In-One Metro Cells which include

the baseband processing function and Remote Radio Units which rely on centralized baseband processing. There are specific deployment advantages to both models and transport architectures must consider both models. The Remote Radio Unit communicate with the baseband processing function via Common Public Radio Interface or CPRI. There are specific deployment advantages to both models and transport architectures must consider both models. CPRI poses some unique challenges requiring transport at layer 1 and imposing strict latency requirements.

II. Future Technologies

Tuesday, 19 March
16:30--18:30

Speakers:

16:30--17:00
4G/5G Mobile Technologies: Can They Be A Blueprint for Optical Networks? Ali Khayrallah, *Ericsson, USA*

 Ali Khayrallah is director of research at Ericsson in San Jose, California. His team is shaping the future of wireless technology, with a focus on radio access. He has been with Ericsson since 1995 in various research positions, first in Research Triangle Park, North Carolina, and now in San Jose. His career interest is leadership in research, technology and innovation. His personal research interest is in information theory and its applications. Previously, he was assistant professor in the electrical engineering department at the University of Delaware. He holds a Ph.D. and an M.S. from the University of Michigan, Ann Arbor, and a B.Eng. from the American University of Beirut. He holds more than 70 US patents and has published more than 50 technical papers.

Abstract
This paper provides a brief perspective of the evolution of mobile networks with the premise of spectrum as a scarce resource. We highlight some key aspects of mobile technology, and we comment about their connection to optical networks.

17:00--17:30
Emerging Disruptive Wireless Technologies: Prospects and Challenges for Integration with Optical Networks; Dalma Novak, *Pharad, LLC, USA*

 Dalma Novak is Vice-President at Pharad, LLC who are developing advanced RF-over-fiber and antenna products. She received her PhD in Electrical Engineering in 1992. From 1992 – 2004 she was a faculty member in the Department of Electrical and Electronic Engineering at The University of Melbourne, Australia. Previously Dr. Novak held positions at Dorsal Networks and Corvis Corporation. Dr. Novak is a Fellow of the IEEE and has published over 250 papers in the area of hybrid fiber radio technologies.

Abstract
We describe some emerging technologies that are being investigated for the realization of next generation wireless networks capable of supporting multiple standards and meeting capacity demands. The challenges associated with their efficient integration in a converged wireless/optical network are also discussed.

17:30--18:00
Analog & Digital Radio over Fiber – Approaches & Applications; Anthony Ng'Oma, *Corning, USA*

 Dr. Anthony Ng'oma leads a team of scientists and engineers working on short reach communication networks and applications at the main research center for Corning Incorporated, which is located in Corning, NY. He has been actively involved in optical communications research in general and fiber-wireless technology research in particular, for >10 years, both in Europe and the US.
Dr. Ng'oma holds a Ph.D. degree in Optical Fiber Communications, a Professional Doctorate in Engineering degree (PD.Eng) in Information and Communication Technology (ICT), both from Eindhoven University of Technology in The Netherlands, a M.Eng, and a B.Eng. degree (with Merit) in Electrical/Electronics Engineering from the University of Zambia, Zambia. He has authored and co-authored more than 60 peer-reviewed technical publications and journals and two book chapters in the field of fiber-optic communication.
Dr. Ng'oma is a member of the IEEE Photonics Society, and the IEEE Microwave Theory and Techniques Society.

Abstract

The rapid penetration of smart handheld devices coupled with the sharp rise in the number of video-centric mobile applications have led to a sharp increase in the demand for wireless data capacity and coverage inside buildings. However, wireless capacity and coverage are hampered by poor propagation of wireless signals inside buildings and the lack of high-capacity infrastructure. Therefore, effective solutions to the wireless bandwidth crunch will require the deployment of a large number of antennas inside buildings, fed by high-capacity backhaul infrastructure. The combination of optical fiber with analog signal transport has long been considered an attractive wireless signal distribution solution. However, analog transport has significant technical challenges when advanced wireless technologies such as MIMO and mm-waves are considered. This paper investigates the efficacy of simple and practical RoF transmission techniques through experimental demonstration of ultra high-capacity wireless systems operating at > 50 Gb/s.

18:00--18:30

SDN and OpenFlow for Converged Access/Aggregation Networks; Hagen Woesner, *BISDN GmbH, Germany*

Hagen Woesner studied computer science in Chemnitz and Berlin and received his diploma and doctorate degree from TU Berlin for work on IEEE 802.11 MAC protocol optimization and optical packet backbone architecture and access protocols. From 2003, he spent three postdoc years with Create-Net, Trento, Italy, working on fiber/wireless interconnection and impairment-based optical routing. Since 2007 he has been with EICT in Berlin, where he is coordinator of the pan-European OpenFlow testbed OFELIA. Recently he co-founded BISDN GmbH, a Berlin-based start-up working on SDN data path software and appliances. He chaired the European Workshop on SDN (EWSDN) in 2012.

Abstract

This paper discusses necessary steps for the migration from today's residential network model to a converged access/aggregation platform based on software defined networks (SDN).

Tingye Li Symposium

A special tribute symposium to optical communications pioneer Tingye Li explored his 40+ years of contributions that spanned the entire history of modern optical telecommunications. Video linked below:

Symposium Video