Advance Program

Coherent Optical Communication Systems

Monday, 21 July 2008

ALL SESSIONS WILL BE HELD IN MARQUESA I

13.30 - 15.00
Session MC1: OPTICAL AND OPTOELECTRONIC DEVICES
Session Chair: Reinhold Noé, *University of Paderborn, Paderborn, Germany*

MC1.1 13.30 - 14.00 (Invited)
High-Speed Vectorial Lightwave Modulation Techniques, T. Kawanishi, T. Sakamoto and A. Chiba, *National Institute of Information and Communications Technology, Tokyo, Japan*

We describe high-speed vectorial modulation techniques for high-capacity transmission systems. Integrated parallel Mach-Zehnder modulators can achieve various types of lightwave modulation, such as differential quadrature phase shift keying, quadrature amplitude modulation.

MC1.2 14.00 - 14.15

Pre-equalization for 10 Gsymbol/s 16-QAM in a Vector Modulator, Y. Kamio, M. Nakamura and T. Miyazaki, *National Institute of Information and Communications Technology, Tokyo, Japan*

We investigated the performance of electronic pre-equalization to compensate for inter-symbol-interference in electrical 16-QAM in a vector modulator. Drastic improvement in the constellation was experimentally confirmed by applying digital filtering with the minimum necessary taps.

MC1.3 14.15 - 14.45 (Invited)

Optoelectronic Devices and Subsystems for Digital Coherent Optical Communication, I. Shpantzer, Y. Achiam, P. S. Cho, A. Greenblatt, G. C. Harston and A. Kaplan, *CeLight, Silver Spring, MD, USA*

40Gb/s coherent communication link's components are reviewed, including the electronic elements and supporting algorithms' stack. The migration to a 100Gb/s link is discussed in terms of respective component specification and different coherent communication formats.

MC1.4 14.45 - 15.00

Active Control of an Optical 90 Hybrid for Coherent Detection, G. C. Harston, P. S. Cho, A. Greenblatt, A. Kaplan, Y. Achiam and I. Shpantzer, *CeLight, Silver Spring, MD, USA*

An algorithm to control the biasing of a lithium niobate optical 90º hybrid for coherent detection was embodied in hardware. The control was able to provide optimal biasing with either homodyne or differential detection.

15.00 - 15.30 **COFFEE BREAK**

15.30 - 16.45
Session MC2: COMPENSATION AND MITIGATION OF POLARIZATION EFFECTS
Session Chair: Takashi Mizuochi, *Mitsubishi Electric Corporation, Kamakura, Japan*

MC2.1 15.30 - 16.00 (Invited)
Realtime Digital Polarization and Carrier Recovery in a Polarization Multiplexed Synchronous Optical QPSK Transmission, R. Noé, S. Hoffmann, T. Pfau, O. Adamczyk, V. Herath, R. Peveling and M. Porrmann, *University of Paderborn, Paderborn, Germany*

This paper presents a phase estimation algorithm for a synchronous optical QPSK transmission system. The algorithm has been used in a digital signal processing unit for realtime carrier and data recovery. It has further been combined with polarization multiplex and electronic polarization control.

MC2.2 16.00 - 16.15

Polarization-Demultiplexing Algorithm in the Digital Coherent Receiver, K. Kikuchi*, University of Tokyo, Tokyo, Japan*

The constant-modulus algorithm has been widely applied to demultiplexing of dual polarizations with a digital coherent receiver. This paper elucidates the physics behind this algorithm, and proposes a modified method of assuring proper polarization demultiplexing.

MC2.3 16.15 - 16.30

PMD Compensation in Multilevel Coded-Modulation Schemes with Coherent Detection using Alamouti-Type Polarization-Time Coding, I. B. Djordjevic*, University of Arizona, Tucson, AZ, USA*, L. Xu and T. Wang*, NEC Laboratories America, Inc., Princeton, NJ, USA*

We present a PMD compensation scheme suitable for use in multilevel coded-modulation schemes, with PMD compensation efficiency comparable to that of OFDM, but with lower complexity of both transmitter and receiver. It is based on Alamouti-type polarization-time coding, with LDPC codes as channel codes.

MC2.4 16.30 - 16.45

32-krad/s Polarization and 3-dB PDL Tracking in a Realtime Digital Coherent Polarization-Multiplexed QPSK Receiver, T. Pfau, M. El-Darawy, C. Wrdehoff, R. Peveling, S. Hoffmann, B. Koch, O. Adamczyk, M. Porrmann and R. Noé*, University of Paderborn, Paderborn, Germany*

The tolerance against fast polarization changes and PDL of a digital coherent QPSK receiver is determined in a 2.8 Gb/s realtime polarization-multiplexed transmission experiment. The sensitivity penalty for polarization changes with a speed of 32 krad/s on the Poincar sphere is 0.5 dB.

Tuesday, 22 July 2008

09.00 - 10.00

Session TuC1: HISTORY AND COMMERCIAL DEPLOYMENT
Session Chair: Shiro Ryu, *SoftBank Telecom Corporation, Kanagawa, Japan*

TuC1.1 09.00 - 09.30 (Invited)

History of Coherent Optical Communication and Challenges for the Future, K. Kikuchi*, University of Tokyo, Tokyo, Japan*

This paper reviews the 30-year history of coherent optical communication systems. We next discuss the state-of-the-art technology of the modern digital coherent receiver, which has been developed recently, and finally describe challenges for the future.

TuC1.2 09.30 - 10.00 (Invited)

Commercially Deployed Coherent System for Video Distribution, H. Yoshinaga*, NTT Corporation, Tsukuba, Japan* and N. Shibata*, National Institute of Advanced Industrial Science and Technology, Japan*

A commercial video distribution system established on the FTTH network in Japan is described. The key to commercial deployment is FM conversion of multichannel FDM video signals by means of an optical heterodyne technique.

10.00 - 10.30 **COFFEE BREAK**

10.30 - 12.00

Session TuC2: NOVEL MODULATION FORMATS
Session Chair: Sebastian Bigo, *Alcatel-Lucent Research & Innovation, France*

TuC2.1 10.30 - 11.00 (Invited)
Novel Modulation Format and High Spectral Efficiency Technology for Coherent Optical Communication Systems, M. Nakazawa*, Tohoku University, Sendai, Miyagi, Japan*

Recent progress on coherent transmission aiming a high spectral efficiency is described, focusing on a polarization-multiplexed 1 Gsymbol/s, 128 QAM transmission. A 14 Gbit/s data signal can be transmitted within an optical bandwidth of 1.4 GHz.

TuC2.2 11.00 - 11.30 (Invited)

High Spectral Efficiency Modulation for High Capacity Transmission, R.-J. Essiambre, G. Kramer, G. J. Foschini and P. J. Winzer*, Alcatel-Lucent, Holmdel, NJ, USA*

We discusss the impact of amplification technologies, multi-level constellations and fiber nonlinearity on the spectral efficiency achievable in fiber-optic networks.

TuC2.3 11.30 - 12.00 (Invited)

High-Speed and High-Spectral Efficiency Coherent Optical OFDM, W. Shieh*, University of Melbourne, Parkville, Victoria, Australia*, Q. Yang*, University of Southern California, Los Angeles, CA, USA* and Y. Ma*, University of Melbourne, Parkville, Victoria, Australia*

We show 107 Gb/s CO-OFDM transmission over 1000-km SSMF fiber without optical-dispersion compensation and without Raman amplification. Orthogonal-band-multiplexed-OFDM is proposed to achieve high-speed and high spectral efficiency transmission without requiring extremely high DAC/ADC sampling rate.

12.00 - 13.30 LUNCH BREAK

13.30 - 15.00

Session TuC3: DIGITAL SIGNAL PROCESSING
Session Chair: Tetsuya Miyazaki, *National Institute of Information and Communications Technology, Tokyo, Japan*

TuC3.1 13.30 - 14.00 (Invited)
DA and AD Converters for 25 GS/s and Above, T. Ellermeyer, J. Mullrich, J. Rupeter, H. Langenhagen, A. Bielik*, MICRAM Microelectronics GmbH, Bochum, Germany* and M. Moeller*, Saarland University - Saarbrücken, Saarbrücken, Saarland, Germany*

We report on the status of the design and expected performance of high speed AD and DA converters in SiGe bipolar technology for future 100 Gbit/s Ethernet systems.

TuC3.2 14.00 - 14.15

5-bit 12.5 Gsamples/s Analog-to-Digital Converter for a Digital Receiver in a Synchronous Optical QPSK Transmission System, O. Adamczyk and R. Noé*, University of Paderborn, Paderborn, Germany*

We present the implementation of an analog-to-digital converter in a SiGe BiCMOS technology. The converter has a resolution of 5 bits with a sampling rate > 12.5 Gsamples/s and consumes 4.3 W of power.

TuC3.3 14.15 - 14.30

Adaptive Optimization for Digital Carrier Phase Estimation in Optical Coherent Receivers, L. Li, Z. Tao*, Fujitsu Research And Development Center, Beijing, Beijing, China*, S.-I. Oda, T. Tanimura, M. Yuki, T. Hoshida and J. C. Rasmussen*, Fujitsu Laboratories Ltd., Kawasaki, Japan*

We present a novel method to monitor and adaptively optimize digital carrier phase estimation in optical coherent receivers. This guarantees the optimal performance irrespective of the differences and changes in devices and transmission channels.

TuC3.4 14.30 - 15.00 (Invited)

Compensation of Dispersion and Nonlinearity in WDM Transmission using Simplified Digital Backpropagation, E. Ip, A. P. T. Lau, D. J. F. Barros and J. M. Kahn*, Stanford University, Stanford, CA, USA*

We study digital backpropagation for compensating linear and nonlinear impairments for wavelength-division-multiplexed transmission in single-mode fiber using a simplified numerical algorithm based on a non-iterative asymmetric split-step Fourier method.

Wednesday, 23 July 2008

09.00 - 10.00

Session WC1: IMPACT OF NONLINEAR EFFECTS
Session Chair: Kim Roberts, *Nortel Networks, Ottawa, ON, Canada*

WC1.1 09.00 - 09.30 (Invited)

Characterization of the Impact of Non-Linear Effects in Coherent Transmission Experiments, S. Bigo*, Alcatel-Lucent, Marcoussis Cedex, France*, G. Charlet*, Alcatel-Lucent, Nozay, France*, O. B. Pardo*, Alcatel-Lucent, Conflans cedex, France* and J. Renaudier*, Alcatel-Lucent, Nozay, France*

We measure the impact of optical nonlinear effects on polarization-multiplexed coherent channels at 40Gb/s, possibly surrounded by legacy channels at 10Gb/s. We then discuss several mitigation strategies against these effects.

WC1.2 09.30 - 10.00 (Invited)

Measurement of Inter-Channel Non-Linear Effects in a Real-Time, Phase Modulated, Coherent Transmission System, M. O'Sullivan*, Nortel Networks, Nepean, ON, Canada*, B. Villeneuve, A. Borowiec, A. Awadalla and M. Moyer*, Nortel Networks, Ottawa, ON, Canada*

The performance of a coherent dual polarization Quadrature Phase Key, DP-QPSK modem, with continuous real-time processing, is examined in the presence of Cross Phase Modulation, XPM. The measured influence of optical compensation is reported.

10.00 - 10.30 **COFFEE BREAK**

MARQUESA IV

10.30 - 12.00

Session WD2: **JOINT SESSION ON COHERENT OPTICAL COMMUNICATION SYSTEMS AND NEXT GENERATION TRANSCEIVER TECHNOLOGY FOR LONG-HAUL COMMUNICATION SYSTEMS**

Session Chair: Nobuhiko Kikuchi, *Hitachi, Ltd., Tokyo, Japan*

WD2.1 10.30 - 11.00 (Invited)

Mitigation of Transmission Impairments in Long-Haul and Submarine Links Using DSP-Based Electronic Predistortion, R. I. Killey, *University College London, London, UK*

Simulations assessing the use of electronic predistortion in 10 Gbit/s RZ-DPSK submarine links are described. It is shown that EPD can be effective in compensating for residual dispersion caused by inexact in-line dispersion slope matching.

WD2.2 11.00 - 11.30 (Invited)

Digital Compensation of the Optical Line: Pre-Distortion Tx & Coherent Rx, K. Roberts, *Nortel Networks, Ottawa, ON, Canada*

Precompensation and coherent postcompensation mitigate many of the depredations of the optical line. Fiber loss, and consequential amplifier noise, remains the major issue.

WD2.3 11.30 - 12.00 (Invited)

Narrowband Filtering Tolerance and Spectral Efficiency of 100GbE PDM-OFDM, S. L. Jansen, I. Morita and H. Tanaka, *KDDI R&D Laboratories, Fujimino, Saitama, Japan*

We show that the tolerance of 100GbE PDM-OFDM with respect to narrowband optical filtering is comparable to that of its single-carrier counterpart. This translates into a comparable spectral efficiency of OFDM and single-carrier modulated signals.

12.00 - 13.30 **LUNCH BREAK**

13.30 - 14.45

Session WC2: **REALTIME AND OFFLINE TRANSMISSION EXPERIMENTS**

Session Chair: Peter A. Andrekson, *Chalmers University of Technology, Gothenburg, Sweden*

WC2.1 13.30 - 14.00 (Invited)

Real-Time Implementation of Coherent Systems, A. Leven, *Alcatel-Lucent, Murray Hill, NJ, USA*, N. Kaneda, *Alcatel-Lucent, Holmdel, NJ, USA* and Y.-K. Chen, *Alcatel-Lucent, Murray Hill, NJ, USA*

DSP-based coherent optical communication systems have gained tremendous interest in recent years. While most experiments were performed using offline processing, some effects can only be observed using real-time processing.

WC2.2 14.00 - 14.15

Investigation of Nonlinear Impairment Effects on Optical Quadrature Phase-Shift Keying Signals Transmitted Through a Long-Haul System, K. Kikuchi, *University of Tokyo, Kashiwa, Chiba, Japan*

We investigate nonlinear impairments of quadrarure phase-shift-keying signals transmitted through a link >1,000 km. The use of the phase-diversity optical homodyne receiver with digital signal processing enables us to diagnose such transmission impairments clearly.

WC2.3 14.15 - 14.30

Real-time 40-Gbit/s 16-QAM Self-Homodyne using a Polarization-Multiplexed Pilot-Carrier, M. Nakamura, Y. Kamio and T. Miyazaki, *National Institute of Information and Communications Technology, Tokyo, Japan*

We demonstrated 40-Gbit/s 16-QAM real-time modulation/demodulation using electrical digital pre-equalization and a pilot-carrier to obtain phase-noise tolerant characteristics with BERs of $<10^{-9}$ using a 200-kHz EC-LD and $<10^{-7}$ using a 30-MHz DFB-LD.

WC2.4 14.30 - 14.45

The Influence of the Dispersion Map in Coherent Optical OFDM Transmission Systems, K. Forozesh, *Uppsala University, Uppsala, Sweden*, S. L. Jansen, *KDDI R&D Laboratories, Fujimino, Saitama,* , S. Randel, *Siemens AG, Munich, Germany*, I. Morita, and H. Tanaka, *KDDI R&D Laboratories, Saitama, Japan*

The influence of the dispersion map is studied on the nonlinear tolerance of OFDM transmission systems. We show that the nonlinear tolerance is severely degraded when inline dispersion compensation is employed in the transmission line.

END OF PROGRAM