Track 2: Optical Transmission Sub-systems, Systems and Technologies

Venue: Changan Room, 3F

October 25

13:30–15:30

M4B • SDM Transmission

Presider: Ning Wang, China Mobile, China

M4B.1 • 13:30 Invited

Submarine Transmission Using Space-Division Multiplexing, John D. Downie[1], Xiaojun Liang[1], Sergejs Makovejs[1]; [1]*Corning Inc, USA.* We inves- tigate space-division multiplexing approaches for high-capacity transmission in submarine systems and compare performance in terms of modeled capacity and relative system cost/bit. Multiple single-core fibers with reduced diameter and multicore fibers are studied.

M4B.2 • 14:00 Invited

High Capacity Transmission Using Space Divi- sion Multiplexing, Ruben S. Luis[1], Benjamin J. Puttnam[1], Georg Rademacher[1], Yoshinari Awaji[1], Hideaki Furukawa[1]; [1]*National Inst of Information & Comm Tech, Japan.* We address the recent developments on S+C+L band, SDM transmission using homogeneous multicore fibers. We evalu- ate amplification techniques including the use of novel doped fiber and distributed fiber amplifiers.

M4B.3 • 14:30

Fault Detection of Few Mode Fiber Based on Spatial Mode Transmission Reflection Analysis, Wenping Zhang[1], Feng Liu[1], Zhenxing He[1], Guijun Hu[2]; [1]*Wenzhou Univ., China;* [2]*Jilin Univ., China.* This paper proposes a fast and simple monitoring technique based on spatial mode transmission- reflection analysis for long-reach FMF-based mode division multiplexing system. Results shows that the proposed method can achieve high fault localization accuracy.

M4B.4 • 14:45

Role of the Acousto-Optic Coupling in a Step- Index Large Effective-Area Fiber with Intramo- dal Brillouin Scattering, Han Zhu[1], Shuo Chen[1], Huiping Tian[1]; [1]*Beijing Univ of Posts & Telecom, China.* We study the acousto-optic interaction in a step-index large effective-area fiber only contain- ing intramodal Brillouin scattering and find the number and value of Brillouin peaks depends on the acousto-optic coupling coefficients. Experi- ments verifies the conclusion.

M4B.5 • 15:00 Invited

Title to be Announced, Juhao Li[1]; [1]*Peking Univ., China.* Abstract not available.

16:00–18:00

M5B • Optical Wireless Transmission Systems

Presider: Songnian Fu, Guangdong University of Technology, China

M5B.1 • 16:00 Invited

Turbulence Mitigation Employing Multimode Diversity Reception for Free-Space Optics Communications, Yetian Huang[1], Hanzi Huang[1], Haoshuo Chen[2], Juan Carlos Alvarado[3], Qianwu Zhang[1], Nicolas Fontaine[2], Mikael

Mazur[2], Roland Ryf[2], Rodrigo Amezcua-Correa[3], Yingxiong Song[1], Yingchun Li[1], Min Wang[1]; [1]*Shanghai Univ., China;* [2]*Nokia Bell Labs, USA;* [3]*Univ. of Central Florida, USA.* We review our demonstration comparing the performance with and without employing multimode diversity reception under a laboratory- simulated isotropic turbulence, and our dem- onstration on an elliptical-aperture multimode diversity receiver to mitigate the impairment from anisotropic turbulence.

M5B.2 • 16:30

3 Gbit/s Wide Field-of-View Visible Light Communication System Based on White Laser Diode, Yuqi Hou[1], Chicheng Ma[1], Dong Li[1], Fangchen Hu[1], Guoqiang Li[1], Chao Shen[1], Nan Chi[1]; [1]*Fudan Univ., China.* A high-speed laser- based white light visible light communication (VLC) system with wide field-of-view (FOV) of 34° has been demonstrated, enabling a data transmission rate exceeding 3 Gbit/s.

M5B.3 • 16:45

Experimental Demonstration of Free-Space Orbital-Angular-Momentum Mode-Group Multiplexing Under Atmosphere Turbulence, Andong Wang[1], Long Zhu[1], Mingliang Deng[1], Bing Lu[1], Xiaojin Guo[1]; [1]*CQUPT, China.* We ex- perimentally utilize transmitter mode diversity in a free-space 144 Gbit/s orbital-angular-momentum (OAM) mode-group multiplexed link, which can improve the received power and BER perfor- mance under atmosphere turbulence.

M5B.4 • 17:00

Hybrid FSO/MMW Communication System With Active Link Switching Based on Weather Conditions, Lun Zhao[1], Shuai Zhang[1], Xuanmin Pan[1], Yejun Liu[1], guo lei[1]; [1]*Chongqing Univ. of Posts and Telecommunications, China.* This paper proposes a hybrid FSO/MMW communication system that can switch freely according to moni- tored weather conditions. The proposed system can improve system performance in different weather conditions.

M5B.5 • 17:15

Adaptive Probabilistic Shaping of PAM-4 Using Polar Codes for FSO Communication, Xiaoyu Liu[1], Jiafei Fang[1], Shilin Xiao[1], Lizhuo Zheng[1], Xiangyu Fu[1], Weisheng Hu[1]; [1]*Shanghai Jiao Tong Univ., China.* An adaptive probabilistic shaping scheme using polar codes is proposed to increase the capacity and combat the fading in FSO system, which outperforms the uniform scheme and PAS-MMB 0.39~0.91dB and 0.10dB respectively in BLER.

M5B.6 • 17:30

Physical-Layer Network Coding Based on Pre- coded OFDM in Relay-Assisted Visible Light Communications, Shuhua Song[1], Zhaoquan Fan[1], Geyang Wang[1], Chengju Hu[1], Jian Zhao[1]; [1]*South China Univ. of Technology, China.* We experimen- tally demonstrate physical-layer network coding (PNC) based on precoded OFDM in a 2.16-Gbit/s asymmetric two-way-relay VLC network, and show that PNC enables full-duplex transmission with significantly improved performance while OCT- P-OFDM outperforms OFDM and DFT-S-OFDM.

M5B.7 • 17:45

A Modified Phase Diversity Algorithm-Based Adaptive Compensation for Orbital Angular Momentum Wireless Optical Communication, Huan Chang[1], Ran Gao[1], Xiaoli Yin[2], Fei Wang[1], Sitong Zhou[1], Qi Zhang[1], Dong Guo[1], Fu Wang[1], Zhipei Li[1], Xiangjun Xin[1]; [1]*Beijing Inst. of Technol- ogy, China;* [2]*Beijing Univ. of Posts and Telecom- munications, China.* A modified phase diversity algorithm (MPDA)-based adaptive optics (MPDA-AO) scheme of compensating for the OAM beam is proposed. Simulation results demonstrate that the proposed

MPDA-AO technique indeed de- contaminates the distorted OAM signaling beam.

October 26

08:30–10:00

T1B • High-Capacity Transmission Systems

Presider: Qunbi Zhuge, Shanghai Jiao Tong University, China

T1B.1 • 08:30 Invited

C+L Optical Amplifier Modeling Assisted by Machine Learning, Maria Vasilica Ionescu[1], Amirhossein Ghazisaeidi[1], Jeremie Renaudier[1]; [1]*Nokia Bell Labs France, France.* Machine learning can provide highly accurate models of amplifier gains as a function of pump powers. We discuss the implementation approaches and challenges in determining the best-fit ML model of an opti- cal amplifier.

T1B.2 • 09:00 Invited

Enabling Technologies and Experiments on Ultra-Wideband Amplified Transmission Sys- tems, Lidia Galdino[1]; [1]*Univ. College London, UK.* Challenges and solutions in experimen- tally demonstrate ultra-wideband (UWB) optical transmission are described. The description of theoretical models and metrics, together with different approaches for UWB transmission system optimisation is proposed and investigated.

T1B.3 • 09:30

Low-Noise Amplification and Equalization of Dissipative Kerr Soliton Microcomb Lines via Laser Injection Locking, Boyuan Liu[1], Qiang Zhang[1], Xinjie Han[1], Yong Geng[1], Kun Qiu[1], Heng Zhou[1]; [1]*Univ of Electronic Science & Tech China, China.* We demonstrate optical injection locking to amplify Kerr soliton comb lines for high speed optical communications, excellent results are achieved regarding comb power amplification, signal-to-noise ratio enhancement and bit-error rate, outperforming conventional fiber amplifier.

T1B.4 • 09:45

Single-Carrier 800 Gbit/s and 1.2 Tbit/s Trans- mission Using 96 GBaud Commercial Optoelec- tronic Components, Qiang Zheng[1], Hong Yang[1], Longbao Wang[1], Zhuopeng Xiao[1], Huijian Zhang[1]; [1]*HiSilicon Optoelectronics Co., Ltd, China.* Using commercial optoelectronic components we ex- perimentally demonstrate an 800 Gbit/s/lambda system with 96 GBaud 32QAM. The BER floor is 9e-5 and the receiver sensitivity is -20.7 dBm, which may support several DCI applications.

10:30–12:00

T2B • Machine Learning in Optical Networks

Presider: Danshi Wang, Beijing University of Posts & Telecom, China

T2B.1 • 10:30 Invited

Failure Location and Prediction With Cross- Layer AI in Self-Optimized Optical Networks (SOON), Yongli Zhao[1], Ke Tian[1], Ying Wang[2], Bing Zhang[1], Zhuotong Li[1], Zipiao Zhao[1], Jie Zhang[1]; [1]*Beijing Univ of Posts & Telecom, China;* [2]*State Grid Information & Telecommunication Company, China.* Failure location and prediction are always important issues in optical transport networks, which can be resolved by cross-layer AI proposed in self-optimized optical networks. Some related works and experiment results have been given in this paper.

T2B.2 • 11:00

Machine Learning Assisted Accurate Estimation of QoT Impairments of Photonics Switching System on 400ZR, Ihtesham Khan[1], Lorenzo Tunesi[1], Muhammad Umar Masood[1], Enrico Ghil- lino[2], Paolo Bardella[1], Andrea Carena[1], Vittorio Curri[1]; *[1]Politecnico di Torino, Italy; [2]Synopsys, USA.* We propose a machine learning-based technique that accurately estimates quality-of- transmission (QoT) impairments of an optical switch on 400ZR. The proposed scheme works in an entirely agnostic way reduces inaccuracy in QoT impairments estimation by 1.5dB.

T2B.3 • 11:15

Machine Learning Assisted Hardware Finger- print Identification for TDM-PON From Eye- Diagram, Huiyuan Gong[1], Mengfan Cheng[2,3], Weidong Shao[2,3], Hongyu Li[2,3], Lei Deng[2,3], Qi Yang[2,3], Deming Liu[2,3]; *[1]Wuhan Research Inst. of Posts and Telecommunications, China; [2]Research Inst. of Huazhong Univ. of Science and Technol- ogy in Shenzhen, China; [3]National Engineering Laboratory for Next Generation Internet Access System (NGIA), School of Optical and Electronic Information, Huazhong Univ. of Science and Technology (HUST), China.* We propose and experimentally demonstrate a hardware identity authentication technique for TDM-PON based on feature identification from eye diagram. The results show that the recognition accuracy can be up to 99%.

T2B.4 • 11:30

Predictive Uncertainty Aware Active Learning for Regression-Based QoT Estimation in Optical Networks, Zheng Li[1], Zhiqun Gu[1], Jiawei Zhang[1], Yuhang Zhou[1], Yuefeng Ji[1]; *[1]Beijing Univ. of Posts and Telecomm, China.* We propose an active learning strategy for regression-model-based QoT estimation to achieve higher accuracy with fewer samples. Results show that our strategy decreases 35.8% MSE on average than traditional method with the restricted sample size.

T2B.5 • 11:45

Excellent Performance Robustness of Flexible Drop Operations of DSP-Switched ROADMs Ex- cluding Optical Filters and O-E-O Conversions, Mingliang Deng[1], Zhirui Luo[1], Zhibo Xing[1], Timera Mamadou[1], Jingwei Shi[1], Lian Qing[1], Jiacheng Bai[1]; *[1]CQUPT, China.* DSP-Switched ROADM drop operation performances are extensively explored against variations in MZM operating characteristics. Numerical results show that the drop operations have excellent performance robustness, which can be further improved with longer digital filter lengths.

13:30–15:30

T3B • Advanced Modulation Formats

Presider: Jianjun Yu, Fudan University, China

T3B.1 • 13:30 Invited

Nonlinearity-Tolerant Multidimensional Modulation Formats for High Speed Optical Communications, Bin Chen[1]; *[1]Hefei Univ. of Technology, China.* Performance trade-offs between lin- ear shaping and nonlinear tolerance of the recently introduced 4D and 8D modulation formats are investigated. Numerical simulations and experiments show an increased nonlinear tolerance and improved transmission distance with respect to coventional modualtion formats.

T3B.2 • 14:00 Invited

Symbol-Pattern-Dependent Adaptive Equalization and Maximum Likelihood Sequence Estimation with a Common Look-up-Table, Yi Cai[1]; *[1]Soochow Univ., USA.* By employing a common look-up-table, we incorporate

the feature of symbol correlation into both adaptive equalization and maximum likelihood sequence estimation. The scheme upgrades the transmission technology to a multi-symbol-oriented pattern- dependent equalization and detection regime.

T3B.3 • 14:30

A Constellation-Shaped 127QAM Scheme Based on Geo- metric Shaping, Xiangyu Liu[1], Qi Zhang[1], Ran Gao[2], Xiangjun Xin[1], Xishuo Wang[1], Huan Chang[2], Bingchun Liu[3], Wenmao Zhou[1], Feng Tian[1], Qinghua Tian[1], Zhipei Li[2]; *[1]Beijing Univ. of Posts and Telecomm, China; [2]School of information and electronics, Beijing Inst. of Technology, China; [3]School of Man- agement Tianjin Univ. of Technology, China.* A novel constel- lation-shaped 127QAM scheme based on geometric-shaping is proposed. In a 140-Gb/s simulation system, the proposed scheme has a 0.87dB OSNR gain and a 186km transmission- distance gain at 2e-2 BER, compared with uniform-128QAM.

T3B.4 • 14:45

Gaussian Mixture Model Clustering Algorithm for a Proba- bilistic Shaping 64QAM Coherent Optical Communication System, Hui Xu[1], Yongjun Wang[1], Chao Li[1], Xiangjun Xin[1]; *[1]Beijing Univ. of Posts and Telecommunications, China.* In this paper, a Gaussian Mixture Model (GMM) clustering algorithm with initial means is proposed. The experiment results show that the proposed algorithm can significantly improve the performance of probabilistic shaping (PS) 64QAM.

T3B.5 • 15:00

Artificial Neural Networks-Assisted Geometric Shaping Optimization Including Gray-Like Mapping, Xiang Liu[1,2], Jiao Zhang[1,2], Min Zhu[1,2], Bingchang Hua[2], Yucong Zou[1,2], Qinru Li[1], Yingxin Wei[1], Weidong Tong[1], Yuancheng Cai[1,2], Mingzheng Lei[2], Liang Tian[2], Aijie Li[2]; *[1]Southeast Univ., China; [2]Purple Mountain Laboratories, China.* Artificial Neural networks- based geometric shaping is proposed that includes Gray-like mappings. Over 0.2dB gain in GMI and BER improvement is achieved over a wide range of SNRs without requiring any presumed model for the channel.

T3B.6 • 15:15

Up to 16384-QAM IFoF Transmission With DML Based on 2-Bit High-Pass Delta-Sigma Modulation, Yixiao Zhu[1], Longjie Yin[1], Qi Wu[1], Lina Man[1], Yiming Tao[1], Weisheng Hu[1]; *[1]Shanghai Jiao Tong Univ., China.* We design a 2-bit high-pass delta-sigma modulator based on 4th-order cascaded resonator feedback structure, and experimentally demonstrate IFoF transmission of 1.88GHz bandwidth 16384-QAM in 32Gb/s DML-DD link. 0.58% EVM is achieved after 20km SSMF transmission.

T3B.7 • 15:30

QPSK-Partition Assisted Frequency Offset Estimation for Probabilistically Shaped Coherent Optical Communication Systems, Xue Tang[1,2], Lishan Yang[1,2], Hengying Xu[1,2], Chenglin Bai[1,2], Weibin Sun[1,2], Xinkuo Yu[1], Lingguo Cao[1], Xiuhua Lv[1], peng Qin[1]; *[1]School of Physics Science and Information Engineering, Liaocheng Univ., China; [2]Shandong Provincial Key Laboratory of Optical Communication Science and Technology, Liaocheng Univ., China.* A QPSK-partition assisted frequency offset estima- tion scheme is proposed for probabilistically shaped coherent systems. High FOE accuracy can be achieved under conditions of moderate/strong shaping. The complexity of this scheme is reduced to O(N).

T3B.8 • 15:45

Pilot-Free Bayesian Filter for Phase Noise Correction of 64QAM CO-OFDM Superchannel, Lakshmi

Narayanan Venkatasubramani[1], Yi Lin[2], Colm Browning[2], Anirudh Vijay[1], R David Koilpillai[1], Liam Barry[2], Deepa Venkitesh[1]; *[1]Indian Inst. of Technology Madras, India; [2]Dublin City Univ., Ireland.* We experimentally demonstrate the use of a pilot-free phase noise mitigation algorithm for a gain-switched comb-based 480 Gbps 64QAM CO-OFDM superchannel system using weighted-blind estimation and Bayesian filter with 18% potential improvement in spectral efficiency.

October 27

08:30–10:00

W1B • IM-DD Systems

Presider: Ning Liu, Soochow University, China

W1B.1 • 08:30

Transmission of 214 Gbps IM/DD PAM-4 Over 10 km Based on 25 GHz-Class EML Using Low-Power Nonlinear MLSE, Huanlu Li[1], Weiyu Wang[1], Jian Tang[1], Haiyang Zhang[1], Zhilei Huang[1], Qinyu Zhou[1], Guoxi Wang[1], Ming Li[2], Yuchun Lu[1]; *[1]Huawei Technologies, China; [2]Inst. of Semiconductors, CAS, China.* 214 Gbps per lane PAM-4 transmissions are demonstrated with 25 GHz class commercial EML. Employing an improved MLSE algorithm enables the system to meet 10 km transmission with under KP4-FEC BER threshold requirement. The experiment results show the potential of commercial EML for 800 GbE application.

W1B.2 • 08:45

Experimental Demonstration of 50-Gb/s/λ O-Band CWDM Direct-Detection Transmission Over 100-km SMF, Yang Hong[1], Natsupa Taengnoi[1], Kyle Bottrill[1], Naresh Thipparapu[1], Yu Wang[1], Jayanta Sahu[1], David Richardson[1], Periklis Pet- ropoulos[1]; *[1]Univ. of Southampton, UK.* We demonstrate the first single-sideband 50-Gb/s/λ coarse WDM direct-detection transmission in the O-band. It is shown that the Kramers-Kronig-detection assisted single-sideband transmission exhibits significant OSNR sensitivity improvements over double-sideband transmission, enabling up to 100-km reach.

W1B.3 • 09:00

Performance Enhanced Gerchberg-Saxton Algorithm Based Electrical Disper- sion Pre-Compensation for Intensity-Modulation and Direct-Detection System, Dongdong Zou[1], Wei Wang[1], Mingzhu Yin[1], Qi Sui[2], Zhaohui Li[1], Fan Li[1]; *[1]Sun Yat-Sen Univ., China; [2]Southern Laboratory of Ocean Science and Engineering, China.* A per- formance enhanced Gerchberg-Saxton algorithm based dispersion pre-compensation scheme is proposed for IM-DD system. The simulation results show that 56-GBaud PAM-4 signal is successfully transmitted over 400-km SMF in C-band enabled by the proposed scheme.

W1B.4 • 09:15

EML-Based IM/DD Transmission Over Dispersion-Uncompensated Links Using Low-Complexity Optimized Detection, Shuangyue Liu[1], Han Cui[1], Xizi Tang[1], Yueming Lu[1], Yaojun Qiao[1]; *[1]Beijing Univ Posts & Telecommunications, China.* We experimentally demonstrate an EML-based 40-Gbit/s OOK IM/DD transmission over 120-km SSMF using a low-complexity optimized detection algorithm, which requires no multiplication during the update of survival path, simultaneously showing its superiority against chromatic dispersion.

W1B.5 • 09:30 Invited

AI for Fast and Accurate Optical Fiber Channel Modeling, Lilin Yi[1], Hang Yang[1], Ze- kun Niu[1], Shilin Xiao[1],

Weisheng Hu[1]; [1]*Shanghai Jiao Tong Univ., China.* Deep learning is investigated to fast learn optical fiber channel with low complexity. The modeling shows robust generalization abilities under different optical launch powers, modu- lation formats, input signal distributions and transmission distance up to 1000km.

10:30–12:00

W2B • Visible Light Communication and Positioning Systems

Presider: Nan Ye, Shanghai University, China

W2B.1 • 10:30

ANN-Based Anti-Tilt High-Precision Indoor Positioning System Using Triple-LED and Security Camera, Shuang Zhao[1], Dahai Han[1], Xiaoyun Li[1], Peiyu Jia[1], Shengnan Li[1], Min Zhang[1]; [1]*Beijing Univ. of Posts and Telecomm, China.* In this paper, an artificial neural network (ANN) based high-precision positioning system using triple-LED and security camera is proposed, which achieves a mean positioning error (MPE) of 0.87 cm in a space of 1m×1m×1m.

W2B.2 • 10:45

An Integrated Visible Light Communication and Positioning CDMA System Implementation Based on OZCZ Code, Danyang Chen[1], Jianping Wang[1], Huimin Lu[1], Lifang Feng[1], Jianli Jin[1]; [1]*Univ of Science and Technology Beijing, China.* A novel integrated visible light communication and positioning CDMA system based on OZCZ code is proposed. The results show that the OZCZ code is better than conventional code considering the system BER and positioning accuracy.

W2B.3 • 11:00

Visible Light Communication Channel Modeling by Experiment-Data-Driven Deep Learning, Yanwen Zhu[1], Dahai Han[1], Chuan Yang[1], Shengnan Li[1], Xiaoyun Li[1], Min Zhang[1]; [1]*Beijing Univ. of Posts and Telecommunications, China.* An experiment-data- driven channel-modeling method based on bidirectional long short-term memory is proposed for visible light communication channels. The resulting mean absolute error is stable in a small range, reaching 0.009 without occupying spectrum resources.

W2B.4 • 11:15

Characterization of a Practical 3-m VLC System Using Commercially Available Tx/ Rx Modules, Chen Chen[1], Yungui Nie[1], Xin Zhong[1], Min Liu[1], Binbin Zhu[2]; [1]*Chongqing Univ., China;* [2]*Shenzhen Hua Chuang Chip Lighting Co., Ltd, China.* We experimen- tally characterize the performance of a practical 3-m VLC system using commercially available Tx/Rx modules. Results show that the achievable rates are at least 120 and 320 Mbit/s when applying OOK and OFDM, respectively.

W2B.5 • 11:30

A 3D Visible Light Positioning and Orienteering Scheme Using Two LEDs and a Pair of Photo-Detectors, Xiaobai Yang[1], Zile Jiang[2], Xiaodi You[1], Jian Chen[3], Changyuan Yu[4], Yongcheng Li[1], Mingyi Gao[1], Gangxiang Shen[1]; [1]*Soochow Univ., China;* [2]*Nanjing Univ., China;* [3]*Nanjing Univ. of Posts and Telecommunications, China;* [4]*The Hong Kong Polytechnic Univ., Hong Kong.* A 3D visible light positioning (VLP) scheme is proposed by referring to the distances between two luminaires and a pair of photo-detectors. VLP accuracy < 10 cm can be achieved while offering terminal orientation information.

W2B.6 • 11:45

Multi-Access Indoor Optical Wireless Communications Enabled by MLC-NOMA and Direct Detection With Kramers-Kronig Receivers, Jianghao Li[1], Qi Yang[2], Dai xiaoxiao[2], Christina Lim[1], Ampalavanapillai Nirmalathas[1]; [1]*The Univ. of Melbourne, Australia;* [2]*School of Optical and Electronic Information, Huazhong Univ. of Science and Technology, China.* We propose a multiple access indoor optical wireless com- munication system enabled by multilevel coding based non-orthogonal multiple access, which is shown by the simulation of a 2m direct detection optical wireless link with Kramers-Kronig reception.

13:30–15:30

W3B • Systems with High Sensitivity

Presider: Nan Ye, Shanghai University, China

W3B.1 • 13:30 Invited

Phase-Sensitive Pre-Amplified Receiver for High Sensitivity Optical Communica- tions, Ravikiran Kakarla[1]; [1]*Univ. of Southampton, UK.* A record sensitivity of 1 photon- per-bit achieved at 10Gbps using quadrature phase-shift keyed transmitter with 100% overhead forward error correction code and a phase-sensitive pre-amplified coherent receiver with a noise figure of 1.2 dB.

W3B.2 • 14:00

A Photon Limited SiPM Based Receiver for Internet of Things, Yangchun Li[1], Yuanyuan Hua[1], Robert Henderson[1], Danial Chitnis[1]; [1]*Univ. of Edinburgh, UK.* We compared two photons counting readout methods on a SiPM based receiver. The results show that integration method performs better BER in non-linear counts and 1Mbps is achieved under 9.44×10^{-9}W with 11.78 photons per bit.

W3B.3 • 14:15

Observing Cross-Channel NLI Generation in Disaggregated Optical Line Systems, Elliot P. London[1], Emanuele E. Virgillito[1], Andrea D'Amico[1], Antonio Napoli[2], Vit- torio Curri[1]; [1]*Politecnico di Torino, Italy;* [2]*Infinera, Germany.* We investigate spatially separated XPM generation in a wide variety of 400G-ZR+ 64GBd pump-and-probe simulations, demonstrating the existence of a per-span upper bound that depends solely upon accumulated dispersion.

W3B.4 • 14:30

Ultrahigh Resolution Narrow Linewidth Measurement Based on Brillouin Laser in a High Q Whispering Gallery Mode Cavity, Yong Geng[1], Boyuan Liu[1], Qiang Zhang[1], Xinjie Han[1], Kun Qiu[1], Heng Zhou[1]; [1]*Univ of Electronic Science & Tech China, China.* We demonstrate ultrahigh resolution narrow linewidth measurement based on Brillouin laser in a high Q Whispering gallery mode cavity. This new scheme can achieve a higher spectral resolution and overcome the main drawbacks of conven- tional schemes.

W3B.5 • 14:45

Time Delay Measurement of Optical Fiber Link With Spatial Resolution, Xufeng Chen[1], Shupeng Li[1], Lihan Wang[1], Xiaohu Tang[1], Xi Liu[1], Jianbin Fu[2], Xiangchuan Wang[1], Yaoyao Shi[1], Shilong Pan[1]; [1]*Nanjing Univ Aeronautics & Astronautics, China;* [2]*Suzhou LiuYaoSi Information Technologies Co., Ltd., China.* Time delay measurement of optical fiber link with spatial resolution is proposed. A spatial resolution of 8.176 cm and length measurement precision of ± 0.14 mm are achieved.

W3B.6 • 15:00

Physical Layer Cryptography Key Generation by Estimating Channel Character- istics Based on Neural Network, Kun Wu[1], Yuefeng Ji[1], Hongxiang Wang[1]; [1]*BUPT, China.* A physical-layer secure key generation scheme based on neural network is proposed. It can efficiently generate symmetric keys with high entropy, adjustable generation rate under the transmission distance of 100 km and bit-rate of 100Gbps.

W3B.7 • 15:15

Physical-Layer Secure Key Distribution Scheme Based on Phase Noise in PSK/ QNSC, Shuang Wei[1], YaJie Li[1], Kongni Zhu[1], Chao Lei[1], Yongli Zhao[1], Jie Zhang[1]; [1]*Beijing Univ. of Posts and Telecommunications, China.* A secure key distribution scheme with phase noise resisting the beam splitting attack in PSK/QNSC is proposed. The highest key consistency rate 98.4% and key generation rate 70.41 Mbit/s are demonstrated over 50 km SSMF.

16:00–18:00

W4B • AdvaNced Direct Detection Techniques

Presider: Fan Zhang, Peking University, China

W4B.1 • 16:00 Invited

Title to be Announced, Alan Pak Tao Lau[1]; [1]*The Hong Kong Polytechnic Univ., Hong Kong*. Abstract not available.

W4B.2 • 16:30

Phase Noise Compensation in Optical Carrier-Assisted Single-Sideband and Direct Detection PAM-4 System, Dongxu Lu[1], Jiahao Huo[1], Jinhui Yuan[1], Xian Zhou[1], Keping Long[1]; [1]*Univ Sci & Tech Beijing (USTB), China.* We propose a joint phase noise compensation scheme including SP-LMS and RPD-BPS algorithm in the optical carrier-assisted SSB-DD PAM4 system with high spectral efficiency, which can tolerate 1-MHz laser linewidth at a BER of 3.8e-3.

W4B.3 • 16:45

Analysis and Compensation of Equalization-Enhanced Phase Noise in Carrier Assisted Differential Detection System, Peng Qin[1], Chenglin Bai[1,2], Hengying Xu[1,2], Lishan Yang[1,2], Weibin Sun[1,2], Xinkuo Yu[1], Xiuhua Lv[1], Xue Tang[1,2], Yanfeng Bi[1], Xueyuan Luo[1]; [1]*School of Physics Science and Information Engineering, Liaocheng Univ., China;* [2]*Shandong Provincial Key Laboratory of Optical Communication Sci- ence and Technology, Liaocheng Univ., China.* In this paper, the influences of EEPN in the A-CADD and S-CADD systems are analyzed for the first time. Meanwhile, we demonstrate the mitigation of the EEPN influence using ML and BPS phase compensation algorithms.

W4B.4 • 17:00

Comparison of Iterative Field Reconstruction Schemes for IM/DD PAM4 Signal Transmission, Masayuki Matsumoto[1], Takuya Takahashi[1]; [1]*Wakayama Univ., Japan.* Iterative field reconstruction for electrical dispersion compensation in PAM4 IM/DD transmission system is studied. It is shown that using transmitted signal constraint in the Gerchberg-Saxton iteration algorithm is effective in enhancing the convergence speed.

W4B.5 • 17:15

SSBI-Oriented MISO Equalizer in the Presence of O/E Front-end Frequency Response, Qi Wu[1], Yixiao Zhu[1], Weisheng Hu[1]; [1]*ShangHaijaotong Univ., China.* A customized algorithm is proposed to adaptively mitigate ISI and SSBI considering O/E front-end response simultaneously based on a MISO equalizer in SSB direct detection system, and validated in 30GBaud SSB-32QAM 80km SSMF transmission experiment.

W4B.6 • 17:30

Fast WHT-Based Block Precoding for DMT Transmission, Ling Wang[1], Ming Chen[1], Gang Chen[1], Aitao Deng[1], Hui Zhou[1], Yi Liu[2], Yun Cheng[2]; *[1]Hunan Normal Univ., China; [2]Hunan Univ. of Humanities, Science and Technology, China.* We experimentally com- pare DFT, OCT and WHT-based block precoding (BP), bit loading and the traditional precoding techniques in a short-reach DMT system. A similar BER performance can be achieved with the low-complexity fast WHT-based BP technique.

W4B.7 • 17:45

Precoding-Enabled Probabilistically-Shaped DMT Transmission With Average Signal Power Constraint, Haimiao Long[1], Ming Chen[1], Long Zhang[1], Gang Chen[1], Ling Wang[1], Yi Liu[2], Yun Cheng[2]; *[1]Hunan Normal Univ., China; [2]Hunan Univ. of Hu- manities, Science and Technology, China.* We experimentally investigate the PS-DMT system enabled by DFT, OCT and WHT-based precoding techniques under average transmit signal power constraint. Up to 2 dB receiver sensitivity improvement can be achieved compared to the conventional PS-DMT.

Track 2: Optical Transmission Sub-systems, Systems and Technologies
Luoyang Room, 3F

13:30–15:30
M4H • Real-time Transmission and Quantum Communications
Presider: Zhiyu Xiao, Huawei Technologies Co Ltd, China

M4H.1 • 13:30 Invited

Real-Time, Software-Defined, Multi-Modulation Format, GPU-Based Receiver, Sjoerd P. van der Heide[1,2], Ruben S. Luis[2], Sebastiaan Goossens[1], Benjamin J. Puttnam[2], Georg Rademacher[2], Ton Koonen[1], Satoshi Shinada[2], Yoshinari Awaji[2], Alex Alvarado[1], Hideaki Furukawa[2], Chigo M. Okonkwo[1]; [1]*Eindhoven Univ. of Technology, Netherlands;* [2]*National Inst. of Information and Communication Technology (NICT), Japan.* Real-time digital signal processing for IM/DD PAM-N and Kramers-Kronig coherent N-QAM is implemented on a commercial off-the-shelf GPU. Transmission over 91 km of field-deployed fiber and a 10,000 km straight-line link is demonstrated.

M4H.2 • 14:00 Invited

Integration of Continuous-Variable Quantum key Distribution and Coherent Optical Communication, Takuya Hirano[1]; [1]*Gakushuin Univ., Japan.* In this talk, we will review the present status of continuous-variable quantum key distribution, including optical configuration and security analysis, and would like to discuss future prospects for integration with coherent optical communications.

M4H.3 • 14:30

A Real Time Implementation of 3-Stage Equalizer for Burst-Mode Digital QPSK Receivers of the Coherent PON, Tao Zeng[1], Zhixue He[1], lingheng meng[1], Feng Jiang[1], Shaohua Yu[1]; [1]*State Key Laboratory of Optical Communication Technologies and Networks, China information and communication technology Group Corporation, China.* In this paper, we implement a real time 3-stage equalizer for burst-mode digital coherent receivers in asynchronous PON upstream, and demonstrate a high performance multi-function preamble header. We evaluate the performance of this architecture in the experiment.

M4H.4 • 14:45

Digital Emulation of Time-Varying PMD for Real-Time DSP Evaluations, Haorui Kan[1], Hong Zhou[1], Erik Börjeson[1], Magnus Karlsson[2], Per Larsson-Edefors[1]; [1]*Dept. of Computer Science and Engineering, Chalmers Univ. of Technology, Sweden;* [2]*Photonics Laboratory, Chalmers Univ. of Technology, Sweden.* We introduce a digital PMD emulator to accelerate BER analysis of coherent receiver DSPs. The emulator creates parameterizable, time-varying impairments, which we use to demonstrate real-time analysis of a CMA equalizer.

M4H.5 • 15:00 Invited

Real-Time MIMO Detection Over SDM Fibers: Feasibility and Challenges, Shohei Beppu[1], Noboru Yoshikane[1]; [1]*KDDI Research, Inc., Japan.* For practical deployment of SDM transmission systems with few-mode or coupled-core fibers, hardware implementation of a real-time MIMO DSP is essential. We show SDM transmission experiments with a real-time MIMO DSP and discuss challenges.

16:00–18:00
M5H • Machine Learning for Optical Communication

Presider: Yunbo Li, China Mobile Communication Corporation R, China

M5H.1 • 16:00 Invited

Physics-Based Deep Learning for Fiber-Optic Communica- tion Systems, Christian Häger[1]; [1]*Chalmers Tekniska Högskola, Sweden.* We will give an introduction and overview of recent advances in designing efficient nonlinear equalization schemes by combining insights about the signal propagation dynamics in optical fibers with novel data-driven optimization techniques.

M5H.2 • 16:30 Invited

Title to be Announced, Meng Xiang[1]; [1] *Guangdong University of Technology, China.* Abstract not available.

M5H.3 • 17:00

Attention-Based Neural Network Equalization in Fiber-Optic Communications, Abtin Shahkarami[1], Mansoor I. Yousefi[1], Yves Jaouen[1]; [1]*Telecom Paris, France.* An attention mechanism is integrated into neural network-based equalizers to prune the fully-connected output layer. For a 100 GBd 16-QAM 20 x 100 km SMF transmission, this approach reduces the computational complexity by ~15% in a CNN+LSTM model.

M5H.4 • 17:15

Sparsely-Connected Cascade Recurrent Neural Network- Based Nonlinear Equalizer for a 100-Gb/s PAM4 Optical Interconnect, Zhaopeng Xu[1], Shuangyu Dong[1], Chenxin Jiang[1], Jonathan H. Manton[1], William Shieh[1]; [1]*Univ. of Melbourne, Aus- tralia.* A sparsely-connected cascade recurrent neural network is proposed based on pruning which enables a 100-Gb/s 15-km PAM4 transmission using a bandwidth-limited DML. Compared with the fully-connected counterpart, 21.66% connections are saved without degrading system performance.

M5H.5 • 17:30

Experimental Evaluation of Computational Complexity for Different Neural Network Equalizers in Optical Commu- nications, Pedro Jorge Freire de Carvalho Souza[1], Yevhenii Osadchuk[1], Antonio Napoli[2], Bernhard Spinnler[2], Wolfgang Schairer[2], Nelson Costa[3], Jaroslaw E. Prilepsky[1], Sergei K. Tu- ritsyn[1]; [1]*Aston Univ., UK;* [2]*Infinera, Germany;* [3]*Infinera, Portugal.* Addressing the neural network-based optical channel equal- izers, we quantify the trade-off between their performance and complexity by carrying out the comparative analysis of several neural network architectures, presenting the results for TWC and SSMF set-ups.

M5H.6 • 17:45

A Ditherless Bias Control Technique for IQ Mach-Zehnder Modulator Based on Partial Derivative and Neural Network, Jinyang Wu[1], Jiaqi Huang[1], Dai Xiaoxiao[1], Qi Yang[1], Mengfan Cheng[1], Lei Deng[1], Deming Liu[1]; [1]*Huazhong Univ. of Science and Technology, China.* We proposed a ditherless automatic bias control algorithm based on partial derivative estimation and neural network. Simulation results show the precision for bias IQ and P can achieve 0.5% and 0.1% of 2Vπ, respectively.

October 26

08:30–10:30

T1H • Coherent Transceivers and Transmission

Presider: Bin Chen, Hefei University of Technology, China

T1H.1 • 08:30 Invited

Large Capacity, High Spectral Efficiency and Long Distance Optical Transmission Based on High-Order QAM, Jianjun Yu[1], Miao Kong[1], Kaihui Wang[1], Junjie Ding[1], Yi Wei[1]; [1]*Fudan Univ., China.* We summarized our recent research results and achieved high-level QAM-based large-capacity, high-spectrum efficiency, and long-distance transmission through advanced digital signal processing

T1H.2 • 09:00 Invited

Coded and Modulation of Coherent 800G per Lambda DWDM Transmission, Zhiyu Xiao[1]; [1]*Huawei Technologies Co Ltd, USA.* For 800G transmission, an appropriate modulation and coding scheme must be selected to achieve the expected SE and performance . In this paper, the application of different modulation and coding techniques on 800G is introduced to obtain the optimal modulation and coding techniques under different target SE definitions.

T1H.3 • 09:30

16-Tb/s (80×200-Gb/s) Nyquist DP-QPSK Transmission Over 10,000-km G.654E Fiber Using Silicon-Based Integrated Coherent Transceiver, Chao Yang[1], Ming Luo[1], Zhixue He[1,3], Lei Wang[2,1], Xi Xiao[1,2], Shaohua Yu[1,2]; [1]*China Information Communication Technologies Group Corporation, China;* [2]*National Information Optoelectronics Innovation Center, China;* [3]*PengCheng National Laboratory, China.* We use a high-bandwidth silicon-based integrated coherent transceiver in the long-haul fiber transmission systems . 16-Tb/s (80×200- Gb/s) Nyquist DP-QPSK transmission over 10,000-km G .654E fiber with Raman amplification is experimentally demonstrated.

T1H.4 • 09:45

Simultaneous Characterization of Polarization Skews and Electrical Channel Skews in Optical Coherent Transceivers, Wing-Chau Ng[1], Yongfu Wang[2], Xuefeng Tang[1], Zhuhong Zhang[1], Chuandong Li[1]; [1]*Huawei Technologies Canada, Canada;* [2]*Huawei Technologies, China.* An accurate calibration algorithm is proposed to simultaneously measure polarization and arbitrary electrical channel skews at transmitter and re- ceiver . Experiment shows its robustness to polarization rotation, with ±0 .6 ps error over 30 ps range .

10:30–12:00

T2H • DML-Enabled Systems

Presider: TBA

T2H.1 • 10:30 Invited

Tb/s Transmission in Sustainable and Flexible Metro Net- works Using Long-Wavelength VCSELs, Pierpaolo Boffi[1], Paola Parolari[1], Alberto Gatto[1], Mariangela Rapisarda[1], Federico Lipparini[1], Michela Svaluto Moreolo[2], Josep Maria Fabrega[2], Christian Neumeyr[3], Giovanni Delrosso[4], Benjamin J . Puttnam[5], Massimiliano Severi[6], Giorgio Parladori[6]; [1]*Politecnico di Milano, Italy;* [2]*Centre Tecnològic de Telecomunicacions de Catalunya*

(CTTC/CERCA), Spain; [3]*Vertilas GmbH, Germany;* [4]*VTT Techni- cal Research Center of Finland, Finland;* [5]*NICT - National Inst. of Information and Communications Technology, Japan;* [6]*SM Optics, Italy.* Tb/s transmission for future metropolitan networks is demonstrated thanks to an innovative photonic cost-effective and energy-efficient transmitter module integrating multiple directly modulated long-wavelength InP VCSELs targeting more than 50-Gb/s per channel, together with multi-core fiber propagation.

T2H.2 • 11:00

Demonstration of 100Gb/s/λ 32QAM-DMT Transmission in Intra-DCI Using 10G-Calss EML Modulator and 4-bit DAC, Mingzhu Yin[1], Zhibin Luo[1], Dongdong Zou[1], Xingwen Yi[1], Zhaohui Li[1], Fan Li[1]; [1]*Sun Yat-Sen Univ., China.* Enabled by fast-precoding DFT-S for PAPR suppression and noise-shaping technique for redistribution of quantization-noise in signal quantization with 4-bit DAC, a low-cost 100Gb/s short-haul Intra-DCI using 10G-class EML modulator and 4-bit DAC is experimentally demonstrated in this paper.

T2H.3 • 11:15

Crosstalk and Power Fading in a WDM-RoF Based MFN Using Directly Modulation 3s-DBR Laser, Haixuan Xu[1], Yao Zhu[1], Yuze Wu[1], Colm Browning[2], Liam Barry[2], Yonglin Yu[1]; [1]*Wuhan National Laboratory for Optoelectronics, Huazhong Univ. of Science and Technology, China;* [2]*The RINCE Inst., Dublin City Univ., Ireland.* We experimentally investigate a RoF-based MFH for 5G system with a tunable 3s-DBR laser. Transmission performance of 12 channels and 16 channels of 211 MHz-bandwidth f-OFDM signals with 16QAM over SSFM are evaluated and compared.

T2H.4 • 11:30

High-Speed Spectral-Scanning FMCW LiDAR System Based on Tunable VCSEL, Yaqi Han[1], Zhi Li[1], Lican Wu[1], H.Y. Fu[1]; [1]*Tsinghua-Berkeley Shenzhen Inst., China.* We demonstrate an ultrafast spectral-scanning LiDAR system by utilizing a compact tunable VCSEL. The proposed system can realize the two-dimensional beam scanning with 8 kHz sweep rate and millimeter-level ranging precision simultaneously.

T2H.5 • 11:45

Demonstration of All-Digital Burst Clock and Data Recovery for Symmetrical Single-Wavelength 50G PON Application Using Low-Bandwidth Optics, Jiao Zhang[1,2], Qingyi Zhou[1], Min Zhu[1,2], Xiang Liu[1,2], Bingchang Hua[2], Yuancheng Cai[1,2], Mingzheng Lei[2], Liang Tian[2], Yucong Zou[2], Aijie Li[2]; [1]*South- east Univ., China;* [2]*Purple Mountain Laboratories, China.* We experimentally demonstrated all-digital burst clock and data recovery for symmetrical 50-Gb/s/λ PON using low-bandwidth optics over the same fiber link to support over 26 dB power budget. The performances of uplink burst-mode is studied.

13:30–15:30

T3G • Coherent DSP

Presider: Yi Cai, Soochow University, China

T3G.1 • 13:30 Tutorial

Ultralong-Distance Undersea Transmission Systems, Jin-Xing Cai[1]; [1]*TE SubCom, USA.* Abstract not available.

T3G.2 • 14:15

Low-Complexity Frequency Offset Estimation Based on Training Symbol for NFDM Systems, Yanfeng Bi[1],

Hengying Xu[1,2], Chenglin Bai[1,2], Weibin Sun[1,2], Lishan Yang[1,2], Xinkuo Yu[1], Xueyuan Luo[1], Lingguo Cao[1]; *[1]School of Physics Science and Information Engineering, China; [2]Shandong Provincial Key Laboratory of Optical Communication Science and Technology, China.* We propose a low-complexity frequency offset estimation scheme based on training symbol for NFDM systems. It achieves FOE error of less than 1MHz within range of ±1GHz, whose complexity is related with the training symbol.

T3G.3 • 14:30 Invited

Title to be Announced, Amirhossein Ghazisaeidi[1]; *[1]Nokia Bell Labs France, France.* Abstract not available.

T3G.4 • 15:00

Mitigated Residual Phase and Performance Enhancement Using Improved Stokes Space Polarization Demultiplexing, Jie Tang[1], Wanzhen Guo[1], Jian Zhao[1]; *[1]South China Univ. of Technology, China.* We investigate improved stokes-space polarization demultiplexing (SS-PDM) in coherent systems using Kalman-based CPR and show that the improved SS-PDM mitigates random phase jumps in conventional SS-PDM and thus improves the performance of the following CPR.

T3G.5 • 15:15

Receiver IQ Imbalance and Skew Compensation for High Order Modulation Formats by Frequency Domain 4x2 MIMO, Liang Junpeng[1,2]; *[1]ZTE Corporation, China; [2]State Key Laboratory of Mobile Network and Mobile Multimedia Technol- ogy, China.* We propose a modulation formats independent frequency domain 4x2 multi-input and multi-output (MIMO) equalizer, which can compensate receiver inphase and quadrature (IQ) imbalance and skew with lower complexity than time domain (TD) 4x2 MIMO.