SiPhotonics/GaAs 28-GHz Transceiver for mmWave-over-Fiber Laser-Less Active Antenna Units

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Abstract: We demonstrate a 28 GHz radio-over-fiber system with laser-less, low-cost active antenna units using silicon photonics and a GaAs driver and LNA. 7-Gb/s downlink and uplink throughput was achieved over 2km SSMF and 5m wireless.
OCIS codes: (060.2330) Fiber optics communications, (060.5625) Radio frequency photonics

1. Introduction

Meeting the demands for future wireless mobile communication will require significant changes in the underlying network [1]. A first important change is the migration to higher carrier frequencies as these bands offer more bandwidth and are less congested than the sub-6 GHz bands. Secondly, a small-cell approach will be adopted to increase the overall data capacity of the network. To allow for the densification of the network, a centralized approach with distributed low-complexity active antenna units (AAUs) is of paramount importance. In such a configuration, centralized offices (COs) contain the high-complexity functionalities, such as the generation and processing of the RF signal, and subsequently distribute the generated data to the intended AAU using radio-over-fiber (RoF) technology. Typical RoF implementations for mmWave distribution rely on IF-over-Fiber and accomplish the frequency up-conversion at the AAU [2,3]. This approach requires the distribution of a synchronous carrier which is used to generate a local oscillator signal in the AAU.

In this work, the complexity of the AAU is further reduced by adopting RF-over-Fiber (RFoF). Furthermore, a reflective electro absorption modulator (EAM), with compact footprint, is used to realize laser-free AAUs, thereby further reducing cost, complexity and weight. In contrast to the broadband approaches used in prior works, a dedicated EAM-driver and photoreceiver are designed for optimal performance in the 28 GHz band using a combination of GaAs pHEMT electronics and silicon photonics. The signal processing and computing resource allocation are transferred to the CO to further simplify the AAU and reduce the latency. This proposed RFoF system features low-complexity, low-cost and easy to install AAUs, which is highly desired in centralized networks and distributed antenna systems (DAS). Besides small signal characterization, the performance and throughput of the RFoF system is evaluated for mmWave communications demonstrating 12 Gb/s transmission over 2km standard single mode fiber (SSMF). After introduction of a 5m wireless path 7 Gb/s transmission is obtained.

2. Experimental setup

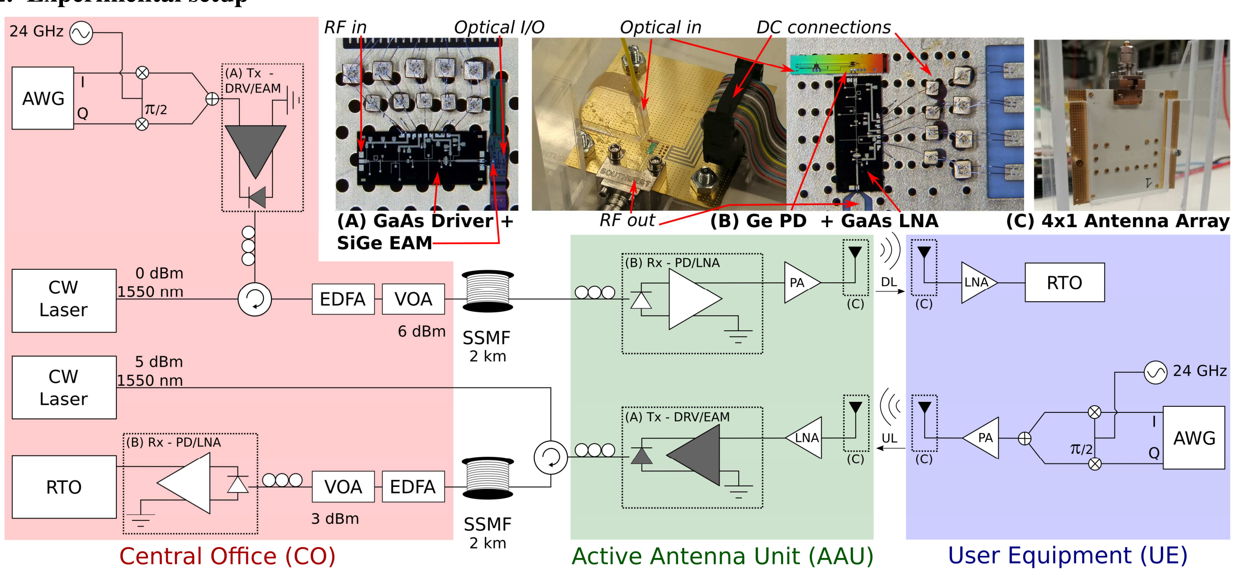


Fig. 1: Block diagram and experimental setup for bidirectional 28 GHz RFoF link

The experimental setup, consisting of both the uplink and downlink of the proposed RFoF system, is shown in Fig. 1. In this work, the 5G New Radio channels nr257/258 were targeted with frequency ranges between 24.25 and 29.5 GHz. Furthermore, nr257/258 adopt a time division duplexing (TDD) scheme [4].

The downlink path starts with an arbitrary waveform generator (AWG) that generates an IF signal which is subsequently up-converted to the RF frequency. The generated RF signal is amplified by a dedicated narrowband GaAs EAM-driver, which offers a small signal gain of 25.2 dB over a 3-dB bandwidth between 24.4 and 29.5 GHz with a noise figure of 2.0 dB. The driver has an input referred 1-dB compression point of -20 dBm and consumes 124 mW. The output of the GaAs driver is fed to a SiGe reflective EAM coupled to silicon waveguides and modulates the incident continuous wave (CW) 1550 nm laser tone incident on the EAM. Since the modulator is reflective, an optical circulator is required to separate the modulated from the unmodulated light. The reflective EAM has a very compact footprint of 340 µm by 220 µm and is fabricated on the iSiPP50G silicon photonics platform with a bandwidth far beyond 28 GHz, which opens the opportunity to realize RFoF systems at even higher frequency bands, such as the extended frequency range in 5G New Radio and the 60-GHz band used by WiGig.

An erbium doped fiber amplifier (EDFA) and a variable optical attenuator (VOA) are used to set the power launched into the SSMF. At the AAU, the photoreceiver converts the light back to the RF domain and subsequently amplifies the signal. The devised photoreceiver comprises a silicon waveguide coupled Ge-on-Si photodetector (PD) and a co-designed GaAs low noise amplifier (LNA). The LNA offers 24 dB gain, corresponding to 224 V/W external conversion gain, over a 3-dB bandwidth between 23.5 and 31.5 GHz [5]. Its associated noise figure is 2.1 dB and an output referred third order intercept point up to 26.5 dBm can be obtained with a power consumption of 303 mW. The devised narrowband GaAs/SiGe transceiver has a total power consumption of 427 mW (driver and receiver). A commercial power amplifier (*HMC943)* is added to ensure that the signal fed to the antenna is sufficiently strong (approximately 10 dBm). Furthermore, 4x1 linear and passive antenna arrays with integrated Wilkinson splitters are used to achieve beamforming gain in the broadside direction. The downlink signal received by the antenna at the user equipment (UE) is first amplified and subsequently monitored by a real-time oscilloscope (RTO, *Keysight DSA-Z634A)*. The captured data was demodulated offline in Matlab.

The uplink path first generates an RF signal and subsequently passes the signal over the wireless link. Next, the signal is amplified with a commercial low noise amplifier (*HMC1040*) and fed to the EAM-driver which modulates the incident CW laser tone. A reflective EAM was used to enable laser-free operation of the AAU. To separate the CW tone incident on the reflective EAM from the modulated light coming from the EAM, an optical circulator is used. Subsequently, the light passes through SSMF and is converted back to the electrical domain at the central office by making use of the aforementioned photoreceiver.

3. Results and Discussion

The transfer function of the RFoF link in optical back-to-back (OB2B) starting from the input of the EAM-driver to the output of the photoreceiver is shown in Fig. 2. The 3-dB bandwidth of the link spans from 24.7 to 28.6 GHz and shows a small signal gain of 28.4 dB when 3 dBm optical power is incident on the photoreceiver.

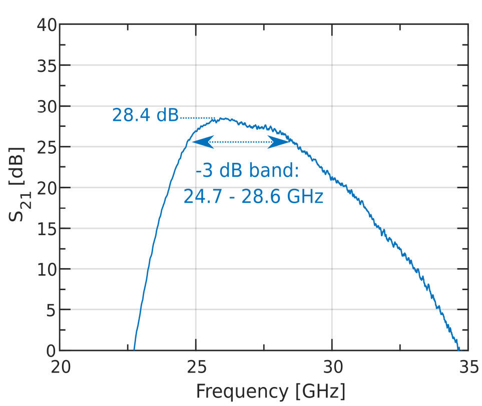


Fig. 2: S_{21} narrowband RFoF link

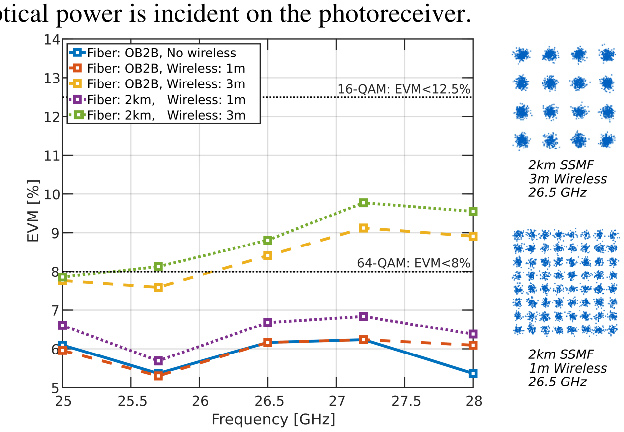
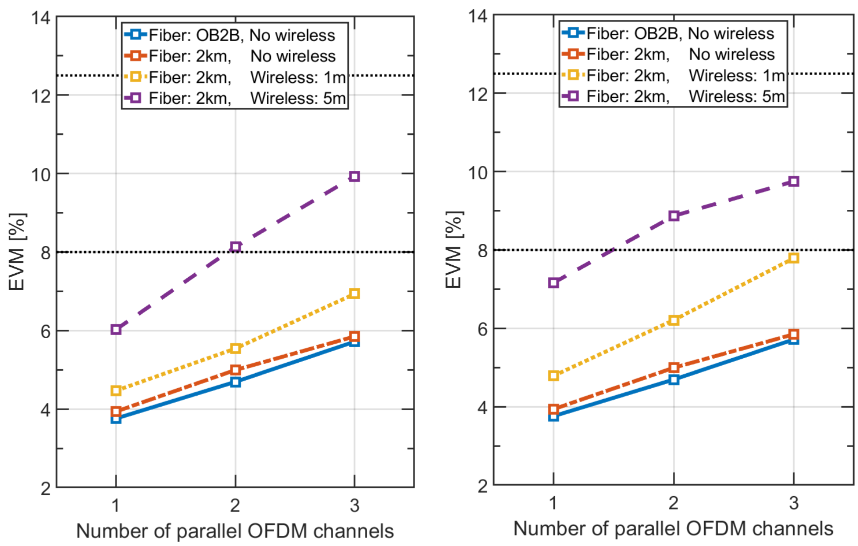


Fig. 3: Downlink single carrier - 5 x 400 MBaud Multiband, exploring maximum RFoF link capacity.

To explore the maximum RFoF link capacity, downlink multiband single carrier experiments were performed. Five 400 MBd channels centered at 25.0, 25.7, 26.5, 27.2 and 28.0 GHz were transmitted simultaneously over the fiber-wireless link. The EVM values (normalized to the average power) of the transmitted data are measured in the absence of a wireless channel for an OB2B link and compared to different wireless scenarios in Fig. 3. For 1m wireless, the EVM stays well below the 8% requirement for 64-QAM [6]. It should be pointed out that the optical insertion loss of 2km SSMF has a limited impact on the signal reception quality. When the wireless distance is increased to 3m, the 12.5% EVM requirement for 16-QAM is still met [6]. Consequently, using 5-channel multiband single carrier data transmission allows for data rates up to 12 Gb/s over 1m wireless distance and up to 8 Gb/s over 3m wireless distance in a typical indoor environment. At larger distances, fading significantly degrades the signal quality.

To overcome equalization challenges after fading, orthogonal frequency division multiplexing (OFDM) signals were also evaluated for this RFoF system. OFDM signals make the data transmission over the wireless channel more robust at the cost of increased requirements on the dynamic range of the E/O and O/E converters and its associated drivers and amplifiers [7]. The OFDM signal parameters used for each channel and its data rate are summarized in Fig. 4(a). Each OFDM channel can support 2.34 Gb/s using 16-QAM. The uplink and downlink path are tested separately due to the envisioned TDD duplexing mode [4]. For one OFDM channel, the EVM after 2km fiber was below 4%. For three OFDM channels after 2km fiber, all EVMs were below 8% [6] and the averaged EVM was around 6%, as shown in Fig. 4(b) and 4(c). For 1m wireless distance, the measured EVMs can even support 64-QAM. An aggregated capacity of 7.02 Gb/s was achieved over 2km SSMF and 5m wireless distance for both downlink and uplink with an EVM that meets the 3GPP specification.

Bandwidth	800MHz
Number of subcarriers	512
Number of pilots	16
Number of DC, null subcarriers	28
Cyclic prefix (CP) size	1/4
Peak-to-average-ratio	10.8 dB
Data rate per channel (16-QAM)	2.34Gb/s



(a) (b) (c)

Fig. 4: (a) OFDM signal parameters. (b) Measured EVM in RFoF-wireless downlink. (c) Measured EVM in RFoF-wireless uplink.

4. Conclusion

We have demonstrated a very low complexity narrowband GaAs electronics/Si photonics transceiver for scalable RFoF architectures. The chipset consumes 427 mW, introduces a link gain of 28.4 dB – with 3 dBm optical power – and supports a link bandwidth from 24.7 to 28.6 GHz. Furthermore, laser-free active antenna unit operation is enabled due to the reflective EAM used in the RFoF transmitters, which reduces the complexity of the active antenna units even further. With this transceiver, 12 Gb/s over 2km SSMF was demonstrated and over 7 Gb/s down- and uplink were demonstrated for a 2km fiber, 5 m wireless mmWave link with an EVM around 10%.

5. Acknowledgements

Ghent University (BOF14/GOA/034), ERC Grant ATTO (695495), Methusalem funding, AFOSR (FA95501810015), H2020 5G-PHOS (761989).

6. References

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OFC Postdeadline Paper Abstracts

Session Title	Location	Time
Th4A • Postdeadline Session I	6C	16:30 – 18:15
Th4B • Postdeadline Session II	6D	16:30 – 18:15
Th4C • Postdeadline Session III	6E	16:30 – 18:15

OFC Postdeadline Paper Abstracts

Room 6C
16:30 -- 18:30
Th4A • Postdeadline Paper Session I
Presider: Daniel Kuchta; IBM TJ Watson Research Center, USA

Th4A.1 • 16:30
Isolator-free > 67-GHz bandwidth DFB+R laser with suppressed chirp, Yasuhiro Matsui1, Richard Schatz2, Di Che3, Ferdous Khan1, Martin Kwakernaak1, Tsurugi Sudo1; *1II-VI Incorporated, USA*; *2Applied Physics, Photonics, KTH Royal Inst. of Technology, Sweden*; *3Nokia Bell Labs, USA*. We realized > 67 GHz bandwidth, a reflection tolerance up to 12.5 %, and a chirp parameter of 0.6 for a DFB laser integrated with a passive waveguide with 3% reflection coating, called DFB+R laser.

Th4A.2 • 16:45
A 112 Gb/s all-silicon micro-ring photodetector for datacom applications, Meer Nazmus Sakib1, Peicheng Liao1, Ranjeet Kumar1, Duanni Huang1, Guan-lin Su1, Chaoxuan Ma1, Haisheng Rong1; *1Intel Labs- Photonics Research, USA*. We demonstrate an all-silicon micro-ring resonant photodetector with a responsivity of 0.23 A/W and dark current <100nA capable of detecting 112 Gb/s PAM-4 signal with an eye closure penalty of <1.0 dB.

Th4A.3 • 17:00
Net 212.5 Gbit/s Transmission in O-band With a SiP MZM, One Driver and Linear Equalization, Maxime Jacques1, Zhenping Xing1, Alireza Samani1, Xueyang Li1, Eslam El-Fiky1, Samiul Alam1, Olivier Carpentier1, Ping-Chiek Koh2, David Plant1; *1McGill Univ., Canada*; 2*Lumentum, USA*. We present an O-band SiP MZM design enabling net transmission of 212.5 (200) Gbit/s over 2 (10) km using PAM-8 modulation and 20% SD-FEC, and net 200 Gbit/s back-to-back using PAM-6 and 6.7% HD-FEC.

Th4A.4 • 17:15

Silicon Photonics Coherent Optical Subassembly with EO and OE Bandwidths of Over 50 GHz, Shogo Yamanaka1, Yuichiro Ikuma1, Toshihiro Itoh1, Yuriko Kawamura1, Kiyofumi Kikuchi1, Yu Kurata1, Makoto Jizodo1, Teruo Jyo2, Shunichi Soma1, Masayuki Takahashi1, Ken Tsuzuki1, Munehiko Nagatani2, Yusuke Nasu1, Asuka Matsushita3, Takashi Yamada1; 1*NTT Device Innovation Center, Japan*; 2*NTT Device Technology Laboratories, Japan*; 3*NTT Network Innovation Laboratories, Japan*. We present a silicon photonics coherent optical subassembly, which has electro-optic/ optic-electro bandwidths of 54 GHz/52 GHz for a transmitter/receiver. We also demonstrate up to 96 Gbaud polarization multiplexed 16QAM signal generation and detection.

Th4A.5 • 17:30

SiPhotonics/GaAs 28-GHz Transceiver for mmWave-over-Fiber Laser-Less Active Antenna Units, Laurens Bogaert1, Joris Van Kerrebrouck1, Haolin Li1, Igor Lima de Paula1, Kasper Van Gasse1, Sam Lemey1, Hendrik Rogier1, Piet Demeester1, Gunther Roelkens1, Johan Bauwelinck1, Guy Torfs1; 1*Ghent Univ., Dep. INTEC, Belgium*. We demonstrate a 28 GHz radio-over-fiber system with laser-less, low-cost active antenna units using silicon photonics and a GaAs driver and LNA. 7-Gb/s downlink and uplink throughput was achieved over 2km SSMF and 5m wireless.

Th4A.6 • 17:45

An 8x8 silicon photonic switch module with nanosecond-scale reconfigurability, Nicolas Dupuis1, Jonathan E. Proesel1, Nicolas Boyer2, Herschel Ainspan1, Christian W. Baks1, Fuad Doany1, Elaine Cyr2, Benjamin Lee1; 1*IBM TJ Watson Research Center, USA*; 2*IBM Canada, Canada*. We demonstrate a fully-packaged digitally programmable 8×8 strictly nonblocking electrooptic silicon photonics switch module. We measured fiber-to-fiber loss between 7.5 and 10.5 dB, crosstalk <−30 dB, and reconfiguration time <10 ns.

Th4A.7 • 18:00

Full-Speed Testing of Silicon Photonic Electro-Optic Modulators from Picowatt-level Scattered Light, Xiaoxi Wang1, Boris A. Korzh2, Matthew Shaw2, Shayan Mookherjea1; 1*Univ. of California San Diego, USA*; 2*Jet Propulsion Laboratory, USA*. We demonstrate a technique for measuring the full-speed performance of integrated modulators from ultraweak surface-coupled and scattered light. This can enable rapid characterization of unpackaged, high-speed wafer-scale integrated photonics without test ports or special fabrication.

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Room 6D
16:30 -- 18:30
Th4B • Postdeadline Paper Session II
Presider: William Shieh; Univ. of Melbourne, Australia

Th4B.1 • 16:30
Broadband Bismuth-Doped Fiber Amplifier With a Record 115-nm Bandwidth in the O and E Bands, Yu Wang1, Naresh Thipparapu1, David Richardson1, Jayanta Sahu1; 1*Optoelectronics Research Center, UK*. We report a bismuth-doped fiber amplifier providing >20dB gain from 1345nm-1460nm with 31dB maximum gain and 4.8dB NF at 1420nm for a -23dBm signal. The gain coefficient and temperature-dependent-gain coefficient are 0.042dB/mW and -0.015dB/oC, respectively.

Th4B.2 • 16:45
First Demonstration of Automated Updates of Disaggregate Blades in Multi-Domain/Layer Optical Path Network, Kiyo Ishii1, Sugang Xu2, Noboru Yoshikane3, Atsuko Takefusa4, Shigeyuki Yanagimachi5, Takeshi Hoshida6, Kohei Shiomoto7, Tomohiro Kudoh8, Takehiro Tsuritani3, Yoshinari Awaji2, Shu Namiki1; 1*National Inst. of Advanced Industrial Science and Technology, Japan*; 2*National Inst. of Information and Communications Technology, Japan*; 3*KDDI Research, Japan*; 4*National Inst. of Informatics, Japan*; 5*NEC Corporation, Japan*; 6*Fujitsu Limited, Japan*; 7*Tokyo City Univ., Japan*; 8*The Univ. of Tokyo, Japan*. Updating an OpenROADM node and subsequent re-routing were automated using a mathematical component-based model, triggered by the addition of node components. This process required only five minutes on an orchestrated testbed using SINET5 and a field optical network.

Th4B.3 • 17:00
First Demonstration of Hollow-Core-Fiber Cable for Low Latency Data Transmission, Benyuan Zhu1, Brian J. Mangan1, Tristan Kremp1, Gabe Puc1, Vitaly Mikhailov1, Kyle Dube2, Yuriy Dulashko1, Merari Cortes1, Yue Liang3, Ken Marceau2, B Violette2, D Cartsounis2, Ralph Lago2, Brian Savran2, Daryl Inniss1, David DiGiovanni1; 1*OFS Laboratories, USA*; 2*OFS Fitel LLC, USA*; 3*OFS Fitel LLC, USA*. We present the first field-deployable hollow-core-fiber (HCF) cable and successfully demonstrate an error-free transmission of direct-detection 10Gb/s DWDM signals over a 3.1km cascaded HCF cable link, enabling 31% latency reduction compared to solid-core-fiber cable.

Th4B.4 • 17:15
Hollow Core NANF with 0.28 dB/km Attenuation in the C and L Bands, Gregory T. Jasion1, Thomas Bradley1, Kerrianne Harrington1, Hesham Sakr1, Yong Chen1,2, Eric Numkam Fokoua1, Ian Davidson1, Austin Taranta1, John Hayes1, David Richardson1, Francesco Poletti1; 1*Optoelectronics Research Centre, Univ. of Southampton, UK*; 2*Lumenisity Ltd, UK*. We report

an effectively single-moded, 1.7km long hollow core Nested Antiresonant Nodeless Fiber (NANF) with record-low 0.28dB/km loss from 1510 to 1600nm, which further reduces the loss gap with standard all-glass single mode fibers.

Th4B.5 • 17:30

Transmission of 61 C-band Channels with L-band Interferers over Record 618km of Hollow-Core-Fiber, Antonino Nespola2, Stefano Straullu2, Thomas Bradley3, Kerrianne Harrington3, Hesham Sakr3, Gregory T. Jasion3, Eric Numkam Fokoua3, Yongmin Jung3, Yong Chen3, John Hayes3, Fabrizio Forghieri4, David Richardson3, Francesco Poletti3, Gabriella Bosco1, Pierluigi Poggiolini1; 1*Politecnico di Torino, Italy*; 2*Links Foundation, Italy*; 3*Optoelectronics Research Centre, Univ. of Southampton, UK*; 4*CISCO Photonics, Italy*. We recirculated 61 PM-QPSK C-band channels @32GBaud, with simultaneous L-band loading, through 7.72km of hollow-core NANF with <1dB/km loss. We reached 772km for the mid-channel, and 618km for all channels at average GMI 3.44 bits/symbol.

Th4B.6 • 17:45

Gain and Temporal Equalizer for Multi-Mode Systems, Mikael Mazur1, Nicolas K. Fontaine1, Yuanhang Zhang2, Haoshuo Chen1, Kwangwoong Kim1, Riccardo Veronese3, Luca Palmieri3, Pierre Sillard4, Roland Ryf1, David Neilson1; 1*Nokia Bell Labs, USA*; 2*CREOL, The Univ. of Central Florida, USA*; 3*Department of Information Engineering, Univ. of Padova, Italy*; 4*Prysmian Group, France*. We present a device enabling individual spectro-temporal control of 15 spatial modes. Realizing independent control over both polarizations on each mode, flexible attenuation and +/-20 ps of tunable delay over bandwidths exceeding 100 nm is enabled.

Th4B.7 • 18:00

Optical Broadcasting and Steering by Demultiplexing Incoherent Spatial Modes, Haoshuo Chen1, Nicolas K. Fontaine1, Yuanhang Zhang1,2, Mikael Mazur1, Juan Carlos Alvarado Zacarias1,2, Roland Ryf1, David Neilson1, Guifang Li2, Rodrigo Amezcua Correa2, Joel Carpenter3; 1*Nokia Bell Labs, USA*; 2*CREOL, Univ. of Central Florida, USA*; 3*The Univ. of Queensland, Australia*. We realize optical broadcasting and reconfigurable beam steering by demultiplexing incoherent spatial modes. We demonstrate point-to-multipoint optical wireless communications using multimode VCSEL and multi-plane light conversion.

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Room 6E
16:30 -- 18:30
Th4C • Postdeadline Paper Session III
Presider: Robert Doverspike; Network Evolution Strategies LLC, USA

Th4C.1 • 16:30
Net 321.24-Gb/s IMDD Transmission Based on a >100-GHz Bandwidth Directly-Modulated Laser, Nikolaos Panteleimon Diamantopoulos1, Hiroshi Yamazaki1,2, Suguru Yamaoka1, Munehiko Nagatani1,2, Hidetaka Nishi1, Hiromasa Tanobe3, Ryo Nakao1, Takuro Fujii1, Koji Takeda1, Takaaki Kakitsuka1,4, Hitoshi Wakita1, Minoru Ida1, Hideyuki Nosaka1,2, Fumio Koyama5, Yutaka Miyamoto2, Shinji Matsuo1; 1*NTT Device Technology Labs, Japan*; 2*NTT Network Innovation Labs, Japan*; 3*NTT Device Innovation Center, Japan*; 4*Waseda Univ., Japan*; 5*Tokyo Inst. of Technology, Japan*. Record DML-based 325-Gb/s (BTB) and 321.24-Gb/s (2-km SSMF) transmissions are demonstrated based on a >100-GHz bandwidth membrane DML-on-SiC, by utilizing a digitally-preprocessed analog multiplexer and adaptive entropy-loaded DMT modulation, surpassing our previous record by ~34%.

Th4C.2 • 16:45
1.52 Tb/s single carrier transmission supported by a 128 GSa/s SiGe DAC, Fred Buchali1, Vahid Aref1, Mathieu Chagnon1, Karsten Schuh1, Horst Hettrich2, Anna Bielik2, Lars Altenhain2, Markus Guntermann2, Rolf Schmid2, Michael Moeller2; 1*Nokia Bell Labs, Germany*; 2*Micram Microelectronics GmbH, Germany*. We report on a new 128 GSa/s SiGe digital to analog converter supporting data generation at 128 GBaud. We demonstrate successful transmission at 1.55 Tb/s net rate in back to back and 1.52 Tb/s after 80 km of SMF.

Th4C.3 • 17:00
Real-Time Demonstration of 600-Gb/s DP-64QAM Self-Homodyne Coherent Bi-Direction Transmission with Un-Cooled DFB Laser, Tao Gui1, Xuefeng Wang2, Ming Tang2, Yi Yu1, Yanzhao Lu1, Liangchuan Li1; 1*Huawei Technologies, China*; 2*WNLO & School of Optical and Electronic Information, Huazhong Univ. of Science and Technology, China*. We report first successful real-time self-homodyne coherent bi-direction transmission demonstration with 600-Gb/s DP-64QAM under un-cooled ~7-MHz linewidth DFB laser. A novel coherent receiver is proposed to achieve automatic stabilization against polarization fluctuations of received LO.

Th4C.4 • 17:15
400Gb/s Real-time Transmission Supporting CPRI and eCPRI Traffic for Hybrid LTE-5G Networks, Son T. Le1, Tomislav Drenski2, Andrew Hills2, Malcom King2, Kwangwoong Kim1, Yasuhiro Matsui3, Theodore Sizer1; 1*Nokia Bell Labs, USA*; 2*Socionext Europe GmbH, UK*; 3*Finisar, USA*. We present the first CMOS ASIC to support either 4×25Gb/s eCPRI or 4×24.33Gb/s CPRI-10 traffic per optical wavelength and demonstrate 200Gb/s and 400Gb/s

transmissions in O and C bands over 20km for hybrid LTE-5G fronthaul networks

Th4C.5 • 17:30
172 Tb/s C+L Band Transmission over 2040 km Strongly Coupled 3-Core Fiber, Georg Rademacher2, Ruben S. Luis2, Ben J. Puttnam2, Roland Ryf1, Sjoerd P. van der Heide2,3, Tobias A. Eriksson2, Nicolas K. Fontaine1, Haoshuo Chen1, Rene-Jean Essiambre1, Yoshinari Awaji2, Hideaki Furukawa2, Naoya Wada2; 1*Nokia Bell Labs, USA*; 2*National Inst. of Information and Communications Technology, Japan*; 3*Inst. for Photonic Integration, Eindhoven Univ. of Technology, Netherlands*. Coupled-core multi-core fiber transmission is demonstrated across 359 C- and L-band channels with low spatial-mode-dispersion. A net-data-rate of 172 Tb/s over 2040 km is achieved, doubling the record data-rate-distance-product for standard cladding diameter SDM fibers.

Th4C.6 • 17:45
Demonstration of photonic neural network for fiber nonlinearity compensation in long-haul transmission systems, Chaoran Huang1, Shinsuke Fujisawa2, Thomas Ferreira de Lima1, Alexander Tait1, Eric Blow1, Yue Tian2, Simon Bilodeau1, Aashu Jha1, Fatih Yaman1, Hussam G. Batshon2, Hsuan-tung Peng1, Bhavin J. Shastri1, Ting Wang1, Paul Prucnal1; 1*Princeton Univ., USA*; 2*NEC Laboratories America Inc., USA*. We demonstrate the experimental implementation of photonic neural network for fiber nonlinearity compensation over a 10,080 km trans-pacific transmission link. Q-factor improvement of 0.51 dB is achieved with only 0.06 dB lower than numerical simulations.

Th4C.7 • 18:00
Wideband Inline-amplified WDM Transmission Using PPLN-based OPA with Over-10-THz Bandwidth, Takayuki Kobayashi1, Shimpei Shimizu1, Masanori Nakamura1, Takeshi Umeki2,1, Takushi Kazama2, Ryoichi Kasahara2, Fukutaro Hamaoka1, Munehiko Nagatani2,1, Hiroshi Yamazaki2,1, Takayuki Mizuno1, Hideyuki Nosaka2,1, Yutaka Miyamoto1; 1*NTT Network Innovation Laboratories, Japan*; 2*NTT Device Technology Laboratories, Japan*. We demonstrate the first inline-amplified transmission with PPLN-based polarization-independent OPA offering 5.125-THz amplification bandwidth and ≥15-dB gain using 800-Gb/s PDM PS-36QAM signals. Results indicate the OPA potentially extends the WDM

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SiPhotonics/GaAs 28-GHz Transceiver for mmWave-over-Fiber Laser-Less Active Antenna Units

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Abstract

We demonstrate a 28 GHz radio-over-fiber system with laser-less, low-cost active antenna units using silicon photonics and a GaAs driver and LNA. 7-Gb/s downlink and uplink throughput was achieved over 2km SSMF and 5m wireless.

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