PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 10560

, "Front Matter: Volume 10560," Proc. SPIE 10560, Metro and Data Center Optical Networks and Short-Reach Links, 1056001 (22 June 2018); doi: 10.1117/12.2319341

Event: SPIE OPTO, 2018, San Francisco, California, United States

PROCEEDINGS OF SPIE

Metro and Data Center Optical Networks and Short-Reach Links

Atul K. Srivastava
Madeleine Glick
Youichi Akasaka
Editors

30–31 January 2018
San Francisco, California, United States

Sponsored by
SPIE

Cosponsored by
Corning Incorporated (United States)
NTT Electronics (Japan)

Published by
SPIE

Volume 10560

Proceedings of SPIE 0277-786X, V. 10560

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Metro and Data Center Optical Networks and Short-Reach Links, edited by Atul K. Srivastava,
Madeleine Glick, Youichi Akasaka, Proc. of SPIE Vol. 10560, 1056001 · © 2018 SPIE
CCC code: 0277-786X/18/\$18 · doi: 10.1117/12.2319341

Proc. of SPIE Vol. 10560 1056001-1

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIDigitalLibrary.org.

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in *Metro and Data Center Optical Networks and Short-Reach Links*, edited by Atul K. Srivastava, Madeleine Glick, Youichi Akasaka, Proceedings of SPIE Vol. 10560 (SPIE, Bellingham, WA, 2018) Seven-digit Article CID Number.

ISSN: 0277-786X
ISSN: 1996-756X (electronic)

ISBN: 9781510616059
ISBN: 9781510616066 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445
SPIE.org

Copyright © 2018, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/18/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

**SPIE. DIGITAL
LIBRARY**
SPIDigitalLibrary.org

Paper Numbering: *Proceedings of SPIE* follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

Contents

v	<i>Authors</i>
vii	<i>Conference Committee</i>

SESSION 1	SHORT REACH TRANSMISSION TECHNIQUES
10560 02	The best modulation format for 100G short-reach and metro networks: DMT, PAM-4, CAP, or duobinary? (Invited Paper) [10560-1]
10560 03	Real-time system based on FPGA for optical communication system (Invited Paper) [10560-2]
10560 04	DSP technologies in the Stokes vector receivers for short-reach optical transmission systems (Invited Paper) [10560-3]
10560 06	Experimental investigation of auxiliary management and control channel superimposition for mobile fronthaul in DWDM-PON system (Invited Paper) [10560-5]
SESSION 2	SHORT REACH NETWORKS I
10560 07	Design and optimization of photonic devices and optical fibers for space-division multiplexing (Invited Paper) [10560-6]
10560 08	An SOA-integrated EADFB laser for enhancement of modulated light output power and extension of transmission distances (Invited Paper) [10560-7]
10560 09	Network topology and node connectivity in OPS/OBS photonic switched optical networks [10560-8]
10560 0A	Impact of number of channels on signal transmission in elastic optical network [10560-9]
SESSION 3	SCALING DATACENTER OPTICAL INTERCONNECTS
10560 0B	Scaling optical interconnects to meet the bandwidth density crunch (Invited Paper) [10560-10]
10560 0C	Photonic switching platform for datacenters enabling rapid network reconfiguration (Invited Paper) [10560-11]
10560 0D	Scalable highly flexible WDM switch for ONoC architectures [10560-12]
10560 0E	High-bandwidth density optically interconnected terabit/s boards (Invited Paper) [10560-13]

10560 OF **Consolidated optical flow switching in cloud data centers (Invited Paper)** [10560-14]

SESSION 4 SHORT REACH NETWORKS II

10560 OG **Large-scale optical node architecture enabling spectral-efficiency maximization in ultra-dense WDM networks** [10560-15]

10560 OH **System and device technologies for coherent optical communications (Invited Paper)** [10560-16]

10560 OI **Using system simulation to evaluate design choices for automotive ethernet over plastic optical fiber** [10560-17]

10560 OJ **DMT visible light communication using commercial RGBA LEDs** [10560-18]

SESSION 5 OPTICAL TRANSCEIVERS AND NOVEL TECHNIQUES I

10560 OK **Optical signal processing using coherent optical frequency combs (Invited Paper)** [10560-19]

10560 ON **Dynamic optical networks based on digital subcarrier multiplexing (Invited Paper)** [10560-22]

SESSION 6 OPTICAL TRANSCEIVERS AND NOVEL TECHNIQUES II

10560 OO **Latest standardization trends for client and networking optical transceivers and its future directions (Invited Paper)** [10560-23]

10560 OP **Demonstration of 153.6-Tbps throughput from 1,536×1,536 optical switch with uniform-loss and cyclic-frequency AWGs (Best Technical Paper Award)** [10560-24]

POSTER SESSION

10560 OT **SDN based in-band adaptive coding by distributed pseudonoise preamble detection in optical networks** [10560-28]

10560 OU **Automated design of add/drop equipment and effective wavelength assignment in complex DWDM networks** [10560-29]

10560 OV **Design and fabrication of restricted mode launching device for high-speed multimode fiber link** [10560-30]

10560 OX **Uplink LTE cascaded priority-based scheduler in IoT and smart grid applications: performance and comparison** [10560-32]

Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Absil, Philippe, 0E
Aldaya, Ivan, 0A
Ali, M. A., 0X
Ban, Yoojin, 0E
Bauwelinck, Johan, 0E
Bianchi, Alberto, 0E
Bogaerts, Lieve, 0E
Calabretta, N., 0B
Cao, Y., 0K
Carpentier, J.-F., 0D
Charbonnier, B., 0D
Chen, Lin, 03
Chen, Ming, 03
Chen, Qinghui, 03
Chiaretti, Guido, 0E
Costa, André A., 0A
De Angelis, Gabriele, 0E
De Heyn, Peter, 0E
Deng, Rui, 03
Djordjevic, Ivan B., 0J, 0T
Fallahpour, A., 0K
Farina, J., 0U
Fujiwara, N., 08
Fumagalli, Andrea, 0N
Galli, Paola, 0E
Ghillino, Enrico, 0I
Glick, Madeleine, 0F
Gonzalez, Ana Belen, 0E
Guelbenzu de Villota, G., 0B
Hasegawa, Hiroshi, 0G, 0P
Hashimoto, Ryota, 0G
Hassebo, Ahmed, 0X
Hatai, Ryosuke, 0V
He, Jing, 03
Hirose, Yoshio, 06
Hoshida, Takeshi, 06
Hui, Rongqing, 0N
Hyuga, Satoshi, 0I
Ishigure, Takaaki, 0V
Ishii, H., 08
Ishimura, Shota, 04
Isono, Hideki, 0O
Juvert Sandez, Joan, 0E
Kagami, Manabu, 0I
Khomchenko, D., 0U
Klamkin, Jonathan, 0H
Kobayashi, W., 08
Koike-Akino, Toshiaki, 0H
Kojima, Keisuke, 0H

Le Maitre, P., 0D
Lee, Benjamin G., 0C
Leon-Garcia, Alberto, 0F
Li, C., 0B
Li, T., 0B
Lopes, Diogo P., 0E
Marciniak, Malgorzata, 0X
Martínez Vázquez, Rebeca, 0E
Martins, Indayara Bertoldi, 09, 0A
Martins, Yara, 09
Matsuzaki, H., 08
Mena, Pablo V., 0I
Michard, A., 0D
Michit, N., 0D
Millar, David S., 0H
Miller, Andy, 0E
Mishra, Jitendra K., 07
Mori, Yojiro, 0G, 0P
Nagai, Hiroki, 0P
Nakagawa, Goji, 06
Nakai, Makoto, 0I
Nishimura, Kosuke, 04
Oda, Shoichiro, 06
Ohiso, Y., 08
Orobtschouk, R., 0D
Osellame, Roberto, 0E
Pajovic, Milutin, 0H
Pan, Chao, 07
Pantouvaki, Marianna, 0E
Parsons, Kieran, 0H
Pérez-Sánchez, G., 0A
Peyghambarian, Nasser, 0F
Preve, Giovanni Battista, 0E
Rahman, B.M. A., 07
Rastegarfar, Houman, 0F
Raz, O., 0B
Richards, Dwight, 0I
Richter, A., 0U
Romagnoli, Marco, 0E
Rudge Barbosa, F., 09, 0A
Sano, K., 08
Sato, Ken-ichi, 0G, 0P
Scarmozzino, Robert, 0I
Serrano Rodrigo, Aina A., 0E
Shi, Jianyang, 02
Shindo, T., 08
Snyder, Bradley, 0E
Sone, Kyosuke, 06
Song, Bowen, 0H

Sorianello, Vito, 0E
Stabile, R., 0B
Tallone, Luigi, 0E
Testa, Francesco, 0E
Tirelli, Stefano, 0E
Van Campenhout, Joris, 0E
Van Thourhout, Dries, 0E
Verheyen, Peter, 0E
VS, Rakesh Krishna, 0J
Wang, Bingnan, 0H
Willner, A. E., 0K
Xu, Tong, 0N
Yamaoka, Shuhei, 0G
Yang, Mingwei, 0T
Yevseyenko, D., 0U
Yin, Xin, 0E
Yoshida, Setsuo, 06
Yoshimatsu, T., 08
Yu, Jianjun, 02
Zhang, Junwen, 02
Ziyadi, M., 0K

Conference Committee

Symposium Chairs

Connie J. Chang-Hasnain, University of California, Berkeley
(United States)

Graham T. Reed, Optoelectronics Research Centre, University of
Southampton (United Kingdom)

Symposium Co-chairs

Jean-Emmanuel Broquin, IMEP-LAHC (France)

Shibin Jiang, AdValue Photonics, Inc. (United States)

Program Track Chair

Benjamin B. Dingel, Nasfine Photonics, Inc. (United States)

Conference Chairs

Atul K. Srivastava, NEL America, Inc. (United States)

Madeleine Glick, Massachusetts Institute of Technology
(United States)

Youichi Akasaka, Fujitsu Laboratories of America, Inc. (United States)

Conference Program Committee

Philippe P. Absil, IMEC (Belgium)

Shlomi Arnon, Ben-Gurion University of the Negev (Israel)

Kasyapa Balemarthy, OFS Optics (India)

Carsten Behrens, University College London (United Kingdom)

Hacene Chaouch, Arista Networks Inc. (United States)

Benjamin B. Dingel, Nasfine Photonics, Inc. (United States)

Ivan B. Djordjevic, The University of Arizona (United States)

Achyut K. Dutta, Banpil Photonics, Inc. (United States)

Mitchell H. Fields, Broadcom Ltd. (United States)

Ronald Freund, Fraunhofer-Institut für Nachrichtentechnik Heinrich-
Hertz-Institut (Germany)

Kiyo Ishii, National Institute of Advanced Industrial Science and
Technology (Japan)

Hideki Isono, Fujitsu Optical Components Ltd. (Japan)

Hai-Feng Liu, Intel Corporation (United States)

B. Jonathan Luff, Mellanox Technologies, Inc. (United States)

Yojiro Mori, Nagoya University (Japan)

Takahiro Nakamura, Photonics Electronics Technology Research Association (Japan)
Wilfried Noell, SUSS MicroOptics SA (Switzerland)
Bishnu P. Pal, Bennett University (India)
Sebastian Randel, Karlsruher Institut für Technologie (Germany)
Houman Rastegarfar, College of Optical Sciences, The University of Arizona (United States)
Jacklyn D. Reis, CPqD (Brazil)
Takashi Saida, NTT Photonics Laboratories (Japan)
Payman Samadi, Columbia University (United States)
Michela Svaluto Moreolo, Center Tecnològic de Telecomunicacions de Catalunya (Spain)
Krishna Swaminathan, Intel Corporation (United States)
Idelfonso Tafur Monroy, DTU Fotonik (Denmark)
Takashi Takemoto, Hitachi, Ltd. (Japan)
Werner Weiershausen, Deutsche Telekom AG (Germany)
Jianjun Yu, ZTE USA (United States)

Session Chairs

- 1 Short Reach Transmission Techniques
Youichi Akasaka, Fujitsu Laboratories of America, Inc. (United States)
Ivan B. Djordjevic, The University of Arizona (United States)
- 2 Short Reach Networks I
Yu Kurata, NTT Electronics Corporation (United States)
Benjamin B. Dingel, Nasfine Photonics, Inc. (United States)
- 3 Scaling Datacenter Optical Interconnects
Madeleine Glick, Massachusetts Institute of Technology (United States)
Hideki Isono, Fujitsu Optical Components Ltd. (Japan)
- 4 Short Reach Networks II
Philippe P. Absil, IMEC (Belgium)
Yojiro Mori, Nagoya University (Japan)
- 5 Optical Transceivers and Novel Techniques I
Atul K. Srivastava, NEL America, Inc. (United States)
Jianjun Yu, ZTE USA (United States)
- 6 Optical Transceivers and Novel Techniques II
Atul K. Srivastava, NEL America, Inc. (United States)
Jianjun Yu, ZTE USA (United States)