PROCEEDINGS OF SPIE

Broadband Access Communication Technologies X

Benjamin B. Dingel
Katsutoshi Tsukamoto
Editors

16–17 February 2016
San Francisco, California, United States

Sponsored and Published by
SPIE

Volume 9772

Proceedings of SPIE 0277-786X, V. 9772

Broadband Access Communication Technologies X, edited by Benjamin B. Dingel,
Katsutoshi Tsukamoto, Proc. of SPIE Vol. 9772, 977201 · © 2016 SPIE
CCC code: 0277-786X/16/$18 · doi: 10.1117/12.2235364

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 SPIEDigitalLibrary.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 *Broadband Access Communication Technologies X*, edited by Benjamin B. Dingel, Katsutoshi Tsukamoto, Proceedings of SPIE Vol. 9772 (SPIE, Bellingham, WA, 2016) Six-digit Article CID Number.

ISSN: 0277-786X
ISSN: 1996-756X (electronic)
ISBN: 9781510600072

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

Printed in the United States of America.

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

SPIE. DIGITAL LIBRARY
SPIEDigitalLibrary.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 six-digit CID article numbering system structured as follows:

- The first four 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

Authors

Numbers in the index correspond to the last two digits of the six-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first four 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.

Conference Committee

Symposium Chairs

Jean-Emmanuel Broquin, IMEP-LAHC (France)
Shibin Jiang, AdValue Photonics, Inc. (United States)

Symposium Co-chairs

David L. Andrews, University of East Anglia (United Kingdom)
Alexei L. Glebov, OptiGrate Corporation (United States)

Program Track Chair

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

Conference Chairs

Benjamin B. Dingel, Nasfine Photonics, Inc. (United States)
Katsutoshi Tsukamoto, Osaka Institute of Technology (Japan)

Conference Program Committee

Frank Deicke, Fraunhofer-Institut für Photonische Mikrosysteme (Germany)
David W. Faulkner, British Telecom Research Laboratories (United Kingdom)
Harald Haas, The University of Edinburgh (United Kingdom)
Mohsen Kavehrad, The Pennsylvania State University (United States)
Rangaraj Madabhushi, Madabhushi Consultants, LLC (United States)
Nicholas Madamopoulos, The City College of New York (United States)
Spiros Mikroulis, University College London (United Kingdom)
Ken-ichi Sato, Nagoya University (Japan)
Chakchai So-In, Khon Kaen University (Thailand)
Atul K. Srivastava, NEL America, Inc. (United States)
Peter Van Daele, University Gent (Belgium)

Session Chairs

1 Optical Communication Plenary Session: Joint Session with Conferences 9772, 9774, and 9775
Benjamin B. Dingel, Nasfine Photonics, Inc. (United States)
Guifang Li, CREOL, The College of Optics and Photonics, University of Central Florida (United States)

2 Coherent Access Networks and Advanced Modulation Formats: Joint Session with Conferences 9772 and 9774
Katsumi Iwatsuki, Tohoku University (Japan)
Xiang Zhou, Google (United States)

3 Advanced Fibers for Data Center, SDM, and Metro Applications: Joint Session with Conferences 9772, 9773, 9774, and 9775
Atul K. Srivastava, NEL America, Inc. (United States)
Guifang Li, CREOL, The College of Optics and Photonics, University of Central Florida (United States)

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

4 Special Workshop on Key Devices and Components for Datacenters and Short Hauls: Joint Session with Conferences 9772, 9773, and 9774
Youichi Akasaka, Fujitsu Network Communications Inc. (United States)
Benjamin B. Dingel, Nasfine Photonics, Inc. (United States)

5 Special Session on Millimeter-Wave Technologies and Radio-Over Fiber Systems for Access I
Spiros Mikroulis, University College London (United Kingdom)
Manoj Thakur, University College London (United Kingdom)

6 Special Session on Millimeter-Wave Technologies and Radio-Over Fiber Systems for Access II
Spiros Mikroulis, University College London (United Kingdom)
Manoj Thakur, University College London (United Kingdom)

7 Resilient Communication Networks: Radio-over-Fiber, Mobile Wireless Access
Katsutoshi Tsukamoto, Osaka Institute of Technology (Japan)
Spiros Mikroulis, University College London (United Kingdom)

8 Optical Wireless Communications and PON Systems for Access
Manoj Thakur, University College London (United Kingdom)
Katsutoshi Tsukamoto, Osaka Institute of Technology (Japan)