## PROCEEDINGS OF SPIE

## **Broadband Access Communication Technologies XIV**

Benjamin B. Dingel Katsutoshi Tsukamoto Spiros Mikroulis Editors

4–5 February 2020 San Francisco, California, United States

Sponsored by SPIE

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

Published by SPIE

**Volume 11307** 

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 XIV*, edited by Benjamin B. Dingel, Katsutoshi Tsukamoto, Spiros Mikroulis, Proceedings of SPIE Vol. 11307 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510633773

ISBN: 9781510633780 (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.orc

Copyright © 2020, 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 \$21.00 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/20/\$21.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

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



**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**

∨ ∨ii	Authors Conference Committee
SESSION 1	5G OPTICAL ACCESS TECHNOLOGIES: SYSTEMS, TRANSPORTS, AND TESTBED
11307 02	Optical access technologies for mobile fronthaul in 5G and beyond (Invited Paper) [11307-1]
11307 03	Beyond 100G signal transmission in optical short reach for mobile fronthaul (Invited Paper) [11307-2]
11307 04	University campus 5G testbed and use case deployments in the Philippines [11307-3]
SESSION 2	5G PHOTONICS: ADVANCED TECHNIQUES, DEVICES, AND COMPONENTS
11307 05	An end-to-end 5G automotive ecosystem for autonomous driving vehicles (Invited Paper) [11307-4]
11307 07	Adaptive and efficient data compression technologies in 5G digital mobile fronthaul networks (Invited Paper) [11307-6]
11307 08	New radio access technologies for 5G with enhanced network reliability and channel capacity (Invited Paper) [11307-7]
SESSION 3	5G PHOTONICS: BEAMFORMING TECHNOLOGIES AND OPTICAL COMPONENTS
11307 09	Software-defined beamforming enabled by spatial division multiplexing in the multicore fiber optical fronthaul (Invited Paper) [11307-8]
11307 0A	An end-to-end 5G fiber wireless A-RoF/IFoF link based on a 60 GHz beamsteering antenna and an InP EML [11307-9]
11307 0C	A multifunctional demultiplexer for optical frequency combs in broadband access networks (Invited Paper) [11307-11]
11307 0D	Dual-wavelength photonic beamformer for OFDM and single-carrier broadband wireless operating over 1-km 7-core fiber fronthaul [11307-12]
SESSION 4	ADVANCED FIBER AND OPTICAL WIRELESS COMMUNICATION

11307 OE	Modal delay and bandwidth measurements of few-mode fibers for short-distance communications (Invited Paper) [11307-13]
11307 0G	Channel characterization for optical extra-WBAN links considering local and global user mobility [11307-15]
11307 OH	3.8-Gbit/s visible light communication (VLC) based on 443-nm superluminescent diode and bit-loading discrete-multiple-tone (DMT) modulation scheme (Best Student Paper Award) [11307-16]
SESSION 5	OPTICAL COMMUNICATIONS: JOINT KEYNOTE SESSION WITH CONFERENCES 11307, 11308, AND 11309
11307 01	Novel applications of plasmonics and photonics devices to sub-THz wireless (Keynote Paper) [11307-17]
SESSION 6	OPTICAL WIRELESS COMMUNICATION
11307 OJ	Propagation dynamics of ultrabroadband terahertz beams with orbital angular momentum for wireless data transfer [11307-19]
11307 OJ 11307 OK	
	wireless data transfer [11307-19]  Indoor multi-user MIMO-OOFDM-IM aided hybrid visible light communication system
	wireless data transfer [11307-19] Indoor multi-user MIMO-OOFDM-IM aided hybrid visible light communication system [11307-20]
11307 OK	wireless data transfer [11307-19]  Indoor multi-user MIMO-OOFDM-IM aided hybrid visible light communication system [11307-20]  POSTER SESSION  Converged RoF-based mobile fronthaul and passive optical network with NOMA-CAP