

## SYMPOSIA

### **Symposium 1: New Horizons in Optical Communication Technologies: Towards 2030 and Beyond**

Date: Tuesday, July 6  
Time: 14:00 - 18:00  
Place: Room B (207)  
Organizers: T. Morioka (NTT Network Innovation Labs., Japan)  
M. Suzuki (KDDI R&D Labs., Japan)

#### Outline:

Over the last twenty years, optical communication technologies have increased the transmission capacity per a fiber by three orders of magnitude, achieving several Tbit/s transmission. If the data traffic continues to increase at the current rate of 40 % to 70 % per year, a further increase in the transmission capacity of three to five orders of magnitude will be needed over the next twenty years. This implies that by 2030, backbone optical fibers should support capacities of well over Pbit/s, with the core network providing Ebit/s throughput; home networks need to offer Tbit/s per second access to support 3-D super-high definition video streams. However, the present optical technologies, primarily based on TDM/WDM, have begun to reveal ultimate physical limitations of the present systems, i.e., the transmission capacity imposed by Shannon's limit and fiber nonlinearities, the maximum optical power (bit/s) that can be transmitted safely in existing optical fibers now limited by fiber fuse, optical bandwidths currently limited by optical amplifiers, and the capacity of optical submarine cables systems now limited by the electrical power that can be supplied to the optical amplifier repeaters. In order to go far beyond these limits and to develop technologies that will enable this dramatic leap forward, novel transmission optical fibers that can handle well over Pbit/s capacity, totally new multiplexing schemes beyond TDM/WDM, as well as far-advanced optical submarine cables systems have to be developed. This symposium is intended to exchange ideas and insights for these future technologies in "New Horizons" and to discuss how to proceed towards 2030 and beyond. The symposium consists of seven invited talks by eminent researchers from across the world. Topics include, but are not limited to:

- Novel transmission optical fibers with high power resistance and low nonlinearity enabling Pbit/s transmission and beyond. Multi-core fibers and multi-mode fibers for Space-division Multiplexing (SDM) and Mode-division Multiplexing (MDM).
- Advanced multi-level modulation technologies (QAM, OFDM), Terabit Ethernet and beyond.
- Novel multiplexing technologies such as Space-division Multiplexing (SDM), Mode-division Multiplexing (MDM), MIMO processing, etc.
- Novel optical amplifiers including ultra-broadband optical amplifiers, multi-core fiber amplifiers, parametric amplifiers, Raman amplifiers, etc.
- Novel optical node architectures towards Ebit/s throughput with the use of novel optical fibers and multiplexing schemes.
- Innovations in optical submarine cable systems.

#### **Session 1: 14:00 - 15:30 Perspectives for Future Transmission Fibers (14:00-15:30)**

"Optical Fibers: History and Future Perspectives"  
M. Ohashi (Osaka Prefecture Univ., Japan)

"Next Generation Fibres for High Power Laser and Telecommunications Applications"  
D. J. Richardson, F. Poletti, M. N. Petrovich (Univ. of Southampton, UK)

"Recent Progress in Multi-Core Fibers for Ultralarge-Capacity Transmission"  
M. Koshiba (Hokkaido Univ., Japan)

#### **Session 2: 16:00 - 18:00 Towards Pbit/s Transmission and Ebit/s Networks (16:00-18:00)**

"Carrier's Perspectives for Future Transmission Systems and Networks"  
S. Matsuoka (NTT Network Innovation Labs, Japan)

"The Role of Photonics and Electronics for Terabit Optical Transport"  
W. Shieh, A. Al Amin, Q. Yang (The Univ. of Melbourne, Australia)

"Optical MIMO-Processing and Mode-Multiplexing: Experimental Achievements and Future Perspectives"  
W. Rosenkranz<sup>(1)</sup>, S. Schöllmann<sup>(2)</sup> <sup>(1)</sup>Univ. of Kiel, Germany, <sup>(2)</sup>Lufthansa Technik AG, Germany)

"Innovations for Future Optical Submarine Cable Systems"  
I. Morita, M. Suzuki (KDDI R&D Labs, Japan)

### **Symposium 2: Future Optical Transport Network to Support 100GE Era and Beyond**

Date: Wednesday, July 7  
Time: 14:00 - 18:00  
Place: Room A (2F 206)  
Organizers: R-P. Braun (Deutsche Telekom, Germany)  
H. Onaka (Fujitsu, Japan)  
T. Takahashi (NTT, Japan)

## Outline

ROADMs have been deployed in regional, metro, and core optical networks in North America, Europe, and Japan. We aim to give an overview of challenges and perspectives of future optical transport network after the ROADM era. We will discuss how emerging advanced transmission technologies and state-of-the-art device technologies evolve the optical transport networking technologies from components to optical switching systems, network control, and management levels. Potential presenters would be component suppliers, system vendors, carriers, government-funded project managers, and other related researchers and engineers.

- Future transport networks which naturally support 100GE and probably 400G, 1T...
- Functionalities required in future optical nodes, e.g. multiple-degree, steering ability, tunability, adaptability, resiliency, transparency, ...
- Impact of ever-growing client interface speed and emerging transmission technologies, such as advanced modulation formats and digital coherent technology, on optical node and network design.
- Energy consumption and foot print, energy efficient networking, and network scalability including higher speed transmission as well as higher switch and router capacity and design.
- Decomposition of network functionality including pluggable transceivers, layer overarching network control, ...
- Cost effective scalable networking.
- Economical drivers

### **Session 1: 14:00 - 15:30 Changing Environment Surrounding Optical Transport Industry**

"100GbE and Beyond for Warehouse Scale Computing"

B. Koley, V. Vusirikala, C. Lam, V. Gil (Google, Inc. USA)

"100Gb/s and Beyond Datacom and Ethernet Optical Interfaces"

C. Cole (Finisar Corp., USA)

"Architecture and Technologies for Higher Speed Transport Networks"

R-P. Braun (Deutsche Telekom AG Laboratories, Germany)

### **Session 2: 16:00 - 18:00 Building Flexible, Capacity-Abundant, and Cost-effective Optical Transport Networks: New Directions and Technologies**

"Dynamic Optical Network Nodes: System Architecture and Sub-Systems Based on Silicon Photonics"

M. Sakauchi, S. Nakamura (NEC System Platforms Research Labs, Japan)

"Toward More Dynamic Optical Networking"

S. L. Woodward, M. D. Feuer (AT&T Labs-Research, USA)

"Spectrally-Efficient Elastic Optical Path Networks"

H. Takara, B. Kozicki, Y. Sone, M. Jinno (NTT Corporation, Japan)

"OFDM-Based Adaptive and Programmable Optical Network"

J. Hu, W. Wei, T. Wang (NEC Laboratory of America, USA)

### **Symposium 3: State of the Art Nanophotonics**

Date: Wednesday, July 7

Time: 14:00 - 17:45

Place: Room D (107)

Organizer: S. Iwamoto (The Univ. of Tokyo, Japan)

#### Outline:

Nanophotonics can realize ultra-compact optoelectronic components beyond the limitations of conventional photonic technologies. Nanophotonic technologies also have potential for new functional/high-performance devices/systems for spanning the telecommunication, information, chemical and biological applications of near and long-term benefit. We aim to give an overview of challenges and perspectives of state-of-the-art nanophotonic technologies. We will discuss how emerging advanced nano technologies and material/fabrication technologies evolve the new photonic functions/applications. The scope extends to theory, modeling and simulation, experimentation, instrumentation, and application.

- Nanostructures and their design, fabrication, characterization and photonic applications (quantum dots, nanotubes, nanowires, nanofibers and other low-dimensional nanostructures)
- Photonic crystal and their design, fabrication, characterization and applications (photonic band-gap materials and surprising new phenomena)
- Meta-materials and their design, fabrication, characterization and photonic applications
- Surface plasmons and nanoplasmonics
- Optical & photonic phenomena in nanostructures
- Nanophotonic sensing and analysis
- New Nanophotonic concepts and systems that facilitate continued integration of various optical and/or electronic functions

"Advances in Quantum Dot Lasers: From Classical Lasers to Single Artificial Atom Lasers with Photonic Crystal Nanocavity"  
Y. Arakawa, M. Sugawara, S. Iwamoto, M. Nomura, A. Tadaechanura  
(The Univ. of Tokyo, Japan)

"Three-Dimensional Metal Nano-Structures for Plasmonic Metamaterials"  
T. Tanaka (RIKEN Advanced Science Institute, Japan, Hokkaido Univ., Japan)

"Optical Properties and Application of MOVPE-Grown III-V Nanowires"  
J. Motohisa (Hokkaido Univ., Japan)

"Active Optical Lattice Filters with Nanophotonic Four-Port Couplers"  
D. L. MacFarlane<sup>(1)</sup>, M. P. Christensen<sup>(2)</sup>, L. R. Hunt<sup>(1)</sup>, J. Kim<sup>(1)</sup>, T. W. Kim<sup>(1)</sup>, T. P. LaFave Jr<sup>(1)</sup>, K. Liu<sup>(1)</sup>, A. El Nagdi<sup>(1)</sup>,  
N. Sultana<sup>(1)</sup>, V. Ramakrishna<sup>(1)</sup>, M. Dabkowski<sup>(1)</sup>The Univ. of Texas, USA, <sup>(2)</sup>Southern Methodist Univ., USA)

"Novel Plasmon Nano Lasers"  
M. Hill, M. Marell (Eindhoven Univ. of Technol., Netherlands)

"Light Emission Control by Photonic Crystals"  
M. Fujita, S. Noda (Univ. of Kyoto, Japan)

"Controlled Thermal Emission of Infrared Waves Based on Engineered Metallic Nanostructures"  
H. T. Miyazaki<sup>(1)</sup>, K. Ikeda<sup>(2)</sup>, T. Kasaya<sup>(1)</sup>, K. Yamamoto<sup>(2)</sup>, Y. Inoue<sup>(2)</sup>, K. Fujimura<sup>(2)</sup>, T. Kanakugi<sup>(2)</sup>, M. Okada<sup>(2)</sup>,  
K. Hatada<sup>(2)</sup>, S. Kitagawa<sup>(2)</sup> <sup>(1)</sup>NIMS, Japan, <sup>(2)</sup>Nalux Co., Ltd., Japan)

"Long-Period Waveguide Grating Filter Based on Long-Range Surface Plasmon Mode of Buried Metal Stripe"  
Q. Liu, K. S. Chiang (City Univ. of Hong Kong, China)

#### **Symposium 4: Photonic Devices for Advanced Modulation Formats**

Date: Thursday, July 8  
Time: 14:00 - 16:00  
Place: Room E (108)  
Organizers: S. Suzuki (NTT Photonics Lab., Japan)  
S. Namiki (AIST, Japan)

##### Outline:

We have recently witnessed a dramatic surge of interest in advanced modulation format from the optical communications community. This is evidenced by an increase in the number of experiments of the multilevel modulation optical system. One of the main drivers behind the emergence of these technologies is the recent advancement of novel photonic devices. Here we will discuss how emerging advanced photonic devices can enable new possibilities in optical communication systems.

- Novel optical waveguide integrated devices and planar lightwave circuits for advanced modulation formats
- Phase modulators using LiNbO<sub>3</sub>, PLZT, InP and other materials
- Hybrid integration with silica planar lightwave circuits, LiNbO<sub>3</sub> and other components
- Modulation and demodulation optical circuits for DQPSK
- Optical 90° hybrid for demodulating optical signals
- Delayed demodulators for Incoherent phase detection
- Mach-Zehnder optical modulators for QAM
- Novel optical circuits for OFDM
- Integrated modulator and receiver technologies for advanced modulation formats
- Integrated optical circuits for digital coherent receiver
- Challenges and device side solution for multilevel modulation formats
- The scope extends to theory, modeling and simulation, experimentation, instrumentation, and application

##### **Session 1: Modulation/Demodulation Device Technologies**

"Precise and High-Speed Control of Light for Advanced Modulation Formats"  
T. Kawanishi (NICT, Japan)

"Optical 90° Hybrid for Demodulating Optical Signals with QPSK Modulation Format"  
S-H. Jeong (Fujitsu Laboratories, Japan)

##### **Session 2: Integration Technologies for Advanced Modulation Formats**

"Recent Progress on Hybrid Silica PLCs/LiNbO<sub>3</sub> Modulator for Advanced Transmission Formats"  
Y. Doi (NTT Photonics Laboratories, Japan)

"Integrated –Optic Demultiplexer for Optical OFDM Sub-Carrier Channels"  
K. Takiguchi (NTT Photonics Laboratories, Japan)