Project No.:21001 Core Institution in Japan:Research Institute of Electrical Communication, Tohoku University

JSPS Core-to-Core Program
-Strategic Research Networks-
FY2011　Research Report

Project No.	21001
Research Theme	Collaborative Research Center on Ultrahigh-speed Optical Communication
Duration of Project	April 1, 2011 – March 31, 2014
Core Institution in Japan	Research Institute of Electrical Communication, Tohoku University

Implementing Organizations

Country	Japan
Core Institution	Research Institute of Electrical Communication, Tohoku University
Co-Chair (name and title)	Masataka NAKAZAWA, Professor
Number of Cooperating Institutions	3
Cooperating Institutions	Graduate School of Engineering, Tohoku University National Institute of Information and Communication Technology National Institute of Advanced Industrial Science and Technology

Country	Germany
Core Institution	Heinrich-Hertz Institute
Co-Chair (name and title)	Colja SCHUBERT, Group Leader
Number of Cooperating Institutions	0
Cooperating Institutions	
Matching Fund	①FhG-MPG cooperation projects ②Semiconductor Nanophotonics: Materials, Models, Devices ③ 7th Framework Programme, Information and Communication Technologies

Country	U.K.
Core Institution	University of Southampton
Co-Chair (name and title)	David RICHARDSON, Professor
Number of Cooperating Institutions	0
Cooperating Institutions	
Matching Fund	①EPSRC ②EPSRC ③Framework 7 ④Framework 7

Country	Denmark
Core Institution	Technical University of Denmark

Co-Chair (name and title)	Palle JEPPESEN, Professor
Number of Cooperating Institutions	0
Cooperating Institutions	
Matching Fund	①Villum Fonden (private Danish Foundation) ②European Research Council (ERC) ③Research Council for Technology and Production Sciences

Result of Program Implementation

Based on the achievement of 1.28 Tbit/s/ch single-polarization DQPSK transmission in 2010, we adopted polarization multiplexing to increase the bit rate to 2.56 Tbit/s/ch, and successfully demonstrated 300 km transmission by employing an ultrafast time-domain optical Fourier transformation technique. Through the experiment, we newly figured out that higher-order polarization-mode dispersion (PMD) leads to a siginicant performance degradation for ultrashort optical pulses, which grows in proportional to the fourth power of the signal bandwidth.

We also organized International Symposium on Ultrafast Photonic Technologies (ISUPT 2011), which was held in HHI, Berlin on September 15-16, 2011. Twenty-one eminent researchers presented an invited talk, and the number of participants reached 80 from around the world. ISUPT 2011 made a great contribution to stimulate discussion and clarify future perspective in the field of ultrafast photonics, ranging from materials and devices to systems, signal processing, and networking.

Achievements in FY2011 (Self Review)

Through the research activities, it has been clarified that the improvement in spectral efficiency plays a crucial role for ultrashort pulses, which is a new direction that we figured out to be explored in future ultrahigh-speed transmission. In this context, we recently proposed a novel scheme of ultrahigh-speed and highly spectral-efficient transmission using optical Nyquist pulses. The advantage of this scheme is demonstrated with increased tolerance to dispersion. Optical Nyquist pulses have potential for overcoming the PMD penalty mentioned above, and are expected to yield great performance improvement in Tbit/s/ch transmission.

As regards the collaborative research framework, ISUPT has been playing a role as a center of worldwide research network in ultrafast photonics. The horizon is being extended to US and Asia as well, and expected to grow on a global scale. The next ISUPT is scheduled to take place in University of Rochester, USA, in 2013.

Future Plan (Measures toward Achieving Research Objectives)

We will pursue the direction of spectral efficiency improvement in ultrahigh-speed transmission by using optical Nyquist pulses and combining with multi-level modulation format. This new scheme has attracted a lot of attention among the researchers, and is expected to enable the extension of the transmission distance to 500 km at the bit rate of 2.56 Tbit/s/ch. In addition to the preformance improvement, it is very important to integrate ultrafast optical devices to reduce size and power consumption, which is indispensable to increase the feasibility of ultrahigh-speed transmission systems. We will strengthen the collaboration with industry and attempt to achieve this goal.