PRESS RELEASE

Keio University

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Keio University
Pioneer Micro Technology Corporation
Koshin Kogaku Co., Ltd.
Optoquest Co., Ltd.

World's First Successful Transmission of Ultra-High-Definition (4K) Videos through a Newly Defined Wavelength Band Named "T-Band"

Together with Pioneer Micro Technology Corporation, Koshin Kogaku Co., Ltd., and Optoquest Co., Ltd., Professor Hiroyuki Tsuda, Associate Professor Ryogo Kubo, and other members at Keio University's Faculty of Science and Technology were the first in the world to successfully demonstrate the transmission of ultra-high-definition (4K) videos using a new communication wavelength band called the T-band.

The T-band used in optical communication has wavelengths of between 1,000 and 1,260 nm. Compared with the C-band (1,530–1,565 nm) and L-band (1,565–1,625 nm), which are normally used in optical fiber transmissions, the T-band has greater transmission loss, making it impractical to send transmissions over long distances. For this reason, the T-band was not used for optical fiber transmissions. However, with the spread of cloud computing, as well as services that provide ultra-high-definition videos in recent years, there has been a rapid increase in demand for short- to medium-range optical communication technology. These distances are in the tens of kilometers and applications include datacenter and access networks. For this, there are high expectations for the T-band, which can provide over 1,000 wavelength channels at a frequency spacing of 50 GHz. In this research, optical components for the T-band —quantum dot gain chip, wavelength tunable laser, semiconductor optical amplifier, and arrayed waveguide grating— were developed, and using these, a wavelength routing system was built. Furthermore, using this newly built wavelength routing system, the transmission of 4K videos was demonstrated. Through the effective use of the massive wavelength resource of 80 THz, which was produced by combining the T-band and the adjacent O-band (1,260–1,360 nm), an expansion in transmission capacity and increase in scalability were seen in short- and medium-range optical networks. There is great expectation for this technology to contribute to the introduction and promotion of new services.

The achievements of this research were presented at the 43rd European Conference on Optical Communication (ECOC 2017), an international conference held in Gothenburg, Sweden on September 21, 2017 (local time).

1. Main Points of Research

- Development of a gain chip that can operate in the T-band (*1), as well as a wavelength tunable laser and a semiconductor optical amplifier (SOA), using quantum dot technology.
- Development of an arrayed waveguide grating (AWG) that can operate in the T-band and the configuration of an AWG router (wavelength router) capable of routing to any destination depending on the wavelength.
- Building of a T-band wavelength routing system using the developed wavelength tunable laser, SOA, and AWG router, and the demonstration of transmission of ultra-high-definition (4K) videos.

2. Background of Research

Currently, to cater to the increase in network traffic due to the popularization of cloud computing and services that provide ultra-high-definition videos, optical communication technology using single-core optical fibers that can transmit optical signals at a speed of over 100 Gbit/s has been developed. However, wavelength bands used in optical networks have been mostly limited to the C-band (*2) and L-band (*3), which have small transmission loss, and the E-band (*4), which includes the zero-dispersion wavelength of the standard optical fiber. On the other hand, if the T-band and O-band (*5), which have not been used so much up to now, can be proactively made use of, it would be possible to expand transmission capacity and increase scalability, which would lead to the development of new services. For this, the development of a light source with excellent characteristics and reliability, optical components such as optical circuits, and wavelength routing technology is essential.

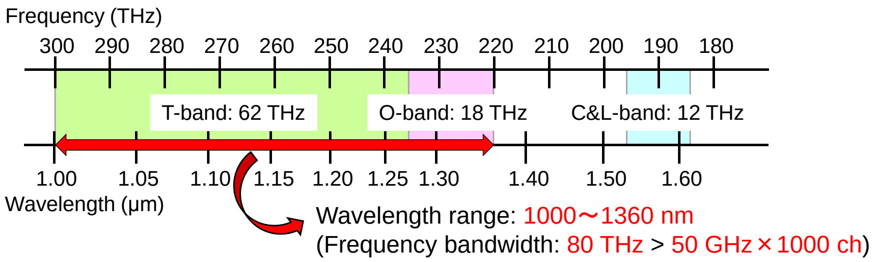

Figure 1: Optical communication wavelength bands: Compared to the 12 THz frequency band of the C- and L-bands, which have been the predominant optical communication wavelength bands up to now, the new T- and O-bands have a massive 80 THz frequency band. T- and O-bands can provide over 1,000 wavelength channels at a frequency spacing of 50 GHz, and the expansion of transmission capacity through parallelization looks promising.

3. Content of Research and Results

In this research, quantum dot technology was used to create a gain chip that can operate in the T-band, and a wavelength tunable laser and an SOA mounted with this gain chip were developed. An AWG that can operate in the T-band was also developed, and an AWG router was configured. Furthermore, a T-band wavelength routing system was built using the developed wavelength tunable laser, SOA, and wavelength router, and an uncompressed 4K video was successfully transmitted. For the transmission of the 4K video, the 12G-SDI (Serial Digital Interface) video signal transmission standard, which has a transmission rate of 12 Gbit/s, was used. In addition, the wavelength switching time for the developed wavelength tunable laser was 100 ms or less, which shows that a low-latency route switching is a possibility.

Compared with the C-band, bigger transmission losses in T-band and O-band optical fibers had been an issue. However, for relatively short-distance transmissions such as those in datacenter networks (*6) and access networks (*7), this is not a limiting factor. If anything, they have more advantages, such as the expansion of transmission capacity due to the wavelength resource and the decrease in electricity consumption due to the implementation of parallelization. By using T- and O-bands, which possess massive wavelength resources, it is possible to increase capacity through the low-cost and low-latency intensity modulation direct detection (IMDD) transmission format.

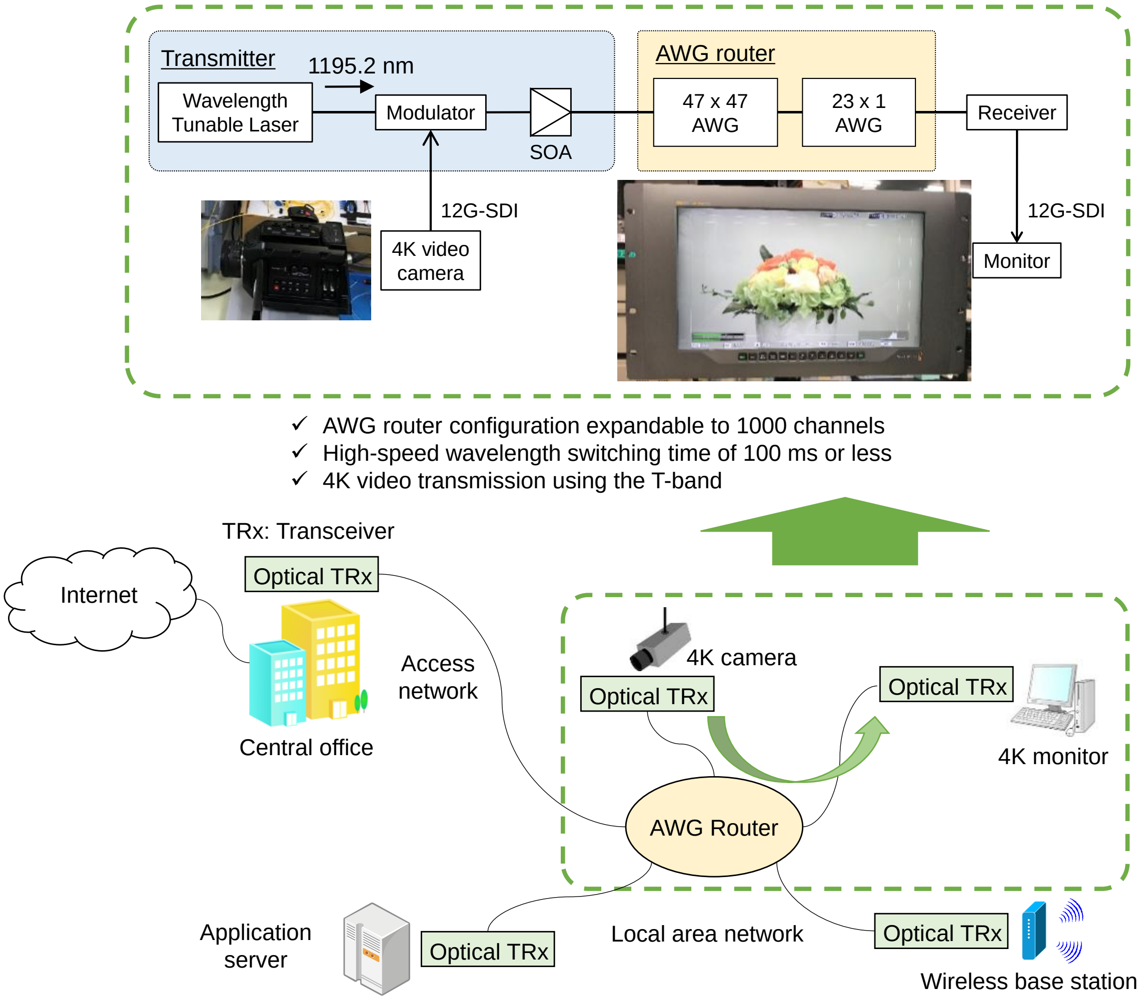

Figure 2: Demonstration of 4K video transmission: For this 4K video transmission demonstration, a relatively short range local area network (LAN) such as that within a regional network, was adopted. The wavelength routing system that was built in the laboratory, consisted of a 4K video camera, transmitter, AWG router, receiver, and monitor. The transmitter was made up of the wavelength tunable laser, optical intensity modulator, and SOA. It received the uncompressed images taken by the 4K video camera, which was passed through the 12G-SDI. The AWG router had two AWGs connected to each other, a 0.2-nm channel spacing 47×47 AWG and a 15.6-nm channel spacing 23×1 AWG. The receiver passed the received 4K video through the 12G-SDI, which was then shown on the monitor.

4. Future Developments

Research and development of AWG routers with 1,000 channels that make use of the vast wavelength resources of T- and O-bands, wideband and high output gain chips and wavelength tunable lasers, and a flexible technology that uses wavelengths are being carried out.
With the development of IoT (Internet of Things), and the spread of 5th generation mobile communication systems (5G), a rapid increase in demand for high capacity optical communication systems that will support these technologies is expected. Achievements from this research are expected to greatly contribute to the expansion of transmission capacity and the improvement in scalability of short- and medium-range optical networks, which will support the information and communication systems of the future. This will lead to the introduction and promotion of new services.

Details of Conference Article

Ryogo Kubo, Hiroyuki Tsuda, Makoto Sudo, Tadashi Hajikano, Yasunori Tomomatsu, and Katsumi Yoshizawa, "Experimental demonstration of 4K-UHD video transmission using T-band wavelength routing system for passive optical local area networks," The 43rd European Conference on Optical Communication (ECOC 2017), Gothenburg, Sweden, paper Th.2.B.4, September 2017.

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Glossary

*1 T-band: in optical communication, a wavelength band ranging between 1,000 to 1,260 nm. The "T" in T-band stands for "thousand."

*2 C-band: in optical communication, a wavelength band ranging between 1,530 to 1,565 nm. The "C" in C-band stands for "conventional."

*3 L-band: in optical communication, a wavelength band ranging between 1,565 to 1,625 nm. The "L" in L-band stands for "long wavelength."

*4 E-band: in optical communication, a wavelength band ranging between 1,360 to 1,460 nm. The "E" in E-band stands for "extended."

*5 O-band: in optical communication, a wavelength band ranging between 1,260 to 1,360 nm. The "O" in O-band stands for "original."

*6 Datacenter network: a network that interconnects servers, etc., at a datacenter

*7 Access network: a network that connects the subscriber to a particular central office

*Please direct any requests or inquires to the contact information provided below.

・Inquiries about research
Keio University Faculty of Science and Technology,
Department of Electronics and Electrical Engineering,
Professor Hiroyuki Tsuda
Associate Professor Ryogo Kubo
E-mail: tsuda@elec.keio.ac.jp, kubo@elec.keio.ac.jp

・Inquiries about press release
Keio University Office of Communications and Public Relations (Takeuchi)
Tel: +81-3-5427-1541 Fax: +81-3-5441-7640
E-mail: m-koho@adst.keio.ac.jp https://www.keio.ac.jp/en/

Pioneer Micro Technology Corporation, Process Engineering Section
Tel: +81-55-241-8611 Fax: +81-55-241-1902
E-mail: support_mtc@post.pioneer.co.jp http:// www.pmtc.co.jp/

Koshin Kogaku Co., Ltd., Applied Products Department (Tomomatsu)
Tel: +81-463-74-1555 Fax: +81-463-74-2312
E-mail: y-tomomatsu@koshin-kogaku.co.jp http://www.koshin-kogaku.co.jp

Optoquest Co., Ltd., 1st Sales Department
Tel: +81-3-5200-0801 Fax: +81-3-5200-0803
E-mail: fukumitsu@optoquest.co.jp http//www.optoquest.co.jp