Press Release

Fujitsu Laboratories Ltd.
Fraunhofer Heinrich Hertz Institute
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Fujitsu and Fraunhofer HHI develop first-ever simultaneous wavelength conversion technology with no wavelength restriction in next-generation optical networks

Successfully field-tested with a wavelength-multiplexed signal in excess of 1 Tbps

Kawasaki, Japan, and Berlin, Germany, September 20, 2016 – Fujitsu Laboratories Ltd. and the Fraunhofer Heinrich Hertz Institute HHI today announced that they have developed a new method to batch convert the wavelengths of wavelength-multiplexed signals necessary for optical communication relay nodes in future wavelength-multiplexed optical networks.

In a field test of the new method, they succeeded in achieving high-bandwidth signal transmission in the range of 1 Tbps. With the newly developed optical wavelength conversion method, because the optical wavelength conversion and the polarization state are controlled simultaneously, batch wavelength conversion of wide-band optical signals can be achieved without restrictions on the wavelengths of the optical signal input or the conversion method. As a result, processing can be achieved with one wavelength converter, regardless of the number of wavelengths multiplexed. Therefore, in converting optical signals in excess of 1 Tbps from ten multiplexed wavelengths, for example, compared to previous technologies that required a circuit for each wavelength converted into an electrical signal, the new method can process the conversion using just one-tenth of the power or less.

By applying this technology to the optical node devices that comprise an optical network, the usage efficiency of the communications band is improved, and it is expected that it will contribute to providing a more stable communications environment.

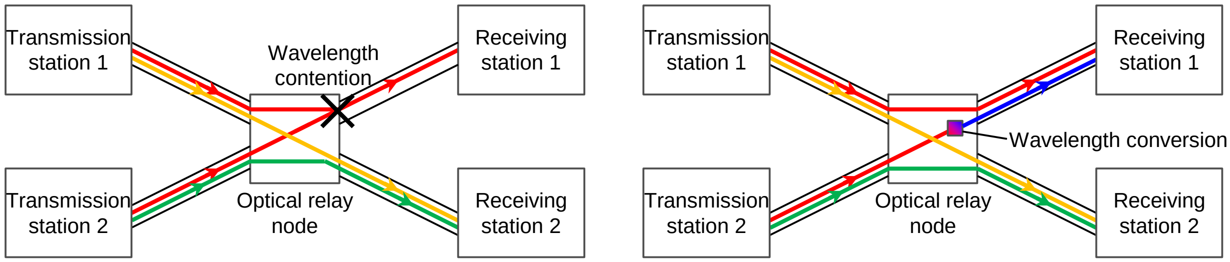
Details of this technology will be announced at ECOC 2016 (42nd European Conference on Optical Communication), an international conference that will be held from Sunday, September 18 to Thursday, September 22 in Dusseldorf, Germany.

Background

The optical fiber networks supporting large-scale datacenters and sophisticated cloud-based ICT services rely on wavelength-division multiplexing (WDM) technology, which brings together optical signals of different wavelengths for transmission in a single optical fiber, connecting multiple points in an optical network with high bandwidth and low latency. In recent years, with the polarization-multiplexed quadrature phase modulation method (*1), the bandwidth achieved per wavelength typically is 100 Gbps, and progress is being made on developing technology that, by increasing the number of multiplexed wavelengths, will make it possible to achieve terabit-class high-bandwidth communications environments in the future.

Technological Issues

When connecting multiple points in an optical network, because optical signals of the same wavelength cannot be transmitted in the same optical fiber, between the optical relay nodes, it is necessary to have the ability to convert wavelengths so that they do not overlap, shifting them to avoid collisions (figure 1).

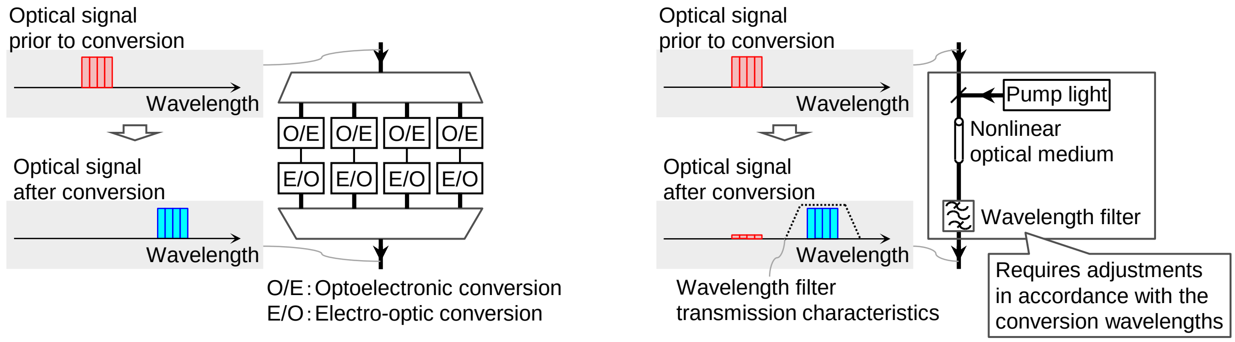


Case in which a wavelength contention occurs

Case in which a wavelength contention is avoided with wavelength conversion

Figure 1. Wavelength collisions at optical relay nodes

Previously, two methods were proposed, a method for momentary conversion into an electric signal (left side of figure 2), and a method using nonlinear optical effects and a wavelength filter (right side of figure 2). With the first method, however, there were two problems. One was the increase in processing latency from the mutual conversion of electrical and optical signals. The other was that, because a conversion circuit is required for each wavelength, an increase in the number of wavelengths multiplexed increases the amount of electricity consumed. Likewise, with the second method, although it enables wavelengths to be converted in one batch, because it requires a filter element that can remove just the wavelength of the signal prior to conversion, it is difficult to handle signals with a variety of wavelengths, making practical implementation problematic.



Wavelength conversion through conversion into electric signals

Wavelength conversion using nonlinear optical effects and a wavelength filter

Figure 2. Previous wavelength conversion technologies

The Newly Developed Technology

Now Fujitsu Laboratories and HHI have discovered a new batch wavelength conversion method that simultaneously controls the optical wavelength conversion and the polarization state, and have created a prototype wavelength conversion circuit based on this principle. Using this prototype circuit, they succeeded in an experiment to batch convert optical polarization division multiplexed optical signals exceeding 1 Tbps. This represents the world’s first successful implementation of a batch wavelength conversion capability that functions without any restrictions on the wavelength of the optical signals input or the conversion method.

The newly developed technology has the following features.

1. New batch wavelength conversion technology using a polarization filter

It is known that, by combining an optical signal comprised of multiple wavelengths with excitation light when inputting into a nonlinear optical medium, it is possible to generate a signal that combines the input optical signal with the wavelength converted light. Fujitsu Laboratories and HHI developed a new batch wavelength conversion technology that, in accordance with the wavelength conversion, alters the polarization state of the optical signal, and, using a polarization filter instead of the wavelength filter used in previous technologies, removes the optical signal prior to the wavelength conversion. It then extracts just the optical signal after the wavelength conversion. By controlling the spacing of the excitation light's wavelength interval, the wavelength after conversion can be controlled voluntarily.

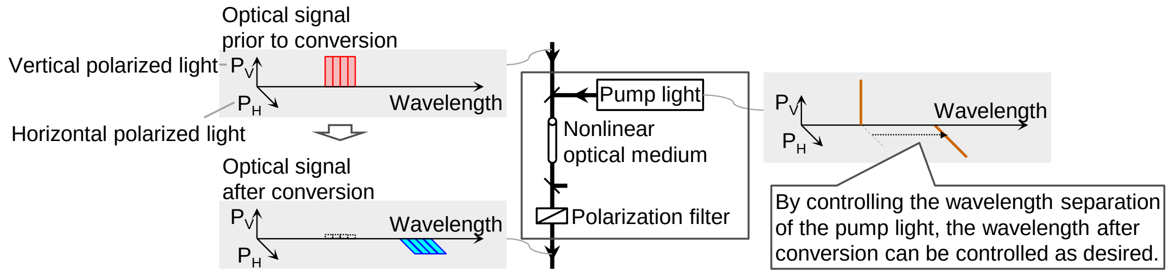


Figure 3. The proposed new wavelength conversion technology

2. Batch wavelength conversion technology for polarization-multiplexed optical signals

The two components of the optical signal consist of the vertically polarized wave and the horizontally polarized wave., By separating them, performing the wavelength conversion in parallel, and then reintegrating the signal, Fujitsu Laboratories and HHI developed technology for polarization-multiplexed signals. Using a prototype circuit based on this principle, they achieved success in a test of a batch conversion of polarization- multiplexed signals exceeding 1 Tbps.

Effects

Whereas, previously, for the wavelength conversion of high-bandwidth optical signal of 1 Tbps, for example, 10 converters were required for conversion into electrical signals, batch conversion using just one converter is possible using the new technology. This enables the achievement of equivalent performance while consuming one-tenth the power or less than previously required. In addition, because there are no restrictions on the wavelengths before or after conversion, this technology will contribute to the creation of next-generation optical networks in which the configuration of the network can be flexibly modified.

Future Plans

With the aim of practical implementation around 2020, Fujitsu Laboratories and HHI will work on further improvements in conversion efficiency as well as improvements in the feasibility of volume production that are needed for practical implementation of this technology.

Glossary and Notes

1. Polarization-multiplexed quadrature phase modulation method

An optical modulation method that has, in practice, become the industry standard for 100 Gbps optical transmission systems. It combines polarization-multiplexing technology, which multiplexes the vertically polarized wave and the horizontally polarized wave of the optical signal to double the transmission capacity, with quadrature phase modulation.

Press Release

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About Fujitsu

Fujitsu is the leading Japanese information and communication technology (ICT) company, offering a full range of technology products, solutions, and services. Approximately 156,000 Fujitsu people support customers in more than 100 countries. We use our experience and the power of ICT to shape the future of society with our customers. Fujitsu Limited (TSE: 6702) reported consolidated revenues of 4.7 trillion yen (US$41 billion) for the fiscal year ended March 31, 2016. For more information, please see http://www.fujitsu.com.

About Fujitsu Laboratories

Founded in 1968 as a wholly owned subsidiary of Fujitsu Limited, Fujitsu Laboratories Ltd. is one of the premier research centers in the world. With a global network of laboratories in Japan, China, the United States and Europe, the organization conducts a wide range of basic and applied research in the areas of Next-generation Services, Computer Servers, Networks, Electronic Devices and Advanced Materials. For more information, please see www.fujitsu.com/jp/group/labs/en/.

About Fraunhofer HHI

Innovations for the digital society of the future are the focus of research and development work at the Fraunhofer Heinrich Hertz Institute HHI. In this area, Fraunhofer HHI is a world leader in the development for mobile and optical communication networks and systems as well as processing and coding of video signals. Together with international partners from research and industry, Fraunhofer HHI works in the whole spectrum of digital infrastructure – from fundamental research to the development of prototypes and solutions. www.hhi.fraunhofer.de

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