Integrated ICT
Network System Research Institute

Director General　Naoya Wada

The Network System Research Institute promotes fundamental research and development of global and advanced network system technologies to meet the recent explosive growth in data traffic and for the diversification of communication quality and network service. This research aims to create a "connected society" that provides its citizens with new opportunities and revolutionizes business and social interactions.

The Photonic Network System Laboratory performs research into ultrahigh-capacity multi-core fiber transmission technologies and optical integrated network technologies to meet the increased demand for data services, which is predicted to increase by three orders of magnitude beyond current levels.

The Network Science and Convergence Device Technology Laboratory performs research into (i) automation of dynamic, on-demand network configuration and control technology, and (ii) information dissemination and sharing based on information-centric networking concepts. In addition, its laboratory studies are geared towards realizing the seamless convergence of core networks, optical access and wireless, to provide end users with high-capacity communications.

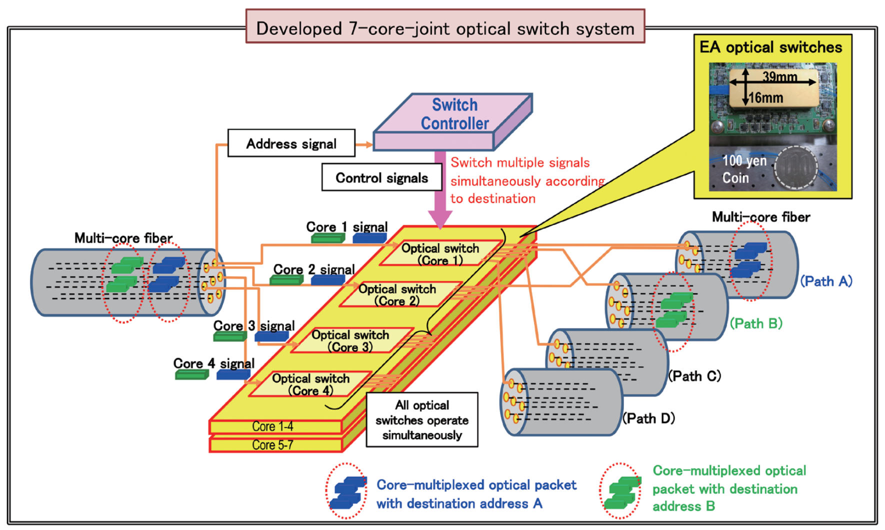

Fig.1 : Developed 7-core-joint optical switch system

83.3 Tbit/s: a new world record in optical switching

Regarding the research and development of multi-core all-optical switching technologies, we have developed a high-speed parallel switching system equipped with a controller that simultaneously drives multiple elements according to the destination signals (Fig.1), enabled by a parallel configuration of high-speed electro-absorption (EA) optical switches with a switching speed on the order of nanoseconds. Using this testbed, we have successfully tested 7-core-multiplexed optical packet switching with a world record switching capacity of 53.3 Tbit/s. This result was chosen for a special session of outstanding papers (commonly referred to as Post-deadline Papers) at the European Conference and Exhibition on Optical Communication (ECOC2017), the top conference in the field of optical communications. Later on, we made further improvements to this technology and achieved a new record switching capacity of 83.3 Tbit/s, which is 6.5 times higher than the previous record set just three years ago.

159 Tbit/s Transmission over 1,045 km using standard diameter multimode optical fiber

We successfully demonstrated transmission of 159 Tbit/s data over 1,045 km using a 3-mode optical fiber with a standard cladding diameter (0.125 mm) that is compatible with standard optical fiber infrastructure (Fig.2). Using the common metric of the product of transmission capacity and distance, this experiment gives a value of 166 Pbit/s·km (petabit kilometers), which is approximately double the existing world record for standard diameter optical fibers for spatial multiplexing. This result was selected for the Post-deadline special session of the Optical Fiber Communication Conference (OFC2018), which is the top conference in the field of optical communications.

Highly integrated two-dimensional photodetector array

We have developed a highly integrated photodetector device (Fig.3) that can detect and convert a large number of high-speed optical signals to the electrical signals simultaneously. This device integrates 32 photodetector units in an area of approximately 0.1 mm², allowing it to simultaneously receive multi-channel optical signals and convert each of them into a high-speed electrical signal of 10 GHz or higher. The development of this device has made it possible to concentrate a large number of photodetectors into a small area, resulting in a drastic reduction of the size and power consumption of large-capacity optical communication devices. This result was selected for ECOC2017.

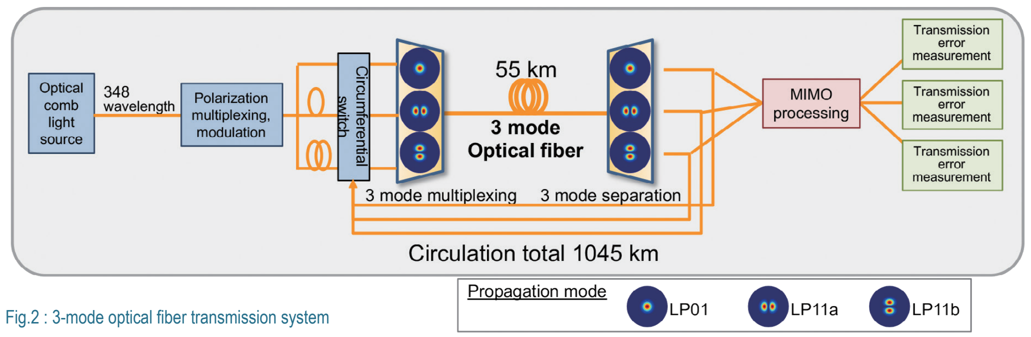

Fig.2 : 3-mode optical fiber transmission system

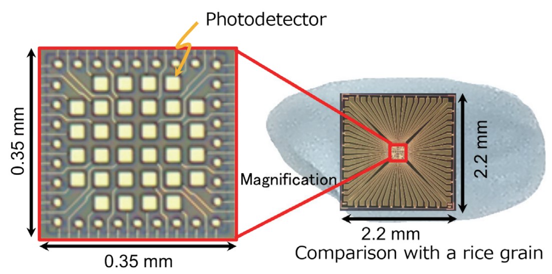

Fig.3 : Ultra-compact, highly integrated two-dimensional photodetector array

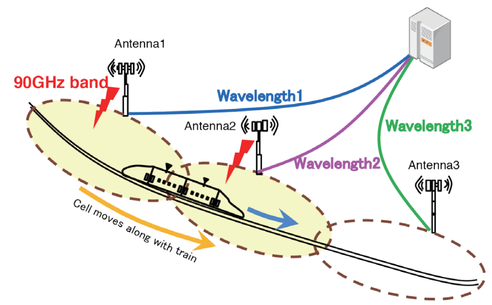

Fig.4 : "Uninterrupted" fiber-wireless communication technology for high-speed railways

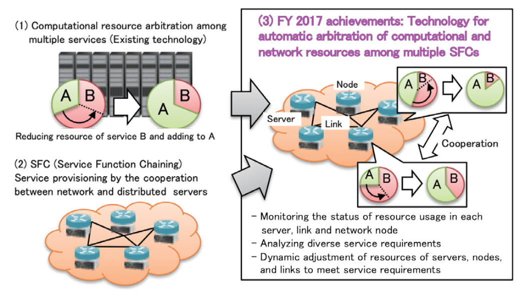

Fig.5 : Automatic Resource Arbitration among Multiple Service Function Chains

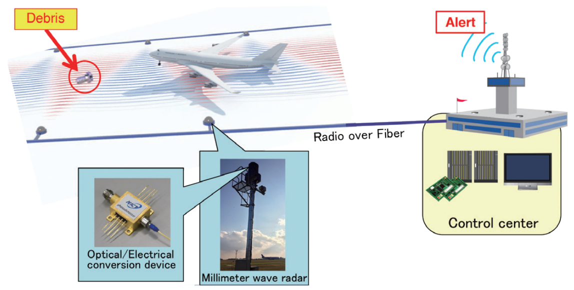

Fig.6 : Foreign Object Debris Detection System

Automatic virtual network configuration and control technology

In the 5G era and beyond, networks will have the capability of instantly configuring virtual network slices with enough network and computing resources for different types of network services. For the agile provisioning of network services and their adaptation to traffic fluctuations, we need technology for the automatic configuration and control of virtual network slices. Meanwhile, service function chaining (SFC) is an innovative approach to in-network processing of traffic, which enables flexible deployment of network service functions on each slice(Fig.5). We have been researching and developing technologies to automate the dynamic arbitration and migration of computational resources among multiple service function chains deployed on multiple virtual network slices. These technologies can mitigate the service degradation caused by CPU-saturation and/or switching of communication paths. We have designed a mechanism for autonomic computational resource control to satisfy diverse quality-of-service requirements in response to network traffic fluctuations, and we have verified that our mechanism can reduce CPU-saturation in all service function chains by at least 90% compared with the conventional fixed resource allocation approach, thereby contributing to the enhancement of service quality. These results were presented at IEEE/IFIP Network Operations and Management Symposium (NOMS2018), which is a prominent international conference in the field of network operations and management.

Efforts leading to social implementation

Using the radio-over-fiber technology and optical and electrical high-frequency convergent device technology, we are continuing with a verification trial of an airport runway monitoring radar system (Fig.6) at Narita Airport, and we are collecting radar observation data for future commercial development. We have also promoted this system with the aim of creating new business and have contributed to the start of testing at Kuala Lumpur Airport in Malaysia.