Initiatives Concerning All-Photonics-Network-related Technologies Based on IOWN

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Abstract

With the ongoing rapid digitization of society, various issues are expected to arise in the near future. Accordingly, NTT is advocating the Innovative Optical and Wireless Network (IOWN) and is working with partners to conduct a variety of research and development activities to bring about innovations based on IOWN. The related technologies NTT is working on to create the All-Photonics Network—one of the three components of IOWN—are introduced in this article.

Keywords: IOWN, All-Photonics Network, network technology

1. Introduction

For the last ten years, our lifestyles have been changing dramatically due to our use of the Internet—which is now an indispensable part of our lives. With various services made available on smartphones, our working styles are also evolving in various business scenes.

Global data traffic is increasing rapidly since the number of devices connected to the Internet is exploding with the development of the Internet of Things. As a result, there will be issues such as the limitations of both transmission and processing capabilities of information and communication technology (ICT) equipment and the increase in energy consumption of the equipment. Although Moore's Law (stating that the number of transistors per area of an integrated circuit doubles every 18 months) has been a measure of developments in the information-processing industry, concerns have been pointed out regarding its future sustainability. In particular, the size of existing transistors has been reduced to the order of several nanometers, and problems concerning heat generation and physical limitations in manufacturing have been pointed out.

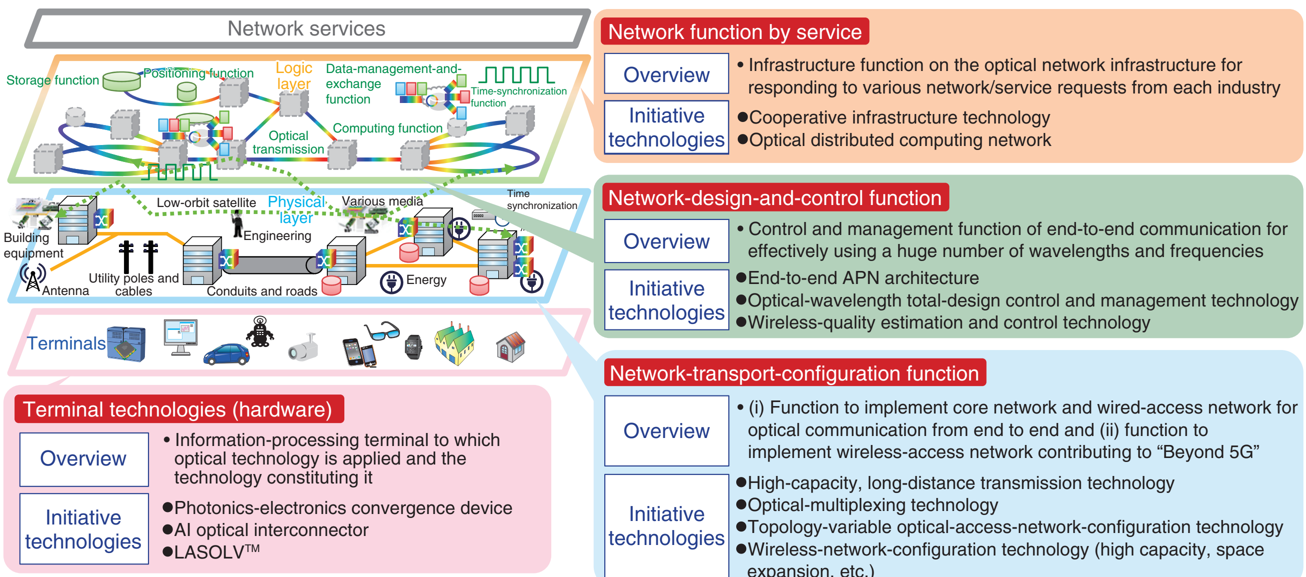
2. What is IOWN

From the above circumstances, we are proposing the Innovative Optical and Wireless Network (IOWN) [1]. IOWN will create an innovative information-processing infrastructure that will transform existing information and communication systems and significantly improve the potential of networks beyond the limitations of conventional technologies and the barriers to power consumption, and we have started activities concerning IOWN with various partners [2]. On the basis of two major changes, namely, from *electronics to photonics* and the resulting *digital to natural*, we are promoting environmentally sustainable growth along with safety and security to benefit both individuals and society as a whole.

IOWN consists of three components: (i) the All-Photonics Network (APN), (ii) Cognitive Foundation® (CF), and (iii) Digital Twin Computing (DTC). The main approaches concerning network-related technology for creating the APN, which will greatly improve the potential of the information-processing infrastructure, are introduced in this article.

3. What is the APN

The APN converts all information transmission and



AI: artificial intelligence

Fig. 1. Basic functions comprising the APN.

relay processing to photonics-based processes; thus, it is possible to fully use broadband properties and the flexibility of light and provide full-mesh-connection optical paths between multiple points (in wavelength units) for each terminal, user, and service. For current communication systems, it is necessary to convert optical and electrical signals in the network multiple times. In contrast, the ultimate target of the APN is to establish communication using only optical signals, that is, no electrical signals are involved.

With the APN, different wavelengths can be assigned to each piece of information. For example, while high-definition content (such as an 8K120P data stream) is being sent, it will be possible to provide mission-critical communications (such as those concerning automated driving and remote surgery) simultaneously with ultra-low delay. Unlike services provided by best-effort Internet lines, ultra-low-latency services that have large capacity and guaranteed bandwidth can be provided by IOWN.

The APN is composed of the following three basic functions (**Fig. 1**): (i) a network-transport-configuration function that creates an optical full-mesh network and wireless-access network for high-speed, high-quality data transfer from end-to-end; (ii) a network-design-and-control function for efficiently accommodating the huge number of wavelengths and frequencies required for building and operating those networks; and (iii) a network function by service that optimally combines ICT resources (such as network resources and computing resources) to provide a dedicated environment that satisfies various service requirements. In addition, terminal technologies, e.g., photonics-electronics convergence devices that achieve low power consumption and low delay per data volume, are indispensable as core technologies for configuring the devices and terminals that implement those three functions.

4. Network-related technologies for implementing the APN

NTT is currently engaged in a variety of research and development activities to implement the APN [3], and our initiatives concerning four characteristic key technologies ("topics") are introduced in the Feature Articles in this issue. As an initiative tackling a new optical transmission infrastructure, Topic 1 concerns ultra-high-capacity optical communication technology related to cutting-edge devices and components to increase the capacity of backbone networks by combining wavelength-division multiplexing and space-division multiplexing [4]. Topic 2 concerns investigations related to the above network-transport-configuration function to increase the capacity of wireless sections and increasing the degrees of freedom in deploying wireless areas [5]. Topic 3 concerns an optical full-mesh network-configuration technology that provides a transport function with large capacity and low delay [6]. Topic 4 concerns an initiative related to the network-design-and-control function, namely, a study on network-design technology for efficiently accommodating a large number of optical paths in the APN [7].

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