Release of NTT Technology Report for Smart World 2022

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Abstract

NTT Research and Development Planning Department annually releases the NTT Technology Report for Smart World, which summarizes its vision for the Innovative Optical and Wireless Network (IOWN) launched in 2019 and technologies intended to make the world a better place for everyone. It has now published the 2022 edition. This article provides an overview and main updates of this new edition.

Keywords: technology, social trend, smart world

1. Innovation to create a sustainable society and regenerate the world

Humanity's constant technological innovations have created a prosperous world but have also caused various problems. To understand umwelts ("environments") beyond the limits of human cognition, we need new infrastructure that can process vast amounts of information. At NTT, we see the potential for breakthrough innovation in the field of optical technology and unveiled the concept of the Innovative Optical and Wireless Network (IOWN) in 2019. We have been making steady progress toward its implementation by 2030, and various pilot projects tailored to different contexts are underway. In this article, we introduce the foundational technologies needed to further advance toward the implementation of IOWN, as well as the efforts to introduce IOWN, which includes conducting field technology demonstrations in collaboration with many companies in Japan and abroad. These IOWN initiatives will enable us to innovate and regenerate the world.

2. Photonics-electronics convergence technology to implement IOWN, two social infrastructures, and five value domains created by IOWN

The implementation of IOWN is supported by photonics-electronics convergence technology, which enables more efficient operation by integrating light and electricity, and two social infrastructures, the All-Photonics Network (APN) and disaggregated computing, which can be built using this technology. With this technology and new infrastructures, IOWN is creating five representative value domains: next-generation data hubs, the 4D digital platform®, secure optical transport network, fifth-generation mobile communication network (5G) evolution/6G wireless technology, and the Space Integrated Computing Network. In NTT Technology Report for Smart World 2022, the photonics-electronics convergence technology, two social infrastructures, and five value domains are explained.

3. Photonics-electronics convergence technology

IOWN will achieve an ultra-high-capacity, ultra-high-speed, and energy-efficient communication infrastructure by introducing optical information transmission on smaller scales, between servers at datacenters, on circuit boards that connect computers to networks, and on chips and semiconductors inside them. To implement optical technology for shorter-distance communications, devices that manipulate light must be dramatically scaled down and made more economical and higher performing. To this end, we are working to establish photonics-electronics convergence technology that integrates light and electricity processing capabilities into a single device and enables more efficient operation. We will

continue our research and development (R&D) efforts together with many partners following the roadmap that sets out five generations of photonics-electronics convergence technology to develop the ultimate ideal form and offer an innovative information and communication platform.

4. Two social infrastructures

4.1 All-Photonics Network

We are developing the APN as the "infrastructure of infrastructures" that will tie together various information and communication technology (ICT) infrastructures in the era of digital transformation/digital circulation. The APN will make it possible to construct a shared ultra-high-speed optical and wireless network that connects telecommunications hubs as well as user facilities and datacenters with end-to-end broadband optical networks and wireless access that anyone can use. In addition to the development of fundamental technologies, various technologies have been demonstrated to enable the APN. For example, in FY2021, we demonstrated Layer-1 communication-path delay-adjustment technology that revolutionizes gaming user experience, ultra-low-latency video-transmission technology for uncompressed 8K120p video, and optical transport network technology using next-generation highly secure cryptography.

4.2 Disaggregated computing

To make the most of infrastructures such as the APN, functions that have been handled by dedicated devices, such as routers and mobile base stations, need to be achieved through powerful computing hardware and software with low power consumption. The concept we have proposed to achieve this is disaggregated computing. The conventional premise in the computing field was to connect boxed computers through networks. Disaggregated computing will directly connect components, such as central processing units and memory, with optical connections, enabling us to treat racks and datacenters as single, large computers. By revolutionizing the physical configuration (hardware architecture), logical configuration (software architecture), and control methods, we will maximize the potential of light to achieve high-speed, low-power, and low-loss performance that far surpasses that of conventional computing.

5. Five value domains created by IOWN

5.1 Next-generation data hubs

With the spread of Internet of Things devices and development of communication networks, the amount of data circulating around the world continues to increase, and their use in various areas will increase with the development of artificial intelligence (AI) and other technologies. However, there are still challenges to overcome to achieve a society that can use data beyond the boundaries of industries and companies. For example, traditional storage and networks will be overwhelmed and difficult to manage. In addition, cross-industry data utilization is currently hindered by the lack of technical mechanisms to prevent secondary distribution or use for unintended purposes. To address these issues, we are engaged in the R&D on next-generation data hubs composed of three technologies: virtual data lake, data broker, and data sandbox, which will accelerate the utilization of data in society.

5.2 4D digital platform®

The 4D digital platform® is an infrastructure that collects a variety of sensing data on people, objects, and things in real time, matching and integrating the four-dimensional (4D) information of latitude, longitude, altitude, and timestamp with high accuracy, and enabling data fusion and future prediction with various industrial infrastructures. By integrating a mobile mapping system and other advanced 3D spatial information with existing map data, as well as using Smart Satellite Selection™, which improves positioning and time synchronization accuracy in urban areas, we will be able to collect highly accurate location and time data. This is then combined with AI to achieve advanced future predictions. The 4D digital platform® provides value through optimization of road traffic and other urban assets, maintenance of social infrastructure, and a more fine-grained understanding of the natural environment.

5.3 Secure optical transport network

We are conducting R&D on secure optical transport networks that can protect networks against attacks involving extremely advanced computers such as quantum computers. The key to making this possible is the use of quantum technology and countermeasures against new attackers at the architectural design level. For the former, we are developing two types of key cryptography and delivery mechanisms: quantum key distribution and post-quantum cryptography-based

key distribution. For countermeasures against new attackers, we may add security without interfering with the low latency of IOWN and the APN by implementing encryption at lower layers.

5.4 5G evolution/6G wireless technology

We believe that six conditions must be met to achieve 6G by 2030: ultra-high-speed and high-capacity communication, significant coverage expansion, ultra-multi-connection and sensing, ultra-low power consumption and low cost, and ultra-low-latency and ultra-reliable communications. However, the expansion of usage areas and the increasing complexity of user needs make it difficult to provide a network optimal for all individuals. To address this issue, we are developing Cradio®, a set of multi-radio proactive control technologies that enable people to enjoy a more natural communication environment. We are currently conducting a series of demonstration tests of automatic driving and remote monitoring and control of agricultural machinery between fields, aiming for practical application by 2030.

5.5 Space Integrated Computing Network

The Space Integrated Computing Network, which we are currently envisioning, will create an independent, decarbonized, and self-sustainable infrastructure in space, unaffected by the Earth's environment. Through space sensing, space datacenters, and space radio access networks, we will integrate multiple orbits including high-altitude platform stations in the stratosphere and satellites in low and geostationary orbits and connect them to the ground via an optical wireless communication network, creating a completely new ICT infrastructure.

6. A worldwide IOWN network

NTT cannot achieve IOWN alone. This new information infrastructure can only be actualized through co-creation with many partners, including companies around the world. The IOWN Global Forum (IOWN GF) is growing beyond national borders, revealing the shape of future co-creation. After beginning to recruit members in March 2020, 93 organizations have joined IOWN GF as of March 2022. Unlike traditional international organizations, the high frequency of discussions has resulted in the release of a white paper in April 2020, use case interim reports (February and June 2021), a technology outlook report (April 2021), and Use Case Release 1 (October 2021), as well as six reference documents that were released in December 2021 in accordance with IOWN's technology development roadmap. We will work with IOWN GF members on proofs of concept and technical studies based on the published documents.

7. Conclusion

NTT Research and Development Planning Department will continue to release a summary of technology trends and the activities of NTT R&D. NTT Technology Report for Smart World 2022 can be downloaded from NTT R&D's website [1].

Reference

[1] NTT Technology Report for Smart World 2022, https://www.rd.ntt/e/research/RDNTT20220720.html

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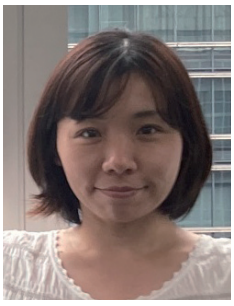

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