Research Is Enjoyment. Long-term Research Can Be Useful to Society

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Overview

The Government of Japan's initiative "Society 5.0" envisions the future of Japan. It describes that in that future society, by analyzing an enormous amount of big data using artificial intelligence that exceeds human ability and feeding the results back to humans through robots and other technologies, it will be possible to create new value that could not be created before and provide it to industry and society. We interviewed Jun-ichi Kani, a senior distinguished researcher at NTT Access Network Service Systems Laboratories, who researches and develops network technologies that will support such a future, about his current research and what is the perfect world for researchers.

Keywords: access network, Full Service Access Network (FSAN), softwarization

The common language is "technology"—coordinate with peers around the world

—Could you start from your current research?

Our team is researching a new optical access network that will accelerate the evolution of information and communication services. We aim to create and spread new optical access networks through (i) research on elemental technologies and architectures that will radically enhance system performance and flexibility and (ii) global collaboration activities. In current optical access networks, data traffic is transferred to the core network at a central office in a manner much like a bus passenger transfers to a train at a station. By integrating access networks to the core network in the future, we aim to create a network that can transmit optical signals to designated locations in an end-to-end manner without the transfer of traffic (**Fig. 1**).

Optical access networks have supported the development of a broadband service called fiber to the home (FTTH). You may think that wired optical networks are no longer needed in the age of the mobile Internet. However, the equipment in central offices will be connected to 5G (fifth-generation mobile communication system) antennas, next-generation wireless local area network (LAN) antennas and so on all by optical fiber networks. What's more, given that all things—from factory machines and various sensors to transportation systems and electric-power systems—are connected by networks, requirements such as bandwidth and latency will be more diverse than before. With this background in mind, we are researching and developing optical access networks for the future on the basis of the idea that optical

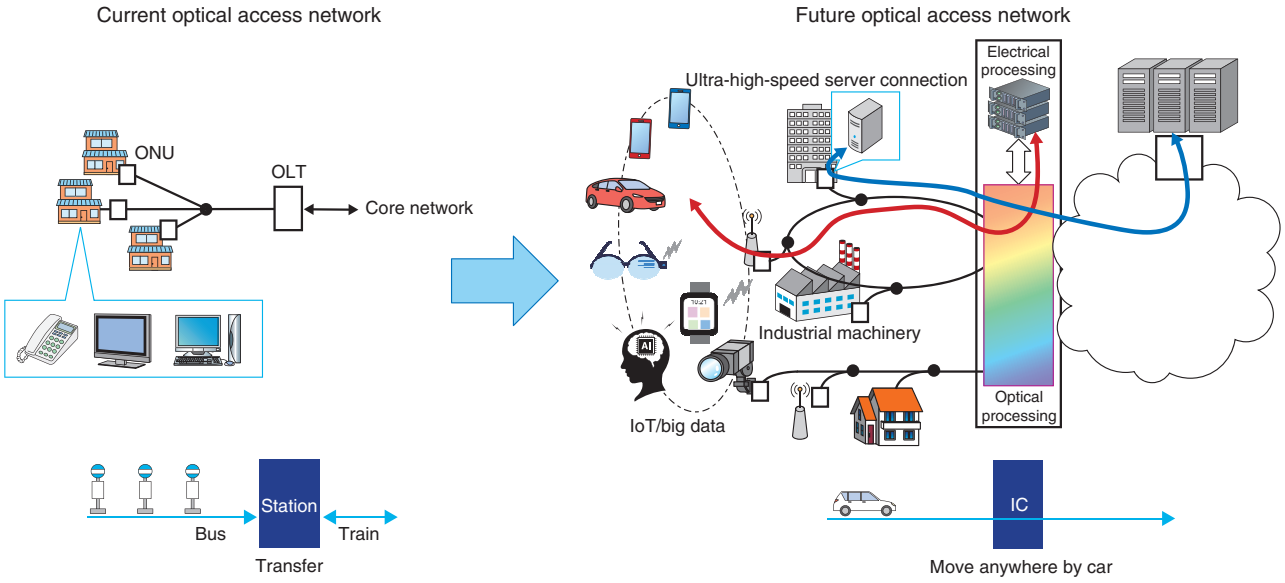
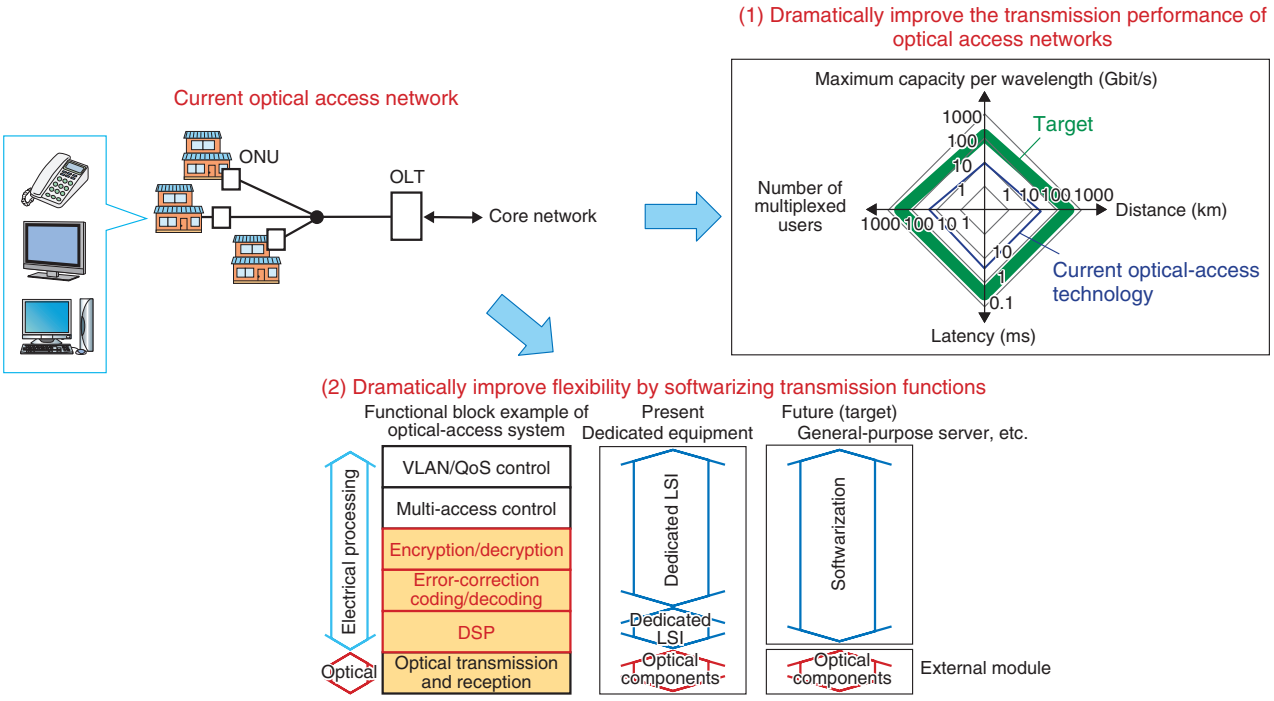


Fig. 1. Future image of optical access network.

access networks will become the common access network platform for various services and systems beyond FTTH.

Specifically, to satisfy a wider range of requirements (such as broadband and low latency) than before, we are taking on the challenge of drastically improving transmission performance of optical access networks (**Fig. 2**). As an example of taking this challenge, the world's first real-time digital coherent optical transceiver for optical access networks has been implemented by our team. Although the digital coherent reception system is used for large-capacity transmission in backbone networks, when it is applied to access, it is necessary to receive intermittent ("burst") signals with large power differences transmitted from different optical network units (ONUs). By devising and developing a real-time-signal-processing circuit in addition to a burst-compatible coherent receiving circuit, we made it possible to transmit 20-Gbit/s signals with a power difference of 20 dB (100 times) or more without errors. At the European Conference on Optical Communication (ECOC) 2016, one of the world's largest international conferences in the field of optical communications, we received a top-score evaluation in the access-network area.

To drastically improve network flexibility, we are also conducting research on softwarizing the transmission functions (Fig. 2). If the transmission functions can be executed as software on general-purpose devices such as servers and personal computers (PCs), replacement, combination, and tuning of transmission functions according to bandwidth and distance requirements will become incredibly easy. This *softwarization* is the key to creating a new network that can be accessed by optical means from anywhere, as I mentioned earlier. We are using graphics processing units and studying new algorithms in collaboration with the University of Tokyo. We achieved a processing speed of 10 Gbit/s regarding error correction, which requires the heaviest processing in current access systems, and received the Best Paper Award (in Access Networks & Systems Track of the Selected Areas in Communications Symposium) at the IEEE Global Communications Conference (GLOBECOM) 2016, a key international conference on communications. Furthermore, by implementing high-speed software processing for digital



LSI: large-scale integrated circuit
QoS: quality of service
VLAN: virtual LAN

Fig. 2. Research for creation of a new optical access network.

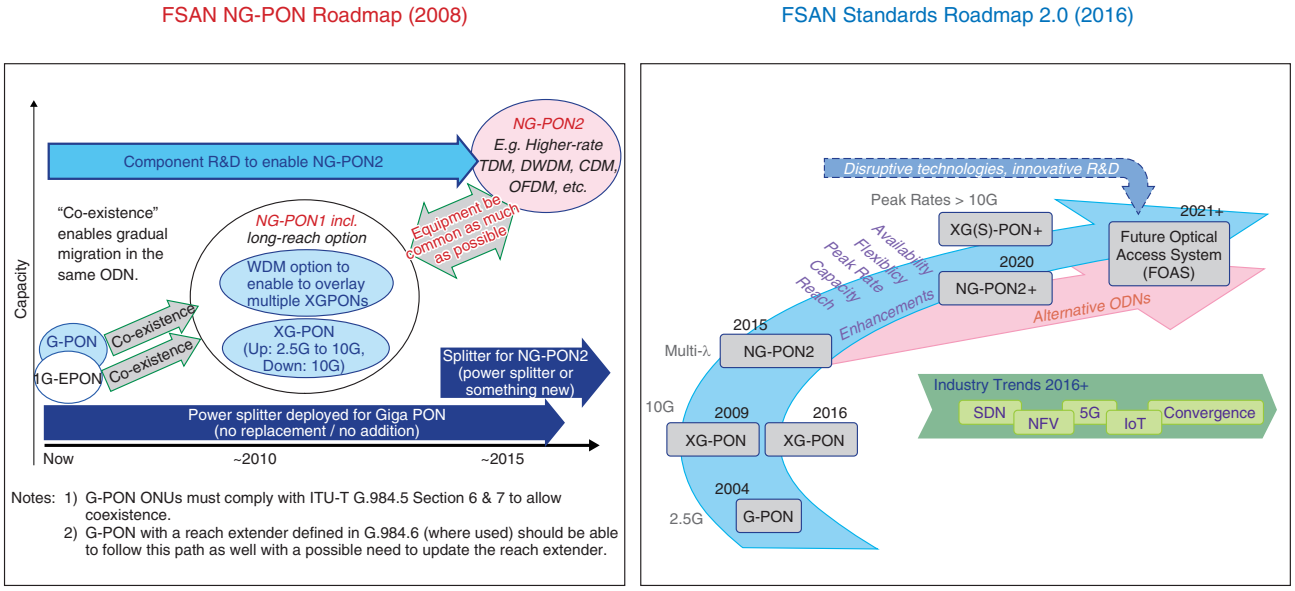
signal processing (DSP), we achieved the world's first softwarization of digital coherent optical transmission and received the top score in the access-network category at the Optical Fiber Communication Conference and Exposition (OFC) 2018, the world's largest international conference on optical communications.

—It seems like you're really leading the world with cutting-edge ideas.

I owe these achievements to our team members. As for improving the performance of the optical access networks, how to upgrade FTTH systems has been debated since around 2004 when current FTTH systems were introduced. I also started to study this issue around that time and have been researching it for over 10 years. In the meantime, mobile networks had emerged. Ahead of that mobile era, in early 2010, I began research on improving the flexibility of optical access networks. During that time, I was able to advance research and development (R&D) by always having good teams.

As part of these research activities, it is also important to be going in the same direction as other researchers and engineers. Technology will not spread unless you coordinate with your peers around the world. To that end, we are discussing and setting directions at the Full Service Access Network (FSAN), a forum in which key operators and vendors of optical access networks discuss optical access network technology. As co-chair of the Next-Generation Passive Optical Network (NG-PON) Task Group from 2003 to 2010 and as chair of that group since 2015, I have been promoting global technology collaboration.

In the early days of co-chairing the NG-PON Task Group with the other co-chair, we sometimes had difficulty in proceeding discussion. When the participants of the task group brought a variety of technical proposals, we couldn't determine the way forward. Given such a state of affairs, in 2008, we talked about making a roadmap for the evolution of optical access network technology, and created such a roadmap through discussions. It was an important milestone in terms that it not only helped to align the discussions



Source: https://www.fsan.org/roadmap/

CDM: code division multiplexing
DWDM: dense wavelength division multiplexing
EPON: Ethernet PON
G-PON: Gigabit-capable PON
NFV: network functions virtualization
ODN: optical distribution network
OFDM: orthogonal frequency division multiplexing
SDN: software-defined network
TDM: time division multiplexing
WDM: wavelength division multiplexing
XG-PON: 10Gigabit-capable PON

Fig. 3. Technology roadmap by FSAN.

in FSAN go in the same direction but also stimulated and promoted R&D of NG-PONs. In 2016, we released FSAN Roadmap 2.0 (**Fig. 3**).

While the roadmap enabled us to head in the same direction, we still face differences of opinion. In such cases, I try to understand the reason for the difference from a technical viewpoint and think of a way we can come together through a new technical proposal. The more you discuss things technically, the more answers you will come up with. Because we are all professionals, we can discuss things in the common language of technology. Despite all the difficulties faced, technology is the ultimate solution.

Open up the future by interacting with people with different values domestically and internationally

—Could you tell us how you started your career as a researcher and what kind of researcher you envision to become?

When I was in elementary school and then junior high school, one of my hobbies was computers. At that time, fields such as biotechnology were evolving, and there were many things I was interested in, not limited to PCs and biotechnology. As I couldn't narrow my interests down to one, I entered the department of applied physics at university to try learning various subjects. Of particular interest was optical physics, and I was researching the properties of a material by using lasers. At the same time, Internet browsers emerged, and I was amazed when I saw one in the lab. At that time, optics and the Internet were completely different entities to me, but I joined NTT because it is related to both and I thought that would be interesting. Since then, the fusion of optics and the Internet has advanced rapidly. I'm not saying I could clearly predict this outcome; my interest was simply triggered by both aspects. In this way, I believe it is very important to have something interest you.

Our current research is on systems, and in some cases, it has to be divided into tasks within a team to work toward a larger goal. Motivation, such as intellectual curiosity, is necessary to produce results as a team, so I want to value this. Accordingly, I tell team members that it is interesting when I find something is interesting from the bottom of my heart. In fact, our job is really interesting. Whether you are experimenting, thinking about new ideas, or discussing

experimental results, I think it's important to share things you truly interested in while moving forward. I work with a good team that acknowledges other members genuinely regardless of age or position.

By the way, when I was a new employee, the research laboratory to which I was assigned had a development center, and I imagined that everyone there would create something useful for society through practical research. Therefore, I wanted to start with creating ideas and launch new technologies useful to society. I thought that desire was the way to be a researcher, and I'm still taking on that challenge. However, it is difficult to define "useful" research. At one point, I thought that R&D that yielded results in a short period was more useful. In reality, research targeting a distant-future society does not mean that it is useless in regard to today's society. For example, the Nobel Laureate Shuji Nakamura's research on blue light emitting diodes (LEDs) and blue lasers is a result of extremely practical research. The development of blue LEDs made it possible to double the storage capacity of a disk and create white LED lights, thus it is practical research but a tremendous long-term challenge. It's easy to think something becomes more useful as it becomes reachable in the short term, but I realize that this is not always the case.

—What do you value when you work?

Do you know about Amara's law? That is, the impact of new technologies is often overestimated in the short term and underestimated in the long term. Various new technologies are studied extensively in the short term as technology trends, but bold predictions in the long term tend to be avoided. However, if we look at the span of 10 or 20 years, many things have changed much more than expected. When creating the roadmap for FSAN, I heard about this law from a fellow German researcher. I thought it was important at that time, but as I got to work, its importance really sank in. As I mentioned earlier, I once thought that short-term considerations would be more useful, but now I don't. It's fun to imagine how the world will change from a long-term perspective, so I try to enjoy researching without underestimating the impact of various technologies. In fact, I've been doing R&D for more than 20 years, and the most fun part has been envisioning a future world. I want to talk to various people. In the case of research, although it is important to think for yourself, talking with people can be very stimulating. Either in our laboratories or on the global stage, you can get inspiration from people with different values.

Whatever you get yourself involved with will eventually be meaningful

—Please say a word to young researchers.

Everyone has an edge in a good way and wants to do something. I want you to extend that ambition as much as possible. Do whatever you are interested in. A famous speech by Steve Jobs is called "Connecting The Dots." While at university, he became interested in calligraphy, which led to a variety of fonts on Mac PCs. He said "You can't connect the dots looking forward; you can only connect them looking backwards." I think it applies to our research, and in my case, my interest in optics and the Internet has led to current research in a similar manner. It's a shame to stop researching on your interests just because it doesn't immediately lead to results. I think that some things could lead to results later, so I'd like you to try various things even if they are unrelated to the current research.

Stand on the global stage. Researchers and engineers around the world are purely amazing, and many people have completely different approaches to thinking, so the range of stimulation is very large. There might be a language barrier, but we have technology in common. It is difficult, but I think this barrier can be overcome by a common language, that is technology.

—How will you proceed in the future?

The Science and Technology Basic Plan by the Japanese Government shows the future of Japan. That future society is called "Society 5.0." Put simply, it is a fusion of cyber space and physical space. Artificial intelligence and virtual reality are thought to be the major players to make this a reality. It is also very important that information be transmitted smoothly by optical communication on an infrastructure that supports them. Although optical communication is behind the scenes in terms of technology that supports the infrastructure, I think it is a crucial technology that will help society by accelerating the evolution of information and communication technology (ICT) services. I'd like to continue to take the challenge of developing advanced technologies of optical access.

Part of my desire is to help the world in a supporting

role, but another part is driven purely by intellectual curiosity. NTT has announced the Innovative Optical and Wireless Network (IOWN) as a future vision of an optical-based network and information-processing platform. To make this vision a reality, our team will take on the challenge of creating a new world and new ways of networking, and we hope to create a new ICT world around 2030.

■ **Interviewee profile**
Jun-ichi Kani
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He received a B.E., M.E., and Ph.D. in applied physics from Waseda University, Tokyo, in 1994, 1996, and 2005. He joined NTT Optical Network Systems Laboratories in 1996, where he researched optical multiplexing and transmission technologies. He has been with NTT Access Network Service Systems Laboratories since 2003, where he is engaged in R&D of optical communications systems for metropolitan and access network applications and currently heads the Access Systems Technology Group. He has been participating in ITU-T and the FSAN initiative since 2003.