CTO Message

Going beyond "testing" with leading-edge technology

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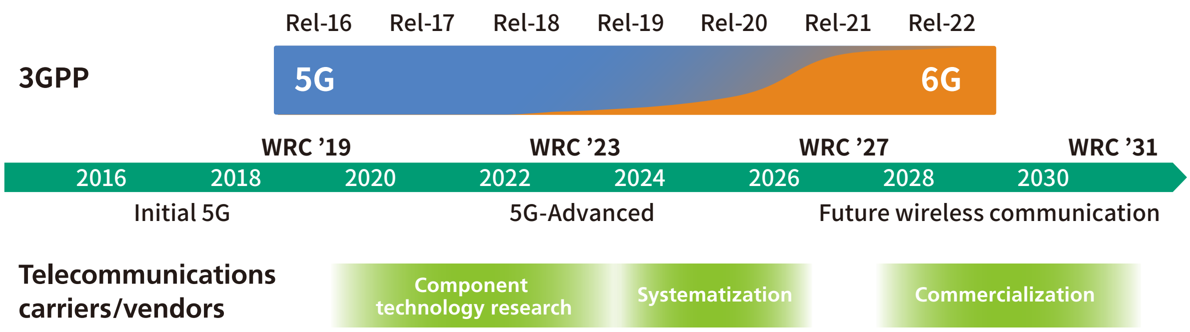
Expectations for 6G

Relevant parties have been discussing 6G since 2018 and companies at the vanguard are already pushing forward research on the fundamental technologies of 6G. 6G aims to take the role not only as the base of telecommunications but as the foundation of the social system, by enhancing 5G and targeting tenfold performance of its three pillars: high-speed/high-capacity, massive simultaneous connection and ultra-low latency.

In addition there are new features aimed for 6G such as;
(1) the "extreme coverage extension" that expands the radio connectivity into the sky, sea, and space,
(2) the "ultra-low power consumption" that significantly reduces the electric power consumption for which demand is expected to increase due to ever-increasing data volume,
(3) the "ultra-high reliability" that ensures the quality of services in various use cases as well as security and privacy protection,
(4) the "autonomy" where equipment are autonomously interacting therefore the networks are optimized according to the needs.

While 5G worked for technological innovation between wired and wireless communications networks, 6G widens the applicable scope and comes to include on-network processing and control functions of information from terminals and sensors, with goals of delivering the end-to-end performance. For example, reducing latency is one of these goals. With such application, sensors and cameras act like our eyes within factories, and acquired data through them are processed in the computer over the network. In order to send responses to factory equipment, it is impera-

Illustration of Transitioning from 5G to 6G Following 3GPP Standards



WRC: World Radiocommunication Conference
*Source: created by Anritsu using publicly available information

In order for Anritsu to be a company that continues to support society 10 to 20 years and beyond in the future, we believe that it is necessary to drive the advancement of "testing" technology and expansion of applicable fields, while also expanding into further fields beyond "testing". The first step in that journey was establishing the Advanced Research Laboratory in 2020, then commencing research activities at that facility. The Laboratory conducts research into 6G technology expected to be commercialized around 2028. At the same time, the Laboratory also carries out basic research looking further into the future as we strive to address challenges for making NEMS technology viable. Through these activities, we are providing technological support for the future of Anritsu's business, while working on test and measurement, ensuring safety and security of food and pharmaceutical products, as well as acquisition of sensing technology that is expected to deliver value beyond our current focus on "testing."

tive to minimize overall latency of the communication cycle from data acquisition to sending instructions to equipment. 6G aims to complete the role that 5G originally aimed for, that is to become the social infrastructure.

At the same time, the IOWN Global Forum* has been established with the objective of sophisticating optical technology-based social infrastructure.

The aim of the Forum includes the realization of new communication platforms through innovative approaches based around optical technology. Therefore, the aim of both IOWN Global Forum and 6G towards the future are well aligned. To that extent, Anritsu has recognized the necessity to carefully watch the situation of both and decided to participate in IOWN Global Forum since 2020.

*IOWN Global Forum: The Innovative Optical and Wireless Network Global Forum, established in 2019
The Forum covers three core technologies: full photonic networks (which adopt photonics-based technologies for all areas reaching networks and devices), what is called "cognitive foundation" (a concept for using information and AI to predict the future and build autonomously optimized networks), and digital twin computing (which uses computers and AI technology to take the information of our physical world and perform computations on it in a virtual (cyber) environment in order to predict the future, provide feedback to the physical world, and intimately connect the two domains).

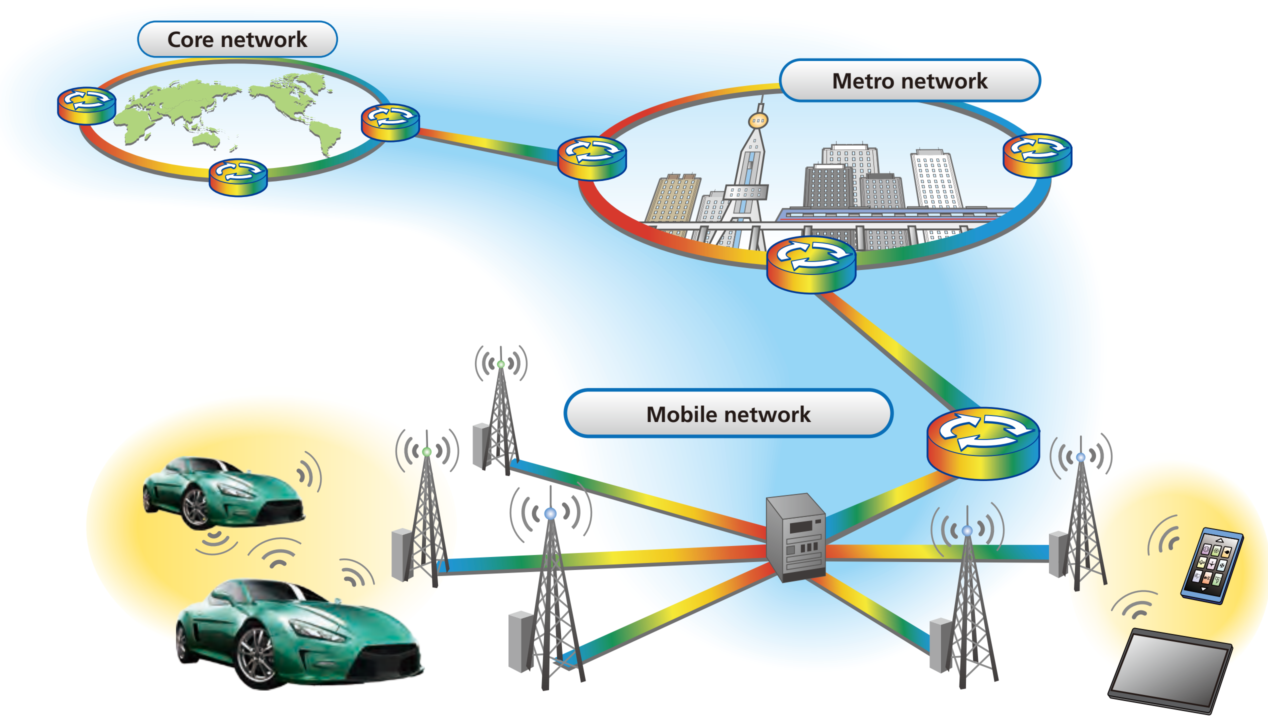
Leading-Edge Technology Research Initiatives for 6G

At the Advanced Research Laboratory, we are engaging in R&D on two measurement technologies needed for 6G.

(1) R&D on 300GHz Band Wireless Signal Wideband/ High-Sensitivity Measuring Technology

Anritsu's 6G initiative was prompted by the Ministry of Internal Affairs and Communications' research and development for expansion of radio wave resources in 2014 the "300GHz band wireless signal wideband/high-sensitivity measuring technology."

Illustration of a Full-Photonic Network



When the research first began, there were not yet ideas of frequencies being used for 6G, but in the four years during which research progressed, the possibility gradually increased that frequencies above 100GHz would be used.

Terahertz waves (generally 100GHz–3THz) fall in the frequency band between radio waves and visible light and had not conventionally been used. However, with the current progress in radio wave and light wave device technologies, as well as the fusion of those technologies, expectations are rising for the use of this frequency band. In 2020, our Laboratory started on core component R&D necessary for developing new measuring instruments for the 300GHz band.

Even with the 28GHz band that is being newly adopted for 5G, it was said that the signals could not reach far distances, so the level of difficulty rises even further when trying to communicate at 300GHz. Many similar challenges accompany the development of measuring instruments, which the Laboratory is striving to tackle.

(2) R&D to further advance 5G mobile communication systems

Prompted by the Ministry of Internal Affairs and Communications' expansion of radio wave resources in 2019, "R&D to further advance 5G mobile communication systems," Anritsu is working on the establishment of radio interference monitoring techniques relevant to full-duplex communications for highly efficient frequency utilization.

In 4G systems, a method called FDD (Frequency Division Duplex) is used, which employs different carrier frequencies for uplink and downlink signals. When these types of multiple signals with different frequencies were propagated in the air, it had been easy to separate each signal by focusing on their different frequencies. However, 5G adopted TDD (Time Division Duplex) (Figure 1) that shares the same frequencies for uplink and downlink between terminals and a 5G base station. Consequently, it became difficult to separate multiple signals of the same frequency moving between many terminals and one base station. In reality, when the base station is interacting with two or more terminals, it is only possible to send data from the base station or from one terminal at the same time so that the communication per terminal becomes less efficient.

Full-duplex is an approach that was developed as a technological solution to this issue. Basically, full-duplex (Figure 2) allows simultaneous sending and receiving from each base station and terminal so that the efficiency of frequency usage doubles.

Meanwhile, when the base station and terminal are simultaneously sending and receiving, it becomes necessary to ensure that the transmitted signal is isolated so that it does not interfere its own receiver. For FDD using different frequencies for uplink and downlink, you can easily pick up desired signals on the specific target frequency using a relatively small component called a filter. In other words, you can block the unnecessary signals at certain frequencies from its own receiver. However, with the full-duplex method using the same frequencies, the filter solution does not work (signal separation is not possible). Therefore, it is not practical to introduce simultaneous sending and receiving with the terminals as eliminating self-interference requires complex and large sized signal processing that results in higher cost and terminal size becoming larger. In fact, we are progressing our research by implementing signal processing to eliminate self interference only with the base station so that a base station communicates with two terminals with the scheme, when one is receiving the signal, the other sends the signal in order to improve communication efficiency. (Figure 3)

Illustration of the New Communications Method

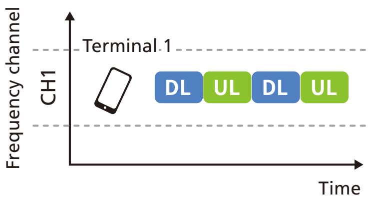


Figure 1: Current approach (TDD cellular)

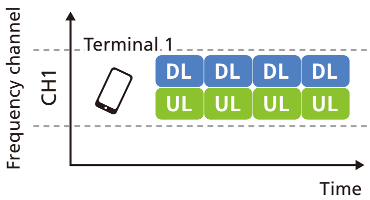
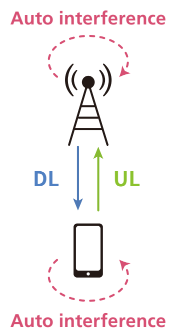


Figure 2: Full-Duplex cellular



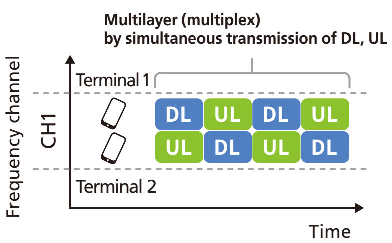


Figure 3: Objective (Full-Duplex cellular)

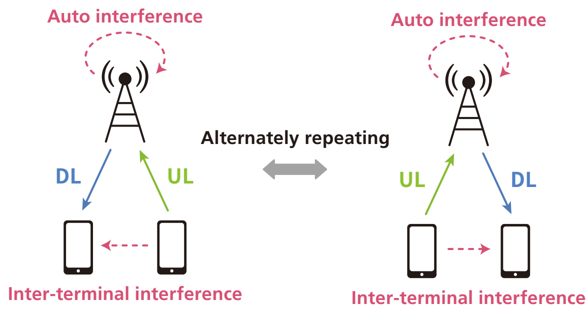
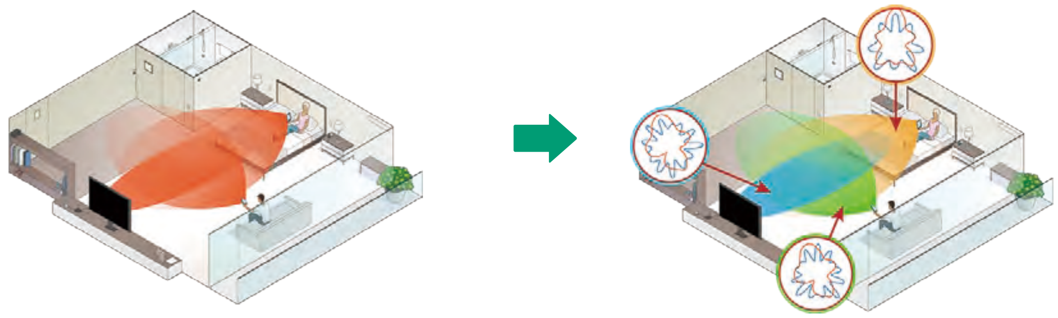


Illustration of Radio Frequency Interference Monitoring

Conventional technology
Only able to measure spatial power distribution

Proposed technology
Able to measure, for example, interference between terminals through signal division



With this method, when multiple terminals are within the distance where the signal of one reaches another, the radio wave signal from the base station is mixed with the radio waves from the second terminal so that communication quality may be degraded. It then becomes necessary to know ahead of time the status of signals from the other terminals in order to determine whether the full-duplex approach can be used.

The radio frequency interference monitoring technology that Anritsu is tackling for this research project enables the user to understand the status of signals from each terminal by using AI to separate and visualize signals that arrive on the same frequency. With this technology, even if signals from the base station or multiple terminals are mixed, each can be separated by their transmission sources and the user can identify the direction where the signal comes from and its power.

Open Activities to Go Beyond "testing"

Research at the Advanced Research Laboratory are conducted with highly diverse members. For our NEMS research, we invited an expert in this field from an university and we have opened a new laboratory as well. The team members are individuals with various backgrounds, including those with professional experiences, one who was involved in research overseas, an expert in specialized equipment, a physical measurement specialist, and a micro-fabrication specialist. Also, the 6G research team is comprised of members with specialties in physics, optics, chemistry, signal processing, and various other fields. Team members with this level of diversity can offer input from each of their speciality perspectives, thereby helping make discussions on each research theme more dynamic. Additionally, when pursuing research, an open approach is used in order to quickly reach objectives not insisting on domestic approaches. We first identify target technology areas to tackle internally and proceed with R&D, while also welcoming in external knowledge through joint projects with university research laboratories and independent research institutions.

We provide a forum for discussions, mainly centering on technology, in order to internally share the knowledge from these research activities. We also receive feedback from business divisions on applications of the technology, and we engage in human resource exchanges. Both optical and microwave technologies are Anritsu's core competencies and we are called upon to foster them and utilize them in business. As part of research programs on microwaves, the Advanced Research Laboratory is working on core components for millimeter waves. This effort has been progressed under close cooperation with our Test & Measurement Company and Sensing & Devices Company.

Additionally, once we enter a 6G world, communications devices are expected to be placed at a density of 1,000 devices per square kilometer, with various types of sensors working with each of these devices. For example, there is a light detection technology called LiDAR that emits laser light and calculates distances based on the time it takes for the light to return after reflecting off objects. LiDAR is expected to have applications for self-driving vehicles that need to recognize pedestrians and other objects. It is also the technology used in the iPhone 12's autofocus feature in dark environments.

To date, Anritsu's optical technology has mainly been used in businesses in the field of optical communications, including test and measurement equipment and optical communication devices. Going forward, we will leverage our strength in compound semiconductor technology and push R&D for optical sensing technology targeting wider uses also in fields other than communications.

Although there are some differences in terms of timeline and viewpoints between future-oriented fundamental research conducted by the Advanced Research Laboratory and business-oriented development effort, discussion should impart positive stimulation to both. Going forward, we will continue to engage in internal debate and exert our full effort to contribute to the future of Anritsu.