Anritsu Advancing beyond

[Interview with CTO]

Anritsu's Contributions to Cutting-Edge Technologies Expected in Next-Generation 6G

As 5G continues to become commonplace in wireless communication networks, 6G is increasingly gaining more attention, the next-generation communication standard. In addition to further enhancing the High-speed, Large-capacity, and Low-latency features of 5G, 6G has the potential to bring innovation to a variety of fields by enabling Ultra-low power consumption, Autonomy, and Scalability.

In this interview, under the theme of the future telecommunications market with 6G, Hanako Noda, CTO and General Manager of Advanced Technology Research Laboratory, discusses the possibilities of 6G technological innovation, the technologies that are attracting attention, and their future prospects about the future telecommunications market with 6G.

Anritsu Corporation
CTO and General Manager of Advanced Technology Research Laboratory

Hanako Noda

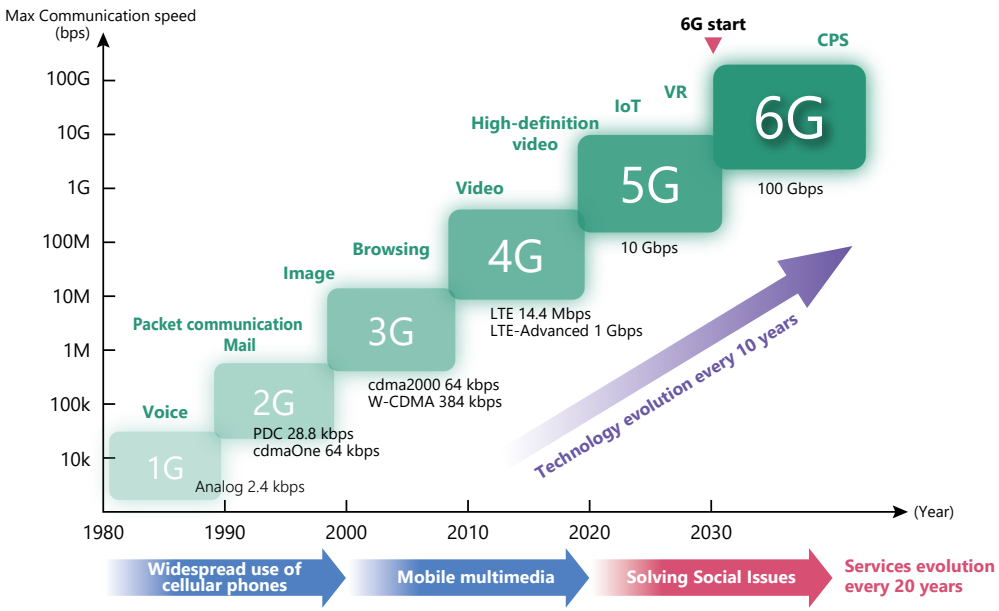
6G Cyber-Physical Systems to Solve Many Social Issues

—— How will 6G change the future?

Noda: Since the introduction of the first mobile phones in the 1980s, mobile communications technology has evolved into new-generation methods every decade. Looking at this from the perspective of service, it is clear that we have undergone significant changes over a cycle time of about 20 years.

First, in the 1G and 2G eras, mobile phones were widely used for voice calls. With the advent of 3G and 4G, photos and videos could be viewed anywhere as mobile multimedia. In the 5G era, that is, after 2020, 5G will contribute to solving social problems by being part of an important social infrastructure, providing solutions such as tele-operation, tele-medicine, and smarter industry to social problems such as the declining birthrate, aging population, and labor shortage.

In the coming 6G era, against a backdrop of the spread of big data and AI, "Predicting the Future" and "Discovering New Knowledge" will become a reality as AI replicates the real world as a "Digital Twin" in cyberspace, enabling simulations that go beyond the limitations of the physical world. We believe that the results of these efforts will be fed back into the real world to realize a "Cyber-Physical System" that can solve many social problems and create new value.

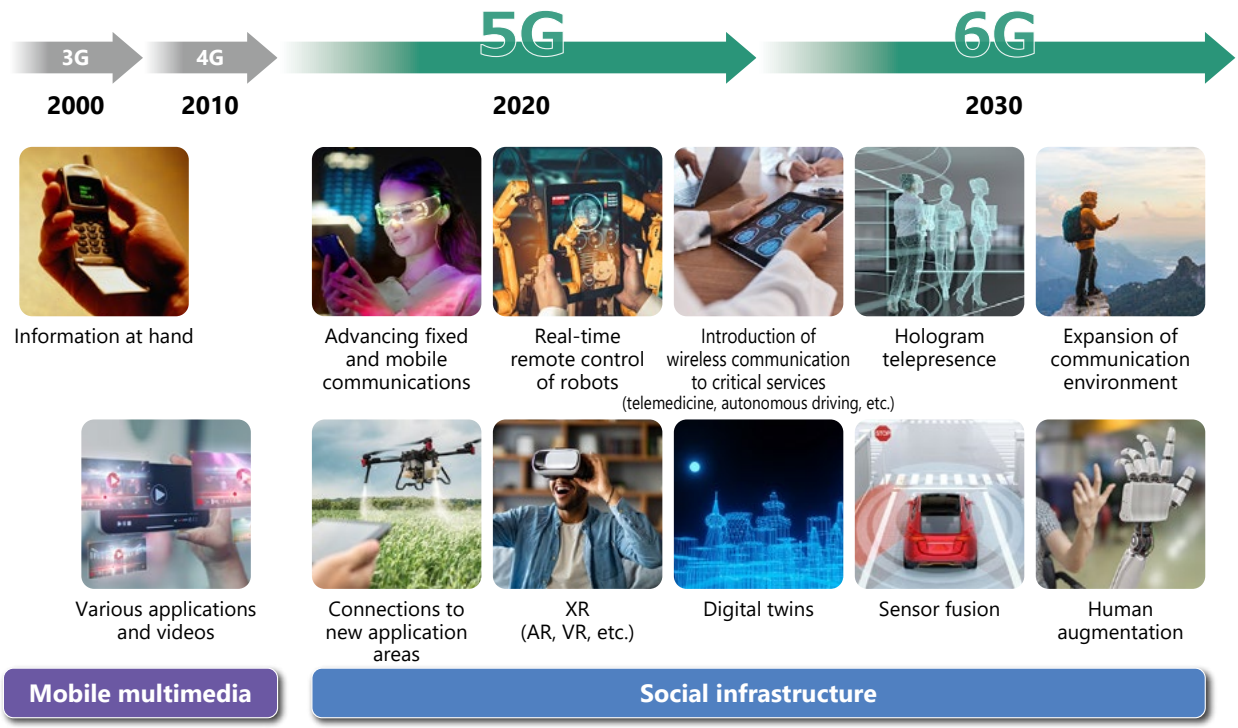


—— Please explain the world that 6G will make possible with a concrete example.

Noda: When I joined Anritsu, when we were designing hardware, we actually obtained components, assembled circuits on printed circuit boards, experimented and evaluated them, and verified their performance at the actual device level. Now, however, when designing a circuit, it is possible to input information on the circuit, component data and materials and simulate them to check and optimize performance before the actual product is manufactured. In the same way, we believe that the world will expand to a point where information from the real world will be captured and analyzed in cyberspace, so that predictions can be made based on that data.

In the area of human-to-human communication, it will be possible to have discussions in cyberspace with robots that perfectly mimic human thoughts, actions, and experiences through wearable devices or microdevices attached to the human body, which will then be fed back into real space in the form of future predictions.

What all the above have in common is a worldview in which data from the physical space where we live today is absorbed into cyberspace through sensors and communications, and real space is reproduced in cyberspace, making it possible to simulate future predictions. With 6G, everything will connect to the network even more than before, and by linking with AI, solutions to social issues will be realized in a variety of fields. We believe that advanced 6G technology will be used in areas such as smart cities, connected cars, smart factories, and tele-medicine to create a more convenient and comfortable society.



6G's New Technology to Achieve Both "Advancement of 5G" and "Realization of a Sustainable Society"

—— What are some of the key 6G technologies that will pave the way to that future?

Noda: First of all, the "Further advancement of 5G" includes "Ultra-high speed and Large capacity", "Ultra-massive simultaneous connectivity", and "Ultra-low latency". These are all breakthrough innovations, cumulatively making 6G 10 times more advanced than 5G.

New functional enhancements are also expected from 6G that will allow the "Achievement of sustainable society". When upgrading 5G, the demand for power related to data communications is expected to increase significantly as the number of data centers and network equipment increases due to the development of AI. To avoid this situation, "Ultra-low power consumption" is being considered by making the communication network an all-optical network.

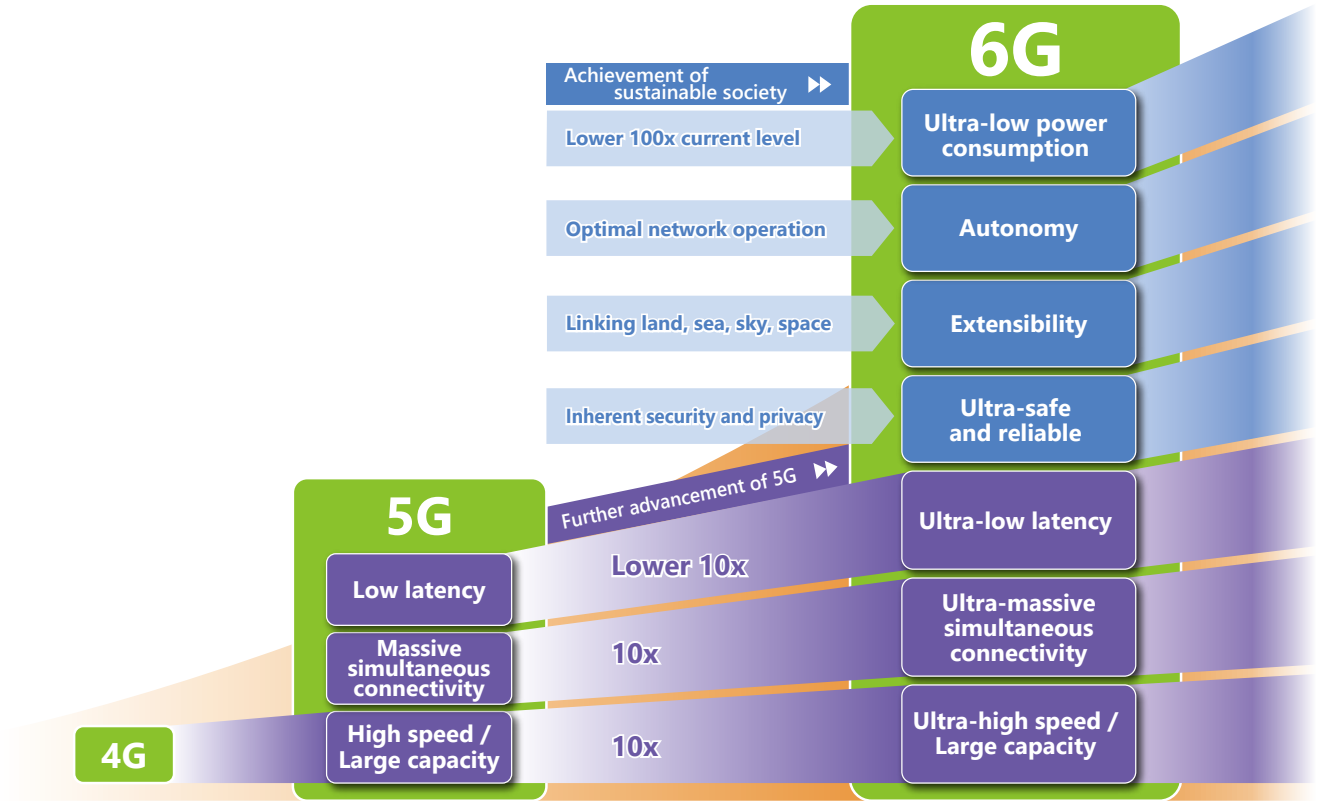
In addition, the current control of telecommunication networks is mostly top-down. This should be made more efficient by having a network configuration with distributed base stations and terminals that work together to provide "Autonomy".

Furthermore, the radio waves emitted by today's base stations are used specifically for ground-based communications. In the future, the situation is expected to be "Extensibility" in coverage so that communication will be possible anywhere at sea, in the air, and in space. For example, to enable logistics

by drones, technology is needed to continuously control those drones and their paths through 5G and 6G communications to prevent collisions.

For 6G, where an extremely large amount of data will be collected and processed, it is an absolute requirement that privacy and security be ensured, and "Ultra-safe and reliable" are also important for the communications infrastructure.

Among the elemental technologies required for 6G, Anritsu is paying particular attention to the millimeter wave and terahertz technologies for Ultra-high speed and Large capacity, the Ultra-low latency technology, and the introduction of AI technology to support network virtualization, as well as all-optical networks for Ultra-low power consumption.



The Technologies Attracting Attention are Millimeter Wave and Terahertz as well as Improved Network Efficiency Through the Introduction of AI.

—— Which of these technologies is of particular interest to CTO Noda, and what are the technical challenges?

Noda: My own focus is on "Millimeter wave and Terahertz" and "The Introduction of AI."

First, millimeter wave and terahertz are important because we believe that among the various means of increasing speed and capacity, the use of a wide bandwidth is the most efficient. In the frequency band called the terahertz band, that is, above 100 GHz, many frequencies are still unused, allowing for a continuous wide bandwidth.

Millimeter wave and terahertz are easily absorbed by water vapor and oxygen molecules, resulting in a high propagation loss and limiting the communication distance. In addition, because of the problem of being easily blocked by obstacles such as buildings and walls, it is necessary to install repeaters and reflectors, while technologies such as Reconfigurable Intelligent Surface (RIS), which controls the direction of reflection, are also being researched and developed.

Measurement instruments compatible with millimeter wave and terahertz technologies are difficult to realize using commercially available components, so the technical hurdles are high, including the need for the in-house development of components.

Naturally, the performance of the measurement instrument must exceed the performance of a customer's product. In addition, the instrument must be delivered in time to satisfy the customer's development schedule. Based on these considerations, Anritsu has responded to the millimeter wave and terahertz technologies at an early stage of market demand by combining its accumulated technologies related to measurement instruments.

—— AI is used in a variety of fields, but how will it relate to telecommunications in the 6G era?

Noda: The "Introduction of AI" is important in the 6G era because we believe it will make telecommunications networks much more efficient.

As I mentioned earlier, in traditional telecommunications networks, service operation is primarily top-down. For example, even if a base station had fewer users or connections due to changes in the environment or in certain time slot, it does not have the authority to adjust its service operations. However, by more closely monitoring radio wave conditions and analyzing them with AI, base stations will be able to perform advanced communication control and operate autonomously. The autonomous cooperation between base stations and terminals is expected to increase the efficiency of communication networks.

Anritsu has long utilized AI to improve the detection accuracy of inspection equipment, control temperature and humidity in factories, and improve manufacturing inspection processes. We believe that research and development must continue to catch up with the speed of AI evolution.

Slightly off topic, but Anritsu's test and measurement instruments are contributing to the evolution of AI. AI is a large-scale deep learning model generated by multiple servers working together, but this collaboration requires high-speed communication. Anritsu's measurement instruments are used to speed up and ensure the quality of this communication, and we are proud to be able to contribute to the evolution of generative AI.

Further Advancement of Anritsu's Technological Advantages Such as Channel Sounding in Dynamic Environments

—— What other 6G technologies do you think Anritsu can contribute technologically?

Noda: 6G is expected to open up new application areas beyond conventional wireless communications by integrating new functions. One of these is Integrated Sensing and Communication (ISAC), which uses communication waves for sensing and efficiently realizes both. A key technology for achieving this is called "Channel Sounding".

Channel sounding is a method of measuring and analyzing the propagation characteristics of radio waves, and until 5G, it has been used to calculate the conditions required to establish communication. Propagation characteristics are properties that indicate how radio waves travel through a space and how they change as they propagate. For example, the propagation characteristics vary with frequency, such as susceptibility to absorption by water vapor and oxygen molecules, reflectivity, and directivity. The materials of any obstacles in the communication path also cause differences in the propagation characteristics. The propagation characteristics of a tree will change from summer to winter depending on the moisture content of the tree. Therefore, it is necessary to check the radio propagation characteristics of the frequency bands used in 6G before actually using the radio waves. Anritsu's channel sounding technology evaluates such radio propagation conditions in a broadband and dynamic environment, and we believe that this technology can make a particular valuable contribution in the millimeter wave and terahertz era.

—— How will Anritsu's accumulated measurement technology be utilized in the 6G era?

Noda: Millimeter wave and terahertz signals are extremely difficult to handle, so when designing test and measurement instruments, developing the components in-house is necessary. The devices required for communication and measurement instrument in this frequency band are expensive because the technology is still evolving and the demand is not large. In recent years, advances in semiconductor and other technologies have enabled devices to operate at higher frequencies, but further technological innovation is needed to allow practical application. High-performance signal processing technology is also required to support high-frequency operation and wide-bandwidth signals. In these areas, we will be able to leverage Anritsu's superiority in measurement technology.

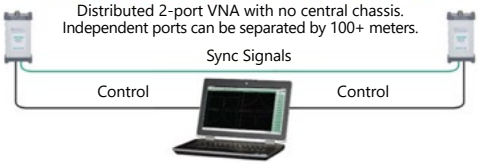
The ISAC technology is also expected to be able to detect the shape, position and movement of objects with high precision by sharing wireless signals for information communication with sensing.

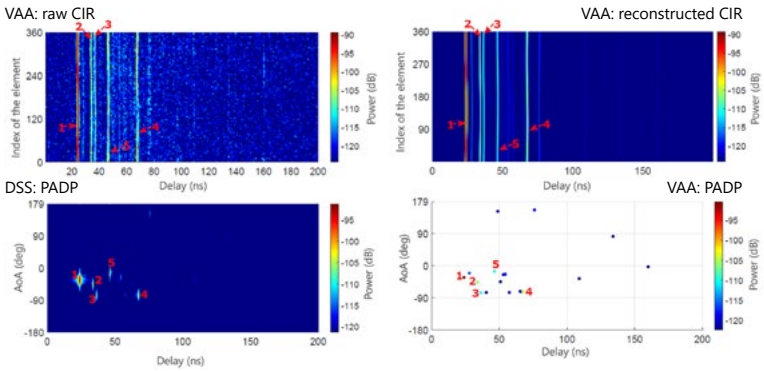
ISAC technology has advanced to the point where it can detect the presence of people in a space and feel their heartbeats. In addition, the time when it will be able to understand people's gestures and even their emotions may come. Utilizing simulation is an efficient way to eliminate radio dead zones, which need to be considered because signal propagation varies depending on the materials present in a space. I believe that "Cyber-Physical System" will likely be built in combination with ISAC to improve the accuracy of simulations.

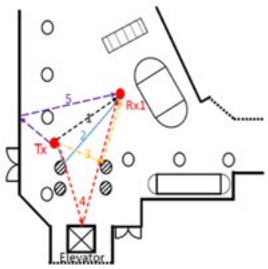
Anritsu's Technology Initiatives to Advance Measurement Technology in Response to the 6G Era

—— Can you tell us a little about Anritsu's specific initiatives toward 6G?

Noda: Here are three examples. First, in collaboration with Aalborg University in Denmark, we had been working on the evaluation of channel soundings for the realization of ISAC. By combining the latest measurement capabilities provided by Anritsu's Vector Network Analyzer (VNA) with Aalborg University's antenna measurement system technology, we have developed new technologies for channel sounding and wireless channel sensing in the 6G frequency band. As an example of real-world problem solving, one customer used the system to observe the propagation of radio waves in a factory with many metal shields and production equipment. Anritsu's unique modular VNAs are connected via optical fiber cable, making it possible to observe propagation conditions over distances of 100 meters or more while moving.

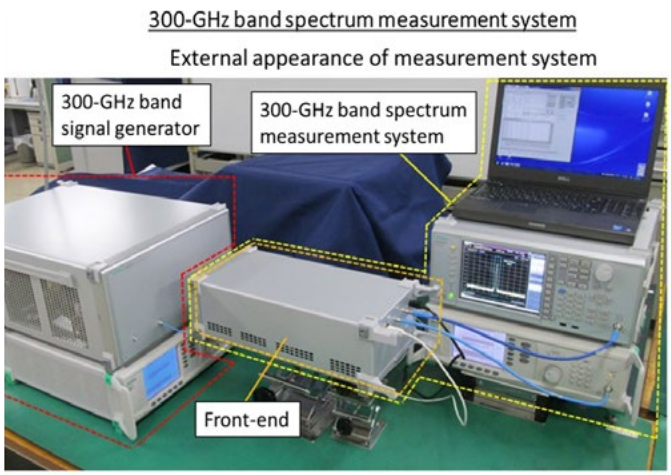






Beyond5G/6G: Channel Sounding

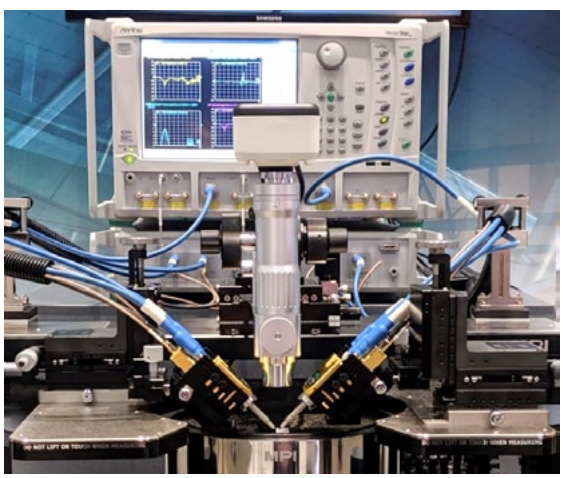
The second is the development of measurement technologies for high-frequency bands. As an initiative for spectrum measurement in the sub-terahertz band above 100 GHz, Anritsu has been developing a spectrum evaluation system for frequencies above 100 GHz since around 2010 as part of research and development for the expansion of radio resources by the Ministry of Internal Affairs and Communications.



300-GHz Spectrum Measurement System

The entire system is designed to operate with low noise and low distortion, enabling highly accurate measurements.

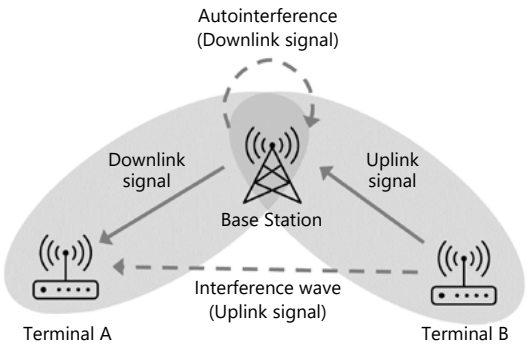
We also offer the broadband model of Vector Network Analyzer ME7838 series to meet the measurement needs of the sub-terahertz band. It offers an unprecedented broadband measurement range of 70 kHz-220 GHz in a single sweep. In preparation for 6G, the system is adopted for materials measurement, circuit evaluation, and component evaluation.



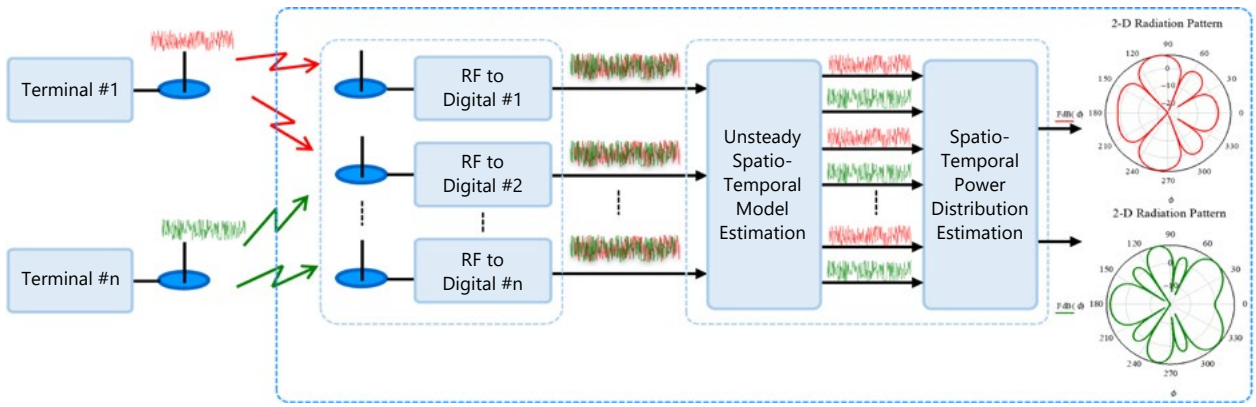
Vector Network Analyzer ME7838 series

The third is the realization of radio interference monitoring for the establishment of full-duplex technology. In-band full-duplex (IBFD), in which multiple communications are performed simultaneously at the same frequency, is under study and investigation as a technology for improving the frequency utilization efficiency required for the 6G era. In the case of existing time-division duplexing (TDD) systems, a single frequency band is used by multiple terminals in a time-division manner, so that the transmission capacity per frequency band is shared by multiple terminals. The in-band full-duplex communication method allows the use of one frequency band by two radio links, theoretically doubling the total transmission capacity.

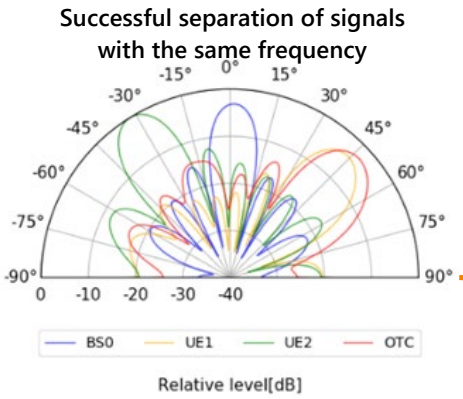
To achieve this, we need to accurately understand the surrounding communication environment so that signals from each terminal do not interfere with each other. Anritsu has developed a technology that uses independent component analysis, a type of AI, to separate mixed OFDM signals arriving from multiple signal sources and identify information such as the strength and direction of arrival of each signal at each location.



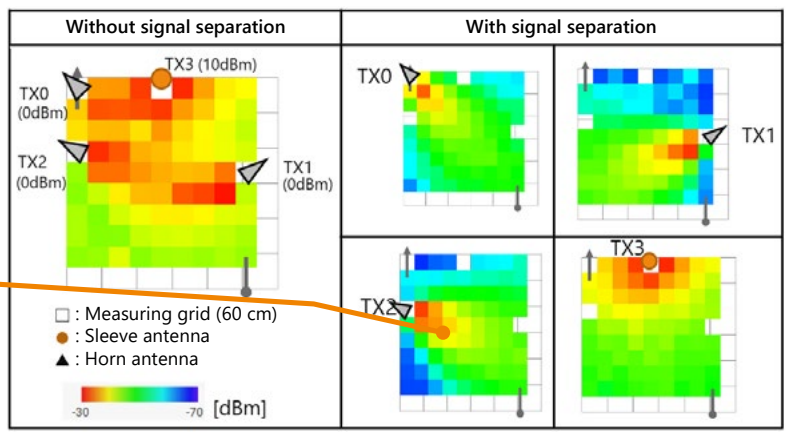
Full-Duplex works to improve frequency effective efficiency



Radio Wave Interference Monitoring: Technology to determine whether Full-Duplex is possible (= presence or absence of interference)



Angular spectrum waveform example of central part



Offering Wide Range of Test and Measurement Instruments Covers the Entire Network, Anritsu's Role in the 6G Era will Be Significant.

—— What role will Anritsu play in the realization of 6G in the future?

Noda: Many of our customers are in the preparation phase to be ready around 2030, when 6G will be commercialized. We believe that Anritsu's role is to provide the products and solutions they need.

To study 6G communication and sensing systems, it is necessary to be able to test and evaluate the radio propagation characteristics. Not only supporting data acquisition, but we provide customers who develop equipment with necessary solutions, including equipment evaluation and the evaluation of the materials used to produce the equipment.

As the 6G standard is further developed, it will also be necessary to support the measurement of signal quality and communication protocols for mobile phones and base stations. Anritsu has been providing solutions for the evaluation of mobile phones and base stations, and we believe that, in the future, Anritsu will provide AI-implemented measurement systems and solutions for evaluating AI-embedded network devices.

—— Finally, what are your expectations for the coming 6G era?

Noda: Personally, I have great expectations for the introduction of the millimeter wave and terahertz to mobile phone technology. Mobile phones are an indispensable part of daily life. The introduction of these technologies will create economies of scale and eliminate cost issues. As a result, millimeter wave and terahertz technologies will spread to other areas, making 6G more accessible and easier to use.

The second is the expected realization of an all-photonics network, where photonics-based technology is introduced into everything from the networks to terminals to achieve the ultra-low power consumption I previously mentioned. To achieve ultra-low latency, not only the wireless communication part but the network as a whole must have low latency. For example, to achieve hazard avoidance in automated driving, the entire process from the camera detecting a person or obstacle to the activation of the brakes must be done with ultra-low latency.

Considering this, I believe that Anritsu has a very important role to play, as it has a wide range of test and measurement technologies, from wired to wireless, and can contribute to ensuring the quality of the overall network.

6G is not just an evolution of communication technology, it has the power to transform society as a whole. 6G will be an essential element in the creation of a smarter and more efficient society. We believe that in the future, "Ubiquitous Communication" will be realized, where the communication infrastructure will support our lives in an invisible way. Anritsu will continue to innovate to realize this future.