# CTO Message

## Anritsu Supporting Evolving 5G Moves to Beyond5G

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**In Japan there has been cooperation between industry, government, and academia in preparation for 5G implementation; using the Tokyo Olympics as the place for its debut. Compared to LTE, 5G promises not only higher communication speeds, but also world-changing innovations. Through measurement technology, Anritsu will support 5G and at the same time we have started preparations for Beyond5G (6G), the next generation to come.**

## Our Changing Environment

How will our world change in the next 20 years? Among megatrends, Anritsu's focus is on demographic changes, the rise of the middle class, and rapid advances in technology. First, regarding demographics, the population is expected to increase by roughly 2.5 billion, mainly in Asia, Africa and the Middle East, while it will decline in advanced countries, where the ratio of aged people will rapidly become larger and a decline in the working population is expected to be a serious problem. The automation of manufacturing is inevitable to supplement the workforce and reduce manufacturing costs. In addition, there is a growing need for self-driving cars as a means of transport for the elderly, especially in areas where transport networks are not well developed. 5G technology is essential for the development of both factory automation and self-driving. Meanwhile, in areas where the population is expanding, the middle-class population will grow, and various new products and services will be created. As the middle class expands, there will be increasing demand in terms of both the quantity and quality of personal consumption. We believe that demand for food inspection will increase further, due to individualized ordering of food and food safety needs. In addition, rapid technological advancements, especially in artificial intelligence (AI), have a high potential for technological disruption in the next decade. It is easy to foresee rapid progress making great changes to our lives in the near future. AI is already being used in a wide variety of fields, making our lives more convenient, and even coming up with better jokes than comedians.

## 5G Changing Lives, Changing the World

5G usage scenarios include ultra-high speed, large capacity communication (eMBB: Enhanced Mobile Broadband), ultra-reliable and low latency communication (URLLC), and massive simultaneous connection communication (mMTC: massive Machine Type Communication). In 3GPP Release 15, which was finalized in 2018, the specification for ultra-high speed, large capacity communication was determined for mobile applications. Advance rollouts of commercial services started in the US and South Korea in December 2018, with the provision of services scheduled to begin in other countries around the world. The specifications for ultra-reliable and low latency communication and multiple simultaneous connection will be determined from Release 16 in March 2020 onwards, with the deployment of commercial services expected from around 2021. Among these, ultra-high reliable and low latency communication promises a digital revolution that will bring significant change to the world.

Ultra-high-speed, large capacity communication relies on the realization of broadband communication and the use of millimeter-wave bands. Use of millimeter waves, such as the 28 GHz band presents the advantage that its frequencies are not as densely allocated as in the legacy 3 GHz frequency bands and below. As a result, wider bands can be allocated, easily realizing large capacity communication. On the other hand, there is the problem of increased propagation loss in space (so-called "free space propagation losses").

## A "safe, secure, and prosperous society" realized by 5G/IoT

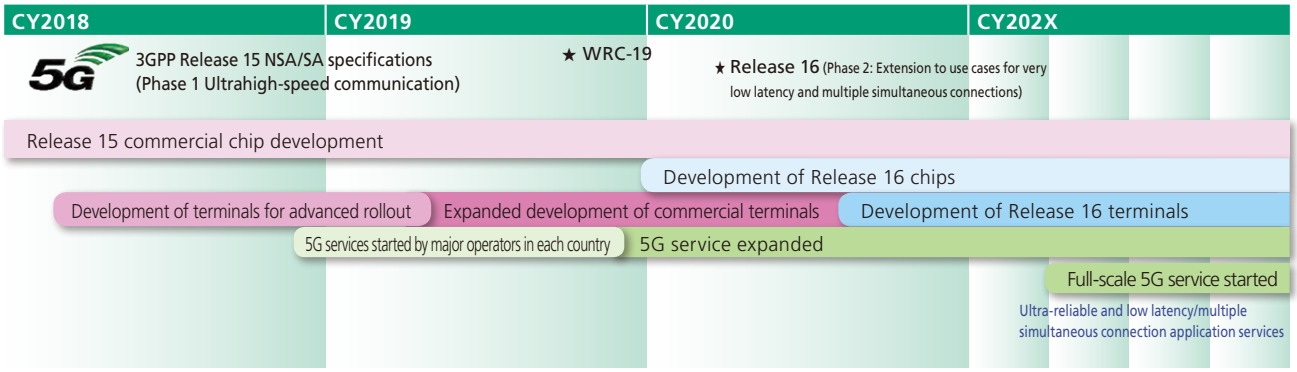

**Ultrahigh-speed**
Speed
**Download: 20Gbps**
**Upload: 10Gbps**
Downloading a two-hour film in three seconds

**Very low latency**
Latency
**1 ms**
Precise operation of remote robots in real time

**Multiple simultaneous connections**
Number of simultaneous connections
**One million devices per km²**
All devices and sensors around you are connected to the network

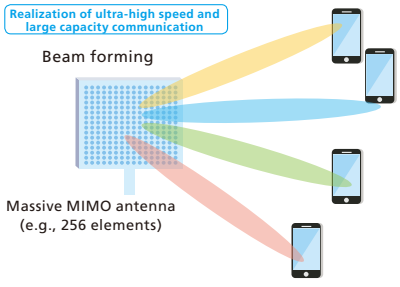
2019 → 202X

## 5G service roadmap




Since the loss is proportional to the square of the frequency, the loss at 30 GHz, for example, increases by 100-fold, compared to that at 3 GHz. As a technology to compensate for increased propagation losses in space, Massive MIMO antennas have been introduced as base station antennas for millimeter wave bands. As shown in the diagram on the right, by simultaneously emitting radio waves from each element of a Massive MIMO antenna composed of 16×16 (256) elements toward a single user to form a beam, a high reception power level can be achieved by the user. Massive MIMO antennas can also form beams for multiple users, and simultaneously perform large-capacity communication with multiple users. If this were realized, at the Olympic games, every spectator at the stadium would be able to wear AR glasses and enjoy watching the events from a freely select-

**Massive MIMO antenna**

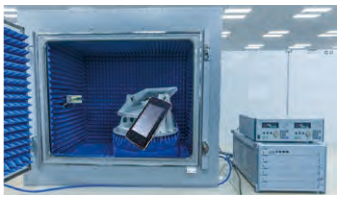



ed viewpoint. A beam forming mechanism is required not only at the base station, but also at the mobile terminal side. When testing mobile terminals up to 4G, mobile terminals and measuring instruments were connected by cables. However, for 5G, especially millimeter waves, it is now necessary to perform testing without cables, but with

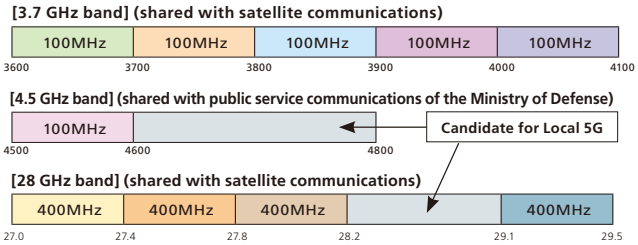
### Conventional measurement and OTA measurement

~ 4G: Conventional measurement

5G: OTA measurement



### Frequencies allocated to 5G

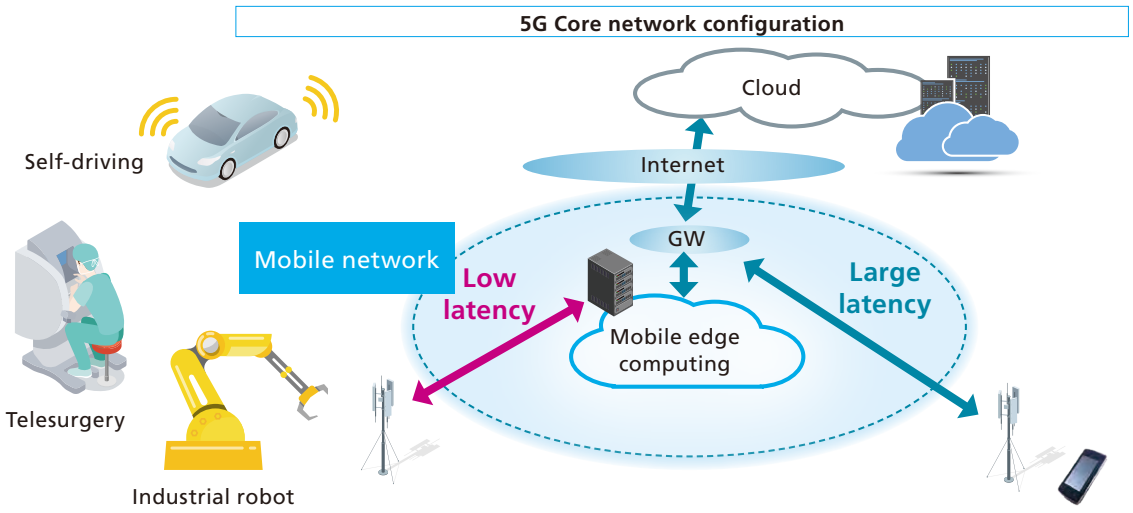



antennas, as a so-called "OTA (Over The Air) testing." OTA testing of high-frequency millimeter waves requires very advanced technology. By harnessing our many years of experience in developing technologies for antennas and antenna testing, Anritsu has developed a mobile phone evaluation system that supports OTA testing.

For ultra-reliable and low latency communication, 3GPP has stipulated technical conditions of "a transmission success rate of 99.999% or higher for a data packet size of 32 bytes or more, and a latency of 1 millisecond (1 ms) or less in each wireless section." Although 1 ms is the latency in a wireless section, in actual use, it is necessary to include processing delays in wired sections, on the Internet, and in application servers. As one example, for usage cases like self-driving and remote control of construction equipment, the latency must be kept to lower than human reaction speed. The time taken for humans to react (i.e., the time between detection of a danger and the initiation of brake operation) is usually regarded to be roughly 200 to 300 ms. It is therefore necessary to limit all of the above-mentioned delays, from the wireless sections to the processing speed of an application server, to less than this value. To achieve low latency, it is necessary to upgrade the core network as well as any wireless sections. To accomplish this, processing systems, so-called "edge devices," must be deployed immediately behind base stations.

Furthermore, "Local 5G" is also attracting attention as a new 5G application. Local 5G is an arrangement in which a regular business is assigned a frequency in a limited area, and is allowed to use 5G as a private network. In addition to the normal features of 5G, local 5G is highly promising, because its area can be designed for high security and in accordance with the user's needs. Promising applications of local 5G include factory automation, the handling of personal information including large-capacity data such as CT images at medical sites, remote control of construction machinery, and real-time video distribution at stadiums and other locations. In Japan, plans are underway to allocate a bandwidth of 200 MHz in the 4.5 GHz band, and a bandwidth of 900 MHz in the 28 GHz band to local 5G. Similar developments are expected in Germany, with its Industry 4.0 strategy, where local 5G will be used in smart factories, etc.

### Mobile edge computing for ultra-reliable and low latency communication



## Toward Beyond5G

5G will continue to evolve, and research and development into Beyond5G has already begun aiming for implementation in 2030, which is 10 years from now. Although there is no clear definition of Beyond5G, the effective use of frequencies has been a perennial issue for wireless communication, and it is believed that research in this area will continue even for Beyond5G. Based on how communication has evolved thus far, it is natural to expect further increases in communication capacity. This is because transmitted video will become a 3D distribution due to the spread of xR (the general term for VR: virtual reality, AR: augmented reality, and MR: mixed reality), and the communication capacity will increase for all types of devices, including unmanned aircraft such as drones and self-driving systems. The frequency range of millimeter and smaller waves enables large-capacity communication, which facilitates use for high-capacity communications, such as Beyond5G. The higher the frequency, the shorter the wavelength and the higher the resolution, and for this reason, utilization of the millimeter band is progressing in various industrial fields, such as imaging and inspection for contaminants. In March 2019, the Federal Communications Commission (FCC) established a new rule to license 95 GHz to 3 THz for 10 years for experimental use, as long as there is no interference with space research or atmospheric observations. This is very encouraging for the practical application of millimeter and terahertz waves. On the other hand, the higher the frequency, the greater the losses within communication devices and along propagation paths. Since greater miniaturization is also required, there are technical difficulties that accompany the use of high frequencies. Anritsu has developed measurement technology in anticipation of the use of millimeter waves. Going forward, we will continue to study technologies related to the use of millimeter and terahertz waves for sensing. We will also promote research and development related to Beyond5G, which we began working on in 2019.

In addition, AI technology is approaching the peak of its third boom, and many AI tools are available. In the future, as 5G evolves, edge computing will be introduced to reduce latency for self-driving, VR, and AR, and AI technology will be introduced into edge devices. As one example, at a smart factory, there are hopes for AI to detect abnormalities and predict failures, as well as visualizing processes by edge processing of huge amounts of data, such as data from acceleration sensors worn by workers, temperature/humidity/vibration sensors, and test data. By combining edge processing with image processing, a specialty of AI technology, Anritsu is working to improve contaminant detection during food inspections. In the future, we hope to provide intelligent and highly sensitive measurement and inspection solutions that combine 5G and AI technologies. We will strive to develop sensing technologies that support "measuring" and data analysis technologies such as AI to make "measuring" smarter, and by uniting these technologies, contribute to the realization of a safe, secure, and abundant society.

**Future uses of millimeter, terahertz, and optical waves**