

# LPWA solutions

Cellular & non-cellular technology

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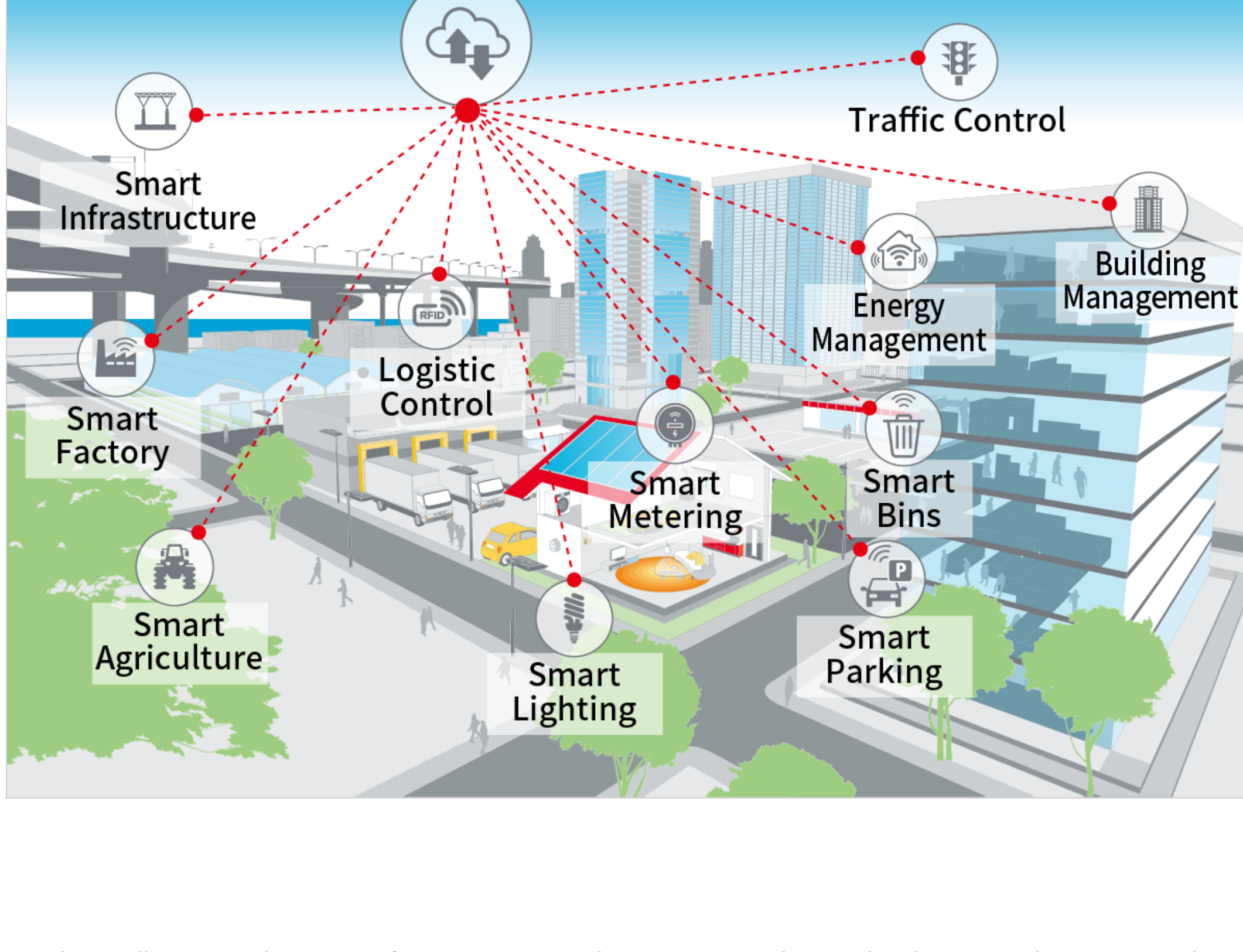
## Ultra-Compact, Low-Power-Consumption Cellular LPWA Modules, Enabling All Kinds of Internet Connections

### Demand for IoT Devices That Can Collect Data over a Wider Range

We want to build a society that runs smoothly and efficiently based on data; one where people live thriving and healthy lives through data and where data is fully utilized for running valuable businesses. Companies and governments around the world are working to build and use new information systems to make this a near future reality. Together with people, goods, and money, the data that we generate every day in business and in our daily lives has become one of the management resources that drive our lives, business, and society.

Recently, the Internet of Things (IoT), which connects all types of things to the Internet, has made it possible to collect not only data generated in the virtual world, but also data generated in various locations in the real world in great detail. There are already examples of IoT devices equipped with sensors and communication functions installed in various locations on factory production lines, in offices, and in homes to help predict failures and improve production efficiency by understanding the status of equipment and facilities in operation.

However, compared to data collection within a specific area of 20 to 30 square meters, such as inside a factory, there were challenges in collecting data from a wide area of several square kilometers, which is required for automatic meter reading for smart meters and monitoring of social infrastructure such as roads and bridge supports. This is because there was no wireless communication technology suitable for use in IoT devices that could be used to wirelessly connect over long distances.



For data collection within a specific area, existing short-range wireless technologies, such as Wi-Fi and Bluetooth®, can be used for PCs and other information devices. Small, low-powered communication modules incorporating these wireless technologies are readily available, making it relatively easy to create compact IoT devices. On the other hand, the above-mentioned IoT devices could not be used to collect data over a wide area, and so the only available choice was to use mobile communication technology for mobile phones, which consumes large amounts of power. However, because it is assumed that the devices will be used in places where frequent recharging is not possible, large-capacity batteries are required to provide sufficient power for practical usage, resulting in larger device sizes.

## Cellular LPWA -- Extremely Easy to Use for Wireless Communications for IoT Devices

Commercial services for cellular LPWA (Low Power Wide Area), a wide area wireless communication technology for IoT devices, began in 2018 to open up potential uses for IoT devices that had been left out due to lack of an appropriate wireless technology.

Cellular LPWA is based on LTE, a communication method for smartphones and other devices that features wide area coverage, and is designed to dramatically reduce power consumption by reducing the data transfer rate and frequency of communication. These low data transfer rates do not allow for the transfer of video data. However, the transfer rates are fast enough to transmit data on vibrations for assessing how old a road is, the temperature of a paddy field, which is essential for managing the growth of rice, and the locations of share cycles. In fact, the low power consumption provides a noticeable improvement in convenience, such as by enabling many years of use on batteries.

Cellular LPWA has the potential to expand the use of IoT devices, but there are hurdles to be cleared in order to accelerate their adoption. Like Wi-Fi and Bluetooth®, an ultra-compact, low-power wireless communication module that can be embedded and installed in any device or location is needed. Murata Manufacturing Co., Ltd. ("Murata" below) has developed one of the world's smallest cellular LPWA modules by applying its technology and expertise gained through the development of many wireless communication modules. At the same time, we collaborate with providers and chip manufacturers to develop and provide modules that ensure reliable connectivity to the Internet without the need for user specialized knowledge of wireless communications.

## Murata's Cellular LPWA Modules Drive Development of Valuable IoT Devices

The value of IoT devices is enhanced by their ability to be used in environments where data cannot be easily retrieved. For this reason, it is extremely important to develop IoT devices having a compact housing that can be installed anywhere and where the number of required battery changes and recharges are minimized. Murata develops and provides high-quality, ultra-compact, low-power-consumption cellular LPWA modules that meet these requirements. We asked the engineers involved in the development of cellular LPWA modules about the usage scenarios they envisioned for cellular LPWA modules during development, as well as the strengths of Murata's modules and their actions in the product development process.



From left to right: Fujiwara (Manager), Hyogo (Manager), Kawanaka (Business Development), and Oh (Business Development)






## Realization of Long-Distance Wireless Communication for IoT Utilizing Existing Mobile Phone Base Stations

--What are the potential applications of cellular LPWA as a means of transferring data collected by IoT devices to the cloud?

First, I would like to talk about LPWA's positioning in the market. Up to now, IoT devices have had to use mobile phone service for applications that required data transfers over long distances, such as over 1 km. However, due to the high cost and high power consumption, this means of communication was not feasible for all applications. LPWA is a wireless communication technology that was created to solve these issues.

There are two types of LPWA: cellular LPWA, which uses mobile phone base stations, and non-cellular LPWA, which mainly uses its own access points (Table 1). Of these, cellular LPWA has the advantage of being able to easily deploy a global network by using the communication networks of major telecommunications carriers. It also offers a wider coverage area than non-cellular, as well as greater communication stability and security. This makes it suitable for smart cities, logistics systems, and cross-country data collection.

Table 1. Types of LPWA

	Cellular LPWA		Non-cellular LPWA		LTE (Reference)
					
Frequency Band	Licensed band		Unlicensed band		Licensed band
Communication Range	10 km or more				5km
Data Transfer Rate	1Mb/s	<150kb/s	<10kb/s	100b/s	5Mb/s
Transmission Power	+23dBm	+23dBm	+20dBm*	+20dBm*	+23dBm
Battery Life	10 years or longer				-
Power Consumption	LOW		LOW		HIGH
Cost (at Deployment)	LOW		LOW		HIGH
Service Start Date	NOW				

\* +20 dBm is available in the U.S. only. EU and Asia use +14 dBm.

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There are two standards within cellular LPWA: LTE Cat. M1 (LTE-M) and NB-IoT. LTE Cat. M1 features excellent mobility and low latency, as well as a maximum data transfer rate of 1 Mbps (theoretical), which is the fastest among LPWA services. It is suitable for applications such as tracking, emergency equipment, and wearables. NB-IoT, on the other hand, features low cost, low power consumption, and large scale connectivity.

It is suitable for applications that handle a small amount of information, such as automatic meter reading for smart meters.

## Ultra-compact Size and Low Power Consumption That Is Second to None

--What features does Murata offer in its wireless communication modules for cellular LPWA?

Murata provides high-quality cellular LPWA modules that comply with national and regional radio laws and are carrier-certified. We offer modules that enable usage with peace of mind in all aspects of communication stability, reliability, security and mobility. Also, we are proud to be second to none when it comes to ultra-compact size and low power consumption.

--What benefits do the ultra-compact sizes of cellular LPWA modules bring to IoT devices?

Among our developed cellular LPWA modules, the Type 1SC, which is encapsulated in a resin package, features an ultra-compact size of 11.1 mm x 11.4 mm x 1.4 mm. Both the Cat. M1 and NB-IoT standards are supported in this single product, and the area ratio is less than half that of a typical compact module\*1.

When modules can be miniaturized to this level, they can be used in wristband wearable devices for health care and medical applications, tracking devices to ensure traceability in logistics, or embedded in share cycles to track movement.

\*1: Compared to the 18.0 mm x 16.0 mm x 2.0 mm LPWA module

--What are the technical hurdles in miniaturizing the module?

If it was simply a matter of mounting small components or drawing a fine wiring pattern, it would not be so difficult. However, the smaller the size of a wireless communication module, the more subtle differences in characteristics and blurring of patterns have a significant impact on the overall characteristics and performance of the entire module. Moreover, because cellular LPWA has higher output than Wi-Fi and Bluetooth®, it tends to be more challenging to tune for radio law compliance and carrier certification.

For more than a decade, Murata has been accumulating expertise in miniaturizing communication modules and developing cellular modules. There are many suppliers with experience in developing Wi-Fi modules, but I believe there are only a few manufacturers that have the expertise to miniaturize cellular modules.

## Lower Power Consumption for More Than 10 Years of Operation Without Battery Replacement

--So what benefits does the low power consumption of modules bring to IoT devices?

IoT devices are not always installed in places where the batteries can be changed and recharged frequently. In fact, IoT devices that can collect data from places where people cannot easily enter are even more valuable. Designing modules that consume less power will enable a longer battery life and easier operation of the IoT devices.

However, reducing power consumption while achieving the communication stability, reliability, security, and mobility required for IoT devices is not easy. Simple communication technologies can be used to implement lower power consumption, but the use of complex communication technologies is essential for providing high-quality modules. It is a challenge for us to find ways to design software and hardware to reduce power consumption.

--What types of technologies have been used to achieve low power consumption?

LTE Cat. M1 and NB-IoT have a technology to reduce power consumption called eDRX<sup>\*2</sup> or PSM<sup>\*3</sup>. Murata's cellular LPWA modules themselves are also designed with low power consumption in mind. The current consumption in standby mode can be reduced to Typ 3.5 µA, which enables 10 to 15 years of operation without battery replacement<sup>\*4</sup>.

\*2: eDRX is an abbreviation for extended Discontinuous Reception. This technology is designed to lower power consumption by reducing the number of times that signals will be received while in standby.

\*3: PSM is an abbreviation for Power Saving Mode. This technology reduces power consumption by receiving signals only during limited time slots.

\*4: Assumes that an application sends sensor data once a day

Moreover, the communication quality and power consumption during usage are not determined solely by the quality of the module alone. It is extremely important to tune the modules so that the entire system, including the communication infrastructure, runs smoothly. Working as partners in close collaboration with carriers that provide cellular LPWA connectivity services, Murata is jointly developing a communication platform that balances high communication quality and security levels with low power consumption at the system level.



# Reliable and Easy Connections Even for Customers Unfamiliar with Wireless Technology

--Murata has developed and supplied many wireless communication modules for mobile phones. What are the differences in developing modules for mobile phones and for IoT devices?

Just because a company is developing IoT devices, it does not mean that the company is an expert in wireless communications technology. This is probably the most significant difference.

Our customers who develop and produce mobile phones have many years of experience in making mobile phones. For this reason, they know how to handle high-frequency radio waves and what to keep in mind in order to make the device usable in a variety of locations. Moreover, because communication quality and reliability are directly related to the value of the device, they are investing enormous development resources in this area.

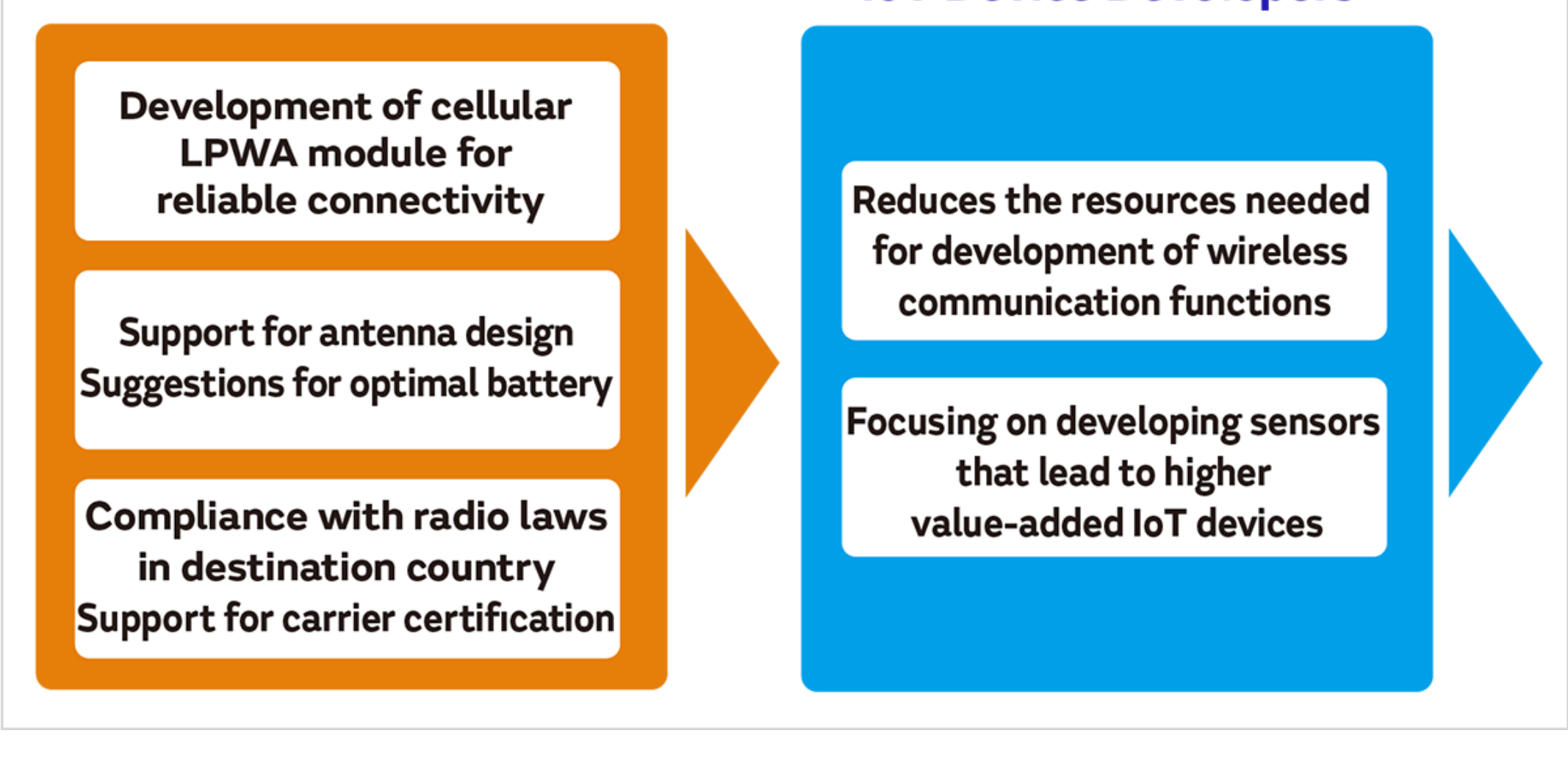
By contrast, many customers developing IoT devices are focusing on sensors and other data collection methods to develop the technology. For example, if you're a customer developing an IoT device for agriculture, you'll develop technology that focuses on where, how, and how often to detect the temperature of the field. Wireless technology to transfer the data is an essential feature. However, wireless technology is a challenging technology to provide differentiation, and they don't want to go into it in depth if possible. Many customers believe that the best thing to do is to obtain a reliable means of data transfer from an outside source. Some customers have tried to develop wireless functions in-house, but found it too difficult to do and came to us for help.

## Ensuring Reliable Connectivity by Creating a Module through Strategic Collaboration with Carriers

--The situation may be completely different for the same wireless device. What must you keep in mind when developing cellular LPWA modules for IoT devices?

Since we are experts in wireless communications, we believe it is important for us to make sure that our wireless communication modules are easy to use and can provide reliable connectivity for anyone. This reduces our customers' resources needed for development of IoT devices and allows them to allocate more resources to data collection, which is their primary focus\*1.

\*1: Our efforts to assist customers in developing IoT devices are not limited to module development. In addition to modules, Murata has many other products, and we can provide multifaceted assistance by supporting antenna design, simulating batteries, and suggesting batteries suitable for applications.



We have extensive experience in testing to verify the connectivity of wireless communication modules. For example, with Wi-Fi, which has been in use for many years, new communication standards have been introduced one after another, leading to complex usage situations where multiple specifications are used together in the market and resulting in a vast number of test items. At Murata, we have created our own evaluation items to enable effective and efficient verification. We also provide testing services to customers who have selected our modules for their products, many of whom have used our testing services in the development of 70 products and 10 million applied devices. We are applying this testing knowledge to the evaluation of cellular LPWA modules to further refine the software for developing modules with reliable connectivity.

It is also important to keep in mind that, even if the IoT device itself is highly complete, reliable connectivity is not possible without smooth integration with the system to be connected. In fact, many customers often hit roadblocks in the operational phase after completing their IoT devices.

We worked with carriers to develop the cellular LPWA module in a way that facilitates integration of the system with the module. For example, we have a strategic collaboration with SoftBank Corp. ("SoftBank" below) to optimize tuning and validation for SoftBank's IoT platform. This allows Murata's modules to be used on the SoftBank platform without any difficulties.

We work with these carriers and partners to ensure that advanced communications protocols that increase the quality and security level of communications are readily available. For example, a protocol called OMA LwM2M\*2 is often used in carrier-provided IoT services, and this can be pre-implemented in a module, allowing customers to easily connect to the carrier's IoT platform. The use of a technology called NIDD\*3 is sometimes required to enhance security functions, and software to utilize this technology is installed in the module after negotiations with carriers and partners. Similar cooperation is taking place with carriers around the world.

\*2: OMA LwM2M, Open Mobile Alliance Lightweight Machine to Machine, is a protocol for managing data communications and IoT devices that connect machines to each other.

\*3: NIDD, Non-IP Data Delivery. Because having an IP address makes you vulnerable to cyberattacks, this is a technology for transferring data without IP addressing.

## Assisting in Radio Law Compliance and Carrier Certification

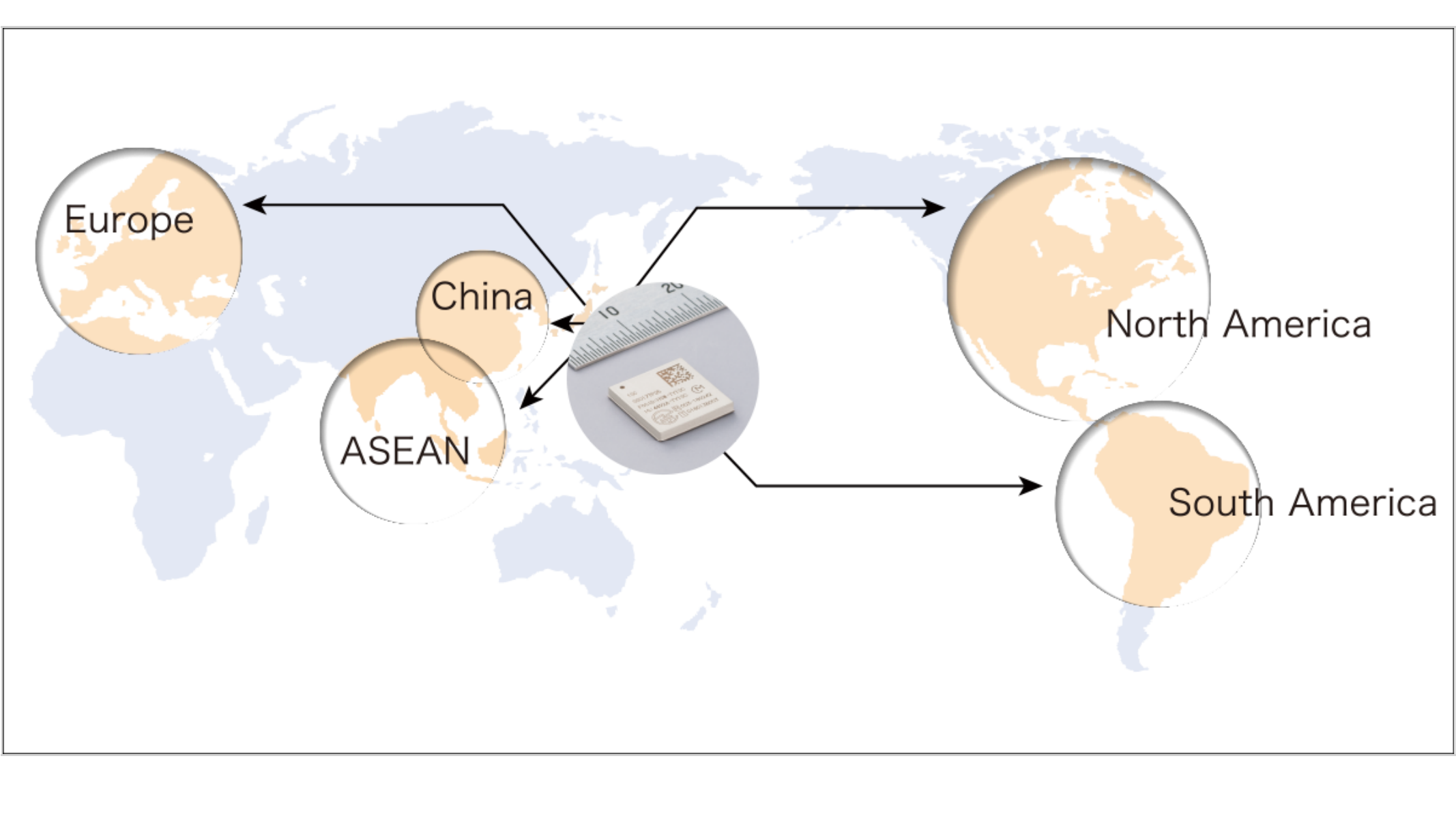
--Who is responsible for complying with national and regional radio laws and obtaining carrier certification?

We obtain certification at the module level if we can. 3GPP\*4 has standardized the high frequency standards used in cellular LPWA, and each carrier and other entities define evaluation items based on this standard. The content is basically the same as LTE, but there are some additional evaluation items specific to LPWA related to low power consumption. In the development of a module, it is essential to have an evaluation environment that reliably verifies the predetermined evaluation items. At Murata, we have invested so much in our evaluation facilities and equipment that we have a system in place to cover evaluation items that other companies cannot.

\*4: 3GPP- 3rd Generation Partnership Project. This organization is responsible for the standardization of mobile communication systems such as LTE and 5G for use around the world. Originally established for the purpose of developing specifications for wireless communications technology for third generation mobile phones, the group continues to develop standards for third-generation and later mobile phones.

However, there are many cases where certification cannot be obtained unless the module is installed in the applied device. In these types of cases, we can assist the customer in the development of their applied device by providing the data required for certification and helping them with pre-verification.

Although the frequency of the radio waves used by cellular LPWA varies by country and region, Murata has designed its modules so that the same modules can be used throughout the world. However, the device must comply with the radio laws of the country and region where the service will be used. Many of the IoT device manufacturers who are our customers do not have a business presence in the region where their products will be released, and so we provide technical support tailored to the region in cooperation with local carriers. Murata's global offices located in the United States, Europe, Asia, and other regions provide a clear-cut advantage to our customers.



## Industrial IoT Devices Must Have Long-term Reliability and Environmental Resistance

--Usually we tend to take for granted that communication devices like smartphones are connected to the Internet, but in reality, they are connected as a result of the efforts of many engineers.

In addition to ensuring reliable connectivity, there are other module-specific requirements for IoT devices that are different from those for mobile phones.

Generally, most consumers think that it is inevitable that consumer electronics will break after the warranty period has expired. Many people think that 5 years at the most, or at least 2 or 3 years of use is enough. In contrast, industrial IoT devices may require long-term reliability that lasts more than 10 years. In particular, because we are implementing low power consumption for our modules and we expect to use them for more than 10 years without battery replacement, it is important to ensure their long-term reliability. In the development of wireless communication modules such as Wi-Fi, we have conducted high-level reliability tests and built them for durability, even for consumer use. And so, these modules can also meet the reliability requirements for industrial applications.

Also, it is possible that IoT devices with cellular LPWA will be used outdoors and in harsh environments. For this reason, we conduct load tests that simulate use in harsh operating environments and repeat tests under various conditions, such as temperature, humidity, and impact, to confirm the reliability of our products for use in a broader range of situations. To provide water resistance, for instance, some applications may require more than just measures at the module level, and instead, measures may need to be implemented for the entire IoT device including the module. In such cases, Murata will provide its expertise to assist the customer with design.

## Cellular LPWA Applications Are Spreading Around the World and into Every Industry

--It looks like applications for cellular LPWA will continue to grow. What applications in particular do you expect to see growth going forward?

Considering the wide application compatibility of cellular LPWA, we believe that its use could expand beyond developed countries such as Japan, the U.S., and Europe to include developing countries such as Brazil, Mexico, and the Philippines. For example, smart agriculture, which monitors the conditions of large tracts of farmland and numerous grazing livestock, is one application that is likely to see widespread use.

In addition, we expect the strengths of our developed modules to be utilized for expanding the applications for wearable devices, where miniaturization is essential. There may be many different use cases in the fields of in-home medicine and health care. Customers have told us that Murata is the only choice for modules when it comes to using cellular LPWA for wearable devices.



## A Leader in Opening Up New IoT Usage Scenarios

Murata's cellular LPWA modules are at the forefront of the industry in opening up new uses for IoT because of their unrivaled ultra-compact design and low-power consumption. Their ease of use, which enables reliable connectivity to the Internet without the need for specialized knowledge of wireless technology, provides added support for application development. In fact, as a company that studies and deals with IoT applications every day, we have received many requests from various IoT-related application development projects. I believe that if Murata is able to reduce the cost of the 1 trillion sensors used around the world, we could spur innovation that will enable everything that was previously handled by local communication to be performed by wide area communication.



From left to right: Hyogo (Manager), Fujiwara (Manager), Oh (Business Development), and Kawanaka (Business Development)

[View LPWA module article \(part 1 of 2\)](#)

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