RAPIDLY EXPANDING LPWA NETWORKS TO DRIVE IOT BUSINESS

Rieko Tsuji
Digital Innovation Dept.
Technology & Innovation Studies Div.
Mitsui & Co. Global Strategic Studies Institute

WHY LPWA NETWORKS WARRANT ATTENTION

LPWA Networks Can Be Communications Infrastructure in IoT Era

Smart meters, traffic tracking, environmental monitoring, and other services that can be realized by collecting data from Internet of things (IoT) devices and sending them to networks, are increasing. As a communication system to connect such IoT devices and networks, low-power-wide-area (LPWA) networks are drawing much attention. Until now, various wireless communication systems have been used/developed for IoT applications, including those using a mobile network operator's infrastructure (e.g., 3G, LTE), those provided by mobile virtual network operators (MVNOs), which lease wireless capacity from a mobile network provider, as well as Wi-Fi and Bluetooth. As IoT services using such communication systems increase, high power consumption and other problems have emerged. LPWA technologies are seen as a solution to these problems, as they offer wide-area coverage for low communication fees but at low data rates, which are not critical for IoT devices. Major features of LPWA networks are as follows.

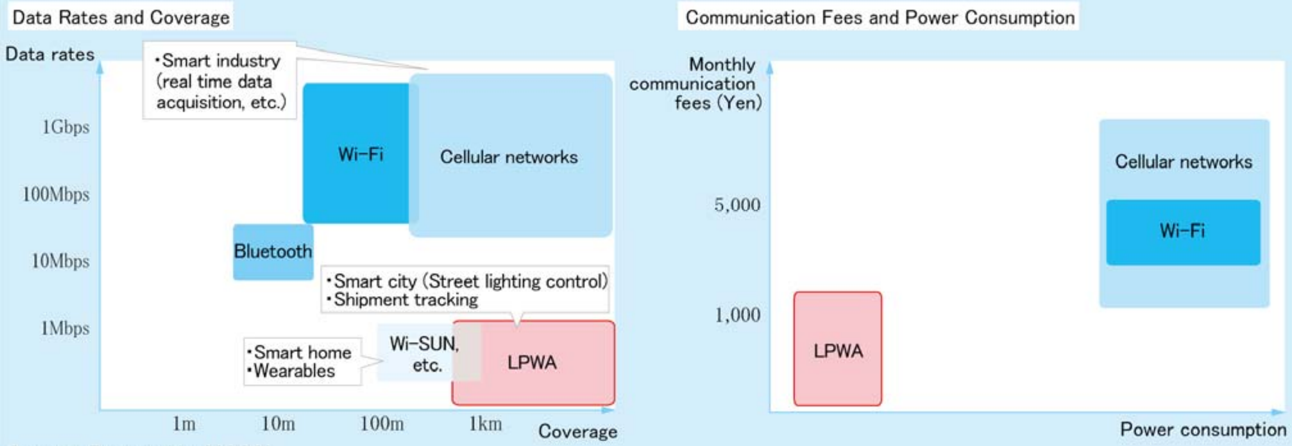
- Low power operation: Battery lifetime of several years with a coin cell battery
- Long range: One base station covers tens of kilometers
- Low data rates: Several dozen bps to 1M bps
- Low communication fees: Several dozen to several hundred yen per month (per connection)

These are nominal specifications, and the actual figures will vary depending on the communication environment. For example, the coverage area will be tens of kilometers on land without major obstacles, but may be limited to about one kilometer in an urban area with many high-rise buildings. Likewise, the power consumption will be affected by the speed and frequency of communications, leading to shorter/longer battery life. As such, the above specifications are not always achieved, due to the situation/structure of a building, the frequency of communications, and other factors.

LPWA Technologies Covered by This Report and Comparisons with Other Communication Systems

It is not clearly defined as to what which communication technologies are classified as LPWA, and not a few companies have developed and use their own technologies. Tokyo Electric Power Company (TEPCO) has adopted the Wi-SUN Alliance specification for its smart meters. In this system, the area covered by each base station is small, only one kilometer at the maximum, but its network coverage area is as large as that of LPWA thanks to multi-hop routing technology, which allows device-to-device communications. Win-SUN is, however, different from other LPWA technologies, as devices need to be located within a certain distance. For this reason, we will not look at Win-SUN in this report. It is important to note, however, that the market for Win-SUN overlaps with that for LPWA in some use cases. Chart 1 summarizes differences between LPWA and other communication systems. LPWA is different from other communication systems, particularly in that it does not focus on data rates. Cellular technologies are designed for high-speed and low-latency communications. Wi-Fi provides high-speed connection, but the coverage area is small.

Chart 1: LPWA and Other Communication Systems



Source: Prepared by MGSSI

2.4 Billion Devices To Be Connected via LPWA Networks in 2023

The LPWA-related market is projected to grow at a CAGR (compound annual growth rate) of 26% in the period between 2017 and 2023. It is estimated that 2.4 billion devices will be connected via LPWA networks in 2023 (Chart 2). According to IHS, revenue from services using LPWA networks will likely surge to nearly 1.0 billion dollars in 2021, showing strong growth potential. Particularly robust growth is expected in areas such as logistics and asset management, security and smart buildings, as well as infrastructure and environment monitoring.

Chart 2: Global Forecast of LPWA Connected Devices

	2017	2023	CAGR
Wide-area IoT	0.6	2.4	26%
Short-range IoT	6.4	17.4	18%
PC/laptop/tablet	1.6	1.7	0%
Mobile phones	7.5	8.8	3%
Fixed phones	1.4	1.3	0%
	17.5 billion	31.6 billion	

Note: Wide-area IoT in the above chart corresponds to devices connected via LPWA networks.
Source: Ericsson Mobility Report 2017

CURRENT STATE OF LPWA

Comparisons of Major LPWA Technologies

LPWA technologies are broadly divided into two groups: (1) cellular-based technologies based on existing LTE communication standards and (2) non-cellular-based technologies. The former can be provided only by mobile network operators which own a mobile spectrum license from a government or regulatory entity in each country, such as AT&T and Verizon in the US. As such operators utilize existing facilities for mobile phones, they can easily offer a nationwide network and secure stability and reliability in communications. However, device prices tend to be high due to the complexity of the specifications. Meanwhile, the latter basically uses spectrum that does not require a spectrum license, and operators who have not been engaged in the telecommunications business can provide LPWA networks. It is also possible for such operators to establish a network on their own by deploying base stations, etc., for their proprietary services. Non-cellular technologies are largely simple, and device prices are generally low. As for communication fees, mobile network operators have offered plans for IoT applications at several hundred yen per month, while non-cellular LPWA network providers charge less than a hundred yen per month. However, such differences are narrowing, as KDDI and Softbank Group started to offer services using cellular-based LPWA technologies such as LTE-M and NB-IoT in 2018 and their rate plans are almost as affordable as non-cellulars'. LPWA technologies can also be divided into (1) in-house developed technologies for proprietary use and (2) open specifications used by several operators. The former includes Sigfox, Sony's LPWA, and RPMA, while the latter includes LTE-M, NB-IoT, LoRaWAN, and NB-Fi. Chart 3 shows specifications and other features of major LPWA technologies.

Chart 3: Comparison of Major LPWA Technologies

Category	Cellular		Non-Cellular				
License	Required		Not required				
Name of standards	LTE-M	NB-IoT	LoRaWAN	Sigfox	Sony's LPWA	RPMA	NB-Fi
Major players	Mobile network operators in each country (AT&T, Verizon, NTT Docomo, KDDI, Softbank, etc.)		LoRa Alliance member companies (more than 500 companies including Actility; mainly using Semtech's chips)	Sigfox (France) and one operator in each country (Kyocera in Japan) (Vendors include Texas Instruments, Silicon Labs, Axom, etc.)	Sony (Japan)	Ingenu (US)	NB-Fi alliance partner companies, including WAVIoT (Russia)
Data rates	**1Mbps**	**20-60Kbps**	**0.3-50Kbps**	100bps	80bps	**8Kbps**	100bps
Communication direction (Devices controllable in bidirectional communication)	Bidirectional		Bidirectional (downlink is optional)	Bidirectional	Only uplink	Bidirectional	Bidirectional
Mobility	**・Connectivity maintained when travelling across different base stations** ・Up to 50km/h	・Connectivity NOT maintained when travelling across different base stations ・Up to 20km/h	・Connectivity NOT maintained when travelling across different base stations (maintained with ver 1.1) ・Up to 40km/h	・Connectivity NOT maintained when travelling across different base stations ・Up to 20km/h	・Connectivity NOT maintained when travelling across different base stations **・Up to 100km/h**	—	—
Power consumption	High	Middle	Low	Low	Low	Low	Low
Communication module prices	About USD 5 -		About USD 1 -	About USD 1 -	—	About USD 5 -	About USD 2 -
Communication fees	Less than Y100 -		Less than Y100 -	**Less than Y10 -**	—	—	—

Source: Prepared by MGSSI based on each company's materials.

Provision and Utilization of LPWA Networks

LPWA network providers' business models can be divided into (1) those of nationwide network service providers and (2) those of network operators who provide services for specific customers.

In (1), operators establish nationwide LPWA networks like mobile networks and charge monthly usage fees. They need to operate on a large scale to secure profits as a network provider. It is also important to have capital strength and experience in network operations, as they also offer maintenance services. Mobile network operators in each country and Sigfox (services provided by Kyocera in Japan) have adopted such business models.

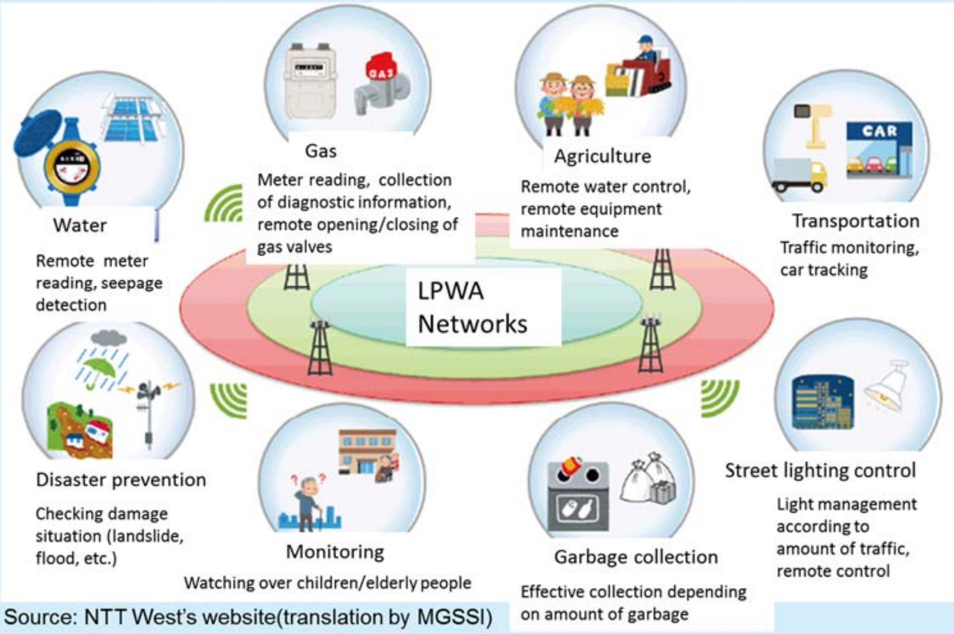
In (2), network operators cooperate with other companies and establish LPWA networks where they are needed. Sony and Ingenu have offered such services, but business models differ from company to company.

Network users will select the best LPWA network for each case, considering data rates, restrictions on frequency of communications, the necessity of bidirectional communication, mobility, and charging systems.

LPWA Technologies to Expand IoT Applications

The emergence of LPWA technologies has significantly lowered hurdles for IoT implementation. Conventional communication systems will be replaced with LPWA networks, and communications functions will be newly added to existing products/services, especially in areas where LPWA's features (such as low communication fees, low power consumption, wide coverage, and low data rates) can be exploited. Such areas include smart cities, monitoring of agricultural land, safety control of construction sites, and shipment tracking (Chart 4). In terms of smart cities, there are many government use cases, including street lighting control, optimization of garbage collection, and smart meters. Amsterdam, Antwerp, and Dublin have already started to use LPWA technologies in such areas.

Chart 4: IoT Services Facilitated by LPWA Networks



Source: NTT West's website(translation by MGSSI)

In the next section, we will look into possible LPWA use cases from the following three points.

(1) Communication fees

LPWA adoption will likely increase in business situations where it was previously difficult to add communication functions due to high costs, or in cases where such functions need to be added to a large number of devices. For example, restaurants may implement temperature monitoring systems for food, which collect data by sensors and issue an alarm when the temperature exceeds the specified figure. With other communication systems, communication fees could amount to several tens of thousands of yen per year and exceed losses from food disposal caused by inappropriate temperature control. For this reason, some restaurants have given up using such systems. However, LPWA will facilitate the implementation, as annual costs are reduced to several thousand yen.

(2) Power consumption

LPWA networks will be more widely used in places where frequent maintenance is necessary or in places that are hard to access. For example, LPWA can be used for early detection of natural disasters in dangerous places to visit (mountains with the risk of hazards, etc.). With other communication systems, it is necessary to change batteries once in several days or several months, but with LPWA, battery life will be extended to several years, and it is much easier to monitor remote areas.

(3) Range of base station

LPWA will be also used to track objects that move in a wide area. For example, it is possible to protect wildlife by putting a GPS tracker on animals in a national park or places with a vast site area, monitoring locations of such animals, and understanding their ecologies. In other communication systems, it is necessary to deploy many base stations, while in LPWA networks, one base station can cover a range of tens of kilometers.

FUTURE OUTLOOK OF LPWA

Segregation and Selection of LPWA Technologies

It is said that network operators can benefit from the economies of scale and that cellular-based LPWA network providers, which can offer nationwide services relatively easily, have an advantage. Meanwhile, non-cellular LPWA network providers started their services from the late 2000s, and have taken a lead in collaborating with partners and establishing an ecosystem, compared to cellular-based LPWA services that started in 2017. Another point to note is that the use of cellular-based LPWA networks is subject to network operators' service regulations, leading to restrictions on frequency, etc. On the other hand, some non-cellular LPWA providers operate their networks on their own at reasonable costs and enable more flexible communication. This will be another strong point for non-cellular LPWA. Going forward, we expect cellular-based networks to drive overall LPWA network expansion, but several optimal networks will likely remain for each use case.

Development of LPWA and Related Areas

Along with the wider use of LPWA technologies with low data rates, edge computing, used in combination with artificial intelligence (AI), is gaining attention. In LPWA networks, it is difficult to transmit large-size data including images due to low data rates and payload. By using AI, edge computing technology further reduces data size on the device side, extracts meaningful information, and transmits it to the cloud. In optimizing garbage collection, for example, images from surveillance cameras that monitor the amount of garbage are not sent directly to the cloud. Instead, they are analyzed on the device side and only the results of analysis (i.e., the amount of garbage) are sent via LPWA. As such, LPWA adoption will likely promote the use of edge computing.

As IoT communications increase, there are more challenges in designing devices. In IoT communications, the large device size is unfavorable due to the limitation of installation space and other factors. In order to achieve desired performance while keeping the device size small, it is essential to change designs for each type of devices by adjusting the position of an antenna, etc. If the number of IoT devices increases along with the wider use of LPWA, innovations in design technologies (e.g., autonomous design using AI) will be necessary.

INSIGHTS FOR NEW BUSINESS OPPORTUNITIES

LPWA will help generate new business opportunities in the following areas.

(1) Replacement of existing communication systems

As described above, communication fees are low in LPWA networks, as one base station covers tens of kilometers. At construction sites or quarries in remote areas, on-site monitoring is currently conducted via LAN cables laid at sites or satellite communications. LPWA networks can be used to obtain information from measurement equipment and send such data to the network, possibly replacing the existing communication systems.

(2) Enhancing value of products/services by adding communication functions

Thanks to low communication fees in LPWA networks, it is now possible to add communication functions to products of which prices are low. For example, if LPWA modules are attached to travellers' bags, bags are traceable if they go missing. Assuming that communication fees are about one hundred yen per year, such costs can be added to the price of a travellers bag without making useres aware of them (about 1,000 yen per bag). Going forward, communication functions will probably be added to objects that are moving (i.e., taking advantage of LPWA's wide area coverage), those that are distributed widely inside/outside the building (a wide area coverage), those in locations where people cannot enter easily (low power consumption), those that exist in quantity (low communication fees), or those of which prices are low (low communication fees).

LPWA networks make it easier to collect data from various objects, including those from which it was previously difficult to obtain such data due to costs, etc. With more options in IoT communications, communications functions are being added to an increasing number of objects, and new services are being created through the utilization of data collected. We expect more use cases in the future and developments on this front will warrant attention.