The Latest Technological Trends of 920MHz Specified Low Power Wireless Modules

White Paper

1. Introduction

Low Power Wide Area (LPWA), which as its name implies covers a wide area with low power consumption, is attracting increased attention as a wireless protocol for IoT. LPWA actually encompasses numerous methods, each with different advantages and drawbacks. In this article we will introduce the latest development trends of Wi-SUN, a promising protocol that is expected to see widespread use.

2. What is Wi-SUN?

Wi-SUN is short for Wireless Smart Utility Network, a communication protocol established in recent years by the Wi-SUN Alliance based on the IEEE802.15.4g standard.
Figure 1 shows how Wi-SUN compares with other communication standards for IoT.

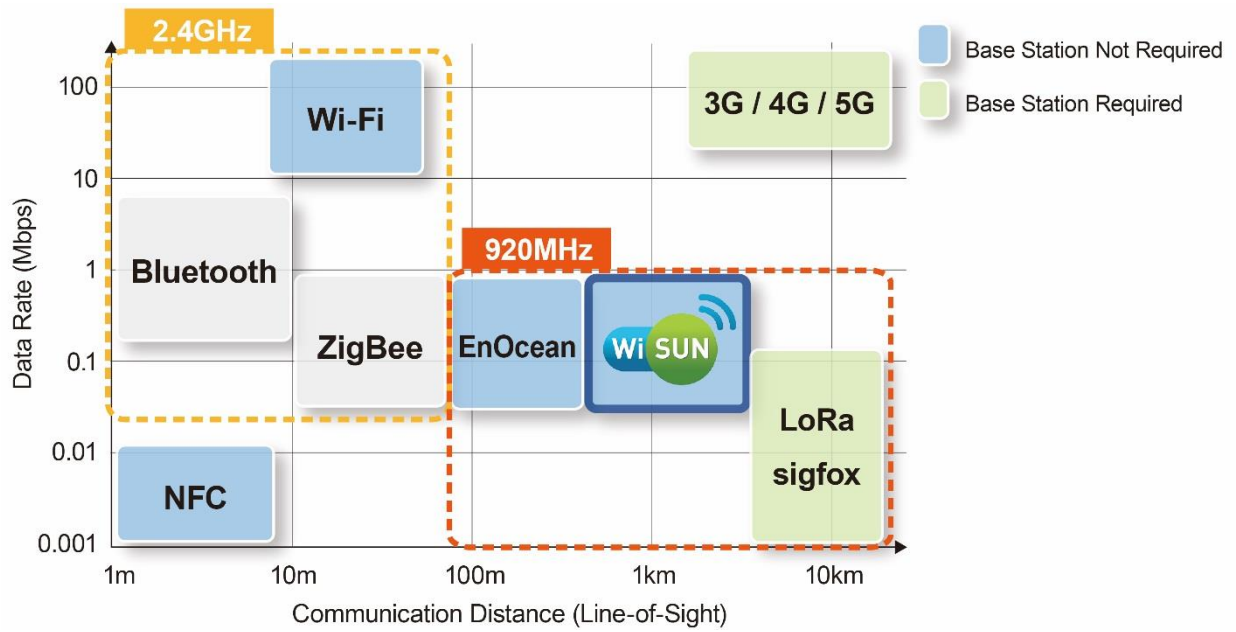

Figure 1. Wireless Communication Standards for IoT

As you can see from the above chart, Wi-SUN is characterized by longer communication distance than Wi-Fi and faster speeds than LoRa WAN and Sigfox. These balanced characteristics featuring a moderate transmission rate without the need for a base station make it ideally suited for the IoT market.

3. Wi-SUN Profile Types

The Wi-SUN Alliance includes Working Groups (WG) that formulate technical specifications and profiles (Fig. 2).

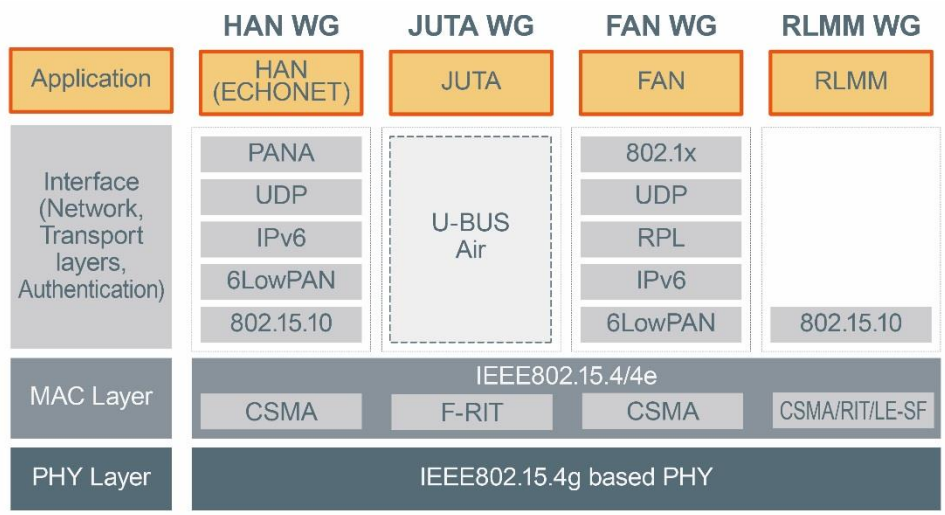

Figure 2. Profiles Developed by the Wi-SUN Alliance

4 Working Groups (HAN WG, FAN WG, RLMM WG, and JUTA WG) are currently establishing 4 different profiles. ROHM is developing products compatible with 3 of the profiles (HAN, FAN, and JUTA - which have already been formulated and certified) and will provide updates on the latest status.

4. Wi-SUN Enhanced HAN

One of the profiles being formulated by the HAN WG is Wi-SUN Enhanced HAN. From January, ROHM began production of the BP35C0-J11 wireless communication module compatible with this standard. Wi-SUN Enhanced HAN incorporates a relay function that extends the transmission distance over conventional HAN along with sleep communication enabling bidirectional transmission even with battery-powered devices. And besides home area networks (HAN), Wi-SUN devices are expected to be adopted in large-scale industrial and commercial facilities (Fig. 3).

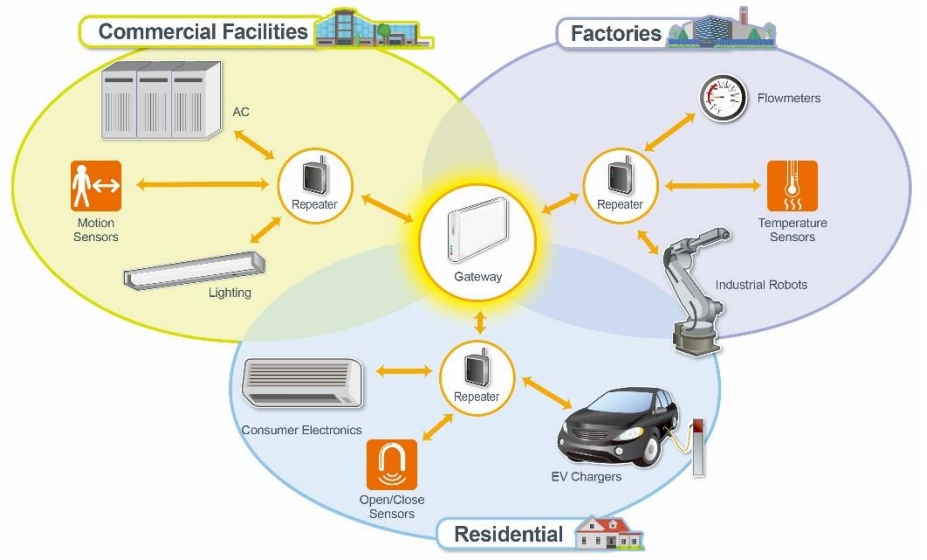

Figure 3. Wi-SUN Enhanced HAN Application Examples

Fig. 4 provides an overview of the Wi-SUN Enhanced HAN standard. With HAN WG, profiles are formulated in the order of B Route communication, single-hop HAN, then the latest Enhanced HAN protocol.

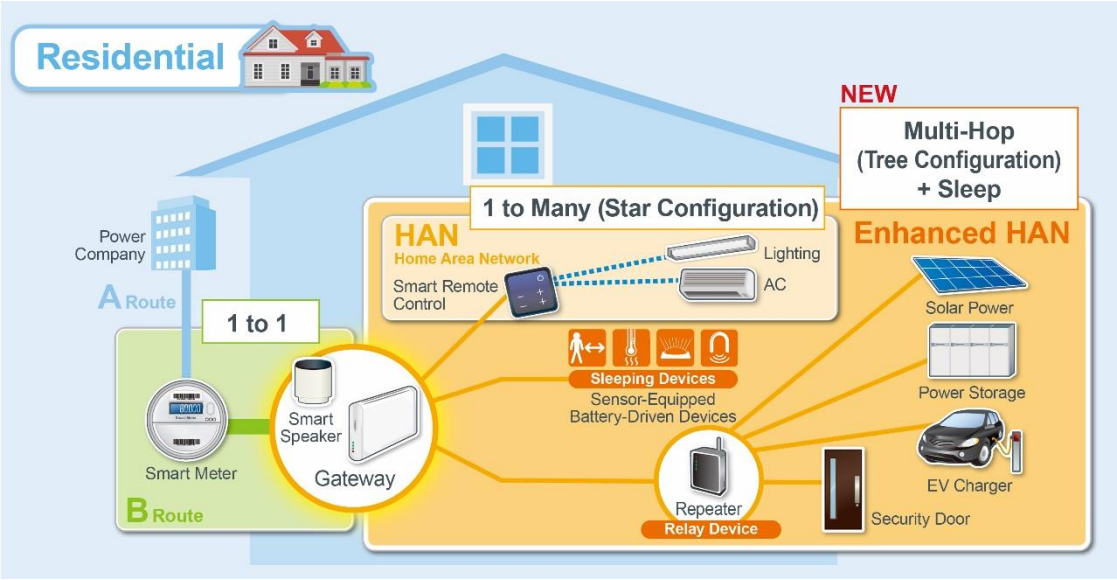

Figure 4. HAN Profiles and Routes (Including Wi-SUN Enhanced HAN)

Wi-SUN Enhanced HAN Features:

1. Enables relay communication

Unlike conventional Wi-SUN HAN which supports one-to-many star connection, Wi-SUN Enhanced HAN utilizes a one-to-many tree configuration. This ensures stable communication via relay, even with no line-of-sight over longer distances, for example in the case of communication between a HEMS controller in the home and a storage battery or EV charger installed outdoors.

2. Provides two-way communication in sleep mode

Normally, during bidirectional wireless communication the radio is continually in reception mode. However, since power is consumed in this state, two-way communication becomes difficult for battery-operated sensor devices, so a transmission-only mode is generally adopted. In contrast, Wi-SUN Enhanced HAN enables low-power bi-directional communication that ensures optimal communication even with battery-equipped devices.

ROHM's BP35C0-J11 Wireless Communication Module Features:

1. Support for all modes

The BP35C0-J11 supports all modes specified by Wi-SUN Enhanced HAN. This makes it ideal for a wide range of applications, from devices with sleep functionality that provide greater energy savings and wireless relays to end products connected to home appliance/sensor networks and 'coordinators' such as gateways that carry out network control. ROHM's wireless module is also suitable for B Route service for connection with smart meters, eliminating the need for troublesome hardware replacement or firmware switching.

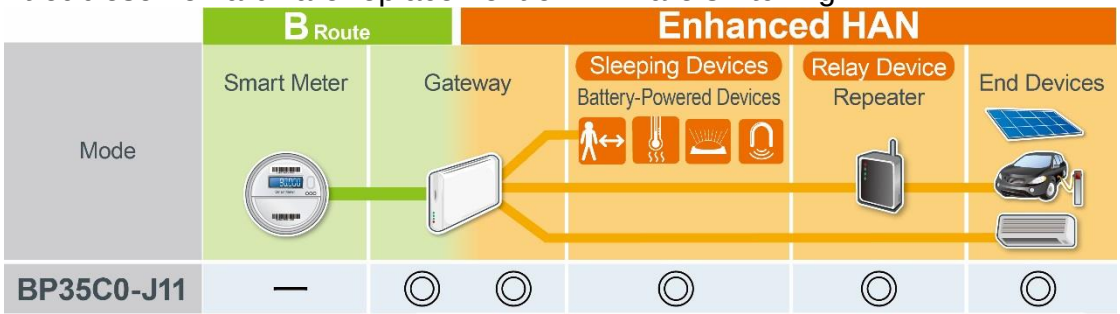

Figure 5. Compatible Modes of the BP35C0-J11

2. Built-in FOTA (Firmware update Over The Air) function

Implementing FOTA requires a standard with moderate communication speeds to wirelessly distribute and update firmware in a timely manner. Also, when considering actual operation, it is necessary to carry out FOTA while conducting normal communication, and the device must have enough space to store firmware. The BP35C0-J11 utilizes LAPIS Semiconductor's wireless IC featuring ① fast 100kbps Wi-SUN communication speed and ② a dedicated firmware storage area to achieve FOTA functionality ideal for efficient operation.

Integrating FOTA makes it possible to quickly respond to problems and carry out minor standard updates with minimal cost.

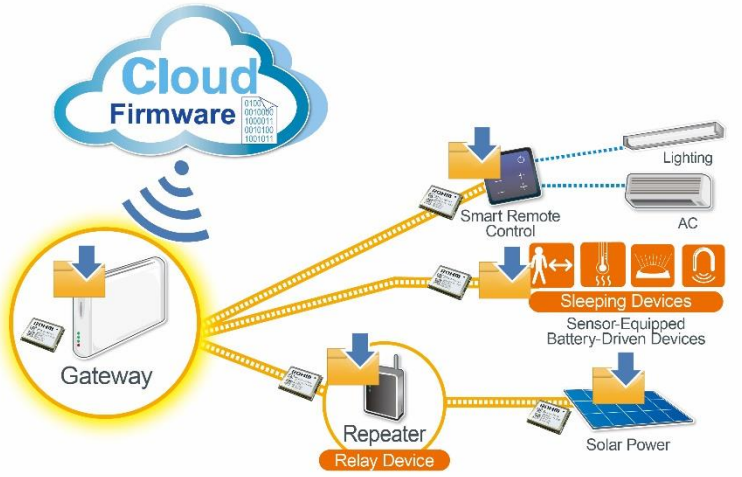

Figure 6. FOTA Diagram

3. Evaluation board

ROHM launched sales of an evaluation board in March designed to facilitate customer evaluation (Fig. 7). In addition, all documents required for development, such as wireless module start guides, hardware specifications, and external antenna lists, are available for download from ROHM's dedicated support page (Japanese only):
https://micro.rohm.com/jp/download_support/wi-sun/

Figure 7. BP35C0-J11 Evaluation Board

5. Wi-SUN JUTA

ROHM is also developing products from the standards formulation stage for Wi-SUN JUTA, a new international wireless communications protocol for battery-driven smart meters. ROHM's wireless communication modules have already been adopted by Tokyo Gas Co., Ltd. and were the first in the industry to obtain Wi-SUN Alliance certification as a Certified Test Bed Unit (CTBU) for the new Wi-SUN JUTA standard released in May 2019.

Wi-SUN Standard Features:

1. Achieves 10+ year operation with battery-powered smart meters

Wi-SUN JUTA carries out intermittent operation (always in sleep mode except when sending/receiving signals at regular intervals) that minimizes receiving time, making it possible to reduce current consumption by more than 98% over conventional Wi-SUN (Wi-SUN Enhanced HAN end device mode) utilizing the same 920MH specified low power band. This allows operation for over 10 years with battery-equipped smart meters (i.e. gas, water).

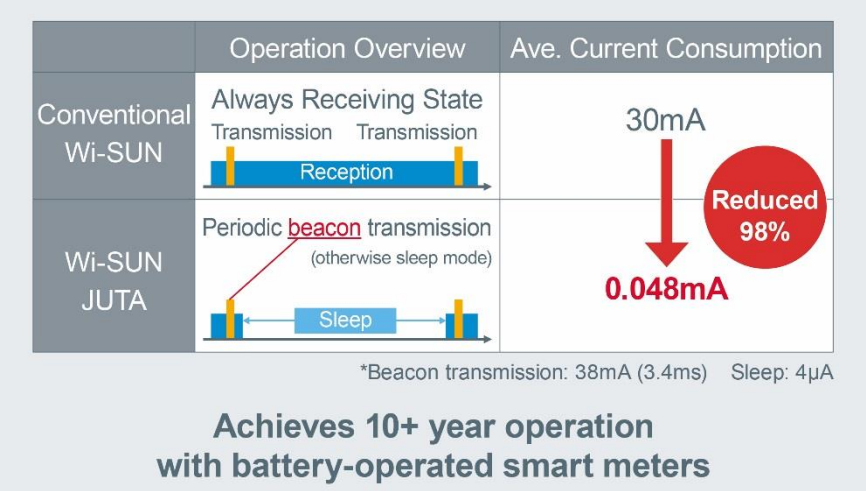

Figure 8. Current Consumption Comparison

2. Ensures high reliability communication even in areas with mixed applications

With standard low-power wireless communication, once initiated the transmitter continues to operate, but with Wi-SUN JUTA receiving operation is carried out until the beacon is caught, during which no transmission operation is performed. As a result, even when the number of communication operations increases the radio wave occupancy time is unlikely to rise, providing stable communication.

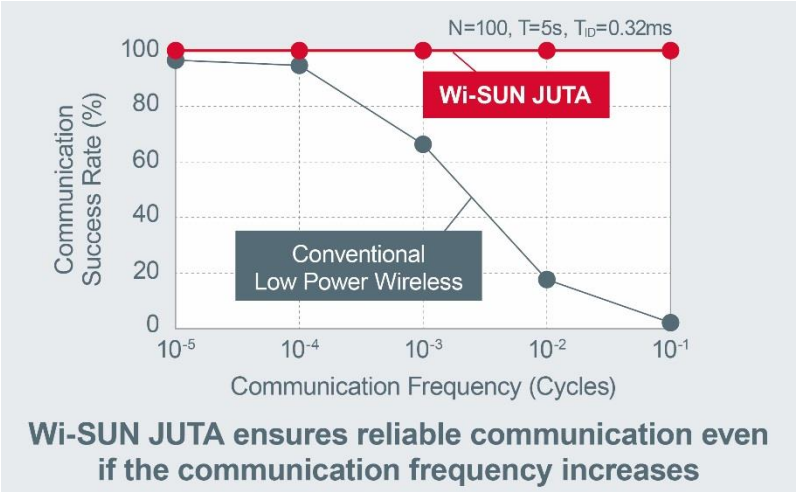

Figure 9. Communication Success Rate vs Communication Frequency

ROHM Wireless Communication Module Features:

1. Enables configuration of high reliability mesh networks

ROHM's module supports multi-hop (relay) communication of up to 4 hops, allowing users to build mesh networks that avoid obstacles by continuously reconfiguring the route until it reaches the destination.

2. Integrated security function

The built-in security function enables communication encryption and security key updates on the wireless communication module side, making It possible to easily perform secure communication without the need for complicated processing at the host side.

6. Wi-SUN FAN

In January 2019 ROHM obtained Wi-SUN FAN certification through a joint development with NISSIN SYSTEMS Co.,Ltd. and the team of Professor Hiroshi Harada at Kyoto University.

Figure 10. Wi-SUN FAN Module and Evaluation Board (Under Development)

Figure 11. Wi-SUN FAN Certification

Wi-SUN FAN Features:

1. Supports multi-hop mesh networks

Unlike conventional star-type systems, multi-hop mesh networks provide full coverage over a wide area by connecting devices utilizing multiple sensor nodes (Fig. 12). The nodes provide a redundant configuration with multiple paths, making it possible to achieve a more secure network that prevents system-wide failures resulting from a single point of failure.

This system uses a protocol called RPL (IPv6 Routing Protocol for Low Power and Low Network), an open specification of IETF. RPL autonomously builds mesh networks by automatically discovering nearby devices. The communication path is first determined by calculating the Rank Value, which is the virtual distance to the Border Router, an access point that collects data based on the quality of wireless communication between devices. Communication is then carried out by selecting the route with the smallest Rank Value. Stable system operation is achieved by selecting another route in response to sudden changes in terrain after installation or radio interference.

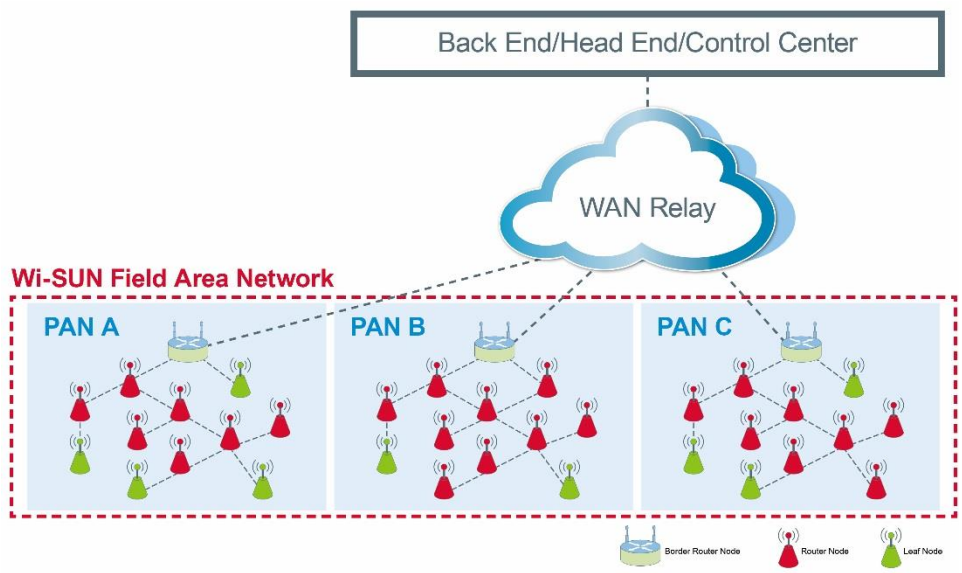

Figure 12. Multi-Hop Mesh Networks

2. Advanced authentication and encryption

Authentication is performed using the EAP-TLS method and RADIUS/AAA servers. In addition, client certificates can be set for connected devices. And since only authorized devices are centrally managed by the border router, individual settings for each device are not needed even if the route changes. Also, secure communication is possible using AES encryption. Client certificates can be GlobalSign certificates issued by the Wi-SUN Alliance, which are designed to operate as formal client certificates when full-scale operation gets underway.

3. Frequency hopping

In Japan, each device operates by performing channel switching in the range of 28 channels from 922.40MHz (Ch 33) to 928.00MHz (Ch 61) at 50kbps transmission and 14 channels from 922.50MHz (CH33/34) to 927.7MHz (Ch 59/60) at 150kbps. For unicast communication, the EUI-64 MAC address of each device is used as the key, and for broadcast communication the pseudo-random number TR51CF (TR51 Channel Function) or DH1CF (Direct Hash Channel Function) is used to calculate the channel used and communicate by switching channels at regular intervals. Channel switching can be changed depending on the purpose and operation of the system. And the switching channel range and mask can be set for each device, allowing users to configure flexible systems.

Constructing a robust system strong against radio interference and noise by frequency hopping ensures secure, confidential communication. Under the current radio law, there is a transmission limit of 6 minutes per hour using the Wi-SUN FAN radio band, but there is a plan to extend the limit to 12 minutes per hour utilizing multiple channels based on frequency hopping, which is expected to expand the application scope once enforced.

7. Future Prospects

ROHM will continue to promote Wi-SUN Enhanced HAN (BP35C0-J11) and JUTA while developing and producing Wi-SUN FAN modules. We hope to make a positive contribution to society by advocating the widespread use of Wi-SUN, which has the broadest application scope in the LPWA market and as a result is attracting attention not only for use in smart meters, but logistics, asset management, security, and smart buildings as well.

*Both ROHM's Wi-SUN Enhanced HAN compatible module BP35C0-J11 and Wi-SUN JUTA wireless communication module are certified under Japan's Radio Law. Plans to comply with overseas regulations are currently underway.

Wi-SUN FAN compatible modules are being developed, with an expected release date in the first quarter of 2020 (January to March).

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