

New IoT Connectivity Platform Integrates Sub-GHz Multi-Hop Wi-SUN FAN Networking with the Matter Smart Home Interoperability Standard

—Basic Functionality of Matter over Wi-SUN FAN Demonstrated in a Remote Building Lighting Control Experiment—

Overview

A research group led by Professor Hiroshi Harada and doctoral student Reo Gakumi of the Graduate School of Informatics at Kyoto University has developed a new Internet of Things (IoT) connectivity platform called Matter over Wi-SUN FAN. The platform combines Wi-SUN FAN, an international standard for sub-GHz multi-hop wireless networking, with Matter, an international application-layer standard that enables the control of smart home devices and interoperability between them.

The researchers developed Matter-compatible devices equipped with Wi-SUN FAN border-router or router functionality for multi-hop wireless communication, along with a smartphone application for device commissioning, including initial setup and authentication. Using these components, they successfully conducted a demonstration experiment simulating remote building-lighting control in a four-story building on Kyoto University's campus. The system can extend communication coverage through Wi-SUN FAN multi-hop networking and mitigate co-channel interference through frequency hopping.

The researchers also successfully registered Matter-compatible devices, following their initial setup using the newly developed commissioning process, with multiple commercially available Matter-compatible smart-home controllers from different manufacturers. The same devices could be registered with these controllers concurrently without modifying the controllers, confirming interoperability with existing Matter platforms. These results demonstrate the potential to leverage Wi-SUN FAN's wide-area, interference-resilient wireless networking while retaining compatibility with existing Matter platforms. Potential applications extend beyond the lighting control demonstrated here to smart homes, building management, and energy management.

Key Points

- Developed Matter over Wi-SUN FAN, a new IoT connectivity platform that uses Wi-SUN FAN's sub-GHz multi-hop wireless communication standard as the network infrastructure for Matter, the international standard for smart home device interoperability.
- Extended communication coverage through Wi-SUN FAN multi-hop wireless networking and mitigated co-channel interference through frequency hopping.
- Demonstrated remote lighting control in a four-story building on Kyoto University's campus and interoperability with multiple commercially available Matter controllers.

1. Background

Matter, an international application-layer standard for controlling smart home devices and enabling interoperability between them, has seen growing adoption in recent years. It allows devices from different manufacturers to be connected and controlled through a common framework. Its applications are expanding beyond smart home devices such as lighting and air-conditioning equipment to building management and energy management involving battery storage systems and electric vehicle (EV) charging equipment.

Matter uses wireless technologies such as Wi-Fi and Thread as its network infrastructure. In the 2.4 GHz band used by these technologies, interference from other wireless systems, limited communication range, and signal attenuation caused by walls and buildings can pose challenges. Addressing these challenges is particularly necessary to ensure stable communication with devices installed outdoors or in separate buildings.

To address these challenges, the researchers focused on Wi-SUN FAN, an international wireless communication standard that operates in frequency bands below 2.4 GHz, including the 920 MHz band. Wi-SUN FAN supports IPv6 multi-hop wireless communication with more than 20 hops, enabling networks to cover extensive indoor and outdoor areas. It also uses frequency hopping to reduce the effects of co-channel interference. Wi-SUN FAN 1.1 additionally supports high-speed data transmission at rates of up to 2.4 Mbps. Using Wi-SUN FAN as Matter's network infrastructure could therefore extend the communication range of Matter-compatible devices and improve communication stability.

Operating Matter over Wi-SUN FAN, however, requires coordination between Wi-SUN FAN network joining, which uses certificate-based authentication, and Matter commissioning, the initial setup process in which users authenticate a device and register it on a network using a smartphone application or similar interface. It also requires service discovery, a mechanism for finding devices and services on the network, and IPv6 reachability, which enables communication with devices across different networks.

Another defining feature of Matter is multi-admin, which allows a single device to be registered with multiple platforms or controllers from different manufacturers at the same time and to be managed and controlled from each. To use this feature over Wi-SUN FAN, it is necessary to confirm that Matter-compatible devices on the Wi-SUN FAN network can be registered with multiple existing Matter controllers and used from their respective platforms.

2. Research Results

The research group developed Matter over Wi-SUN FAN by integrating wireless communication functions compliant with Wi-SUN FAN 1.1 and application-layer functions based on Matter 1.5. The system connects and controls Matter-compatible devices using Wi-SUN FAN as its network infrastructure. Each device performs Matter authentication and application processing using Wi-SUN FAN's IPv6 multi-hop wireless communication capabilities. To enable Matter to operate over Wi-SUN FAN, the group integrated the generation and provisioning of authentication credentials required to join the Wi-SUN FAN network, service discovery for Matter-compatible devices, and the establishment of IPv6 communication paths. The group also developed a Matter-compatible device with border router (BR) functionality that forms and manages the Wi-SUN FAN mesh network and connects it to an existing local area network (LAN) (**Figure 1**).



Figure 1. Developed Matter device with Wi-SUN FAN Border Router functionality

This device forwards traffic between the Wi-SUN FAN network and the existing LAN while also operating as a Matter-compatible device that can itself be accessed and controlled. The researchers implemented proxy advertising functionality that advertises information about Matter-compatible devices on the Wi-SUN FAN network to the existing LAN on their behalf. This allows smartphones and Matter controllers connected to the LAN via Wi-Fi or other wireless technologies to discover, communicate with, and control these devices without changing Matter's existing authentication mechanisms or application functionality.

The researchers further developed a Matter-compatible device with router functionality that relays traffic between devices in a Wi-SUN FAN multi-hop wireless network (**Figure 2**).

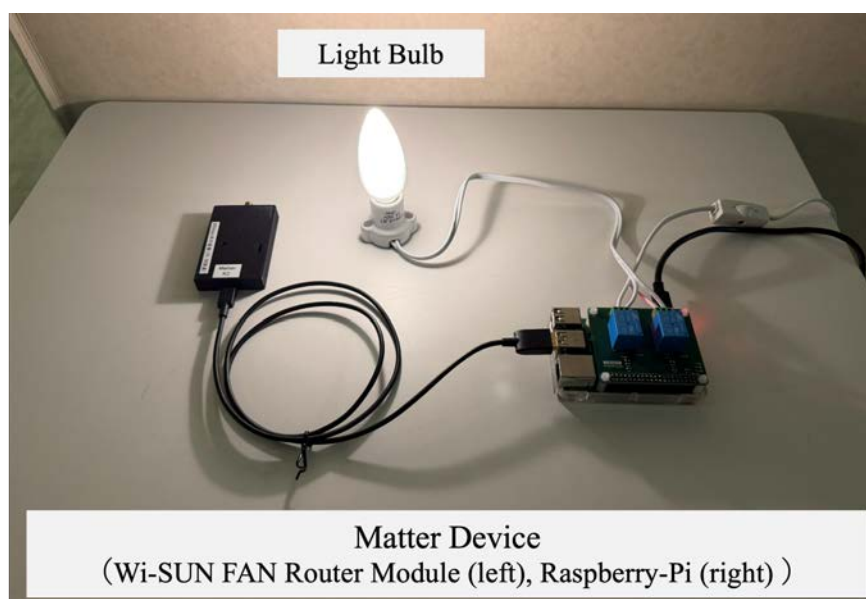


Figure 2. Developed Matter device with Wi-SUN FAN Router functionality and lighting control unit

It combines Matter application functionality with Wi-SUN FAN wireless communication functionality, operating as a Matter-compatible device while relaying wireless traffic for other devices.

The group also developed a smartphone application with commissioning functionality for initial device setup and authentication, as well as controller functionality for operating registered devices (**Figure 3**).

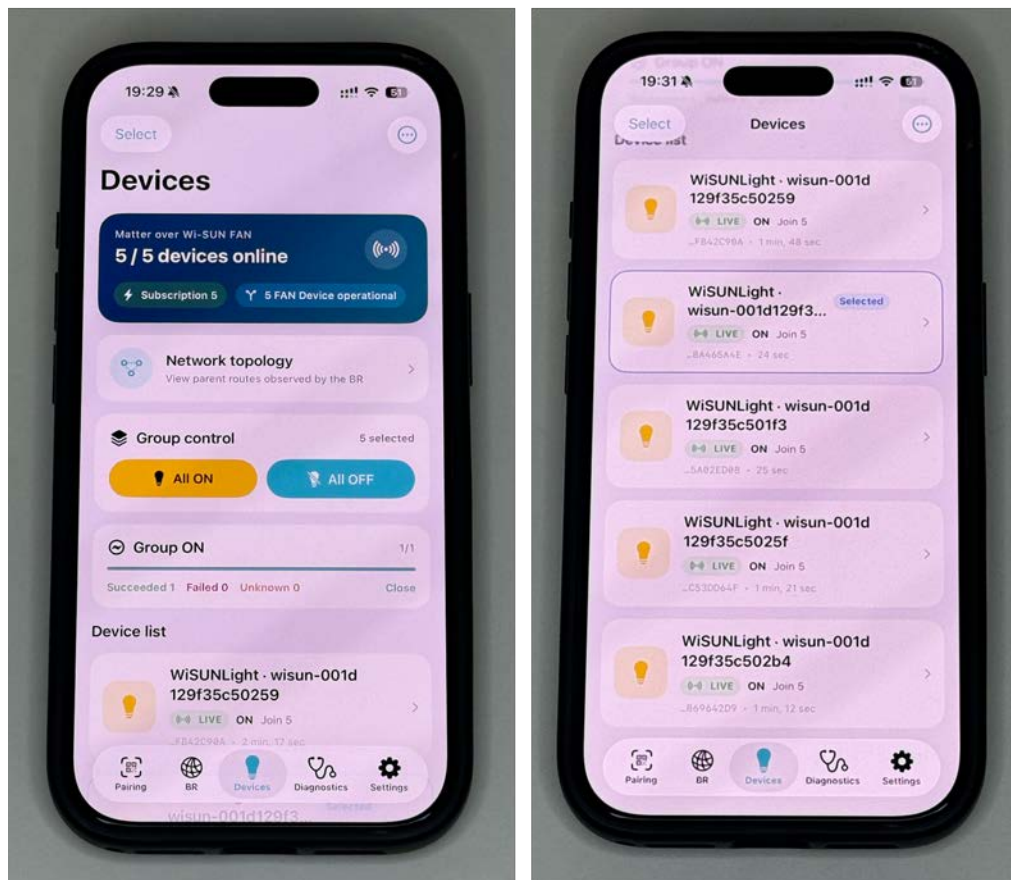


Figure 3. Developed smartphone application for commissioning and controlling Matter over Wi-SUN FAN devices

By coordinating Wi-SUN FAN network joining with Matter commissioning, the application enables the entire process, from initial setup of Matter-compatible devices to turning lights on and off.

To demonstrate the effectiveness of the developed Matter over Wi-SUN FAN system, the researchers conducted an experiment simulating remote control of building lighting in a four-story building on Kyoto University's campus (**Figure 4**).

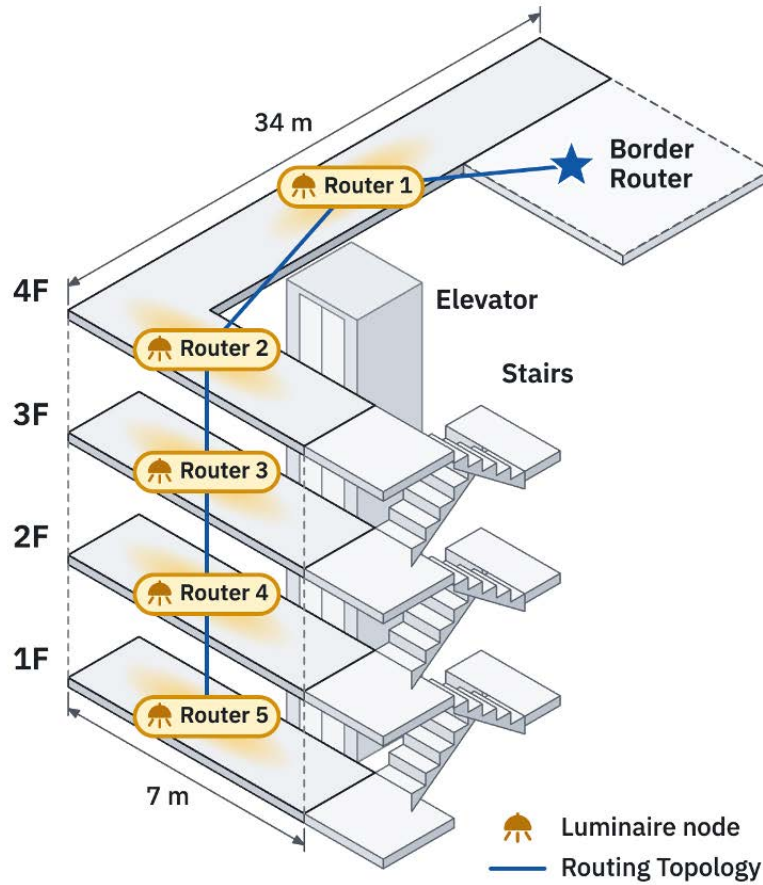


Figure 4. Experimental setup for remote control of building lighting using Matter over Wi-SUN FAN in a four-story building

A Matter-compatible device with BR functionality was installed in a room on the fourth floor. Five Matter-compatible devices with router functionality, designated R1 through R5, were connected to lighting fixtures and placed in corridors on the first through fourth floors. Together, these devices formed an IPv6 multi-hop wireless network. The researchers first registered the devices using the newly developed smartphone application. From the fourth-floor room housing the BR device, they then used software to turn the lights on each floor on and off at regular intervals. The experiment confirmed that Matter-compatible devices could be remotely controlled across multiple floors of a building using Wi-SUN FAN multi-hop wireless communication.

The researchers also developed an embedded device implementing both Matter application functionality and Wi-SUN FAN wireless communication functionality on a single system-on-chip (SoC).

Figure 5 shows the developed SoC device and lighting control unit. Using this device, the group conducted interoperability experiments with multiple commercially available Matter-compatible smart home controllers.

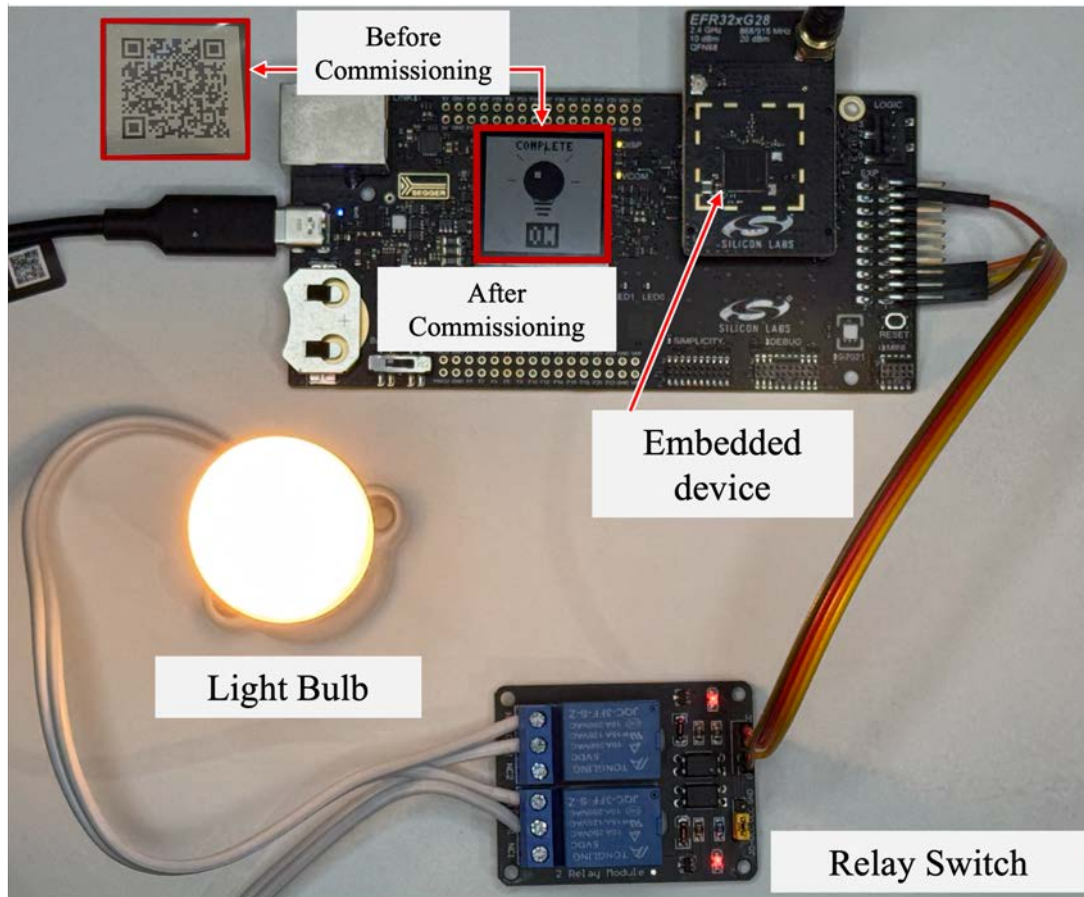


Figure 5. Developed embedded device integrating Matter and Wi-SUN FAN on a single SoC, and lighting control unit

Figure 6 shows the two-hop network configuration and multi-admin setup used in the experiment. The smart home platforms and controllers used were Apple's Apple Home (HomePod mini), Google's Google Home (Google Nest Hub, 2nd generation), and Amazon's Alexa (Echo Show 5, 3rd generation). The researchers confirmed that Matter-compatible devices whose initial setup had been completed using the newly developed commissioning functionality could be registered with these three platforms at the same time and controlled from each, without modifying the existing Matter controllers.

These results confirm that the developed Matter over Wi-SUN FAN system enables wide-area connectivity for Matter-compatible devices through Wi-SUN FAN multi-hop wireless communication, while providing interoperability with existing Matter platforms.

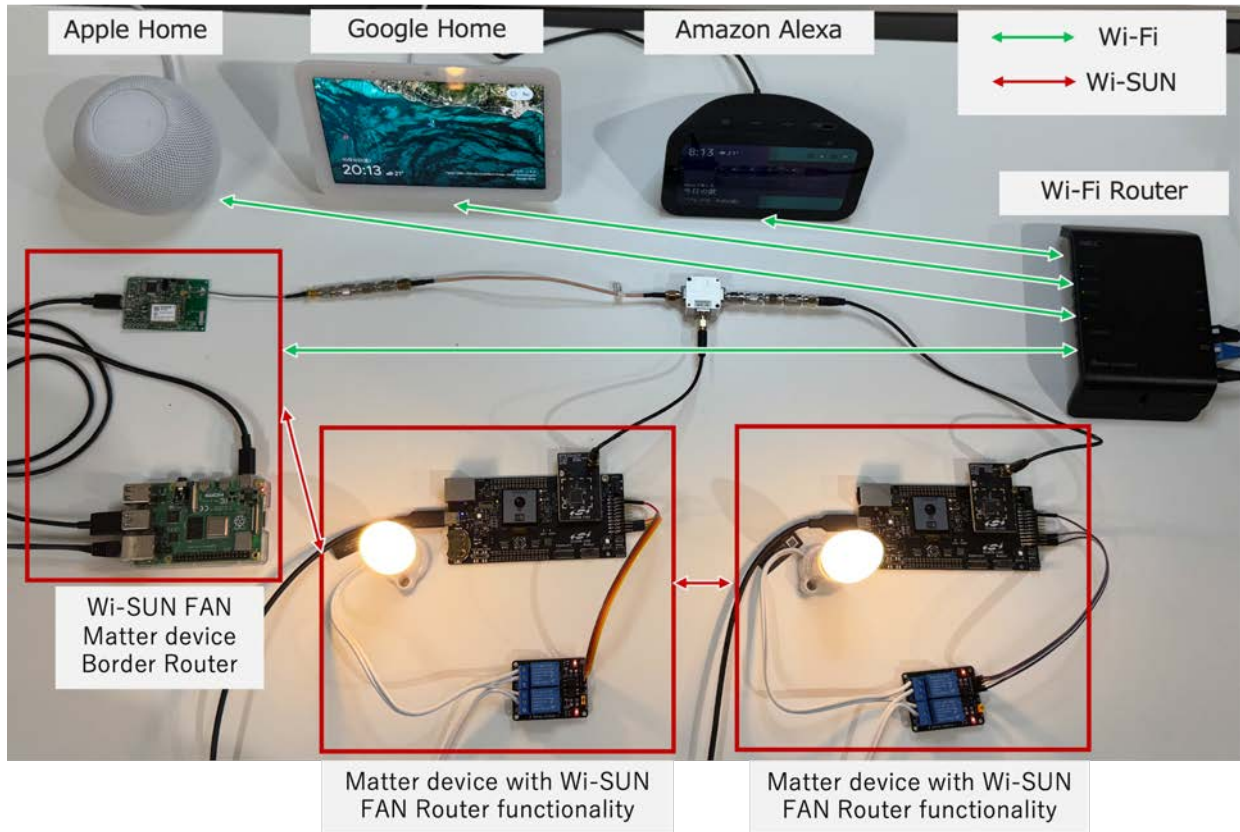


Figure 6. Experimental setup for multi-admin connection between the developed Matter device and three commercial Matter controllers

3. Potential Impact and Future Prospects

The newly developed Matter over Wi-SUN FAN IoT connectivity platform extends the communication range of Matter-compatible devices. The researchers demonstrated remote control of building lighting across multiple floors and interoperability with existing Matter platforms. This development could enable Matter-based connectivity and control for measurement instruments, battery storage systems, solar power generation equipment, and EV charging equipment installed outdoors or in separate buildings, in addition to conventional smart home devices. Potential applications include home energy management systems (HEMS) and building management systems. The group will pursue further demonstrations in smart homes, building management, and energy management, with the aim of bringing the platform into practical use as IoT connectivity infrastructure for smart cities. The research findings are scheduled to be presented at the forum commemorating Professor Hiroshi Harada's receipt of the Medal with Purple Ribbon, to be held on October 22, 2026.

4. Acknowledgments

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<Terminology>

1. Wi-SUN FAN (Field Area Network)

Wi-SUN FAN is a communication standard established by the Wi-SUN Alliance to provide wireless connectivity for smart grids, including smart metering and distribution automation, and for smart city applications such as infrastructure management, intelligent transportation systems, and smart lighting. It specifies IPv6-based multi-hop communication for devices such as sensors and meters, enabling wide-area, highly reliable IoT networks. Version 1.0 was established in 2016. Version 1.1 has since been established, adding support for higher data rates, lower power consumption, and other enhancements.

2. Matter

Matter is an international application-layer standard developed by the Connectivity Standards Alliance (CSA) to enable interoperability among smart home devices over IPv6. It is not tied to a single wireless technology. It defines mechanisms for device authentication, secure communication, and common methods for device control, enabling connectivity and control across devices and platforms from different manufacturers. It also supports multi-admin functionality, which allows a single device to be managed and controlled from multiple platforms. The initiative began in December 2019, and the first official release, Matter 1.0, was published in October 2022. Since Matter 1.4, substantial additions have been made to device types and functionality for home energy management systems (HEMS).