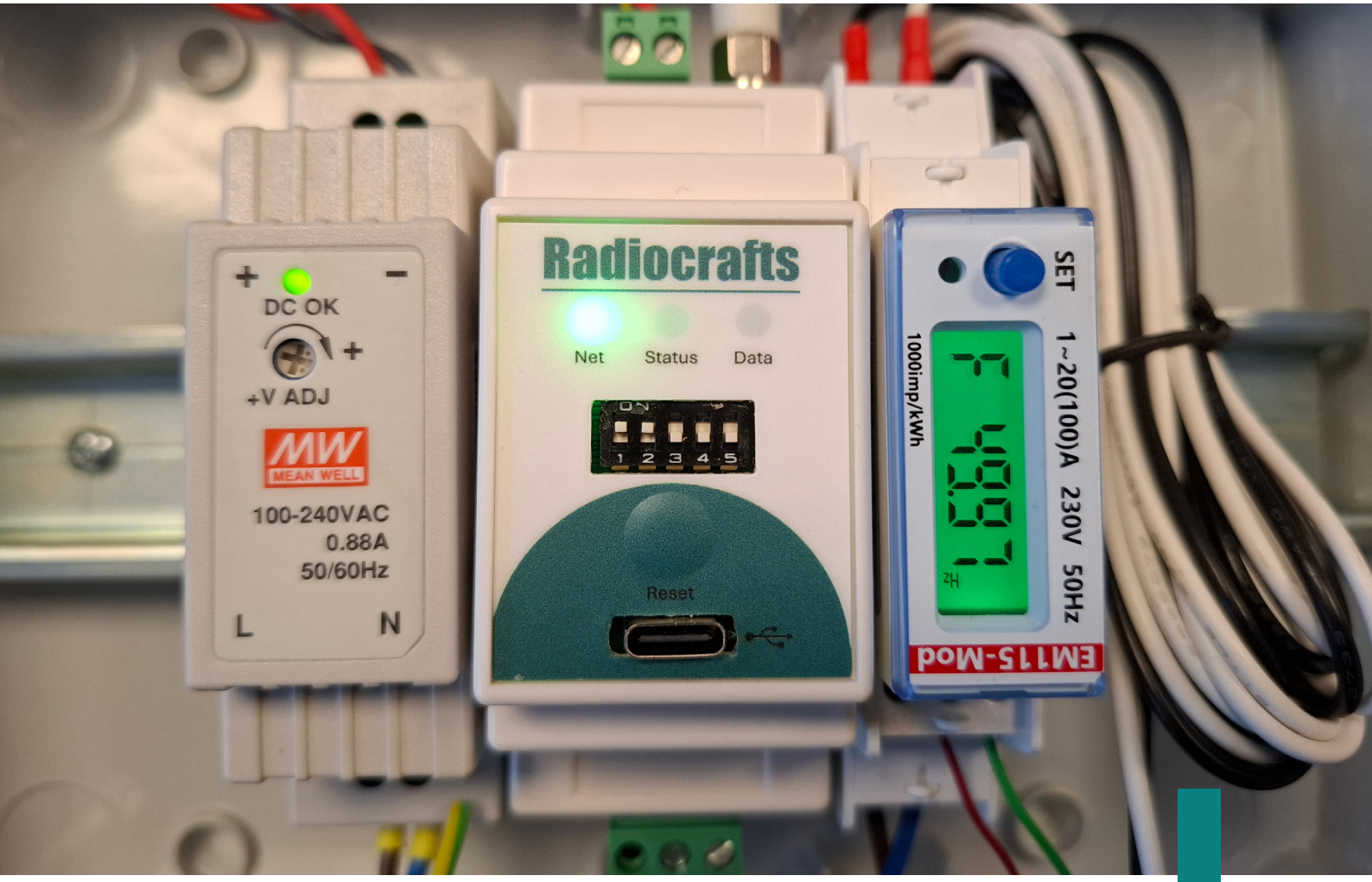
Radiocrafts
Embedded Wireless Solutions



WIRELESS TECHNOLOGY

SELECTION GUIDE

FOR SUB-METERING

SCALING WITH RELIABILITY IN SMART ENERGY

CONTENTS

INTRODUCTION

WHICH WIRELESS TECH

As wireless technology replaces hard-wired cabling in **sub-metering** worldwide, choosing the right wireless solution is critical to ensuring reliable performance under all operating conditions. This is because as projects grow in size, the reliability and scalability challenges grow as well.

This guide will examine the trade-offs and priorities a user must consider when comparing all four of the most commonly considered wireless technologies in sub-metering today : **RIIM**, **Zigbee**, **Wi-SUN**, and **LoRa**.

COMPARISON

RIIM VS ZIGBEE, WI-SUN & LORA

Specifications	RIIM	Zigbee	Wi-SUN	LoRa
Data Delivery Success Rate	99.99% +	90% +	95% +	85% +
Max Outdoor Network Range	40 x 40 km	5 x 5 km	30 x 30 km	48 x 48 km
Max Urban Network Range	19 x 19 km	0.45 x 0.45 km	15 x 15 km	11 x 11 km
Max Indoor Network Range	4 x 4 km	0.3 x 0.3 km	4 x 4 km	7 x 7 km
Max Data Rate	50 or 150 kbps	Up to 250 kbps	Up to 300 kbps	Up to 50 kbps
Mesh	✓	✓	✓	x / ✓
Automatic Channel Selection	✓	x	✓	x

WHY WIRELESS NOT WIRED

THE DRAWBACKS OF WIRED

Higher costs and complexity

Installing kilometers of copper and fiber optic cables is expensive, labor-intensive, and costly in large building complexes. The rising cost of copper, a scarce resource, further increases the cost of cabling.

Higher maintenance and damage risk

Cables are vulnerable to damage from weather, animals, and wear, that can be costly to repair. Risks like lightning strikes can disrupt entire systems.

Inflexibility

Expanding or upgrading wired systems requires extensive rework, often involving significant, inconvenient and costly, structural re-engineering and disruption.

THE ADVANTAGES OF WIRELESS

Lower installation and maintenance costs

Wireless has a lower total cost of ownership than wired. Wireless eliminates the need for expensive cabling and reduces maintenance costs because there are no cables to repair or replace.

Ease of installation

Wireless networks can be installed quickly and non-invasively, making them ideal for buildings, new and old.

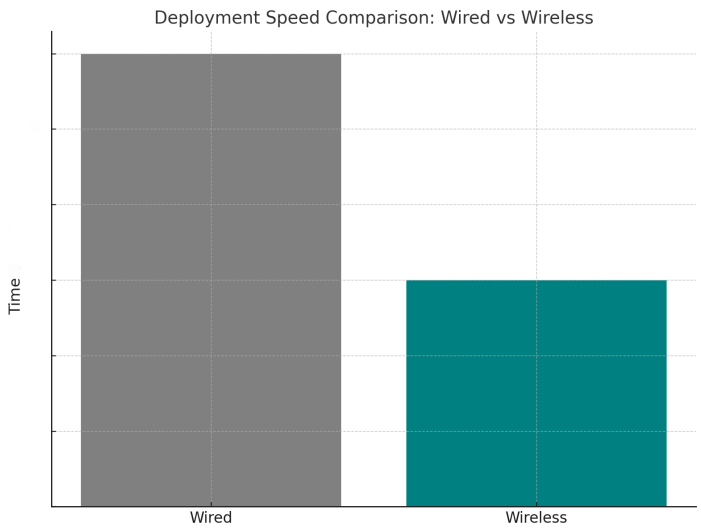
Scalable and adaptable

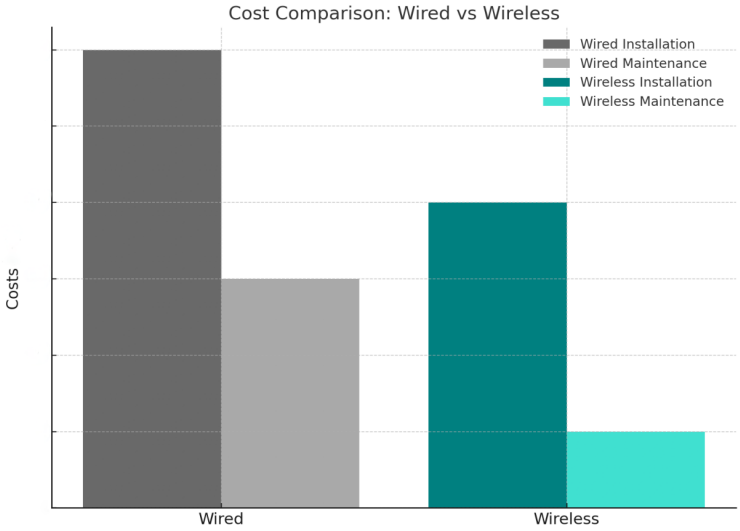
Wireless networks can also be more easily expanded or reconfigured to support future proofing over the decades.

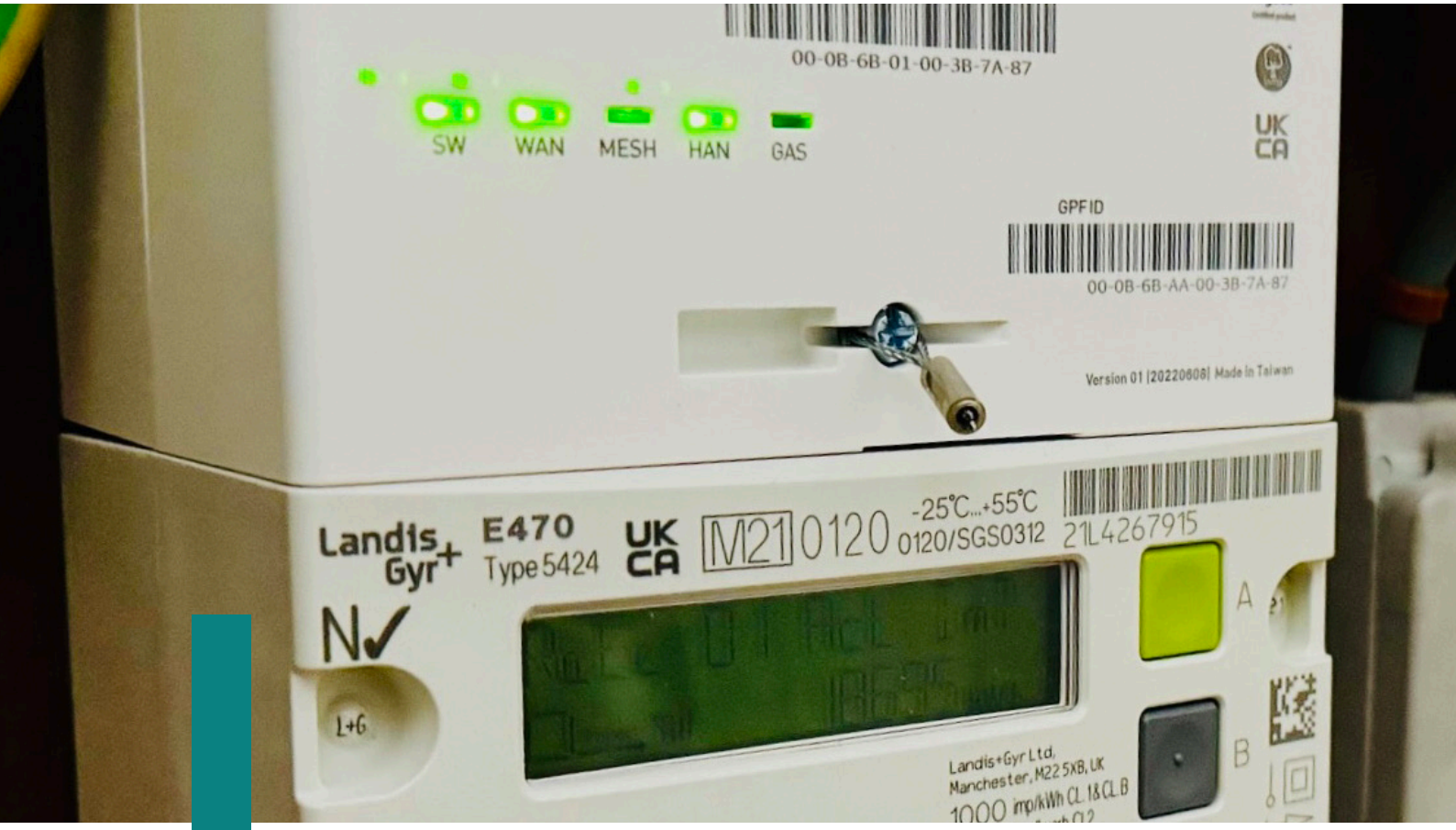
All the drawbacks of wired are removed by switching to wireless technology.

WIRED vs WIRELESS

DEPLOYMENT & COST







WIRELESS CHALLENGES IN

SUB-METERING

Sub-metering is essential for large, multi-occupancy buildings, both new and old, to accurately measure and bill individual consumption of electricity, gas, water, and heat, on a more fine-grained level than conventional utility metering. In parallel, new legislations are mandating more efficient smart utility monitoring to encourage lower resource use, improve cost visibility, and help users avoid peak demand pricing.

SUB-METERING

WIRELESS CHALLENGES

The challenges of retrofitting

Retrofitting sub-metering into any existing building presents significant challenges. Older structures were rarely designed to accommodate such systems, often featuring dense and inaccessible layouts constructed with reinforced steel and concrete walls and floors. These construction materials can significantly diminish wireless signals.

The larger the installation or building, new build or existing, the larger the associated range and reliability issues become.

Yet the sub-metering installation must operate seamlessly for decades, including after any building alteration works that may well occur over such a long period of time.

Interference and range

While all wireless networks face interference and range challenges, these are particularly pronounced in sub-metering applications. Reliable communication must extend to the farthest sub-meters, requiring deep, in-building penetration to reach underground basements, car parks, and the highest floors of skyscrapers.

RIIM by Radiocrafts vs ZigBee vs Wi SUN vs LoRa

RIIM VERSUS

ZIGBEE, WI-SUN, & LORA

An abundance of wireless technologies exists, both standards-based and proprietary, because no single wireless technology can meet the diverse needs of all applications.

Here we compare the four mostly commonly considered wireless protocols in sub-metering: **RIIM**, **Zigbee**, **Wi-SUN**, and **LoRa**.

COMPARISON

RIIM VS ZIGBEE, WI-SUN & LORA

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ZIGBEE

2.4 GHZ

Zigbee is a consumer-focused, low-power wireless protocol that operates on the 2.4 GHz frequency band, the same as Bluetooth and Wi-Fi. This is the highest operating frequency of the four protocols compared here, with the other three all operating at sub-GHz.

In consumer focused wireless applications such as home automation, entertainment, and personal fitness, 2.4 GHz has proven a huge success.

While not as widely deployed as Bluetooth or Wi-Fi, Zigbee is gaining significant traction in smart home applications like lighting, security, and energy management.

As a rule of thumb, higher frequencies support higher data rates, but at the trade-off of range and building penetration. Higher frequencies are more vulnerable to interference and physical obstructions. This means Zigbee's 2.4 GHz operating frequency can struggle in dense sub-metering environments.

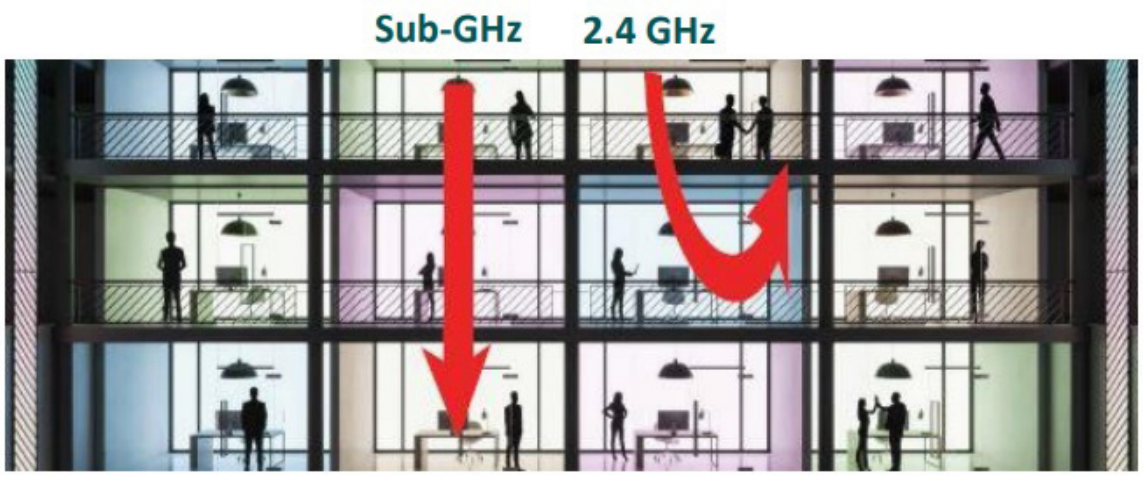
While Zigbee theoretically supports data rates up to 250 kbps, its real-world performance is usually limited to 20–100 kbps due to its low-power design. Although slightly faster than LoRa, Zigbee lags behind RIIM and Wi-SUN, which deliver significantly greater throughput.

Zigbee's range is typically limited to 10–20 meters indoors and 100 x 100 meters outdoors, which is approximately ten times less than sub-GHz frequencies can achieve.

Additionally, Zigbee was not designed for large industrial installations that can experience a 10-20% packet loss rate. Nor does Zigbee support frequency hopping which is required for reliability. As a result, Zigbee is less reliable than RIIM or Wi-SUN, but comparable to LoRa.

IN SUMMARY

While Zigbee is very effective for consumer applications, its limited range, lower reliability, and less efficient scalability make it a less viable choice for large industrial applications like sub-metering.



WI-SUN

SUB GHz

Wi-SUN is a standards-based, sub-GHz mesh wireless networking protocol designed for large-scale industrial Internet of Things (IoT) applications. Unlike other wireless technologies discussed here, Wi-SUN is specifically optimized for dynamic environments with moving devices.

As a result, Wi-SUN uses unsynchronized channel hopping that is optimized for devices in motion. In static environments, this dynamic optimization means Wi-SUN cannot rely on time synchronization to coordinate transmissions and avoid interference like RIIM.

As a result, Wi-SUN trades some static reliability for dynamic flexibility. Whereas RIIM prioritizes static reliability through the use of time synchronized transmissions.

In real-world scenarios, this means Wi-SUN achieves a typical data delivery success rate of around 95%. While completely adequate for many industrial applications, this is significantly lower than RIIM's near-perfect 99.99% reliability that sub-metering demands.

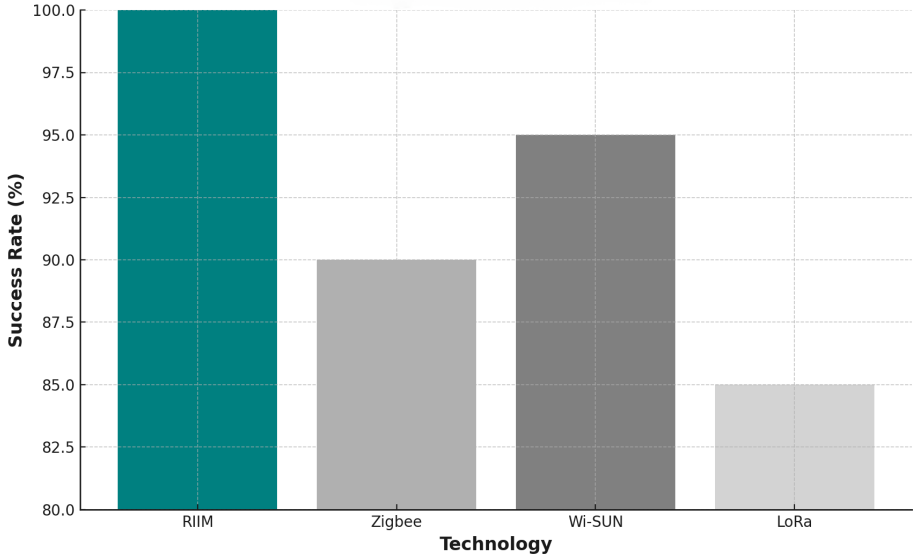
Finally, as a standards-based protocol, Wi-SUN, like both Zigbee and LoRa, cannot easily be tweaked or tailored to meet the specific requirements of demanding applications.

IN SUMMARY

While Wi-SUN provides flexibility for dynamic industrial environments, its lower reliability and lack of customization options make it less ideal than RIIM for static industrial applications like sub-metering.

COMPARISON

DATA DELIVERY SUCCESS RATE



LORA

SUB GHz

LoRa is a low-power, wide area protocol well-suited for applications with low data rate requirements and infrequent communication. Examples include remote agricultural and environmental (e.g. wild fire) sensing.

LoRa also has the longest range of all wireless technologies considered here. However, LoRa faces limitations in large-scale industrial applications that demand continuous monitoring and control, and so a higher data throughput than LoRa can support.

LoRa lacks time synchronization, making it more susceptible to packet collisions and interference. As a result, its real-world data delivery success rates decline as the number of connected devices grows, reducing reliability in larger networks.

To cover a large installation, multiple LoRa networks with fewer devices per network are required. This significantly increases cost and complexity due to the need for a larger number of additional gateways.

LoRa also has a severely limited downlink speed limiting its ability to acknowledge packet delivery. This results in latency, bottlenecks, and extended Over-the-Air (OTA) firmware update times. In large installations, these delays increase with network size.

Unlike RIIM and Wi-SUN, LoRa does not support mesh networking, which limits its scalability and reliability in complex deployments. Without mesh capabilities, LoRa networks require additional gateways, further increasing costs and complexity in large installations.

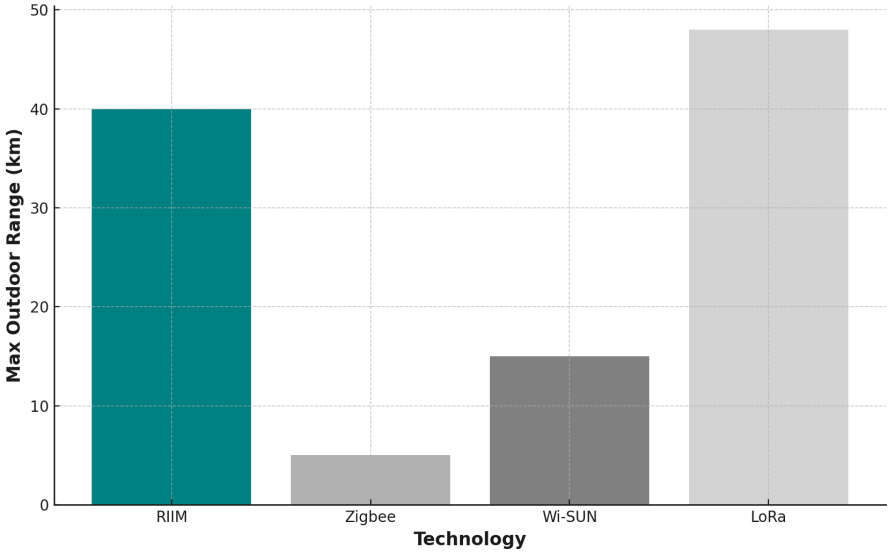
LoRa lacks the time synchronization of RIIM, leading to more frequent packet collisions and greater vulnerability to interference.

IN SUMMARY

While LoRa is well-suited for low-power, long-range infrequent data transmission applications, its limitations in data rate, reliability, updates, and scaling, make it less suited for complex sub-metering applications.

COMPARISON

MAX OUTDOOR NETWORK RANGE



RIIM FOR SUB-METERING

FLEXIBILITY, EFFICIENCY, & SCALABILITY

Sub-metering projects demand a highly reliable, long-range network capable of operating within buildings constructed from radio frequency-attenuating materials like concrete and steel.

Unlike standards-based wireless technologies that can't easily be modified, RIIM is a proprietary technology that can be optimized to specifically meet the whole building range requirements of sub-metering.

Granular monitoring

Wireless sub-metering demands detailed and frequent polling of sub-meters, up to several times per second, to accurately track electricity, gas, water, and heat consumption.

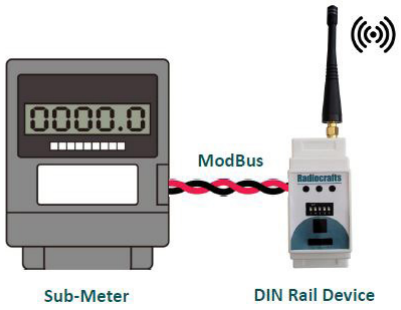
Other common advanced control and monitoring capabilities include peak demand management, electric vehicle (EV) car park charging, distributed energy storage, renewable energy integration, and the continuous exchange of real-time price signals to accurately align energy consumption with costs.

Customizing and scaling with RIIM

With the ability to support up to 1,000 devices in a single installation, RIIM is perfectly suited for large-scale applications, including multi-floor skyscrapers, industrial warehouses, and factories.

RIIM's sub-GHz mesh technology offers exceptional reliability and strong physical penetration, allowing it to reach deep into buildings of all sizes, including difficult-to-access areas like basements and underground parking garages.

In sub-metering retrofit applications, wired buses like ModBus are commonly used and often preferred to remain partially intact. This is why RIIM offers seamless ModBus integration out of the box.



WHY CHOOSE RIIM

SCALABILITY, RANGE & ROBUST LONG-TERM RELIABILITY

Radiocrafts' Industrial IP Mesh (**RIIM**) is a proprietary wireless technology optimized for large industrial applications that demand robust, reliable long-range communication.

RIIM operates on the license-free, global sub-GHz frequency band reserved for Industrial, Scientific, and Medical (ISM) applications. Its specific operating frequency varies by region: E.g. 868 MHz in Europe, and 915 MHz in the US.

RIIM enabled devices can communicate over distances of 1.5 km outdoors and 150 m indoors or in densely-built urban environments.

Because a RIIM data packet can hop up to 27 times from device to device within a network, this extends the network range to 40 km x 40 km outdoors, 19 x 19 km for urban, and 4 x 4 km indoors.

RIIM's extensive range and coverage, combined with its capacity to connect up to 1,000 devices from a single gateway, make it highly scalable and flexible in router placement.

This flexibility can significantly help reduce installation costs, as often only one gateway is required to support a large-scale building complex. For even larger areas, an additional gateway can be added. This simplicity enhances RIIM's reliability and ensures network issues can be resolved quickly.

Pre-certified modules are good to go

RIIM is supplied as an FCC and CE pre-certified RF module-based solution, designed for seamless integration into sub-metering applications.

Symmetric upload download speeds

RIIM provides equally fast upload and download performance, significantly reducing network congestion during periods of high activity. This ensures that users can efficiently and reliably send commands, and update device firmware, even when the network is fully deployed and operating at capacity.

For example, RIIM can typically complete firmware Over-the-Air (OTA) updates for an entire wireless sub-metering network in under three minutes, which is exceptionally fast compared to other sub-GHz mesh technologies.

Hardwired wireless reliability

While sub-GHz operation is also offered by technologies such as Wi-SUN and LoRa, RIIM sets itself apart with a 99.99% data transmission success rate in real-world environments.

This level of reliability rivals that of a hardwired cable and surpasses Wi-SUN, LoRa, and Zigbee.

Time-Synchronized Channel Hopping

RIIM's reliability arises from its use of Time-Synchronized Channel Hopping (TSCH).

TSCH is a standards-based (IEEE 802.15.4-2015) frequency hopping methodology that is natively integrated into RIIM's physical (PHY) hardware and managed communication (MAC) software layers.

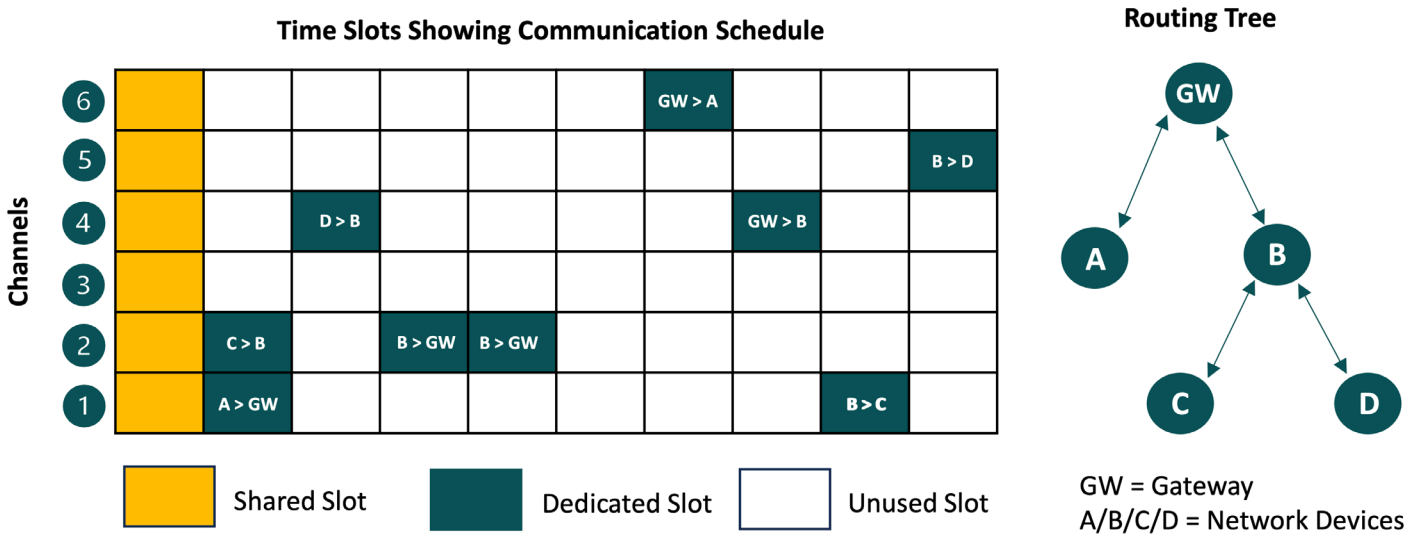
TSCH ensures consistent and robust network performance by transmitting data across multiple pre-set radio channels within precisely synchronized time slots.

In this way, RIIM devices always know exactly which channel and time slot to use for data transmission, eliminating uncertainty.

If a data packet is lost between devices, it is automatically re-sent on a different channel in the next available time slot, increasing the reliability of the network significantly. This approach is particularly critical in the crowded Sub-GHz ISM band, where countless devices compete for bandwidth. By leveraging TSCH, RIIM maintains reliable communication in even the most congested RF environments.

HOW IT WORKS

TSCH



Interference immunity

In addition to TSCH, RIIM employs a pioneering technique called Polite Spectrum Access, which combines what's termed Adaptive Frequency Agility (AFA) and Listen Before Talk (LBT) methods to significantly reduce interference and data packet collisions.

This further ensures exceptional resilience to radio frequency noise, even in environments crowded with other wireless devices.

In practice, the RIIM protocol scans all available channels for interference before each transmission. If interference is detected, RIIM excludes those channels from its TSCH frequency hopping list to transmit on only the best and least noisy channels.

In Europe, RIIM's Polite Spectrum Access strategy allows it to transmit approximately 37 times more data than other sub-GHz wireless technologies, while fully complying with strict EU regulations mandating how often a device can send data.

Mesh networking

RIIM features a self-forming, self-healing, and self-optimizing mesh network architecture.

The mesh network design allows devices to communicate directly, or relay data through intermediate nodes, ensuring reliable performance even if some nodes go offline or encounter interference.

RIIM's mesh network also makes the deployment of sub-metering networks virtually plug-and-play. In fact, the entire commissioning and onboarding process is fully automatic, eliminating the complexities typically associated with setting up large networks.

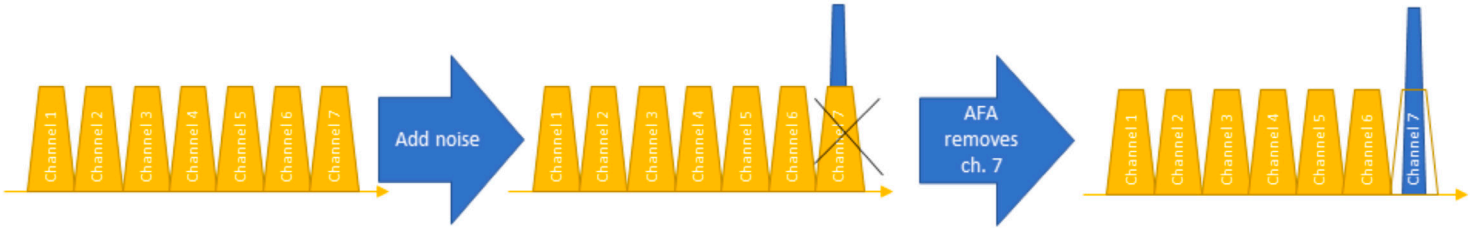
RIIM uses factory-shipped devices that automatically configure themselves with minimal effort, requiring little more than a simple 2D barcode scan to join the network.

RANGE & PENETRATION

In densely built urban or indoor environments, RIIM can cover a sub-metering building complex or campus as large as 19 x 19 kilometers from a single gateway.

HOW IT WORKS

POLITE SPECTRUM ACCESS



WHICH WIRELESS TECH

WHAT OUR CUSTOMERS SAY

"The Radiocrafts RIIM module has allowed us to create and implement a mesh-based, cloud-connected datalogger for use in ultra-difficult real-world RF environments."**– Logan Stephens, Design Manager of InFact**

"Our partnership with Radiocrafts has been instrumental in the success of our products. The RIIM module proved to be a high-quality product allowing us to create a highly robust and long-range mesh network fitting for our application. In addition, we are elated with the Radiocrafts support team who provided quick and efficient support every step of the way from the proof-of-concept phase all the way to production." **– Tore Johnsen, CEO of Aiwell AS**

"Working with Radiocrafts on integrating their new RIIM product line with our electric sub-meter energy management at the board level was a refreshing experience in today's world. We truly value our relationship with Radiocrafts, their expertise, and are looking forward to a mutually beneficial relationship."

– Ryan Fetgatter, CEO of EZ Meter

QUICK FACTS

ABOUT RADIOCRAFTS

IN SUB-METERING

Radiocrafts' wireless technology has been widely adopted in the smart metering market, with over 3 million modules installed to date. 50% of Paris's water utility meters are powered by Radiocrafts wireless tech.

SUMMARY

WHY SUB-GHz MESH

Sub-metering is a uniquely demanding challenge for wireless technology.

It demands robust, whole-building penetration, with reliable connectivity extending from the deepest basements and car parking garages, to the highest floors of skyscrapers.

With the wrong choice of wireless technology, sub-metering applications will struggle with reliability and coverage issues. Challenges that only worsen as projects scale in size, driving up maintenance complexity, downtime, and cost.

Sub-metering applications are designed to last for decades, requiring the durability to withstand the test of time. This includes robust operating interference immunity that ensures seamless operation, even as the local wireless operating environment evolves unpredictably over the years.

The ideal wireless technology would be fit-and-forget reliable, future-proofed, and easy to install, maintain, and adapt. This minimizes the total cost of ownership and ensures the project avoids serious operational issues, both now and in the future.

RIIM sets a benchmark for wireless sub-metering, offering reliability, range, scalability, and a future-proofed design built to last for decades.

TAKE THE NEXT STEP

WITH RIIM WIRELESS TECHNOLOGY

ARE YOU READY TO TAKE YOUR SUB-METERING PROJECT TO THE NEXT LEVEL?

GET STARTED TODAY

ORDER YOUR RIIM DEVELOPMENT KIT

Experience RIIM's capabilities firsthand with our user-friendly development kit, designed for real-world testing in sub-metering applications. The kit enables out-of-the-box wireless network setup, allowing you to quickly assess network performance and explore the full potential of RIIM in your application.

BOOK A FREE DEMO CONSULTATION

Schedule a free Teams consultation or book an on-site demo with a Radiocrafts expert. Discover how RIIM can optimize your sub-metering project and get practical, real-world advice and insights.

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