

# IoT Wireless Protocol Landscape - Unlicensed Spectrum

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# Atria University: Creating Graduates Who Solve Societal Problems

## Liberal STEM : Interdisciplinary UG & PG Courses

- Digital Transformation
- Energy Sciences
- eMobility
- Life Sciences
- Sustainable Entrepreneurship

## Pedagogy: Experiential Project- Based Learning

- Ensure balance between Theory and Practice.
- Lectures limited to <35%
- Students implement projects, collaborate with peers, and present learnings in an engaging environment.

## Immersive Learning Sprints

- Holistic subject learning in 90-hour Learning Sprints.
- Focus on hands-on projects, presentations, peer learning, and mock interviews.
- Multi-modal assessments measure competence holistically.

## CoE-Centric Model

Industry practitioners dedicate 60-70% time to state-of-the-art projects and 30-40% to teaching students, ensuring that real-world expertise drives education.

# Short-Range Wireless IoT Protocols: 2025 Landscape

The short-range wireless ecosystem has evolved significantly, with three dominant protocol families addressing diverse IoT connectivity requirements across residential, commercial, and industrial applications. Typically operate on 2.4 GHz Spectrum.

## Low-Power IP Stack

Matter over WiFi / Thread

### Matter + Thread + 802.15.4

- **Matter v1.5:** Support for cameras (with TCP transport). Enhanced multi-admin support and improved device commissioning flows
- **Thread v1.4:** Optimised mesh routing algorithms, reduced power consumption by 15-20%
- **802.15.4:** New channel access mechanisms for denser deployments

Ideal for smart home interoperability with unified application layer across IP-based networks.

## BLE: The Incumbent

### Bluetooth LE 6.0 Updates

- **Channel Sounding:** Centimetre-level (?) distance measurement for precise indoor positioning (RTLS)
- **Decision-Based Advertising:** Intelligent filtering reduces scanner power by 40%
- **Frame Space Updates:** Higher throughput and improved coexistence with Wi-Fi 6E/7

Dominant in wearables, health monitoring, and asset tracking with 5+ billion annual shipments.

## Ultra-Wideband (UWB)

### FiRa 3.0 and IEEE 802.15.4z Enhancements

- **Secure ranging:** Sub-10cm accuracy (?) with anti-relay attack protection (HRP mode)
- **Multi-device ranging:** Simultaneous tracking of 50+ tags in industrial settings
- **Smartphone Adoption:** Adoption by Apple and Android ecosystem is a major boost.

Critical for automotive digital keys, industrial RTLS, and secure access control systems.

# Longer-Range Wireless IoT Protocols: Extended Connectivity

For applications requiring kilometre-scale coverage—agriculture, utilities, smart cities—these protocols balance range, power efficiency, and data throughput to address infrastructure-scale deployments. Typically operate on Sub 1-GHz Spectrum.

## Wi-Fi HaLow (802.11ah)

### Sub-GHz Wi-Fi for IoT

- 1 km+ range in open environments; penetrates walls 2x better than 2.4 GHz
- New 2025 chipsets from Morse Micro and Newracom enable mass adoption
- Target-Wake-Time (TWT) extends battery life to years for low-duty-cycle sensors
- Native IP support simplifies integration with existing Wi-Fi infrastructure
- Video-capable Long Range

Use cases: Smart Meters, Video surveillance, industrial sensors, and building automation.

## LoRa + LoRaWAN

### LPWAN - Incumbent (?)

- **LoRaWAN 1.1 relay specification:** Mesh-like coverage extension without additional gateways
- LoRa 2.4 GHz variant enables global harmonised spectrum deployment
- LoRa Edge combines geolocation (GNSS, Wi-Fi sniffing) with LoRaWAN connectivity

Use cases: Agriculture, utilities, and asset tracking with 10+ year battery life.

## Wi-SUN (Smart Utility Networks)

### Mesh Networking for Critical Infrastructure

- **Wi-SUN FAN 1.1:** Field Area Network specification with multi-hop mesh up to 1000+ nodes
- IPv6-native architecture ensures future-proof addressing and security
- Frequency-hopping spread spectrum (FHSS) provides interference resilience
- Widely deployed in smart metering (100M+ devices globally as of 2024)

Preferred for utilities, street lighting, and municipal infrastructure.

# Key Industry Trends Shaping the IoT Protocol Landscape

## Edge AI Integration

AI inferencing capabilities are being embedded directly into wireless SoCs, enabling intelligent decision-making at the network edge. TinyML frameworks are optimising models for ultra-low-power operation, reducing cloud dependency and latency.

## Physical AI Revolution

Convergence of wireless protocols with robotics and autonomous systems is accelerating. Real-time sensor fusion from multiple wireless inputs enables sophisticated physical interactions, transforming industrial automation and autonomous vehicles.

## Security-First Design

Cryptographic modules being integrated into protocol stacks to future-proof IoT deployments. Hardware-based security elements and secure boot mechanisms are becoming standard requirements across all major wireless SoCs.

 **Market Insight:** The global IoT connectivity market is currently \$21 billion and projected to reach \$28.5 billion by 2027, with unlicensed spectrum protocols capturing 65% of device connections. Multi-protocol SoCs supporting protocols like BLE, Thread, and WiFi on a single chip are becoming the industry standard, reducing BoM costs by 30-40%.

References: Bluetooth SIG Market Reports 2024-2025, CSA Matter Specification Updates, FiRa Consortium Technical Documents, LoRa Alliance Regional Reports, Wi-SUN Alliance Market Analysis, IoT Analytics Global Connectivity Report 2025

# Thank You

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