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Wireless connectivity made simple.

WHITEPAPER: NeoMesh on LoRa® PHY

A UNIFIED WIRELESS PLATFORM DELIVERING LONG RANGE, NOISE IMMUNITY, LOW POWER, AND MASSIVE SCALABILITY

Executive Summary
IoT deployments today frequently span thousands of sensors distributed across difficult environments—underground, across farms and forests, throughout industxrial facilities, or inside large buildings. Each deployment brings a unique set of challenges, and no single wireless technology has traditionally been able to satisfy all of them.

This white paper presents a new combined approach: **NeoMesh using LoRa® modulation as its physical layer.** NeoMesh provides a fully decentralized, self-healing, ultra-low-power mesh network capable of supporting thousands of nodes without complex installation or reliance on mains-powered routers. LoRa delivers long-range communication and exceptional immunity to noise and interference. Together they can create a wireless system with strong performance across a broader range of environments than either technology can address alone.

1. INTRODUCTION

Wireless connectivity is the backbone of modern IoT systems. Yet real-world operating conditions vary widely. A dense smart building, an underground mine, and a 30,000-acre farm place very different demands on wireless links, including range, power limitations, scalability, interference resistance, and regulatory constraints.

Technologies like Zigbee, BLE Mesh, Thread, and LoRaWAN® have grown in popularity, but each addresses only a subset of the challenges. The combination of NeoMesh's mesh topology with LoRa®'s modulation scheme creates a new option that meets the needs of environments where long range, low power, and simplicity of installation must co-exist.

2. THE ROLE OF THE PHYSICAL LAYER

Higher layers of wireless protocols often receive the most attention, yet the performance of any radio system depends fundamentally on its physical layer. Receiver sensitivity, determined by bandwidth, noise figure, and required SNR, dictates how far a signal can travel and how well it can be received in the presence of interference.

Early low-power wireless systems often relied on OOK or FSK modulation. These were easy to implement but required relatively high SNR to achieve acceptable error rates. LoRa® modulation, by contrast, dramatically lowers the required SNR, enabling reception of signals even when they fall below the noise floor. The extent to which LoRa can receive below the noise floor is given by the spreading factor:

SF	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
SNR [DB]	-2.5	-5.5	-8.2	-11.0	-13.7	-16.5	-19.5	-22.2

3. LORA® MODULATION

LoRa® employs Chirp Spread Spectrum modulation, which spreads the information across a swept-frequency signal. This method provides two major advantages: it improves resistance to noise and interference; and it allows receivers to demodulate signals with negative SNR. Depending on the spreading factor selected, LoRa®links can operate more than 20 dB below the noise floor. This capability explains the exceptional range that LoRa® systems are known for and has driven the deployment of more than 350 million LoRa-based devices worldwide.

It should be understood that LoRa® is distinct from LoRaWAN®. LoRa® is the physical modulation technique used on the radio. LoRaWAN® is a protocol stack designed around a star topology with gateways. The white paper focuses on LoRa® as a physical layer, not on the LoRaWAN® architecture.

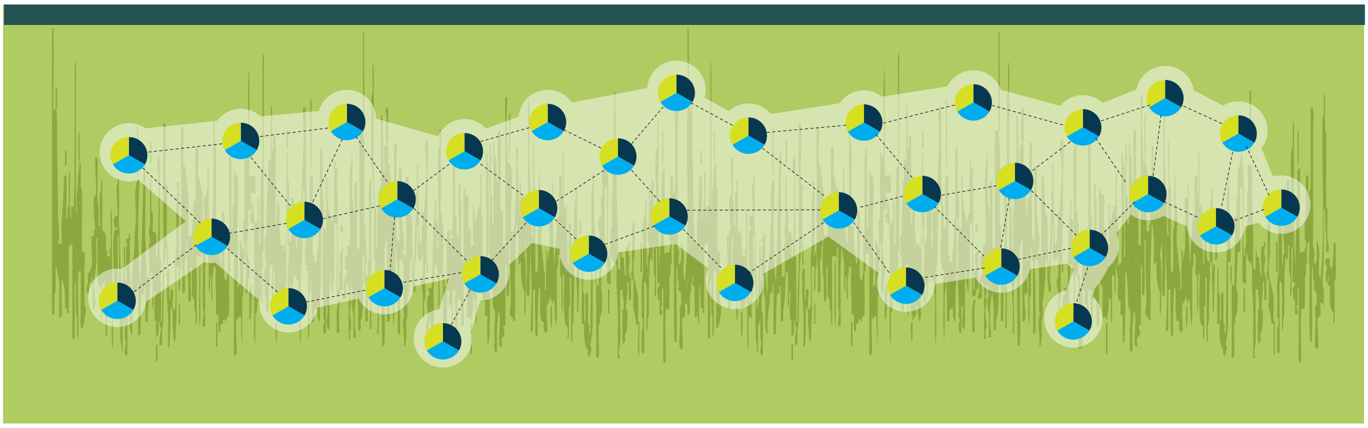
4. NEOMESH: A 2ND-GENERATION MESH NETWORK

NeoMesh was introduced as a truly decentralized mesh networking technology. All nodes are built with identical full functionality, and all can route data. Instead of relying on mains-powered routers or network coordinators, each node is synchronized with the rest of the network. Nodes wake only at precise moments when communication is expected, enabling years of battery operation even in large networks.

The SpeedRouting protocol allows NeoMesh networks to handle mobile nodes, shifting topologies, and arbitrarily deep-routing paths without hop-count limitations. This makes it well suited for installations where node locations may change or where communication paths must adapt automatically.

Originally, NeoMesh operated over FSK in 2.4 GHz and sub-GHz bands at data rates of 250–500 kbps. These modes enabled ultra-low power transmission because packets were short. However, some deployments require either greater range per hop or improved noise immunity. LoRa® modulation addresses these requirements.

Very good resilience to noise for both 2.4GHz and sub GHz frequency band



5. WHY NEOMESH ON LORA®?

The strength of combining NeoMesh with LoRa lies in the complementary nature of the technologies. LoRa® provides the increased link budget needed for long-range communication or communication in highly attenuating environments such as underground galleries, dense forests, or buildings full of walls and interference sources. NeoMesh provides a network topology that eliminates the need for many gateways or the presence of mains power at installation sites.

While LoRa®'s data rate is more limited than FSK's, NeoMesh typically transmits very small payloads with short on-air times, so the low throughput of LoRa is not a barrier. Instead, LoRa's robustness becomes a significant advantage, while NeoMesh ensures that networks can scale, self-heal, and operate for years on battery power.

The combined system also enables 2.4 GHz operation, which brings advantages such as smaller antennas and the ability to use a single hardware SKU globally—an important consideration for manufacturers deploying products across regions with differing sub-GHz bands.

6.USE CASES

Agriculture

Large farms can span kilometers, and powering distributed gateways is often impractical. NeoMesh allows battery-powered nodes to form a self-routing network, while LoRa® reduces the number of nodes required due to its long-range capability. With remote monitoring solutions for example water levels, pumps, rainfall, temperature, and soil conditions across vast landscapes can easily be monitored.

Forestry and Environmental Monitoring

Forests absorb and scatter radio signals. LoRa® helps overcome this attenuation, while NeoMesh eliminates the need for powered gateways deep in the forest. Researchers studying wildfire detection, wildlife tracking, or canopy stress analysis can deploy sensors simply by placing them within mesh range, allowing the network to configure itself.

Smart Buildings

Smart buildings, especially retrofits, benefit from simple installation and minimal wiring. However, the 2.4 GHz band is crowded with Wi-Fi and Bluetooth. LoRa's noise resilience allows reliable communication even in these conditions, while NeoMesh's synchronized, low-power operation makes it feasible to install large numbers of battery-powered nodes. Using 2.4 GHz also avoids the regional variation found in sub-GHz bands, reducing manufacturing complexity.

Mining

Underground mines are challenging RF environments: they are noisy, attenuating, and impossible to cover with mains-powered gateways. A LoRaWAN architecture would require large numbers of high-power gateways. NeoMesh on LoRa® removes this need entirely. Battery-powered mesh nodes provide continuous communication for gas detection, fire monitoring, structural safety, and equipment status without any wired infrastructure.

7. AVAILABILITY

NeoMesh on LoRa is now commercially available through Embit's EMB-LR1121-e/mesh module. This module integrates the Semtech LR1121 transceiver and an STM32 MCU, and supports global operation across 2.4 GHz, 868 MHz, and 915 MHz bands. Multiple LoRa® configurations are supported, and the module can also operate with (G)FSK modulation if desired.

NeoCortec also provides the NeoMesh protocol stack on a licensing basis, enabling integration into custom hardware platforms or high-volume applications.

8. CONCLUSION

The combination of NeoMesh and LoRa® modulation forms a wireless connectivity platform that achieves long range, strong noise immunity, years-long battery life, and effortless scalability. It eliminates many of the installation hurdles associated with traditional mesh networks and the infrastructure burden associated with LoRaWAN. By merging a highly capable PHY layer with a next-generation mesh protocol, the solution delivers reliable coverage in environments ranging from dense buildings to remote agricultural fields to underground mines.

This unified approach marks a significant step forward in practical IoT connectivity and expands the range of applications in which low-power wireless systems can be deployed successfully.

CONTACT

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