Wireless Mesh Sensor Networks – the E-zeroBatteryZone® NeoMesh on LoRa®

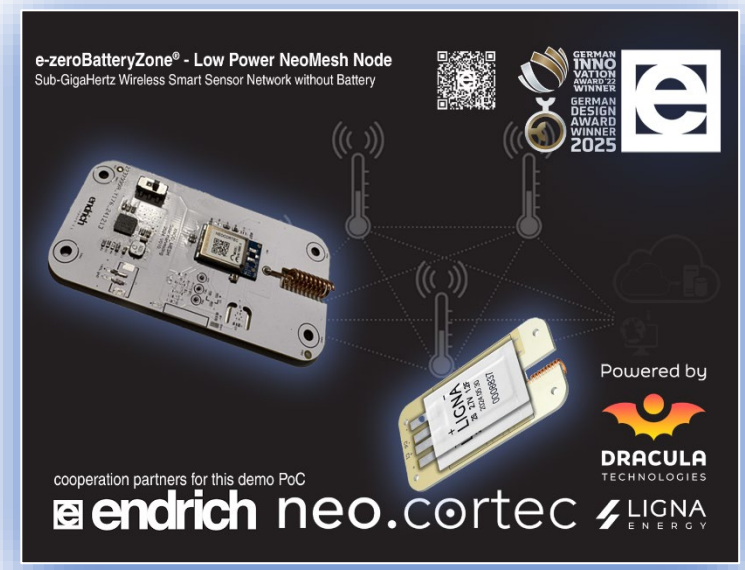
Zoltán Kiss, Export Manager - Head of R&D, and Csaba Kocsis, Electronics Development Engineer
Endrich Bauelemente Vertriebs GmbH

In the previous issue of the magazine, we reported on an important innovation: we developed and are preparing to present at the EmbeddedWorld 2025 exhibition in Nuremberg the ultra-thin E-zeroBatteryZone® wireless smart sensors, which seamlessly integrate into the E-IoT ecosystem using NeoCortec's low-power Mesh protocol. Endrich's innovation is powered by several key partners, including the Danish company NeoCortec, who have been with us since the inception of the first design, providing low-power radio modules; Swedish company Ligna Energy, whose specialized, ultra-thin, environmentally-friendly supercapacitors are used; and French company Dracula Technologies, whose solar cells can harness light energy even under low indoor illumination, making this solution both powerful and sustainable.

But this is not the only innovation we are preparing to showcase; 2025 will be the year of cooperation at Endrich, and taking advantage of the fact that the NeoMesh protocol can also run on LoRa PHY, the first NeoMesh on LoRa® sensor module has been completed as the newest member of the E-IoT family. This is also a product, which was made possible through extensive cooperation: based on the Semtech LoRa chipset, Italian company Embit SRL created a radio module on which NeoCortec's ultra-low-power network protocol runs, which Endrich integrated into a solar-powered E-zeroBatteryZone® NeoMesh on LoRa® smart sensor network node.

Ultra-low power wireless IoT sensor networks – the power of the NeoCortec software stack

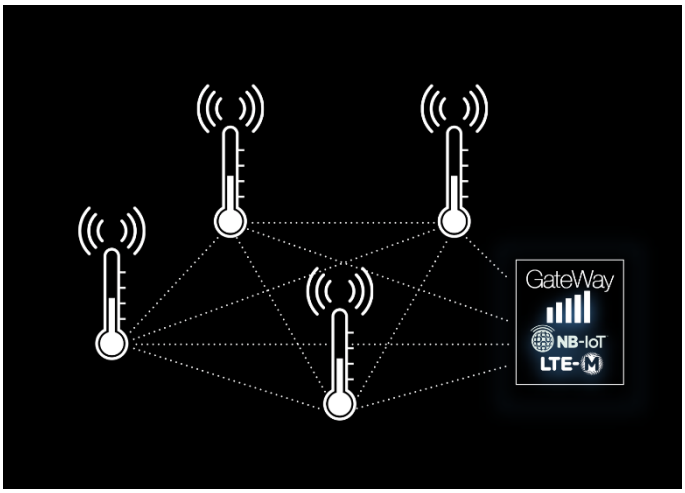
Taking advantage of the extremely low power consumption of radio modules running the NeoMesh protocol, it is possible to create large-scale, ad-hoc wireless sensor networks, enabled by automatic routing, which were introduced in the previous part of this series with the battery-free smart sensor nodes. These nodes can be connected to the Internet cloud service via a NeoMesh/LPWAN gateway at a single point. A large number of intelligent sensors can be integrated into the network and deployed quickly without any on-site installation settings. The ultra-low power consumption enables the use of the newly introduced battery-free devices, which are equipped with special solar cells and are suitable for continuous operation even under indoor lighting conditions. The distance between the nodes in the network can be several tens of meters indoors, and the mesh can include hundreds of sensors, meaning that, when designed properly, a large area can be covered with sensors.



The question arises as to whether, in cases where sensors do not need to be placed just a few meters apart, it is cost-effective to position the devices so densely just to maintain the operation of the radio communication protocol, many of which would only serve as repeaters or signal relay devices. Fortunately, the NeoMesh protocol, as a software stack, can be ported to other physical devices, so in specific cases, the Bluetooth module stack can be replaced, or the protocol can even be run on LoRa PHY. LoRa communication enables much greater range, meaning that a "sparser" mesh can be created to solve the task that traditional NeoMesh would only be able to address by adding redundant node elements.

In addition to the traditional NeoMesh-based device presented earlier, the E-zeroBatteryZone® product family has been expanded with a new member, the NeoMesh on LoRa®-based sensor module, which implements the NeoMesh protocol's communication version using LoRa modulation. At Endrich, we are pleased to offer a wide-range, locally deployable wireless network solution that utilizes energy-harvesting, battery-free technology to complement the E-IoT sensor family.

LoRa-based Mesh Networks in General – E-IoT and LoRa



LoRa (Long Range) is a low-power, long-range/wide area (LPWAN) wireless communication technology primarily developed for IoT (Internet of Things) applications. LoRa enables data transmission over several kilometers while minimizing device power consumption. One of its key advantages is that it does not require licensed frequencies, making it usable worldwide. LoRa-based systems often use the LoRaWAN (Long Range Wide Area Network) protocol to manage network communication, which facilitates data exchange between sensors and devices in areas such as urban infrastructure, agriculture, smart metering, and other industrial applications. LoRa technology offers long-range data transmission while ensuring security, easy implementation, and cost-efficiency, making it an ideal choice for applications in remote and hard-to-reach locations.

LoRaWAN providers differ regionally, which can be a disadvantage. As a result, the E-IoT ecosystem avoids using LoRaWAN. In different countries and regions, different providers may operate the LoRaWAN networks, so if a device or application wants to operate globally, it must consider multiple network providers. This is especially important if an IoT solution needs to function across multiple countries or continents, as each provider has different infrastructure and tariffs.

It can be a fairly expensive but good solution if the user has their own LoRaWAN network and can operate independently of the providers. The advantage of such solutions is that they offer more control over the network infrastructure, but the installation and operational costs may increase.

Therefore, for global applications, it is essential to consider the availability of local LoRaWAN providers and potential compatibility issues. This is why at Endrich, we prefer other LPWAN solutions that primarily use cellular networks (NB-IoT, LTE-M). However, LoRa modulation undoubtedly offers many advantages when building large-scale local networks, and we cannot overlook this fact. That is why we decided that, although the E-IoT ecosystem entirely avoids the LoRaWAN protocol, we will apply the NeoMesh on LoRa® concept.

LoRa-based mesh protocols are becoming increasingly popular among radio communication technologies, especially for low-power, long-range devices such as sensor networks and telecommunications. These protocols enable devices to form an extensive network, allowing remote nodes to send and receive messages without the need for a direct connection to a central base station. One widely used open-source protocol is Meshtastic. Since it does not fully meet the expectations for such networks, particularly regarding ultra-low power consumption of the nodes, we once again looked to the NeoMesh protocol for the breakthrough.

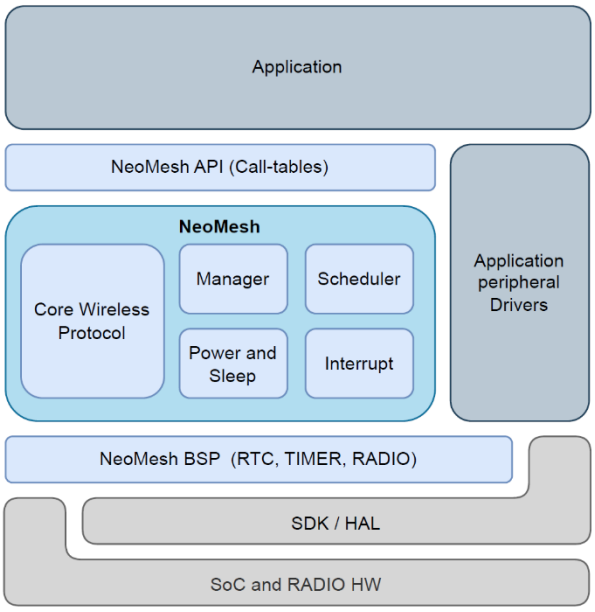
In his presentation at the Munich Wireless Congress at the end of 2023, Thomas Steen Halkier, the CEO of NeoCortec, predicted the possibility of implementing the NeoMesh protocol on LoRa modulation, and it was then that I decided we needed to focus on this solution.

NeoCortec's NeoMesh on LoRa®

The NeoCortec NeoMesh on LoRa® solution uses LoRa technology to create scalable and reliable mesh networks. Instead of requiring a central hub, network devices can forward messages to each other, forming a self-healing, ad-hoc, robust network that enables automatic routing. The NeoCortec implementation focuses on low power consumption, easy integration, and secure, cost-effective connections for IoT applications in various industries. The NeoCortec NeoMesh on LoRa® is characterized by ultra-low system power consumption, thanks to a tightly synchronized, time-based node architecture (node devices spend most of their time in energy-efficient sleep mode

and wake up in precise time synchronization for short transmission periods). As a result, every device in the network can operate on battery power. The patented NeoMesh protocol stack, which features a highly scalable architecture, allows for the application of flexible topologies through real-time dynamic routing, running on a variety of hardware modules. The LoRa modulation used ensures the creation of a long-range mesh network that meets noise immunity requirements. The devices are available for both Sub GHz and 2.4 GHz frequencies and can be implemented on radio modules from multiple manufacturers.

Time-synchronized operation allows for industry-leading low power consumption for active mesh network nodes.

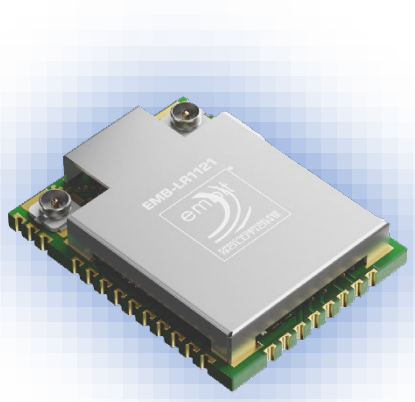


The full AES128 encryption and 32-bit CRC combination elevate the system's reliability and data security to the next level. The foundation of NeoMesh on LoRa® is distributed network intelligence with autonomous nodes, capable of operating without a central network manager. The patented routing algorithm, optimized for dynamic, low-power mesh network topologies, ensures that sensor data can find its way to the cloud even from large areas, without the need for additional network routing devices. Channel hopping ensures immunity to noise and interoperability across all frequency bands. The software stack's low memory footprint (<100 kB Flash memory) enables cost-effective integration and supports various MCU families and radio modules, including those from TI, SiLabs, nRF, Semtech, and STM. We have incorporated the module from the Italian company Embit into our own devices.

*When comparing the traditional FSK-based NeoMesh and the NeoMesh on LoRa® (powered by NeoCortec), it becomes clear that the latter is capable of bridging longer distances at a higher power consumption. LoRa promises a longer range than traditional FSK NeoMesh. The improved sensitivity comes from reducing the data transmission rate, and LoRa achieves higher data rates at a given sensitivity, but the maximum data rate is limited. The traditional FSK NeoMesh requires a positive signal-to-noise ratio (SNR), typically >+7 dB, while the LoRa-based version can tolerate negative SNR (-2.5 -> -20 dB, SF 5 -> SF12).

(*Based on Thomas Steen Halkier's presentation from Wireless Congress in Munich, 2023 Nov.)

The technology is recommended for use primarily in the following cases, where the following requirements are simultaneously met:



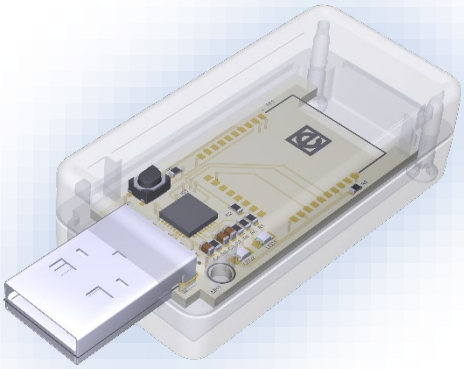
- Low device density – Long distance between nodes (>50 m)
- Battery-operated WLAN network is required
- Relatively low throughput is sufficient

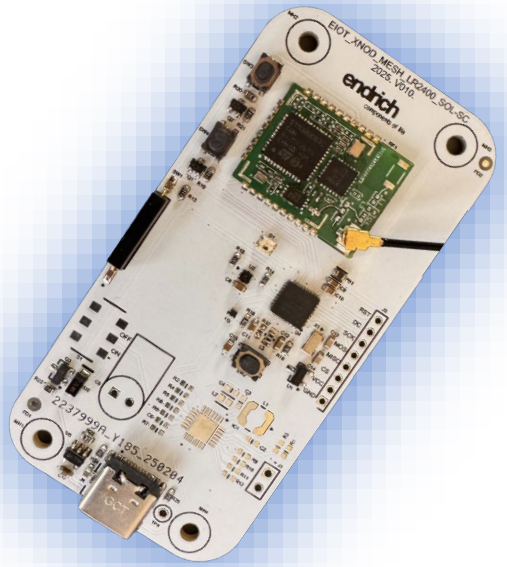
The fields of application are diverse, ranging from highly reliable wireless IoT sensor networks, automatic meter reading, advanced metering infrastructure, mobile ad-hoc networks, home control, building automation, industrial automation, alarm and security systems, to agricultural and forest monitoring, all of which require this type of advanced WLAN technology.

The E-NeoMesh on LoRa® Product Family

Endrich is one of the first companies in the world to create a NeoMesh on LoRa® device using the NeoCortec protocol, and we are preparing a special design for this. This device is solar-powered and does not require batteries, demonstrating the excellent power consumption characteristics of the LoRa PHY. Therefore, the first device in the E-zeroBatteryZone® NeoMesh on LoRa® product family is this battery-free temperature sensor node, followed by the USB gateway device, which, when inserted into a computer, can be used as a NeoMesh on LoRa®/Internet gateway, enabling the visualization of data coming from NeoMesh on LoRa® and sending it to the cloud. Both devices use 2.4 GHz EMBIT modules, on which the NeoCortec mesh protocol runs.

The official presentation will take place at the EmbeddedWorld25 exhibition in Nuremberg, where devices can be seen on the booths of Semtech, Embit, NeoCortec, and Endrich. One of the exhibition halls will be equipped with a NeoMesh on LoRa® network to demonstrate its capabilities.





We warmly invite our dear readers to visit our stand, where we will also have a few copies of the Endrich "E-IoT" concept book, which was released at the end of last year.

endrich

"The book Zoltan has written is a source of goodies for everyone who wants to dig a level deeper into the world of IoT. The concept of IoT can be overwhelming as it encompasses so many technical disciplines, ranging from sensors, batteries, microcontrollers & embedded low-level software all the way to different types of wireless communication and in the end complex cloud architectures.
This book, and particularly the E-IoT system, offers valuable detailed information on all aspects of such a system. I highly recommend anyone who is considering designing IoT solutions or maybe just interested in learning about IoT technology, to read Zoltan's book."

Thomas Steen Halkier, CEO Nocortec, Denmark

"The use of IoT (Internet of Things) and Industry 4.0 has garnered adoption across global market segments as the next generation of smart systems. This "A COMPLETE IOT ECOSYSTEM" book addresses both the hardware and software requirements to support the collective network of connected devices. This excellent technical reference outlines the technology that facilitates enhanced communication between smart devices and the cloud. The author Dipl. Ing. Zoltán Kiss has extensive experience in the IoT industry while receiving multiple technical awards as recognition for his technical knowledge in the IoT field. The "A COMPLETE IOT ECOSYSTEM" book is highly recommended for those persons who want to know how to use smart sensors and get associated data into the cloud."

Ian Doyle, Director of Sales & Marketing EMEA at ProTek Devices USA