BEHRTECH™

# MYTHINGS™ vs. LoRa

## A Comparative Study of Quality-of-Service Under External Interference

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# Introduction

The Internet of Things (IoT) is giving rise to an explosion of connected devices. By 2025, total IoT connections are expected to surpass 22 billion, with Low-Power Wide Area Networks (LPWAN) seen as the prominent facilitator of this growth. The escalating number of IoT devices generates heavy radio traffic in the license-free spectrum where multiple wireless systems co-exist. According to ABI Research, as of late 2018, license-free LPWAN technologies account for 71 percent of the market. This glimpse into the future stresses the significance of interference resilience as the key to Quality-of-Service (QoS) and the future viability of these solutions.

Commissioned by BehrTech, a systematic, impartial study has been conducted to evaluate and compare the real-world QoS of MYTHINGS and LoRa – two major LPWAN solutions on the market. At the core of MYTHINGS is Telegram Splitting – Ultra Narrow Band (TS-UNB), the only LPWAN technology in the license-free spectrum standardized by ETSI (TS 103-357).

The study measured network performance, defined by Packet Error Rate (PER), under interference conditions. PER signifies the percentage of failed transmissions out of total sent messages. In LPWAN, acknowledgment of successfully received messages is mostly bypassed to minimize power consumption. As a result, PER becomes a pivotal indicator of LPWAN's reliability and QoS. The Industrial IoT sector with mission-critical applications typically demands a PER of less than one percent.

This study will prove that in real-world Industrial IoT deployments (IIoT), MYTHINGS delivers significantly higher interference resilience than LoRa. More specifically, it will show that in a high interference environment at the same network range, MYTHINGS does not lose a single message, while LoRa loses more than 10 percent of total messages and that when high interference exists, there is always a certain extent of failed LoRa transmissions, regardless of signal power and range.

# Test Setup

For a wireless network, especially for an unsynchronized LPWAN network, inter-system interference (i.e. external interference) is defined as radio signals from its own or other wireless systems within shared (license free spectrum) frequency bands. In this study, inter-system interference is generated based on the LPWAN Interference Model Standard developed by IEEE. The interference model is a random pattern of varying interferences (i.e. long and short radio bursts with higher and lower bandwidth), that are defined by real-world measurements. It represents actual interferences that impact wireless networks being rolled out today and in the future.

The test setup is illustrated in Figure 1. Connected to the transmitter, a step attenuator is used to adjust the desired signal power to simulate different distances between the transmitter and a base station. At the same time, a vector signal generator emits thousands of uncoordinated interfering signals, based on varied assumptions that mimic different real-world environments (e.g. rural and urban). A combiner then mixes interfering signals with the respective MYTHINGS or LoRa transmissions to establish the interference playgrounds and examine whether messages successfully arrived at the base station. To serve the purpose of this study, all hardware components were connected using cables.

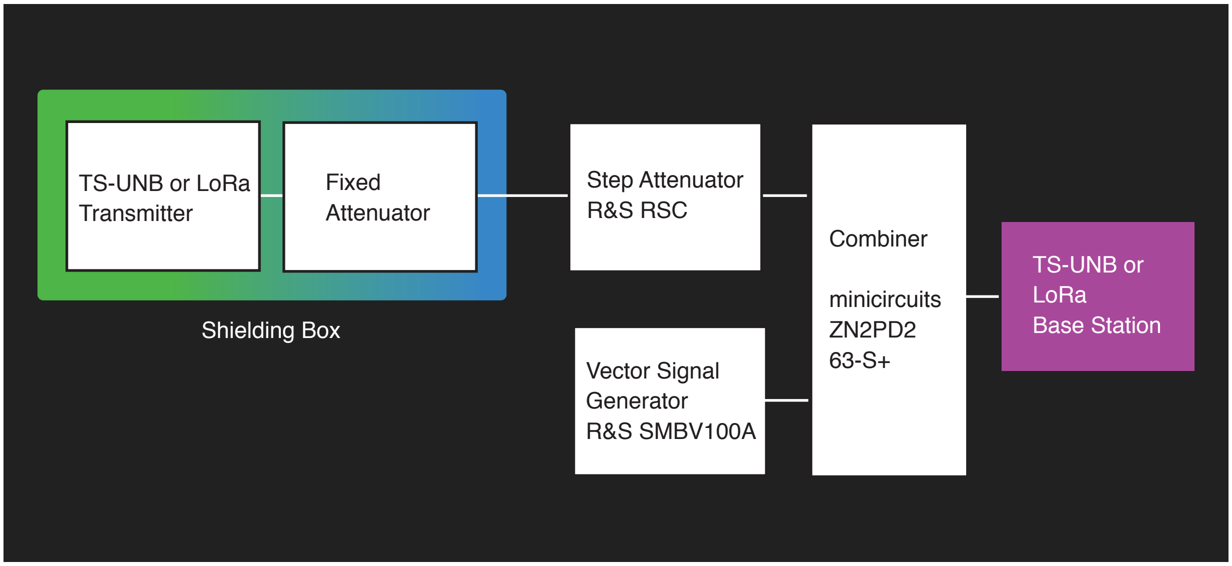


*Figure 1: Test Setup*

The test was set up for a credible and unbiased comparison. The following approaches were taken to avoid misleading results:

**01** **Hardware choice:** The tested hardware was chosen to guarantee the optimal performance of each technology. For LoRa, the EU-mode MultiConnect Conduit IoT Starter Kit by Multitech was selected. The Starter Kit was tuned for LoRa Spreading Factor (SF) 12, which offers the highest interference resilience and highest sensitivity compared to other Spreading factors at the expense of lower data rates. For MYTHINGS, the EU-mode MYTHINGS Pilot Kit by BehrTech was selected.

**02** **Interference pattern:** Interfering signals were generated so that MYTHINGS and LoRa systems experience the same interference pattern at the same signal level.

**03** **Laboratory setup:** A metal shielding box was employed to avoid cross-talk from the transmitter to the base station through a wireless radio link. This ensures that all transmitted LoRa and MYTHINGS messages must go through the simulated interference playgrounds. High-quality cables were used to minimize unwanted power attenuation.

**04** **Measurement duration:** Sufficient measurement duration (i.e. 60 minutes and four hours) was conducted for statistically valid results.

# Interference Models

Four interference classes were established to depict different levels of signal density (denoted as α) in the interference playground.

| Interference Class | Signal Density | Equivalent Real-World Scenario |
|---|---|---|
| None | α = 0 | No Interference |
| Low | α = 1 | Smart Building |
| Medium | α = 10 | Smart City |
| Dense | α = 50 | IoT / Industrial IoT |

The definitions of interference classes, signal density and equivalent scenarios were derived from real-world figures. Large cities like Berlin, Barcelona and New York typically have a population density of around 4,000 to 16,000 people per $km^2$, with two people comprising one household on average. This means there could be between 2000 and 8000 households per $km^2$.

To calculate signal density (α), it was then assumed that there are around 7,000 households per $km^2$. The Smart City scenario ($\alpha = 10$) presupposed there are 10 connected devices per household, equivalent to 70,000 devices per $km^2$. Given current forecasts on IoT connections, the IoT/ IIoT scenario ($\alpha = 50$) considered there are 100 connected devices per household, equivalent to 700,000 devices per $km^2$. In both cases, it was assumed that each device transmitted a 5-millisecond long message every 10 seconds.

## What is Dense?

| Key Assumptions | |
|---|---|
| | • 7000 households / $km^2$<br>• 100 connected devices / household<br>• 700,000 devices / $km^2$<br>• 6 messages / minute<br>• Each message is 5-millisecond long |

This test focused on the IoT/ IIoT scenario with a "dense" level of interference, as it aligns with the projected growth of IoT applications in the near future.

# Results

Figures 2-5 illustrate network performance of MYTHINGS versus LoRa in two test scenarios – one without the presence of interference and the other with dense interference equivalent to an IoT/ IIoT deployment.

Results were measured as the Packet Error Rate (i.e. the percentage of unsuccessful transmissions) in relation to signal power of each system – over a 60-minute duration. Note that the signal power can be directly compared to the range between the transmitter and the base station. The lower the signal power, the farther the distance and the higher the chance of packet error.

## No Interference Scenario

Figures 2 and 3 show test results in the “no interference” scenario. As expected, there was hardly any difference in network performance between the two systems, when only noise was present. At a signal level of up to -129 dBm, all messages were successfully received (PER = 0) in both the MYTHINGS and LoRa networks. This validated that the hardware (i.e. Starter Kits) chosen for testing was credible and error-free. Note that in all scenarios, the background noise (i.e. Additive White Gaussian Noise) was set to 10 dB above thermal noise to avoid uncontrolled noise fluctuations.

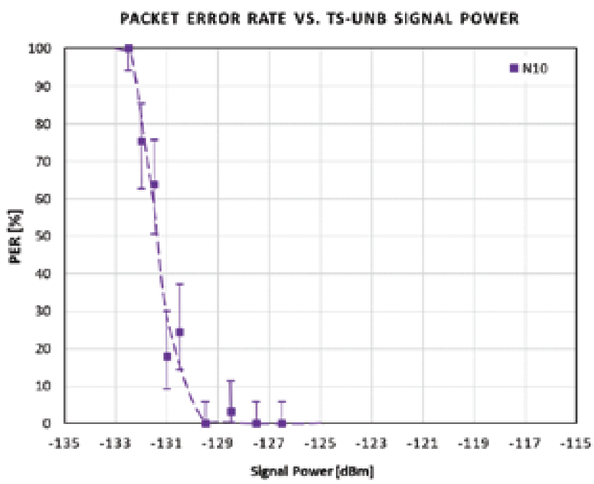


*Figure 2: MYTHINGS performance in a no interference scenario*

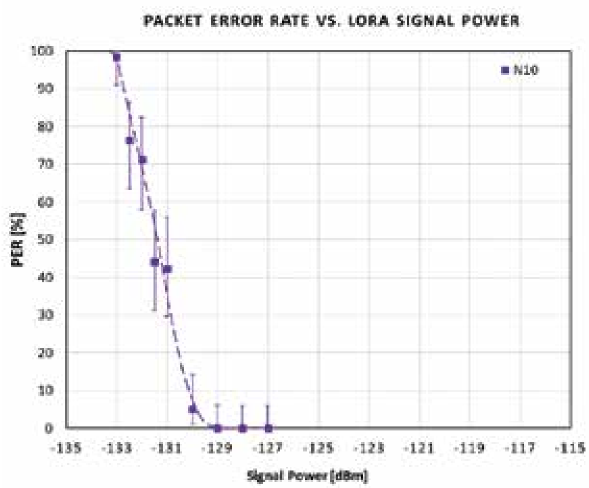


*Figure 3: LoRa performance in a no interference scenario*

## Dense Interference Scenario (Industrial IoT)

On the other hand, a significant difference in QoS was observed in the “dense interference” scenario (Figure 4-5). At the same signal power of -126 dBm (i.e. the same network range), no messages were lost in the MYTHINGS network, while more than 10 percent of total messages (i.e. 120 packets) were lost in the LoRa network.

In an IIoT application, less than one percent PER is required. More notably, even when signal power increased (i.e. higher power consumption or reduced range), there remained a four to five percent PER in the LoRa system. Therefore, it can be concluded that when high interference exists, there is always a certain extent of failed LoRa transmissions, regardless of signal power and range.

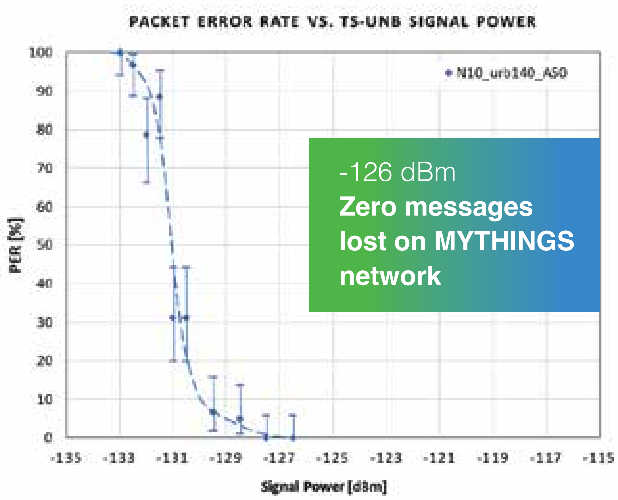


*Figure 4: MYTHINGS performance in a dense interference scenario*

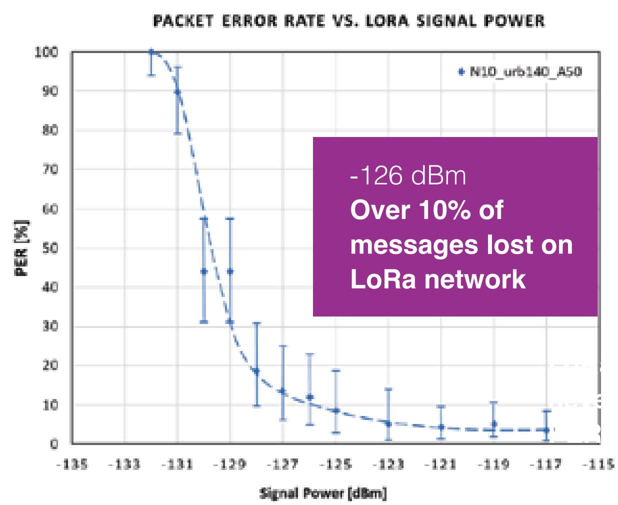


*Figure 5: LoRa performance in a dense interference scenario*

To further consolidate the statistical validity of these results, measurements were recorded once again over a four-hour period (Figure 6). Findings showed that the magnitude of difference between MYTHINGS and LoRa network performance was consistent with the previous 60-minute test. There was a steep drop in packet error for MYTHINGS while packet loss was consistent for LoRa.

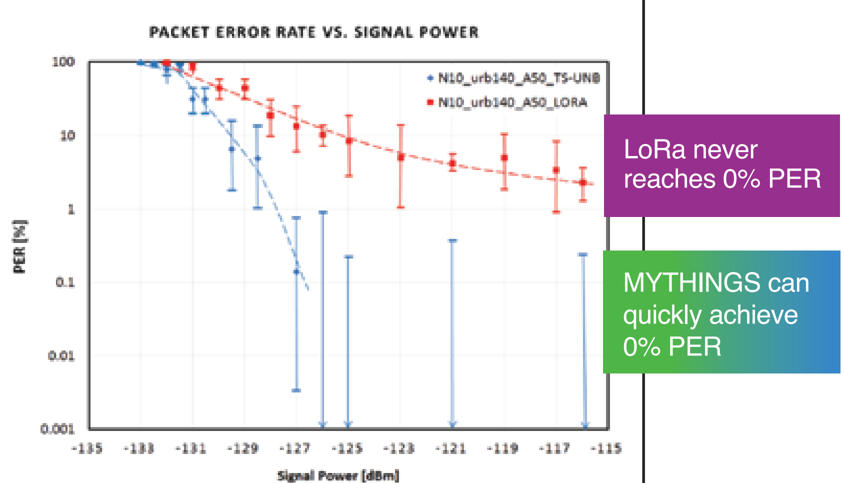


*Figure 6: MYTHINGS vs. LoRa in four hour test*

# Conclusion

The goal of this study is to evaluate and compare the reliability and Quality-of-Service of MYTHINGS versus LoRa networks in IoT/ IIoT scenarios with high levels of radio and electromagnetic interference. To ensure a fair and accurate comparison, the test was carried out with careful planning and setup, selection of high-end hardware and equipment and a statistically satisfactory measurement duration.

Results showed that in an ideal environment (e.g. laboratory) where no interference is present, the two networks performed almost equally. However, in real-world contexts with interference from co-existing radio systems and connected devices, there was a significant difference in network reliability between MYTHINGS and LoRa.

Even at SF 12 for the highest range and interference immunity, the LoRa system failed to achieve a below one percent PER. On the other hand, the MYTHINGS system could quickly zero out packet loss. This means external interference has minimal affects on the MYTHINGS network and message reception is highly reliable. On the contrary, message reception in the LoRa network is unpredictable from one day to another, as there are always changes in the environment, fluctuating interferences or other radio systems transmitting.

With rapidly-growing wireless IoT deployments and the increasing use of existing license free spectrum, it can be concluded that legacy LPWAN solutions will experience extensive Quality-of-Service and scalability challenges. MYTHINGS with the ETSI standard TS-UNB at its core, is able to deliver a completely new level of QoS for future-proof, next-gen IoT networks.

When it comes to real-world IIoT deployments, every message counts and failing to deliver critical data when it's needed the most can result in major consequences. Compared to LoRa, MYTHINGS delivers significantly higher interference resilience in the license-free spectrum, providing robust and future-proof connectivity as device traffic exponentially grows. With MYTHINGS, businesses can seamlessly integrate new IoT applications and devices into their existing infrastructure without compromising network performance.

BehrTech offers a disruptive wireless connectivity software platform that is purpose-built for massive-scale Industrial Internet of Things (IIoT) networks. At the core of the platform is MIOTY, a new communication technology standardized by ETSI that provides reliable, robust, and scalable connectivity unlike any other technology on the market. With its approach to interoperability, BehrTech makes it easy for end users to retrofit its MYTHINGS platform in any environment and enables partners, system integrators, and VARs to deliver fully-integrated IIoT solutions that enable data-driven decisions to be made.
decisions to be made.

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Resources:

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