**IEEE P802.15**

**Wireless Specialty Networks (WSN)**

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| Project | IEEE P802.15 Working Group for Wireless Specialty Networks (WSN) |
| Title | **802.15.4w Technical Guidance Document** |
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| Re: | Task Group 15.4w Technical Guidance for Proposals |
| Abstract | TG4w - Technical Guidance for PHY proposals. |
| Purpose | To capture essential PHY requirements, parameterized into a set of PHY characteristics that technical proposals can address. Guide discussion within task group, help proposers and provide a framework for evaluation of proposals by the TG. |
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### Contents:

[802.15.4w Technical Guidance Document 3](#_Toc508287737)

[Introduction 3](#_Toc508287738)

[802.15.4 Purpose 3](#_Toc508287739)

[802.15 TG4w Need 3](#_Toc508287740)

[802.15 TG4w Scope 3](#_Toc508287741)

[Methodology 3](#_Toc508287742)

[Proposal Criteria 4](#_Toc508287743)

DRAFT 802.15.4w Technical Guidance Document

# Introduction

## 802.15.4 Purpose

The standard provides for ultra low complexity, ultra low cost, ultra low power consumption, and low data rate wireless connectivity among inexpensive devices. In addition, one of the alternate PHYs provides precision ranging capability that is accurate to one meter. Multiple PHYs are defined to support a variety of frequency bands.

## 802.15 TG4w Need

There is significant commercial interest in LPWANs on the part of Wireless Carriers, Utilities, and others around the world as part of their Internet of Things (IoT) arsenal. According to analyst reports, LPWANs are increasingly being used to achievecost-effective connectivity for billions of devices spread over large areas where low power (i.e. long battery life or harvested energy) and long range are important factors and where data rate and low latency are not.

A main functional requirement for LPWANs is achieving improved link margin of typically 155 dB - 160 dB to deal with interferers and achieve distances of typically 10 km - 15 km in rural areas using a low transmit power (typically 14 dBm), while maintaining low energy consumption. This translates to minimum required receiver sensitivities on the order of -140 dBm or better. These needs have driven the increased use of sub-GHz bands over the recent years by various proprietary solutions.

Current standards have not been designed for a very high link margin in license-exempt frequency bands with strong interference while minimizing power consumption and achieving multiyear battery life. To compound matters, interference issues are expected to increase with wide deployment of IEEE Std 802.11ah. The end result is the inability to achieve the required transmission reliability in such scenarios. This amendment is needed to close this gap and to provide adequate receiver sensitivities of typically -140 dBm while still delivering multiyear battery life.

## 802.15 TG4w Scope

This amendment defines a Low Power Wide Area Network (LPWAN) extension to the IEEE Std 802.15.4 Low Energy, Critical Infrastructure Monitoring (LECIM) PHY layer to cover network cell radii of typically
10-15 km in rural areas. It uses the LECIM PHY Frequency Shift Keying (FSK) modulation schemes with extensions to lower bit-rates (e.g. payload bit-rate typically <30 kb/s). Additionally, it extends the frequency bands to additional sub-GHz unlicensed and licensed frequency bands to cover the market demand. For improved data integrity in channels with high levels of interference, it defines mechanisms for the fragmented transmission of Forward Error Correction (FEC) code-words, as well as time and frequency patterns for the transmission of the fragments. Modifications to the Medium Access Control (MAC) layer, needed to support this PHY extension, are defined.

## Methodology

The methodology is based on a consensus approach to defining a minimal set of features, characteristics, performance and constraints to be considered when making a proposal.

This document provides a functional view of the PHY characteristics, in the form of specific parameters which define externally verifiable performance and interoperability considerations.

The parameters discussed in this document are essential parameters for the design of physical layer and also satisfy IEEE 802.15.4w PAR. The proposal shall reference the relevant regulations. Devices implementing shall abide by regulations in the region it is operating.

Additional information on the intended use-cases and channel models are presented in the LPWA Interest Group (IG) report that is available on mentor (DCN 15-17-0528-01)

### Proposal Criteria

The following shall be included in the proposal:

**Mandatory and Optional Features**

Proposals shall clearly stipulate the mandatory and optional behaviors/features.

**Minimum Required Sensitivity**

The proposal shall be able to reach a minimum reception level of -140 dBm normalized to a noise figure of
3 dB.

**Data Rate**

The proposer shall support lower data rates compared to the LECIM FSK PHY.

**Symbol/Chip Rate**

The proposer shall specify the symbol/chip rate.

**Forward Error Correction**

The proposer shall specify the forward error correction schemes.

**Modulation/ Coding**

The proposer shall specify the utilized FSK modulation/coding schemes.

**Fragmentation**

The proposer shall specify the fragmentation method. The proposal may include methods to use optional ARQ and PHY security schemes.

**Time- / Frequency Patterns**

The proposer shall specify the time- and frequency patterns of the fragments.

**Frequency, Synchronization and Timing**

The proposer shall state the required accuracies for all types of devices and whether or not they are symmetric.

**PHY Frame Structure**

The PHY shall be based on the LECIM FSK PHY.

**Transmit PSD**

The proposer should state adjacent channel leakage power ratio (ACL). ACL is defined as the ratio of the power contained in the adjacent channel to the desired channel.

**Coexistence Features**

The proposal shall at a minimum include discussion of the coexistence impacts wrt. other IEEE 802 networks.

It is recommended that the proposer addresses other networks in the same and/or adjacent bands.

In addition, it is highly recommended that the proposer explains how interference to existing IEEE 802.15.4 networks can be avoided.

**Operational Bands**

At least one of the operational bands relevant to the scope of the project shall be supported.

**Multipath Robustness**

The proposer shall describe the immunity to multi-path reception. Simulation results using the channel model defined in section 5.2 of the IG report (DCN 15-17-0528-01) (outdoor urban, hBS=140m, 3Hz Doppler) showing the impact of multi-path on the PER are recommended.

**Interference Robustness**

The proposer shall describe the immunity to interference. Simulation results using the interference model defined in section 4.3 of the IG report (DCN 15-17-0528-01) (Parameters: Channel model outdoor urban, hBS=140m) showing the impact on the PER are recommended.