**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 15.4t Technical Guidance for Proposals | |
| Abstract | TG4w - Technical Guidance for PHY proposals. | |
| Purpose | To capture essential PHY requirements derived from the CFA responses, 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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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 wirelessmeter. Multiple PHYs are defined to support a variety of frequency bands.

## 802.15 TGw 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 achieve cost-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 a high link margin to deal with interferers and achieve distance, while maintaining low energy consumption. This translates to minimum required receiver sensitivities on the order of -140dBm 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 guarantee the required transmission reliability in such scenarios. This amendment is needed to close this gap and to provide reliable transmission at receiver sensitivities of -140dBm while 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 LECIM PHY layer. It uses the LECIM PHY FSK modulation schemes with extensions to lower bit-rates (e.g. payload bit-rate typically <30kBit/s). Additionally, it extends the frequency bands to additional sub-GHz unlicensed and licensed frequency bands to cover the market demand. For improved robustness 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. Furthermore, it

defines lower code rates of the FEC in addition to the K=7 R=1/2 convolutional code. Modifications to the Medium Access Control (MAC) layer, needed to support this PHY extension, are defined as needed.

## 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.

## 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 -140dBm with 1% PER and a 20 octet PSDU.

**Compatibility**

tbd

**Data Rate**

The proposal shall be capable of supporting at least 30kBit/s data rate.

**Symbol/Chip Rate**

The proposer shall specify the symbol/chip rate.

**Forward Error Correction**

The proposer shall specify the forward error correction.

**Modulation/ Coding**

The proposer shall specify the utilized modulation/coding scheme.

**Fragmentation**

The proposer shall specify the fragmentation method.

**Time- / Frequency Patterns**

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

**Synchronization and Timing**

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

**PHY Frame Structure**

The proposer shall specify the PHY frame structure, including preamble length, total frame length, FCS, etc.

**Transmit Power**

The device shall support transmit powers in alignment with the present LECIM physical layer.

**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.

**Interference Rejection Capability**

The ACR (adjacent channel rejection) and ALCR (alternate channel rejection) shall be stated.

**Channel Availability**

The proposer shall specify the minimum number of co-located networks supportable without causing any degradation in performance.

**Interoperability**

The proposer shall describe the interoperable features of the proposal including any optional behaviors. For instance, it should be made clear whether the data rate can dynamically change.

**Coexistence Features**

The proposal shall state the level of co-existence of the proposed network with other IEEE 802 networks.

**Operational Bands**

At least the operational band stated in the PAR shall be supported.

**MAC Layer Changes and Compatibility**

The proposal shall state all MAC Layer changes required to support the proposed PHY and their compatibility with the MAC used with the present LECIM physical layer. Ideally the proposal shall include NO (or very minimal) changes to the 802.15.4 MAC operation - for compatibility reasons.

**Frequency Regulation**

The proposer shall show the compliance to the frequency regulation in the proposed operational bands with the minimum required sensitivity parameters.

**Multipath Robustness**

The proposer shall indicate the minimum required reception level to achieve a 10% PER with 20 bytes PSDU using the Channel model outdoor urban (hBS=140m, 3Hz Doppler) defined in section 5.2 of 15-17/528r1.

**Interference Robustness**

The proposer shall indicate the minimum required reception level to achieve a 10% PER with 20 bytes PSDU using the interference model “Dense” defined in section 4.3 of 15-17/528r1 (Parameters: Channel model outdoor urban, hBS=140m).

**Max. Spectral Throughput**

The proposer shall indicate the maximum theoretical throughput in a bandwidth of 1MHz assuming the minimum required sensitivity parameters.