IEEE SA
STANDARDS ASSOCIATION

# IEEE Recommended Practice for Local and Metropolitan Area Networks—Part 19: Coexistence Methods for IEEE 802.11 and IEEE 802.15.4 Based Systems Operating in the Sub-1 GHz Frequency Bands

IEEE Computer Society

Developed by the
LAN/MAN Standards Committee

IEEE Std 802.19.3™-2021

IEEE

STANDARDS

# IEEE Recommended Practice for Local and Metropolitan Area Networks—Part 19: Coexistence Methods for IEEE 802.11 and IEEE 802.15.4 Based Systems Operating in the Sub-1 GHz Frequency Bands

Developed by the

**LAN/MAN Standards Committee**
of the
**IEEE Computer Society**

Approved 25 March 2021

**IEEE SA Standards Board**

**Abstract:** Millions of IEEE Std 802.15.4g™ based devices are currently operating in sub-1 GHz frequency bands to provide the low to moderate data rate capabilities. IEEE Std 802.11ah™ may operate in the same sub-1 GHz frequency bands and provides higher data rate capabilities. This recommended practice enables IEEE Std 802.15.4g and IEEE Std 802.11ah to effectively operate in license exempt sub-1 GHz frequency bands, by providing best practices and coexistence methods.

**Keywords:** coexistence, CSMA/CA, energy detection, FSK, IEEE 802.11ah™, IEEE 802.15.4g™, interference, OFDM, receiver sensitivity, sub-1 GHz frequency bands, Wi-Fi HaLow™, Wi-SUN®

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA



PDF: ISBN 978-1-5044-7487-0 STD24652
Print: ISBN 978-1-5044-7488-7 STDPD24652

## Important Notices and Disclaimers Concerning IEEE Standards Documents

IEEE Standards documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page (https://standards.ieee.org/ipr/disclaimers.html), appear in all standards and may be found under the heading "Important Notices and Disclaimers Concerning IEEE Standards Documents."

## Notice and Disclaimer of Liability Concerning the Use of IEEE Standards Documents

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE SA) Standards Board. IEEE develops its standards through an accredited consensus development process, which brings together volunteers representing varied viewpoints and interests to achieve the final product. IEEE Standards are documents developed by volunteers with scientific, academic, and industry-based expertise in technical working groups. Volunteers are not necessarily members of IEEE or IEEE SA, and participate without compensation from IEEE. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information or the soundness of any judgments contained in its standards.

IEEE does not warrant or represent the accuracy or completeness of the material contained in its standards, and expressly disclaims all warranties (express, implied and statutory) not included in this or any other document relating to the standard, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; and quality, accuracy, effectiveness, currency, or completeness of material. In addition, IEEE disclaims any and all conditions relating to results and workmanlike effort. In addition, IEEE does not warrant or represent that the use of the material contained in its standards is free from patent infringement. IEEE Standards documents are supplied "AS IS" and "WITH ALL FAULTS."

Use of an IEEE standard is wholly voluntary. The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard.

In publishing and making its standards available, IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity, nor is IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing any IEEE Standards document, should rely upon his or her own independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given IEEE standard.

IN NO EVENT SHALL IEEE BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: THE NEED TO PROCURE SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

## Translations

The IEEE consensus development process involves the review of documents in English only. In the event that an IEEE standard is translated, only the English version published by IEEE is the approved IEEE standard.

## Official statements

A statement, written or oral, that is not processed in accordance with the IEEE SA Standards Board Operations Manual shall not be considered or inferred to be the official position of IEEE or any of its committees and shall not be considered to be, nor be relied upon as, a formal position of IEEE. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that the presenter's views should be considered the personal views of that individual rather than the formal position of IEEE, IEEE SA, the Standards Committee, or the Working Group.

## Comments on standards

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE or IEEE SA. However, **IEEE does not provide interpretations, consulting information, or advice pertaining to IEEE Standards documents**.

Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Since IEEE standards represent a consensus of concerned interests, it is important that any responses to comments and questions also receive the concurrence of a balance of interests. For this reason, IEEE and the members of its Societies and Standards Coordinating Committees are not able to provide an instant response to comments, or questions except in those cases where the matter has previously been addressed. For the same reason, IEEE does not respond to interpretation requests. Any person who would like to participate in evaluating comments or in revisions to an IEEE standard is welcome to join the relevant IEEE working group. You can indicate interest in a working group using the Interests tab in the Manage Profile & Interests area of the IEEE SA myProject system. An IEEE Account is needed to access the application.

Comments on standards should be submitted using the Contact Us form.

## Laws and regulations

Users of IEEE Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any IEEE Standards document does not constitute compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. IEEE does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

## Data privacy

Users of IEEE Standards documents should evaluate the standards for considerations of data privacy and data ownership in the context of assessing and using the standards in compliance with applicable laws and regulations.

## Copyrights

IEEE draft and approved standards are copyrighted by IEEE under US and international copyright laws. They are made available by IEEE and are adopted for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of engineering practices and methods. By making these documents available for use and adoption by public authorities and private users, IEEE does not waive any rights in copyright to the documents.

## Photocopies

Subject to payment of the appropriate licensing fees, IEEE will grant users a limited, non-exclusive license to photocopy portions of any individual standard for company or organizational internal use or individual, non-commercial use only. To arrange for payment of licensing fees, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400; https://www.copyright.com/. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

## Updating of IEEE Standards documents

Users of IEEE Standards documents should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata. An official IEEE document at any point in time consists of the current edition of the document together with any amendments, corrigenda, or errata then in effect.

Every IEEE standard is subjected to review at least every 10 years. When a document is more than 10 years old and has not undergone a revision process, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE standard.

In order to determine whether a given document is the current edition and whether it has been amended through the issuance of amendments, corrigenda, or errata, visit IEEE Xplore or contact IEEE. For more information about the IEEE SA or IEEE's standards development process, visit the IEEE SA Website.

## Errata

Errata, if any, for all IEEE standards can be accessed on the IEEE SA Website. Search for standard number and year of approval to access the web page of the published standard. Errata links are located under the Additional Resources Details section. Errata are also available in IEEE Xplore. Users are encouraged to periodically check for errata.

## Patents

IEEE Standards are developed in compliance with the IEEE SA Patent Policy.

## IMPORTANT NOTICE

IEEE Standards do not guarantee or ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. IEEE Standards development activities consider research and information presented to the standards development group in developing any safety recommendations. Other information about safety practices, changes in technology or technology implementation, or impact by peripheral systems also may be pertinent to safety considerations during implementation of the standard. Implementers and users of IEEE Standards documents are responsible for determining and complying with all appropriate safety, security, environmental, health, and interference protection practices and all applicable laws and regulations.

## Participants

At the time this IEEE recommended practice was completed, the IEEE 802.19 Working Group had the following membership:

**Stephen Shellhammer**, *IEEE 802.19 Working Group Chair*
**Tuncer Baykas**, *IEEE 802.19 Working Group Vice-Chair*

**Benjamin A. Rolfe**, *Task Group 3 Chair*
**Shoichi Kitazawa**, *Task Group 3 Vice-Chair*
**Jianlin Guo**, *Task Group 3 Technical Editor*
**Harry Bims**, *Task Group 3 Secretary*

Osama Aboulmagd
Eugene Baik
David Barras
William Carney
Luc Darmon
Subir Das
Rolf de Vegt
Anthony Fagan
Sho Furuichi
James Gilb
Tim Godfrey
Timothy Harrington
Chris Hartman
Robert Heile
Jay Holcomb
Sung Hyun Hwang
Yasuhiko Inoue
Vincent Knowles Jones IV
Paul Kettle
James Lansford
Jae Seung Lee
Apurva Mody
Yuichi Morioka
Yukimasa Nagai
Alireza Nejatian
Jaroslaw Niewczas
Paul Nikolich
Yujin Noh
Philip Orlik
Stephen [kiwin] Palm
James Petranovich
Demir Rakanovic
Joerg Robert
Jon Walter Rosdahl
Kazuyuki Sakoda
Ioannis Sarris
Naotaka Sa
Pe Sa
Dorot Stanley
Ta ori Sumi
Chen Sun
Mineo Takai
Prabodh Varshney
Billy Verso
Leif Wilhelmsson
Hassan Yaghoobi
Kazuto Yano
Chunhui Zhu

The following members of the individual Standards Association balloting group voted on this recommended practice. Balloters may have voted for approval, disapproval, or abstention.

Robert Aiello
Song-Haur An
Amelia Andersdotter
Abdoulaye Berthe
Harry Bims
William Byrd
Paul Cardinal
Juan Carreon
Pin Chang
Charles Cook
Todor Cooklev
Hendricus De Ruijter
Liu Fangfang
Avraham Freedman
David Gandall
Jianlin Gu
Marco Hernandez
Werner Hoelzl
Klaus Hueske
Tetsushi Ikegami
Yasuhiko Inoue
Volker Jungnickel
Piotr Karocki
Stuart Kerry
Yongbum Kim
Shoichi Kitazawa
Pi-Cheng Law
Rick Murphy
Yukimasa Nagai
Nabil Nasser
Philip Orlik
Satoshi Oyama
Bansi Patel
Arumugam Paventhan
Clinton Powell
Venkatesha Prasad
R. K. Rannow
Lakshman Raut
Maximilian Riegel
Robert Robinson
Benjamin A. Rolfe
Ruben E. Salazar Cardozo
Stephan Sand
Naotaka Sato
Stephen Shellhammer
Ian Sherlock
Dorothy Stanley
Walter Struppler
Don Sturek
Mark Sturza
Takenori Sumi
Mark-Rene Uchida
Dmitri Varsanofiev
Prabodh Varshney
John Vergis
Billy Verso
Xiaohui Wang
Lisa Ward
Scott Willy
Kazuto Yano
Yu Yuan
Oren Yuen

When the IEEE SA Standards Board approved this recommended practice on 25 March 2021, it had the following membership:

**Gary Hoffman**, *Chair*
**Jon Walter Rosdahl**, *Vice Chair*
**John D. Kulick**, *Past Chair*
**Konstantinos Karachalios**, *Secretary*

Edward A. Addy
Doug Edwards
Ramy Ahmed Fathy
J. Travis Griffith
Joseph L. Koepfinger*
Thomas Koshy
David J. Law
Howard Li
Daozhuang Lin
Kevin Lu
Daleep C. Mohla
Chenhui Niu
Damir Novosel
Annette Reilly
Dorothy Stanley
Mehmet Ulema
Lei Wang
F. Keith Waters
Karl Weber
Sha Wei
Howard Wolfman
Daidi Zhong

*Member Emeritus

## Introduction

This introduction is not part of IEEE Std 802.19.3-2021, IEEE Recommended Practice for Local and Metropolitan Area Networks—Part 19: Coexistence Methods for IEEE 802.11 and IEEE 802.15.4 Based Systems Operating in the Sub-1 GHz Frequency Bands.

Many millions of devices based on IEEE Std 802.15.4™ are currently operating in sub-1 GHz frequency bands, and the field is expanding rapidly. Critical applications, such as grid modernization (smart grid) and Internet of Things (IoT), are using the low to moderate data rate capabilities of IEEE Std 802.15.4. IEEE Std 802.11ah™ may operate in the same sub-1 GHz frequency bands and provides higher data rate capabilities than IEEE Std 802.15.4. For example, Japan formed the 802.11ah Promotion Council (AHPC) to promote the widespread use of IEEE Std 802.11ah technology in areas such as home, office, industry, infrastructure, and mobility. In consideration of the current usage, as well as anticipation of as yet unforeseen usage models enabled by the standards within the scope of this recommended practice, and to fully realize the opportunity for successful deployment of products sharing the spectrum, strategies and tactics to achieve good coexistence performance are critical.

This recommended practice enables IEEE Std 802.15.4 and IEEE Std 802.11ah to effectively operate in license exempt sub-1 GHz frequency bands by providing best practices and coexistence methods. This recommended practice uses existing features of the referenced standards and provides guidance to implementers and users of IEEE 802® wireless standards.

## Contents

# IEEE Recommended Practice for Local and Metropolitan Area Networks—Part 19: Coexistence Methods for IEEE 802.11 and IEEE 802.15.4 Based Systems Operating in the Sub-1 GHz Frequency Bands

## 1. Overview

### 1.1 Scope

This recommended practice provides guidance on the implementation, configuration, and commissioning of systems sharing spectrum between IEEE Std 802.11ah™-2016 and IEEE Std 802.15.4™ smart utility networking (SUN) frequency shift keying (FSK) physical layer (PHY) operating in sub-1 GHz frequency bands.

### 1.2 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).[1,2]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

[1] The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.

[2] The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.