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IEEE Standard for Low-Rate Wireless Networks

IEEE Computer Society

Developed by the
LAN/MAN Standards Committee

IEEE Std 802.15.4™-2020
(Revision of IEEE Std 802.15.4-2015)

IEEE

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Approved on 6 May 2020

IEEE SA Standards Board

Abstract: The physical layer (PHY) and medium access control (MAC) sublayer specifications for low-data-rate wireless connectivity with fixed, portable, and moving devices with no battery or very limited battery consumption requirements are defined in this standard. In addition, the standard provides modes that allow for precision ranging. PHYs are defined for devices operating in a variety of geographic regions.

Keywords: ad hoc network, IEEE 802.15.4™, low data rate, low power, LR-WPAN, mobility, PAN, personal area network, radio frequency, RF, short range, wireless, wireless network, wireless personal area network, WPAN

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3 Park Avenue, New York, NY 10016-5997, USA

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James P. K. Gilb, *Working Group Technical Editor*
Patrick W. Kinney, *Secretary*

Gary Stuebing, *802.15.4md Task Group Chair*
Don Sturek, *802.15.4md Task Group Vice Chair*
Kunal P. Shah, *802.15.4md Technical Editor*

Hendrik Ahlendorf
Koorosh Akhavan
Bernd Baer
David Barras
Tuncer Baykas
Philip Beecher
Friedbert Berens
Lennert Bober
Monique Brown
Chris Calvert
Radhakrishna Canchi
Jaesang Cha
Matthew Chang
Soo-Young Chang
Clint Chaplin
Sangsung Choi
Boris Danev
Luc Darmon
Hendricus De Ruijter
Brandon Dewberry
Anthony Fagan
Matthew Gillmore
Tim Godfrey
Jianlin Guo
Joachim Hammerschmidt
Shinsuke Hara
Hiroshi Harada
Timothy Harrington
Chris Hartman
Christopher Hett
Jay Holcomb
Oliver Holland
Iwao Hosako
Brima Ibrahim
Tetsushi Ikegami
Yeong Min Jang
Seongah Jeong
Seong-Soon Joo
Volker Jungnickel
Paul Kettle
Shoichi Kitazawa
Tero Kivinen
Daniel Knobloch
Ryuji Kohno
Fumihide Kojima
Ann Krieger
Thomas Kuerner
Jack Lee
Mingyu Lee
Frank Leong
Huan-Bang Li
Zheda Li
Sang-Kyu Lim
Thomas Lorbach
Masood Maqbool
Vinayagam Mariappan
Alejandro Marquez
Michael McInnis
Apurva Mody
Ayman Naguib
Jaroslaw Niewczas
Paul Nikolich
Philip Orlik
Aditya Padaki
Glenn Parsons
Charles Perkins
Albert Petrick
Joe Polland
Clinton Powell
Demir Rakanovic
Ivan Reede
Joerg Robert
Benjamin Rolfe
Ren Sakata
Ruben E. Salazar Cardozo
Ioannis Sarris
Peter Sauer
Nikola Serafimovski
Tushar Shah
Stephen Shellhammer
Karthik Srinivasagopalan
Billy Verso
Johannes Wechsler
Brian Weis
Peter Yee
Shaun Yu

Major contributions in the revision process were received from the following individuals:

Harry Bims
Hendricus De Ruijter
Chris Hett
Roger Hislop
Klaus Hueske
Shoichi Kitazawa
Tero Kivinen
Clint Powell
R. K. Rannow
George Robert
Benjamin Rolfe
Ruben E. Salazar Cardozo
Kunal P. Shah
Gary Stuebing
Don Sturek
Billy Verso
Lisa Ward
Hidetoshi Yokota

The following members of the individual balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

Thomas Alexander
David Barras
Philip E. Beecher
Harry Bims
Nancy Bravin
Vern Brethour
Demetrio Bucaneg, Jr
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Paul Cardinal
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Yongbum Kim
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Tetsu Nishimura
Bansi Patel
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George Vlantis
Lisa Ward
Karl Weber
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Andreas Wolf
Chi Xu
Shang-Te Yang
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Many individuals have participated in the IEEE P802.15 Working Group during various stages of the standard's development. Since the initial publication, many amendments have added functionality or updated material in this standard, and now three revisions have been published. Here is a historical list of the working group participants who dedicated their valuable time, energy, and knowledge to the advancement of this standard at the time of its original publication and for its revisions. Many of these members also worked on amendments.

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Greg Breen, *Low-Band PHY Technical Editing*
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David Cypher, *PICs/SDLs Technical Editing*
Robert D. Poor, *Coexistence Technical Editing*
Farron Dacus, *Regulatory Technical Editing*

Roberto Aiello
Masaaki Akahane
Richard Alfvin
Arun Arunachalam
Naiel Askar
Venkat I. Bahl
Daniel Bailey
Jay Bain
James Baker
Jaiganesh Balakrishnan
Anuj Batra
Timothy Blaney
Kenneth Boehike
Stan Bottoms
Mark V. Bowles
Chuck Brabenac
Soo-Young Chang
Francois Po_Shin Chin
Aik Chindapol
Craig Conkling
Anand Dabak
Kai Dombrowski
Mary DuVal
Michael Dydyk
Jason L. Ellis
Mark W. Fidler
Jeff R. Foerster
David S. Furuno
Pierre Gandolfo
Atul Garg
James Gilb
Nada Golmie
Yasuo Harada
Allen Heberling
Barry Herold
Robert Y. Huang
Eran Igler
Katsumi Ishii
Jeyhan Karaoguz
Masami Katagiri
Joy H. Kelly
Stuart J. Kerry
Yongsuk Kim
Young Hwan Kim
Günter Kleindl
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Yeong-Chang Maa
Steven March
Ralph Mason
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Leonard E. Miller
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Tony Morelli
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Teik-Kheong Tan
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Stephen E. Taylor
Hans vanLeeuwen
Ritesh Vishwakarma
Thierry Walrant
Jing Wang
Fijio Watanabe
Mathew Welborn
Richard Wilson
Stephen Wood
Edward G. Woodrow
Hirohisa Yamaguchi
Amos Young
Song-Lin Young
Nakache Yves-paul
Jim Zyren

Major contributions were received from the following individuals:

Tony Adamson
David Archer
David Avery
Venkat Bahl
Daniel Bailey
Edul Batliwala
Pratik Bose
Boaz Carmeli
Farron Dacus
Martin Digon
Ian C. Gifford
Ed Hogervorst
Stephen Korfhage
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Nick Shepherd
Ari Singer
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Carl Stevenson
Mark Tilinghast
Hans Van Leeuwen
Jacco van Muiswinkel
Luis Pereira
Richard Wilson
Wim Zwart

The following members of the IEEE P802.15 Working Group participated in the development of the first revision, IEEE Std 802.15.4-2006:

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Richard Alfvin
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Kwan-Wu Chin
Sarm-Goo Cho
Sungsoo Choi
Yun Choi
Chun-Ting Chou
Manoj Choudhary
Celestino Corral
Joe Decuir
Javier Del Prado Pavon
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Stefan Drude
Amal Ekbal
Jason Ellis
Shahriar Emami
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Amir Freund
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Ian Gifford
Sung-Wook Goh
Sorin Goldenberg
Vivek Gupta
Rainer Hach
Robert Hall
Shinsuke Hara
Jeff Harris
Allen Heberling
Eric Heinze
Barry Herold
Keisuke Higuchi
Jin-Meng Ho
Patrick Houghton
Robert Huang
Tian-Wei Huang
Hideto Ikeda
Tetsushi Ikegami
Adrian Jennings
Ho-In Jeon
Tzyy Hong Jiang
David Julian
Jeyhan Karaoguz
Michael Kelly
Stuart Kerry
Jae-Hyon Kim
Jaeyoung Kim
Jinkyeong Kim
Yongsuk Kim
Kursat Kimyacioglu
Matthias Kindler
Guenter Kleindl
Ryuji Kohno
Mike Krell
Yasushi Kudo
Akiomi Kunisa
Yuzo Kuramochi
Jiun-You Lai
Ismail Lakkis
John Lampe
Kyung Kuk Lee
Wooyong Lee
David Leeper
Huan-Bang Li
Haixiang Liang
Ian Macnamara
Akira Maeki
Patricia Martigne
Abbie Mathew
Taisuke Matsumoto
Gustaf Max
Michael McLaughlin
Charlie Mellone
Klaus Meyer
Samuel Mo
Andreas Molisch
Mark Moore
Ken Naganuma
Yves-Paul Nakache
Hiroyuki Nakase
Saishankar Nandagopalan
Chiu Ngo
Erwin Noble
John O'Conor
Knut Odman
Hiroyo Ogawa
Yasuyuki Okuma
Philip Orlik
Laurent Ouvry
John Pardee
Nirmalendu Patra
Dave Patton
Xiaoming Peng
Tony Pollock
Vidyasagar Premkumar
Yihong Qi
Raad Raad
Pekka Ranta
Dani Raphaeli
Gregg Rasor
Charles Razzell
Ivan Reede
Yuko Rikuta
Terry Robar
Glyn Roberts
Richard Roberts
Benjamin A. Rolfe
Philippe Rouzet
Chandos Rypinski
Ali Sadri
Saeid Safavi
Zafer Sahinoglu
Tomoki Saito
Syed Saleem
Kamran Sayrafian
Jean Schwoerer
Erik Schylander
Alireza Seyedi
Sanjeev Sharma
Siddharth Shetty
John Shi
Shusaku Shimada
Yuichi Shiraki
Gadi Shor
William Shvodian
Thomas Siep
Michael Sim
Kazimierz Siwiak
V. Somayazulu
Amjad Soomro
Carl Stevenson
Kazuaki Takahashi
Kenichi Takizawa
Teik-Kheong Tan
Mike Tanahashi
Yasushi Tanaka
James Taylor
Arnaud Tonnerre
Ichihiko Toyoda

Jerry Upton
Bart Van Poucke
Chris Weber
Matthew Welborn
Magnus Wiklund
Gerald Wineinger
Patrick Worfolk
Tracy Wright
Hirohisa Yamaguchi
Kamya Yekeh Yazdandoost
Su-Khiong Yong
Zhan Yu
Serdar Yurdakul
Mahmoud Zadeh
Bin Zhen

Major contributions in the revision process were received from the following individuals:

Jon Adams
Helmut P. Adamski
Jonathan Avey
Jon Beniston
Bernd Grohmann
José A. Gutierrez
Jesper Holm
ZhiJian Hu
Phil A. Jamieson
Yuen-Sam Kwok
Colin Lanzl
Myung Lee
Zhongding Lei
Liang Li
Yong Liu
Frederick Martin
Frank Poegel
Matthias Scheide
D. C. Seward
Huai-Rong Shao
Mark Shea
Stephen J. Shellhammer
Mark A. Tillinghast
Johannes Van Leeuwen
Richard Wilson
Ping Xiong
Bing Xu
ChenYang Yang
Chunhui Zhu

The following members of the IEEE P802.15 Working Group participated in the development of the second revision, IEEE Std 802.15.4-2011:

Robert F. Heile, *Chair*
Rick Alfvin, *Co-Vice Chair*
Patrick W. Kinney, *Co-Vice Chair*
James P. K. Gilb, *Working Group Technical Editor*
Patrick W. Kinney, *Secretary*

James P. K. Gilb, *Task Group 4i Chair and Technical Editor*

Emad Afifi
Gahng-Seop Ahn
Roberto Aiello
Arthur Astrin
Taehan Bae
Michael Bahr
John Barr
Anuj Batra
Tuncer Baykas
Philip E. Beecher
Ashutosh Bhatia
Ghulam Bhatti
Gary Birk
Mathew Boytim
Peter David Bradley
Nancy Bravin
David Britz
Monique B. Brown
Sverre Brubk
Brian Buchanan
John Buffington
Kiran Bynam
Brent Cain
Edgar H. Callaway
Chris Calvert
Ruben E. Salazar Cardozo
Douglas Castor
Jaesang Cha
Russell Chandler
Kuor-Hsin Chang
Soo-Young Chang
Clint Chaplin
Hind Chebbo
Chang-Soon Choi
Sangsung Choi
Ciaran Connell
David Cypher
Matthew Dahl
David Davenport
Mark Dawkins
Hendricus de Ruijter
Upkar Dhaliwal
Gang Ding
Paul Dixon
Guido Dolmans
Igor Dotlic
Michael Dow
Dietmar Eggert
David Evans
Charles Farlow
John Farserotu
Jeffrey Fischbeck
Mike Fischer
George Flammer
Ryosuke Fujiwara
Noriyasu Fukatsu
Kiyoshi Fukui
John Geiger
Gregory Gillooly
Tim Godfrey
Paul Gorday
Elad Gottlib
Robert Hall
Shinsuke Hara
Hiroshi Harada
Timothy Harrington
Rodney Hemminger
Marco Hernandez
Garth Hillman
Jin-Meng Ho
Wei Hong
Srinath Hosur
David Howard
Jung-Hwan Hwang
Taeho Hwang

Ichirou Ida
Tetsushi Ikegami
Akio Iso
Yeong Min Jang
Adrian Jennings
Wuncheol Jeong
Steven Jillings
Noh-Gyoung Kang
Tae-Gyu Kang
Shuzo Kato
Tatsuya Kato
Jeritt Kent
Prithpal Khakuria
Dae Ho Kim
Dong-Sun Kim
Dukhyun Kim
Jaehwan Kim
Jeffrey King
Ryuji Kohno
Fumihide Kojima
Bruce Kraemer
Raymond Krasinski
Masahiro Kuroda
John Lampe
Zhou Lan
Khanh Le
Cheolhyo Lee
Hyungsoo Lee
Myung Lee
Daniel Lewis
Huan-Bang Li
Liang Li
Sang-Kyu Lim
Jeremy Link
Mike Lynch
Robert Mason
Tomokuni Matsumura
Jeff McCullough
Michael McGillan
Michael D. McInnis
Michael McLaughlin
Charles Millet
Siamak Mirnezami
Rishi Mohindra
Emmanuel Monnerie
Rajendra Moorti
Robert Moskowitz
Hamilton Moy
Peter Murray
Theodore Myers
Chiu Ngo
Paul Nikolich
Hirohito Nishiyama
David Olson
Okundu Omeni
Ryoji Ono
Laurent Ouvry
James Pace
Hyung-Il Park
Jahng Park
Seung-Hoon Park
Taejoon Park
Ranjeet Patro
Al Petrick
Dalibor Pokrajac
Daniel Popa
Stephen Pope
Clinton C. Powell
Richard Powell
Chang-Woo Pyo
Mohammad Rahman
Sridhar Rajagopal
Jayaram Ramasastry
Marc Reed
Ivan Reede
Richard Roberts
Craig Rodine
June Chul Roh
Benjamin A. Rolfe
Seung-Moon Ryu
Didier Sagan
Kentaro Sakamoto
Will San Filippo
H. Sanderford
Kamran Sayrafian
Timothy Schmidl
Michael Schmidt
Jean Schwoerer
Cristina Seibert
Neal Seidl
Kunal Shah
Steve Shearer
Stephen Shellhammer
Shusaku Shimada
Chang Sub Shin
Cheol Ho Shin
Michael Sim
Jonathan Simon
Jaeseung Son
Paul Stadnik
René Struik
Chin-Sean Sum
Hui-Hsia Sung
Gu Sungi
Kenichi Takizawa
Hirokazu Tanaka
Larry Taylor
Mark Thompson
James Tomcik
Ichihiko Toyoda
David Tracey
Khanh Tran
Jerry Upton
Jana van Greunen
Hartman van Wyk
Michel Veillette
Billy Verso
Bhupender Virk
Joachim Walewski
Junyi Wang
Quan Wang
Xiang Wang
Andy Ward
Scott Weikel
Nicholas West
Mark Wilbur
Ludwig Winkel
Eun Tae Won
Alan Chi Wai Wong
Tao Xing
Wen-Bin Yang
Yang Yang
Kazuyuki Yasukawa
Kamya Yazdandoost
Kaoru Yokoo
Mu Zhao
Bin Zhen

Major contributions in the revision process were received from the following individuals:

Philip E. Beecher
Vern Brethour
Monique B. Brown
Edgar H. Callaway
Kuor-Hsin Chang
Clint Chaplin
James P. K. Gilb
Patrick W. Kinney
Michael D. McInnis
Clinton C. Powell
Benjamin A. Rolfe
Timothy Schmidl
René Struik
Billy Verso

The following members of the IEEE P802.15 Working Group participated in the development of the second revision, IEEE Std 802.15.4-2015:

Robert F. Heile, *Chair*
Rick Alfvin, *Co-Vice Chair*
Patrick W. Kinney, *Co-Vice Chair*
James P. K. Gilb, *Working Group Technical Editor*
Patrick W. Kinney, *Secretary*

Patrick W. Kinney, *802.15 Maintenance Committee Chair*
Benjamin A. Rolfe, *802.15 Maintenance Committee Vice Chair*
James P. K. Gilb, *Technical Editor*

Mounir Achir
Keiji Akiyama
Arthur Astrin
Philip Beecher
Frederik Beer
Chandrashekhar P. S. Bhat
Kiran Bynam
Edgar Callaway
Chris Calvert
Radhakrishna Canchi
Kapseok Chang
Soo-Young Chang
Clint Chaplin
Stephen Chasko
Paul Chilton
Sangsung Choi
Hendricus de Ruijter
Guido Dolmans
Igor Dotlic
Stefan Drude
Dietmar Eggert
Shahriar Emami
Andrew Estrada
David Evans
George Flammer
Kiyoshi Fukui
Matthew Gillmore
Tim Godfrey
Elad Gottlib
Jussi Haapola
Rainer Hach
Shinsuke Hara
Timothy Harrington
James Hartman
Marco Hernandez
Ken Hiraga
Iwao Hosako
Yeong Min Jang
Seong-Soon Joo
Akifumi Kasamatsu
Shuzo Kato
Toyoyuki Kato
Jeritt Kent
Jaehwan Kim
Youngsoo Kim
Shoichi Kitazawa
Tero Kivinen
Ryuji Kohno
Fumihide Kojima
Thomas Kuerner
Byung-Jae Kwak
Jae Seung Lee
Myung Lee
Sangjae Lee
Huan-Bang Li
Liang Li
Qing Li
Michael Lynch
Itaru Maekawa
Hiroyuki Matsumura
Michael McLaughlin
Michael McInnis
Kenichi Mori
Robert Moskowitz
Jinesh P. Nair
Chiu Ngo
Paul Nikolich
John Notor
Hiroyo Ogawa
Taejoon Park
Glenn Parsons
Charles Perkins
Albert Petrick
Clinton C. Powell
Verotiana Rabarijaona
Ivan Reede
Richard Roberts
Ruben E. Salazar Cardozo
Noriyuki Sato
Norihiko Sekine
Kunal Shah
Stephen Shellhammer
Shusaku Shimada
Gary Stuebing
Don Sturek
Mineo Takai
Kou Togashi
Billy Verso
Gabriel Villardi
Brian Weis
Makoto Yaita
Peter Yee
Yu Zeng
Chunhui (Allan) Zhu

Major contributions in the revision process were received from the following individuals:

Philip Beecher
Monique Brown
Edgar Callaway
Soo-Young Chang
James P. K. Gilb
Tim Godfrey
Jussi Haapola
Timothy Harrington
Jeritt Kent
Patrick W. Kinney
Tero Kivinen
Amarjeet Kumar
Michael McInnis
Robert Moskowitz
Clinton C. Powell
Verotiana Rabarijaona
Benjamin A. Rolfe
Ruben E. Salazar Cardozo
Cristina Seibert
Kunal Shal
Shusakh Shimada
Chin-Sean Sum
Larry Taylor
Billy Verso

Introduction

This introduction is not part of IEEE Std 802.15.4-2020, IEEE Standard for Low-Rate Wireless Networks.

This is the fourth revision of IEEE Std 802.15.4. From the beginning, the goal of the IEEE P802.15 Working Group was to produce a standard that enabled very low-cost, low-power communications. The initial standard, IEEE Std 802.15.4-2003, defined two optional physical layers (PHYs), operating in different frequency bands with a simple and effective medium access control (MAC).

In 2006, the standard was revised and added two more PHY options. The MAC remained backward compatible, but the revision added MAC frames with an increased version number and a variety of MAC enhancements, including the following:

— Support for a shared time base with a data timestamping mechanism
— Support for beacon scheduling
— Synchronization of broadcast messages in beacon-enabled personal area networks (PANs)
— Improved MAC layer security

In 2011, the standard was revised to include the three amendments approved subsequent to the 2006 revision. This effort added four more PHY options along with the MAC capability to support ranging. Additionally, the organization of the standard was changed so that each PHY would have a separate clause, and the MAC clause was split into functional description, interface specification, and security specification.

The 2015 revision of the standard was created to roll in the amendments approved subsequent to the 2011 revision: six PHY amendments and one MAC amendment, with corrigenda and clarifications. The features added by the amendments include the following:

— Enhanced frame formats maintaining backward compatibility
— Information Elements (IEs)
— Channel agility
— Extended superframe options
— Low-energy mechanisms
— An enhanced acknowledgment frame that can carry data and can be secured
— Prioritized channel access
— A variety of new PHY modulation, coding, and band options to support a wide variety of application needs including radio frequency identification (RFID), smart utility networks (SUNs), television white space (TVWS) operation, low-energy critical infrastructure monitoring (LECIM), and rail communications and control (RCC)

Much of the corrigenda and clarifications were collected from requests from individuals after the revision in 2011. Major corrigenda items included changes to the security text to correct errors and clarify the text, removal of the encrypt only mode, addition of security policy checks for the IEs, corrections regarding personal area network identifier (PAN ID) compression behavior to eliminate ambiguous specification, and changes to the IEs subclauses to include more information necessary for users of this standard.

The Project Authorization Request (PAR) for IEEE Std 802.15.4-2015 was first proposed in July 2013 and was approved in October 2013 by IEEE's New Standards Committee (NesCom). After three working group ballots and two IEEE SA Committee ballots, the final standard was approved in December 2015, just over two years from start to finish.

The current revision of the standard was revised to include six approved amendments subsequent to the 2015 revision. This effort added two more PHY amendments and one MAC amendment, with corrigenda and clarifications. The features added by the amendments include the following:

— A variety of new PHY modulation, coding, and band options to support a wide variety of application needs including smart utility networks (SUNs), china medical band (CMB), ternary amplitude shift keying (TASK) and rate switch Gaussian frequency shift keying (RS-GFSK)

Much of the corrigenda and clarifications were collected from requests from individuals after the revision in 2015. Major corrigenda items included changes to the transmission order of the address field.

Contents

IEEE Standard for Low-Rate Wireless Networks

1. Overview

1.1 Scope

This standard defines the physical layer (PHY) and medium access control (MAC) sublayer specifications for low-data-rate wireless connectivity with fixed, portable, and moving devices with no battery or very limited battery consumption requirements. In addition, the standard provides modes that allow for precision ranging. PHYs are defined for devices operating in a variety of geographic regions.

1.2 Purpose

The standard provides for ultra low complexity, ultra low cost, ultra low power consumption, and low data rate wireless connectivity among inexpensive devices, especially targeting the communications requirements of what is now commonly referred to as the Internet of Things. In addition, some of the alternate PHYs provide precision ranging capability that is accurate to one meter. Multiple PHYs are defined to support a variety of frequency bands.