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Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements —

Part 15-4: Wireless medium access control (MAC) and physical layer (PHY) specifications for low-rate wireless personal area networks (WPANs)

Technologies de l'information — Télécommunications et échange d'information entre systèmes — Réseaux locaux et métropolitains — Exigences spécifiques —

Partie 15-4: Spécifications du contrôle d'accès du milieu sans fil (MAC) et de la couche physique (PHY) pour les réseaux personnels sans fil de faible débit (WPAN)

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IEEE Standard for Low-Rate Wireless Networks

Developed by the

LAN/MAN Standards Committee
of the
IEEE Computer Society

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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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.

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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.

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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.

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2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ANSI X3.66-1979, Advanced Data Communication Control Procedures.[1]

Code of Federal Regulations, Title 47: Telecommunication, Part 90—Private Land Mobile Radio Services, Subpart S—Regulations Governing Licensing and Use of Frequencies in the 806–824, 851–869, 896–901, and 935–940 MHz Bands (47 CFR, Part 90, Subpart S).[2]

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FIPS Pub 197, Advanced Encryption Standard (AES).[3]

IEEE Std 802®-2014, IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture.[4, 5]

IETF RFC 6225, Dynamic Host Configuration Protocol Options for Coordinate-Based Location Configuration Information, Internet Engineering Task Force.[6]

[1]ANSI publications are available from the American National Standards Institute (http://www.ansi.org/)
[2]CFR publications are available from the U.S. Government Printing Office (http://www.gpo.gov/).
[3]FIPS publications are available from the National Technical Information Service (NTIS) (http://www.ntis.org/).
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