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IEEE Std 802.15.3™-2016
(Revision of
IEEE Std 802.15.3-2003)

IEEE Standard for High Data Rate Wireless Multi-Media Networks

Sponsor

LAN/MAN Standards Committee
of the
IEEE Computer Society

Approved 15 May 2016
IEEE-SA Standards Board

Abstract: The protocol and compatible interconnection of data and multimedia communication equipment via 2.4 GHz and 60 GHz radio transmissions in a Wireless Personal Area Network (WPAN) using low power and multiple modulation formats to support scalable data rates is defined in this standard. The Medium Access Control (MAC) sublayer protocol supports both isochronous and asynchronous data types.

Keywords: ad hoc network, IEEE 802.15.3™, mobility, mm-wave, radio frequency, wireless

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Introduction

This introduction is not part of IEEE Std 802.15.3-2016, IEEE Standard for High Data Rate Wireless Multi-Media Networks.

IEEE Std 802.15.3-2016 was originally developed to provide superior quality of service (QoS) over relatively medium range wireless links.

The idea of a high-rate addition to the IEEE 802.15 family of standards was first proposed in November 1999 at the IEEE Plenary meeting in Kaua'i, HI. The 802.15.3 task group began its official work at the March 2000 IEEE Plenary meeting in Albuquerque, NM, creating a criteria document and evaluation method. The down-selection of MAC and PHY proposals was completed at the November 2000 IEEE 802 Plenary meeting in Tampa, FL, and the writing of the draft began in December 2000. After working on the draft for one year, the document was ready for the task group ballot process in December 2001. The draft received final working group approval at the November 2002 IEEE Plenary meeting in Kaua'i, HI, and began the sponsor ballot process following the meeting. The draft went through one sponsor ballot and two recirculations before it was submitted to the IEEE Standards Association Standards Board (IEEE-SASB) for approval. The IEEE-SASB approved 802.15.3 as an IEEE standard in June 2003.

IEEE Std 802.15.3-2003 defined an ad-hoc MAC that enabled simple and fast network formation, excellent QoS, strong security with 128-bit AES encryption in CCM mode and methods to coexist with other wireless networks in the band. The PHY operated in the license exempt 2.4 GHz band with data rates of 11 Mb/s to 55 Mb/s at distances of greater than 70 m.

Interest in working on an amendment to fix and enhance IEEE Std 802.15.3 began in the September 2003 meeting in Singapore. A study group was formed at the November 2003 meeting in Albuquerque, which completed a project authorization request that was approved in March 2004. Work progressed quickly, and the first task group letter ballot was successfully completed in March 2005. After one recirculation, the draft began sponsor ballot in August 2005. The ballot was successful, and after a recirculation ballot to validate some minor changes, IEEE Std 802.15.3b was approved by the IEEE Standards Board on 6 December 2005, just over two years after the study group started.

IEEE Std 802.15.3b-2005 fixed mistakes and added enhancements that improve the efficiency of the base standard. Some of the key changes/additions in this amendment are as follows:

- An improved definition of the medium access control (MAC) layer management entity (MLME) service access point (SAP).
- A new acknowledgment (ACK) policy, implied-ACK, which allows polling and a more efficient use of channel time.
- A method for relinquishing time in a channel time allocation (CTA) to allow another device (DEV) time to transmit data.
- The ability to assign device identifiers (DEVIDs) to group addresses to allow multicast connections.
- Faster recovery of network operations when the piconet coordinator (PNC) abruptly disconnects\ with the conditional handover and the next PNC processes.
- Multiple contention periods during a superframe.

In the July 2003 meeting in San Francisco, an interest group was formed to consider a mmWave PHY for the existing standard. A study group was formally created in the March 2004 IEEE 802 plenary meeting in Orlando and developed a project authorization request that was approved in March 2005. The first meeting as a task group was in May 2005 in Cairns, Australia and the group worked steadily developing channel models and evaluation documents. The PHY modes were selected in November 2007 at the Atlanta meeting

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and draft progressed rapidly, entering working group letter ballot in June 2008. After three working group recirculation ballots, sponsor ballot started in March 2009. A total of three sponsor recirculation ballots were held, leading to approval of IEEE Std 802.15.3c-2009 by the IEEE-SA Standards Board on 11 September 2009.

Some of the key features of IEEE Std 802.15.3c-2009 and additions are as follows:

— Operation in the 60 GHz band.
— New data rates, with the highest greater than 5 Gb/s.
— Beamforming negotiation for the transmitter to increase the communication range.
— MAC packet aggregation and the acknowledgment of individual subpackets to reduce retransmission overhead.

The PHY specifices three modes and one common mode. The three PHY modes are as follows:

— Single carrier (SC) mode optimized for low power and low complexity.
— High-speed interface (HSI) mode optimized for low-latency bidirectional data transfer.
— Audio/video (AV) mode optimized for the delivery of uncompressed, high-definition video and audio.

In 2015, there were two new projects that wanted to add additional optional PHYs. To support the development of these new amendments, the base standard needed to be revised to create a single document that incorporated the prior two amendments. A PAR was generated in July 2015 at the IEEE Plenary meeting in Waikoloa Village, HI. The PAR was approved by the IEEE SASB in September 2015 and the initial draft was completed soon thereafter (by the same Technical Editor who worked on the previous three documents). After two working group ballots, the sponsor ballot began in December 2015 and completed in February 2016 after two Sponsor ballot recirculations. IEEE Std 802.15.3-2016 was approved by the IEEE-SA Standards Board in May 2016.

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IEEE Standard for High Data Rate Wireless Multi-Media Networks

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1. Overview

1.1 Scope

This standard defines PHY and MAC specifications for high data rate wireless connectivity (typically over 200 Mbps) with fixed, portable, and moving devices. Data rates are high enough to satisfy a set of consumer multimedia industry needs, as well as to support emerging wireless switched point-to-point and high rate close proximity point-to-point applications.

1.2 Purpose

The purpose of this standard is to provide for low complexity, low cost, low power consumption, and high data rate wireless connectivity among devices that support a variety of applications such as a set of consumer multimedia industry needs, wireless switched point-to-point applications in data centers, wireless backhaul/fronthaul intra-device communications, and a wide variety of additional use cases such as rapid large multimedia data downloads and file exchanges between two devices in close proximity, including between mobile devices and stationary devices (kiosks, ticket gates, etc.), and/or wireless data storage devices.

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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; therefore, each referenced document is cited in the 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 (ADCCP).[1]

IEEE Std 802®-2014, IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture.[2, 3]

ISO/IEC 646:1991, Information Technology—ISO 7-bit coded character set for information interchange.[4]

NIST FIPS Pub 197: Advanced Encryption Standard (AES), Federal Information Processing Standards Publication 197, US Department of Commerce/N.I.S.T., November 26, 2001.[5]

[1] ANSI publications are available from the American National Standards Institute (http://www.ansi.org).

[2] IEEE publications are available from the Institute of Electrical and Electronics Engineers (http://standards.ieee.org/).

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[4] ISO/IEC publications are available from the International Organization for Standardization (http://www.iso.ch/) and the International Electrotechnical Commission (http://www.iec.ch/). ISO/IEC publications are also available in the United States from the American National Standards Institute (http://www.ansi.org).

[5] NIST FIPS publications are available from the National Institute for Standards and Technology (http://www.nist.gov).

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3. Definitions, acronyms, and abbreviations

3.1 Definitions

For this standard, the following terms and definitions apply. *The IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.[6]

ad hoc network: A network typically created in a spontaneous manner. The principal characteristic of an ad hoc network is its limited temporal and spatial extent.

association: The service used to assign a device identifier to a device to enable communications in a piconet.

channel time allocation: A contiguous period of time in the superframe allocated by the piconet coordinator for communication between specified source and destination.

coexistence: The ability of one system to perform a task in a given shared environment where other systems have an ability to perform their tasks and may or may not be using the same set of rules.

data authentication: Authentication of the sender of the data and provision of data integrity.

data integrity: The assurance that the data has not been modified from its original form.

dBm: Decibels relative to a milliwatt.

device: An entity that implements an IEEE 802.15.3 conformant media access control and physical layer interface to the wireless medium.

device address: The EUI-48 associated with device in an IEEE 802.15.3 piconet.

disassociation: The service that removes an existing association.

frame: Format of aggregated bits that are transmitted together in time.

guard interval: A time period placed at the front of a symbol for inter-symbol interference avoidance.

integrity code: A data string generated using a symmetric key that is typically appended to data in order to provide data integrity and source authentication similar to a digital signature.

interoperable: The ability of two systems to perform a given task using a single set of rules.

medium access control command data unit: The unit of data exchanged between two peer medium access control entities using the services of the physical layer to implement the medium access control management protocol.

medium access control protocol data unit: The unit of data exchanged between two peer medium access control entities using the services of the physical layer.

medium access control service data unit: Information that is delivered as a unit between medium access control service access points.

[6] *The IEEE Standards Dictionary Online* is available at http://www.ieee.org/portal/innovate/products/standard/standards_dictionary.html.

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payload protection: The generic term for providing security services on the contents of a data message, including confidentiality, integrity, and authentication.

piconet: A collection of one or more logically associated devices that share a single identifier with a common coordinator.

piconet coordinator: An entity that has device functionality and also provides coordination and other services, e.g., quality of service, synchronization, association, via the wireless medium for associated devices.

quality of service: A collective measure of the level of service (e.g., availability, latency, throughput, error rate) delivered between devices.

secure frame: A command or data frame in which cryptographic techniques are applied to provide encryption or integrity.

secure piconet: A piconet in which cryptographic techniques are implemented to provide security services.

stream: A unidirectional, logical data connection between two devices that may or may not have quality of service requirements associated with it.

superframe: The basic time division of an IEEE 802.15.3 piconet containing a beacon, the channel time allocation period and optionally the contention access period.

symmetric key: A secret key shared between two or more parties that may be used for encryption/ decryption or integrity protection/integrity verification.

wireless medium: The medium used to implement the transfer of protocol data units between peer physical layer entities of a wireless personal area network.

3.2 Acronyms and abbreviations

AAS	asymmetric antenna system
ACK	acknowledgment
AES	advanced encryption standard
AS	application specific
ATP	association timeout period
AV	audio/visual
AWGN	additive white Gaussian noise
BBIFS	beam-forming beam-level interframe spacing
BCRD	bidirectional channel time allocation relinquish duration
BcstID	broadcast identifier
BER	bit error rate
BIFS	backoff interframe space
Blk-ACK	block acknowledgment
BPSK	binary phase-shift keying
BSID	beacon source identifier
BSIFS	beam-forming sector-level interframe spacing
BST	beam switching/steering and tracking
CAP	contention access period

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