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(amendment to IEEE Std 802.11-2016
as amended by IEEE Std 802.11ai™-2016,
IEEE Std 802.11ah™-2016,
IEEE P802.11aq™/D12.0,
IEEE P802.11ak™/D4.3,
IEEE P802.11aj™/D8.0,
IEEE P802.11ax™/D2.0,
IEEE P802.11ay™/D0.5,
and IEEE P802.11az™/D0.0)

IEEE P802.11ba™/D0.01

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

Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

Amendment 9: Wake-Up Radio Operation

Prepared by the 802.11 Working Group of the

LAN/MAN Standards Committee
of the
IEEE Computer Society

Abstract: This amendment defines modifications to both the IEEE 802.11 physical layer (PHY) and the medium access control (MAC) sublayer for wake-up radio operation.

Keywords: wake-up radio, wake-up receiver, PHY, physical layer, MAC, medium access control, primary connectivity radio

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Introduction

This amendment defines modifications to both the IEEE 802.11 physical layer (PHY) and the medium access control (MAC) sublayer for wake-up radio operation.

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Editor's Note: The Standards Program Manager and Staff liaison will be inserted below.

<name>
IEEE Standards Program Manager, Document Development

<name>
IEEE Standards Program Managers, Technical Program Development

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Amendment 9: Wake-Up Radio Operation

[This amendment is based on IEEE Std 802.11-2016 amended by IEEE Std 802.11ai-2016, IEEE P802.11ah-2016, IEEE P802.11aq/D12.0, IEEE P802.11ak/D4.3, IEEE P802.11aj/D8.0, IEEE P802.11ax/D2.0, IEEE P802.11ay/D0.5, and IEEE P802.11az/D0.0]

NOTE—The editing instructions contained in this amendment define how to merge the material contained therein into the existing base standard and its amendments to form the comprehensive standard.

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Tags are shown close to the point of change. When a whole subclause is new, the heading is tagged.

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Editor's Note: A cumulative status of the versions of this draft is shown below.

Table 1—Draft Status

Draft	Date	Status
D0.0	2017-10-23	Proposed draft specification
D0.01	2017-11-20	Updated WUR PHY structure and added basic WUR PHY parameters

3. Definitions, acronyms, and abbreviations

3.2 Definitions specific to IEEE 802.11

Insert the following definitions maintaining alphabetical order:

primary connectivity radio (PCR): A radio with the capability to transmit and receive 20 MHz non-HT PPDU.

wake-up radio (WUR): A companion radio to a primary connectivity radio with the capability to transmit or receive WUR PPDU.

wake-up receiver (WURx): A companion receiver to a primary connectivity radio with the capability to receive WUR PPDU.

wake-up radio (WUR) physical layer (PHY) protocol data unit (PPDU): A PPDU transmitted with the TXVECTOR parameter FORMAT equal to WUR.

3.4 Abbreviations and acronyms

Insert the following acronym definitions (maintaining alphabetical order):

OOK	on-off keying
PCR	primary connectivity radio
TD	type dependent
WUR	wake-up radio
WURx	wake-up receiver

4. General description

4.3 Components of the IEEE Std 802.11 architecture

Insert a new subclause after subclause 4.3.15 as follows:

4.3.15a Wake-up radio (WUR) STA

The main PHY features in a WUR STA are the following:

— <Texts to be filled>

The main MAC features in a WUR STA are the following:

— <Texts to be filled>

A WUR non-AP STA can receive a wake-up frame from a WUR AP STA to trigger a transition of the corresponding primary connectivity radio to the awake state.

9. Frame formats

9.1 General requirements

Change the paragraph as follows:

The format of the MAC frames is specified in this clause. WUR frame format is defined in Subclause 9.10, and other MAC frame formats are defined in Subclauses 9.2 to 9.9. A STA shall be able to properly construct a subset of the frames specified in this clause for transmission and to decode a (potentially different) subset of the frames specified in this clause upon validation following reception. The particular subset of these frames that a STA constructs and decodes is determined by the functions supported by that particular STA. A STA shall be able to validate every received frame using the frame check sequence (FCS) and to interpret certain fields from the MAC headers of all frames.

A STA shall transmit frames using only the frame formats described in Clause 9.

9.4 Management and Extension frame body components

9.4.1 Fields that are not elements

9.4.1.11 Action field

<Texts to be modified>

9.4.2 Elements

Insert the following new subclauses after the last subclause in 9.4.2:

9.4.2.262 WUR Mode element

<Texts to be filled>

9.4.2.263 WUR Capabilities element

<Texts to be filled>

9.6 Action frame format details

Insert the following new subclause after the last subclause in 9.6:

9.6.31 WUR Action details

<Texts to be filled>

Insert the following new subclause after the last subclause in 9:

9.10 WUR frame formats

<Texts to be filled>

Insert new Clauses 31 and 32 following Clause 30 as follows:

31. Wake-Up Radio (WUR) MAC specification

31.1 Introduction

<Texts to be filled>

31.2 Channel access

<Texts to be filled>

31.3 Maintaining synchronization

<Texts to be filled>

31.4 WURx duty cycle operation

<Texts to be filled>

31.5 Power management with WUR mode

<Texts to be filled>

31.6 Wake-up operation

<Texts to be filled>

32. Wake-Up Radio (WUR) PHY specification

32.1 Introduction

<Texts to be filled>

32.2 WUR PHY service interface

<Texts to be filled>

32.3 WUR PHY

32.3.1 Introduction

<Texts to be filled>

32.3.2 WUR PPDU format

<Texts to be filled>

32.3.3 Transmitter block diagram

<Texts to be filled>

32.3.4 Overview of the PPDU encoding process

<Texts to be filled>

32.3.5 WUR modulation and coding schemes (WUR-MCSs)

<Texts to be filled>

32.3.6 Timing related parameters

<Texts to be filled>

Table 32-1 (Timing-related constants) defines the timing-related parameters for WUR PPDU formats.

Table 32-2 (Frequently used parameters) defines parameters used frequently in Clause 32 (Wake-Up Radio (WUR) PHY specification).

32.3.7 Mathematical description of signals

<Texts to be filled>

32.3.8 WUR preamble

32.3.8.1 Introduction

<Texts to be filled>

Table 32-1— Timing-related constants

Parameter	Value	Description
$\Delta_{F,\text{WUR}}$	312.5 kHz	Subcarrier frequency spacing for WUR PPDU
$T_{DFT,\text{WUR}}$	3.2 μs	IDFT/DFT period for the WUR PPDU
$T_{GI,\text{WUR}}$	0.8 μs	Guard interval duration for the WUR PPDU
$T_{GI,\text{L-LTF}}$	1.6 μs	Guard interval duration for the L-LTF field
$T_{SYM0,ON}$	4 μs	ON duration of WUR MCS0 OOK symbol in WUR Data field
$T_{SYM0,OFF}$	4 μs	OFF duration of WUR MCS0 OOK symbol in WUR Data field
T_{SYM0}	4 μs = $T_{SYM0,ON}$ = $T_{SYM0,OFF}$	Duration of WUR MCS0 OOK symbol in WUR Data field
$T_{SYM1,ON}$	2 μs	ON duration of WUR MCS1 OOK symbol in WUR Data field
$T_{SYM1,OFF}$	2 μs	OFF duration of WUR MCS1 OOK symbol in WUR Data field
T_{SYM1}	2 μs = $T_{SYM1,ON}$ = $T_{SYM1,OFF}$	Duration of WUR MCS1 OOK symbol in WUR Data field
T_{SYM}	T_{SYM0} or T_{SYM1} depending on WUR MCS	Duration of OOK symbol in WUR Data field
T_{SYNC}	TBD	Duration of OOK symbol in WUR SYNC field
$T_{\text{L-STF}}$	8 μs = 10 × $T_{DFT,\text{WUR}}$ /4	Non-HT Short Training field duration
$T_{\text{L-LTF}}$	8 μs = 2 × $T_{DFT,\text{WUR}}$ + $T_{GI,\text{L-LTF}}$	Non-HT Long Training field duration
$T_{\text{L-SIG}}$	4 μs	Non-HT SIGNAL field duration
$T_{\text{WUR-MARK}}$	4 μs	WUR MARK field duration
$T_{\text{WUR-SYNC0}}$	64 μs	WUR SYNC field duration for WUR MCS0
$T_{\text{WUR-SYNC1}}$	128 μs	WUR SYNC field duration for WUR MCS1

32.3.8.2 Non-WUR portion of WUR format preamble

<Texts to be filled>

32.3.8.3 WUR SYNC field

<Texts to be filled>

32.3.9 WUR Data field

<Texts to be filled>

Table 32-2— Frequently used parameters

Symbol	Explanation
N_{SPDB}	Number of OOK symbols per data bit. For WUR MCS0, N_{SPDB} =4. For WUR MCS1, N_{SPDB} =2.
N_{SPCB}	Number of OOK symbols per encoded bit. N_{SPCB} =1.
N_{CBPDB}	Number of coded bits per data bit. For WUR MCS0, N_{CBPDB} =4. For WUR MCS1, N_{CBPDB} =2.
N_{TX}	Number of transmit chains
$N_{WUR\text{-}SYNC}$	Number of OOK symbols in the WUR SYNC field

32.3.10 WUR transmit specification

<Texts to be filled>

32.3.11 WUR receiver specification

<Texts to be filled>

32.3.12 WUR transmit procedure

<Texts to be filled>

32.3.13 WUR receive procedure

<Texts to be filled>

32.4 WUR PLME

<Texts to be filled>

32.5 Parameters for WUR-MCSs

<Texts to be filled>