IEEE P802.11
Wireless LANs

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| TGbd Coexistence Assessment Document |
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Abstract

This serves as the coexistence assurance document for TGbd in meeting the requirement of the CSD.

Revision History:

r0: Draft CAD for accompanying WG LB for 11bd D1.0

r1: Incorporate comments from the group. Separate description for ITS band and non-ITS band operation.

r2: update doc. header.

r3: update the CA document based on D1.0 LB251 comments

r4: updates based on group discussions on 5.9GHz band.

# Introduction

This document addresses coexistence of IEEE std 802.11bd [1] per the PAR [2] and CSD [3]. The relevant sections of the P802.11bd PAR and CSD are outlined below:

* PAR scope:
	+ This amendment defines operations in frequency bands for 5.9 GHz and 60 GHz. The new amendment shall enable backward compatibility and coexistence with deployed OCB devices operating in the same band.
* CSD:
	+ Response to 1.1.2: “Will the WG create a CA document as part of the WG balloting process as described in Clause 13? YES”

# Bands of Operation

As specified in the PAR, 802.11bd is an amendment to the IEEE 802.11 standard, defining enhancements to OFDM in the 5.9 GHz frequency band1 and DMG in the unlicensed2 60 GHz frequency band [4]. The channelization for the 5.9 GHz frequency band and 60 GHz frequency band remain unchanged as defined in Annex E (Country elements and operating classes) in IEEE std 802.11-2020 [4].

# Active IEEE 802 wireless standards operating in the same frequency bands of operation as IEEE 802.11bd

802.15 standards and amendments specifically in the 60 GHz band are listed below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Identifier** | **Standards/Amendment** | **Clause**  | **PHY Name** | **Frequency Band (GHz)** |
| 3-1 | 802.15.3-2016 | 11 | SC PHY, HSI PHY, AV PHY | 57.240 – 65.880 GHz |
| 3-2 | 802.15.3e | 11a | HR-SC PHY, OOK PHY | 57.240 – 65.880 GHz |

# Selected non-802 market relevant standards operating in the same frequency bands as IEEE 802.11bd

|  |  |  |
| --- | --- | --- |
| **Identifier** | **Standards/Amendment** | **Frequency Band (GHz)** |
| 4-1 | 3GPP C-V2X | 5.9 GHz |

# Mechanisms supporting Coexistence with non-802.11 systems

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1 the frequence range of the 5.9 GHz band depends on the regulatory region

2 “unlicensed” may be referred to “license exempt” in some geographical regions, e.g. Europe.

The mechanism defined in IEEE 802.11 standards for 802.11 devices to co-exist with non-802.11 devices is carrier sense multiple access with collision avoidance (CSMA/CA). For 802.11bd operation on 5.9 GHz frequency band, 802.11bd devices continue to use rules, which are defined in 802.11bd Clause 32.3.11.5 of [1].

According to these rules, an 802.11bd PHY shall set its CCA indication to busy for

* any signal that exceeds -65 dBm in the primary 10 MHz channel. For 10 MHz channel, the rule is the same as defined in 17.3.10.6 [4], which corresponds to 802.11p [5].
* any signal that exceeds -65 dBm in the secondary 10 MHz channel.

For 802.11bd operation on 60 GHz frequency band, 802.11bd devices continue to use the same CCA rules as defined in 20.5.4.2.2 [4] (which corresponds to 802.11ad).

# Coexistence analysis: non 802.11 systems

Section 3 standards 3-1 and 3-2 overlap with planned IEEE 802.11bd operation in the 60 GHz band. CSMA/CA is the mechanism used by existing IEEE 802.11 standards for coexistence in the 60 GHz band and will also be used by 802.11bd. No change to coexistence is anticipated with 802.11bd operation in the 60 GHz band.

Section 4 standards 4-1 overlaps with IEEE 802.11bd operation in the 5.9 GHz band. CSMA/CA is the mechanism used by existing IEEE 802.11 standards for coexistence in the 5.9 GHz band and will also be used by 802.11bd. No significant changes to coexistence are anticipated with 802.11bd operation in the 5.9 GHz band.

In addition to the CCA rules, 802.11bd STAs operating in the licensed ITS band further comply with the regulatory rules in each regulatory region to facilitate coexistence. The regulatory rules may include allowed operating channel width, channel sharing rules, and etc..

# Mechanisms supporting Coexistence with legacy 802.11 systems

802.11bd devices working on 5.9 GHz frequency band use a common preamble, the non-HT short training field, non-HT long training field, and non-HT signal field as the initial fields in each 10 MHz channel as implemented in 802.11p 10 MHz PPDU [5]. Therefore, 802.11bd provides PHY-level coexistence with 802.11p 10 MHz devices working on 5.9 GHz frequency band [5] using -85dBm CCA sensitivity. Note that due to the tone spacing difference, 802.11bd can coexist with 802.11p 20 MHz devices working on 5.9 GHz frequency band [5] using -65dBm CCA sensitivity per 10 MHz channel.

802.11bd devices working on 60 GHz frequency band reuse the 802.11ad PPDU format and other interference mitigation techniques without change to provide coexistence with other 802.11 devices working on 60 GHz frequency band.

# New 802.11bd features which may affect coexistence

The following features introduced in 802.11bd for 5.9 GHz frequency band may affect OCB coverage area, transmitted RF energy and transmission duration in the operating environment:

* Preamble power boost
* New OFDM waveform design and new 20 MHz transmit spectrum mask
* NON\_NGV\_10 repetition transmission

Each of these features and their potential impact on coexistence is described below.

## Preamble power boost

In 802.11bd 10 MHz PPDU modulated with binary phase shift keying (BPSK), short and long training fields are boosted by 3dB. The legacy signal field is repeated twice for all 11bd PPDU. Dual Carrier Modulation is also defined for the data field to collect diversity gain.

This modification can extend 802.11bd 10 MHz PPDU communication range, which may affect coexistence with neighboring legacy devices.

## New OFDM waveform design and new 20 MHz transmit spectrum mask

In 802.11p, the 10 MHz channelization uses a 64pt FFT with edge tones at tone indices of +/-26. In 802.11bd, the 10 MHz channelization uses a 64pt FFT with edge tones at tone indices of +/-28. More spectrum is occupied within the channel bandwidth with the new 802.11bd OFDM waveform design. The spectral rolloff for 802.11bd 10 MHz PPDU will be sharper and may result in less out-of-band emissions beyond +/-5.5 MHz.

In 802.11p, the 20 MHz channelization uses a 64pt FFT with edge tones at tone indices of +/-26. In 802.11bd, the 20 MHz channelization uses a 128pt FFT with edge tones at tone indices of +/-58. More spectrum is occupied within the channel bandwidth with the new 802.11bd OFDM waveform design, and tone spacing is half of 802.11p 20 MHz. Thus 802.11bd devices can not decode 802.11p 20 MHz PPDU and vice versa. CCA rule of energy detection (ED) threshold of -65dBm per 10 MHz channel applies.

In additional, 802.11bd defines a new transmit mask C2 for 20 MHz transmission complying with power class C, which requires the same transmit spectrum roll-off as the transmit mask for 10 MHz transmission complying with power class C [1]. The spectral rolloff for 802.11bd 20 MHz PPDU will be sharper and result is less out-of-band emissions beyond +/-10 MHz. This new mask can mitigate adjacent channel interference of 20 MHz operation, thus provide better coexistence with operations on adjacent 10 MHz channels.

## NON\_NGV\_10 repetition transmission

802.11bd defines repetitive transmission of NON\_NGV 10 MHz PPDU. This mode allows transmitter to repeat NON\_NGV 10 MHz PPDU transmission up to three times, where the gap between each two repetitions is SIFS time. This feature guarantees interoperability with legacy devices and can enable 802.11bd devices to collect time diversity from repetitive reception.

This modification may extend communication range of legacy NON\_NGV 10 MHz PPDU to both 802.11bd and 802.11p devices. This may affect coexistence with neighboring legacy devices as repetition transmission duration is longer. The impact of increased transmission time is mitigated through upper layer control of number of repetition based on traffic density.

# Definitions

* OCB: outside the context of a basic service set, is a mode of operation in which a STA is not a member of a basic service set (BSS) and does not utilize IEEE 802.11 authentication, association, or data confidentiality services.
* ITS: Intelligent transportation system
* NGV: Next Generation V2X
* NON\_NGV\_10: Non-NGV 10 MHz format, is the PPDU format as specified in Clause 17 (Orthogonal frequency division multiplexing (OFDM) PHY specification) for 10 MHz channel spacing.

#  References

[1] P802.11bd D1.0

[2] 11-18-0861-09-0ngv-ieee-802-11-ngv-sg-proposed-par

[3] 11-18-0862-03-0ngv-ieee-802-11-ngv-sg-proposed-csd

[4] IEEE Std 802.11-2020

[5] IEEE 802.11P-2010