IEEE P802.11
Wireless LANs

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| TGbn Coexistence Assessment Document |
| Date: May 5, 2025 |
| Author(s): |
| Name | Affiliation | Address | Phone | Email |
| Sigurd Schelstraete | MaxLinear |  |  | sschelstraete@maxlinear.com |
| Yanchun Li | Huawei |  |  | liyanchun@huawei.com |
| Stephen McCann | Huawei |  |  | stephen.mccann@huawei.com |

Abstract

This serves as the Coexistence Assessment document for P802.11bn.

R0: Initial version.

R1: minor changes

R2: Add CoBF and DBE coexistence analysis.

R3: Editorial changes and minor fixes

# Introduction

This document addresses the coexistence of IEEE P802.11bn [1] following the PAR [2] and CSD [3].

The P802.11bn PAR [2] describes the frequency range where the new amendment is expected to operate as follows:

This amendment applies to carrier frequency operation between 1 GHz and 7.250 GHz.

This amendment provides for backward compatibility and coexistence with legacy IEEE 802.11 devices in the 2.4 GHz, 5 GHz and 6 GHz unlicensed bands

The following excerpt of the CSD [3] confirms that the WG will produce a Coexistence Assurance (CA) document for P802.11bn:

### 1.1.2 Coexistence

A WG proposing a wireless project shall prepare a Coexistence Assessment (CA) document unless it is not applicable.

1. Will the WG create a CA document as part of the WG balloting process as described in Clause 13? YES
2. If not, explain why the CA document is not applicable.

# Frequency Bands of Operation defined in IEEE P802.11bn

Though the PAR [2] specifies the frequency range between 1 GHz and 7.250 GHz, P802.11bn intends to operate in the unlicensed 2.4 GHz, 5 GHz and 6 GHz bands.

The P802.11bn channelization in 2.4 GHz, 5 GHz and 6 GHz is identical to the one specified in P802.11be-2024 [4]. No new bandwidths or channels are introduced in 802.11bn relative to the previous generation of 802.11.

# Active IEEE 802 wireless standards operating in the same frequency bands of operation as IEEE P802.11bn

IEEE 802.15 standards and amendments specifically in the 2.4, 5, and 6 GHz bands are listed below:

Table 1: IEEE 802.15 Standards and Amendments

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Identifier** | **Standards/Amendment** | **Clause**  | **PHY Name** | **Frequency Band** |
| 3-1 | 802.15.3-2016 | 10 | PHY for 2.4 GHz | 2.4 – 2.4835 GHz |
| 3-2 | 802.15.4-2020 | 12 | O-QPSK PHY | 2450, 868, 915, 780, 2380 MHz |
| 3-3 | 802.15.4-2020 | 14 | CSS PHY | 2450 MHz |
| 3-4 | 802.15.4-2020 | 15 | HRP UWB PHY | 249.6 – 749.6 MHz, 3.1 – 4.8 GHz and 6.0 – 10.6 GHz |
| 3-5 | 802.15.4-2020 | 17 | MSK PHY | 433.05 – 434.79 MHz and 2400 – 2483 MHz  |
| 3-6 | 802.15.4-2020 | 18 | LRP UWB PHY | 6.2826 – 9.1856 GHz  |
| 3-7 | 802.15.4-2020 | 19 | SUN FSK PHY | 169, 450, 470, 863, 901, 915, 928, 1427, 2450 MHz |
| 3-8 | 802.15.4-2020 | 20 | SUN OFDM PHY | 470–510, 779–787, 863–870, 902–928, 917–923.5, 920–928, 2400–2483.5 MHz |
| 3-9 | 802.15.4-2020 | 21 | SUN O-QPSK PHY | 470, 780, 868, 915, 917, 920, and 2450 MHz |
| 3-10 | 802.15.4q-2016 | 31 | TASK PHY | 433.050-434.790, 470-510, 779-787, 863-876, 902–928, 2400-2483.5 MHz |
| 3-11 | 802.15.4q-2016 | 32 | RS-GFSK PHY | 915 and 2450 MHz |
| 3-12 | 802.15.4t-2017 | 18 | MSK PHY | 433.05 – 434.79 MHz and 2400 – 2483 MHz |
| 3-13 | 802.15.4z-2020 | Amendment | HRP UWB PHYLRP UWB PHY | 6-10 GHz |
| 3-14 | 802.15.4-2020 | 22 | LECIM DSSS | 2.4 – 2.485 GHz |

# Selected non-IEEE 802 market relevant standards operating in the same frequency bands as IEEE P802.11bn

|  |  |  |
| --- | --- | --- |
| **Identifier** | **Standards/Amendment** | **Frequency Band (GHz)** |
| 4-1 | 3GPP LTE LAA | 5GHz/6GHz |
| 4-2 | 3GPP NR-U | 5GHz/6GHz |

# Existing Licensed Services in the 6 GHz band [10][[1]](#footnote-2)

|  |  |  |
| --- | --- | --- |
| **Identifier** | **Standards/Amendment** | **Frequency Band (GHz)** |
| 5-1 | Fixed Services (FS) | 5925 – 6425 MHz and 6525 – 7125 MHz |
| 5-2 | Fixed Satellite Services (FSS) | 5925 – 7125 MHz |
| 5-3 | Mobile Services | 6425 – 6525 MHz and 6875 – 7125 MHz |

# Mechanisms supporting Coexistence with non-IEEE 802.11 systems

The mechanism defined in IEEE 802.11 standards for 802.11 devices to coexist with non-802.11 devices (other than licensed services in the 6 GHz band or radar operation in 5 GHz) is carrier sense multiple access with collision avoidance (CSMA/CA). P802.11bn continues to use clear channel assessment (CCA) rules in the 2.4, 5 and 6 GHz bands.

The current draft P802.11bn CCA rules are described in 38.3.25.6 (CCA sensitivity) of [1]. These rules are identical to the ones used by previous generations of 802.11.

According to these rules, a PHY must set its CCA indication to busy if:

* A non-HT, HT\_MF, HT\_GF, VHT, HE, or EHT PPDU is present with power measured within the primary 20 MHz channel at or above –82 dBm
* A signal is present with power measured within the primary 20 MHz channel at or above –62 dBm[[2]](#footnote-3).

For signals with bandwidth greater than 20 MHz, the PHY shall also provide a per-20 MHz CCA indication, which shall individually be set to busy if:

* A non-HT, HT\_MF, HT\_GF, VHT, HE, or EHT PPDU is present for which the power measured within the 20 MHz subchannel is at or above -72 dBm
* A signal is present within the 20 MHz subchannel at or above a threshold of –62 dBm.

802.11bn defines “Prioritized EDCA (P-EDCA)”. Under P-EDCA, a STA can deviate from the regular rules of CSMA/CA under TBD conditions. The compliance of this mode of operation with several regulatory standards remains to be verified.

For coexistence with licensed services in the 6 GHz band, operation of P802.11bn in the 6 GHz band further complies with the regulatory rules specified for this band [5]. This includes the ability to reduce transmit power and rules for selecting channels under the direction of an Automated Frequency Coordination (AFC) system.

For coexistence with radar operation in 5 GHz, P802.11bn uses DFS as specified in 802.11-2024 [9].

# Coexistence analysis: non-IEEE 802.11 systems

IEEE 802.15 standards 3-1 through 3-3, 3-5, 3-7 and 3-12 (see Table 1) overlap with IEEE 802.11 and P802.11bn operation in the 2.4 GHz band only. CSMA/CA is the mechanism used by existing IEEE 802.11 standards for coexistence in the 2.4 GHz band and will also be used by P802.11bn. No significant changes to coexistence are anticipated with P802.11bn operation in the 2.4 GHz band.

IEEE 802.15 standards 3-4 and 3-6 and the amendment 3-13 (see Table 1) overlap with planned IEEE P802.11bn operation in the 6 GHz band. IEEE P802.11bn shall operate in the band under new regulations (see [5] for FCC rules). IEEE 802.15 standards 3-4 and 3-6 and the 3-13 ultra-wideband (low power spectral density) systems (see Table 1) operate beneath the noise floor of systems operating in the 6 GHz band. The Electronic Communications Committee (www.cept.org/ecc) has produced a report on sharing and compatibility between proposed radio local area networks (RLANs) and current systems in the band including UWB, see [7].

CSMA/CA is used to provide coexistence in the 5 GHz and 6 GHz bands including the specifications identified in section 4 of this document.

Note -- This CSMA/CA mechanism is not effective as a coexistence mechanism with IEEE 802.15 UWB radios since the UWB signals will typically be below the CSMA detection threshold. Conversely, UWB does not require 802.11-like CSMA/CA mechanisms.

For coexistence with licensed users of the 6 GHz bands identified in section 5 of this document, three modes of operation are defined:

1. Standard Power operation
	* Only allowed in 5.925 – 6.425 GHz (FCC U-NII-5) and 6.525 – 6.875 GHz (FCC U-NII-7)
	* Operation only under direction of an AFC system that identifies allowed spectrum and transmit power as a function of AP location, height above ground level (AGL) and the known location of licensed services in the area
	* Client device must limit its power to no more than 6 dB below its associated standard power access point's authorized transmit power
2. Low Power Indoors operation
	* Allowed in full 6 GHz band (i.e. 5.925 to 7.125 GHz)
	* Only indoors at reduced power to avoid interference with licensed users
3. Very Low Power operation
	* Envisioned for indoors and outdoors in the full 6 GHz band
	* Operates at significantly reduced maximum power to avoid interference with fixed and mobile licensed users.

P802.11bn implements the mechanisms needed to communicate the transmit power restrictions to the P802.11bn devices, specifically through the use of Transmit Power Envelope (TPE) element in Beacons, Probe Responses, etc.

Coexistence with BT in 6 GHz will be achieved by both BT and 802.11bn implemented Listen Before Talk (LBT) to check if the channel is clear before transmitting.

# Mechanisms supporting Coexistence with legacy 802.11 systems

P802.11bn continues to use a common legacy preamble, i.e., the non-HT short training field, non-HT long training field, and non-HT signal field as the initial fields in all new P802.11bn PPDUs for coexistence with legacy 802.11 systems. This is the same mechanism that was implemented in mixed-format 802.11n, 802.11ac, 802.11ax and 802.11be PPDUs. Therefore PHY-level coexistence with legacy devices will be similar to 802.11n, 802.11ac, 802.11ax and 802.11be.

# New IEEE P802.11bn features which may affect coexistence

The following features introduced in P802.11bn may affect coexistence with other protocols or devices – either at the signal level or the operational level.

* Prioritized EDCA
* Multi-AP operation
* Non-Primary Channel Access (NPCA)
* Peer-to-Peer (P2P) Communications
* Dynamic Subband Operation
* Dynamic Bandwidth Expansion (DBE)
* Distributed RU (DRU)
* Extended Long Range (ELR)

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

## Prioritized EDCA

Prioritized EDCA (P-EDCA) is an enhancement of the EDCA mechanism (see 10.23.2 (HCF contention-based channel access (EDCA)) that intends to reduce the access delay distribution tail of AC\_VO traffic. This is achieved by restricting the STAs that can participate in channel contention to a subset of eligible STAs – under certain conditions. The eligible STAs will transmit a DS-CTS signal to preempt any other STAs from acquiring the medium and subsequently use EDCA parameters that give them priority over other systems on the medium.

Several regulatory standards set general requirements for the Listen Before Talk mechanism needed in channel access in 5 and 6 GHz bands. P-EDCA needs to define its rules in compliance with the applicable standards.

## Multi-AP operation

In multi-AP operation, two or more APs coordinate their transmissions to improve efficiency, performance or latency. The spectrum use of APs participating in a multi-AP transaction is not expected to be different from an AP that is not part of a multi-AP exchange.

In cases where APs share part of their resources with another AP in the group, the question of fairness needs to be addressed to prevent that any individual AP acquires a significantly higher share of network resources than it would when operating as an independent AP.

Multi-AP operation framework includes Coordinated Beamforming (Co-BF), Coordinated Spatial Reuse (Co-SR), Coordinated TDMA (Co-TDMA) and Coordinated Restricted TWT (Co-RTWT) schemes.

Coordinated Beamforming (Co-BF) allows concurrent transmissions of two APs with minimal interference to each other’s STAs. The transmitted PPDU is in a UHR MU PPDU format. The UHR STAs can successfully identify the BSS Colors of these two APs in the U-SIG field of the UHR MU PPDU.

However, there is potential issue when UHR Co-BF capable AP/STAs coexist with legacy EHT STAs. The legacy EHT STAs can only identify the sharing AP’s BSS color in UHR Co-BF transmission, when the legacy EHT STAs’ associated AP involves the transmission as a shared AP. These EHT STAs may initiate an uplink transmission during the time that their associated AP is participating in a Co-BF transmission. Thus, this scheme may cause an energy drain and unexpected interference. The EHT STAs will also have false estimation of interference level from a sharing AP when they measure the sharing AP’s Co-BF transmission.

## Non-Primary Channel Access (NPCA)

Non-Primary Channel Access (NPCA) allows a contending STA that observes the primary channel to be occupied by an OBSS transmission to contend on a designated non-primary channel (called the NPCA primary channel) instead.

Some regulatory standards have limitations on how often the primary channel of an 802.11 network can be changed. NPCA needs to define its rules in compliance with the applicable standards.

## Peer-to-Peer (P2P) Communications

802.11be defines TXOP sharing as a means for the AP to share an acquired TXOP with a non-AP STA. The non-AP STA can use this shared TXOP to transmit to the AP or to a single non-AP STA. P2P communication extends this mechanism by creating a TXOP that can be shared among several non-AP devices for direct communication between them. These devices may use a modified channel access mechanism for this, that needs to be evaluated in terms of fairness.

## Dynamic Subband Operation

In Dynamic Subband Operation (DSO), a DSO-capable device with limited bandwidth (e.g. 80 MHz) may be assigned to a non-primary 80 MHz for its PPDU as part of an OFDMA transmission. This allows the AP to efficiently use a wider bandwidth (e.g. 160 MHz), even if individual intended receivers only support a lower bandwidth (e.g. 80 MHz).

This operation is not significantly different from performing “regular” OFDMA in a wider bandwidth, so no coexistence issues are expected.

## Dynamic Bandwidth Expansion (DBE)

Dynamic Bandwidth Expansion (DBE) is a mode of operation that allows a UHR AP to expand bandwidth that is greater than the BSS bandwidth. This operation’s signaling is based on the UHR BSS parameter critical update. Legacy STAs and APs that rely on legacy operating bandwidth information in beacons will encounter an unexpected traffic load in 20MHz channels that have not been covered by the legacy operating bandwidth.

## Distributed RU (DRU)

Distributed Resource Units (DRU) use a tone allocation that markedly differs from Resource Units (RU) used in 802.11ax and 802.11be. In a DRU, the tones are not allocated as a contiguous block of tones but are instead distributed on a semi-regular grid within a larger bandwidth (the “Distribution Bandwidth”). In regulatory domains with PSD-limited transmissions, such spreading may allow the transmitting STA to boost its power relative to a STA using a regular RU.

802.11bn needs to ensure that DRU operation complies with applicable regulatory standards.

## Extended Long Range (ELR)

802.11bn defines an Extended Long Range (ELR) transmission format. Use of this format potentially extends the reach of a BSS beyond what would be achieved in 802.11be. Such an extension may come at the expense of increased airtime usage for devices using ELR.

In addition, intended receivers of ELR transmissions may have to operate at sensitivities that are higher than the one specified by the 802.11 standard.

## Other notable features

P802.11bn reuses a number of features that were first introduced in 802.11be, such as:

* Operation in 6 GHz
* Spatial Reuse
* Multi-link operation
* 320 MHz channels in 6 GHz
* UL/DL OFDMA and UL/DL MU-MIMO
* MRU
* Puncturing

The possible impact and coexistence of these features was discussed in the TGbe Coexistence Assurance Document [8]. No changes are expected for P802.11bn.

# Definitions

# References

[1] IEEE P802.11bn, D0.2

[2] <https://www.ieee802.org/11/PARs/P802.11bn_PAR.pdf>

[3] <https://mentor.ieee.org/802-ec/dcn/24/ec-24-0039-00-ACSD-p802-11bn.docx>

[4] IEEE Std 802.11be-2024

[5] FCC Rules Part 15, subpart E (Unlicensed National Information Infrastructure Devices), <https://www.ecfr.gov/current/title-47/chapter-I/subchapter-A/part-15#subpart-E>

[6] IEEE Std 802.11-2024: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

[7] Sharing and compatibility studies related to Wireless Access Systems including Radio Local Area Networks (WAS/RLAN) in the frequency band 5925-6425 MHz, ECC Report 302, CEPT ECC, [https://cept.org/files/9522/Draft%20ECC%20Report%20302rev..docx](https://urldefense.proofpoint.com/v2/url?u=https-3A__cept.org_files_9522_Draft-2520ECC-2520Report-2520302rev..docx&d=DwMGaQ&c=C5b8zRQO1miGmBeVZ2LFWg&r=CJpcKjV7C3TczgWxHrsFmPscm1VuXKM-giLBsGdAZJk&m=i3Xw2ZPlZqLehRXO1WKeeMT68mo8u1Yuo4S2bxPohs8&s=UARqQgc-kmo67ikGQVCJkqodqWbENbRgzBpCjczFxAw&e=)

[8] TGbe Coexistence Assessment Document, IEEE 802.11-2021/0706r8, <https://mentor.ieee.org/802.11/dcn/21/11-21-0706-08-00be-tgbe-coexistence-assessment-document.docx>

1. This describes North-American spectrum only [↑](#footnote-ref-2)
2. -62 dBm is the value used in IEEE 802.11be. ETSI has specified a value of -72 dBm. [↑](#footnote-ref-3)