IEEE P802.11
Wireless LANs

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| TGax Coexistence Assurance Document |
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Abstract

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

# Introduction

This document addresses coexistence of IEEE 802.11ax per the PAR and CSD [2,3]. The relevent sections of each are outlined below:

* PAR scope:
	+ This amendment defines operations in frequency bands between 1 GHz and 6 GHz. The new amendment shall enable backward compatibility and coexistence with legacy IEEE 802.11 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”

# Band of Operation

Though the PAR specifies the frequency range between 1 GHz and 6 GHz, the focus of 802.11ax is on the 2.4 GHz and the 5 GHz frequency bands. Therefore 802.11ax will be an enhancement to 802.11n in 2.4 GHz and 802.11ac in 5 GHz.

# Coexistence with non-802.11 systems

The main mechanism for 802.11 devices to coexist with non-802.11 devices is clear channel assessment (CCA). 802.11ax continues to use the 802.11ac CCA rules in 5 GHz and the 802.11n CCA rules in 2.4 GHz.

According to 802.11ac 22.3.20.5 [4], a PHY must set its CCA indication to busy as follows

* “Any signal within the primary 20 MHz channel at or above -62 dBm.”
* “Any signal within the secondary 20 MHz channel at or above -62 dBm.”
* “Any signal within the secondary 40 MHz channel at or above -59 dBm.”
* “Any signal within the secondary 80 MHz channel at or above -56 dBm.”

The first two bullets above are the same as 802.11n. The conditions for secondary 40 MHz channel and secondary 80 MHz channel are new to 11ac with the introduction of 80 MHz and 160 MHz channels, respectively. Since the power spectral density is the same for each case, the CCA performance will be comparable for the various bandwidths.

For 2.4 GHz we refer to 20.3.21.4 [5] (which corresponds to 802.11n), which corresponds to the same rules for 20 and 40 MHz described in the paragraph above.

# Coexistence with legacy 802.11 systems

802.11ax continues to use the Legacy Preamble Field as the initial field in all new 802.11ax PPDUs for coexistence with legacy 802.11 systems as was implemented in 802.11n/ac PPDUs. Therefore PHY-level coexistence with legacy devices will be similar as was in 802.11n and 802.11ac.

# New Features

The following features may affect 802.11ax coverage area and transmitted energy in the environment:

* Uplink multi-user operation
* Spatial reuse
* Extended range operation
* New OFDM waveform design
* Preamble Puncturing

## Uplink Multi-User Operation

While 802.11n added multi antenna transmission with MIMO and 802.11ac added downlink multi-user MIMO, the total EIRP transmitted by a device was limited by both regulatory restrictions and device costs resulting in energy on the air similar to 802.11g/a devices.

With 802.11ax uplink multi-user operation, multiple client devices will transmit simultaneously to AP during an uplink transmission. With uplink OFDMA and 80 MHz, up to 37 client devices could be transmitting simultaneously. Furthermore, with uplink OFDMA an individual client device could transmit on a resource unit as narrow as ~2 MHz, resulting in substantially higher power spectral density depending on the regulatory limits. With uplink MU-MIMO, up to 8 client devices could be transmitting simultaneously. The aggregate energy on the air during an uplink multi-user transmission will be the sum of all the client devices, and could be much higher than in 802.11n/ac.

## Spatial Reuse

802.11ax introduces the concept of spatial reuse (SR) to increase capacity in a dense environment by increase frequency reuse between BSS’s. Two SR operations have been specified, as follows. The first type of SR allows a device to increase its “OBSS\_PD threshold” in conjunction with decreasing its transmit power. In 802.11n/ac, the signal detect level of a valid 802.11 signal is -82 dBm in 20 MHz. This SR rule allows for an OBSS signal detect level up to -62 dBm of valid OBSS 802.11ax signals, depending on the corresponding decrease in transmit power of the device.

The second rule employs a more dynamic approach by which a device examines new SR information in the 802.11ax preamble on a packet by packet basis. The new SR information in the preamble provides a parameter that allows a third party device to determine whether it would be possible to initiate an SR transmission during a subsequent uplink multi-user transmission.

The important aspect of SR with respect to coexistence is that with 802.11ax SR techiques there may be more simultaneous transmissions on the air, which may increase the overall interference floor.

## Extended Range Operation

802.11ax introduces a new PPDU format with a more robust preamble to address outdoor extended range environments. The short and long training fields are boosted by 3 dB, and the signal fields are repeated twice. For the data field of the PPDU, both Dual Carrier Modulation and narrower transmission bandwidth can both be used for diversity gain and noise bandwidth reduction, respectively. These modifications can expand 802.11ax BSS coverage area relative to 802.11n/ac, which may affect coexistence with neighboring systems. That said, in 2.4 GHz a BSS employing 1 Mbps 802.11b waveforms with long preamble would have comparable coverage area.

## New OFDM Waveform Design

In 802.11n (in 2.4 GHz) and 802.11n/ac (in 5 GHz) the 20 MHz channelization uses a 64pt FFT with edge tones at +/-28. In 802.11ax (in both 2.4 and 5 GHz) the 20 MHz channelization uses a 256pt FFT with edge tones at +/-122. More spectrum is occupied within the channel bandwidth with the new 802.11ax OFDM waveform design. That said, due to the narrower subcarrier spacing (312.5 kHz for 802.11n/ac vs 78.125 kHz for 802.11ax), the spectral rolloff for 802.11ax will be sharper and will result is less out of band emissions beyond +/- 11 MHz (see figure below).



## Preamble Puncturing

In a downlink multi-user transmission, an AP may choose to not populate certain sub-channels of its 80 or 160 MHz channel bandwidth if it finds the sub-channels busy. In the HE-STF, HE-LFT and data field that are transmitted in HE format, this is performed by only assigning the free sub-channels to users. The L-STF, L-LTF, L-SIG, RL-SIG, and HE-SIG-B preamble fields are transmitted in legacy mode and utilize the technique termed Preamble Puncturing to not transmit preamble fields in the corresponding 20 MHz sub-channels.

With respect to coexistence, the spectral “holes” created by preamble puncturing are not protected by a TX spectral mask. The TX spectral mask only applies to the entire 80 or 160 MHz channel bandwidth. Therefore other systems in these sub-channels could see higher out-of-band emissions than that experienced by two neighboring systems where the out-of band transmissions by each system are restricted by a TX spectral mask.

# Definitions

* Orthogonal frequency-division multiple access (OFDMA) - users are allocated different subsets of subcarriers which can change from one PPDU to the next
* Dual Carrier Modulation (DCM) – replicate the same information on different subcarriers for frequency diversity gain and narrow band interference protection

# References

[1] Draft P802.11ax D1.0

[2] 11-14-0165-01-0hew-802-11-hew-sg-proposed-par

[3] 11-14-0169-01-0hew-ieee-802-11-hew-sg-proposed-csd

[4] IEEE Std 802.11ac-2013

[5] IEEE Std 802.11-2012