**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title | **Proposed Resolution for Comments #988** |
| Date Submitted | August 29, 2024 |
| Sources | Carlos Aldana (Meta) , Guoqing Li (Meta), Kumail Haider (Meta), Davide Magrin (Meta), Pooria Pakrooh (Qualcomm), Bin Tian (Qualcomm), Li-Hsiang Sun (Mediatek), Wenzheng Li (Calterah), Pelin Salem (Cisco), Carlos Cordeiro (Intel), Gaurav Patwardhan (HPE), Ashish Shukla (Amazon) |  |
| Re: |   |
| Abstract |  |
| Purpose | To propose resolution to comment with CID #988 for “P802.15.4ab™/Draft 1.0 Standard for Low-Rate Wireless Networks”  |
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***Comment Index #988***

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| 988 | Technical | 71 | 10.38.7.3 | 13 | SSBD can be used to specify LBT behavior. Please add the following text: "Channel access using listen before talk shall be used for improved coexistence performance. When used for narrowband assist, SSBD shall use the following control attribute values:phyCcaDuration should be set as required by local regulations;macSsbdMinBf and macSsbdMaxBf shall be set to 0;macSsbdMaxBackoffs shall be set to 0;macSsbdTxOnEnd shall be set to FALSE;macSsbdPersistence shall be set to FALSE;phyCcaMode shall be set to 1 (energy above threshold)phyCcaEdThreshold shall be set to -67 dBm/MHz - Ptx for channels 0 to 49 and to -74 dBm/MHz - Ptx for channels 50 to 249, where Ptx is the equipment’s instantaneous transmit power in dBm." |  |

**Discussion:** This proposal is based on the work [3] presented in the joint 802.11/802.15.4ab Coex SC meeting in July 2024, where we found the optimal energy detect threshold for NB devices in the presence of a typical 802.11 configuration with ~-60 dBm RSSI. In UNII-3, we considered an 80 MHz wide 802.11 system, even though 160 MHz is possible and in UNII-5, we considered a 320 MHz wide 802.11 system since 320 MHz wide 802.11 devices are available in the field today. From an 802.15.4ab system perspective, we minimized the probability of either

1. Losing a transmission opportunity because the ED threshold is set too low
2. Causing irrecoverable interference to a nearby 802.11 system because the ED threshold was too high.

Since ETSI usually has the most detailed requirements and acts as inspiration for other standards in other parts of the world, we should define the coexistence mechanism based on existing ETSI rules [2][5].

Besides the ED threshold parameters, the other SSBD parameters have been generalized from those presented in [1] and consistent with the FBE section of [2], where a single CCA measurement of at least 9us is made before a transmission:

*Immediately before starting transmissions on a channel or group of adjacent or non-adjacent channels the initiating device shall perform a Clear Channel Assessment (CCA) check during a single observation slot. A channel is an occupied channel as long as transmissions in that channel are present at a power level greater than the ED Threshold (EDT) in clause 4.3.6.3.3.*

*A single observation slot as defined in clause 3.1 and as referenced by the procedure in clause 4.3.6.3.1.4 shall have a duration of not less than 9 μs.*

In [4], if a CCA fails and the device wishes to remain in the same narrowband channel, the device shall wait TBDsamechannelccatime, with preferred minimum value of 200us, before performing another CCA. Such delay is likely unacceptable for 802.15.4ab applications where slot-based transmissions are used and a +-10us error in slot boundaries is expected when a ranging block is set to 100ms, corresponding to +-100ppm.



Note that a ranging block is defined in units of ranging rounds, which are typically in the order of 10ms, and can be in the range of 1 to 255. Similarly, a ranging round is defined in units of ranging slots, which are typically in the order of 1ms, and can be as small as 250us (smallest ranging slot) and as large as 510ms (255 \* 2ms). This means that a ranging block can be set to a single ranging round and be as small as 250us.

In UWB MMS, the ranging round has 3 phases, as shown in the figure below



The Control Phase and the optional Report Phase consist of NB transmissions. The Ranging Phase sends RIF or RSF UWB fragments. The current 802.15.4ab spec Draft 1.0 allows for the Ranging Phase to transmit 0 UWB fragments when *macMmsRpDuration, phyUwbMmsRifNumberFrags, and phyUwbMmsRsfNumberFrags* are set to 0. This would mean that the ranging round solely consists of NB packets, enabling 100% NB duty cycle. This is a huge problem as NB VLP devices can transmit up 10dBm/MHz in Europe [2] whereas a 320 MHz 802.11 VLP device in UNII-5 can transmit up to -11 dBm/MHz, a 21 dB difference. Similarly, an 80 MHz 802.11 VLP device in UNII-5 can transmit up to -5dBm/MHz, a 15 dB difference from NB VLP.

NOTE: If a CCA fails, [4] allows for the device to switch to another channel and perform a new CCA after at least TBDsecondarychannelccatime, which has preferred value of 100us.

Therefore, the proposed text describes a single-shot LBT measurement using SSBD parameters for both NBA-MMS and UWB data offload to narrowband (Section 10.43):

*Channel access using listen before talk shall be used for improved coexistence performance. When used for narrowband assist, SSBD, as described in Section 10.44, shall be used with the following control attribute values:*

*phyCcaDuration shall be set to the minimum value required by local regulations;
macSsbdMaxBf may be set to any finite value;*

*macSsbdUnitBackoffPeriod may be set to any finite value;*

*macSsbdMinBf shall be set to 0;
macSsbdMaxBackoffs shall be set to 0;
macSsbdTxOnEnd shall be set to FALSE;
macSsbdPersistence shall be set to FALSE;
phyCcaMode shall be set to 1 (energy above threshold)
phyCcaEdThreshold shall be set to -67 dBm/MHz - Ptx in channels 0 to 49 and to*

*-74 dBm/MHz - Ptx in channels 50 to 249, where Ptx is the equipment’s instantaneous transmit power for the upcoming packet in dBm and Ptx<=Pmax = min(TXMAX\_capability, TXMAX\_power\_Regulatory). TXMAX\_power\_Regulatory is the max power allowed in the regulatory domain and TXMAX\_capability is the max power allowed to be transmitted by the device.*

*The transmitter has two options:*

1. *If Pcca\_dBm\_MHz <= phyCcaEdThreshold (i.e., channel is idle), then transmit up to Pmax*
2. *If Pcca\_dBm\_MHz > phyCcaEdThreshold (i.e., channel is busy), then either*
	1. *do not transmit OR*
	2. *stay in the same channel and transmit according to TX procedure below.*

***TX Procedure***

*Transmit up to Ptx2\_dBm using the formula below:*

*Ptx2\_dBm < = min(Pmax, -67-Pcca\_dBm\_MHz) in channels 0 to 49*

*Ptx2\_dBm <= min(Pmax, -74-Pcca\_dBm\_MHz) in channels 50 to 249*

For example, if TXMAX\_capability=21 dBm, TXMAX\_power\_Regulatory=30 dBm, Pcca\_dBm\_MHz = -75 dBm, the 802.15.4ab transmitter can transmit up to 8 dBm in channels 0 to 49 (UNII-3). If the same level is measured in channels 50 to 249 (UNII-5), the 802.15.4ab transmitter can transmit up to 1 dBm. The table below shows a possible mapping of CCA levels to transmit power (in dBm) using the TXMAX\_capability=21 dBm, TXMAX\_power\_Regulatory=30 dBm assumptions.

|  |  |  |
| --- | --- | --- |
| CCA Power (dBm/MHz) | Max TX Power in channels 50 to 249 | Max TX Power in channels 0 to 49 |
| -67 | -7 | 0 |
| -68 | -6 | 1 |
| -69 | -5 | 2 |
| -70 | -4 | 3 |
| -71 | -3 | 4 |
| -72 | -2 | 5 |
| -73 | -1 | 6 |
| -74 | 0 | 7 |
| -75 | 1 | 8 |
| -76 | 2 | 9 |
| -77 | 3 | 10 |
| -78 | 4 | 11 |
| -79 | 5 | 12 |
| -80 | 6 | 13 |
| -81 | 7 | 14 |
| -82 | 8 | 15 |
| -83 | 9 | 16 |
| -84 | 10 | 17 |
| -85 | 11 | 18 |
| -86 | 12 | 19 |
| -87 | 13 | 20 |
| -88 | 14 | 21 |

Note that the noise floor of a 10 dB Noise Figure 802.15.4ab NB device at 290 Kelvin (62 degrees Fahrenheit, 16.85 degrees Celsius) is -174 dBm/Hz + 10\*log10(2.5e6) + 10 = -100 dBm. If 14 dBm is the intended transmit power in UNII-5 (which is the max value in Europe), the ED threshold of -88 dBm/MHz = -84 dBm is 16 dB above the noise floor. Therefore, the probability that a 9us measurement over a “noise only” window causes a channel to be busy is negligible. Even if the temperature increases to 311 Kelvin (100.13 degrees Fahrenheit, 37.85 degrees Celsius), the noise floor increases by 0.3 dB, since the noise floor is equal to kTB, where k is the Boltzmann constant, T is temperature in Kelvin, and B is bandwidth of the receiver. **Proposed Resolution :** Revised

**NOTE TO EDITOR:** Replace the following text in Section 10.38.7.3

LBT shall be applied to channel numbers 50 to 249 according to regulatory constraints. LBT may be applied to all channels in the absence of regulatory constraints, for example, to improve coexistence with other spectrum users.

**with the following:**

Channel access using listen before talk shall be used for improved coexistence performance. When used for narrowband assist, SSBD, as described in Section 10.44, shall be used with the following control attribute values so that a single CCA is performed before each transmission attempt:

phyCcaDuration shall be set to the minimum value required by local regulations;
macSsbdMaxBf may be set to any finite value;

macSsbdUnitBackoffPeriod may be set to any finite value;

macSsbdMinBf shall be set to 0;

macSsbdMaxBackoffs shall be set to 0;
macSsbdTxOnEnd shall be set to FALSE;
macSsbdPersistence shall be set to FALSE;
phyCcaMode shall be set to 1 (energy above threshold)
phyCcaEdThreshold shall be set to -67 dBm/MHz - Ptx in channels 0 to 49 and to

-74 dBm/MHz - Ptx in channels 50 to 249, where Ptx is the equipment’s instantaneous transmit power for the upcoming packet in dBm and Ptx<=Pmax = min(TXMAX\_capability, TXMAX\_power\_Regulatory). TXMAX\_power\_Regulatory is the max power allowed in the regulatory domain and TXMAX\_capability is the max power allowed to be transmitted by the device.

Figure 1 shows the simplified SSBD algorithm:



Figure 1

The transmitter has two options:

1. If Pcca\_dBm\_MHz <= phyCcaEdThreshold (i.e., channel is idle), then transmit up to Pmax
2. If Pcca\_dBm\_MHz > phyCcaEdThreshold (i.e., channel is busy), then either
	1. do not transmit OR
	2. stay in the same channel and transmit according to TX procedure below.

**TX Procedure**

Transmit up to Ptx2\_dBm using the formula below:

Ptx2\_dBm < = min(Pmax, -67-Pcca\_dBm\_MHz) in channels 0 to 49

Ptx2\_dBm <= min(Pmax, -74-Pcca\_dBm\_MHz) in channels 50 to 249

**NOTE TO EDITOR**: Please also add the new text at the end of Section 10.43.2.

**References** :

[1]15-24-0226-03-04ab “DraftC comment resolution – NB channel access – CIDs 149, 161”

[2] ETSI EN 303 687 V1.1.1 (2023-06)

[3] IEEE 802.11-24/1182r0, “Transmit Power Control Based EDT for NB”

[4] BRAN(24)124017r2\_NB\_Channel\_Access\_Mechanism\_Draft.docx, “NBE normative text”

[5] ETSI EN 300 440 v2.2.1 (2018-07)