**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title | **LB207 comment resolution - CAD - CIDs 10, 24, 26, 27, 28, 29** |
| Date Submitted | July 17, 2024 |
| Sources | Alex Krebs (Apple)  krebs @ apple.com |
| Re: |  |
| Abstract |  |
| Purpose | To propose resolution for MMS related comments for “P802.15.4ab™/D (pre-ballot) C Draft Standard for Low-Rate Wireless Networks”. |
| Notice | This document does not represent the agreed views of the IEEE 802.15 Working Group or IEEE 802.15.4ab Task Group. It represents only the views of the participants listed in the “Sources” field above.It is offered as a basis for discussion and is not binding on the contributing individuals. The material in this document is subject to change in form and content after further study. The contributors reserve the right to add, amend or withdraw material contained herein. |

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| **Index #** | **Page** | **Sub-clause** | **Comment** | **Proposed Change** |
| CAD010 | 10 | 3.1.3 | 802.19 comment from Menzo Wentink on CA document: "802.15.4 ranging services that operate under regulatory and public safety requirement constraints use typical airtime duty cycles between 1.5 and 5% typically [31] [32]]."  802.15.4ab NB may be used for one-to-many MMS ranging, to send data, or as channel access coordination signal. It seems that the duty cycle could easily be higher than 5%. | Please provide a realistic estimate for the expected NB duty cycle. |

Discussion:

The comment points out that the provided typical duty cycle values of 1.5-5% may not representative of other applications but NBA-UWB MMS, such as sending data frames. The proposed change asks to provide text to the CAD stating a realistic estimate of the expected NB duty cycle.

We agree with the comment that additional data transfer capabilities are introduced that are not assessed in the CAD draft yet. The proposed resolution aims to amend the CAD in that regard.

As for the ask for a realistic estimate of the expected NB duty cycle, we assess that the duty cycle of all bulk data transfer and the frequency of coordination packets to be sent depends on the specific application supported, which is out of scope of the 802.15.4ab standard hence cannot be assessed in the CAD. We aim to add also this information to the CAD.

Proposed resolution: Revise

Disposition detail:

*Add the following text between the first and the second paragraph of sub-clause 3.1.3:*

Additionally, the 15.4ab specification introduces the NB allocation IE that faciliates offloading of data frames from a UWB channel to a NB channel for radios that support both wireless technologies in one device. The content of the data frames is out of scope of the 15.4ab specification. While the 15.4ab NB PHY only supports PSDU lengths of up to 127 octets, the NB duty cycle may well exceed 5% COT depending on the application specific use of this IE as well as on the specific NB modulation and the congestion situation on the UWB channel triggering the application of this IE. The following simulations and measurement results indicate that concurrent high duty cycle, low dwell-time NB and 802.11 WLAN radio operation may cause significant throughput and latency degradation for 802.11 WLAN devices that solely rely on LBT/CCA as the only coexistence technique [a1-a6].

*Add the following items to the bibliography section (with editorial renumbering as needed):*

[a1] Coexistence of Narrowband Frequency Hopping (NB FH) systems and Wi-Fi, Jeff Bailey (Carleton University), 11-22/1578r1

[a2] Effect of no-LBT on 802.11 devices, Carlos Aldana (Meta), 11-23/1259r1

[a3] Bluetooth Wi-Fi Coexistence: Channel Access Simulation Study, Ratnesh Kumbhkar (Intel), 11-23/1503r0

[a4] IEEE 802.11 and Bluetooth Coexistence Simulations, Sebastian Max (Ericsson), 11-23/1477r1

[a5] NBFH coexistence with Wi-Fi, Menzo Wentink (Qualcomm), 11-23/1622r0

[a6] Co-Existence of Wi-Fi with Narrowband Technology, Stone Liu (Carleton University), 11-24/1059r2

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| CAD024 | 10 | 3.1.3 | 802.19 comment from Eugene Baik on CA document: A device having a low average duty cycle alone may not ensure coexistence with other technologies and even other 802.15.ab devices.  An average duty cycle limitation of 1.5-5% would be for just one device, while the aggregate coexistence impact of multiple devices in the vicinity is dependent on the number of devices, which could be quite large.  Additionally, a specifc % value and the time scale of the averaging are parameters that needs to be defined. Short term spikes in DC could disproportionately affect network behavior in the absence of other coexistence mechanisms. | Consider requiring Energy Detection based LBT for CCA when 802.15.4ab devices want to transmit on the medium when sharing with 802.11, as that would scale with increased number of devices in the network. |

Discussion:

The comment points out that the term "average duty cycle" is not sufficiently meaningful without mentioning the averaging time period, suggesting that short term spikes in duty cycle may have an adverse effect on coexistence, and that the COT of multiple independently operating 802.15.4ab radios will be higher than for a single operating device.

The proposed resolution is unrelated to the CAD text, suggesting a technical change in the 15.4ab specification instead. The proposed technical change for 15.4ab has been discussed extensively in the task group without finding consensus leading to make the proposed change. Comments with similar proposed resolutions have been submitted against 802.15.4abD01 text and will be discussed in the TG.

Proposed resolution: Reject

Disposition detail: No actionable items wrt CAD text

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| CAD026 | 10 | 3.1.3 | 802.19 comment from Pooria Pakrooh on CA document: Many of arguments in this document in subclauses 3.1.1 and 3.1.2.2 are building on the fact that UWB power is potentially much lower than 802.11 devices.  On the other hand, NB EIRP could be up to 21dB stronger than 802.11. Therefore, the impact of NB on 802.11 devices needs to be addressed. | Specify a mandatory coexistence mechanism, which guarantees coexistence of the NB operation with other 802.15.4ab and other 802.11 devices. To avoid causing extra burden for very low duty cycle ranging operation, a duty cycle threshold can be defined such that very low duty cycle operations do not have to follow the mandatory mechanism.  This document does not provide analysis on the impact of NB operation in UNII-3/5 on the 802.11 devices.  Ensure there is sufficient analysis. There are many studies in 802.11 Coex SC, and 15.4ab group, which show detrimental impact of NB on 802.11 throughput and latency. Those need to be included to give proper insight to the reader. |
| CAD027 | 10 | 3.1.3 | 802.19 comment from Pooria Pakrooh on CA document: There are several issues with the statements in subclause 3.1.3:  1. There is no duty cycle limitation in the 4ab draft defined for NB operation in UNII-3 and UNII-5 bands .  2. For ranging, in case of multiple peer-to-peer ranging devices, and one-to-many ranging, the aggregate duty cycle could be very high. There is no guarantee to support the claim about 5% duty cycle limit.  3. Ranging is not the only functionality that uses NB operation in UNII-3/5. In fact, given all the new functionalities defined in 4ab, the duty cycle of NB operation could be well above 5%. For example, NB data offload feature defined in subclause 10.43, or acquisition packet transmissions in channels other than the default channel can have unlimited duty cycle.  4. It is not specified what is the definition of duty cycle. Definition of duty cycle depends on the measurement time (1ms, 1s, 1minute, 1hr, etc), otherwise it does not provide any useful information. Therefore, the statement below is misleading.  Sentence copied from CA document: "802.15.4 ranging services that operate under regulatory and public safety requirement constraints use typical airtime duty cycles between 1.5 and 5% typically [31] [32]]. 95% or greater of the available airtime is typically available to other radio technologies operating in the same frequency bands." | Specify a mandatory coexistence mechanism, which guarantees coexistence of the NB operation with other 802.15.4ab and other 802.11 devices. To avoid causing extra burden for very low duty cycle ranging operation, a duty cycle threshold can be defined such that very low duty cycle operations do not have to follow the mandatory mechanism.  A possible solution is to use the proposal in DCN 15-24-0212-05, as below:  "A NB capable device operating in UNII-3 or UNII-5 band shall measure its NB transmission duty cycle. For a NB capable device, if its NB transmission duty cycle is more than 2.5% (exact threshold value to be discussed further), it shall perform listen-before-talk (LBT) before any NB transmission. Otherwise, LBT is optional." |
| CAD028 | 10 | 3.1.3 | 802.19 comment from Pooria Pakrooh on CA document: The sentence below is not accurate. Even though the default advertising channel is defined outside of the spectrum used by 802.11 devices, nothing prevents devices to send these advertising packets in interfering channels with 802.11. Also, as defined in 15.4ab, these advertising/acquisition packets can be transmitted at arbitrarily low interval, which can lead to serious coexistence consequences.  Sentence copied from the CA document: "Periodic NB packet transmissions on fixed channels such as background advertising and control traffic are allocated in 4ab in newly allocated spectrum outside of the channel map used by 802.11 WLAN such that no interference is cast [29]." | Do the following changes to ensure proper coexistence:  1. Add a mandatory coexistence mechanism, which guarantees coexistence of the NB OQPSK with other NB usage, as well as 802.11 technology. One possible solution is to use the proposal in DCN 15-24-0212-05, as below: "A NB capable device operating in UNII-3 or UNII-5 band shall measure its NB transmission duty cycle. For a NB capable device, if its NB transmission duty cycle is more than 2.5% (the exact threshold value to be discussed further), it shall perform listen-before-talk (LBT) before any NB transmission. Otherwise, LBT is optional."  2. Limit advertising/acquisition packets to channel(s) outside of 802.11 spectrum to make this statement accurate. |

Discussion: The proposed resolutions aim to provide a technical proposal to be considered by the 802.15.4ab TG. Similar comments has been submitted against the 15.4abD01 and will be discussed in the TG. No actionable items wrt CAD text are proposed.

Proposed resolution: Reject

Disposition detail: No actionable items wrt CAD text

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| CAD029 | 10 | 3.1.3 | 802.19 comment from Pooria Pakrooh on CA document: The sentence below is unclear and misleading. What is the value for the fixed upper bound? Does that depend on block/round structure? If so, this upper bound can be very large and provides no meaningful coexistence improvement.  Sentence copied from the CA document: "Instead all packet transmissions are cancelled following a non-recoverable packet error, thereby guaranteeing a fixed upper bound on duty cycle that is set by the 4ab MAC ranging configuration." | Clarify the upper bound value. If there is no clear upper bound, remove this sentence, instead define a meaningful coexistence mechanism that can be evaluated, and ensures efficient coexistence with other radios in UNII-3 and UNII-5. |

Discussion: The comment asks clarification on the statement that a fixed upper bound on the duty cycle is achieved by the LBT/CCA implementation specified in 15.4ab for NBA-UWB MMS. We agree that the meaning of "fixed" but "set by the 4ab MAC ranging configuration" is contradictory. Therefore we revise the CAD text in that regard as detailed below. Additional proposed changes are not actionable wrt CAD text.

Proposed resolution: Revise

Disposition detail:

*Replace the sentence*

Instead all packet transmissions are cancelled following a non-recoverable packet error, thereby guaranteeing a fixed upper bound on duty cycle that is set by the 4ab MAC ranging configuration.

*by*

Instead all packet transmissions are cancelled following a CCA busy event or a non-recoverable packet error, thereby freeing the channel without attempting packet retransmissions until the next pre-scheduled ranging block.