CCA Modes in 802.15.4

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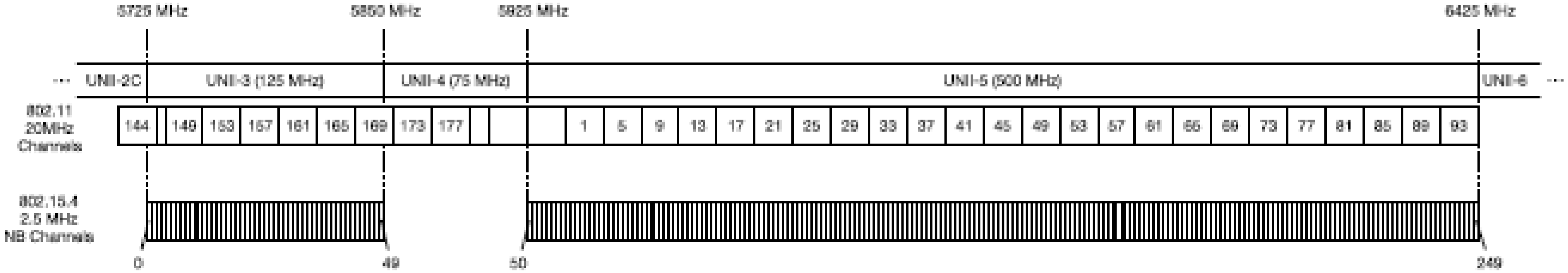
Abstract

This submission provides a background on 802.15.4ab NB modes, reviews the CCA Modes in 802.15.4me Draft 3, and provides a way forward to improve coexistence between 802.11 and 802.15.4ab NB.

Background on NB Frequencies

- **802.15.4ab defines 250 total NB channels in UNII-3 (50) and UNII-5 (200)**



$f_c = 5726.25 + k \times 2.5$ in megahertz for $k = 0, \ldots, 49$

$f_c = 5926.25 + (k - 50) \times 2.5$ in megahertz for $k = 50, \ldots, 249$

where k is the channel number.

Background: No-LBT Data Transmission using NB (10.43)

10.43 UWB data offload to narrowband

10.43.1 Introduction

Given the combination of UWB with a narrowband radio for the narrowband assisted (NBA) MMS ranging specified in 10.38, the narrowband radio may also be useful as a data transport in situations where the UWB channels are congested. How the coordinating and enabling NB data communications is accomplished is beyond the scope of this standard and up to the implementer. Out-of-band signaling and/or custom messages may be used for this.

10.43.2 Operation

The initiator may transmit an NB allocation packet during the measurement report phase followed by the ranging phase. The NB allocation packet shall include an NB Allocation IE (defined in 10.43.3.1) to responder(s). After the ranging phase, ERDEVs are scheduled in the measurement phase to exchange the required information for NB data communications. In the example Figure 168, the initiator sends an NB allocation packet including the NB Allocation IE with NB channel and offset to responder for starting NB data communication during measurement phase.

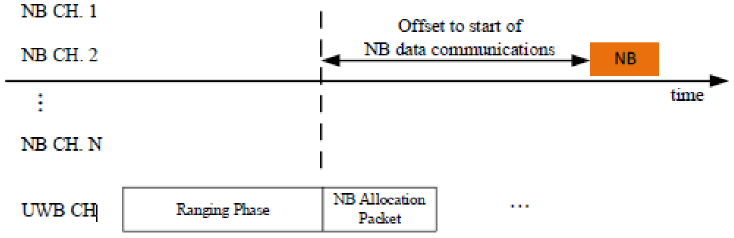
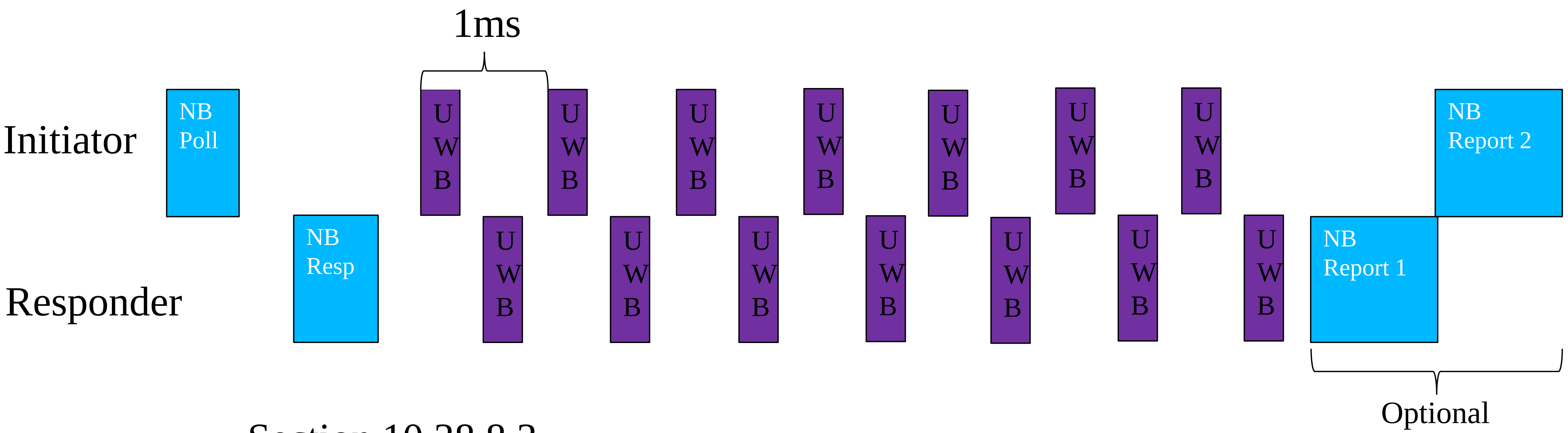


Figure 168—Example of NB data communication triggered by NB Allocation IE packet

At the end of time offset, initiator shall transmit NB packet on the allocated NB channel. The responder may listen for incoming NB packet. Once the responder has received NB packet, it may transmit NB packet.

Background: NBA-MMS (10.38) with optional LBT



Section 10.38.8.3

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. The LBT protocol shall be applied by initiator and responder independently in each transmission slot, even if the same channel is used consecutively.

Background on Coex SC Strawpoll

“802.11 Coex SC recommends that 802.15.4ab considers adopting a mandatory coexistence mechanism to enable shared use of the spectrum and adequate performance between 802.11 and 802.15.4ab. This mandatory coex mechanism should consist of one or more of LBT or other techniques”

44 Y, 13N, 0 Abstain

6 CCA Modes in 802.15.4me-D03

11.2.8 Clear channel assessment (CCA)

With the exception of the HRP UWB PHY, a compliant PHY shall provide the capability to perform CCA according to at least one of the following methods:

— *CCA Mode 1: Energy above threshold.* CCA shall report a busy medium upon detecting any energy above the ED threshold.

— *CCA Mode 2: Carrier sense only.* CCA shall report a busy medium only upon the detection of a signal compliant with this standard with the same modulation and spreading characteristics of the PHY that is currently in use by the device.

— *CCA Mode 3: Carrier sense with energy above threshold.* CCA shall report a busy medium using a logical combination of:

  — Detection of a signal with the modulation and spreading characteristics of this standard

  — Energy above the ED threshold, where the logical operator may be AND or OR

— *CCA Mode 4: ALOHA.* CCA shall always report an idle medium.

An HRP UWB PHY shall implement one CCA Mode 1 through CCA Mode 4 or one of the following methods:

— *CCA Mode 5: HRP UWB preamble sense based on the SHR of a frame.* In this mode, the CCA shall operate to detect the UWB preamble as specified in 16.2.6 and selected by the *phyCurrentCode*. The device shall spend at least its normal operational preamble detection time looking for this preamble before reporting an idle medium in the case where no preamble is detected. In the case where the preamble is detected, the CCA shall report a busy medium, and thereafter, shall not report an idle medium until a period has elapsed that is not shorter than the time required at the current network operational data rate and PSR, (e.g., as specified by the DataRate and UwbPreambleSymbolRepetitions parameters of the MCPS-DATA.request), to complete the transmission of a frame of 127 octets, or 1023 octets for the HRP-ERDEV in the HPRF mode, and to receive its acknowledgment.

— *CCA Mode 6: HRP UWB preamble sense based on the packet with the multiplexed preamble as specified in 16.6.* CCA shall report a busy medium upon detection of a preamble symbol as specified in 16.2.6.

Additional Text in Section 11.2.8 in 802.15.4me D03

- CCA mode 4 would typically be used in low duty cycle applications.
- The PHY PIB attribute *phyCcaMode*, as described in 12.3.2, shall indicate the appropriate operation mode. The CCA parameters are subject to the following criteria:
    a. Unless otherwise specified in this standard for the PHY being used, the ED threshold shall be *phyCcaEdThreshold*.
    b. The CCA detection time shall be equal to *phyCcaDuration*, as defined in Table 12-2.

CCA Mode, CCA Duration and ED Threshold in Table 12-2

phyCcaMode	Integer	1–6	The CCA mode, as defined in 11.2.8.
phyCcaDuration	Integer	0–1000000	The duration for CCA, specified in microseconds. If the recommeded value is not specified by the PHY clause the recommended duration of 8 symbols is used.
phyCcaEdThreshold	Implementation dependent	Implementation dependent	Threshold value for energy above threshold used in CCA. Typically specified in units of power, e.g. dBm, relative to a given frequency bandwidth, for example at most 10 dB greater than the specified receiver sensitivity for that PHY,

Proposal by Ben in 802.15.4ab (Comment to Draft C)

Benjamin Rolfe		161		Blind Creek Associates	Technical	57	10.38.8.3	13	The behavior defined in this clause already exists in the standard. Use one of the existing channel access methods, defining the control parameters to use to achieve the desired behavior. Unslotted CSMA or SSBD are the optimal choices. For example using SSBD we set		Replace clause text: Channel access using listen before talk may be required by regulatory domains, and/or may be desired for improved coexistence performance. When used for narrow band assist SSBD as defined in 6.2.2.2 is recommended using the following control attribute values: phyCcaDuration should be set to less than 16 microseconds or as required by local regulations; macSsbdUnitBackoffPeriod should be set to 1 (microsecond); macSsbdMinBf and macSsbdMaxBf should be set to 1; macSsbdMaxBackoffs should be set to 1; macSsbdTxOnEnd should be set to FALSE; phyCcaMode should be set to 1 (energy above threshold) Note: use of these settings assures the channel access attempt will complete within 16 microseconds. With these attribute values, channel access will return Success when CCA indicates clear, and Failure when energy above the detection threshold is detected. When channel access returns Failure, the radio shall defer transmission for the current ranging block. Figure 35 illustrates this channel access for the two-sided packet exchange across two consecutive ranging slots between the initiator and responder, as needed during the UWB MMS control phase. The timings shown in Figure 35 are based on information in [B3]. LBT shall used when required by regulatory constraints. LBT may be used to all channels in the absence of regulatory constraints, for example, to improve coexistence with other spectrum users. When used, LBT shall be performed by initiator and responder independently in each transmission slot, even if the same channel is used consecutively. And update the figure as needed

Proposed Way Forward

For both NB-Data and NBA-MMS described 802.15.4ab Sections 10.43 and 10.38, CCA mode 1, <u>is the mandatory</u> channel access mechanism with the following parameters:

1. ED threshold of -80 dBm/MHz
2. phyCCADuration value between 16-25 us
3. probability of detection > = 90%

- **Alternatively, if SSBD is the preferred channel access mechanism, in addition to the 3 parameters above, these additional SSBD parameters shall be used**
  - macSsbdMaxBackoffs = 0
  - macSsbdPersistence = 0
  - macSsbdTxOnEnd = False
  - macSsbdUnitBackoffPeriod = 1 (microsecond)
  - macSsbdMinBf and macSsbdMaxBf = 1

References

- P802-15-04me-D03.pdf
- P802.15.4ab-pre-ballot-C.pdf
- IEEE 802.15-23/243r2 (NB Assisted Data Communications)
- IEEE 802.15-22/381r5 (NBA-UWB MMS Ranging Text Proposal for 15.4ab)
- IEEE 802.11-23/1259r1 (Effect of no-LBT NB on 802.11 devices)
- IEEE 802.11-24/130r0 (Effect of no-LBT NB on 802.11 devices: Part 2)
- IEEE 802.11-24/148r0 (NB Simulation Results Comparison)
- IEEE 802.11-23/1279r0 (NB with LBT)
- IEEE 802.15-23/243r2 (NB Assisted Data Communications)
- IEEE 802.15-22/381r5 (NBA-UWB ranging text proposal for 15.4ab TFD)
- IEEE 802.15-21/593r2 (More on NBA-MMS)
- IEEE 802.15-21/292r0 (Opportunities for improved UWB/NB coordination)