**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title | d2P802.15.4k CIDs 295, 296, 298, 317-320 resolution | |
| Date Submitted | [13 Nov 2012] | |
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| Re: | [d2P802.15.4k Comment Resolution] | |
| Abstract | Response to d2 letter ballot comments CIDs 295, 296, 298, 317-320 | |
| Purpose | Draft standard development | |
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Comment Resolution for CIDs 295, 296, 298, 317-320

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<Note: The modifications to the text address CIDs 295, 296, and 317-320.>

This subclause describes the CSMA-CA and alternate backoff mechanism used for the transmission of a critical event priority message when PCA is enabled (i.e., *macPriorityChannelAccess* is TRUE). The CSMA-CA with PCA algorithm shall be used before the transmission of critical event priority messages transmitted within the CAP.

If periodic beacons are being used in the PAN, the MAC sublayer shall employ the slotted version of the CSMA-CA with PCA algorithm of Figure 11c for transmissions in the CAP of the superframe. Conversely, if periodic beacons are not being used in the PAN or if a beacon could not be located in a beacon-enabled PAN, the MAC sublayer shall transmit using the unslotted version of the CSMA-CA with PCA algorithm of Figure 11d. ~~Figure 11c and Figure 11d illustrate the steps of the CSMA-CA algorithm when a PCA frame is to be transmitted. Figure 11c shows the case for slotted CSMA-CA with PCA, and Figure 11d shows the case for unslotted CSMA-CA with PCA~~. ~~If t~~The algorithm ends in “Success,” indicating the MAC has successfully transmitted the frame. ~~Otherwise, the algorithm terminates with a channel access failure due to having exceeded the maximum number of retransmissions.~~

The *NB* is not used in CSMA-CA with PCA. During transmission of a priority message~~, when the CCA returns a status of channel busy~~, the alternate backoff mechanism shall be used: the backoff exponent *BE* shall be set to the value of *macMinBE–1* or 1, whichever is higher, prior to the first transmission attempt, and *BE* shall remain constant for subsequent retransmissions. The MAC sublayer shall maintain a variable *Total backoffs*, which indicates the number of remaing backoff periods, since the start of the CSMA-CA with PCA algorithm, where the CCA algorithm must return idle status before transmission. The *Total backoffs* is initialized to a random value between 0 and *2BE-1*. The PCA follows a persistent CSMA mechanism, meaning that a device continues to monitor the channel and decrements the ~~contention window~~*Total backoffs* by a ~~random number of backoff periods~~one any time the channel is sensed idle in a backoff period~~for a duration of~~ *~~aUnitBackoffPeriod~~,* in order to gain access to the channel in a timely manner. The alternate backoff mechanism is illustrated in Figure 11c and Figure 11d within dashed-line rectangles.

In a slotted CSMA-CA with PCA, the MAC sublayer shall ensure that, after the persistent random backoff, the remaining CSMA-CA operations can be undertaken and the entire transaction can be transmitted before the end of the CAP. If the number of *Total backoffs* is greater than the remaining number of backoff periods in the CAP, the MAC sublayer shall pause the *Total backoffs* countdown at the end of the CAP and resume it at the start of the CAP in the next superframe. If the number of *Total backoffs* is less than or equal to the remaining number of backoff periods in the CAP, the MAC sublayer shall apply the alternate backoff algorithm one CCA attempt further and then evaluate again whether it can proceed. The MAC sublayer shall proceed if the remaining CSMA-CA algorithm steps, the frame transmission, and any acknowledgment can be completed before the end of the CAP. If the MAC sublayer can proceed, it shall request that the PHY perform the next CCA in the current superframe. If the MAC sublayer cannot proceed, it shall wait until the start of the CAP in the next superframe before continuing to apply the alternate backoff algorithm.

In Figure 11c, the MAC sublayer initializes the *CW* to *CW0*, and chooses the *BE* and *Total backoffs* according to the alternate backoff mechanism. Then it locates the backoff period boundary and issues a CCA to the PHY. If the CCA returns idle channel, the *Total backoffs* is decremented by one, unless it is zero, and the MAC locates the next backoff period boundary. When *Total backoffs* is zero the alternate backoff mechanism ends and the *CW* is evaluated. The algorithm runs until *CW* reaches zero and transmission commences. If the CCA returns busy channel, the *Total backoffs* is not decremented and the *CW* is reset *CW0*.

When operating a LECIM PHY in a nonbeacon-enabled PAN using unslotted CSMA-CA, the critical event priority transmission may be initiated at any time. In Figure 11d, the MAC sublayer chooses the *BE* and *Total backoffs* according to the alternate backoff mechanism. Then it issues a CCA to the PHY. If the CCA returns idle channel, the *Total backoffs* is decremented by one, unless it is zero, and the MAC shall wait for *aUnitBackoffPeriod* – CCA assessment time before issuing a new CCA evaluation. When *Total backoffs* is zero transmission commences. If the CCA returns busy channel, the *Total backoffs* is not decremented and the MAC shall wait for *aUnitBackoffPeriod* – CCA assessment time before issuing a new CCA evaluation.

CSMA-CA PCA

Slotted?

*CW*=*CW0*

*BE*=max(1*,macMinBE-1*), Total backoffs = random(2*BE*-1) unit backoff periods

Y

Locate backoff period boundary

Perform CCA on backoff period boundary

Channel idle?

Total backoffs = Total backoffs-1

Total backoffs = 0?

Y

N

N

Success

Y

Y

*CW* = *CW*-1

*CW* = 0?

N

*CW* = *CW*0

N

See Figure 11d

Alternate Backoff mechanism

Figure 11c-Algorithm for slotted CSMA-CA with PCA

*BE*=max(1*,macMinBE-1*), Total backoffs = random(2*BE*-1) unit backoff periods

Perform CCA

Channel idle?

Total backoffs = Total backoffs-1,

wait aUnitBackoffPeriod-CCA assessment time

Total backoffs = 0?

Y

N

N

Success

Y

Wait *aUnitBackoffPeriod*- CCA assessment time

CSMA-CA PCA

Slotted?

N

Y

See Figure 11c

Alternate Backoff mechanism

Figure 11d-Algorithm for unslotted CSMA-CA with PCA

In a beacon-enabled PAN, the length of a PCA allocation shall be at least 880 symbol durations. When *macPriorityChannelAccess* is TRUE, the minimum number of PCA allocations in a superframe is defined by the MAC personal area network information base (PIB) attributes *macPCAAllocationSuperRate, macPCAAllocationRate,* and *macCritMsgDelayTol.* The relations of the parameters are illustrated in Table 0a.

In Table 0a, *SD* is the superframe duration, argument, and indicates the closest integer larger than or equal to its argument. When *macPCAAllocationSuperRate* is FALSE, *macPCAAllocationRate* indicates the maximum number of consecutive superframes for which only one PCA allocation is required. In this case, the PCA allocations shall only occur within the superframes having sequence numbers that are integer divisible by the *macPCAAllocationRate* value. When *macPCAAllocationSuperRate* is TRUE, *macPCAAllocationRate* indicates the minimum number of PCA allocations required per superframe.

If there are multiple PCA allocations per superframe, the first allocation shall occur immediately after the beacon transmission. The remaining PCA allocations are distributed throughout the superframe, but no PCA allocation shall occur outside a CAP.

When a critical event priority transmission is initiated within the CAP during a time that is not a PCA allocation, the primary CSMA-CA, as defined in 5.1.1.4, with the previously described alternate backoff mechanism shall be used.

If DSME is utilized with *macCAPReductionFlag* set to TRUE and the multi-superframe duration is longer than *macCritMsgDelayTol,* then *macPriorityChannelAccess* shall be set to FALSE.

When *macPriorityChannelAccess* is TRUE, a PCA allocation cannot occur if the CAP length duration is less than *aMinCAPLength* plus the time required for a single PCA allocation.

<Note: The text below address CID 298>

This is a technical comment and not editorial and the response is accept. However, it will cause the following changes in Figures 11c and 11d:

Remove all instances of macMaxCSMABackoffs and NB. They are not used in PCA.

The Figures 11c and 11d in this document 629 address the removal.

Rationale:

In 802.15.4 CSMA-CA the macMaxCSMABackoffs is incremented every time the channel is assessed busy. In PCA the CSMA-CA algorithm runs in persistent mode where a device draws the *Total backoffs* value and makes a decision every aUnitBackoffPeriod (carries out a CCA) whether to decrement it by one or not (actually Figure 11d of d2P802-15-4k is incorrect as we do not have backoff period boundaries in unslotted CSMA-CA). The Total backoffs is decremented by one if the channel was assessed free and it stays the same if CCA indicated channel busy. A Transmission is attempted only once the Total backoffs reaches a value of 0. If the transmission attempt fails, then will be the *macMaxFrameRetries* be incremented by one.