**IEEE P802.15**

**Wireless Personal Area Networks**

|  |  |  |
| --- | --- | --- |
| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title | d3P802.15.4k Section 5.1.1.4.5 Comment Resolution | |
| Date Submitted | [16 Jan 2013] | |
| Source | [Jussi Haapola] [Centre for Wireless Communications] [] | Voice: [ +358 40 8363 018 ] Fax: [ ] E-mail: [jhaapola@ee.oulu.fi] |
| Re: | [d3P802.15.4k Comment Resolution] | |
| Abstract | Response to d3 sponsor ballot comments on section 5.1.1.4.5 | |
| Purpose | Draft standard development | |
| Notice | This document has been prepared to assist the IEEE P802.15. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein. | |
| Release | The contributor acknowledges and accepts that this contribution becomes the property of IEEE and may be made publicly available by P802.15. | |

Comment Resolution Section 5.1.1.4.5

Contents

Contents

5. MAC protocol 1

5.1 MAC functional description 1

5.1.1 Channel Access 1

3.2 Acronyms and abbreviations

TB Total backoffs

1. MAC protocol
   1. MAC functional description
      1. Channel Access
         1. Superframe structure
         2. Incoming and outgoing superframe timing
         3. Interframe spacing (IFS)
         4. CSMA-CA Algorithm
            1. LECIM Aloha Priority Channel Access

~~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).~~ An MSDU or MSDU fragment in which the CriticalEventMessage parameter in the MCPS-DATA.request primitive is TRUE is referred to as a critical event message. The CSMA-CA with PCA backoff algorithm ~~shall~~is ~~be~~ used before the transmission of a critical event ~~priority~~ message~~s~~ ~~transmitted within~~during the CAP.

If periodic beacons are being used in the PAN, the MAC sublayer ~~shall~~ employs the slotted version of the CSMA-CA with PCA backoff algorithm, as shown in 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~~may transmit using the unslotted version of the CSMA-CA with PCA backoff algorithm, as shown in Figure 11d. ~~The algorithm ends in “Success,” indicating that the MAC has successfully transmitted the frame.~~

The variable *NB* is not used in CSMA-CA with PCA backoff algorithm. ~~During transmission of a priority message,~~ tThe ~~alternate~~PCA backoff ~~mechanism~~algorithm ~~shall~~ ~~be~~is used during transmission of a priority message: the backoff exponent *BE* ~~shall be set~~is initialized to the value of *macMinBE* – 1 or 1, whichever is larger, prior to the first transmission attempt, and *BE* ~~shall~~ remains constant for subsequent retransmissions. The MAC sublayer ~~shall~~is responsible for maintaining a variable, called *Total backoffs* (TB)*,* which indicates the number of remaining backoff periods since the start of the CSMA-CA with PCA backoff algorithm~~, where the CCA algorithm must return idle status before transmission~~. *~~Total backoffs~~*TBis initialized to a random value between 0 and 2*BE* – 1 . The PCA backoff algorithm follows a persistent CSMA mechanism, meaning that ~~a~~the device continues to monitor the channel and decrements *~~Total backoffs~~*TBby one any time the channel is sensed idle in a backoff period, 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 the dashed-line rectangles~~ The slotted PCA backoff algorithm is illustrated in Figure 11c and the unslotted PCA backoff algorithm is illustrated in Figure 11d in within the dashed line rectangles, respectively.

In slotted CSMA-CA with PCA backoff algorithm, 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 *~~Total backoffs~~*TBis greater than the remaining number of backoff periods in the CAP, the MAC sublayer ~~shall~~ pauses the *~~Total backoffs~~*TBcountdown at the end of the CAP and resumes it at the start of the CAP in the next superframe. If *~~Total backoffs~~*TBis less than or equal to the remaining number of backoff periods in the CAP, the MAC sublayer ~~shall~~ appl~~yi~~es the ~~alternate~~PCA backoff algorithm one CCA attempt further and then evaluates again whether ~~it can proceed~~there is sufficient time to proceed. The MAC sublayer ~~shall~~may 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 there is sufficient time to proceed, itthe MAC sublayer shall requests that the PHY performs the next CCA in the current superframe~~. If ~~the MAC sublayer cannot proceed~~there is no sufficient time to proceed, ~~it shall~~the MAC sublayer waits until the start of the CAP in the next superframe before continuing to apply the ~~alternate backoff algorithm~~PCA backoff algorithm.

~~In Figure 11c, the MAC sublayer initializes~~ *~~CW~~* ~~to~~ *~~CW~~~~0~~*~~, and chooses~~ *~~BE~~* ~~and~~ *~~Total backoffs~~*~~TB~~~~according to the alternate backoff mechanism. Then, it locates the backoff period boundary and issues a CCA to the PHY requests that the PHY perform CCA. If the CCA returns idle channel,~~ *~~Total backoffs~~*~~TB~~~~is decremented by one, unless it is already zero, and the MAC locates the next backoff period boundary. When~~ *~~Total backoffs~~*~~TB~~~~is zero, the alternate backoff mechanism ends and~~ *~~CW~~* ~~is evaluateddecremented, and if zero, the channel is deemed clear. The algorithm runs until~~ *~~CW~~* ~~reaches zero and transmission commences. If the CCA returnsreports a busy channel,~~ *~~Total backoffs~~*~~TB~~~~is not decremented and~~ *~~CW~~* ~~is reset to~~ *~~CW~~~~0~~*~~.~~

CSMA-CA PCA

*CW*=*CW0*

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

Locate backoff period boundary

Perform CCA on backoff period boundary

*TB* = *TB*-1

Y

N

N

Success

Y

Y

*CW* = *CW*-1

N

PCA backoff algorithm

Failure

Y

N

Timeout?

Channel Idle?

*TB* = 0?

*CW* =*CW*0

*CW* =*0?*

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

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

Perform CCA

*TB* = *TB*-1,

wait aUnitBackoffPeriod-CCA assessment time

*TB* = 0?

Y

N

N

Success

Y

CSMA-CA PCA

PCA backoff algorithm

Failure

Y

N

Timeout?

Channel Idle?

Wait *aUnitBackoffPeriod* - CCA assessment time

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

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

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 0.0a.

Table 0.0a—PCA MAC PIB attribute relations when *macPriorityChannelAccess* is TRUE

|  |  |  |
| --- | --- | --- |
| **Value of *macPCAAllocationSuperRate*** | **Superframe Duration (SD)** | ***macPCAAllocationRate*** |
| FALSE | *SD* ≤ | Maximum value |
| TRUE | < *SD* ≤  *macCritMsgDelayTol* | Minimum value  1 |
| TRUE | *SD > macCritMsgDelayTol* | Minimum value |

<note to editor: one column is removed from Table 0.0a>

In Table 0.0a, *~~SD~~* ~~is the superframe duration,~~  indicates the closest integer less than or equal to its argument, and indicates the closest integer larger than or equal to its argument. When *macPCAAllocationSuperRate* is FALSE, *macPCAAllocationRate* is interpreted as a subrate and it indicates the maximum number of consecutive superframes for which only one PCA allocation is required. In this case, the PCA allocations ~~shall~~need only to occur within the superframes having ~~sequence numbers~~*macBSN* that are integer divisible by the *macPCAAllocationRate* value. When SD ≤ *macCritMsgDelayTol/3, macPCAAllocationSuperRate* shall be set as FALSE, otherwise it shall be set to TRUE*.* 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~~ occurs at the start of the CAP~~immediately after the beacon transmission~~. The remaining PCA allocations are distributed throughout the superframe, but no PCA allocation shall occur outside ~~a~~the CAP.

When a critical event ~~priority~~message 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~~PCA backoff ~~mechanism~~algorithm ~~shall~~may 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~~shall not occur if the CAP length duration is less than *aMinCAPLength* plus the time required for a single PCA allocation.

<note: addressed comments:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 77 | Rolfe, Benjamin | Blind Creek Associates | 9 | 5.1.1.4.5 | 15 | There are a lot of "shalls" describing internal variables and other things that are implementation specifics. When describing an algorithm the normative behaviors are the externally visible things that can be observed as a result of the algorithm - any equivalent would be compliant if it produces the same thing. This is a problem in the base standard also, so it's not entirely our fault, but we shouldn't make it worse! | No | Fix the "shall" abuse. | A | Addressed in Document 15-13-0066-00-004k | b |
| 78 | Rolfe, Benjamin | Blind Creek Associates | 9 | 5.1.1.4.5 | 53 | "Evaluated" is not specific - the figure shows that CW is decremented and when it gets to zero we declare success. The text should say "is decremented, and if zero, the channel is deemed clear". | No | See comment. | A | Addressed in Document 15-13-0066-00-004k | b |
| 114 | Brown, Monique | On Ramp Wireless, Inc. | 9 | 5.1.1.4.5 | 29 | Improve wording. | No | Change from "a variable Total backoffs" to "a variable \_called\_ Total backoffs." | A | Addressed in Document 15-13-0066-00-004k | c |
| 115 | Brown, Monique | On Ramp Wireless, Inc. | 9 | 5.1.1.4.5 | 32 | Improve wording. | No | Change from "a device continues" to "\_the\_ device continues." | A | Addressed in Document 15-13-0066-00-004k | d |
| 116 | Brown, Monique | On Ramp Wireless, Inc. | 9 | 5.1.1.4.5 | 53 | Text says: "alternate backoff mechanism ends and CW is evaluated." The figure shows that the alternate backoff mechanism ends and CW is decremented before being evaluated. | No | Add wording to the description to match the figure. Say something like: "...mechanism ends and CW is \_decremented\_." | AiP | See comment 78 | c |
| 117 | Brown, Monique | On Ramp Wireless, Inc. | 9 | 5.1.1.4.5 | 54 | Improve wording. | No | Change from "If the CCA returns busy channel" to "If the CCA \_reports a\_ busy channel." Make the same change on page 12, line 6 (the unslotted case). | A | Addressed in Document 15-13-0066-00-004k | d |
| 204 | Gilb, James | Tensorcom, Inc. | 9 | 5.1.1.4.5 | 14 | This paragraph is a mess. The first sentence is contradicted by the second. In the first, it says that it is used when PCA is enabled. In the second it says it is used when a critical event priority message is transmitted. | Yes | Delete the first sentence "This subclause describes ... is TRUE." Add a sentence "An MSDU or MSDU fragment in which the CriticalEventMessage parameter in the MCPS-DATA.request primitive is TRUE is referred to as a critical event message." as the first sentence. Search for all uses of the this and use "critical event message" exclusively" Change "before the transmission of critical event Pirority messages transmitted in the CAP." to be "before the transmission of a critical event message during the CAP." | AiP | Addressed in Document 15-13-0066-00-004k | b |
| 205 | Gilb, James | Tensorcom, Inc. | 9 | 5.1.1.4.5 | 23 | This is a pretty cool protocol in that it never fails and the MAC always transmits the message. In reality, the algorithm can exit with failure (due to timeout, most likely). Note that Figure 11 has 2 failure possibilities | Yes | Fix figure 11c to show a time out failure and delete "The algorithm ends ... transmitted the frame." | AiP | Addressed in Document 15-13-0066-00-004k | b |
| 206 | Gilb, James | Tensorcom, Inc. | 9 | 5.1.1.4.5 | 31 | Incorrect term. The word "must" shall not be entrusted to the use of mere mortals. In this case, it is used incorrectly (as usual). | Yes | Delete "where the CCA ... before transmission." as this is already covered in Figure 11c. | A | Addressed in Document 15-13-0066-00-004k | b |
| 207 | Gilb, James | Tensorcom, Inc. | 9 | 5.1.1.4.5 | 29 | The other variables or abbreviated, why not this one? | Yes | Change "Total Backoffs" to be "TB" after the first occurrence, similar to CW. | A | Addressed in Document 15-13-0066-00-004k | c |
| 208 | Gilb, James | Tensorcom, Inc. | 9 | 5.1.1.4.5 | 41 | The use of "can" in this paragraph is not quite right. The MAC is capable of continuing, but it is not allowed to. | Yes | In this case, replace the "can proceed" with "there is sufficient time to proceed" and similar for the rest of the paragraph. | A | Addressed in Document 15-13-0066-00-004k | c |
| 209 | Gilb, James | Tensorcom, Inc. | 9 | 5.1.1.4.5 | 50 | The PHY does not "issue a CCA". The PHY performs CCA and returns the channel idle or not idle. The MAC requests that the PHY performs CCA. | Yes | Change "issues a CCA to the PHY" to be "requests that the PHY perform CCA." | A | Addressed in Document 15-13-0066-00-004k | c |
| 210 | Gilb, James | Tensorcom, Inc. | 9 | 5.1.1.4.5 | 49 | This entire paragraph attempts to describe that which is already adequately described in Figure 11c. Hence, the paragraph should be deleted. | Yes | Delete "In Figure 11c ... is reset to CW0" | A | Addressed in Document 15-13-0066-00-004k | c |
| 211 | Gilb, James | Tensorcom, Inc. | 9 | 5.1.1.4.5 | 51 | At this step, Total backoffs can't be zero if the algorithm if followed correctly. | Yes | Delete ", unless it is already zero," | A | See comment 210 | c |
| 118 | Brown, Monique | On Ramp Wireless, Inc. | 10 | 5.1.1.4.5 | 30 | I don't see a "failure" case? What if for some reason the channel is never idle? Will it just keep trying until the battery dies? | No | Add a failure case if appropriate. Same comment for Figure 11d. | A | See comment 205 | c |
| 213 | Gilb, James | Tensorcom, Inc. | 10 | 5.1.1.4.5 | 10 | No need to have the "slotted" decision box here, the title of the graph clearly states that this is for slotted. | Yes | Delete the "slotted" decision box in Figure 11c and 11d. Change line 34, p. 9 from "The alternate ... within the dashed rectangles." to be "The slotted PCA algorithm (PCAA) is illustrated in Figure 11c while the unslotted PCAA is illustrated in Figure 11d. | AiP | Addressed in Document 15-13-0066-00-004k | c |
| 212 | Gilb, James | Tensorcom, Inc. | 11 | 5.1.1.4.5 | 3 | it seems like we should be able to do this in one figure for the alternative backoff mechanism and reference the algorithm for CSMA-CA with PCA. | Yes | Describe the alternate backoff mechanism in a single figure and reference it in the other figures. Alternately, it seems that this "alternate backoff mechanism" really only applies to PCA, so just refer to it as PCAA (priority channel access algorithm) | AiP |  | b |
| 43 | Shen, Jie | Wuxi SensingNet Industrialisation Research Institute | 12 | 5.1.1.4.5 | 44 | is the sequence number of superframe is the beacon sequence number? Is the BSN of the PAN coordinator? | No | please give more description. | AiP | Addressed in Document 15-13-0066-00-004k | b |
| 58 | Liu, HaiTao | Wuxi SensingNet Industrialisation Research Institute | 12 | 5.1.1.4.5 | 44 | the sequence number of superframe begins from which time? | No |  | AiP | See comment 43 | b |
| 66 | Xing, Tao | Shanghai institute of microsystem and infomation technology | 12 | 5.1.1.4.5 | 22 | "Maximum value" here is confusing. | No | change to "Maximum value of superframes for which only one PCA is required" | R | Change would be redundant with page 12 line 42. | b |
| 67 | Xing, Tao | Shanghai institute of microsystem and infomation technology | 12 | 5.1.1.4.5 | 27 | "Minimum value" here is confusing. | No | change to "Minimum value of PCAs in one superframe" | R | Redundant with page 12 line 45 | b |
| 68 | Xing, Tao | Shanghai institute of microsystem and infomation technology | 12 | 5.1.1.4.5 | 33 | "Minimum value" here is confusing. | No | change to "Minimum value of PCAs in one superframe" | R | Redundant with page 12 line 45 | b |
| 69 | Xing, Tao | Shanghai institute of microsystem and infomation technology | 12 | 5.1.1.4.5 | 25 | divide by 3, is because of the maximum value of retransmission is 3? | No | please give more clear description, or it really make people confusing. | R | No relation with retransmissions. A fixed specified value. | c |
| 119 | Brown, Monique | On Ramp Wireless, Inc. | 12 | 5.1.1.4.5 | 50 | Improve wording. | No | Change from "throughout the superframe...outside a CAP" to "throughout the superframe...outside \_the\_ CAP." | A | Addressed in Document 15-13-0066-00-004k | d |
| 214 | Gilb, James | Tensorcom, Inc. | 12 | 5.1.1.4.5 | 4 | The PHY does not "issue a CCA". The PHY performs CCA and returns the channel idle or not idle. The MAC requests that the PHY performs CCA. | Yes | Change "issues a CCA to the PHY" to be "requests that the PHY perform CCA." and the change "If the CCA returns ..." to be "if the PHY returns" | A | Addressed in Document 15-13-0066-00-004k | c |
| 215 | Gilb, James | Tensorcom, Inc. | 12 | 5.1.1.4.5 | 5 | At this step, Total backoffs can't be zero if the algorithm if followed correctly. | Yes | Delete ", unless it is already zero," | A | Addressed in Document 15-13-0066-00-004k | c |
| 216 | Gilb, James | Tensorcom, Inc. | 12 | 5.1.1.4.5 | 1 | This paragraph simply repeats the information from the figure and that can only result in errors. | Yes | Delete the paragraph and just reference the figure. If the figure does not have all the required information, then add it to the figure. Also delete the paragraph on page 9, line 49 as well and heavily edit the paragraph on page 9, line 37 to remove information that is given in Figure 11c | AiP | Addressed in Document 15-13-0066-00-004k | c |
| 217 | Gilb, James | Tensorcom, Inc. | 12 | 5.1.1.4.5 | 21 | Why is this number the maximum, but the other two numbers are minima? | Yes | Change "Maximum value" to be "minimum values | R | This SD duration condition is subrate and the other rows of the table are superrates. Hence the Maximum value here is correct. | c |
| 218 | Gilb, James | Tensorcom, Inc. | 12 | 5.1.1.4.5 | 21 | This table is very confusing. First of all, the column "macPriorityChannelAccess" is not needed because it is the same for all cases. | Yes | Re-organize the table to have macPCAAllocatonSuperRate to be first, followed by SD and then macPCAAllocationRate | AiP | Addressed in Document 15-13-0066-00-004k | c |
| 219 | Gilb, James | Tensorcom, Inc. | 12 | 5.1.1.4.5 | 21 | If macPCAAllocationSuperRate is FALSE, then there is no value given for macPCAllocationRate when SD > macCritMsgDelaytol/3 | Yes | If this case is not allowed, where is it defined this way in the text. Also, where is it defined that SD is required to be > macCritMsgDelayTol/3. If this condition is a requirement, it needs to be stated as such. | AiP | Addressed in Document 15-13-0066-00-004k | c |
| 220 | Gilb, James | Tensorcom, Inc. | 12 | 5.1.1.4.5 | 53 | "the primary CSMA-CA" is not defined anywhere. Also, there is no distinct figure that defines the alternate backoff mechanism. | Yes | Provide a figure that distinctly defines the alternate backoff mechanism. | AiP | Addressed in Document 15-13-0066-00-004k | b |
| 221 | Gilb, James | Tensorcom, Inc. | 13 | 5.1.1.4.5 | 4 | Improper use of "can", this is a requirement, not a capability. | Yes | Change "cannot occur" to be "shall not occur" | A | Addressed in Document 15-13-0066-00-004k | c |

>