IEEE P802.11
Wireless LANs

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| LB266 Comment Resolution Multi-link Traffic Indication Part1 |
| Date: 2022-8-24 |
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Abstract

This submission proposes comment resolution(s) for the following 33 CID(s) received in LB266 on TGbe D2.0 related to multi-link traffic indication:

* 9.3.3.2 Beacon frame format
* 9.4.2.315 Multi-link traffic indication element
* 35.3.12.4 Traffic indication:

CIDs:

10386, 12158, 10572, 13735, 11121, 13734, 13855, 12050, 10206, 13960

10028, 11642, 13071, 13377, 13794, 13920, 13620, 13378, 10426, 12484

12643, 10876, 12380, 13795, 10877, 12640, 12641, 12642, 10246, 13376,

10027, 13619, 13992, 13856, 13733

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: minor update.
* Rev 2: updated for D2.2 and based on offline feedbacks.
* Rev 3: minor updates.
* Rev 4: added CID 13856 and 13733

CIDs for SP:

10386, 12158, 10572, 13735, 11121, 13734, 10206, 13960

10028, 11642, 13071, 13920, 13620, 10426, 12484

12643, 10876, 12380, 10877, 13856, 13733

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| --- | --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Clause Number** | **Page.****Line** | **Comment** | **Proposed Change** | **Resolution** |
| 10386 | GEORGE CHERIAN | 9.4.2.315 | 0.00 | Remove the Multi-Link Traffic Indication element from the beacon, since it can cause beacon bloating, that can affect legacy clients | As in the comment | Revised.The comment is describing a potential ‘beacon bloating’ issue related to the size of a Beacon frame becoming too big with addition of the Multi-Link Traffic Indication element added to a Beacon frame. As IEEE 802.11WG develops new amendments, new information elements are defined that are included in a Beacon frame and as commented in CID 12158, there needs to be a way to deliver these new information elements without causing a problem to the Beacon frame defined in the current 802.11 standard going forward.TGbe editor to make the changes with the CID tag (#10386) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 12158 | Michail Koundourakis | 9.3.3.2 | 172.31 | Multi-Link Traffic Indication has variable size and can become very long, to the point the Beacon frames size increases beyond the valid limit. | We need to come up with a solution about how to communication information which does not fit in the Beacon. | Revised.The comment is describing a potential ‘beacon bloating’ issue related to the size of a Beacon frame becoming too big with addition of the Multi-Link Traffic Indication element added to a Beacon frame. As IEEE 802.11WG develops new amendments, new information elements are defined that are included in a Beacon frame and as commented in CID 12158, there needs to be a way to deliver these new information elements without causing a problem to the Beacon frame defined in the current 802.11 standard going forward.TGbe editor to make the changes with the CID tag (#10386) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 10572 | Abhishek Patil | 9.4.2.315 | 250.02 | The Multi-Link Traffic element will cause beacon bloat which would further cause inter-op issues between an EHT AP affiliated with an AP MLD and a legacy client associated with it. The size of the Multi-Link Traffic Indication element is governed by the number of link bitmaps being signaled (including the ones for legacy and default mapping) in the element. The size of each link bitmap is the same and determined by the maximum bitmap to be signaled for any client. In addition, the number of bits in the link bitmap are based on the 'spread' of the Link ID value assigned to each link on which the AP MLD operates on and current there aren't any rules requiring continuous link IDs. | Move the Multi-Link Traffic Indication element out of the Beacon frame and provide the indication via a separate frame. | Revised.The comment is describing a potential ‘beacon bloating’ issue related to the size of a Beacon frame becoming too big with addition of the Multi-Link Traffic Indication element added to a Beacon frame. As IEEE 802.11WG develops new amendments, new information elements are defined that are included in a Beacon frame and as commented in CID 12158, there needs to be a way to deliver these new information elements without causing a problem to the Beacon frame defined in the current 802.11 standard going forward.TGbe editor to make the changes with the CID tag (#10386) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 13735 | Yunbo Li | 9.4.2.315 | 250.55 | For a potential scenario that a lot of non-AP MLDs are associated and with multiple links, the Per-Link Traffic Indication List field may be a big signaling overhead. Considering different non-Aps associated with different number of links, and some Link ID may not used (e.g. link removed), ... Should make the frame format design of Multi-Link Traffic Indication element more flexible to save the signaling overhead. | as in comment. | Revised.The comment is describing a potential ‘beacon bloating’ issue related to the size of a Beacon frame becoming too big with addition of the Multi-Link Traffic Indication element added to a Beacon frame. As IEEE 802.11WG develops new amendments, new information elements are defined that are included in a Beacon frame and as commented in CID 12158, there needs to be a way to deliver these new information elements without causing a problem to the Beacon frame defined in the current 802.11 standard going forward.Also, the format of the Multi-Link Traffic Indication element has been revised to exclude non-AP MLDs that are using default mapping for all enabled links and STAs and also optimizing the Per-link traffic indication bitmap subfield.TGbe editor to make the changes with the CID tag (#13735) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 11121 | Brian Hart | 9.4.2.315 | 250.57 | We need to limit the size of Beacons due to legacy implementations, and the Multi-Link Traffic element could be a big problem here. The size of Multi-Link Traffic element is currently directly proportional to max linkId among \*all\* the non-AP MLDs being signaled. Even if only a single STA has link 15 defined, then \*all\* non-AP STAs need 16 bits and then this element is 16x bigger than the TIM at worst, but 3x bigger seems likely to be typical in the EHT timeframe. Then future amendments are expected to add support for more links between an AP MLD and non-AP MLD, so this will only get worse. | Move the Multi-Link Traffic element out of the Beacon. A frame sent shortly after each DTIM Beacon would suffice instead | Revised.The comment is describing a potential ‘beacon bloating’ issue related to the size of a Beacon frame becoming too big with addition of the Multi-Link Traffic Indication element added to a Beacon frame. As IEEE 802.11WG develops new amendments, new information elements are defined that are included in a Beacon frame and as commented in CID 12158, there needs to be a way to deliver these new information elements without causing a problem to the Beacon frame defined in the current 802.11 standard going forward.TGbe editor to make the changes with the CID tag (#11121) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 13734 | Yunbo Li | 35.3.12.4 | 442.63 | It should clarify that one or more Multi-Link Traffic Indication element could be carried, and each element for a different segment of AIDs. Signaling overhead can be reduced in some cases, For example, different non-AP MLDs have different number of associated links, or there a large segment of non-AP MLDs that are in power save mode, but in default T2L mapping, so they don't need to be signalled in Multi-Link Traffic Indicaiton element. | as in comment. | Revised.The comment is describing a potential ‘beacon bloating’ issue related to the size of a Beacon frame becoming too big with addition of the Multi-Link Traffic Indication element added to a Beacon frame. As IEEE 802.11WG develops new amendments, new information elements are defined that are included in a Beacon frame and as commented in CID 12158, there needs to be a way to deliver these new information elements without causing a problem to the Beacon frame defined in the current 802.11 standard going forward.Also, the format of the Multi-Link Traffic Indication element has been revised to exclude non-AP MLDs that are using default mapping for all enabled links and STAs and also optimizing the Per-link traffic indication bitmap subfield.TGbe editor to make the changes with the CID tag (#13735) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 13855 | Sanghyun Kim | 35.3.12.4 | 442.63 | It is important to reduce cases that an AP MLD transmits a ML-TIM element in order to minimize Beacon overheads from the ML-TIM element.Please describe the below cases where a AP MLD does not need to include the ML-TIM element in a Beacon frame.1. An AP MLD does not need to indicate link information when the TID of the BU is mapped to all the enabled links of the non-AP MLD. (The non-AP MLD may transmit PS-Poll on any link of the enabled links to receive the BU.)2. A non-AP STA that has successfully negotiated a TID-to-link mapping with the AP MLD might have a link that all the TIDs are mapped. For the case, the AP MLD does not need to indicate link information regarding the buffered BU(s) for the non-AP MLD. (The non-AP MLD may transmit PS-Poll on the link that all the TIDs are mapped.) | As in comment. | RevisedFor item 1, revised the condition to include the MLTI element as follows: “…the AP MLD has buffered BU(s) with TID(s) that is not mapped to all the enabled links for the non-AP MLD(s).” The item 2 in the comment could limit the channel access to the link on which all TIDs are mapped. TGbe editor to make the changes with the CID tag (#13855) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 12050 | Massinissa Lalam | 9.3.3.2 | 172.31 | "Multi-Link Traffic Indication" should be renamed to "Multi-Link Traffic Indication Mapping" accross the whole amendment. It would also be coherent with the M put in "dot11MultiLinkTIMActivated". | As in comment | Revised.The ‘traffic indication’ seems to correctly represent the meaning of the information element. Revised “dot11MultiLinkTIMActivated” to “dot11MultiLinkTrafficIndiationActivated”.TGbe editor to make the changes with the CID tag (#12050) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 10206 | John Wullert | 9.4.2.315 | 250.40 | The sentence "The AID Offset subfield indicates a bit numbered k of the traffic indication virtual bitmap." is not clear. The value of k is not defined and the phrase "a bit numbered k" does not clearly define its purpose. | Rephrase sentence to define "k" and clarify its purpose. | Revised.With the addition of the AID Bitmap element, the AID Offset subfield is no longer used. The field is replaced with the Link ID Offset subfield.TGbe editor to make the changes with the CID tag (#10206) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 13960 | Geonjung Ko | 9.4.2.315 | 250.41 | It would be better to add a description that can be understood by itself. The current description should be interpreted with the below part. | Please add the description such as:"The AID Offset subfield indicates an AID that corresponds to the first Per-Link Traffic Indication Bitmap subfield in the Per-Link Traffic Indication List field." | Revised.With the addition of the AID Bitmap element, the AID Offset subfield is no longer used. The field is replaced with the Link ID Offset subfield.TGbe editor to make the changes with the CID tag (#13960) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 10028 | Morteza Mehrnoush | 9.4.2.315 | 251.06 | In this sentense it should be changed to "not all TIDs" because it's already negotiated a mapping and so it's not all TID to all link mapping. Please change it to: "negotiated a TID-to-link mapping with an AP MLD and not all the TIDs are mapped to all the enabled links" | as in comment | Rejected.The phrase “…or link recommendation for a non-AP MLD that has negotiated a TID-to-link mapping with an AP MLD and all TIDs are mapped to all the enabled links…” is to cover a case where TID-to-link mapping is done but mapping all TIDs to all enabled links. This is allowed in the current spec. |
| 11642 | Morteza Mehrnoush | 9.4.2.315 | 251.06 | In this sentense it should be changed to "not all TIDs" because it's already negotiated a mapping and so it's not all TID to all link mapping. Please change it to: "negotiated a TID-to-link mapping with an AP MLD and not all the TIDs are mapped to all the enabled links" | as in comment | Rejected.The phrase “…or link recommendation for a non-AP MLD that has negotiated a TID-to-link mapping with an AP MLD and all TIDs are mapped to all the enabled links…” is to cover a case where TID-to-link mapping is done but mapping all TIDs to all enabled links. This is allowed in the current spec. |
| 13071 | Chittabrata Ghosh | 9.4.2.315 | 251.06 | In this sentense it should be changed to "not all TIDs" because it's already negotiated a mapping and so it's not all TID to all link mapping. Please change it to: "negotiated a TID-to-link mapping with an AP MLD and not all the TIDs are mapped to all the enabled links" | as in comment | Rejected.The phrase “…or link recommendation for a non-AP MLD that has negotiated a TID-to-link mapping with an AP MLD and all TIDs are mapped to all the enabled links…” is to cover a case where TID-to-link mapping is done but mapping all TIDs to all enabled links. This is allowed in the current spec. |
| 13377 | Liwen Chu | 35.3.12.4 | 442.63 | The buffered BU for at least one non-AP MLD with successful negotiation of TID to Link mapping is not the mandatory condition for AP MLD to transmit Multi-Link Traffic Indication element. The related TID-to-link mapping should be all TIDs are mapped to different links. Please see L30P444, L31P172. | update the text according to the comment. | Revised.The ‘not all TIDs are mapped to all enabled links’ has been added.TGbe editor to make the changes with the CID tag (#13377) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 13794 | Yuchen Guo | 35.3.12.4 | 443.01 | Add "nondefault" before "TID-to-Link mapping", same for Line 23 of this page | As in the comment | Revised.The ‘not all TIDs are mapped to all enabled links’ has been added.TGbe editor to make the changes with the CID tag (#13794) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 13920 | Ming Gan | 35.3.12.4 | 443.12 | please add an exception, add ""except for TID to same links subset" after "with nondefault mapping" | add ""except for TID to same links subset" after "with nondefault mapping" | Revised.The additional condition, ‘not all TIDs are mapped to all enabled links’ has been added.TGbe editor to make the changes with the CID tag (#13920) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 13620 | Rubayet Shafin | 35.3.12.4 | 443.14 | "STA of the non-AP MLD" should be replaced with "STA affiliated with the non-AP MLD" for homegeneity in the spec | As in comment | Revised.The sentence has been deleted as part of the comment resolution of CID13734.To editor: no changes required. |
| 13378 | Liwen Chu | 35.3.12.4 | 443.23 | the sentence should be applied to an non-AP MLD that negotiated a TID -to-link mapping where all TIDs are mapped to different links. | update the text according to the comment. | Revised.The additional condition, ‘not all TIDs are mapped to all enabled links’ has been added.TGbe editor to make the changes with the CID tag (#13378) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 10426 | yan li | 35.3.12.4 | 443.28 | Since figure 35-16 shows AIDs assigned to pre-EHT STAs are out of the scope of AIDs for Non-AP MLD,do we need a note to clarify that AIDs for per-EHT STAs should be out of the consecutive bit set for non-AP MLD(e.g.if AID(5) is for pre-EHT STA and AIDs(4,6) are for non-AP MLDs,per-traffic indication bitmap corresponding to AID(6) may incorrectly be mapped to AID(5) for pre-EHT STA when AID offset is set to 4). | separate the bit set of AIDs for pre-EHT STAs from the bit set of AIDs for non-AP MLDs | Revised.The comment has been resolved by using the AID Bitmap element instead of the TIM element to indicate the AIDs of the non-AP MLDs that correspond to the Per-link Traffic Indication Bitmap subfields in the Multi-Link Traffic Indication element. TGbe editor to make the changes with the CID tag (#10426) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 12484 | Prashant Kota | 35.3.12.4 | 443.28 | In "Figure 35-16--Example of Multi-Link Traffic Indication element construction", solid line separating default mapped AIDS from non-default mapped AIDs is between (Nx8 = k) and (Nx8+1). | We propose to place the solid line between (Nx8-1) and (Nx8 = k) | Revised.The figure has been revised and there is no longer the solid line that separates different groups of MLDs.TGbe editor to make the changes with the CID tag (#12484) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 12643 | Arik Klein | 35.3.12.4 | 443.28 | Figure 35-16 shows different ranges of AIDs that are assigned for non-AP MLD with default mapping and for non-AP MLD with non-default mapping. It seems to be incorrect since AID is assigned as one-time value once the non-AP MLD has became associated with the AP MLD (till this association is torn-down) while having default mapping or non-default mapping may be changed frequently during the association period (so the AID will not be re-assigned for each change).Moreover, it contradicts with the following sentence in section 9.4.2.315(P251L7):"When a Per-Link Traffic Indication Bitmap subfield corresponds to an AID of a STA that is not affiliated with a non-AP MLD, the Per-Link Traffic Indication Bitmap subfield is reserved" (which means that the adjacent bits in the Partial Virtual bitmap of the TIM may corresponds to non-AP MLDs and non-MLD STAs) | Please remove the captions "AID assigned to Pre-EHT STAs or Non-AP MLDs (default mapping)" and "AIDs assigned to Non-AP MLDs (non default mapping)" from Figure 35-16 or explain why these ranges are required. | Revised.The figure has been revised and there is no longer separation between different groups of MLDs.TGbe editor to make the changes with the CID tag (#12643) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 10876 | Yousi Lin | 35.3.12.4 | 443.50 | The AID list in figure 35-16 may not always follow the given order. Non-AP MLDs with default mapping or non default mapping can be changing all the time. | as in comment | Revised.The comment has been resolved by using the AID Bitmap element instead of the TIM element to indicate the AIDs of the non-AP MLDs that correspond to the Per-link Traffic Indication Bitmap subfields in the Multi-Link Traffic Indication element. TGbe editor to make the changes with the CID tag (#10876) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 12380 | Rojan Chitrakar | 35.3.12.4 | 443.50 | As shown in Figure 35-16, an AP MLD should maintain separate AID spaces used to allocate AIDs for associated STAs that do not require additional ML Traffic Indication Bitmap (e.g., pre-EHT STAs or Non-AP MLDs with default TID-to-Link mapping) and a separate AID space used to allocate AIDs for associated STAs that require additional ML Traffic Indication Bitmap (e.g., EHT STAs or Non-AP MLDs with non-default TID-to-Link mapping), else the ML traffic element will carry unnecessary ML Traffic Indication Bitmap even for STAs that do not require them. | Add normative sentences stating that an AP MLD should maintain separate AID space used to allocate AIDs for associated STAs that do not require additional ML Traffic Indication Bitmap (e.g., pre-EHT STAs or Non-AP MLDs with default TID-to-Link mapping) and a separate AID space used to allocate AIDs for associated STAs that require additional ML Traffic Indication Bitmap (e.g., EHT STAs or Non-AP MLDs with non-default TID-to-Link mapping). At the very least, the AID assignment should be described in the context of the cited example. | Revised.The comment has been resolved by using the AID Bitmap element instead of the TIM element to indicate the AIDs of the non-AP MLDs that correspond to the Per-link Traffic Indication Bitmap subfields in the Multi-Link Traffic Indication element. TGbe editor to make the changes with the CID tag (#12380) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 13795 | Yuchen Guo | 35.3.12.4 | 444.06 | Add "nondefault" before "TID-to-Link mapping", same for Line 30 of this page | As in the comment | Revised.The additional condition, ‘not all TIDs are mapped to all enabled links’ has been added.TGbe editor to make the changes with the CID tag (#13795) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 10877 | Yousi Lin | 35.3.12.4 | 444.24 | "the MMPDU shall carry information to determine..." What is the "information"? Please specify. | as in comment | Revised.The information is replaced with the Multi-Link Link Information element. TGbe editor to make the changes with the CID tag (#10877) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 13992 | Geonjung Ko | 35.3.12.3 | 443.61 | Change "Multi-Link Traffic element" to "Multi-Link Traffic Indication element". | As in comment | Accepted. |
| 13733 | Yunbo Li | 35.3.12.4 | 443.48 | There are several places in the bottom of figure that should be "Per-Link Traffic Indication Bitmap subfield" instead of "Multi-link Traffic Indication Bitmap" in Figure 35-16 | change them accordingly | RevisedThe figure has been updated as suggested.TGbe editor to make the changes with the CID tag (#13733) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 13856 | Sanghyun Kim | 35.3.12.4 | 443.44 | The rule to set the 'Bitmap size' is missing. | Provide a rule for setting the Bitmap size subfield | RevisedAdded a rule to set the Bitmap Size subfield.TGbe editor to make the changes with the CID tag (#13856) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |

**Discussion:**

The comments in CID 10386, 12158, 10572, 13735, 11121, and 13734 are describing a potential ‘beacon bloating’ issue related to the size of a Beacon frame becoming too big with addition of the Multi-Link Traffic Indication element added to a Beacon frame, especially for a legacy STA. As IEEE 802.11WG develops new amendments, new information elements are defined that are included in a Beacon frame and as commented in CID 12158, there needs to be a way to deliver these new information elements without causing a problem to the Beacon frame defined in the current 802.11 standard going forward.

CID 13734 and 13735 comment that the Multi-Link Traffic Indication element needs to be further optimized to reduce overhead for the case when buffered data for non-AP MLDs are using default mapping and doesn’t need signaling in the Multi-Link Traffic Indication element.

To resolve these comments, the proposed resolution is to define a new Action No Ack frame (Beacon-A frame) that can contain information elements that are defined in TGbe or other new amendments that could potentially cause the ‘beacon bloating’ problem. The proposed resolution is to include the Multi-Link Traffic Indication element in the Beacon-A frame and remove it from the Beacon frame. To indicate whether a Beacon-A frame is present after a Beacon frame, a bit (B14) in the Capability Information field is defined as the Beacon-A Present Flag and included in the Beacon frame.



Regarding CID 13734 and 13735 on reducing the signalling overhead of the Multi-Link Traffic Indication element, the proposed resolution is to use the AID Bitmap element defined in doc. 11-22/1026r7 instead of the TIM element to indicate the AIDs of non-AP MLDs that correspond to the Per-link Traffic Indication Bitmap subfields included in the Multi-Link Traffic Indication element. The AID Bitmap element includes AIDs of non-AP MLDs that have buffered BUs at the AP MLD and that have setup non-default TID-to-link mapping (i.e., not all TIDs are mapped to all enabled links) for traffic indication or default mapping (all TIDs mapped to all enabled links) for link recommendation. This removes Per-Link Traffic Indication Bitmap subfields that correspond to STAs (i.e., non-MLD) or non-AP MLDs with default mapping that the AP MLD doesn’t intend to indicate link recommendation from the Multi-Link Traffic Indication element and thus minimizes overhead. This also resolves the issue of a non-AP MLD switching between non-default TID-to-link mapping and default mapping.

Since the AID Bitmap element indicates the AIDs of the non-AP MLDs that correspond to the Per-Link Traffic Indication Bitmap subfields that are included in the Multi-Link Traffic Indication element, the AID Offset subfield is no longer needed.

Moreover, as commented in CID 11121, since Link ID may start from anywhere between 0-15, the Link ID Offset subfield is added to indicate the Link ID value that B0 (1st bit position) of the Per-link Traffic Indication Bitmap subfield is representing. Also, with the Link ID Offset subfield, the AP MLD can now even shorten the size of the Per-link Traffic Indication Bitmap subfields by indicating the lowest Link ID, *d*, that has buffered BUs or indicated as a recommended link, among the Per-link Traffic Indication Bitmap subfields in the Multi-link Traffic Indication element. The following figure shows the comparison between the current approach and the proposed resolution.



***TGbe editor: Please modify following table in subclause 9.3.3.2 Beacon frame format as follows in D2.0*** *(#10386, 12158, 10572, 11121)*

**9.3.3.2 Beacon frame format**

 ***Update existing order 12 and insert four new rows to Table 9-60 (Beacon frame body) in numeric order:***.

**Table 9-60—Beacon frame body**

|  |  |  |
| --- | --- | --- |
| **Order**  | **Information**  | **Notes** |
| 12  | Quiet  | The Quiet element is optionally present if dot11SpectrumManagementRequired is true or dot11RadioMeasurementActivated is trueor dot11RestrictedTWTOptionImplemented is true. |
| <Lastassigned +1> | Multi-Link  | The Basic Multi-Link element is present if dot11MultiLinkActivated is true; otherwise it is not present. |
| <Lastassigned +2> | EHT Capabilities  | The EHT Capabilities element is present if dot11EHTOptionImplemented is true; otherwise it is not present. |
| <Lastassigned +3> | EHT Operation  | The EHT Operation element is present if dot11EHTOptionImplemented is true; otherwise it is not present. |
|  |  |  |

***TGbe editor: Please modify following table in subclause 9.4.1.4 Capability Information field as follows in D2.0*** *(#10386, 12158, 10572, 11121)*

* + - 1. **Capability Information field**

***Change*** [***Figure 9-132 (Capability Information field format (non-DMG STA))***](#bookmark78) ***as follows:***

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| B0 | B1 | B2 | B3 | B4 | B5 | B6 | B7 |
| ESS | IBSS | Reserved | Reserved | Privacy | Short Preamble | ~~Reserved~~ Critical Update Flag | ~~Reserved~~ Nontransmitted BSSIDs Critical Update Flag |
| B8 | B9 | B10 | B11 | B12 | B13 | B14 | B15 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Spectrum Management | QoS | Short Slot Time | APSD | Radio Measurement | EPD | Beacon-A Present Flag | Reserved |

**Figure 9-132—Capability Information field format (non-DMG STA)**

***TGbe editor: Please insert the following paragraph after the EPD subfield definition (A STA sets the EPD subfield…) in subclause 9.4.1.4 Capability Information field*** *(#10386, 12158, 10572, 11121)*

The Beacon-A Present Flag subfield is reserved except when the Capability Information field is carried in a Beacon frame transmitted by an AP affiliated with an AP MLD outside the Basic Multi-Link element. An AP affiliated with an AP MLD sets the Beacon-A Present Flag subfield to 1 if a Beacon-A frame is present SIFS after the Beacon frame. Otherwise, the AP sets the subfield to 0.

***TGbe editor: Please modify the table below in subclause 9.6.35.1 Protected EHT Action field as follows in D2.0*** *(#10386, 12158, 10572, 11121)*

**9.6.35 Protected EHT Action frame details
9.6.35.1 Protected EHT Action field**

**Table 9-623c—Protected EHT Action field values**

|  |  |  |
| --- | --- | --- |
| **Value** | **Meaning** | **Time priority** |
| 8 | Beacon-A | Yes |
| 9-255 | Reserved |  |

***TGbe editor: Please add the following subclause 9.6.35.10 Beacon-A frame format after the last action frame format defined in 9.6.35 as follows in D2.0*** *(#10386, 12158, 10572, 11121)*

**9.6.35.10 Beacon-A frame format**

The Beacon-A frame is an Action No Ack frame of category EHT. The Action field of a Beacon-A frame contains the information shown in Table 9-xxx (Beacon-A frame Action field format)

**Table 9-xxx—Beacon-A frame Action field format**

|  |  |
| --- | --- |
| **Order** | **Meaning** |
| 1 | Category |
| 2 | Protected EHT Action |
| 3 | AID Bitmap element (see 9.4.2.317 (AID Bitmap element)) is present if dot11MultiLinkTrafficIndicatonActivated is true; otherwise it is not present. |
| 4 | Multi-Link Traffic Indication element (see 9.4.2.315 (Multi-Link Traffic Indication element)) is present if dot11MultiLinkTrafficIndicatonActivated is true; otherwise it is not present. |

The Category field is defined in Table 9-79 (Category values). The Protected EHT Action field is defined in Table 9-623a (EHT Action field values).

The AID Bitmap element is described in 9.4.2.317 (AID Bitmap element).

The Multi-Link Traffic Indication element is described in 9.4.2.315 (Multi-Link Traffic Indication element).

***TGbe editor: Please modify the following subclause 9.4.2.315 Multi-Link Traffic Indication element as follows in D2.0*** *(#10386, 12158, 10572, 13735, 11121)*

**9.4.2.315 Multi-Link Traffic Indication element**

**…**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |
|  | Element ID | Length | Element ID Extension | Multi-Link Traffic IndicationControl | Per-Link TrafficIndication List |
| Octets: | 1 | 1 | 1 | 1 | variable |

**Figure 9-1002ao—Multi-Link Traffic Indication element format**

…

The Multi-Link Traffic Indication Control field is defined in Figure 9-1002ap (Multi-Link Traffic Indication Control field format).

|  |  |  |
| --- | --- | --- |
|  | B0 B3 | B4 B7 |
|  | Bitmap Size | Link ID Offset |
| Bits: | 4 | 4 |

**Figure 9-1002ap—Multi-Link Traffic Indication Control field format**

(#10206, 13960)

The Link ID Offset subfield indicates a Link ID equal to *d* that corresponds to B0 of each Per-Link Traffic Indication Bitmap in the Per-Link Traffic Indication List field.

The Per-Link Traffic Indication List field is defined in Figure 9-1002aq (Per-Link Traffic Indication List field format). The Per-Link Traffic Indication List field contains Per-Link Traffic Indication Bitmap subfields that correspond to the AIDs of the non-AP MLDs that are listed in the Partial AID Bitmap subfield of the AID Bitmap element that is included in a Beacon-A frame or in a Link Recommendation frame. The Per-Link Traffic Indication List field contains *l* Per-Link Traffic Indication Bitmap subfields, where *l* is the number of the bits that are set to 1 in the Partial AID Bitmap subfield of the AID Bitmap element.

The Per-Link Traffic Indication Bitmap subfield is defined in Figure 9-1002ar (Per-Link Traffic Indication
Bitmap subfield format). Each Per-Link Traffic Indication Bitmap subfield indicates per-link traffic indications for a non-AP MLD that has negotiated a TID-to-link mapping with an AP MLD and not all TIDs are
mapped to all the enabled links or link recommendation for a non-AP MLD that has negotiated a TID-to-link
mapping with an AP MLD and all TIDs are mapped to all the enabled links or link recommendation for a
non-AP MLD that is in the default mapping mode.

Each bit in the Per-Link Traffic Indication Bitmap subfield corresponds to a link and the bit position *i* of the bitmap, B*i*, corresponds to a link with link ID equal to (*i + d*),where *d* is the value indicated in the Link ID Offset subfield. In a Beacon-A frame, when the Per-Link Traffic Indication Bitmap subfield corresponds to a non-AP MLD that has successfully negotiated TID-to-link mapping and not all TIDs are mapped to all the enabled links, a value of 1 in the bit position *i* in the bitmap that corresponds to a link on which a STA affiliated with a non-AP MLD is operating indicates that there is buffered BU(s) with TID(s) mapped to the link with the link ID equal to (*i + d*)or MMPDU(s); a value of 0 in a bit position in the bitmap indicates that there is no buffered BU(s) with TID(s) mapped to the corresponding link nor MMPDU(s). When the Per-Link Traffic Indication Bitmap subfield corresponds to a non-AP MLD that is in
the default mapping mode or has negotiated a TID-to-link mapping with an AP MLD and all TIDs are
mapped to all the enabled links, a value of 1 in the bit position *i* in the bitmap indicates that the link with the
link ID equal to *i* is recommended for retrieving buffered BU(s).

***TGbe editor: Please modify the following subclause 35.3.12.4 Traffic Indication as follows in D2.2***

**35.3.12.4 Traffic indication**

***TGbe editor: Please modify the following paragraph in P471L39 in subclause 35.3.12.4 Traffic Indication as follows in D2.2:***

An AP MLD may (#12808)use Multi-Link Traffic Indication element and (#10386)AID Bitmap element carried in a Beacon-A frame to recommend a non-AP MLD to use one or more enabled links to retrieve individually addressed
buffered BU(s). An AP MLD may also use Multi-Link Traffic Indication element and AID Bitmap element
in a Link Recommendation frame to recommend a non-AP MLD to use one or more enabled links for all
exchanges both for DL and UL. The AP’s indication may be carried in a broadcast or a unicast frame.

***TGbe editor: Please modify the following paragraph in P471L63 in subclause 35.3.12.4 Traffic Indication as follows in D2.2:***

An AP affiliated with an AP MLD shall include (#10386)the AID Bitmap element (see 9.4.2.318 (AID Bitmap element)) and the Multi-Link Traffic Indication element (see 9.4.2.315 (Multi-Link Traffic Indication element)) in a (#10386)Beacon-A frame if at least one of the associated non-AP MLD(s) has successfully negotiated a TID-to-link mapping (see 35.3.7.1.3 (Negotiation of TID-to-link mapping)) with the AP MLD for DL or bidirectional traffic and (#13377, 13794)not all TIDs are mapped to all enabled links and the AP MLD has buffered BU(s) (#13855)with TID(s) that are not mapped to all the enabled links for the non-AP MLD(s). (#10386)The AP affiliated with the AP MLD shall transmit the Beacon-A frame SIFS after a Beacon frame and the Beacon-A Present Flag subfield in the Capability Information field in the Beacon frame shall be set to 1. The AID Bitmap element shall include a list of AID(s) that correspond to the non-AP MLD(s) that successfully negotiated a TID-to-link mapping with the AP MLD and not all TIDs are mapped to all enabled links and the AP MLD has buffered BU(s) with TID(s) that are not mapped to all the enabled links for that non-AP MLD(s).

(#10386)For link recommendation, the AID Bitmap element may include a list of AID(s) that correspond to the non-AP MLD(s) that successfully negotiated a TID-to-link mapping with an AP MLD and all TIDs are mapped to all the enabled links or the non-AP MLD(s) that is in the default mapping mode and the AP MLD has buffered BU(s) for that non-AP MLD(s).

The Multi-Link Traffic Indication element includes Per-Link Traffic Indication Bitmap subfield(s) in the Per-Link Traffic Indication Bitmap List field. The Per-Link Traffic Indication Bitmap subfield(s) corresponds to the AID(s) of the non-AP MLD(s) (#10386)listed in the Partial AID Bitmap subfield in the AID Bitmap element. (#10206)The order of the Per-Link Traffic Indication Bitmap subfield(s) follows the order of the bits that are set to 1 in the Partial (#10386)AID Bitmap subfield of the (#10386)AID Bitmap element. (#11121)The bit position *i* of the Per-Link Traffic Indication Bitmap subfield that corresponds to the link with the link ID that is equal to (*i+d*), where *d* is the value indicated in the Link ID Offset subfield of the Multi-Link Traffic Indication Control field, shall be set to 1 if the AP MLD has buffered BU(s) with TID(s) that are mapped to the link with the link ID (*i+d*) and not mapped to all the enabled links for that non-AP MLD, otherwise the bit shall be set to 0. (#13856)The Bitmap Size subfield of the Multi-Link Traffic Indication Control field shall be set to *m*, where *m* is equal to the largest link ID value minus the smallest link ID value amongst the bits that are set to 1 in the Per-Link Traffic Indication Bitmap subfield(s).

If a non-AP MLD is in the default mapping mode (see 35.3.7.1.2 (Default mapping mode)), the bit position *i* of the Per-Link Traffic Indication Bitmap subfield that corresponds to the link with the link ID equals to *i* on which a STA affiliated with the non-AP MLD is operating may be set to 1 to indicate to the non-AP MLD a link on which buffered BU(s) should be retrieved.

An example of the construction of the Multi-Link Traffic Indication element is shown in Figure 35-16 (Example of Multi-Link Traffic Indication element construction).

A non-AP MLD that successfully negotiated a TID-to-link mapping with an AP MLD (#13378, 13794) and not all TIDs are mapped to all enabled links shall determine which AP has buffered BU(s) with TID(s) by interpreting (#10386)the AID Bitmap element and the Multi-Link Traffic Indication element(#10386) in a Beacon-A frame.



**Figure 35-20—Example of AID Bitmap element and Multi-Link Traffic Indication element construction (#10386, 10426, 12484, 12643, 10876, 12380, 13733)**

***TGbe editor: Please modify the following paragraph in P472L60 of TGbe D2.2 as follows:***

When a non-AP MLD that is in the default mapping mode (see 35.3.7.1.2 (Default mapping mode)) detects
that the bit corresponding to its AID is 1 in the (#10386)AID Bitmap element and the Multi-Link Traffic (#13992)Indication element is present in a (#10386)Beacon-A frame and the Multi-Link Traffic Indication element includes a Per-Link Traffic Indication Bitmap subfield that corresponds to the non-AP MLD, any (#12242)non-AP STA affiliated with the non-AP MLD that operates on the link(s) indicated as 1 in the Per-Link Traffic Indication Bitmap subfield should issue a PS-Poll frame, or a UAPSD trigger frame if the STA is using U-APSD and all ACs are delivery enabled, to retrieve buffered BU(s) from the AP MLD.

When a non-AP MLD that has successfully negotiated TID-to-link mapping (see 35.3.7.1.3 (Negotiation of
TID-to-link mapping)) (#13795)and not all TIDs are mapped to all the enabled links detects that the bit corresponding to its AID is equal to 1 in the (#10386)AID Bitmap element and any bit of the Per-Link Traffic Indication Bitmap subfield that corresponds to a link on which a (#12242)non-AP STA affiliated with the non-AP MLD is operating is equal to 1 in the Multi-Link Traffic element, the (#12242)non-AP STA affiliated with the non-AP MLD that operates on that link may issue a PS-Poll frame, or a U-APSD trigger frame if the STA is using U-APSD and all ACs are delivery enabled, to retrieve buffered BU(s) from the AP MLD.

***TGbe editor: Please modify the following paragraphs in P473L22 of TGbe D2.2 as follows:***

If a buffered BU is an MMPDU that is intended for one (#12242)non-AP STA affiliated with a non-AP
MLD (#10581)(see Table 11-3 (Bufferable/nonbufferable classification of MMPDUs)), and if it is
transmitted on a link where another STA (other than the intended STA) affiliated with the same non-AP
MLD is operating on, following the procedure above, the MMPDU (#10877)shall carry the MLO Link Information element to determine the intended destination STA affiliated with the non-AP MLD (see 35.3.14.2 (Identification of the Intended STA)).

(#12808)An AP affiliated with an AP MLD may also schedule for transmission a Link Recommendation
frame to provide link recommendation for a set of non-AP MLDs as follows:
— The bit corresponding to the AID of a non-AP MLD shall be set to 1 in the Partial AID Bitmap
subfield of the AID Bitmap element in the Link Recommendation frame if the AP intends to provide
a link recommendation for this non-AP MLD.
— The Multi-Link Traffic Indication element includes Per-Link Traffic Indication Bitmap subfield(s),
in the Per-Link Traffic Indication Bitmap List field, which correspond(s) to the AID(s) of the non-AP MLD(s), (#10386)listed in the AID bitmap of the AID Bitmap element carried in
the Link Recommendation frame. (#10386)The order of the Per-Link Traffic
Indication Bitmap subfield(s) follows the order of the bits that are set to 1 in the Partial AID Bitmap
subfield of the AID Bitmap element carried in the Link Recommendation frame that corresponds to
the AID(s) of the non-AP MLD(s). The bit position *i* of the Per-Link Traffic Indication Bitmap
subfield in the Multi-Link Traffic Indication element that corresponds to the link with the link ID
equal to *i* on which a STA affiliated with the non-AP MLD is operating shall be set to 1 to indicate to
the non-AP MLD that it should exchange frames on this link both in DL and UL, while following the
rules defined in 35.3.7.1.1 (General).

***TGbe editor: Please modify the following paragraph in P474L1 of TGbe D2.2 as follows:***

An AP MLD shall set (#12050)dot11MultiLinkTrafficIndicationActivated to true if dot11TIDtoLinkMappingActivated is true and if any of the following conditions is met and otherwise shall set to false:
— At least one of the associated non-AP MLD(s) has successfully negotiated a TID-to-link mapping
(see 35.3.7.1.3 (Negotiation of TID-to-link mapping)) with the AP MLD and not all TIDs are
mapped to all the enabled links (#12808)(i.e., TID-to-link Mapping Negotiation Supported subfield
set to 1) and the AP MLD has buffered BU(s) (#13855)with TID(s) that are not mapped to all enabled links for that non-AP MLD
— The AP MLD intends to provide link recommendations (#12808)in a (#10386)Beacon-A frame to retrieve
individually addressed buffered BUs to at least one of the associated non-AP MLD(s) that has
successfully negotiated a TID-to-link mapping with the AP MLD and all TIDs are mapped to all the
enabled links and the AP MLD has buffered BU(s) for that non-AP MLD
— The AP MLD intends to provide link recommendations (#12808)in a (#10386)Beacon-A frame to retrieve
individually addressed buffered BUs to at least one of the associated non-AP MLD(s) that is in the
default mapping mode (see 35.3.7.1.2 (Default mapping mode)) and the AP MLD has buffered
BU(s) for that non-AP MLD.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Clause Number** | **Page.****Line** | **Comment** | **Proposed Change** | **Resolution** |
| 12640 | Arik Klein | 35.3.12.4 | 442.30 | AP may be a member of multiple BSSID set. Please rephrase the following sentence for better understanding to follow this terminology, as proposed: "An AP affiliated with an AP MLD where the AP is not in a multiple BSSID set shall indicate ..." | The sentence should be rephrased as follows: "An AP affiliated with an AP MLD where the AP is not a member of a multiple BSSID set shall indicate ..." | Accepted. |
| 12641 | Arik Klein | 35.3.12.4 | 442.46 | Please use the "AP affiliated with AP MLD" terminology and revise the following sentence accordingly:" An AP MLD shall buffer a BU with a TID at the AP MLD if the TID is not mapped to any link on which the corresponding STA of a non-AP MLD is in active mode, ..." | The sentence should be revised as follows: " An AP MLD shall buffer a BU with a TID at the AP MLD if the TID is not mapped to any link on which the corresponding \*non-AP STA affiliated with\* a non-AP MLD is in active mode, ..." | Accepted. |
| 12642 | Arik Klein | 35.3.12.4 | 442.47 | Need to use a unified terminology along the TGbe spec, and replace "of" with "affiliated with" in the following sentence :"An AP MLD shall buffer a BU with a TID at the AP MLD if the TID is not mapped to any link on which the corresponding STA of a non-AP MLD is in active mode" | Please correct the sentence as follows: "An AP MLD shall buffer a BU with a TID at the AP MLD if the TID is not mapped to any link on which the corresponding \*non-AP\* STA \*affiliated with\* a non-AP MLD is in active mode" | Accepted. |
| 10246 | John Wullert | 35.3.12.4 | 442.48 | Is it possible to ensure that the requirement that "The traffic indication for a non-AP MLD shall be consistent across the Beacon frames..." is met, given that the Beacons are not synchronized? | Description of similar capabilities in Clause 35.3.15.1 indicates that the traffic indication is "based on the latest information about the other APs that the AP has when the AP schedules the DTIM beacon" (P450L56). Suggest revising the requirement here to use similar langague. | Revised.Agree with the commenter. The intention of the sentence was to say that TIM indicates buffer status of BUs at an AP MLD for a non-AP MLD.TGbe editor to make the changes with the CID tag (#10246) in doc.: IEEE 802.11-22/1381r4[https://mentor.ieee.org/802.11/dcn/22/11-22-1381-04-00be-lb266-cr-ml-traffic-indication-part1.docx] |
| 13376 | Liwen Chu | 35.3.12.4 | 442.56 | TPC Request, Measruement Request are not the only two frames that need to be trnasmitted in the specific link. Refer to the subclause about Management frame transmission or list the complete Management frames here. | update the text according to the comment. | Revised.The paragraph has been updated based on the resolution of CID#10581 and now it is referring to Table 11-3 (Bufferable/nonbufferable classification ofMMPDUs). TGbe editor to make the changes with the CID tag (#10581) in doc 11-22/1412r1. |
| 10027 | Morteza Mehrnoush | 35.3.12.4 | 442.61 | Please remove extra a in "shall not buffer a a TPC..." | as in comment | Accepted. |
| 13619 | Rubayet Shafin | 35.3.12.4 | 442.61 | There are double "a"s before TPC request | Please delete one "a" | Accepted. |

***TGbe editor: Please modify the following subclause 35.3.12.4 Traffic Indication as follows in D2.2****:*

**35.3.12.4 Traffic indication**An AP affiliated with an AP MLD where the AP is not (#12640)a member of a multiple BSSID set shall indicate pending buffered traffic for a non-AP MLD associated with that AP MLD using the partial virtual bitmap of the TIM element as described in 9.4.2.5 (TIM element) and by following the rules described in this subclause.

…

***TGbe editor: Please modify the following paragraphs in P471L46 and P471L56 in 35.3.12.4 Traffic Indication as follows in D2.2****:*

An AP MLD shall buffer a BU with a TID at the AP MLD if the TID is not mapped to any link on which the corresponding (#12641, 12642)non-AP STA affiliated with a non-AP MLD is in active mode, and it shall set the bit in the partial virtual bitmap of the TIM element that corresponds to the AID of the non-AP MLD to 1. (#10246)The traffic indication for a non-AP MLD that is indicated by the bit in the partial virtual bitmap of the TIM element in a Beacon frame that matches the AID of the non-AP MLD shall be set to a value that reflects the buffer status of the BUs at the AP MLD for that non-AP MLD when each AP affiliated with the AP MLD that is operating on a corresponding link that is part of the multi-link setup schedules the Beacon frame.

An AP MLD shall buffer an MMPDU (#10581)(see Table 11-3 (Bufferable/nonbufferable classification of
MMPDUs)) and intended for receipt by a (#12242)non-AP STA affiliated with a non-AP MLD in the AP
MLD when all STAs affiliated with the non-AP MLD are in power save mode. In this case, the bit in the partial virtual bitmap of the TIM element that corresponds to the AID of the non-AP MLD shall be set to 1. An AP MLD shall not
buffer (#10027, 13619)a TPC Request frame or a Link Measurement Request frame.