IEEE P802.11
Wireless LANs

|  |
| --- |
| CR for CIDs related to Group-addressed frame Reception in EMLSR/NSTR |
| Date: July 14, 2022 |
| Author(s): |
| Name | Affiliation | Address | Phone | email |
| Vishnu V. Ratnam | Samsung Research America |  |  | vishnu.r@samsung.com |
| Minyoung Park | Intel Corporation |  |  |  |
| Boon Loong Ng | Samsung Research America |  |  |  |
| Rubayet Shafin | Samsung Research America |  |  |  |
| Peshal Nayak | Samsung Research America |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

 Abstract

This submission proposes resolution for 13 CIDs received for TGbe LB266:

SP: Do you agree to the resolutions provided in doc 11-22/1335r0 for the following 13 CIDs for inclusion in the latest 11be draft?

10008 10039 10434 10863 11594 12726 12728 12813 12892 13587 13588 13589 13813

Result: Yes/No/Abstain

**Revisions:**

* Rev 0: Initial version of the document.

Interpretation of a Motion to Adopt

A motion to approve this submission means that the editing instructions and any changed or added material are actioned in the TGbe Draft. This introduction is not part of the adopted material.

***Editing instructions formatted like this are intended to be copied into the TGbe Draft (i.e. they are instructions to the 802.11 editor on how to merge the text with the baseline documents).***

***TGbe Editor: Editing instructions preceded by “TGbe Editor” are instructions to the TGbe editor to modify existing material in the TGbe draft. As a result of adopting the changes, the TGbe editor will execute the instructions rather than copy them to the TGbe Draft.***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CID | Clause | Page.Line | Comment | Proposed Change | Resolution |
| 10434 | 35.3.17 | 463.18 | A group addressed frame may be destined for non-AP MLDs including a non-AP MLD operating in the EMLSR mode, other EHT STAs and/or legacy STAs. How the non-AP MLD operating in the EMLSR mode receives the group addressed frame is unclear. | A procedure for the transmission and reception of the group addressed frames between an AP MLD and its associtated non-AP MLDs operating in the EMLSR mode needs to be specified. | **Revised**Agree in principle. The text in Clause 35.3.17 has been updated to indicate that if at least one recipient non-AP MLD is in EMLSR mode, the group-addressed frames are buffered and delivered following rules defined in Clause 35.3.15.**TGbe editor, please implement changes as shown in doc 11-22/1335r0 tagged 10434** |
| 12813 | 35.3.17 | 461.56 | It is unclear how group addressed frames are delivered to a non-AP MLD that is in EMLSR mode when all STAs and non-AP MLDs associated with an AP MLD are in active mode. | Please consider to adopt the resolution proposed in doc 11-21/1484r4. The proposed resolution is to deliver group addressed frames to a non-AP MLD that is in EMLSR mode as if all STAs of the non-AP MLD are in PS mode. | **Revised**Agree in principle. The text in Clause 35.3.17 has been updated to indicate that if at least one recipient non-AP MLD is in EMLSR mode, the group-addressed frames are buffered and delivered following rules defined in Clause 35.3.15.**TGbe editor, please implement changes as shown in doc 11-22/1335r0 tagged 12813** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CID | Clause | Page.Line | Comment | Proposed Change | Resolution |
| 13587 | 35.3.17 | 463.38 | "...except when the frame exchanges initiated by the initial Control frame on one of the EMLSR links overlaps with group addressed frame transmissions on the other EMLSR link where the non-AP STA intends to receive the group addressed frames."Please add the folloing:"In which case, the STA affiliated with the non-AP MLD does not respond to the initial Control frame and receives the group addressed frames." | As in the comment. | **Revised**Agree in principle. It has been clarified in Clause 35.3.17. **TGbe editor, please implement changes as shown in doc 11-22/1335r0 tagged 13587** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CID | Clause | Page.Line | Comment | Proposed Change | Resolution |
| 10039 | 35.3.17 | 463.38 | It's not clear how the non-AP MLD can receive the beacons over the EMLSR links; also the groupcast frame delivery is not explained in the spec. Please add text to cover this. | as in comment | **Revised**Agree in principle. Rules to be followed by an AP MLD to avoid frame exchange overlap with beacons on other EMLSR links have been added in Clause 35.3.17. This enables the non-AP MLD to switch to the desired link to decode the beacon frames. The text in Clause 35.3.17 has also been updated to indicate that if at least one recipient non-AP MLD is in EMLSR mode, the group-addressed frames are buffered and delivered following rules defined in Clause 35.3.15.**TGbe editor, please implement changes as shown in doc 11-22/1335r0 tagged 10039** |
| 10863 | 35.3.17 | 461.56 | Behavior of non-AP MLD that is in EMLSR mode for the reception on Beacon and other group addressed frames should be specified. | as in comment | **Revised**Agree in principle. Rules to be followed by an AP MLD and non-AP MLD to avoid frame exchange overlap with beacons on other EMLSR links have been added in Clause 35.3.17. This enables the non-AP MLD to switch to the desired link to decode the beacon frames.**TGbe editor, please implement changes as shown in doc 11-22/1335r0 tagged 10863** |
| 12726 | 35.3.17 | 461.55 | EMLSR STAs shall be able to receive beacon frames on their EML links in order to determine the TWT/rTWT SPs of which they are member of | Please provide rules for an EMLSR STAs to be able to receive beacon frames on their EMLSR links. | **Revised**Agree in principle. Rules to be followed by an AP MLD to avoid frame exchange overlap with beacons on other EMLSR links have been added in Clause 35.3.17. This enables the non-AP MLD to switch to the desired link to decode the beacon frames.**TGbe editor, please implement changes as shown in doc 11-22/1335r0 tagged 12726** |
| 12728 | 35.3.17 | 461.55 | EMLSR STAs shall be able to receive beacon frames on their EMLSR links in order to determine the TWT/rTWT SPs of which they are member of. There is an issue if an IC frame is received during a TBTT expiry on another link. | Please provide rules for an EMLSR STAs or AP, to deal with the case of initial Control frame overlapping the TBTT on other EMLSR Link . | **Revised**Agree in principle. Rules to be followed by an AP MLD to avoid frame exchange overlap with beacons on other EMLSR links have been added in Clause 35.3.17. This enables the non-AP MLD to switch to the desired link to decode the beacon frames.**TGbe editor, please implement changes as shown in doc 11-22/1335r0 tagged 12728** |
| 12892 | 35.3.17 | 464.63 | In Note 7, it is not clear how any STA affiliated with a non-AP MLD that is operating in the EMLSR mode can receive Beacon frames, while listening operation only "includes CCA and receiving the initial Control frame of frame exchanges that is initiated by the AP MLD". | Please clarify how a STA affiliated with a non-AP MLD that is operating in the EMLSR mode can receive Beacons, if during listening it performs just CCA and reception of certain Control frames. | **Revised**Agree in principle. Rules to be followed by an AP MLD to avoid frame exchange overlap with beacons on other EMLSR links have been added in Clause 35.3.17. This enables the non-AP MLD to switch to the desired link to decode the beacon frames.**TGbe editor, please implement changes as shown in doc 11-22/1335r0 tagged 12892** |
| 13588 | 35.3.17 | 463.40 | "...where the non-AP STA intends to receive the group addressed frames."Based on the current spec, the non-AP STA may singal which STA will receive the group addressed frame, through 26.8.6 (Negotiation of wake TBTT and wake interval).And, in 26.8.6, "The TBTT scheduled STA shall be in the awake state to listen to Beacon frames transmitted at negotiated wake TBTTs and shall operate as described in 26.8.3.3 (Rulesfor TWT scheduled STA)."So, during the negotiated wake TBTT, the AP shall not send the initial Control frame. Please clarify the this. | As in the comment. | **Revised**Agree in principle. Rules to be followed by an AP MLD to avoid frame exchange overlap with beacons on other EMLSR links have been added in Clause 35.3.17. This enables the non-AP MLD to switch to the desired link to decode the beacon frames.**TGbe editor, please implement changes as shown in doc 11-22/1335r0 tagged 13588** |
| 13813 | 35.3.17 | 463.39 | Is it possible that a initial control frame is overlapped in time with group addressed frames on other links? we should avoid that | please clarify | **Revised**Agree in principle. Rules to be followed by an AP MLD to avoid frame exchange overlap with beacons on other EMLSR links have been added in Clause 35.3.17. This enables the non-AP MLD to switch to the desired link to decode the beacon frames.**TGbe editor, please implement changes as shown in doc 11-22/1335r0 tagged 13813** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CID | Clause | Page.Line | Comment | Proposed Change | Resolution |
| 10008 | 35.3.17 | 463.38 | 11be SPEC should have a resolution to address the initial frame overlapped with goup addressed frame reception.e.g. EMLSR non-AP MLD indicates the group addressed frame receving link to AP MLD,so that AP MLD know when and where to send the initial frame. | the commenter will provide a resolution on this. | **Revised**Agree in principle. An EHT action frame to indicate a link for receiving group addressed frames has been added in Clause 9.6.35.9 and its use is described in Clause 35.3.15.2.2.**TGbe editor, please implement changes as shown in doc 11-22/1335r0 tagged 10008** |
| 11594 | 35.3.17 | 463.25 | A mechanism for an EMLSR nonAP MLD to reliably receive beacon frames and other group addressed frames, without significantly hindering data traffic reception is required. | Define a mechanism where an EMLSR nonAP MLD can negotiate a primary link for receiving group addressed frames via an indication in the EML operating mode notification frame. | **Revised**Agree in principle. An EHT action frame to indicate a link for receiving group addressed frames has been added in Clause 9.6.35.9 and its use is described in 35.3.15.2.2.**TGbe editor, please implement changes as shown in doc 11-22/1335r0 tagged 11594** |
| 13589 | 35.3.17 | 463.40 | "...where the non-AP STA intends to receive the group addressed frames."Please add the field in the EML Operating Mode Notification frame to indicate the STA that intends to receive the group addressed frames as the optional feature. | As in the comment. | **Revised**Agree in principle. An EHT action frame to indicate a link for receiving group addressed frames has been added in Clause 9.6.35.9 and its use is described in Clause 35.3.15.2.2.**TGbe editor, please implement changes as shown in doc 11-22/1335r0 tagged 13589** |

## Discussion:

Group-addressed frame transmission:

When a non-AP MLD is operating in EMLSR mode, an AP affiliated with an AP MLD initiates frame exchange sequences by transmitting a MU-RTS or BSRP frame addressed to one of the STAs affiliated with the non-AP MLD. However, this is not applicable for a group address frame because the group address frame is for all associated non-AP MLDs. A simple solution to this problem is to transmit group addressed frames immediately following a Beacon frame containing DTIM transmission. A non-AP MLD in the EMLSR mode knows when DTIM beacon will be transmitted so can receive group addressed frames following the DTIM beacon.

Group-addressed frame protection:

Since an EMLSR non-AP MLD can only receive frames on one EMLSR-enabled link at a time, an AP MLD may need to provide “protection” for group-addressed frame transmission times as follows:

1. An AP of an AP MLD should terminate a frame exchange sequence with an EMLSR non-AP MLD before the group-addressed frame transmission time on another EMLSR link, if the non-AP MLD is expected to receive those group-addressed frames. This is so that the non-AP MLD can switch to the corresponding link and decode the group-addressed frames.
2. An AP of the AP MLD should not transmit an ICF to a STA of an EMLSR non-AP MLD if the ICF overlaps in time with the group-addressed frame transmission time on another EMLSR link, if the non-AP MLD is expected to receive those group-addressed frames. This is because, when an EMLSR non-AP MLD is receiving group-addressed frames on an EMLSR-enabled link, it may not be able to receive and respond to initial control frames (ICFs) transmitted by an AP of the AP MLD on another EMLSR-enabled link. This can cause the AP to lose the TXOP and suffer a back-off if the ICF it transmits initiates the TXOP.

Additional ‘guard time’ should also be considered to account for the EMLSR Transition delay which is required by the EMLSR non-AP MLD to switch between links. The above discussion is depicted pictorially below, where a beacon frame on link 2 is used as an example for the group addressed frame to be decoded by STA2 of the non-AP MLD, and to enable such reception, a frame exchange sequence on link 1 is terminated and an ICF restriction region (yellow) is used on links 1 and 3.



The aforementioned protection mechanisms can also be extended to a non-AP MLD operating in EMLMR mode. This is because, during a frame exchange sequence on one EMLMR link, the other EMLMR links may be in doze state and cannot receive group-addressed management and data frames reliably.

Group link notification:



Since there is no existing way for an AP MLD to know which group-addressed frames the non-AP MLD intends to receive and on which link, the aforementioned “protection” measures may need to be followed for group-addressed frame transmissions on all EMLSR/EMLMR/NSTR links, as shown in the figure above. This may reduce both the downlink throughput and uplink throughput (in case of trigger-based uplink) of an EMLSR/EMLMR/NSTR device.

Correspondingly, it is beneficial to add an “optional” procedure whereby an EMLSR/EMLMR/NSTR non-AP MLD can notify a group link for receiving group-addressed frames. This enables the AP MLD to only follow the aforementioned “protection” measures for group-addressed frames that are transmitted on the group link, thus improving the throughput of the non-AP MLD. Note that a non-AP MLD that has notified a group link can still occasionally receive group-addressed frames on other links, albeit without the protection measures.

***TGbe editor: Please note Baseline is 11be D2***

***TGbe editor: Please insert the following clause***

**9.4.1.75 Group Link field** **[10008][11594][13589]**

[10008][11594][13589]The Group Link field is defined in Figure 9-144j (Group Link field format)

 B0 B1 B4 B5 B7

|  |  |  |
| --- | --- | --- |
| Group Link Present | Group Link ID | Reserved |

 Bits: 1 4 3

 **Figure 9-144j—Group Link field format**[10008][11594][13589]

[10008][11594][13589]The Group Link Present subfield is set to 1 to indicate a link on which group-addressed frames are expected to be received by a non-AP MLD, referred to as the group link, and is set to 0 otherwise.

[10008][11594][13589]When the Group Link Present subfield is set to 1, the Group Link ID subfield indicates the Link ID of the group link, and the STA affiliated with the non-AP MLD operating on the group link is expected to receive the group-addressed frames. When the Group Link Present subfield is set to 0, the Group Link ID subfield is reserved.

**9.4.2.312.2.2 Common Info field of the Basic Multi-Link element**

***TGbe editor: Please change the figure as follows***

 B0 B3 B4 B5 B6 B7 B11 B12 B13 B14 B15

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Maximum Number of Simultaneous Links | SRS Support | TID-To-Link Mapping Negotiation Supported | Frequency Separation For STR/AP MLD Type Indication | AAR Support | Group Link Support[10008] [11594] [13589] | Reserved |

 Bits: 4 1 2 5 1 1 2

**Figure 9-1002l—MLD Capabilities and Operations subfield format**

***TGbe editor: Please add the following row to the end of the table***

**Figure 9-401i—Subfields of the MLD Capabilities and Operations field**

|  |  |  |
| --- | --- | --- |
| Subfield | Definition | Encoding |
| Group Link Support[10008][11594][13589] | An AP MLD indicates support for receiving Group Link Notification frames | For an AP MLD:Is set to 1 if the AP MLD supports reception of Group Link Notification frames and is set to 0 otherwise.For a non-AP MLD this subfield is reserved. |

**9.6.35.1 Protected EHT Action field**

***TGbe editor: Please change the table as follows***

|  |  |  |
| --- | --- | --- |
| Value | Meaning | Time priority |
| 6 | EML Operating Mode Notification | No |
| 7 [10008][11594] [13589] | Group Link Notification | No |
| 8-255 |  |  |

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

***TGbe editor: Please insert the following clause***

**9.6.35.9 Group Link Notification details [10008][11594][13589]**

[10008][11594][13589]The Group Link Notification frame is used by a non-AP MLD to notify to an AP MLD a link on which the non-AP MLD is expected to receive group-addressed frames.

[10008][11594][13589]The Action field of the Group Link Notification frame contains the information shown in Table 9-623k (Group Link Notification Action field format).

|  |  |
| --- | --- |
| Order | Information |
| 1 | Category |
| 2 | Protected EHT Action |
| 3 | Group Link (see 9.4.1.75 (Group Link field)) |

**Figure 9-623k—Group Link Notification frame Action field format**[10008][11594][13589]

[10008][11594][13589]The Category field is defined in 9.4.1.11 (Action field).

[10008][11594][13589]The Protected EHT Action field is defined in 9.6.35.1 (Protected EHT Action field).

**35.3.15.2 Group addressed frame reception**

**35.3.15.2.1 General [10008][11594][13589]**

***TGbe editor: Please insert the following paragraphs at the end of the subclause***

[10008][11594][13589] A non-AP MLD that has notified to an AP MLD a link on which group addressed frames are expected to be received, referred as the group link, as defined in 35.3.15.2.2 (Group link notification), should receive group addressed frames on the group link, unless a STA operating on another link needs to receive group addressed frames.

[10008][11594][13589] NOTE: For example, such needs can include a STA affiliated with the non-AP MLD receiving a BSS Parameters Change Count subfield for an AP operating on another link that is different from the previously received value or the Critical Update Flag subfield being set to 1 and other implementation specific reasons.

***TGbe editor: Please insert the following subclause***

**35.3.15.2.2 Group link notification [10008][11594][13589]**

[10008][11594][13589]An AP affiliated with an AP MLD with dot11GroupLinkOptionImplemented that is equal to true shall set the Group Link Support subfield in the MLD Capabilities and Operations field in the Basic Multi-link element it transmits to 1; otherwise the AP shall set the Group Link Support subfield to 0.

[10008][11594][13589]To notify a link for group-addressed frame reception, referred to as the group link, a STA affiliated with a non-AP MLD with dot11GroupLinkOptionImplemented shall transmit, to an AP affiliated with the associated AP MLD, a Group Link Notification frame, if it has received a Basic Multi-Link element from the AP with the Group Link Support subfield set to 1. To notify the group link, the non-AP MLD shall set, in the transmitted Group Link Notification frame, the Group Link Present subfield of the Group Link field to 1 and the Group Link ID subfield to the link identifier of the desired group link. The indicated link in the Group Link ID subfield shall replace any group link indicated in a previous Group Link Notification Frame transmitted by a STA affiliated with the non-AP MLD, if any. To terminate an existing notification of a group link for group-addressed frame reception, a STA affiliated with a non-AP MLD shall transmit a Group Link Notification frame with the Group Link Present subfield of the Group Link field set to 0.

[10008][11594][13589]The Group Link Notification frame shall not be transmitted by an AP affiliated with an AP MLD.

**35.3.16.4 Nonsimultaneous transmit and receive (NSTR) operation**

***TGbe editor: Please insert the following note after the fourth paragraph of the subclause***

[10008][11594][13589] The expectation to receive group addressed frames on a link by the non-AP MLD may be indicated in the Group Link Notification frame sent by a STA affiliated with the non-AP MLD, as defined in 35.3.15.2 (Group addressed frame reception).

**35.3.17 Enhanced multi-link single radio operation**

***TGbe editor: Please insert the following bullets to the eighth paragraph of the subclause***

When a non-AP MLD is operating in the EMLSR mode with an AP MLD supporting the EMLSR mode, the following applies:

***…***

* An AP affiliated with the AP MLD that initiates [10039][10434][12813]individually addressed frame exchanges with the non-AP MLD on one of the EMLSR links shall begin the frame exchanges by transmitting the initial Control frame to the non-AP MLD with the limitations specified below.

***…***

* + The initial Control frame shall be an MU-RTS Trigger frame or a BSRP Trigger frame. A STA affiliated with a non-AP MLD that is in the listening operation and that receives an MU-RTS Trigger Frame or BSRP Trigger frame addressed to it shall respond as defined in 35.5.2.2 (Rules for soliciting UL MU frames), except when the frame exchanges initiated by the initial Control frame on one of the EMLSR links overlaps with group addressed frame transmissions on the other EMLSR link where the non-AP STA intends to receive the group addressed frames [13587]in which case the non-AP STA may switch to the other EMLSR link to receive the group addressed frames. The number of spatial streams for the response to the BSRP Trigger frame shall be limited to one.

***…***

* [10039][10434][12813]If any non-AP MLD with dot11EHTEMLSROptionImplemented equal to true that is associated with an AP MLD with dot11EHTEMLSROptionImplemented equal to true is operating in EMLSR mode, the AP MLD shall buffer all non-GCR-SP group addressed BUs that arrive via the DS and deliver the non-GCR-SP group addressed BUs following the rules defined in 35.3.15 (Multi-link group addressed frame delivery and reception). [13587]A non-AP MLD that is operating in EMLSR mode may switch to a link on which non-GCR-SP group addressed BUs are delivered. A non-AP MLD that is operating in EMLSR mode that switched to a link to receive non-GCR-SP group addressed BUs shall return to the listening operation after receiving an indication from the AP MLD that there is no more buffered non-GCR-SP group addressed BUs following the rules defined in 11.2.3.7 (Receive operation for STAs in PS mode).
* [10039][10863][12726][12728][12892][13588][13813]When a Group Link has not been notified or has been terminated by transmitting a [10008][11594][13589]Group Link Notification frame as defined in 35.3.15.2 (Group addressed frame reception), an AP affiliated with the AP MLD should ensure that frame exchanges initiated with a STA affiliated with the non-AP MLD on one of the EMLSR links ends at least an EMLSR transition delay, indicated in the EMLSR Transition Delay subfield, before the group addressed MPDU transmissions or starts at least the EMLSR transition delay after the group addressed MPDU transmissions by another AP affiliated with the same AP MLD in another EMLSR link, if the STA affiliated with the non-AP MLD in the other EMLSR link is expected to receive those group addressed MPDUs.
* [10008][11594][13589] When an EMLSR link is notified as the Group Link by transmitting a Group Link Notification frame, as defined in 35.3.15.2 (Group addressed frame reception), an AP affiliated with the AP MLD should ensure that frame exchanges initiated with a STA affiliated with the non-AP MLD on one of the other EMLSR links ends at least an EMLSR transition delay, indicated in the EMLSR Transition Delay subfield, before the group addressed MPDU transmissions or starts at least the EMLSR transition delay after the group addressed MPDU transmissions by the AP affiliated with the same AP MLD that operates on the indicated Group link.
* When a STA of the non-AP MLD initiates a TXOP the following applies:
	+ The non-AP MLD shall switch back to the listening operation on the EMLSR links after the time duration indicated in the EMLSR Transition Delay subfield after the end of the TXOP.
	+ [10039][10863][12726][12728][12892][13588][13813]The STA should end the TXOP at least an EMLSR transition delay, indicated in the EMLSR Transition Delay subfield, before the TBTT(s) of the other EMLSR link(s) if the non-AP MLD intends to receive the Beacon frame(s) that are scheduled to be transmitted at those TBTT(s)
* Only one STA affiliated with the non-AP MLD that is operating on one of the EMLSR links may initiate frame exchanges with the AP MLD.

NOTE—The STA might not do so if it is not aware of the TSF of the other link(s).