IEEE P802.11  
Wireless LANs

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| LB 266 Resolution for CIDs related to MLO Architecture Section 5 (Part 1) | | | | |
| Date: August, 2022 | | | | |
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Abstract

This submission proposes resolutions for following 34 CIDs received for TGbe LB266:

10197, 10277, 10278, 10441, 10443, 10444, 10445, 10527, 10774, 11168, 12041, 12225, 12226, 12227, 12259, 12307, 12308, 12309, 12310, 12311, 12312, 12313, 12314, 12315, 12316, 12944, 12945, 12946, 12947, 12948, 12949, 13293, 13294, 13295

**Revisions:**

* Rev 0: Initial version of the document.
* Rev 1: minor editorial changes to some resolutions
* Rev 2: added the green tags for the CIDs that are not expected to be controversial

***TGbe editor: The baseline for this document is 11be D2.1***

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.***

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| --- | --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Clause** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 10197 | John Wullert | 5.1.5.1 | 70.13 | List of features of MLD Upper MAC omits EPCS | Add the following bullet to the list: "Coordination of distribution and management of EPCS EDCA parameters across lower MAC instances based on Link ID." | **Revised**  Agree in principle. Add this bullet: “Coordination of distribution and management of EDCA parameters across the MLD lower MAC sublayers” to keep it at high level.  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 10197** |
| 10277 | Michael Montemurro | 5.1.5.1 | 69.03 | To be clearer, update the figure to number the affiliated APs | In the figure, change the left Affiliated AP to "Affiliated AP 1" and the right Affiliated AP to "Affiliated AP n". | **Accepted** |
| 10278 | Michael Montemurro | 5.1.5.1 | 69.63 | The cited text could be clearer. | Change "Instead, the MLD AP processes group addressed MSDUs to the point of assigning a sequence number" to "Instead, the AP MLD receives group addressed MSDUs and assigns a sequence number prior to distributing the group addressed frames to the affiliated APs for transmission." | **Revised**  Agreed in principle. Made the suggested change and also added clarification to the MLD upper MAC sublayer functions description.  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 10278** |
| 10441 | Yonggang Fang | 5.1.5.1 | 67.31 | Suggest to change "Then, one or more MSDUs are delivered to the MAC SAP or, via the DSAF to the DS" to "Then, one or more MSDUs are delivered to LLC sublayer via the MAC SAP or, via the DSAF to the DS via the DSAF " | in the comment. | **Revised**  Generally agree with the comment. Proposed resolution accounts for the suggested changes.  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 10441** |
| 10443 | Yonggang Fang | 5.1.5.1 | 68.31 | PS Defer Queuing is located at above the Sequence Number Assignment function in the Figure 5-2a. If a TID is mapped to multiple links and there is a pending data of TID for an associated MLD, which link will the PS Defer Queuing is associated with? | Suggest to delete "PS Defer Queuing" at UMAC and insert "PS Defering" into the tail of Tx protocol stack of AP MLD UMAC, or head of LMAC of each link. Please make same change in other places of the document, P69L27, P70L19. | **Revised**  Agree in principle. Added the following text to the figures:  “AP MLD buffers an individually addressed frame if all the affiliated non-AP STAs, for which the TID of the MPDU carried in the frame is mapped to, are in doze state.”.  **TGbe editor, please make changes as in CID 10443** |
| 10444 | Yonggang Fang | 5.1.5.1 | 70.05 | The Fig 5-2a and 5-2b are reference architecture of MAC data plane. It is mandatory that "Group addressed MMPDUs generated within the AP MLD upper MAC sublayer shall be transferred to the appropriate affiliated APs for transmission"? | suggest change "shall be" to "is" | **Revised**  Agree with the comment. Changed “shall be” to “are”.  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 10444** |
| 10445 | Yonggang Fang | 5.1.5.1 | 70.22 | Link Merging is a function shown in Figure 5-2a. It should be included in the description. | Please add "/ Merging reciption of MPDUs from one or morelinks" after "Selection of the MLD lower MAC sublayer for transmission (TID-to-link mapping (see 35.3.7.1 (TID-to-link mapping)))" | **Revised**  Agee in principle. Added “Merging reception of MPDUs from one or more links”  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 10445** |
| 10527 | Abhishek Patil | 5.1.5.1 | 68.31 | MPDUs for a TID are queued at the MLD level and they are buffered if all STAs affiliated with the non-AP MLD to which the TID is mapped to are in doze state. If at least one STA affiliated with the non-AP MLD that is operating on a link to which the TID is mapped to is in active state, the AP MLD doesn't buffer the MPDU (and can directly proceed to DL). Therefore, on the tx-side, the "PS Defer Queuing (AP MLD Only)" block needs to take into account TID-to-Link mapping. | Update figure 5-2a and 5-2b accordingly. One way to address this would be to add a side NOTE in the figure which says that the "PS Defer Queuing (AP MLD Only)" block takes into account TID-to-Link mapping. Also mention that the TID-to-Link mapping block controls which link the MPDU can be DL (retrieved by the non-AP MLD). | **Revised**  Agree in principle. Same resolution as 10443.  **TGbe editor, please make changes as shown in Figure 5-2a and Figure 5-2b in 11-22/1222r2 tagged 10443** |
| 10774 | Chien-Fang Hsu | 5.1.5.1 | 68.31 | PS defer is a filtering process to control the MSDU dispatching to the Lower MAC. The behavior should be in the bottom of the Upper MAC. Also, the queuing is not necessary to be tied together with the PS defer. This topic was discussed in dcn21-1111 discussion thread. | Remove the queuing from the "PS defer queuing" and put the "PS deferring" below the TID-to-link mapping. | **Revised**  Added text to indicate that “PS deferring” depends on the TID-top-link mapping. Same resolution as 10443.  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 10443** |
| 11168 | Joseph Levy | 5.1.5.1 | 69.52 | An AP MLD is defined and the term AP MLD is used throughout the amendment. However, there are several locations where the term MLD AP is used: in the title of Figure 5.2b (4 locations 29.10, 67.55, 69.52, 71.40), 69.62 and 69.64 | Replace "MLD AP" with "AP MLD" at the cited locations: 29.10, 67.55, 69.52, 71.40, 69.62 and 69.64. | **Accepted** |
| 12041 | Massinissa Lalam | 5.1.5.1 | 69.59 | What is an "MLD non-AP STA peer" ? I think "non-AP MLD peer" should be used | As in comment | **Revised**  Agree in principle. Changed to “MPDUs received over any link from a STA affiliated with a non-AP MLD peer…”  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 12041** |
| 12225 | Stephen McCann | 5.1.5.1 | 68.31 | There's no description of how the "PS Defer Queuing" block operates in Figure 5-2a | Text defining the operation of the "PS Defer Queuing" block needs to be added to this clause. | **Revised**  Agree in principle. Same resolution as 10443.  **TGbe editor, same resolution as CID 10443** |
| 12226 | Stephen McCann | 5.1.5.1 | 69.52 | typo "MLD AP" | Change "MLD AP" to "AP MLD". Make the same change at P69L62 and P69L63. | **Accepted** |
| 12227 | Stephen McCann | 5.1.5.1 | 69.59 | It's not clear what an "MLD non-AP STA peer" is? | Change "MLD non-AP STA peer" to "non-AP MLD affiliated STA" | **Revised**  Agree in principle. Changed to “MPDUs received over any link from a STA affiliated with a non-AP MLD peer…”  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 12041** |
| 12259 | Stephen McCann | 5.1.5.1 | 70.14 | typo "association" | change "association" to "MLD association" | **Revised**  Agree in principle. Changed to “MLD association” and “MLD reassociation”.  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 12259** |
| 12307 | Guogang Huang | 5.1.5.1 | 67.32 | "Then, one or more MSDUs are delivered to the MAC SAP or, via the DSAF to the DS." This sentence is ambiguity. For simplicity, please revise this sentence as follows:  Then, one or more MSDUs are delivered to the MAC SAP. | Change "Then, one or more MSDUs are delivered to the MAC SAP or, via the DSAF to the DS." to "Then, one or more MSDUs are delivered to the MAC SAP." | **Revised**  Agree in principle. Same resolution as in 10441.  **TGbe editor, please make changes as CID 10441** |
| 12308 | Guogang Huang | 5.1.5.1 | 67.45 | Please remove the redundant word "frames", i.e.  The GTK of a link is used to encrypt the group addressed MPDUs and MMPDUs prior to transmission on the link. The GTK of a link is used to decrypt the group addressed MPDUs and MMPDUs received on the link. | Change the sentence at the identified location to "The GTK of a link is used to encrypt the group addressed MPDUs and MMPDUs prior to transmission on the link. The GTK of a link is used to decrypt the group addressed MPDUs and MMPDUs received on the link." | **Revised**  This sentence has been removed due to the resolution of CID 12314 but the same issue is on page 70/lines 2 & 3, for which accounted for the suggested change, as part of resolution of CID 12314 as well.  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 12314** |
| 12309 | Guogang Huang | 5.1.5.1 | 68.39 | Please add some text to describe the function of Link Merging block | As in comment | **Revised**  Added “(first-in-first-out)” after “merging process” on page 56/line 29  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 12309** |
| 12310 | Guogang Huang | 5.1.5.1 | 69.57 | Please revise this paragraph as follows:  An additional function is added for data MPDU reception to distribute the MPDUs to the appropriate upper MAC sublayer based on the type of association with the peer, which is tracked per TA. MPDUs received from a STA affiliated with a non-AP MLD are delivered to the AP MLD upper MAC, and other MPDUs are delivered to the non-MLD upper MAC for that link. | Change the paragraph at the identified location to "An additional function is added for data MPDU reception to distribute the MPDUs to the appropriate upper MAC sublayer based on the type of association with the peer, which is tracked per TA. MPDUs received from a STA affiliated with a non-AP MLD are delivered to the AP MLD upper MAC, and other MPDUs are delivered to the non-MLD upper MAC for that link." | **Revised**  Agree in principle. Changed to “MPDUs received over any link from a STA affiliated with a non-AP MLD peer…”  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 12041** |
| 12311 | Guogang Huang | 5.1.5.1 | 69.52 | Please revise the title of Figure 5--2b as follows:  Figure 5-2b--MAC data plane architecture for AP MLD and affiliated APs | Replace the title of Figure 5-2b as "MAC data plane architecture for AP MLD and affiliated APs". | **Accepted** |
| 12312 | Guogang Huang | 5.1.5.1 | 69.27 | The annotation of the right bracket should be revised, e.g. MLD upper MAC sublayer: MLD common functions OR non-MLD upper MAC layer | As in comment | **Revised**  Agree in principle. Separate into 3 brackets now. The middle AP one says “MLD upper MAC sublayer: MLD common functions. The AP1 and APn say “Non-MLD upper MAC sublayer”.  **TGbe editor, this is the same change as CID 12312** |
| 12313 | Guogang Huang | 5.1.5.1 | 69.63 | Please change "MLD AP" to "AP MLD" | Change "MLD AP" to "AP MLD" | **Accepted** |
| 12314 | Guogang Huang | 5.1.5.1 | 70.02 | The same text is repeated at page 69. Please remove the redundant text and keep one. | As in comment | **Revised**  The repeated text the commenter refers to is actually on page 67. Agree to remove the referred text on page 67 and remove the “frames” in the same text on page 70.  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 12314** |
| 12315 | Guogang Huang | 5.1.5.1 | 70.06 | The word "appropriate" is not good. Suggest to use the word "intended". | Change "appropriate affiliated APs" to "intended affiliated APs". | **Accepted** |
| 12316 | Guogang Huang | 5.1.5.1 | 70.06 | Please revise this sentence as follows:  Group addressed MMPDUs generated within the AP MLD upper MAC sublayer shall be transferred to the intended AP MLD low MAC sublayer for transmission. | Change the sentence at the identified location to " Group addressed MMPDUs generated within the AP MLD upper MAC sublayer shall be transferred to the intended AP MLD low MAC sublayer for transmission." | **Revised**  Agreed in principle. The “shall be” is changed to “are” by CID 10444  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 12315** |
| 12944 | Chunyu Hu | 5.1.5.1 | 67.37 | The description in NOTE 2 should have normative texts to be clear about the rules for MMPDU and Control/Extension frames. | Convert NOTE 2 to main text with necessary changes. | **Rejected**  This NOTE is to mirror a similar note in the baseline:  “NOTE—Many of the processes shown in Figure 5-1 (MAC data plane architecture(#1001)(11ay)) also apply to  MMPDU flows for the MAC control plane architecture, and the processes shown at the bottom also apply to Control and Extension frames.” |
| 12945 | Chunyu Hu | 5.1.5.1 | 67.42 | "on all the links" in the first sentence: a transmission cannot happen on all the links. Each transmission happens independently on each link from PPDU construction point of view. | Change to "on any link", or "on any of the links" | **Revised**  Change to “on any of the links”  **TGbe editor, please make changes as shown in 11-22/1222r2 tagged 12945** |
| 12946 | Chunyu Hu | 5.1.5.1 | 67.43 | "on all the links" in the second sentence in this paraph can be misleading and interpreted that the frame mentioned gonna be received on every links. "on any of the links" is more accurate. | Change to "on any of the links" | **Accepted** |
| 12947 | Chunyu Hu | 5.1.5.1 | 69.59 | "an MLD non-AP STA peer" doesn't read correctly. | Change to "a peer non-AP MLD". | **Revised**  Agree in principle. Changed to “MPDUs received over any link from a STA affiliated with a non-AP MLD peer…”  **TGbe editor, same resolution as CID 12041** |
| 12948 | Chunyu Hu | 5.1.5.1 | 69.62 | In "Instead, the MLD AP", should it be "the AP MLD" following the definition/term used elsewhere? | Change to "the AP MLD" | **Accepted** |
| 12949 | Chunyu Hu | 5.1.5.1 | 69.63 | The sentence "The MLD AP and affiliated APs then coordinate to power save buffer" doesn't read correctly: what does "power save buffer" mean? Also note that "The MLD AP" should be written as "The AP MLD". | Fix the broken sentence. See comment. | **Revised**  Remove “power save”.  **TGbe editor, please remove “power save” from the cited sentence.** |
| 13293 | Binita Gupta | 5.1.5.1 | 70.33 | The non-MLO affiliated upper MAC sublayer function should also specify non-MLO security association (e.g. PMKSA, PTKSA), since different PMK/PTK are used by affiliated AP for non-MLO than used for AP MLD. | Add a bullet indicating non-MLO security association (e.g. PMKSA, PTKSA) for affiliated AP upper MAC. | **Rejected**  This paragraph focuses on MLD and the related functionalities. For “legacy’ AP functionalities of the “non-MLO upper MAC”, it’s captured in the bullet as “Non-MLO peer operations”. Page 70/line 34.  “- Non-MLO peer operations, above the MLD lower MAC sublayer” |
| 13294 | Binita Gupta | 5.1.5.2 | 69.53 | Figure 5-2b does not distinguish between Upper MAC for AP MLD and affiliated APs as indicated in Figure 4-30c. | Modify the figure to put boxes around functions to show which Upper MAC MLD parts belong to AP MLD upper MAC and which parts belong to affiliated AP upper MAC. | **Rejected**  The diagram is getting crowded and Figure 4-30c is already very clear about which parts are AP MLD and which parts are affiliated AP upper MAC. |
| 13295 | Binita Gupta | 5.1.5.3 | 70.33 | The non-MLO affiliated upper MAC sublayer function should also specify link specific encryption/decryption using PTK for unicast frames for non MLO non-AP STAs. | Add a bullet indicating link specific encryption/decryption using PTK for unicast frames for non MLO non-AP STAs. | **Rejected**  This paragraph focuses on MLD and the related functionalities. For “legacy’ AP functionalities of the “non-MLO upper MAC”, it’s captured in the bullet as “Non-MLO peer operations”. Page 70/line 34.  “- Non-MLO peer operations, above the MLD lower MAC sublayer” |

1. **MAC service definition**
   1. **Overview of MAC services**
      1. **MAC data service architecture**
         1. **General**

***Insert the following paragraphs at the end of this subclause:***

For MLO, one or more links are used for communication between the AP MLD and non-AP MLD after MLD (re)setup as described in 35.3.5 (Multi-link (re)setup). The MAC data plane architecture with *n* links (i.e., processes that involve transport of all or part of an MSDU) is shown in [Figure 5-2a (MAC data plane](file:///C:\Users\dho\AppData\Local\Temp\Temp2_Draft%20P802.11be_D2.1%20-%20Word.zip\Draft%20P802.11be_D2.1%20-%20Word\TGbe_Cl_05.doc#bookmark0) [architecture (MLO) for unicast data frames](file:///C:\Users\dho\AppData\Local\Temp\Temp2_Draft%20P802.11be_D2.1%20-%20Word.zip\Draft%20P802.11be_D2.1%20-%20Word\TGbe_Cl_05.doc#bookmark0))).

During transmission, an MSDU from the MAC SAP goes through the processes shown in the left hand side of [Figure 5-2a (MAC data plane architecture (MLO) for unicast data frames),](file:///C:\Users\dho\AppData\Local\Temp\Temp2_Draft%20P802.11be_D2.1%20-%20Word.zip\Draft%20P802.11be_D2.1%20-%20Word\TGbe_Cl_05.doc#bookmark0) then through the TID-to-link mapping process (see 35.3.7.1 (TID-to-link mapping)) that forwards the MPDUs down to one of the MLD lower MAC sublayers and then to the corresponding PHY SAP.

NOTE 1—TID-to-link mapping negotiation between peer MLDs is an optional feature.

During reception, MPDUs originating from different PHY SAPs first go through an MLD lower MAC sublayer, followed by a merging process (first-in-first-out)(#12309), and then go through the rest of the processes in the right-hand side of [Figure 5-2a (MAC data plane architecture (MLO) for unicast data frame](file:///C:\Users\dho\AppData\Local\Temp\Temp2_Draft%20P802.11be_D2.1%20-%20Word.zip\Draft%20P802.11be_D2.1%20-%20Word\TGbe_Cl_05.doc#bookmark0)s). Then, one or more MSDUs are delivered to the LLC sublayer via(#10441) the MAC SAP or, via the DSAF to the DS. The IEEE 802.1X Controlled/Uncontrolled Ports discard any received MSDUs if the Controlled Port is not enabled and if the MSDU does not represent an IEEE 802.1X frame.

NOTE 2—Many of the processes shown in [Figure 5-2a (MAC data plane architecture (MLO) for unicast data frames)](file:///C:\Users\dho\AppData\Local\Temp\Temp2_Draft%20P802.11be_D2.1%20-%20Word.zip\Draft%20P802.11be_D2.1%20-%20Word\TGbe_Cl_05.doc#bookmark0) also apply to MLD-level MMPDU flows for the MAC control plane architecture, and the processes shown at the MLD lower MAC sublayer also apply to Control and Extension frames.

When MLO is being used, the same security association (PTKSA) is used to encrypt the unicast MPDUs and MMPDUs prior to transmission on any of(#12945) the links. The same security association (PTKSA) is used to decrypt the unicast MPDUs and MMPDUs received on any of the links(#12946). (#12314)

For an AP MLD to support group addressed transmissions and also non-MLO peer STA associations, [Figure 5-2a (MAC data plane architecture (MLO) for unicast data frames)](file:///C:\Users\dho\AppData\Local\Temp\Temp2_Draft%20P802.11be_D2.1%20-%20Word.zip\Draft%20P802.11be_D2.1%20-%20Word\TGbe_Cl_05.doc#bookmark0) is combined with *n* affiliated APs, within a structure as shown in Figure 4-30c (High level architecture for AP MLD with affiliated APs). The Non-MLD(#12314) upper MAC sublayer components of the affiliated APs are the same as those for the AP MLD, but handle group addressed security associations (GTK, IGTK, and BIGTK), and handle traffic to and from associated non-AP STAs (not operating in MLO) with single link security associations for pairwise transient(#12314) keys (PTKs). The overall structure is as shown in [Figure 5-2b (MAC data plane architecture for AP MLD and](file:///C:\\Users\\dho\\AppData\\Local\\Temp\\Temp2_Draft%20P802.11be_D2.1%20-%20Word.zip\\Draft%20P802.11be_D2.1%20-%20Word\\TGbe_Cl_05.doc" \l "bookmark1) [affiliated APs).](file:///C:\Users\dho\AppData\Local\Temp\Temp2_Draft%20P802.11be_D2.1%20-%20Word.zip\Draft%20P802.11be_D2.1%20-%20Word\TGbe_Cl_05.doc#bookmark1)



(#10443)

**Figure 5-2a—MAC data plane architecture (MLO) for unicast data frames**

(#10443)(#12312)

**Figure 5-2b—MAC data plane architecture for AP MLD and affiliated APs**

An additional function is added for data MPDU reception to distribute the MPDUs to the appropriate MLD upper MAC sublayer based on the type of association with the peer, which is tracked per TA. MPDUs received over any link from a STA affiliated with a non-AP MLD (#12041)peer are delivered to the AP MLD upper MAC, and other MPDUs are delivered to the affiliated AP upper MAC for that link.

Group addressed MSDUs at the DS are not transmitted directly by affiliated APs. Instead, the AP MLDreceives group addressed MSDUs and assigns a sequence number prior to distributing the group addressed frames to the affiliated APs for transmission(#10278). The AP MLD and affiliated APs then coordinate to power save buffer (if appropriate), assign packet numbers, and encrypt the resulting MPDU in the individual affiliated APs’ stacks. The GTK of an affiliated AP is used to encrypt the group addressed (#12314)MPDUs and MMPDUs prior to transmission on the link managed by that affiliated AP. The GTK of the corresponding affiliated STA is used to decrypt the group addressed (#12314)MPDUs and MMPDUs received on a link. Group addressed MMPDUs generated within the AP MLD upper MAC sublayer are(#10444) transferred to the intended(#12315) affiliated APs for transmission.

NOTE 3—An implementation must confirm that an MSDU that would otherwise be transmitted to peer MLD STAs is still transmitted, even if group addressed filtering of multicast MSDUs is being performed such that the MSDU might not be transmitted by the affiliated APs.

The MLD upper MAC sublayer functions include:

* Authentication, MLD association, and MLD reassociation (between an AP MLD and a non-AP MLD)(#12259)
* Security association (e.g., PMKSA, PTKSA) and distribution of GTK/IGTK/BIGTK
* SN/PN assignment for frames to be encrypted by PTK for unicast frames
* SN assignment for group addressed MSDUs and MMPDUs to be encrypted by the corresponding affiliated AP with GTK/IGTK/BIGTK (#10278)
* Power save buffering of individually addressed frames (only on AP MLD)
* Encryption/decryption using PTK for unicast frames
* Selection of the MLD lower MAC sublayer for transmission (TID-to-link mapping (see 35.3.7.1 (TID-to-link mapping)))
* Merging reception of MPDUs from one or more links(#10445)
* Reordering of packets to ensure in-order delivery per each Block Ack session
* Block Ack scoreboarding for individually addressed frames (in collaboration with the MLD lower MAC sublayer). Optionally, the MLD upper MAC sublayer delivers the Block Ack record on one link to the MLD lower MAC sublayer of other links
* MLD level management information exchange/indication via the MLD lower MAC sublayer
* Coordination of distribution and management of EDCA parameters across the MLD lower MAC sublayers of the links(#10197)