IEEE P802.11  
Wireless LANs

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| 11be D4.0 CR for 35.3.2 and 35.3.5 | | | | |
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Abstract

This submission proposes resolutions for the following CIDs:

19237, 19757, 19758, 19829, 19056, 19057, 19077, 19243, 19244, 19245,

19246, 19247, 19338, 19767, 19924, 19925, 19926, 19927, 20003, 19497,

19498

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: Add email address and format change.
* Rev 2: Changed based on the discussion during the teleconference

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 D4.0 Draft. This introduction is not part of the adopted material.

***Editing instructions formatted like this are intended to be copied into the TGbe D4.0 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** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 19237 | John Wullert | 35.3.2 | 490.32 | Multiple bullet items follow the opening clause, so verb should be plural | Change to "the following apply:" | Accepted - |
| 19757 | Abhishek Patil | 35.3.2 | 490.39 | What is the need to state: "and the AP operating on the link is an AP affiliated with the AP MLD" in the second bullet? The paragraph starts by saying individual frame exchange between two MLDs (which covers this case). | Delete " the AP operating on the link is an AP affiliated with the AP MLD" from the second bullet. | Revised –  Simply deleting the referred description may not work because the following subbullets has reference to the AP.  We revise the description to simply say “from an AP affiliated with an AP MLD operating on the link”  TGbe editor to make the changes shown in 11-23/1381r2 under all headings that include CID 19757 |
| 19758 | Abhishek Patil | 35.3.2 | 490.57 | The text: "and the settings of the To DS and From DS bits in the MAC header of the Data frame," is incomplete. Fix it by pointing to the correct table in clause 9 (for setting the values for ToDs and FromDS fields) | As in comment | Revised –  Agree in principle with the commenter. We add the reference.  TGbe editor to make the changes shown in 11-23/1381r2 under all headings that include CID 19758 |
| 19829 | Muhammad Kumail Haider | 35.3.5 | 507.13 | ML setup or ML (re)setup should be preceded by "an" and not a | Please change a->an before ML setup and ML (re)setup across this subclause and throughout the draft | Revised –  Agree in principle with the commenter. We search “a ML” through the spec and do corresponding changes.  TGbe editor to make the changes shown in 11-23/1381r2 under all headings that include CID 19829 |
| 19056 | Po-Kai Huang | 35.3.5.1 | 508.07 | A Link that is removed or deleted is not a setup link anymore. Tweak the lanuage to accommodate the remove and delete case. | Change the sentence to: A link that is requested by the non-AP MLD for (re)setup in the (Re)Association Request frame, is accepted by the AP MLD in the (Re)Association Response frame and is not removed (see 35.3.6.3 (Removing affiliated APs)) or deleted (see 35.3.6.4 (ML reconfiguration to the ML setup)) at a later time is a setup link between the AP MLD and the associated non-AP MLD. | Accepted- |
| 19057 | Po-Kai Huang | 35.3.5.1 | 508.04 | It can be useful to mandate that assocaition request frame use the same link as authenticationf frame to avoid interop issue because this is the most common approach to proceed. It is possible that client may do authentication beforehand to shorten the time to do authetnication later, but in that case, PMKSA caching can still be used. | Add the following right before "The (Re)Association Response frame shall be transmitted by the AP MLD through the affiliated AP that receives the (Re)Association Request frame.": "For the (Re)Association Request frame sent by a non-AP MLD to an AP MLD: - the A2 field shall be the same as the A2 field of the latest Authentication frame(s) sent from the non-AP MLD to the AP MLD that leads to a successful authentication to set the state to State 2. (see 11.3.2) - the A1 field shall be the same as the A1 field of the latest Authentication frame(s) sent from the non-AP MLD to the AP MLD that leads to a successful authentication to set the state to State 2. (see 11.3.2) NOTE - If non-AP MLD has performed a successful authentication beforehand with an AP MLD to save time for the later association, and the non-AP MLD cannot transmit to the AP affiliated with the AP MLD that responds to the Authentication frame sent from the non-AP MLD that leads to successful authentication (for example, due to the reason that AP MLD removes the affiliated AP), then the non-AP MLD might initiate another authentication exchange with AP MLD through any AP affiliated with the AP MLD using PMKSA caching." | Accepted - |
| 19077 | Pei Zhou | 35.3.5.1 | 507.38 | If a (Re)Association Request frame includes the Basic Multi-Link element to initiate ML (re)setup, but the AP MLD refuses (all links) and indicates "REFUSED\_REASON\_UNSPECIFIED" in the Status Code field in the (Re)Association Response frame body. In this case the (Re)Association Response frame sent in response to the (Re)Association Request frame could not include the Basic Multi-link element. | Change "shall" to "may". | Rejected –  In this case, it is the AP MLD rejects the association attempt, so the Basic Multi-link element is still included. |
| 19243 | John Wullert | 35.3.5.1 | 507.43 | Omission of Basis Multi-Link element is restrictive, so phrase should be set off with "that" | Replace "The (Re)Association Response frame sent in response to a (Re)Association Request frame, which does not include the Basic Multi-Link element, does not include..." with "The (Re)Association Response frame sent in response to a (Re)Association Request frame that does not include the Basic Multi-Link element does not include..." | Accepted- |
| 19244 | John Wullert | 35.3.5.1 | 507.58 | Given that the AP must respond to the (re)association request, it seems like it must take one of the enumerated actions | Replace "The AP MLD may do one of the following:" with "The AP MLD shall do one of the following:" | Accepted - |
| 19245 | John Wullert | 35.3.5.1 | 508.14 | The meaning of the word "independent" is not clear in NOTE 4. Is that intended to mean that there is no dependency, or that they are separate and different, or something else? | Revise the sentences in the note to clarify the intention, such as "The link(s) that are requested for resetup are separate and different from the existing setup link(s) with an associated AP MLD." | Rejected-  Based on the dictionary definition, “independent” means “not dependent”. |
| 19246 | John Wullert | 35.3.5.1 | 508.14 | The use of "The" in the beginning of NOTE 5 suggests there is only one link, when there may be multiple links requested, any of which might not exist. | Replace the note text with "A link requested by the non-AP MLD might not exist when the AP MLD prepares the (Re)Association Response frame because the AP MLD has removed the corresponding affiliated AP (see 35.3.6.3 (Removing affiliated APs)). In such cases, the AP MLD does not include the Per-STA Profile subelement for the requested, non-existent link." | Revised –  We change “The” to “A”.  TGbe editor to make the changes shown in 11-23/1381r2 under all headings that include CID 19246 |
| 19247 | John Wullert | 35.3.5.1 | 508.49 | The phrase "part of the links" is not completely clear. | Replace with "An MLD that requests or accepts ML (re)setup ensures that for any two links that are among the set of links..." | Rejected –  “part of the” is also common used in the spec (224 instances in revme). The commenter is not clear why it is not completely clear. |
| 19338 | Brian Hart | 35.3.5.1 | 508.55 | There are mitigations for this failure which shold be mentioned | After "shall not accept any requested links." insert "The AP may include a Neighbor Report element that includes a Basic Link subelement and zero or more Per-STA Profile subelements for the AP MLD in the (Re)Association Response to indicate other links of the AP MLD where (re)setup can be accepted." | Rejected –  In the note of (re)association response for neigobor report, we already have the following *“One or more Neighbor Report elements is present if the Status Code field is REJECTED\_WITH\_SUGGESTED\_BSS\_TRANSITION”*. |
| 19767 | Abhishek Patil | 35.3.5.1 | 507.47 | Clarify that the (re)association request frame is sent on the same link as the preceding authentication frame. See discussion in 11-23/743r2 (bugfix as part of resolution for CID 17616). | As in comment | Revised –  Agree in principle with the commenter.  TGbe editor to make the changes shown in 11-23/1381r2 under all headings that include CID 19057 |
| 19924 | Rubayet Shafin | 35.3.5.1 | 507.28 | should be ' "an" ML (re)setup'. Same issue in many places throughout the clause. | correct the article usage in this clause. | Revised –  Agree in principle with the commenter. We search “a ML” through the spec and do corresponding changes.  TGbe editor to make the changes shown in 11-23/1381r2 under all headings that include CID 19829 |
| 19925 | Rubayet Shafin | 35.3.5.1 | 507.31 | grammatical issue with this sentence. | Either delete "a (Re)Association Request frame" or change it to " 'Using' a (Re)Association Request frame" | Revised –  We move “a (Re)Association Request frame” forward so the sentence may read better.  TGbe editor to make the changes shown in 11-23/1381r2 under all headings that include CID 19925 |
| 19926 | Rubayet Shafin | 35.3.5.1 | 507.63 | a note is needed clarifying why the link on which the (Re)Association Request frame is received cannot be outside the subset. | as in comment. | Rejected –  4-way handshake after the (re)association request/response exchange ties to the link used by the (re)association request/response exchange. If the link for (re)association request/response exchange is not accepted, then a separate design is required to handle the following 4-way handshake. |
| 19927 | Rubayet Shafin | 35.3.5.1 | 508.54 | a note is needed to clarify why the AP MLD cannot accept other links while rejecting the link on which the (Re)Association Request frame was received. | as in comment. | Rejected –  4-way handshake after the (re)association request/response exchange ties to the link used by the (re)association request/response exchange. If the link for (re)association request/response exchange is not accepted, then a separate design is required to handle the following 4-way handshake. |
| 20003 | Albert Petrick | 35.3.5.1 | 509.16 | Note 8 doesn't read correctly as one long continuous sentence. Restructure Note into 2 sentences. | As commented | Revised –  We simply keep the phrase saying “for the indication of group address frames” and provide reference to multiple BSSID and AP MLD new indication.  TGbe editor to make the changes shown in 11-23/1381r2 under all headings that include CID 20003 |
| 19497 | Michael Montemurro | 35.3.5.2 | 509.50 | [WFA-R] The text implies is that only CCMP and GCMP can be used by an MLD. This is good. WEP and TKIP should be at end of life. It would be very good to add a NOTE to make this clear. | As in comment | Revised –  We add a note to clarify that WEP and TKIP are obsolete in the spec.  *12.3.2.1 WEP overview*  *WEP is an obsolete cipher that has been removed from the standard as a standalone mechanism.*  *5.1.2 Security* services  *The use of TKIP is (#1643)obsolete. The TKIP algorithm is unsuitable for the purposes of this standard.*  TGbe editor to make the changes shown in 11-23/1381r2 under all headings that include CID 19497 |
| 19498 | Michael Montemurro | 35.3.5.2 | 509.46 | [WFA-R] It is not clear whether a non-MLD STA that associates to an AP that is affiliated with an AP MLD is permitted to use WEP and TKIP. Since the ETH MAC did not exist when WEP and TKIP were needed for backward compatibility, it would be best for only CCMP and GCMP to be used with the ETH MAC. | As in comment | Revised –  We add a note to clarify that WEP and TKIP are obsolete in the spec.  *12.3.2.1 WEP overview*  *WEP is an obsolete cipher that has been removed from the standard as a standalone mechanism.*  *5.1.2 Security* services  *The use of TKIP is (#1643)obsolete. The TKIP algorithm is unsuitable for the purposes of this standard.*  TGbe editor to make the changes shown in 11-23/1381r2 under all headings that include CID 19497 |

**Discussion:**

*TGbe editor: Change Clause 35.3.2 as follows (track change on):*

* + 1. **Multi-link device addressing**

An MLD uses an MLD MAC address that singly identifies the MLD. STAs affiliated with an MLD shall use different MAC addresses.

NOTE 1—The MLD MAC address of an MLD might be the same as the MAC address of one affiliated STA or might be different from the MAC address of any affiliated STA.

For an individually addressed frame sent on a link between two MLDs, the following apply(#19237):

* the value of the Address 2 (TA) field (if present) in the MAC header of the frame that is not a Probe Response frame shall be the MAC address of the transmitting STA affiliated with the MLD corresponding to that link except for the Individual/Group bit, which is set to 1 when the TA field value is a bandwidth signaling TA and set to 0 otherwise.
* if the frame is a Probe Response frame from an AP affiliated with the AP MLD operating on the link(#19757)
  + if the AP does not belong to a multiple BSSID set or corresponds to the transmitted BSSID in a multiple BSSID set, then the value of the Address 2 (TA) field in the MAC header of the frame shall be set to the MAC address of the AP.
  + if the AP corresponds to the nontransmitted BSSID in a multiple BSSID set, then the value of the Address 2 (TA) field in the MAC header of the frame shall be set to the transmitted BSSID in the multiple BSSID set (see 11.1.4.3.4 (Criteria for sending a response)).
* the value of the Address 1 (RA) field in the MAC header of the frame shall be the MAC address of the receiving STA affiliated with the MLD corresponding to that link.
* if the frame is a Management frame, the value of the Address 3 field in the MAC header of the Management frame shall be set based on 9.3.3.1 (Format of (PV0) Management frames).
* if the frame is a Data frame, the value of the Address 3 field and the Address 4 field (if present) in the MAC header of the Data frame shall be set based on Table 9-58 (Address field contents for Data frames transmitted by nonmesh STAs) and the settings of the To DS and From DS bits in the MAC header of the Data frame (see 9.2.4.1.4 (To DS and From DS subfields))(#19758), where the BSSID is the MAC address of the AP affiliated with the AP MLD corresponding to that link.

NOTE 2—For frames sent over a direct path in a single link TDLS direct link, by a non-AP STA affiliated with a non- AP MLD, the value of the Address 2 (TA) field is set to the MLD MAC address of the non-AP MLD as described in [35.3.21.2 (TDLS direct link over a single link)](#bookmark79).

NOTE 3—For MLO, the SA and DA of an MSDU carrying EAPOL-Key PDUs is set to the applicable MLD MAC address. See 12.2.4 (RSNA establishment).

For a frame sent by a STA affiliated with the MLD with Address 1 field set to a group address (if allowed as described in 9.3.1 (Control frames), 9.3.2 (Data frames), and 9.3.3 ((PV0) Management frames)), the value of the Address 2 field, the Address 3 field (if present), and the Address 4 field (if present) in the MAC header of the frame shall be set as defined in 9.3.1 (Control frames), 9.3.2 (Data frames), and 9.3.3 ((PV0) Management frames), where the BSSID is the following:

* if the STA is an AP, then the BSSID is the MAC address of the AP
* if the STA is a non-AP STA affiliated with the non-AP MLD that has performed ML setup with an AP MLD, and a link is set up between the non-AP STA affiliated with the non-AP MLD and an AP affiliated with the AP MLD, then the BSSID is set to the MAC address of the AP affiliated with the AP MLD.

*TGbe editor: Change Clause 35.3.5 as follows (track change on):*

* + 1. **ML (re)setup**
       1. **ML (re)setup procedure**

The ML (re)setup procedure sets up link(s) between a non-AP MLD and an AP MLD and is completed through the exchange of (Re)Association Request and (Re)Association Response frames. The non-AP MLD and AP MLD shall follow the (re)association procedure between MLDs as described in 11.3 (STA authenticationAuthentication and association).

NOTE 1—Prior to utilizing (Re)Association Request/Response frame exchange to perform ML (re)setup with an AP MLD, the non-AP MLD and AP MLD follow the authentication procedure between MLDs as described in 11.3 (STA authenticationAuthentication and association).

A non-AP MLD may initiate an ML (re)setup(#19829) with an AP MLD to (re)set up one or more links with the AP MLD. When a non-AP MLD initiates an ML (re)setup(#19829) with an AP MLD, the non-AP MLD shall transmit a (Re)Association Request frame(#19925) through a non-AP STA that is affiliated with the non-AP MLD and is operating on a link that is expected to be part of the ML (re)setup(#19925).

A (Re)Association Request/Response frame exchange is for an ML (re)setup(#19829) only if both the (Re)Association Request frame and the (Re)Association Response frame include a Basic Multi-Link element. If a (Re)Association Request frame includes the Basic Multi-Link element (see 9.3.3.5 (Association Request frame format) and 9.3.3.7 (Reassociation Request frame format)), then the (Re)Association Response frame sent in response to the (Re)Association Request frame shall include the Basic Multi-link element.

NOTE 2—The (Re)Association Request frame sent by a non-AP EHT STA with dot11MultiLinkActivated set to false does not include the Basic Multi-Link element (see Table 9-62 (Association Request frame body) and Table 9-64 (Reassociation Request frame body)). The (Re)Association Response frame sent in response to a (Re)Association Request frame that does not include the Basic Multi-Link element(#19243) does not include the Basic Multi-Link element either (see Table 9-63 (Association Response frame body) and Table 9-65 (Reassociation Response frame body)).

In the (Re)Association Request frame, the non-AP MLD indicates the link(s) that are requested for (re)setup and the capabilities and operational parameters of the non-AP STA(s) affiliated with the non-AP MLD corresponding to the requested link(s) as described in [35.3.5.4 (Basic Multi-Link element usage in the](#bookmark28) [context of ML (re)setup, authentication, and FT action frame exchange between two MLDs)](#bookmark28). A non-AP MLD may request to (re)set up link(s) with a subset of AP(s) affiliated with the AP MLD.

In the (Re)Association Response frame, the AP MLD shall indicate the requested link(s) that are accepted and the requested link(s) that are rejected for (re)setup and the capabilities and operational parameters of the requested link(s) as described in [35.3.5.4 (Basic Multi-Link element usage in the context of ML (re)setup,](#bookmark28) [authentication, and FT action frame exchange between two MLDs)](#bookmark28). The AP MLD shall(#19244) do one of the following:

* accept all the links that are requested for (re)setup, or
* accept a subset of the links that are requested for (re)setup, and the subset of the links include the link on which the (Re)Association Request frame was received, or
* reject all the links that are requested for (re)setup.

For the (Re)Association Request frame sent by a non-AP MLD to an AP MLD:

* the A2 field shall be the same as the A2 field of the latest Authentication frame(s) sent from the non-AP MLD to the AP MLD that leads to a successful authentication to set the state to State 2. (see 11.3.2)
* the A1 field shall be the same as the A1 field of the latest Authentication frame(s) sent from the non-AP MLD to the AP MLD that leads to a successful authentication to set the state to State 2. (see 11.3.2) (#19057)

NOTE - If non-AP MLD has performed a successful authentication beforehand with an AP MLD to save time for the later association, and the non-AP MLD cannot transmit to the AP affiliated with the AP MLD that responds to the Authentication frame sent from the non-AP MLD that leads to successful authentication (for example, due to the reason that AP MLD removes the affiliated AP), then the non-AP MLD might initiate another authentication exchange with AP MLD through any AP affiliated with the AP MLD using PMKSA caching.(#19057)

The (Re)Association Response frame shall be transmitted by the AP MLD through the affiliated AP that receives the (Re)Association Request frame.

A link that is requested by the non-AP MLD for (re)setup in the (Re)Association Request frame and is accepted by the AP MLD in the (Re)Association Response frame and is not removed (see 35.3.6.3 (Removing affiliated APs)) or deleted (see 35.3.6.4 (ML reconfiguration to the ML setup)) at a later time(#19056) is a setup link between the AP MLD and the associated non-AP MLD.

NOTE 3—The corresponding AP of the setup link might be removed after the (Re)Association Request/Response frame exchange as defined in [35.3.6 (ML reconfiguration)](#bookmark29).

NOTE 4—The link(s) that are requested for resetup are independent of the existing setup link(s) with an associated AP MLD. The capability and operation parameters of each requested link during ML resetup are independent of the capability and operation parameters of each existing setup link with an associated AP MLD.

NOTE 5—A(#19246) link requested by the non-AP MLD might not exist while the AP MLD prepares the (Re)Association Response frame because the AP MLD has removed the corresponding affiliated AP (see [35.3.6.3 (Removing affiliated](#bookmark31) [APs)](#bookmark31)) in which case the AP MLD does not include the Per-STA Profile subelement for the requested link.

The AP MLD shall not accept a link that is requested for (re)setup if any of the following condition is true:

* The non-AP STA affiliated with the non-AP MLD corresponding to the link does not support all of the rates in the BSSBasicRateSet parameter and all of the membership selectors in the BSSMembershipSelectorSet parameter of the AP affiliated with the AP MLD corresponding to the link in the MLME-START.request primitive.
* The non-AP STA affiliated with the non-AP MLD corresponding to the link does not support all of the MCSs in the Basic HT-MCS Set field of the HT Operation parameter of the AP affiliated with the AP MLD (if present) corresponding to the link in the MLME-START.request primitive.
* The non-AP STA affiliated with the non-AP MLD corresponding to the link does not support all of the <VHT-MCS, NSS> tuples indicated by the Basic VHT-MCS And NSS Set field of the VHT Operation parameter of the AP affiliated with the AP MLD (if present) corresponding to the link in the MLME-START.request primitive.
* The non-AP STA affiliated with the non-AP MLD corresponding to the link does not support all of the <HE-MCS, NSS> tuples indicated by the Basic HE-MCS And NSS Set field of the HE Operation parameter of the AP affiliated with the AP MLD corresponding to the link in the MLME- START.request primitive.
* The non-AP STA affiliated with the non-AP MLD corresponding to the link does not support all of the <EHT-MCS, NSS> tuples indicated by the Basic EHT-MCS And NSS Set field of the EHT Operation parameter of the AP affiliated with the AP MLD corresponding to the link in the MLME- START.request primitive.

An MLD that requests or accepts ML (re)setup ensures that for any two links that are part of the links requested or accepted by the ML (re)setup, each link is located on different nonoverlapping operating channels.

If the link on which the (Re)Association Request frame was received cannot be accepted by the AP MLD, the AP MLD shall treat the ML (re)setup as a failure and shall not accept any requested links. If the link on which the (Re)Association Request frame was received is accepted by the AP MLD, the ML (re)setup is successful.

NOTE 6—See [35.3.5.4 (Basic Multi-Link element usage in the context of ML (re)setup, authentication, and FT action](#bookmark28) [frame exchange between two MLDs)](#bookmark28) for the setting of the Status Code field.

An AP MLD shall assign a single AID to a non-AP MLD upon successful ML setup. All the non-AP STAs affiliated with the non-AP MLD shall have the same AID as the one assigned to the non-AP MLD during ML setup.

An AP affiliated with an AP MLD shall not assign, to a non-AP MLD, an AID value that is less than 2*n* where *n* is the maximum of the value carried in the MaxBSSID Indicator (*n*) field of the Multiple BSSID element, corresponding to each link that is accepted as part of the ML (re)setup, if at least one of the APs affiliated with the AP MLD belongs to a multiple BSSID set.

NOTE 7—In a multiple BSSID set, the first 2n bits of the partial virtual bitmap of the TIM element are reserved for the indication of group addressed frame for the BSSIDs in the set (see 11.1.3.8.5 (Traffic advertisement in a multiple BSSID set)).

NOTE 8—An AP affiliated with an AP MLD does not assign, to a non-AP STA or a non-AP MLD that has an ML (re)setup(#19829) with the AP MLD and has a setup link on which the AP operates, an AID corresponding to a bit of the bitmap in the Partial Virtual Bitmap field that is for the indication of group addressed frames (see 11.1.3.8.5 (Traffic advertisement in a multiple BSSID set) and(#20003) [35.3.15.1 (AP MLD operation for group addressed frames)](#bookmark66)).

After successful ML (re)setup between a non-AP MLD and an AP MLD, the non-AP MLD is associated with the AP MLD following the (re)association procedure between MLDs as described in 11.3 (STA authenticationAuthentication and association) (i.e., in State 3 or State 4, see 11.3.2 (State variables)), and the non-AP MLD and the AP MLD have setup link(s) for multi-link operation (see [35.3 (Multi-link operation)](#bookmark10)).

For each setup link, the corresponding non-AP STA affiliated with the non-AP MLD is in the same associated state as the non-AP MLD and is associated with the corresponding AP affiliated with the AP MLD. For each setup link, there is no mapping between the non-AP STA affiliated with the non-AP MLD and the AP affiliated with the AP MLD provided to the DS.

NOTE 9—The non-AP MLD and the AP MLD have an association (see 11.3 (STA authenticationAuthentication and association)), and the DS is notified of this mapping between the non-AP MLD and the AP MLD (see 4.5.3.3 (Association)).

NOTE 10—For each setup link, each service (and the corresponding rules) between a non-AP STA affiliated with the non-AP MLD and its associated AP affiliated with the AP MLD is the same as the service (and the corresponding rules) between a non-AP STA not affiliated with the non-AP MLD and its associated AP unless specified otherwise.

An example of ML setup is shown in AF.4 (Example of ML setup).

* + - 1. **ML security**

After a successful ML (re)setup between a non-AP MLD and an AP MLD, a PMKSA and a PTKSA are established between the non-AP MLD and the AP MLD. In addition, a GTKSA, an IGTKSA if management frame protection is enabled, and a BIGTKSA if beacon protection is enabled, are established between the non-AP MLD and the AP MLD for each setup link (see Clause 12 (Security)). The PTKSA is used for cryptographic encapsulation and decapsulation of individually addressed MPDUs across all setup links and the GTKSA of a link is used for cryptographic encapsulation and decapsulation of group addressed MPDUs on the link as described in 12.5.2.3 (CCMP cryptographic encapsulation), 12.5.4.3 (GCMP cryptographic encapsulation), 12.5.2.4 (CCMP decapsulation), and 12.5.4.4 (GCMP decapsulation). If management frame protection is enabled, the IGTKSA of a link is used to provide integrity protection for group addressed robust Management frames across on the link as described in 12.6.19 (Protection of robust Management frames). When beacon protection is enabled, the BIGTKSA of a link is used to provide integrity protection for Beacon frames on the link as described in 12.6.23 (Protection of Beacon frames).

NOTE – The use of WEP or TKIP is obsolete. See 12.3.2.1 (WEP overview) and 5.1.2 (Security services).(#19497)

Different APs affiliated with an AP MLD use different GTK/IGTK/BIGTK. Each AP and the corresponding non-AP STA affiliated with an associated non-AP MLD maintains a single PN/IPN/BIPN for each GTK/ IGTK/BIGTK. The GTK/IGTK/BIGTK of each setup links are delivered to the non-AP MLD using a single 4-way handshake as defined in 12.7.6 (4-way handshake). When a GTK/IGTK/BIGTK update is triggered for an AP affiliated with the AP MLD, the updated GTK/IGTK/BIGTK may be delivered to the non-AP MLD using the Group key handshake over any enabled link as defined in 12.7.7 (Group key handshake).

NOTE—When a non-AP MLD changes the link used for group addressed frame reception, the non-AP MLD supplicant is able to request a group addressed handshake by sending an EAPOL-Key frame to the AP MLD authenticator with the Key Type set to Group (0) and the Request bit set to 1 (see 12.7.7.1 (General)) to refresh Key RSC/BPN/IPN.

* + - 1. **Multi-link tear down procedure**

An MLD tears down all the setup links with an associated MLD by sending a Disassociation frame through one of the STAs affiliated with the MLD, on a setup link, to the STA affiliated with the associated MLD subject to additional constraints (see [35.3.7 (Link management)](#bookmark34)). The MLD and the associated MLD shall follow the MLD disassociation procedure as described in 11.3 (STA authenticationAuthentication and association).

After multi-link teardown, the non-AP MLD and all the non-AP STAs affiliated with the non-AP MLD are in the unassociated state (see 11.3.2 (State variables)).

-------------Editorial change for CID 19829. Only the relevant paragraph is shown.-------------------------

*TGbe editor: Change Clause 6.5.9.1.3 as follows (track change on):*

**6.5.9.1.3 When generated**

This primitive is generated by the SME for a STA to disassociate from a STA with which it has an association, or by the SME for an MLD(#19829) to disassociate from an MLD(#19829) with which it has an association.

*TGbe editor: Change Clause 9.3.3.6 as follows (track change on):*

**9.3.3.6 Association Response frame format**

***Update existing order 40 and insert four new rows to Table 9-63 (Association Response frame body) in numeric order (not all lines shown):***

**Table 9-63—Association Response frame body**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |

|  |  |  |
| --- | --- | --- |
| <Last assigned + 4> | TID-To-Link Mapping | One or two TID-To-Link Mapping elements are present if dot11- MultiLinkActivated is true, dot11TIDtoLinkMappingActivated is true, and the AP sends an Association Response frame in response to a received Association Request frame that is initiating both an ML setup(#19829) and a TTLM negotiation. Otherwise, it is not present. |

*TGbe editor: Change Clause 9.3.3.7 as follows (track change on):*

**9.3.3.7 Reassociation Request frame format**

***Insert three new rows to Table 9-64 (Reassociation Request frame body) in numeric order (not all lines shown):***

**Table 9-64—Reassociation Request frame body**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <Last assigned + 3> | TID-To-Link Mapping | One or two TID-To-Link Mapping elements are present if dot11- MultiLinkActivated is true, dot11TIDtoLinkMappingActivated is true, and a non-AP STA affiliated with a non-AP MLD initiates both an ML resetup(#19829) and a TTLM negotiation. Otherwise, it is not present. |

*TGbe editor: Change Clause 9.3.3.8 as follows (track change on):*

**9.3.3.8 Reassociation Response frame format**

***Update existing order 43 and insert four new rows to Table 9-65 (Reassociation Response frame body) in numeric order (not all lines shown):***.

**Table 9-65—Reassociation Response frame body**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |

|  |  |  |
| --- | --- | --- |
| <Last assigned + 4> | TID-To-Link Mapping | One or two TID-To-Link Mapping elements are present if dot11- MultiLinkActivated is true, dot11TIDtoLinkMappingActivated is true, and the AP sends a Reassociation Response frame in response to a received Reassociation Request frame that is initiating both an ML resetup(#19829) and a TTLM negotiation. Otherwise, it is not present. |

*TGbe editor: Change Clause 12.2.10 as follows (track change on):*

**12.2.10 Requirements for support of MAC privacy enhancements**

***Insert the following paragraphs and NOTE at the end of the subclause:***

MAC privacy enhancements are enabled on a non-AP MLD when dot11MACPrivacyActivated is set to true. When enabled, the non-AP MLD shall adhere to the above requirements for a non-AP STA (that is not affiliated with an AP MLD) in selecting an(#19829) MLD MAC address, including sequence number space and scrambler requirements. The above requirements defined for a non-AP STA in managing its MAC address during association or establishing transaction state with an AP shall apply to the non-AP MLD in managing its MLD MAC address during association or establishing transaction state with an AP MLD.

*TGbe editor: Change Clause 35.3.4.6 as follows (track change on):*

**35.3.4.6 Frame exchange sequences during MLO discovery and ML setup**

A non-AP MLD is expected to discover an AP MLD and affiliated AP(s) of interest before initiating an ML setup(#19829) with the AP MLD. The non-AP MLD can use one or a combination of the following methods for discovering the AP MLD and affiliated AP(s) of interest:

*TGbe editor: Change Clause 35.3.5.4 as follows (track change on):*

**35.3.5.4 Basic Multi-Link element usage in the context of ML (re)setup, authentication, and FT action frame exchange between two MLDs**

A non-AP STA affiliated with a non-AP MLD that initiates an(#19829) ML (re)setup with an AP MLD shall include a Basic Multi-Link element in a (Re)Association Request frame it transmits.

*TGbe editor: Change Clause 35.3.7.2.3 as follows (track change on):*

**35.3.7.2.3 Negotiation of TTLM**

During an(#19829) ML (re)setup procedure, a non-AP MLD may initiate a TTLM negotiation by including the TIDTo-Link Mapping element in the (Re)Association Request frame if an AP MLD has indicated a support of TTLM negotiation. Otherwise, the non-AP MLD shall not include the TID-To-Link Mapping element in the (Re)Association Request frame.

35.3.6.4 ML reconfiguration to the ML setup

If an(#19829) ML reconfiguration operation results in one or more links being added to the ML setup of a non-AP MLD, the non-AP MLD and the AP MLD shall operate with all the TIDs mapped to the newly added links until a TTLM is updated according to the procedure defined in 35.3.7.2 (TTLM).

If an(#19829) ML reconfiguration deletes one or more links from the ML setup of a non-AP MLD and that results in a TID not being mapped to any of the remaining setup links (if it exists) in either direction for that non-AP MLD, then the non-AP MLD and the AP MLD shall operate with that TID mapped to all remaining enabled links for that direction after the deletion of the setup link, until a TTLM is established for that TID.

*TGbe editor: Change Clause 35.3.7.2.5 as follows (track change on):*

**35.3.7.2.5 Association procedures for TTLM**

During an(#19829) ML (re)setup procedure, a non-AP MLD may initiate a TTLM negotiation by including the TIDTo-link Mapping element in the (Re)Association Request frame if an AP MLD has indicated a support of TTLM negotiation.

NOTE—An(#19829) ML (re)setup can be successful even if the TTLM negotiation embedded in the ML (re)setup procedure is not successful.

*TGbe editor: Change Clause 35.3.10 as follows (track change on):*

**35.3.10 BSS parameter critical update procedure**

When a non-AP STA affiliated with a non-AP MLD receives a BSS Parameters Change Count subfield for a certain AP that is affiliated with an AP MLD with which the non-AP MLD has performed an(#19829) ML setup and that operates on the link that is part of the ML setup, and the value of the BSS Parameters Change Count subfield for the AP is different from the previously received value, then the non-AP MLD shall follow one of the following mechanisms:

— The non-AP STA affiliated with the non-AP MLD that is associated with the AP attempts to receive a Beacon frame or a Probe Response frame from the AP.

— Any non-AP STA affiliated with the non-AP MLD attempts to send a Probe Request frame to its

associated AP soliciting information of the AP.

*TGbe editor: Change Clause 35.3.15.1 as follows (track change on):*

**35.3.15.1 AP MLD operation for group addressed frames**

If an AP affiliated with an AP MLD is not part of a multiple BSSID set, then the AP shall indicate if each of the other AP(s) affiliated with the same AP MLD has buffered group addressed frames by using a bit in the Partial Virtual Bitmap field of the TIM element after the bit corresponding to AID 0.

— The indication is in the DTIM beacon sent by the AP and is based on the latest information about the other APs that the AP has when the AP schedules the DTIM beacon.

— These bits in the Partial Virtual Bitmap field of the TIM element for the other AP(s) affiliated with the same AP MLD shall be contiguous.

• The bits 1 to *N* of the bitmap in the Partial Virtual Bitmap field are for the AP MLD where *N* is

equal to 2(Group Addressed BU Indication Exponent + 1) – 1, and the Group Addressed BU Indication

Exponent is the Group Addressed BU Indication Exponent subfield of the EHT Operation

Parameters field. The AIDs from 1 to *N* shall not be allocated to a non-AP STA, or a non-AP

MLD that has an(#19829) ML setup with the AP MLD and has a setup link on which the AP operates.

• The first *n* bits of *N* bits are used to indicate that one or more group addressed frames are buffered for each AP of the other AP(s) that are affiliated with the same AP MLD and that operate on enabled link(s) by setting the corresponding bit value to 1 in an increasing order of their link IDs. The remaining (*N* – *n*) bits are set to 0.

If an AP affiliated with an AP MLD corresponds to a transmitted BSSID in a multiple BSSID set, then the AP shall indicate if each of the other AP(s) affiliated with the same AP MLD has buffered group addressed frames by using a bit in the Partial Virtual Bitmap field of the TIM element after the last bit corresponding to a nontransmitted BSSID (maximum possible number of BSSIDs – 1) which is in the same multiple BSSID set as the AP.

— The indication is in the DTIM beacon sent by the AP and is based on the latest information about the other APs that the AP has when the AP schedules the DTIM beacon.

— These bits in the Partial Virtual Bitmap field of the TIM element for the other AP(s) affiliated with the same AP MLD shall be contiguous.

• The bits *X* to *X* + *N* – 1 of the bitmap in the Partial Virtual Bitmap field are for the AP MLD

where *X* – 1 is the last bit corresponding to the nontransmitted BSSID (if any) that is in the same

multiple BSSID set as the AP and *N* is equal to 2(Group Addressed BU Indication Exponent + 1) – 1, and

the Group Addressed BU Indication Exponent is the Group Addressed BU Indication Exponent

subfield of the EHT Operation Parameters field. The AIDs from *X* to *X* + *N* – 1 shall not be allocated to a non-AP STA, and to a non-AP MLD that has an(#19829) ML setup with the AP MLD and has a setup link on which the AP operates.

• The first *n* bits of *N* bits are used to indicate that one or more group addressed frames are buffered for each AP of the other AP(s) affiliated with the same AP MLD by setting the corresponding bit value to 1 in an increasing order of their link IDs. The remaining (*N* – *n*) bits are set to 0.

If an AP affiliated with an AP MLD is a nontransmitted BSSID in a multiple BSSID set, then the AP that corresponds to the transmitted BSSID in the same multiple BSSID set shall indicate if each of the other AP(s) affiliated with the same AP MLD as the nontransmitted BSSID has buffered group addressed frames by using a bit in the Partial Virtual Bitmap field of the TIM element after the last bit corresponding to the nontransmitted BSSID (maximum possible number of BSSIDs – 1) which is in the same multiple BSSID set as the AP.

— The indication is in the DTIM beacon corresponding to that nontransmitted BSSID sent by the

transmitted BSSID of the same multiple BSSID set as the nontransmitted BSSID and is based on the latest information about the other APs affiliated with the AP MLD that the transmitted BSSID has when it schedules the DTIM beacon.

— These bits in the Partial Virtual Bitmap field of the TIM element for the other AP(s) affiliated with the same AP MLD shall be contiguous. The AP shall set the Group Addressed BU Indication Limit subfield of the EHT Operation element to 1 if the total number of bits needed to indicate the presence of buffered group addressed frames of all other APs affiliated with the same AP MLDs as all nontransmitted BSSIDs in the TIM element is greater than 48 bits, otherwise, the AP shall set the Group Addressed BU Indication Limit subfield to 0. For the *k*th nontransmitted BSSID affiliated with an MLD, where *k* is numbered in an increasing order of AP MLD ID of this MLD and starts from 1:

• The bits *Y* + (*k* – 1) × *N* to *Y* + *k* × *N* – 1 of the bitmap in the Partial Virtual Bitmap field, if less

than *Y* + 48, are for the AP MLD with which the *k*th nontransmitted BSSID is affiliated where

Y – 1 is the last bit for the AP MLD with which the AP that corresponds to the transmitted

BSSID is affiliated with and *N* is equal to 2(Group Addressed BU Indication Exponent + 1) – 1, and the

Group Addressed BU Indication Exponent is the Group Addressed BU Indication Exponent subfield of the EHT Operation Parameters field. The AIDs from *Y* + (*k* – 1) × *N* to *Y* + *k* × *N* – 1 shall

not be allocated to a non-AP STA, and to a non-AP MLD that has an(#19829) ML setup with the AP MLD

and has a setup link in which the AP operates.

• The first *n* bits of *N* bits are used to indicate that one or more group addressed frames are buffered for each AP of the other AP(s) affiliated with the same AP MLD by setting the corresponding bit value to 1 as the *k*th nontransmitted BSSID in an increasing order of their link IDs. The remaining (*N* – *n*) bits are set to 0.

*TGbe editor: Change Clause 35.3.16.2.1 as follows (track change on):*

**35.3.16.2.1 Genera**

A multi-radio non-AP MLD shall announce each pair of links formed by links that requested an ML setup(#19829) as STR or NSTR in a transmitted (Re)Association Request frame, by setting the corresponding bit in the NSTR Indication Bitmap subfield of the Basic Multi-Link element to 0 or 1, respectively (see 9.4.2.312.2 (Basic Multi-Link element)).

An(#19829) MLD shall be capable of simultaneously transmitting or receiving frames via affiliated STAs up to a value indicated in the Maximum Number Of Simultaneous Links subfield in the Basic Multi-Link element plus 1, under the rules defined in subclauses below.

*TGbe editor: Change Clause 35.3.24.2 as follows (track change on):*

**35.3.24.2 Individual TWT agreements**

**35.3.24.2.1 General**

A STA affiliated with an(#19829) MLD may negotiate individual TWT agreements with a STA affiliated with a peer MLD as defined in 10.47.1 (TWT overview) and 26.8.2 (Individual TWT agreements) via an enabled link except the following:

*TGbe editor: Change Clause AF.13.1 as follows (track change on):*

**AF.13.1 Example of MLD operation over an STR link pair**

Figure AF-43 (Channel access of two MLDs over an STR link pair) shows an example of an AP MLD and a non-AP MLD that are operating over an STR link pair and that are contending for access to the WM and subsequent frame exchanges between two MLDs on those links. After the AP MLD has performed an ML setup(#19829) with the non-AP MLD to set up link 1 and link 2 successfully and the links are enabled, then AP 2 may receive data frames from non-AP STA 2 on link 2, while AP 1 contends for the WM and then transmits data frames to non-AP STA 1 on link 1 after it obtains a TXOP.