IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| LB266 CRs for 4.9.5 and 7.1, Reference Model and DS | | | | |
| Date: 2022-11-03 | | | | |
| Author(s): | | | | |
| Name | Company | Address | Phone | email |
| Mark Hamilton | Ruckus/CommScope | 350 W. Java Dr  Sunnyvale, CA | +1 303 818 8472 | [mark.hamilton2152@gmail.com](mailto:mark.hamilton2152@gmail.com) |
|  |  |  |  |  |

Abstract

This submission proposes resolutions to the following CIDs for TGbe LB266:

***TGbe editor: The baseline for this document is P802.11be\_D2.2 and P802.11REVme\_D2.0***

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.***

R0 – Initial discussion document.

R1 –

**Introduction**

**LB266 CIDs:**

| CID | Commenter | Clause | Pg.Ln | Comment | Proposed Change | **Resolution** |
| --- | --- | --- | --- | --- | --- | --- |
| 10352 | Tomoko Adachi | 4.9.5 | 0.00 | The difference between a multi-band capable device and an MLD should be clarified. In 4.9.4 of REVme D1.3, it says "A multi-band capable device can manage operation over more than one frequency band/channel. The operation across the different frequency bands/channels can be simultaneous or nonsimultaneous." In 4.9.5 of 11be D2.0, it says "MLO allows operation over multiple links. An MLD manages such communication over multiple links. Communication across different frequency bands/channels can occur simultaneously or not depending on the capabilities of both the AP MLD and the non-AP MLD". So, it can be understood that an MLD is a special case for a multi-band capable device. The group needs to decide whether this observation is accepted or not and add proper description depending on the decision. (If yes, then all the MLDs have the dot11multibandimplemented set to true while the definition of the MIB in Annex C should be corrected to apply to a device and to apply also to different channels in the same band, for example.) | As in comment. | **Revised. TGbe editor: Make changes as shown in <this doc> and labeled as #10352.**  NOTE to commenter, a comment will be filed in REVme to add a definition in subclause 3.2, such as:  **“multi-band device:** A logical entity that supports operation over more than one frequency band/channel using fast session transfer (FST).**”** |
| 10276 | Michael Montemurro | 4.9.5 | 48.64 | PKTSA should be PTKSA | Change "PKTSA" to "PTKSA" | **Accepted**  **Note to TGbe Editor: change is on 64.48.** |
| 10519 | Abhishek Patil | 4.9.5 | 61.54 | Clause number 4.9.5 is already assigned to 11ay (see baseline REVme D1.2) | Align the subclause number to be consistent with baseline spec | **Accepted** |
| 11481 | Xiaofei Wang | 4.9.5 | 61.56 | It is not clear which device is being discussed in the sentence "MLO allows operation over multiple links". The second sentence is also not clear, since it is not clear to which "communication" it is referring. | change to "MLO allows a single MLD operating over multiple links." | **Revised. Use 12038's Proposed Change.** |
| 12038 | Massinissa Lalam | 4.9.5 | 61.56 | Not sure the sentence "MLO allows operation over multiple links." brings a lot of information as it reads "Multi-link operation allows operation over multiple links." ... replace "MLO allows operation over multiple links. An MLD manages such communication over multiple links." with "MLO defines a set of procedures allowing communication over multiple links between MLDs." or something among those lines. | As in comment | **Accepted.** |
| 12300 | Guogang Huang | 4.9.5 | 61.57 | links, different frequency bands/channels. suggest keeping consistent throughout | Communication across different setup links can occur simultaneously or not depending on the capabilities of both the AP MLD and the non-AP MLD | **Revised. Replace (third) sentence with, "Communication across links using different frequency bands or channels can occur …"** |
| 12301 | Guogang Huang | 4.9.5 | 61.64 | links, different frequency bands or channels. suggest keeping consistent throughout | The MLO procedures (see 35.3 (Multi-link operation)) allow a pair of MLDs to discover, synchronize, (de)authenticate, (re)associate, disassociate, and manage resources with each other on any setup link. | **Revised. Replace "manage resources" with "manage links and other resources".  Note to commenter: since this is discussing management of the links themselves, we can't say that it is done over setup links.** |
| 10520 | Abhishek Patil | 4.9.5 | 62.01 | Clause 35.3.1 doesn't discuss single MAC-SAP. | Delete "As described in 35.3.1 (General), each " and replace with "Each" | **Accepted** |
| 11482 | Xiaofei Wang | 4.9.5 | 62.01 | It seems to be sufficient to say "each MLD has a single MAC-SAP." rather than repeating it for both AP and non-AP MLD. | as in comment | **Accepted.** |
| 11483 | Xiaofei Wang | 4.9.5 | 62.02 | This second sentence can be simplified to say "each STA affiliated with an MLD has a different MAC address" rather than repeating it for both. | as in comment | **Rejected. We have enough trouble with terminology, especially trying to be clear in these introductory clauses, without getting into the subtle point that an affiliated AP is a type of affiliated STA.** |
| 12302 | Guogang Huang | 4.9.5 | 62.02 | Considering that the MAC processing of the traffic destinated to a legacy STA is not exactly the same as the MAC processing of the traffic destinated to a non-AP MLD, these two types of traffic shall be separated through the different MAC SAPs. Hence, for an AP MLD, each affiliated AP shall have a MAC address different from any other AP affiliated with the same AP MLD and the AP MLD MAC address. | Change  "Each AP affiliated with an AP MLD has a MAC address different from any other AP affiliated with the AP MLD, and each STA affiliated with a non-AP MLD has a MAC address different from any other STA affiliated with the non-AP MLD."  to  "For an AP MLD,each affiliated AP shall have a MAC address different from any other AP affiliated with the same AP MLD and the AP MLD MAC address. For a non-AP MLD, each affiliated STA has a MAC address different from any other STA affiliated with the same non-AP MLD " | **Rejected. Agree that each affiliated AP and the AP MLD itself, all have separate connections to the DS, and thus separate SAPs. Note, however, that the SAP that is of interest is the DS SAP (not a MAC SAP). (Look at Figure 5-2b in the 11be draft for details.) It’s not clear that to have these SAPs separated, and the DS able to understand the distinction between them, that the AP MLD has to have a unique MAC address. It’s important to notice that the DS is \_not\_ delivering MSDUs to the “address of the DS SAP” (e.g. the MAC address of the MAC entity at the DS connection), but instead the DS is delivering MSDUs based on the DA in the MSDU, which is the MAC address of the non-AP STA/MLD. How the DS maps the non-AP STA/MLD addresses (the DAs) to the connection points for the APs (legacy or MLD) is not specified. Thus: 1) The MAC-SAP is at the top of the MAC Sublayer, different from DS-SAP. 2) From DS point of view, it cares about DS-SAP for mapping to the non-AP STA/MLD. 3) It is not necessary to have a unique MAC address for AP MLD.** |
| 12942 | Chunyu Hu | 4.9.5 | 62.02 | "Each AP affiliated with an AP MLD has a MAC address different from any other AP affiliated with the AP MLD, and each STA affiliated with a non-AP MLD has a MAC address different from any other STA affiliated with the non-AP MLD." -- improve readability and make it conciser. | Change to "Each STA affiliated with a MLD has a MAC address different from any other STA affiliated with the MLD." | **Rejected. We have enough trouble with terminology, especially trying to be clear in these introductory clauses, without getting into the subtle point that an affiliated AP is a type of affiliated STA.** |
| 12039 | Massinissa Lalam | 4.9.5 | 62.04 | I have an issue with "and each STA affiliated with a non-AP MLD has a MAC address different from any other STA affiliated with the non-AP MLD."as it should be "and each non-AP STA affiliated with a non-AP MLD has a MAC address different from any other non-AP STA affiliated with the non-AP MLD." One could argue that all affiliated STAs of a non-AP MLD are non-AP STA per definition and thus the precision is useless, but in this case why add it for AP MLD in the beginning of the sentence "Each AP affiliated with an AP MLD has a MAC ..." as we could well say "Each STA affiliated with an AP MLD ..." because by definition those STAs are APs? | Replace "STA affiliated" with "non-AP STA affiliated" where appropriate, at least in this subclause. | **Accepted. Note to commenter, the same change is already done (globally) in D2.2 for CID 12242.** |
| 12943 | Chunyu Hu | 4.9.5 | 62.07 | In "An example of an AP MLD with two links ...", it should be "two APs." | See comment. | **Revised.**  **Replace “links” with “affiliated APs”.**  **Note to commenter: The two APs are affiliated APs, to align with the previous paragraph.** |
| 11484 | Xiaofei Wang | 4.9.5 | 62.14 | Please clarify what "in general" means, does it mean the addresses never are the same, or sometimes they are the different but they are allowed to be the same? It is more clear to use precise language rather than use a term "in general". | as in comment | **Revised. Agree in principle. Add a sentence to the end of the paragraph, "However, the architecture supports an implementation where M could equal either w or x, and where P could equal y or z."** |
| 10196 | John Wullert | 4.9.5 | 62.15 | The sentence "In general, the MAC address of an MLD and the MAC address of the STAs affiliated with the MLD are all different (e.g., M, P, w, x, y, and z have different values)." is written in a manner that suggests that the STAs affiliated with an MLD have a single MAC address. | Rephrase as "In general, the MAC address of an MLD and the MAC addresses of the STAs affiliated with the MLD are all different (e.g., M, P, w, x, y, and z have different values)." | **Accepted. Note to TGbe Editor, the change is to add "es" to the end of "MAC address" just before "of the STAs".** |
| 13292 | Binita Gupta | 4.9.5 | 62.15 | Since MLD MAC address can be same as one of the STA MAC address, should clarify that as well. | Add following at the end of para or as a note "In some implementations, the MLD MAC address can be same as one of the affiliated STA MAC address" | **Revised. Agree in principle. Add a sentence to the end of the paragraph, "However, the architecture supports an implementation where M could equal either w or x, and where P could equal y or z."** |
| 10521 | Abhishek Patil | 4.9.5 | 62.24 | Is colored figure permitted in IEEE 802.11 spec? | As in comment | **Revised. TGbe Editor to remove the shading in Figure 4-30a.** |
| 10433 | Rocco Di Taranto | 4.9.5 | 63.29 | Typo in the caption of Figure 4.30b | Link 1 (i.e., an AP1 affiliated with an AP MLD or a STA1 affiliated with a non-AP MLD (e.g., in 2.4 GHz)) --  Similarly for Link 2 in the same line | **Accepted. Note to TGbe Editor, the change is to lower-case the "a" before STA1/STA2.** |
| 11602 | Lei Wang | 4.9.5 | 63.34 | The sentence "An MLD supports multiple MAC sublayers ..." seems not consistent with Figure 4-30b, where the MLD has one upper MAC Sublayer and multiple lower MAC Sublayers. | Change the sentence in line 34 page 63 to the following: An MLD supports a single MLD upper MAC sublayer and multiple MLD lower MAC sublayers, coordinated by an SME. | **Revised. Agree with the intent. However, at this paragraph, the concepts of MLD upper MAC sublayer and MLD lower MAC sublayer have not been introduced yet (that is three paragraphs later).  TGbe edtior: Replace "sublayers" with "functions".** |
| 12040 | Massinissa Lalam | 4.9.5 | 63.49 | Remove "AP or" in "(shared with an AP or STA affiliated with the MLD)" since an AP is also a STA, if it applies to both AP and non-AP STA, then stating STA should be enough | As in comment | **Revised. We have enough trouble with terminology, especially trying to be clear in these introductory clauses, without getting into the subtle point that an affiliated AP is a type of affiliated STA.  TGbe editor: Insert "non-AP" before "STA" in the parenthetical phrase.** |
| 10438 | Rocco Di Taranto | 4.9.5 | 63.50 | Typo: word mispelled | Some of the functionalities require joint processing of both the MLD upper MAC sublayer | **Accepted. Note to TGbe Editor, replace "subalyer" with "sublayer"** |
| 12769 | Romain GUIGNARD | 4.9.5 | 63.50 | Please correct "subalyer" to sublayer in the following sentence: "Some of the functionalities require joint processing of both the MLD upper MAC subalyer and the MLD lower MAC sublayer." | As in comment | **Accepted.** |
| 10522 | Abhishek Patil | 4.9.5 | 63.56 | The intention of the text starting 'and' is not clear. The lower MAC functionality if specific to each AP. Is the intention to say that the affiliated APs and AP MLD share some sort of a context (e.g., common SN for group address frames)? | Rephrase the sentence to clearly convey the intended meaning. | **Revised. Delete ", and are shared between each affiliated AP and the AP MLD operations". Insert a new sentence, "Use of these MLD lower MAC functions is shared by the AP MLD's upper MAC sublayer, and the affiliated AP's upper MAC sublayer (see Figure 4-30c)."** |
| 10523 | Abhishek Patil | 4.9.5 | 63.57 | What does "one or more" imply? Isn't it sufficient to say 'an affiliated AP's upper MAC components'? | Rephrase the sentence to clearly convey the intended meaning. | **Rejected. "One or more" seems to be the correct phrase. Some operations may require the use of only one affiliated AP's MLD upper MAC sublayer, but other operations may require the use of multiple/all of the APs affiliated with the AP MLD.** |
| 12303 | Guogang Huang | 4.9.5 | 63.58 | Please revise this sentence as follows:  In particular, the affiliated AP upper MAC sublayer components support group addressed traffic,... | Change "In particular, the affiliated AP MLD upper MAC sublayer components support group addressed traffic, and traffic" to "In particular, the affiliated AP upper MAC sublayer components support group addressed traffic" | **Revised. Replace "and traffic to or from any non-AP STAs (which are not capable of MLO)" with "and any group or individually addressed traffic to or from any (non-MLO) non-AP STAs.** |
| 11485 | Xiaofei Wang | 4.9.5 | 64.06 | It is not clear from Figure 4-30c that if a legacy STA associated with an AP affiliated with an AP MLD, then does the affiliated AP still need to use the MAC-SAP identified by the MLD MAC address? | please clarify the working in relationship to the MAC-SAP when a legacy STA associated with a single AP affiliated with the AP MLD. | **Rejected. The MAC SAP details are in clause 5 (in Figure 5-2b, for example). Figure 4-30c does indicate "MLD Data frames" and "Non-MLD Data frames" to give the high-level distinction for legacy STA's traffic, but more details (like the SAPs and therefore DSAFs) would add too much complexity to FIgure 4-30c.** |
| 12305 | Guogang Huang | 4.9.5 | 64.09 | Considering different operations are applied to non-MLD Data frames and MLD Data frames, i.e. different PTKSA, different SN spaces, non-MLD Data frames and MLD Data frames should be incoming from different MAC SAPs, i.e. Affiliated AP's MAC SAP and MLD MAC SAP. Please revise Figure 4-30c. | As in comment | **Rejected. The MAC SAP details are in clause 5 (in Figure 5-2b, for example). Figure 4-30c does indicate "MLD Data frames" and "Non-MLD Data frames" to give the high-level distinction for legacy STA's traffic, but more details (like the SAPs and therefore DSAFs) would add too much complexity to FIgure 4-30c.** |
| 12304 | Guogang Huang | 4.9.5 | 64.14 | affiliated AP upper MAC, non-MLD upper MAC. Please choose one and use it throughout. Suggest to use non-MLD upper MAC throughout. | Replace "affiliated AP upper MAC" with "non-MLD upper MAC" throughout the draft standards. | **Revised. It is probably more correct to denote these entities as the "affiliated AP's upper MAC sublayer", and the fact that they are non-MLD is a property of the entity not part of its name/designation.  TGbe editor: Replace "The non-MLD upper MAC sublayer components of the affiliated APs" in the 5th paragraph of 5.1.5.1 with "The affiliated APs' upper MAC sublayer components".** |
| 11603 | Lei Wang | 4.9.5 | 64.36 | The word "legacy" in the text of "cloud" shape boxes should be changed to "non-MLO", in order to cover both 11be non-AP STAs not operating in MLO mode and legacy STAs (prior-to 11be). | Change the word "legacy" to "non-MLO" in the cloud shape boxes in line 36 page 64. | **Accepted.** |
| 10524 | Abhishek Patil | 4.9.5 | 64.46 | A non-AP MLD can be a single radio device in which case, it can be operating over one link at a time. Revise the sentence to replace "multiple" with "one or more" | Replace the sentence as: "... non-AP MLD can operate at any given time in either MLO over one or more lower MAC and PHY pairs for association to an AP MLD ..." | **Accepted.** |
| 10525 | Abhishek Patil | 4.9.5 | 64.46 | A non-MLO non-AP STA (or an EHT STA that is operating in non-MLO mode) is not affiliated with an MLD (see P405). Also, a non-MLO association is between an EHT STA that is not affiliated w/ an MLD (see P424). Therefore, the upper MAC (MLD functionality) doesn't apply for non-MLO case. | Move the OR part as a separate sentence and update figure 4-30d to show non-MLO instances (similar to how it is done for the AP side figure 4-30c). | **Revised. Figure 4-30d is explicitly (per the title) only showing the MLD case. Such a non-MLO non-AP STA would not be MLD, and the cited text and Figure 4-30d do not apply - the legacy figures for a non-AP STA apply instead.**  **TGbe editor: Make changes as shown in <this doc> and labeled as #10525.** |
| 11604 | Lei Wang | 4.9.5 | 65.02 | a type in the text in brackets, where it should be "... with affilicated non-AP STAs", not "...with affiliated APs". | Change "... with affiliated APs" to "...with affiliated non-AP STAs". | **Accepted.** |
| 12306 | Guogang Huang | 4.9.5 | 65.08 | Data frames should be incoming from the MAC SAP. Please make the corresponding change on Figure 4-30d. | Update Figure 4-30d to show that Data frames are incoming from the MAC SAP. | **Rejected. The MAC SAP details are in clause 5 (in Figure 5-2a, for example). Figure 4-30d does indicate "Data frames" to give the high-level view of the traffic, but more details (like the SAPs and therefore other "Role specific behaviors") would add too much complexity to FIgure 4-30d.** |
| 10526 | Abhishek Patil | 4.9.5 | 65.45 | The figure title is incorrect | Update the title to say: "... for non-AP MLD with affilated non-AP STAs" | **Accepted.** |
| 11605 | Lei Wang | 4.9.5 | 65.45 | a typo in the figure title, "Figure 4-30d--High level architecture for non-AP MLD with affiliated APs", where it should be "... with affilicated non-AP STAs", not "...with affiliated APs". | Change "... with affiliated APs" to "...with affiliated non-AP STAs". | **Accepted.** |
| 12044 | Massinissa Lalam | 7.1 | 112.13 | "The DS SAP is indicated in this Figure", why a capital F to figure if direct reference is missing? | As in comment | **Revised. Change to "figure" (lower-case 'f').** |
| 10204 | John Wullert | 7.1 | 112.14 | Addition of AP MLD results in DS having more than four users. Given that the affiliated APs of the AP MLD may also be DS users, providing a precise count might be confusing without additional explanation. | Replace "the DS has four users" with "the DS has multiple users" | **Accepted** |
| 12770 | Romain GUIGNARD | 7.1 | 112.15 | "and AP MLD" has been added in the following sentence: "In Figure 7-1 (DS architecture), the DS has four users, two APs, a mesh gate, and a portal, and an AP MLD, so the DS is shown passing behind the MAC/PHYs of the STAs.". Thus I assume that the DS has now five users. | Please change "the DS has four users" to "the DS has five users". | **Revised. Replace "the DS has four users" with "the DS has multiple users"** |
| 13516 | Mark Hamilton | 7.1 | 112.17 | The persistent problem with Figures 7-1 and 7-2 continues, where the DS "star" (behind the 802.11 stacks) becomes just a black box. | Updated figures will be provided, that remove Visio shading that is apparently causing a problem when imported to Frame. | **Accepted.** |
| 12088 | Chaoming Luo | 7.1 | 112.18 | What does the black background in the figure 7-1 and 7-2 mean? | Apply corrections to the figure | **Revised. The black background should be the "star pointed" shape per the baseline Figure 7-1. An redrawn figure will be provided to the TGbe editor.** |
| 10670 | Duncan Ho | 7.1 | 112.20 | Part of Figure 7-1 is blacked out | Remove the blacked out part | **Revised. The black background should be the "star pointed" shape per the baseline Figure 7-1. An redrawn figure will be provided to the TGbe editor.** |
| 10285 | Michael Montemurro | 7.1 | 112.30 | There can be multiple non-AP MLDs and MUMS is not defined anywhere. | Update Figure 7.1, changing "non-AP MLD" to "non-AP MLDs" and "MUMS" to "ML MAC". | **Rejected. 1) Yes, there can be multiple non-AP MLDs, but only one is shown. If it is labeled as "non-AP MLDs" (plural) that could be confusing that each affiliated STA is itself a non-AP MLD. 2) MUMS is defined in the legend, as "MLD upper MAC sublayer" which is the correct term (not ML MAC).** |
| 10529 | Abhishek Patil | 7.1 | 113.04 | Clarify that this applies only for non-MLO (i.e., legacy) STAs that are associated with the AP on the link. In other words, each AP affiliated provides access to DS only for legacy STAs associated with it while AP MLD provides access to the DS for non-AP MLDs associated with it. A non-AP STA affiliated with a non-AP MLD does not have access to the DS via the AP on that link. | As in comment | **Revised. TGbe editor: Make changes as shown in <this doc> and labeled as #10529** |
| 10530 | Abhishek Patil | 7.1 | 113.13 | Figure 7-1 and 7-2 have dark areas which makes it hard to read the contents | Update the figure to remove the dark areas | **Revised. The black background should be the "star pointed" shape per the baseline Figure 7-1. An redrawn figure will be provided to the TGbe editor.** |
| 10671 | Duncan Ho | 7.1 | 113.15 | Part of Figure 7-2 is blacked out | Remove the blacked out part | **Revised. The black background should be the "star pointed" shape per the baseline Figure 7-1. An redrawn figure will be provided to the TGbe editor.** |

**Discussion: None.**

**Proposed Changes:**

***TGbe editor: Please add subclause 4.9.4 changes as follows:***

**4.9.4 Reference model for multi-band operation**

***Change the second paragraph as follows:***

A multi-band capable device can manage operation over more than one frequency band/channel using transparent FST and nontransparent FST(#10352). The operation across the different frequency bands/channels using transparent FST and nontransparent FST(#10352) can be simultaneous or nonsimultaneous.

***TGbe editor: Please modify subclause 4.9.5 as follows (including renumbering this new subclause to be 4.9.6):***

**4.9.6(#10519) Reference model for multi-link operation (MLO)**

MLO defines a set of procedures allowing communication over multiple links between MLDs(#12038)(# 11481). An MLD manages such communication over multiple links. Communication across links using(#12300) different frequency bands or channels can occur simultaneously or not depending on the capabilities of both the AP MLD and the non-AP MLD (see 35.3.16.3 (Simultaneous transmit and receive (STR) operation) and 35.3.16.4 (Nonsimultaneous transmit and receive (NSTR) operation)).

The MLO procedures (see 35.3 (Multi-link operation)) allow a pair of MLDs to discover, synchronize, (de)authenticate, (re)associate, disassociate, and manage links and other(#12301) resources with each other on any common bands or channels that are supported by both MLDs.

(#10520)Each MLD has a single MAC-SAP(#11482). Each AP affiliated with an AP MLD has a MAC address different from any other AP affiliated with the AP MLD, and each (#12242)(#12039)non-AP STA affiliated with a non-AP MLD has a MAC address different from any other (#12242)(#12039)non-AP STA affiliated with the non-AP MLD.

An example of an AP MLD with two affiliated APs(#12943) (Link 1 and Link 2) is shown in Figure 4-30a (Example MLD and the affiliated STA communication system). The figure shows an AP MLD with MLD MAC address *M* and the MLD lower MAC sublayers of two affiliated APs (AP1 with MAC address *w* and AP2 with MAC address *x*). The AP MLD is associated with a non-AP MLD with MLD MAC address *P* and the MLD lower MAC sublayers of two affiliated STAs (STA1 with MAC address *y* and STA2 with MAC address *z*) are shown. Link 1 is established between AP1 and STA1 and link 2 is established between AP2 and STA2. In general, the MAC address of an MLD and the MAC addresses(#10196) of the STAs affiliated with the MLD are all different (e.g., *M*, *P*, *w*, *x*, *y*, and *z* have different values). However, the architecture supports an implementation where M could equal either w or x, and where P could equal y or z.(#11484)(#13292)

 (#10521)

**Figure 4-30a – Example MLD and the affiliated STA communication system**

The reference model of a multi-link device (MLD) (see 35.3 (Multi-link operation)) is shown in Figure 4-30b (Reference model for an MLD for two links).

NOTE 1—For simplicity, Figure 4-30b (Reference model for an MLD for two links) depicts the reference model when there are two links, while in general, an MLD can support more than two links.

NOTE 2—The SME boundary top is left open in Figure 4-30b (Reference model for an MLD for two links) to indicate that the SME can contain other functions that are not defined by this standard.

(#10433)

**Figure 4-30b – Reference model for an MLD for two links**

An MLD supports multiple MAC functions(#11602), coordinated by an SME.

The SME maintains the authentication and association states. The Authenticator and the MAC-SAP of the AP MLD are identified by the same AP MLD MAC address. The Supplicant and the MAC-SAP of the non- AP MLD are identified by the same non-AP MLD MAC address.

The SME is responsible for coordinating each of the MLMEs of all affiliated STAs, and to maintain an RSNA key management entity and IEEE 802.1X Authenticator or Supplicant in each upper MAC sublayer component, for MLO.

The MAC Sublayer is further divided into an MLD upper MAC sublayer and an MLD lower MAC sublayer. The MLD upper MAC sublayer performs functionalities that are common across all links, and the MLD lower MAC sublayer (shared with an AP or non-AP(#12040) STA affiliated with the MLD) performs functionalities that are local to each link. Some of the functionalities require joint processing of both the MLD upper MAC sublayer(#10438)(#12769) and the MLD lower MAC sublayer.

An AP MLD always operates in cooperation with one or more affiliated APs, one for each link. The MLD lower MAC sublayer components implement link specific functions that operate independently of the lower MAC in other affiliated APs. Use of there MLD lower MAC functions is shared by the AP MLD’s upper MAC sublayer, and the affiliated AP’s upper MAC sublayer (see Figure 4-30c).(#10522) Some behaviors of MLO require the use of one or more affiliated APs’ upper MAC components. In particular, the affiliated AP MLD upper MAC sublayer components support group addressed traffic, and any group or individually addressed traffic to or from any (non-MLO) non-AP STAs(#12303). The high-level structure of an AP MLD along with its affiliated APs is shown in [Figure 4-30c (High level architecture for AP MLD with affiliated APs)](#bookmark4).

(#11603)

**Figure 4-30c – High-level architecture for AP MLD with affiliated APs**

The non-AP MLD reference model includes the MLD upper MAC sublayer and MLD lower MAC sublayers (one for each link). The single upper MAC within a non-AP MLD can operate at any given time in either MLO over one or more(#10524) lower MAC and PHY pairs for association to an AP MLD, or as a (non-MLO) non-AP STA using only one set of lower MAC and PHY for association to an AP (which may or may not be affiliated with an AP MLD). A single Supplicant on the non-AP MLD manages the PTKSA(#10276), and multiple group key security associations (one set per link). The reference architecture when operating in MLO(#10525) is shown in [Figure 4-30d (High](#bookmark5) [level architecture for non-AP MLD with affiliated non-AP STAs(#11604))](#bookmark5). The reference architecture of Figure 4-24 applies when operating as a (non-MLO) non-AP STA.(#10525)



**Figure 4-30d – High-level architecture for non-AP MLD with affiliated non-AP STAs(#10526)(#11605)**

***TGbe editor: Please modify 5th paragraph in subclause 5.1.5.1as follows:***

**5.1.5 MAC data service architecture**

**5.1.5.1 General**

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(#10443)) 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 affiliated APs’ upper MAC sublayer components(#12304) 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 (#12314)pairwise transient keys (PTKs). The overall structure is as shown in Figure 5-2b (MAC data plane architecture for AP MLD and affiliated APs(#10443)(#11168)(#12312)).

***TGbe editor: Please modify subclause 7.1 as follows:***

**7.1 Introduction**

***Change the contents of this subclause, including Figure 7-1 (DS architecture), as follows:***

The DS SAP is the interface between the DS SAP service users and the DS SAP service provider. The DS SAP service users are the connected APs, mesh gates, ~~and~~ the portal, and AP MLDs. The DS SAP service provider is the DS. Figure 7-1 (DS architecture) shows the location of the DS in the IEEE 802.11 architecture. The DS SAP is indicated in this (#12044)figure by the lines connecting the DS to its service users. In Figure 7-1 (DS architecture), the DS has multiple(#10204)(#12770) users, two APs, a mesh gate, ~~and~~ a portal, and an AP MLD, so the DS is shown passing behind the MAC/PHYs of the STAs.

(#13516)(#12088)(#10670)(#10530)

**Figure 7-1 – DS architecture**

The DS SAP interface specification describes the primitives required to get MAC service tuples in and out of the DS and

* update the DS’s mapping of STAs to APs or to mesh gates,
* update the DS’s mapping of non-AP MLDs to AP MLDs

Describing the DS itself or the functions thereof is out of scope of this ~~annex~~standard.

The DS SAP actions are as follows:

1. Accept MSDUs (as part of MAC service tuples) from APs, mesh gates, the portal, and AP MLDs.
2. Deliver MSDUs (as part of MAC service tuples) to APs, mesh gates, ~~or~~ the portal, or the AP MLDs.
3. Accept STA-to-AP mapping updates from the APs.
4. Accept STA-to-mesh gate mapping updates from the mesh gates.
5. Accept non-AP-MLD-to-AP-MLD mapping updates from the AP MLDs.

NOTE—For MLDs, the source address or destination address parameters of the MAC service tuples (see 5.2.3.2 (Semantics of the service primitive)) are set to the MLD MAC address of the non-AP MLD, which is the identity of the non-AP MLD known by the DS.

When the DS delivers the MAC service tuples to an AP, the AP then determines when and how to deliver the MAC service tuples to the AP’s MAC (via the MAC SAP). When the DS delivers the MAC service tuples to a mesh gate, the mesh gate then determines when and how to deliver the MAC service tuples to the mesh gate’s MAC (via the MAC SAP). When the DS delivers the MAC service tuples to an AP MLD through DSAF, the AP MLD then determines when and how to deliver the MAC service tuples to the AP MLD’s MLD ~~U~~upper MAC sublayer (via the MAC SAP).

In the case of an AP MLD and its affiliated AP(s) connected to the DS, there are individual DS SAPs for each affiliated AP and one for the AP MLD, as shown in Figure 7-2. (#10529)The AP MLD will provide a mapping to its associated non-AP MLDs, by their MLD MAC addresses. non-MLO (#10529)Thus, the non-AP devices form distinct sets of MAC addresses, and the DS can deliver any service tuples with a one-to-one mapping of destination address to DS SAP.

(#13516)(#12088)(#10530)(#10671)

**Figure 7-2 – Example DS access for an AP MLD with two affiliated APs**