IEEE P802.11
Wireless LANs

Comment resolutions for Reference Model and MLO Architecture

Date: 2024-05-07

Author(s):

Name	Affiliation	Address	Phone	email
Sanket Kalamkar	Qualcomm Technologies Inc	5665 Morehouse Drive, San Diego, CA 92131		sankal@qti.qualcomm.com
Alfred Asterjadhi	Qualcomm Technologies Inc	5665 Morehouse Drive, San Diego, CA 92131		

Abstract

This submission proposes resolutions for following CIDs received for TGbe D6.0:

23012, 23013, 23146, 23147, 23148, ~~23155~~, ~~23156~~, ~~23157~~, 23158, 23159, 23161, ~~23162~~, 23163, 23164, 23165, ~~23166~~

Revisions:

- Rev 0: Initial version of the document.
- Rev 1: Some changes to the proposed resolution based on offline feedback.
- Rev 2: Editorial change
- Rev 3: Changes based on offline feedback

TGbe editor: The baseline for this document is 11be D6.0

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.

CID	Commenter	Clause	Pg/Ln	Comment	Proposed Change	Resolution
23012	Binita Gupta	4.9.6	77.65	In text "In particular, the affiliated APs' upper MAC sublayer components support group addressed traffic, and any group group or individually addressed traffic to or from any non-MLD non-AP STAs", the first reference to group addressed traffic is for group addressed MLD traffic. Change text to clarify that.	"Change to ""In particular, the affiliated APs' upper MAC sublayer components support group addressed *MLD"" traffic, and any group group or individually addressed traffic to or from any non-MLD non-AP STAs"""	**Revised.** Disagree with the commenter in principle. The group addressed traffic at an affiliated AP's upper MAC sublayer can be both MLD and non-MLD traffic. So, to indicate that, the proposed resolution is to update the sentence of interest as follows: "In particular, the affiliated APs' upper MAC sublayer components support group addressed traffic, and any individually addressed traffic to or from any non-MLD non-AP STAs." **TGbe Editor: please implement the changes shown in this document tagged as #23012.**

23013	Binita Gupta	4.9.6	78.40	In this clause and in Figure 4-33c, it is not clarified whether the group addressed MLD traffic is first received by the MLD Upper MAC layer and then sent to the non-MLD upper MAC for link specific encryption of groupcast MLD traffic. Figure 4-33c does not show how the groupcast MLD traffic is received by the non-MLD upper MAC. P83L64 specifies that group addressed traffic is first received by the AP MLD.	Clarify how the groupcast MLD traffic is received by the Non-MLD upper MAC in Figure 4-33c and in the text on P77L64.	**Revised.** Agree with the commenter in that there is an inconsistency in Figure 4-33c. To fix that inconsistency, the proposed resolution is to remove the word “MLD” within the wording “group addressed MLD traffic” from two boxes “Non-MLD upper MAC sublayer” in Figure 4-33c. The rationale is that there is no need to have distinction as “group addressed MLD traffic” versus “group addressed non-MLD traffic.” To clarify the flow of the groupcast traffic from the AP MLD to the affiliated APs, the proposed resolution is to add two arrows from the box “MLD upper MAC sublayer” to the two boxes “Non-MLD upper MAC sublayer” (one on right and one on left) along with the associated text “Groupcast distribution” in Figure 4-33c. How the groupcast traffic is distributed to the affiliated APs from the AP MLD is local to the implementation. To add further clarity, the proposed resolution is to add the following text as a note after P84L07 in subclause 5.1.5.1: “How the AP MLD distributes group

						addressed frames to the affiliated APs and coordinates the preparation of these frames for transmission is implementation specific." **TGbe Editor: please implement the changes shown in this document tagged as #23013.**
23146	Brian Hart	-	00.00	This is an evolution of CID 22293 which was disposed of under the invalid reasoning that "However, performing all these changes does not fix any technical inconsistency since these [MIB variables] are internal variables and need not be exposed" which will come as a major surprise to the users of STAs that do expose these MIB variables (for decades). The STA statistics (under Dot11CountersEntry and Dot11QosCountersEntry) related to MSDUs, and arguably to MPDUs too, are defined at the link level but some parameters don't make sense at the link level - like dot11FrameDuplicateCount, dot11QosFailedCount, dot11QosRetryCount, dot11QosFrameDuplicateCount, dot11QosDiscardedFrameCount etc.	Address this inconsistency: e.g., a) redefine meaning to be at MLD layer in a non-AP MLO (but this solution is insufficient for an AP MLD due to legacy clents(?)), or b) create new MLD-level MIB variables for these kinds of parameters and then defined a new Measurement Req/Rep of type STA Statistics Report for MLD-level MIB variables.	**Rejected.** The comment fails to identify a specific issue to be addressed. It fails to identify changes in sufficient detail so that the specific wording of the changes that will satisfy the commenter can be determined.

23147	Brian Hart	35.3.14.1	580.16	This is an evolution of CID 22293 which was disposed of under the invalid reasoning that "However, performing all these changes does not fix any technical inconsistency since these [MIB variables] are internal variables and need not be exposed" which will come as a major surprise to the users of STAs that do expose these MIB variables (for decades). This bulleted list specifically calls out frames that operate at the MLD level, but there is no such list for MIB variables	Create a centralized list of MIB variables that operate at the MIB level, including where the MIB dependency might be non-obvious (e.g., P222L21/27/33 …P223L8/13/18, P571L62,P580L4/6, P682L56, P683L7). If other comments related to MLD Sublayer Management Entity are adopted, mention that as the transport mechanism for the MIB-to-MIB synchronization function. Convert existing normative text to "as defined in <section where this new content is hosted>	**Rejected.** The comment fails to identify a specific issue to be addressed. It fails to identify changes in sufficient detail so that the specific wording of the changes that will satisfy the commenter can be determined.
23148	Brian Hart	C.1	16.77	This is an evolution of CID 22293 which was disposed of under the invalid reasoning that "However, performing all these changes does not fix any technical inconsistency since these [MIB variables] are internal variables and need not be exposed" which will come as a major surprise to the users of STAs that do expose these MIB variables (for decades). MLO requires specialized MIB behavior (i.e., synchronization between MIBs) that is not called out	After the following sentence from the baseline "The MAC and PHY MIBs are described in Abstract Syntax Notation One (ASN.1), defined in ISO/IEC 8824-1:1995, ISO/IEC 8824-2:1995, ISO/IEC 8824-3:1995 and ISO/IEC 8824-4:1995, (#4112)and as adapted per Structure of Management Information Version 2 (SMIv2) specified in IETF RFC 2578" append the following "where the MAC MIB in an MLD is subject to further constraints (see xxx ... akin to the list at P580L16 but for MIB variables)".	**Rejected.** The comment fails to identify a specific issue to be addressed. It fails to identify changes in sufficient detail so that the specific wording of the changes that will satisfy the commenter can be determined.

23155	Brian Hart	4.9.6	79.01	This is an evolution of CID 22291 that only partially addressed the concerns raised. "The reference architecture of Figure 4-24 (Portion of the ISO/IEC basic reference model covered in this standard) applies when operating as a non-MLD non-AP STA." is too narrow., and is already true so should not be stated here	We need to be able to make this statement for non-MLDs (and it is already made in the baseline, at 11meD5.0 fig 4-27) and for AP and non-AP MLDs (which we need to say here). Then: 1) Add SAPs to figs 4-33c/d. 2) Make this statement for MLDs here.	**Revised.** Disagree to the proposed change in principle. Rather than removing the sentence "The reference architecture of Figure 4-24 (Portion of the ISO/IEC basic reference model covered in this standard) applies when operating as a non-MLD non-AP STA," the proposed resolution is to make it a note to have clarity on the reference model for non-MLD non-AP STA. 1) The SAPs for the MLD are already shown in Figures 4-33a and 4-33b. Also, SAPs for the affiliated APs of an AP MLD are shown in Figure 5-2b. Hence, there is no need to overcrowd Figures 4-33c and 4-33d. 2) Figure 4-33b already shows a reference model for MLDs. A statement for the reference model for MLDs is already present in Clause 4 at P76L46. **TGbe Editor: please implement the changes shown in this document tagged as #23155.**

23156	Brian Hart	4.9.6	79.01	Check fig# - I see 4-27 not 4-24 in 11meD5.0	Check fig#	**Revised.** Agree with the commenter that the figure number should be 4-27 instead of 4-24. **TGbe Editor: Please change the figure number mentioned at P79L01 to 4-27 from 4-24.**
23157	Brian Hart	4.9.6	79.06	This is an evolution of CID 22291 that only partially addressed the concerns raised. Figure 4-33b is unusually unhelpful since it is unmoored to any SAPs. This issue is highlighted by the text "The reference architecture of Figure 4-24 (Portion of the ISO/IEC basic reference model covered in this standard) applies when operating as a non-MLD non-AP STA." since it is clear that we need something similar for non-AP MLDs and then the relevant SAPs must be identified in order to apply such a layer-based problem decomposition.	Add a SAP at top of fig 4-33d, for the non-AP MLD.	**Rejected.** The SAPs for a non-AP MLD are already shown in Figure 4-33b.
23158	Brian Hart	4.9.6	78.06	This is an evolution of CID 22291 that only partially addressed the concerns raised. Figure 4-33c is unusually unhelpful since it is unmoored to any SAPs.	Add SAPs at top of fig 4-33c, for affiliated APs and AP MLD.	**Rejected.** The SAPs for affiliated APs and AP MLD are already shown in Figures 4-33a, 4-33b, and 5-2b. Hence, there is no need to overcrowd Figure 4-33c.

23159	Brian Hart	4.9.6	78.15	This is an evolution of CID 22291 that only partially addressed the concerns raised. In Fig 4-33c, groupcast is only shown as appearing within the non-MLD upper MAC sublayer which is misleading and incomplete, since the MLD upper MAC sublayer is responsbile for assigning SNs.	Either (non-preferred) 1a) append "(for individually address frames)" to the caption and 1b) remove "and group addressed MLD traffic" x2; or (preferred) 2a) add a line labelled "Groupcast dissemination" from partway down the"MLD upper MAC subblayer" box to partway down the "non-MLD upper MAC sublayer" box x2, 2b) change "Non-MLD Data frames" ellipse to "Non-MLD individually addressed Data frames" ellipse x2 and 2c) change "MLD Data frames" ellipse to "MLD individually and group addressed Data frames" ellipse.	**Revised.** Agree with the commenter in that there is an inconsistency in Figure 4-33c. To fix that inconsistency, the proposed resolution is to remove the word “MLD” within the phrase “group addressed MLD traffic” from two boxes “Non-MLD upper MAC sublayer” in Figure 4-33c. The rationale is that the non-MLD upper MAC sublayer of an affiliated AP handles both MLD and non-MLD group addressed traffic. The solution in 2a) is preferred to that in 1a) and 1b). For 2a): Agree with the commenter in principle. To clarify the flow of the groupcast traffic from the AP MLD to the affiliated APs, the proposed resolution is to add two arrows from the box “MLD upper MAC sublayer” to the two boxes “Non-MLD upper MAC sublayer” (one on right and one on left) along with the associated text “Groupcast distribution” in Figure 4-33c. Furthermore, how the groupcast traffic is distributed to the affiliated APs from the AP MLD is local to the implementation. To add further clarity, the proposed resolution is to add the following text as a note after P84L07 in subclause 5.1.5.1: “How the AP MLD distributes group

						addressed frames to the affiliated APs and coordinates the preparation of these frames for transmission is implementation specific." For 2b): Non-MLD Data frames could be both individually and group addressed frames, which is captured by the current wording "Non-MLD Data frames." For 2c): The current wording "MLD Data frames" is general enough to include both individually and group addressed frames. **TGbe Editor: This is the same as comment resolution for CID #23013.**

23161	Brian Hart	4.9.6	83.63	This is an evolution of CID 22291 that only partially addressed the concerns raised. No normative requirement that an AP MLD is part of the same DS (or ESS) as its affiliated APs	1) Add such a requirement in clause 4 or 5; 2) Show the MAC SAPs and single DS in fig 4-33c; 3) Show that this is a single DS in figure 5-2b (perhaps via a footnote: "The three instances of "DS" refer to the same DS")	**Revised.** Agree in part with the proposed changes. 1) Agree with the commenter. The proposed resolution is to add the text “An AP MLD is part of the same ESS as its affiliated APs.” at P67L18. 2) The MAC SAPs and single DS are already shown in Figures 4-33a and 4-33b. Also, SAPs for the affiliated APs of an AP MLD are shown in Figure 5-2b. Furthermore, as per the resolution to Comment #3 of this CID, Figure 5-2b now clarifies that an AP MLD and its affiliated APs are part of the same DS. Hence, there is no need to overcrowd Figures 4-33c and 4-33d. 3) Agree with the commenter to add a footnote. **TGbe Editor**: **Please add the following text at P67L18: “An AP MLD is part of the same ESS as its affiliated APs.” Please implement this change as shown in this document tagged as #23161.** **TGbe Editor**: **Please add the following footnote at P83L51. “The three instances of DS refer to the same DS.”**

23162	Brian Hart	4.9.6	76.41	This is an evolution of CID 22291 that only partially addressed the concerns raised. Caption of figure 4-33a is misleading since the end2end communication is between two MLDs, and communication between MLD and affiliated STA is secondary	Try "Example communication system between two MLDs via their affiliated STAs (for individually addressed MSDUs)"	**Revised.** Agree with the commenter. But the proposed resolution is 'revised' since the commenter is using the word "try" instead of an assertive language. **TGbe Editor: Change the caption of Figure 4-33a to "Example communication system between two MLDs via their affiliated STAs (for individually addressed MSDUs)".**
23163	Brian Hart	4.9.6	77.14	This is an evolution of CID 22291 that only partially addressed the concerns raised. Figure 4-33b is misleading and incomplete in regards to groupcast: . Fig 4-33b shows a direct connection from MLD Upper MAC MAC sublayer to MLD Lower MAC entity, whereas text and Figu 4-33c indicates that groupcast must go from AP MLD Upper MAC sublayer to non-MLD upper MAC sublayer to MLD lower MAC entity.	Add non-MLD upper MAC sublayer to fig 33b - e.g., in the each two places where MLD Upper MAC Sublayer abuts MLD Lower MAC entity, for about half the abutment, insert a new box labelled "non-MLD upper MAC sublayer". Add a bidir arrow through the remaining abutment with label "Individually addressed" and a downward (or bidir?) arrow thru the newly inserted "non-MLD upper MAC sublayer" with label "Group addressed". Enlarge the figure for these insertions as needed.	**Accepted.** Agree with the commenter in principle. **Figure 4-33b to be changed.**
23164	Brian Hart	4.9.6	77.38	This is an evolution of CID 22291 that only partially addressed the concerns raised. From 11.3.1 in the baseline, "A STA (local) for which dot11OCBActivated is false keeps an enumerated state variable for each STA (remote) with which direct communication via the WM is needed." and this knowledge is needed for frame filtering (11.3.3) etc. But here we have "The SME maintains the authentication and association states." In the non-MLO world the STA can snoop MLME-ASSOCIATE.resp/.conf function to maintain knowledge of that state, but snooping is no longer sufficient in the MLO world since these functions might be exchanged by a different MLME with the SME.	Define a new primitive whereby the SME can report a STA's state to each MLME. Or, since this inter-MLME coordination issue might come up more than just here, define a new MLD Sublayer Management Entity that acts as a conduit of information between MLMEs whereby the conduit (unlike the MLME-SAP) does not require explicit standardization. See MIB-related comments also.	**Rejected.** The comment fails to identify a specific issue to be addressed. It fails to identify changes in sufficient detail so that the specific wording of the changes that will satisfy the commenter can be determined.

23165	Brian Hart	6.1	87.01	This is an evolution of CID 22293 which was disposed of under the invalid reasoning that "However, performing all these changes does not fix any technical inconsistency since these [MIB variables] are internal variables and need not be exposed" which will come as a major surprise to the users of STAs that do expose these MIB variables (for decades). Fig 6-1 in the baseline expresses where the MAC MIB resides, but how that applies to the MLO arch is unclear.	Provide a companion figure to 6-1 for MLO that shows the two (or N) MLMEs (for two or N links). I believe there is one MIB per MLME(?) so this figure should show two (or N) MIBs. As well, MLO-level MIB variables need to be the same in each MIB, so the figure should describe a synchronization function between the two or N MIBs. This synchronization function could be subsumed into a new MLD Sublayer Management Entity that acts as a conduit of information between MLMEs whereby the conduit (unlike the MLME-SAP) does not require explicit standardization. See other related MIB comments also	**Rejected.** The comment fails to identify a specific issue to be addressed. It fails to identify changes in sufficient detail so that the specific wording of the changes that will satisfy the commenter can be determined.

23166	Brian Hart	4.9.6	76.20	This is an evolution of CID 22291 that only partially addressed the concerns raised. Text at P75L58 says "two affiliated APs (AP1 with MAC address w and AP2 with MAC address x)." and text at P78L52 says "each MLD lower MAC entity (corresponding to a STA affiliated with the MLD)" but figure parenthetical says "MLD Lower MAC Entity" (singular)	Change to "Entities". Ditto P76L28	**Revised.** Agree with the commenter in principle. In addition, multiple other instances are detected where it is still mentioned “MLD lower MAC sublayer” instead of “MLD lower MAC entity.” Such 15 instances are as follows: P77L48, P77L51, P77L54, P81L38, P82L46, P83L39, P84L36, P84L43, P84L55, P84L63, P85L7, P85L9, P85L14, P85L16, P85L21 **TGbe Editor: Please change “entity” to “entities” at P76L20 and P76L28 in Figure 4-33a.** **TGbe Editor: Please change “MLD lower MAC sublayer” to “MLD lower MAC entity” at the following locations:** **P77L48, P77L51, P77L54, P81L38, P82L46, P83L39, P84L36, P84L43, P84L55, P84L63, P85L7, P85L9, P85L14, P85L16, P85L21**

TGbe Editor: ***Change the paragraph below of subclause 4.9.6 as follows (#CID 23012):***

An AP MLD always operates in cooperation with one or more affiliated APs, one for each link. The MLD lower MAC entities implement link specific functions that operate independently of the lower MAC in other affiliated APs. 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 4-33c (High level structure for AP MLD with affiliated APs)). Some behaviors of MLO require the use of one or more affiliated APs’ upper MAC sublayer components. In particular, the affiliated APs’ upper MAC sublayer components support group addressed traffic, and any ~~group or~~ individually addressed traffic to or from any non-MLD non-AP STAs(#23012).

TGbe Editor: ***Change Figure 4-33c below of subclause 4.9.6 as follows (#CID 23013):***

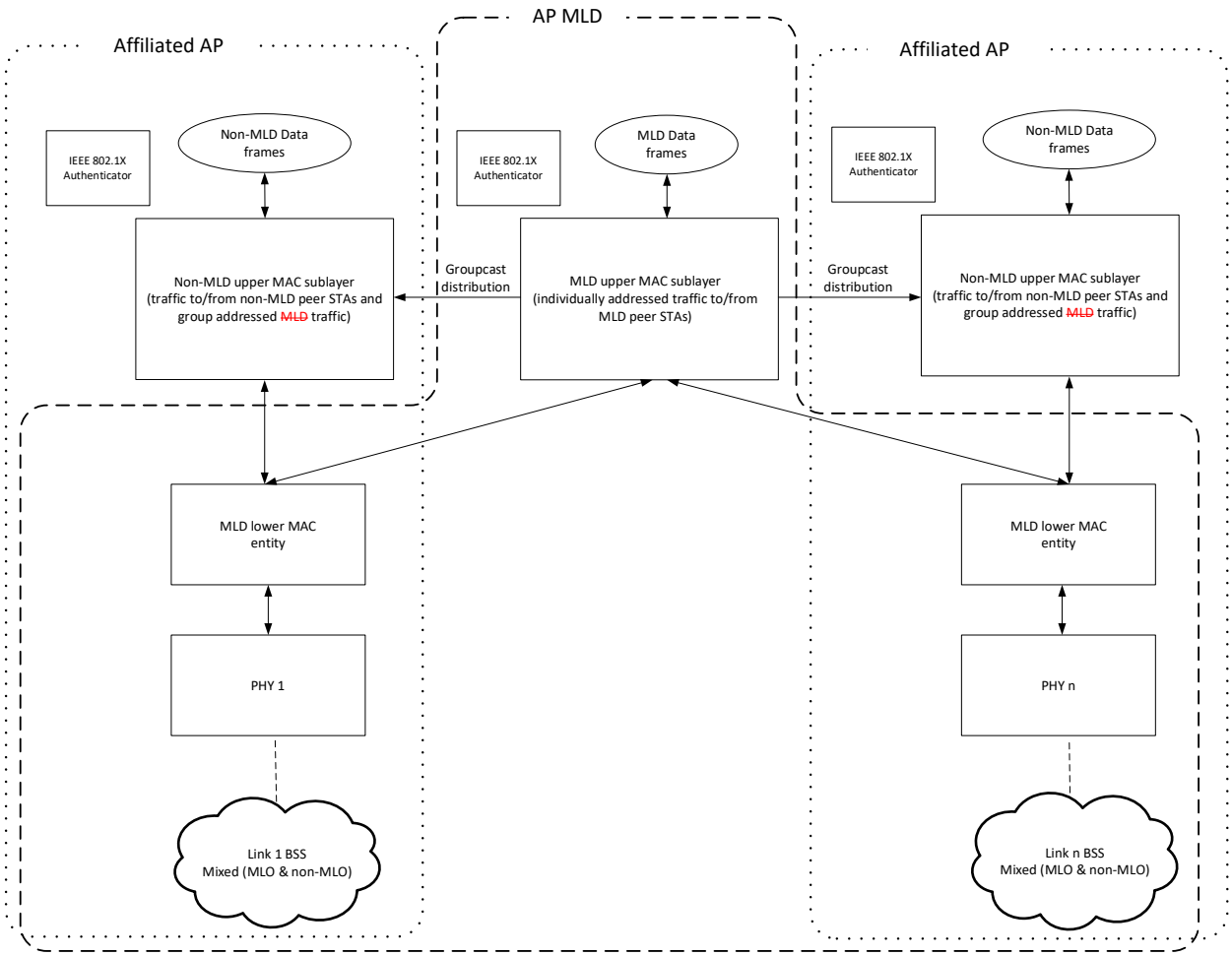

Figure 4-33c—High level structure for AP MLD with affiliated APs(#23012, #23159)

TGbe Editor: ***Add the following note in subclause 5.1.5.1 (after P84L07) as follows (#CID 23013):***

Group addressed MSDUs at the DS are not transmitted directly by affiliated APs. 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. The AP MLD and affiliated APs then coordinate to 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 MPDUs and MMPDUs prior to transmission on the link managed by that affiliated AP. Group addressed MMPDUs generated within the AP MLD upper MAC sublayer are transferred to the intended affiliated APs for transmission. On a non-AP STA affiliated with a non-AP MLD, the GTK of the transmitting AP is used to decrypt the group addressed MPDUs and MMPDUs received from that AP.

NOTE—How the AP MLD distributes group addressed frames to the affiliated APs and coordinates the preparation of these frames for transmission is implementation specific(#23013, #23159).

TGbe Editor: ***Change the paragraph below of subclause 4.9.6 (P79L01) as follows (#CID 23155):***

The non-AP MLD reference model includes the MLD upper MAC sublayer and one or more MLD lower MAC entities (one for each link). The MLD upper MAC sublayer performs functionalities that are common across all links, and each MLD lower MAC entity (corresponding to a STA affiliated with the MLD) performs functionalities that are local to each link. The single upper MAC within a non-AP MLD can operate at any given time as either MLO over one or more lower MAC and PHY pairs for association to an AP MLD, or as a non-MLD non-AP STA using only one lower MAC and PHY pair for association to an AP (which might or might not be affiliated with an AP MLD). A single Supplicant on the non-AP MLD manages the PTKSA, and multiple group key security associations (one set per link). The MLO reference architecture is shown in Figure 4-33d (High level architecture for non-AP MLD with affiliated non-AP STAs). ~~The reference architecture of Figure 4-24 (Portion of the ISO/IEC basic reference model covered in this standard) applies when operating as a non-MLD non-AP STA.~~

NOTE—The reference architecture of Figure 4-24 (Portion of the ISO/IEC basic reference model covered in this standard) applies when operating as a non-MLD non-AP STA(#23155).

TGbe Editor: ***Change the paragraph below of subclause 4.3.5.2 at P67L18 as follows (#CID 23161):***

The DS and infrastructure BSSs allow IEEE Std 802.11 to create a wireless network of arbitrary size and complexity. IEEE Std 802.11 refers to this type of network as the ESS. An ESS is the union of the infrastructure BSSs with the same SSID connected by a single DS. All BSSs in an ESS have the same SSID. All BSSs created by APs affiliated with an AP MLD have the same SSID and belong to the same ESS. An AP MLD is part of the same ESS as its affiliated APs. The ESS does not include the DS.

==========

Do you agree to the resolution provided in doc 11-24/1051r3 for the following CIDs?

23012, 23013, 23146, 23147, 23148, 23158, 23159, 23161, 23163, 23164, 23165