IEEE P802.11
Wireless LANs

|  |
| --- |
| 11bn PDT-CR MAC Seamless Roaming (Part 2) |
| Date: March, 2025 |
| Author(s): |
| Name | Affiliation | Address | Phone | Email |
| Duncan Ho | Qualcomm Technologies, Inc | 5665 Morehouse Dr, San Diego CA 92131 USA | +1 (858) 845-3214 | dho@qti.qualcomm.com |
| Liwen Chu | NXP |  |  |  |
| Xiangxin Gu | Spreadtrum |  |  |  |
| Xiandong Dong | Xiaomi |  |  |  |
| Tuncer Baykas | Ofinno |  |  |  |
| Gaurav Patwardhan | HPE |  |  |  |
| Ning Gao | Oppo |  |  |  |
| Pei Zhou | TCL |  |  |  |
| Frank Hsu | Mediatek Inc. |  |  |  |
| Xuwen Zhao |  |  |  |  |
| Juseong Moon | KNUT |  |  |  |
| Ronny Yongho Kim | KNUT |  |  |  |
| John Wullert | Peraton Labs |  |  |  |
| Tuncer Baykas | Ofinno |  |  |  |
| Manasi Ekkundi | Samsung Electronics |  |  |  |
| Jarkko Kneckt | Apple |  |  |  |
| Pooya Monajemi | Apple |  |  |  |
| Chitto Ghosh | Apple |  |  |  |
| Insun Jang | LGE |  |  |  |
| Fangxin Xu | Shenzhen Longsailing Semiconductor |  |  |  |
| SunHee Baek | LG Electronics |  |  |  |
| Ryuichi Hirata | Sony |  |  |  |
| Thomas Handte | Sony |  |  |  |
| Liangxiao Xin | Oppo |  |  |  |
| Liuming Lu | Oppo |  |  |  |
| Yunpeng Yang | TP-link |  |  |  |
| Arik Klein | Huawei |  |  |  |
| Zisheng Wang | ZTE |  |  |  |
| Prabodh Varshney | Nokia |  |  |  |
| Liubogoshchev | Nokia |  |  |  |
| Yun Li | ZTE |  |  |  |
| Thomas Derham | Broadcom |  |  |  |
| Abhishek Chaturvedi | Samsung |  |  |  |
| Hang Yang | Ruijie Networks Co., Ltd. |  |  |  |
| Alfred Asterjadhi | Qualcomm Technologies, Inc. |  |  |  |
| Subir Das | Peraton Labs |  |  |  |
| Abhishek Patil | Qualcomm Technologies, Inc. |  |  |  |
| Peshal Nayak | Samsung |  |  |  |
| Zhenpeng Shi | Huawei |  |  |  |
| Massinissa Lalam | Sagemcom |  |  |  |
| Julien Sevin | Canon |  |  |  |
| Yuki Fujimori | Canon |  |  |  |
| Haorui Yang | China Mobile |  |  |  |
| Tomo Adachi | Toshiba |  |  |  |
| Kyosuke Inoue | Sharp Corporation |  |  |  |
| Stephane Baron | Canon |  |  |  |
| Brian Hart | Cisco |  |  |  |
| Yu Hsien Chang |  |  |  |  |
| Rubayet Shafin | Samsung Electronics |  |  |  |
| Lei Zhou | New H3C |  |  |  |
| Gabor Bajko | Mediatek |  |  |  |
| Shuang Fan | Sanechips |  |  |  |
| Lili Hervieu | CableLabs |  |  |  |
| Hanqing Lou | InterDigital |  |  |  |
| Jeongki Kim | Ofinno |  |  |  |
| Kosuke Aio | Sony Corporation |  |  |  |
| Giovanni Chisci | Qualcomm Incorporated |  |  |  |
| Binita Gupta | Cisco |  |  |  |
| Guogang Huang | Huawei |  |  |  |
| Po-Kai Huang | Intel |  |  |  |
| Mike Montemurro | Huawei |  |  |  |
| Peshal Nayak | Samsung |  |  |  |
| Jay Yang | ZTE |  |  |  |
| Yelin Yoon | LGE |  |  |  |
| Nima Namvar | Charter Communications |  |  |  |
| Ross Jian Yu | Huawei |  |  |  |
| Shawn Kim | Wilus Inc. |  |  |  |
| Yue Zhao | Huawei |  |  |  |
| Sungjin Park | LGE |  |  |  |
| Xiaofei Wang | InterDigital |  |  |  |

Abstract

This document contains Proposed Draft Text (PDT) for the Seamless Roaming feature of the proposed TGbn (UHR, Ultra High Reliability) amendment to the 802.11 standard.

This submission also proposes resolutions for the following CIDs received for TGbn CC50:

203, 505, 883, 3935, 3933, 2021, 3466, 720, 882, 531, 3464 (<-11CIDs)

**Revision information**

The following is a summary of the important changes that occurred within each revision of this document:

|  |  |
| --- | --- |
| **Revision** | **Major changes** |
| 0 | Use 25/ 566r5 as the baseline and make changes on top of it.Summary of major technical aspects:* **Security**:
	+ Added a 1-bit in the SMD Information to indicate whether the SMD allows a per-AP MLD PTK. If this bit is set, the non-AP MLD can choose to use a per-AP MLD PTK, indicated in the ST preparation request. The current AP and non-AP will exchange DHss to generate a new PTK, which will also be part of the PTKSA.
	+ If a per-AP MLD PTK is used, PN for both UL and DL are not reset and they will keep increasing. A new PTK will be generated and it becomes part of the PTKSA. The PTK uses the same derivation as the PTK derivation during the initial association between the non-AP MLD and the SMD-ME, with DHss added to the end of the key derivation inputs.
* **SN related changes:**
	+ The current AP MLD indicates to the non-AP MLD the starting SN assigned to the target AP MLD for all DL TIDs.
* **DL data drain related changes:**
	+ Added a note to say the DLDrainTime is sufficiently large for the non-AP MLD to receive the DL data.
	+ The DLDrainTime shall be set to 0 in case the execution is via the target AP MLD.
	+ Clarified the current AP MLD keeps sending DL data even after it receives the ST execution request and will continue to do so even if the current AP MLD rejects the ST execution request.
	+ Clarified the current AP MLD should refrain from transmitting DL data frames to the non-AP MLD after the DLDrainTime early terminates or ends.
	+ Added that if the non-AP MLD terminates the DLDrainTime early, it shall indicate that to the current AP MLD (as a best-effort, retx is not required).
	+ Added conditions the current AP MLD sends early termination indication:
		- When the AP has no more pending DL data.
		- The AP has transmitted DL data up to the last SN available for all TIDs.
	+ If the non-AP MLD has requested not to transfer of DL SNs, the target AP MLD shall not transmit DL data until the DLDrainTime terminates or non-AP MLD indicates early termination.
	+ If the non-AP MLD has requested transfer of DL SNs, the target AP MLD shall not transmit DL frames that go beyond its transmit window.
	+ A non-AP MLD may request the current AP MLD to send an indication about DL data completion.
* **Created a new subclause for ST via an Unprepared target AP MLD.**
 |
| 1 | Some updates:* Corrected in section 37.9.5.2 (preparation), it’s the SMD-ME that’s handling the keys, not the SMD.
* Added in section 37.9.5.3 (per-AP MLD PTK derivation) that the SME-ME and non-AP MLD will use KDK to derive some TBD key material for each AP MLD that’s part of the SMD. The key material and DHss will then be used to generate a new PTK.
 |
| 2 | * Removed CIDs 883 and 3935 along with the proposed resolution – the non-AP MLD indicates to the current AP MLD that the non-AP MLD has completed DL retrieval with the current AP MLD.
* Clarified the DHss contains the public key generated by the sender.
* Added MIC with DHss for verification of the new PTK generated.
* Removed the new subclause for ST via an Unprepared target AP MLD.
 |
| 3 | * Removed the KDK part since more discussion is needed.
 |
| 4 | Updated per the comments received during the presentation in TGbn on 5/12/2025* Updated the resolution of CID3760
* Removed some of the details in the new PTK derivation when a per-AP MLD PTK is used.
* Clarified “Buffer size” in 37.9.9 refers to the Buffer size of the current AP MLD.
* Added early termination and “DL completed” indication in the call flow (as examples).
* Removed CIDs 2022, 2391, and 3932 and the proposed resolution.
 |
| 5 | * Removed all security related to PDT Part 3 (25/753r0)
* Used the PDT Part 1 (25/566r10) as the base and make changes on top.
* Removed CIDs 3940, 221, 2536, 3806, 3939. They are all about adding supporting direct roaming via an unprepared target AP MLD.
* Removed the MIC (needs further discussion)
* Added text to allow a non-AP MLD to indicate prioritization of SCS IDs during preparation and the AP MLD sends back a list of accepted SCS IDs.
* Adjusted the text to make a target AP MLD relies on an explicit indication from the non-AP MLD as opposed to rely on DLDrainTime since the start of the DLDrainTime is ambiguous to the target AP MLD). The non-AP MLD shall send this termination indication to the target AP MLD when the non-AP MLD wants to terminate the DLDrainTime early or the DLDrainTime expires on its own.
 |

**Introduction**

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 TGbn Draft. The abstract, revision information, introduction, explanation of the proposed changes and references sections are not part of the adopted material.

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

CIDs included in this document:

|  |  |  |
| --- | --- | --- |
| Topics |  | CIDs |
| **Editorial** |  |  |
|  |  |  |
| Misc. |  |  |
|  |  |  |
| **Roaming Discovery** |  |  |
| Add discovery, target selection sections |  |  |
| SMD discovery | M#352, M#353 |  |
|  |  |  |
| **Initial Assoc** |  |  |
| Create a new section | M#352 |  |
|  |  |  |
| **Target selection recommendation** |  |  |
| Use BTM | M#364 |  |
|  |  |  |
| **Roaming Preparation** |  |  |
| Some introduction text |  |  |
| STA can perform prep with any target (already the current assumption) |  |  |
| Use Link Reconfiguration Req/Resp to prepare target | M#345 |  |
| STA indicates some context not to be transferred | M#351 |  |
| Target links in power save | M#337 |  |
| Timeout and prep state cleanup | M#335 |  |
| Indicate target AP MLD MAC addr during prep | M#336 |  |
| Include the Listen Interval during link prep | M#337 |  |
| Preparing one or more targets | M#368 |  |
|  |  |  |
| **Roaming Execution** |  |  |
| Use the Link Reconfiguration Req/Resp for execution | M#346 |  |
| Indicate target AP MLD MAC addr during execution | M#337 |  |
| Include the Listen Interval during link execution | M#337 |  |
| DL data retrieval | M#337, M#338 | 203, 505, 883, 3935, 3933, 2021, 3466, 720, 882, 3464 |
| UL transmission |  | 531 |
|  |  |  |
| **Per-AP MLD PTK** |  |  |
| Allow a Per-AP MLD PTK | M#348, M#356 |  |
|  |  |  |

Details of the CIDs and proposed resolution:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Clause** | **Pg/Ln** | **Comment** | **Proposed Change** | **Resolution** |
| 2789 | Chittabrata Ghosh | 37.8.2.5.2 | 75.55 | A new PTK derivation mechanism should beallowed between non-AP MLD and target APMLD for secured seamless roaming; please adddetails about process of derving the new PTKduring the roaming preparation procedure | As in the comment | Revised.Added when a new PTK is generated, DHss is used to generate new PTKs.Added details when per-AP MLD PTK is used. Added if the SMD supports per-AP MLD PTK, the STA may choose to use a per-AP MLD PTK. |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| 3940 | Binita Gupta | 37.8.2.5.3 | 76.01 | For Shared PTK mode, client can roam through the target AP MLD using PMF protected roaming request/response frames, encrypted with shared PTK. This procedure is similar to sending PMF protected frames for roaming through the serving AP MLD, and provides a unified design for roaming through current serving AP and the target AP. Need to define one time use client MAC Address to be used in the TA field of PMF protected frames to identify the client at the target AP MLD. | For Shared PTK mode, define procedure for the client to roam through the target AP MLD using PMF protected frames and use the TA field in the protected frame to identify the client for mapping to the right PTK. | Revised.Added a new subclause 37.9.11 to capture this case with details TBD. |
| 3941 | Binita Gupta | 37.8.2.5.5 | 76.01 | For the case of directly roaming through a target AP MLD for last minute roam, the shared PTK mode enables a client to send PMF protected roaming request. The serving AP MLD can pre-prepare its neighboring AP MLDs with the static context information for the client, including client identifier (e.g. a Roaming MAC Address that can be used in the TA field of PMF protected frame), security context with PMKSA and PTKSA. This enables the client to roam directly through the target AP when needed. | For Shared PTK mode, define procedure for the client to roam through the target AP MLD using PMF protected frames.Define a way for AP MLD to signal that it supports pre-roaming preparation of its neighboring AP MLDs to enable direct roaming through the target AP MLD. Can also define an explicit signaling such as BTM Request indicating that neighboring AP MLDs have been prepared for direct roaming through the target. | Revised.Need to be resolved together with CID#3940. |
| 162 | Jay Yang | 37.8.2.5 | 75.38 | When non-AP MLD authenticate with SMD, the authentitor MAC address shall be set to the SMD-ME MAC address | as the comments | Revised.Already addressed in CID#3866. Resolved in 25/676r1. |
| DL data tx |  |  |  |  |  |  |
| 203 | Chunyu Hu | 37.8.2.5.3 | 76.12 | Can the current AP MLD continue to transmit DL frames to the request non-AP MLD after receiving the Request frame? Need to clarify this. | Please see the comment. | **Revised**Clarified that during the time between the Link Reconfiguration Request and Link Reconfiguration Response frames the current AP MLD may continue downlink transmissions, and after the (accepted) Response frame, the duration of DLDrainTime applies unless early termination. |
| 505 | Peshal Nayak | 37.8.2.5.3 | 76.09 | When does this second TBD period of time start from? The text states that the first TBD period of time starts from the time the TBD response frame is received. It is unclear where the second TBD period of time start from. | Provide clarification on when the second TBD period of time starts from. | **Revised.**Same resolution as CID#203 |
| 720 | Chien-Fang Hsu | 37.8.2.5.3 | 76.07 | "The period of TBD time starts from the time the TBD Response frame is received." is ambiguous because the RX may have received the Response frame but ended with FCS errors. | Change to either "The period of TBD time starts from the time the TBD Response frame is successfully received" or "The period of TBD time starts from the time the TBD Response frame is acknowledged." | **Revised.**Same resolution as CID#203 |
| 882 | John Wullert | 37.8.2.5.3 | 76.06 | The text says that "The periodof TBD time starts from the time the TBD Response frame is received", but the AP MLD cannot know the time that the response is received by the non-AP MLD. | Revise text to use a starting point for the period that is a time known to the AP MLD. | **Revised.**Same resolution as CID#203 |
| 3757 | Liuming Lu | 37.8.2.5.3 Roaming execution procedure | 75.06 | The start time of the time period for the current AP MLD to transmit the individually addressed DL Data frames to the non-AP MLD after receiving the TBD Request frame is unclear. The period of TBD time should start from the time the TBD request frame is successfully received by the current AP MLD. | As in the comment. Please clarify. | **Revised.**Same resolution as CID#203 |
| 3933 | Binita Gupta | 37.8.2.5.5 | 76.34 | During seamless roaming, to avoid/minimize data loss, the buffered DL data needs to be drained/delivered to the non-AP MLD by the serving AP MLD. This should be the default mode of operation to minimize data loss and must be supported both by AP MLD and the non-AP MLD. | Define details on draining of buffered DL data from serving AP MLD to the non-AP MLD. Move the text on DL data delivery from clause 37.8.2.5.3 to this clause. | Revised.Agreed in principle. Added a lot of details in subclause 37.9.9. |
| 2021 | Yelin Yoon | 37.8.2.5.5 | 76.36 | How the duration of DL data transmission (the TBD (Transition) time) is set needs to be defined | As in comment | Revised.Agreed in principle. Made changes tagged as (#2021) in this document. |
| 3464 | Pooya Monajemi | 37.8.2.5.4 | 76.32 | A time period to receive downlink data from the origin AP must be long enough to accommodate any currently bufferred downlink frames at the origin AP, any future downlink frames that arrive from the DS before the mapping update, non-AP STA unavailability (e.g. while sending UL to the target AP), and also congestion on the medium. | Spec must recommend a large value for the aforementioned time period while also implementing a mechanism to terminate the transition period earlier when no further data is buffered at the origin AP | Revised.Agreed in principle. Same resolution as #2021. No further actions needed for the editor. |
| 3466 | Pooya Monajemi | 37.8.2.5.5 | 76.36 | The target AP MLD needs to be notified when transmission of new DL data can begin (in case of SN reset) or continue beyond the original BA window limits (in case of continued SN). Furthermore, the non-AP MLD may need to proactively send this notification to the target AP MLD (regardless of state of DL buffers on the origin AP)Relying solely on a pre-defined timer will either incur DL loss if too short or add unncessary latency if too long, and setting a proper value is impossible ahead of time. | Define a mechanism for the non-AP MLD notify the target AP MLD of continuation of DL (in case of continuous SN, beyond the original BA windows at the time of context transfer) | Revised.Agreed and it’s already covered by Motion #349. |
| 531 | Po-Kai Huang | 37.8.2.5.3 | 76.03 | During the roaming execution request/response exchange, since there is a potential DS mapping change, it is not ideal to send any UL data. This is also true even when there is data forwarding. The reason is that sending the data directly to a better channel condition of target AP MLD is better than send the data frame firs to the current AP MLD thorugh a worse channel condition and go through another backhaul with unpredictable performance. | Add "The non-AP MLD shall not send any data during the request/response frame exchange" | Revised.Clarify the non-AP MLD shall not send UL data to the current AP MLD. See the changes tagged as (#531). |
| 883 | John Wullert | 37.8.2.5.3 | 76.07 | The text indicates that the non-AP MLD can choose to receive buffered downlink frames. What would the non-AP MLD do if it chooses not to receive them - simply ignore frames sent by the AP MLD? | Indicate that the non-AP MLD may inform the AP MLD to stop sending buffered traffic using a TBD frame or describe some means by which the non-AP MLD can affect its choice to receive or not receive. | **Revised.**Agreed in principle. Signaling has been added to allow the non-AP MLD to terminate the DLDrainTime period early. The changes are tagged as(#883) in this document. |
| 3935 | Binita Gupta | 37.8.2.5.5 | 76.34 | For buffered DL data delivery, post roaming transition, when either side is done with delivery of buffered data, it must notify the other side. If serving AP MLD is done with delivery of buffered data and has empty buffers, then it needs to notify the client so that it can transition to the target asap. Similarly, if client decides to move to the target AP MLD completely and no longer interested in fetching buffered BUs, if should signal that to the serving AP so that AP does not keep trying to deliver buffered data to the client, which would be wasting channel resources. Both sides can either initiate link deletion in this scenario or provide in-band indication such as 'empty buffer' by the AP MLD and 'Not interested in More Data' by the STA. | Define mechanism for AP to signal when it is done delivering buffered DL data to the client. Also, define mechanism for client to signal when it is fully moving to the target AP MLD and not interested in any remaining buffered data. | **Revised.**Agreed in principle and same resolution as CID#883. No further actions are needed for the editor. |

**Text to be adopted begins here.**

***TGbn editor: Note the following uses part of the SMD BSS Transition PDT Part 1 (25/566r10) as the base for making changes.***

## SMD BSS transition

### General

SMD BSS transition is a mechanism for a non-AP MLD to transition from its current AP MLD to a target AP MLD (#3891)without requiring reassociation. SMD BSS transition minimizes the time during which connectivity between the non-AP MLD and the DS is lost. The non-AP MLD remains in State 4 of association with a seamless mobility domain management entity (SMD-ME) during the SMD BSS transition while preserving the context for data transmission for a seamless experience.`[M#279] To support SMD BSS transition, an SMD is introduced in the IEEE 802.11 architecture. The SMD consists of multiple AP MLDs, where a non-AP MLD can use the SMD BSS transition procedure to transition between the AP MLDs within the SMD. An SMD-ME provides SMD-level authentication and association (see 11.3 (STA authentication and association)), IEEE 802.1X Authenticator functions and RSNA key management functions for non-AP MLDs across all AP MLDs within the SMD.

[M#280]Two data path models between the non-AP MLD and the DS are supported by the SMD:

* One MAC SAP for the SMD.
* Separate MAC SAP per AP MLD of the SMD.

[M#280]Only one of these data path models is used within an SMD.

[M#280](#154)In the case of a separate MAC SAP per AP MLD, the DS mapping is updated when the non-AP MLD transitions to another AP MLD within the SMD and the component of the 802.1X Authenticator in the SMD-ME interacts with an 802.1X Authenticator component in the AP MLD that manages the 802.1X Controlled Port for the non-AP MLD.

[M#280]In the case of a single MAC SAP for the SMD, the 802.1X Authenticator in the SMD-ME manages the 802.1X Controlled Port for the non-AP MLD.

[#369] The SMD and the 802.1X Authenticator component in the corresponding SMD-ME are uniquely identified by an SMD identifier (see 9.4.2.xxx (SMD Information element)). The SMD identifier is used in establishing a single PMKSA and PTKSA for a non-AP MLD that associates with the SMD-ME.

[M#378] [M#279] If the SMD is part of an FT mobility domain, the single PMKSA to be used in the SMD is a PMK-R1 security association that is bound to the SMD-ME (through the SMD identifier (see 9.4.2.xxx (SMD Information element)), when the non-AP MLD initially associates with the SMD-ME using FT initial MD association. [M#279] A non-AP MLD can transition from one SMD to another SMD that is part of the same mobility domain using fast BSS transition.

[M#279] A non-AP MLD performs initial association with the SMD-ME through an AP MLD within the SMD that establishes an SMD-level security association across all AP MLDs in the SMD. The non-AP MLD transitions between AP MLDs within the SMD while maintaining its association and security association with the SMD-ME. This new mobility type is called SMD BSS transition.[M#284, M#285] When a non-AP MLD is in the process of transitioning from its current AP MLD to a target AP MLD within the SMD, the same PMKSA and PTKSA created as part of RSNA security association established with the SMD-ME shall be used to protect the communications with its current AP MLD and the target AP MLD.

SMD BSS transition includes the following procedures:

* SMD BSS transition discovery (see 37.9.2)
* Initial association to the SMD-ME (see 37.9.3)
* Target AP MLD selection recommendation (see 37.9.4)
* SMD BSS transition preparation (see 37.9.5)
* SMD BSS transition execution
	+ Through current AP MLD (see 37.9.6)
	+ Through target AP MLD (see 37.9.7)

### SMD BSS transition discovery procedure (#188)(#507)(#2000)(#2352)

A non-AP MLD can use mechanisms such as active scanning (see 11.1.4.3.2 (Active scanning procedure for a non-DMG STA) and 35.3.4.2 (Use of multi-link probe request and response)), the BSS transition management framework (see 11.21.7 (BSS transition management) and 35.3.23 (BSS transition management for MLDs)) or the neighbor report framework (see 11.10.10 (Usage of the neighbor report)) for discovery of the neighboring AP MLDs and SMD BSS transition support by those AP MLDs.

NOTE 1 – A neighboring AP MLD might or might not be part of the same SMD.

[M#344] NOTE 2 – An AP is not required to report non-collocated APs in the Reduced Neighbor Report element that is carried in its Beacon and FILS Discovery frames.

[M#352](#3912) An SMD Information element provides an SMD identifier and SMD capabilities for an SMD. (#1066)An AP MLD that is managed by an SMD shall include the SMD Information element in the Probe Response frames. The SMD Information element is provided as part of the Neighbor Report element in the BSS Transition Management Request frame and Neighbor Report Response frames for a reported AP that is part of a different SMD than the reporting AP.

[M#333] A mechanism is defined to retrieve probe response content for neighboring AP MLD(s) of the current AP MLD, through the current AP MLD.

### Initial association to the SMD-ME [M#352][M#369]

[M#352](#3912) To perform SMD-level association, a non-AP MLD shall initiate association and authentication with the SMD-ME. The SMD Information element shall be included in the Authentication frame when authenticating with the SMD-ME. The SMD Information element shall be included in the (Re)Association Request and Response frames when performing initial association with the SMD-ME.

[M#369] As part of performing authentication of a non-AP MLD with the SMD-ME, a single PMKSA shall be established between the non-AP MLD and the SMD-ME using the SMD identifier. The PMKSA includes an SMD-level PMK.

[M#369] As part of initial association of a non-AP MLD with the SMD-ME, an SMD-level PTKSA is derived between the non-AP MLD and the SMD-ME using the SMD identifier.

### Target AP MLD selection recommendation [M#364] (#188) (#2000)(#2002)(#2003)(#2004)(#2353)(#2005)

The current AP MLD may use the BSS transition management procedure (see 11.21.7 (BSS transition management) and 35.3.23 (BSS transition management for MLDs)) [TBD updates if required] to recommend one or more candidate target AP MLDs within the same SMD (or a different neighboring SMD) to the non-AP MLD, as shown in Figure 37-x2. (TBD detailed information to be carried in the BSS transition management frames).

A non-AP MLD may send a BSS Transition Management Query frame (see 11.21.7.2 (BSS transition management query)) to its current AP MLD to request recommendation for candidate target AP MLDs. The current AP MLD shall respond with a BSS Transition Management Request frame. In addition, the current AP MLD may send an unsolicited BSS Transition Management Request frame (see 11.21.7.4 (BSS transition management response)) to the non-AP MLD to indicate its recommendation for candidate target AP MLDs for SMD BSS transition. TBD – detailed information to be carried.



**Figure 37-x2— Candidate selection for target AP MLDs**

### SMD BSS transition preparation procedure

#### General

When a non-AP MLD uses SMD BSS transition to transition from its current AP MLD to a target AP MLD within an SMD, an SMD BSS transition preparation procedure as shown in Figure 37-x3 (#3004)shall be performed before performing the SMD BSS transition execution procedure that is described in 37.9.6 (SMD BSS transition execution procedure via the current AP MLD) and 37.9.7 (SMD BSS transition execution procedure via the target AP MLD) to minimize the time during which connectivity between the non-AP MLD and the DS is lost. The SMD BSS transition preparation procedure consists of (#2006)the following:

* Transfer of the context (see 37.9.7 (Context)) related to the non-AP MLD from its current AP MLD to the target AP MLD or the renegotiation of the context with the target AP MLD. (#3003)
* Setting up the link(s) with the target AP MLD as described in 37.9.5.2.



**Figure 37-x3— SMD BSS transition preparation and execution procedures**

[M#368](#3922)(#2010) A non-AP MLD prepares one or more candidate target AP MLDs within an SMD by sending a separate ST preparation request for each candidate target AP MLD. If a SMD BSS transition preparation was successful with one or more candidate target AP MLDs, then the non-AP MLD shall attempt SMD BSS transition execution with only one of those target AP MLDs at a time. If the attempted SMD BSS transition execution fails, the non-AP MLD may attempt SMD BSS transition execution with another prepared AP MLD. [TBD on policy indication from the AP on multiple target AP MLDs preparation].

#### Target links preparation

[M#283](#2715) When a non-AP MLD performs the SMD BSS transition preparation procedure to prepare a target AP MLD, the non-AP MLD shall send an ST preparation request[M#345](#493)(#2007)(#2009)(#2715)(#3457)(#3892)(#3921) to its current AP MLD.

The ST preparation request shall include the following:

* [M#345](#493)A target AP MLD MAC address.
* The Per-STA Profile subelement for each affiliated non-AP STA that the non-AP MLD is requesting to set up with the target AP MLD in the Reconfiguration Multi-link element (see 35.3.6.4 (Link reconfiguration to the setup links)) carried in the ST preparation request.
* [M#337](#517)The Listen Interval field.
* A list of SCS IDs if the non-AP MLD request that the target AP MLD prioritizes resource reservation for certain SCS streams.

[M#351](#499) The non-AP MLD shall indicate in the ST preparation request whether the non-AP MLD requests part of the context not to be transferred as described in 37.9.8 (Context) (TBD actual signaling).After receiving the ST preparation request:

* If the target AP MLD accepts one or more links requested by the non-AP MLD in the ST preparation request:
	+ The target AP MLD shall set up the accepted links at the target AP MLD according to the procedures defined in 35.3.6.4 (Link reconfiguration to the setup links).
	+ If a separate MAC SAP per AP MLD is used as described in 37.9.1 (General), the target AP MLD shall keep the IEEE 802.1X Controlled Port blocked so that general data traffic cannot pass directly between the non-AP MLD and the target AP MLD.
	+ The context for the non-AP MLD shall be transferred from the current AP MLD to the target AP MLD per 37.9.8 (Context).
	+ (#3927)The current AP MLD shall transfer the SCS descriptors of all the currently established SCS of that non-AP MLD to the target AP MLD.
		- The target AP MLD may accept or reject an SCS stream (e.g. based on its resource availability) and indicate that to the current AP MLD.
	+ (#3927)The current AP MLD shall transfer the MSCS Descriptor of the established MSCS with the non-AP MLD.
		- The target AP MLD may accept or reject the MSCS (e.g. based on its resource availability) in the ST preparation response and indicate that to the current AP MLD.
	+ If the non-AP MLD requests that the target AP MLD prioritizes resource reservation for certain SCS streams by providing a list of SCS IDs, the AP MLD should consider prioritizing requested SCS streams from the non-AP MLD when deciding whether to accept or reject an SCS.
* The current AP MLD shall send an ST preparation response[M#345](#493)(#2007)(#2009)(#2715) (#3457)(#3892)(#3921)to the non-AP MLD and the frame shall include the following:
	+ The status (Accept/Reject) of each requested link setup at the target AP MLD.
	+ If the status is Accept for at least one link, the frame shall include the following:
		- The AID assigned to the non-AP MLD by the target AP MLD
		- (#3927)A list of already established SCS streams that have been accepted by the target AP MLD. SCS streams that are not indicated as accepted are not setup at the target AP MLD
		- An indication of the status (accept or reject) of the transfer of MSCS context to the target AP MLD.
		- A list of SCS streams that have been requested by the non-AP MLD and accepted by the target AP MLD (if any).
* Group keys shall not be included in the ST preparation response.
* [M#335] (#515) If an ST execution request from the non-AP MLD requesting SMD BSS transition to a target AP MLD is not received by the current AP MLD or the target AP MLD within the timeout(#515) value indicated in the SMD Information element, the following shall be deleted:
	+ The setup links at the target AP MLD.
	+ The transferred context at the target AP MLD.

TBD on whether/how the renegotiation of context is performed in these request/response frames.

When a non-AP MLD receives an ST preparation response from the current AP MLD indicating that the SMD BSS transition preparation was successfully completed with at least one setup link established at the target AP MLD:

* The Basic Multi-link element in the ST preparation response shall be processed by the non-AP MLD according to the procedures defined in 35.3.6.4 (Link reconfiguration to the setup links).
* [M#337](#514)The non-AP MLD shall be in power save mode for all the setup links with the target AP MLD as specified in 35.3.6.4 (Link reconfiguration to the setup links).
* [M#335] (#515) The non-AP MLD may initiate the SMD BSS transition execution procedure by sending an ST execution request requesting SMD BSS transition to the same target AP MLD within the timeout value, either via the current AP MLD (see 37.9.6 (SMD BSS transition execution procedure via the current AP MLD)) or via the target AP MLD (see 37.9.7 (SMD BSS transition execution procedure via the target AP MLD)).

NOTE – The DS mapping update operation is not performed during the ST preparation procedure.

NOTE – The SCS streams that were not indicated as accepted in the ST preparation response are not set up at the target AP MLD.

### SMD BSS transition execution procedure via the current AP MLD

When a non-AP MLD uses SMD BSS transition to transition from its current AP MLD to a target AP MLD within an SMD through its current AP MLD, the non-AP MLD shall send an [M#346](#511)(#2017)(#3260)(#3458)(#3929)ST execution request to its current AP MLD (#3893) (TBD if the non-AP MLD shall stop sending Data frames to its current AP MLD)[M#346] The Per-STA Profile subelement in the Reconfiguration Multi-Link element shall not be present in the ST execution request.

[M#335](#515) If the current AP MLD receives an ST execution request within the timeout value(#515) described in 37.9.5.2 (Target links preparation) and the target AP MLD has been prepared for SMD BSS transition for the non-AP MLD as described in 37.9.5 (SMD BSS transition preparation procedure), then:

* The current AP MLD shall transfer any context that is required per37.9.8 (Context) and has not already been transferred to the target AP MLD (if any).
* If a separate MAC SAP per AP MLD is used as described in 37.9.1 (General), the target AP MLD may initiate the DS mapping update for the non-AP MLD and unblock the IEEE 802.1X Controlled Port for general data traffic to pass between the non-AP MLD and the target AP MLD.
* [M#351] If the non-AP MLD had requested its current AP MLD not to transfer the next SN for existing DL block ack agreements of all TIDs (see 37.9.8 (Context)), the target AP MLD shall reset the SN to 0 for all the DL TIDs and the non-AP MLD shall initialize *WinStartB* to 0 for each DL TID with a block ack agreement, before DL traffic delivery from the target AP MLD to the non-AP MLD.
* [M#351] If the non-AP MLD had requested its current AP MLD not to transfer the latest SN that has been passed up for existing UL block ack agreement of all TIDs (see 37.9.8 (Context)), the non-AP MLD shall reset the SN to 0 for all the UL TIDs and the target AP MLD shall initialize *WinStartB* to 0 for each UL TID with a block ack agreement, before UL traffic delivery from non-AP MLD to the target AP MLD.
* Once the DLDrainTime has expired or terminated as described in 37.9.9 (Downlink data transmission)), the target AP MLD considers the SMD BSS transition execution procedure complete (i.e., the non-AP MLD has fully transitioned to the target AP MLD).
* The current AP MLD shall send an [M#346](#511)(#2017)(#3260)(#3458)(#3929)ST execution response with the status value set to SUCCESS to the non-AP MLD after the transfer of the context is completed(#530) (if any). The current AP MLD shall include the following in the ST execution response:
	+ [M#338] (#522)(#3590)The DLDrainTime.
	+ Group keys of the successfully setup links at the target AP MLD.
* (#154)If a separate MAC SAP per AP MLD is used as described in 37.9.1 (General) and the target AP MLD has not initiated the DS mapping update for the non-AP MLD, the target AP MLD shall initiate it for the non-AP MLD and unblock the IEEE 802.1X Controlled Port for general data traffic to pass between the non-AP MLD and the target AP MLD.
* The target AP MLD shall consider the SMD BSS transition execution procedure complete (i.e., the non-AP MLD has fully transitioned to the target AP MLD) if the non-AP MLD has indicated that the DLDrainTime has terminated.

NOTE 1 – The necessary contents of the ST execution response (e.g. security parameters) might have been provided by the target AP MLD to the current AP MLD during the SMD BSS transition preparation procedure.

(#2021)NOTE 2 – The current AP MLD sets the DLDrainTime to a value sufficiently large for the non-AP MLD to receive DL data. Factors that might delay the process of retrieval of buffered downlink data include, for instance, increased path loss, non-AP unavailability due in part to uplink transmissions to target AP MLD, delay in DS mapping update, and medium congestion, DL data forwarding.

[M#44] The non-AP MLD shall not transmit Class 3 frames to the target AP MLD until it has received the ST execution response with status value set to SUCCESS from the current AP MLD for at least one link.

### SMD BSS transition execution procedure via the target AP MLD [M#284]

When a non-AP MLD uses SMD BSS transition to transition from its current AP MLD to a target AP MLD within an SMD through the target AP MLD, the non-AP MLD shall send an ST execution request to the target AP MLD (#3893) (TBD if the non-AP MLD shall stop sending Data frames to its current AP MLD).

[M#346] The Per-STA Profile subelement in the Reconfiguration Multi-Link element shall not be present in the ST execution request.

After the non-AP MLD transmits the ST execution request to the target AP MLD on one of the setup links with the target AP MLD, the non-AP STA corresponding to that link shall remain in awake state while the other non-AP STAs corresponding to the setup links remain in doze state as described in 35.3.6.4 (Link reconfiguration to the setup links).

The ST execution request and ST execution response for SMD BSS transition execution shall be transmitted on the same link between the non-AP MLD and the target AP MLD.

[M#335](#515) If the target AP MLD receives an ST execution request within the timeout value(#515) directly from the non-AP MLD described in 37.9.5.2 (Target links preparation) and the target AP MLD has been prepared for SMD BSS transition for that non-AP MLD, then:

* The target AP MLD shall transfer any context from the current AP MLD that is required per 37.9.8 (Context) and has not already been transferred to the target AP MLD (if any).
* If a separate MAC SAP per AP MLD is used as described in 37.9.1 (General), the target AP MLD may initiate the DS mapping update for the non-AP MLD and unblock the IEEE 802.1X Controlled Port for general data traffic to pass between the non-AP MLD and the target AP MLD.
* [M#351] If the non-AP MLD had requested its current AP MLD not to transfer the next SN for existing DL block ack agreement of all TIDs (see 37.9.8 (Context)), the target AP MLD shall reset the SN to 0 for all the DL TIDs and the non-AP MLD shall initialize *WinStartB* to 0 for each DL TID with a block ack agreement, before DL traffic delivery from the target AP MLD to the non-AP MLD.
* [M#351] If the non-AP MLD had requested its current AP MLD not to transfer the latest SN that has been passed up for existing UL block ack agreement of all TIDs (see 37.9.8 (Context)), the non-AP MLD shall reset the SN to 0 for all the UL TIDs and the target AP MLD shall initialize *WinStartB* to 0 for each UL TID with a block ack agreement, before UL traffic delivery from non-AP MLD to the target AP MLD.
* The target AP MLD shall send an ST execution response to the non-AP MLD after the transfer of the context is completed(#530) (if any). The target AP MLD shall include the following in the ST execution response:
	+ [M#338](#522)(#3590)The DLDrainTime (TBD if the value of the DLDrainTime shall be set to 0).
	+ Group keys of the successfully setup links at the target AP MLD.
* (#154)If a separate MAC SAP per AP MLD is used as described in 37.9.1 (General) and the target AP MLD has not initiated the DS mapping update for the non-AP MLD, the target AP MLD shall initiate it for the non-AP MLD and unblock the IEEE 802.1X Controlled Port for general data traffic to pass between the non-AP MLD and the target AP MLD.
* The target AP MLD shall consider the SMD BSS transition execution procedure complete (i.e., the non-AP MLD has fully transitioned to the target AP MLD) if the non-AP MLD has indicated that the DLDrainTime has terminated.

NOTE – The necessary contents of the ST execution response (e.g. security parameters) might have been provided by the target AP MLD to the current AP MLD during the SMD BSS transition preparation procedure.

The non-AP MLD shall not transmit Class 3 frames (other than the ST execution request to the target AP MLD) until it has received the ST execution response frame with the status value set to SUCCESS from the target AP MLD for at least one link.

### Context [M#282]M#354]

The following context can be transferred to the target AP MLD with the exceptions described in the next paragraph:

* The block ack parameters and block ack timeout value for any block ack agreement on each TID.
* The next SN to be assigned for DL individually addressed Data frame of each TID.
* The latest duplicate receiver cache for each TID without block ack agreement.
* The latest SN that has been passed up to the DS for each TID with UL block ack agreement.
* The starting PN to be assigned for DL individually addressed frame by the target AP MLD.
* The initial value to be used by each replay counter of the target AP MLD for UL individually addressed frame.
* *WinStartO* of each existing DL block ack agreement.
* (#3927)Information of SCS Descriptor elements of established SCS streams with the current AP MLD.
* (#3927)Information of MSCS Descriptor element of established MSCS and the corresponding UP{tuple} with the current AP MLD.

NOTE 1 – The *WinStartO* of each existing DL block ack agreement ensures the target AP MLD does not exceed the reordering buffer window of the non-AP MLD.

NOTE 2 – TBD on the agreed buffer size with the target AP MLD.

[M#351] A non-AP MLD may request the following part of the context not to be transferred from its current AP MLD to the target AP MLD and the current AP MLD shall accept such a request:

* The next SN for existing DL block ack agreements.
* The latest SN that has been passed up for existing UL block ack agreements.

### Downlink data transmission(#3459)

(#203)(#3757)If the current AP MLD sends an ST execution response that indicates accepted status to a non-AP MLD in response to an ST execution request sent by the non-AP MLD, the current AP MLD may transmit DL frames to the non-AP MLD for a duration of the DLDrainTime after the reception of the acknowledgement of the ST execution response, unless the DLDrainTime duration is terminated early according to rules in this section (see Figure 37-x3). After the expiration or early termination of the DLDrainTime, the current AP MLD should refrain from transmitting DL data frames to the non-AP MLD.

(#203)NOTE 1 – The current AP MLD might transmit DL frames to the non-AP MLD in the interval between receiving the ST execution request and transmitting the ST execution response.

When the non-AP MLD receives an ST execution response to an ST execution request, (#3006)(#3367) the non-AP MLD may choose to receive individually addressed buffered Data frames from its current AP MLD [M#338](#520)for the DLDrainTime (upon reception of the ST execution response) if the DLDrainTime is greater than 0. During tthe DLDrainTime, the following applies:

* [M#337] The non-AP MLD is not required to listen to any Beacon frames of the APs affiliated with the target AP MLD.
* [M#349](#524) The non-AP MLD shall send the indication of termination of the DLDrainTime to the target AP MLD if the non-AP MLD terminates the DLDrainTime before the DLDrainTime expires.
* [M#350] The current AP MLD shall support signaling termination of DL data transmission to the non-AP MLD before the DLDrainTime expires (actual signaling TBD).
* The current AP MLD should send the indication of termination of DL data transmissions when any of the following is true:
	+ The current AP MLD has no more pending DL data and is not expecting more DL data from the DS for (# 535) DL transmissions during the DLDrainTime.
	+ The current AP MLD has transferred next SN for DL as part of context to the target AP MLD and the current AP MLD has used the last SN available to the current AP MLD for all TIDs during the DLDrainTime.
* If the non-AP MLD had requested the current AP MLD to not transfer DL SNs as described in 37.9.8 (Context) during the SMD BSS transition preparation procedure:
	+ The target AP MLD shall not transmit DL data frames to the non-AP MLD until receiving an indication of termination of the DLDrainTime from the non-AP MLD.
	+ After receiving an indication of termination of the DLDrainTime from the non-AP MLD, the target AP MLD is allowed to transmit DL frames to the non-AP MLD subject to the Power states of the affiliated STAs of the non-AP MLD.
	+ The target AP MLD shall reset the SNs to 0 for all DL TIDs before starting transmissions to the non-AP MLD.
* If the non-AP MLD had requested the current AP MLD to transfer DL SNs as described in 37.9.8 (Context) during the SMD BSS transition preparation procedure:
	+ The target AP MLD is allowed to transmit DL frames to the non-AP MLD subject to the Power states of the affiliated STAs of the non-AP MLD. The target AP MLD shall start DL transmissions for all DL TIDs with the next SN values that were received during the context transfer.
	+ The target AP MLD shall not transmit DL frames to the non-AP MLD with SN values above *WinStartO* + Buffer Size (of the current AP MLD) received during context transfer, unless the non-AP MLD has indicated termination of the DLDrainTime.
	+ The target AP MLD shall not advance the DL block acknowledgement windows for any TID unless the non-AP MLD has indicated termination of the DLDrainTime.
* When the DLDrainTime expires without any early termination, the non-AP MLD shall indicate to the target AP MLD using the same signaling of the early termination that the DLDrainTime has expired.
* The current AP MLD should provide information that allows the non-AP MLD to identify the completion of downlink retrieval for a partial set of traffic categories (TID or AC) if requested by the non-AP MLD in the execution request.

### Downlink data forwarding

As part of SMD BSS transition, the current AP MLD may forward DL data to the target AP MLD (when and how to initiate the forwarding of DL data is TBD).

**Text to be adopted ends here.**