IEEE P802.11  
Wireless LANs

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| 11bn PDT-CR MAC Seamless Roaming (Part 2) | | | | |
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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, 2022, 3932, 2021, 3466, 3915, 2789, 2543, 3760, 3940, 3941, 720, 882, 2391, 531, 221, 2536, 3806, 3939, 3464 (<-22CIDs)

**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 DLDrainTimer 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 DLDrainTimer early terminates or ends.   + Added that if the non-AP MLD terminates the DLDrainTimer 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. |

**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 |  | 3004 |
| 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, 2022, 3932, 2021, 3466, 720, 882, 2391, 3464 |
| UL transmission |  | 531 |
|  |  |  |
| **Per-AP MLD PTK** |  |  |
| Allow a Per-AP MLD PTK | M#348, M#356 | 3915, 2789, 2543, 3760, 3940, 3941 |
|  |  |  |
| **Roaming directly via the target** |  | 221, 2536, 3806, 3939 |

Details of the CIDs and proposed resolution:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Clause** | **Pg/Ln** | **Comment** | **Proposed Change** | **Resolution** |
| 3915 | Binita Gupta | 37.8.2.5 | 75.36 | In 11bn for seamless roaming, two modes have been discussed for PTK generation. A shared PTK used across all AP MLDs of the SMD, and a different PTK mode generating a different PTK for each AP MLD of the SMD. The client behavior is obviously different for each of these modes. Hence we need to advertise which mode/modes are supported by the AP MLDs/SMD. This could be through defining these modes in the RSNE/RSNXE, in SMD element or via different AKMs (as is done for FT). | Define a mechanism for the AP MLD to advertise the PTK mode supported (shared PTK mode or different PTK mode) for the SMD. Make the shared PTK mode mandatory to be supported by AP MLDs and non-AP MLDs since that mode is common across both distributed and centralized SMD architectures. | Revised.  Agreed in principle. Added 1-bit in SMD information to indicate if the per-AP MLD PTK mode is supported or not. Single PTK mode is the basic mode that is mandatory for both the AP MLD and non-AP MLD to support for seamless roaming. |
| 2789 | Chittabrata Ghosh | 37.8.2.5.2 | 75.55 | A new PTK derivation mechanism should be allowed between non-AP MLD and target AP MLD for secured seamless roaming; please add details about process of derving the new PTK during 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. |
| 2543 | Jarkko Kneckt | 37.8.2.5.1 | 75.43 | Seamlessly roaming STA should be able to rekey its PTK when is roams to a new AP MLD in SMD. The rekey should be done by using ephmeral Diffie Hellmann public keys and according to 3- frame exchange PASN protocol. | Please allow a seamlessly roaming non-AP MLD to rekey its PTKSA with the roaming target AP MLD. The PTK rekey protocol uses ephmeral Diffie Hellmann public keys and 3-frames exchange according to PASN protocol. | Revised.  There are already motions to define a mode where new PTK can be generated, and per-AP TK can be used. Same resolution as CID#3915 |
| 3760 | Liuming Lu | 37.8.2.5 Seamless Roaming | 75.46 | Whether the non-AP MLD remains Single PMKSA or PTKSA during the transition is unclear. A flexible security association during the transition needs to be considered in order to adapt to different scenarios for seamless roaming. | As in the comment. | Rejected.  PMKSA and PTKSA remain the same during roaming. |
| 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 period of 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. |
| 2022 | Yelin Yoon | 37.8.2.5.3 | 76.08 | The non-AP MLD needs information on the last buffered DL data to know when it has received all the buffered data from the current AP MLD so that it can transition to the target AP MLD even before the TBD time has not been reached yet. | The last SN value of the buffered data is included in a TBD (Roaming) Response frame. | Revised.  Agreed in principle. Added text tagged as (#2022). |
| 3932 | Binita Gupta | 37.8.2.5.4 | 76.30 | To maintain SN continuity for DL Tx, the serving AP MLD would transfer the next SN to be used to the target AP MLD. There will be some extra SN space added to account for MSDUs still being tricked down from the DS. If entire extra SN space does not get used, then there will be some SNs for which no MPDUs are ever sent. Then client needs to be notified of this so that it can advance its Rx Reorder buffer window. | In the roaming signaling, define a way to provide next SN that was sent to the target AP MLD and SN of the last MPDU delivered to the non-AP MLD from the serving AP MLD. This way the client can advance its Rx Reorder buffer for any SN gap between Next SN and last SN. | Revised.  Agreed in principle. Same resolution as #2022. No further actions are needed for the editor. |
| 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. |
| 2391 | Renlong Zhou | 37.8.2.5.3 | 76.01 | Define the conditions for non-AP MLD break the link with current AP MLD; | As it says in the comment | Revised.  Agreed in principle. Same resolution as #2022. No further actions are needed for the editor. |
| 3004 | Mark RISON | 37.8.2.5.2 | 75.58 | If "Setting up the link(s) with the target AP MLD." is part of the roaming preparation procedure, then this procedure can't be optional ("may" at 75.50) | Change the "may" to "shall" | Revised.  Changed “may” to “should”. |
| 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). |
| 221 | Pei Zhou | 37.8.2.5.3 | 76.04 | In the PDT and SFD, it is possible for non-AP MLD to send a request to target AP MLD to initiate seamless roaming. But in d0.1, this case is missing. | Please add the case that non-AP MLD transmits TBD Request frame to target AP MLD if relevant motion(s) pass. | Revised.  Agreed in principle.  Created a new subclause 37.9.11 to capture this case. |
| 2536 | Jarkko Kneckt | 37.8.2.5 | 75.36 | The seamless roaming protocol should tolerate non-AP MLD links losses to the serving AP MLD at any time during the roaming. The connectivity loss shall not prevent the seamless roaming. | Please allow seamless roaming initiation directly with the target AP MLD. Please add support to seamless roaming signaling to tolerate links loss with the serving AP MLD at any point during the roaming. | Revised.  Agreed in principle.  Created a new subclause 37.9.11 to capture this case. |
| 3806 | Yongho Seok | 37.8.2.5.3 | 76.04 | "When a non-AP MLD uses Seamless roaming to transition from the current AP MLD to a target AP MLD, the non-AP MLD shall send a TBD Request frame to the current AP MLD." Depending on the DS type and link quality, directly sending a TBD Request frame to the target AP MLD can be more efficient. | Please define the seamless roaming mechanism for directly signaling to the target AP MLD. | Revised.  Agreed in principle.  Created a new subclause 37.9.11 to capture this case. |
| 3939 | Binita Gupta | 37.8.2.5.3 | 76.01 | A client should be able to roam directly though the target AP MLD in case of last minute or panic roam. This should be possible for both cases - a)when client has performed a roaming prep via the serving AP MLD, and b)when the client has not performed roaming prep with the serving AP. | Define procedure for Direct Roaming through the Target AP MLD for both the cases covered in the comment. | Revised.  Agreed in principle.  Created a new subclause 37.9.11 to capture this case. |

**Text to be adopted begins here.**

***TGbn editor: Please add the following new subclause 9.4.2.xxx (SMD Information element) to the 802.11bn draft D0.1:***

**9.4.2.xxx SMD Information element [M#352][M#369](#3920)(#3470)**

The SMD Information element contains the SMD Identifier field and SMD Capabilities field for a seamless mobility domain. The format of the SMD Information element is shown in Figure 9-xx1 (SMD Information element format).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Element ID | Length | Element ID Extension | SMD Identifier | SMD Capabilities | Timeout Value |

Octets: 1 1 1 6 1 3

**Figure 9-xx1—SMD Information element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1 (General).

The SMD Identifier field indicates a unique identifier for the SMD and is in the format of a 48-bit MAC address.

The format of the SMD Capabilities field is defined in Figure 9-xx2 (SMD Capabilities field format).

B0 B1 B2 B7

|  |  |  |
| --- | --- | --- |
| DL Data Forwarding | (#3915)Per-AP MLD PTK | Reserved |

Bits: 1 1 6

**Figure 9-xx2—SMD Capabilities field format**

The DL Data Forwarding field is set to 1 if forwarding of buffered DL data of a non-AP MLD from the current AP MLD to a target AP MLD is supported by the SMD and is set to 0 otherwise.

(#3915)The Per-AP MLD PTK field is set to 1 if the SMD supports a per-AP MLD PTK and is set to 0 otherwise.The Timeout Value field contains an unsigned 32-bit integer and it is set to the timeout between the ST preparation response and ST execution request in units of TU. It is encoded according to the conventions in 9.2.2 (Conventions).

[TBD other fields for other SMD level capabilities]

***TGbn editor: Please modify subclause 37.9 SMD BSS transition in the 802.11bn draft D0.2 as follows:***

## 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 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 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#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 with improvements.

[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 procedure (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 procedure
  + Through current AP MLD (see 37.9.6)
  + Through a target AP MLD (see 37.9.7)

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

[Editorial note: this section captures how a UHR non-AP MLD discovers whether an AP MLD supports SMD BSS transition, the corresponding sub-capabilities of SMD BSS transition, and the SMD/SMD-ME that manages this AP MLD.]

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 BTM 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 and 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 BTM Request 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.

NOTE - The neighboring AP MLD and the current AP MLD are in the same ESS.

### 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 an SMD-ME. The SMD Information element shall be included in the (Re)Association Request & 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 (TBD PMK computation details).

[M#378][#279] If the SMD is part of an FT mobility domain, and if the non-AP MLD initially associates with the SMD-ME using FT initial MD association, then the single PMKSA to be used in the SMD shall be a PMK-R1 security association that is bound to the SMD-ME (TBD PMK-R1 computation details)

[M#369] As part of initial association of a non-AP MLD with the SMD-ME, an SMD level PTK is derived between the non-AP MLD and the SMD-ME using the SMD Identifier (TBD PTK computation details).

### 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 BTM frames).

A non-AP MLD may send a BTM 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 BTM Request frame. In addition, the current AP MLD may send an unsolicited BTM 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 should(#3004) 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). The SMD BSS transition preparation procedure consists of (#2006)the following to minimize the time during which connectivity between the non-AP MLD and the DS is lost:

* 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 may prepare 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#336](#516) The AP MLD MAC address of the single target AP MLD
* [M#345](#493) The per-STA profile of the links to be 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 STA preparation request.
* [M#356] A Diffie-Hellman Parameter element (see 9.4.2.312 (Diffie-Hellman Parameter element)) that contains the public key generated by the non-AP MLD if a per-AP MLD PTK is used.

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

[M#337](#517)The non-AP MLD shall include the Listen Interval in the ST preparation request.

(#3915)If the SMD-ME corresponding to the current AP MLD supports a per-AP MLD PTK, the non-AP MLD may use a per-AP MLD PTK. The non-AP MLD shall not use a per-AP MLD PTK if the SMD-ME corresponding to the current AP MLD does not support a per-AP MLD PTK.

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) [Editorial note: need to capture any exceptions or differences or additional rules with respect to 35.3.6.4].
  + 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 if separate MAC-SAP per AP MLD is used as described in 37.9.1 (General).
  + The transferable context (see 37.9.8 (Context)) is transferred from the current AP MLD to the target AP MLD.
  + [M#335](#515)(#2790) The non-AP MLD and the target AP MLD shall not modify the setup links unless another preparation is performed.
  + [M#348] If a per-AP MLD PTK is used, the target AP MLD shall derive a new TK with the non-AP MLD as described in 37.9.5.3.
* The current AP MLD shall send an STA 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.
  + The AID assigned to the non-AP MLD by the target AP MLD.
  + [M#356] A Diffie-Hellman Parameter element (see 9.4.2.312 (Diffie-Hellman Parameter element)) that contains the public key generated by the target AP MLD and a MIC generated by the target AP MLD if a per-AP MLD PTK is used.
* [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 a timeout(#515) value indicated in the SMD Information element, the SMD BSS transition preparation at the target AP MLD, including setup links, transferred context, [M#348]and the newly derived K if a per-AP MLD PTK is used shall be deleted.

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 at the target AP MLD:

* The non-AP MLD shall process the Reconfiguration Multi-link element in the ST preparation response according to the procedures defined in 35.3.6.4 (Link reconfiguration to the setup links).
* [M#348] If a per-AP MLD PTK is used, the non-AP MLD shall derive a new TK with the target AP MLD as described in 37.9.5.3.
* [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 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 described above in this subclause.

#### Per-AP MLD PTK derivation [M#356]

The PTK derived by a non-AP MLD with a target AP MLD during SMD BSS transition for the negotiated AKM suite reuses the same formula structure used to derive the PTK in the initial association (between the non-AP MLD and the SMD-ME) with the addition of DHss to the PTK derivation input at the end if the existing PTK derivation input does not have DHss.

When a new PTK is generated, a new KCK, KEK, TK, and KDK are also generated. The PTK generated is a pairwise secret between the AP MLD and the non-AP MLD and it is also part of the PTKSA.

### 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) ((#531). The non-AP MLD shall stop sending Data frames to its current AP MLD. [M#337](#519)(#518) The ST execution request shall include the target AP MLD MAC address. The ST execution request shall include the Listen Interval(#517) if it was not included during SMD BSS transition preparation. [M#346] The Per-STA Profile subelement in the Reconfiguration Multi-Link element may not be present in the ST execution request if it was included during SMD BSS transition preparation.

[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, 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 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 BA 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 BA 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 BA 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 BA 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 shall consider the SMD BSS transition execution procedure complete (i.e., the non-AP MLD has fully transitioned to the target AP MLD). The non-AP MLD shall initialize WinStartB to 0 for each DL TID that has a block ack agreement established.
* 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). The current AP MLD shall include the following in the ST execution response:
  + [M#338] (#522)(#3590)The DLDrainTime.
  + (#2022) The starting SN assigned to the target AP MLD for all downlink TIDs, if the non-AP MLD had requested the current AP MLD to transfer downlink SNs as described in 37.9.8 (Context).
  + (#154)If 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 may 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.
* If a per-AP MLD PTK is used, the target AP MLD shall not reset the PNs for either UL or DL. The PNs keep increasing monotonically when the non-AP MLD transitions to the target AP MLD even though the target AP MLD is using a new TK.
* The target AP MLD shall consider the SMD BSS transition execution has completed if the period of DLDrainTime has passed since the ST execution response or the non-AP MLD has indicated that the period of DLDrainTime is to be terminated early (i.e., the non-AP MLD has fully transitioned to the target AP MLD).

(#2021)NOTE – 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 from the current AP MLD.The non-AP MLD shall not exchange management frames with the current AP MLD once it has received a ST execution response.

### 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). (#531)The non-AP MLD shall stop sending Data frames to its current AP MLD.

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 the active state (PM=0) while the other non-AP STAs corresponding to the setup links remain in doze state of power save mode 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 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 BA 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 BA 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 BA 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 BA 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). The target AP MLD shall include the following in the ST execution response:
  + [M#338](#522)(#3590)The DLDrainTime ( the DLDrainTime shall be set to 0).
  + (#154)If 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 may 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.
* [#348] If a per-AP MLD PTK is used, the target AP MLD shall not reset the PNs for either UL or DL. The PNs keep increasing monotonically when the non-AP MLD transitions to the target AP MLD even though the target AP MLD is using a new TK.
* 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).

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 from the target AP MLD. The non-AP MLD shall not exchange management frames with the current AP MLD once it has received a ST execution response.

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

The following context can be transferred to the target AP MLD:

* 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 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.

NOTE 1 – The WinStartO of each existing DL block ack agreement ensures the target AP MLD does not exceed 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 transmits a ST execution response frame that indicates accepted status to a non-AP MLD (in the Reconfiguration Status List field in the ST execution response) 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 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 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.

(#203)NOTE 2 – The current AP MLD continues to transmit DL frames to the non-AP MLD if the ST execution response indicates rejected status.

When the non-AP MLD receives an ST execution response to an ST execution request sent by the non-AP MLD, (#3006)(#3367) the non-AP MLD may receive the individually addressed buffered DL Data frames from its current AP MLD [M#338](#520)for a period of DLDrainTime if the DLDrainTime is greater than 0. During the period of (non-zero) 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#350] The current AP MLD shall support signaling termination of DL data transmission to the non-AP MLD before the DLDrainTime ends (actual signaling TBD).

NOTE – AP sends the indication when there is no more pending DL data on any TID. TBD other conditions.

* [M#349](#524) The non-AP MLD may provide an indication to the target AP MLD to indicate that the period of DLDrainTime is to be terminated before the DLDrainTime ends.
* [M#350] The current AP MLD shall support signaling termination of DL data transmissions to the non-AP MLD before the DLDrainTime ends (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 (# 535) for DL transmissions during DLDrainTime and DS mapping update is expected to be complete.
  + The current AP MLD has transferred DL SNs as part of context and the current AP MLD has transmitted data belonging to the last SN available to the current AP MLD for all TIDs during DLDrainTime.
* If the non-AP MLD had requested the current AP MLD to not transfer DL SNs as described in 37.9.8 (Context):
  + The target AP MLD shall not transmit DL data frames to the non-AP MLD until the end of DLDrainTime or until receiving an indication of termination of DLDrainTime from the non-AP MLD.
  + After the end of DLDrainTime or receiving an indication of termination of DLDrainTime from the non-AP MLD, the target AP MLD shall 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 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 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 received during context transfer, unless the non-AP MLD has indicated termination of 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 DLDrainTime or the DLDrainTime has ended.
  + When the DLDrainTime ends 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 ended.
* 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.**

**References:**

1. [11-24-0171r20](https://mentor.ieee.org/802.11/dcn/24/11-24-0171-20-00bn-tgbn-motions-list-part-1.pptx): 11-24-0171-20-00bn-tgbn-motions-list-part-1, Alfred Asterjadhi (Qualcomm Inc.)
2. [11-25-0014r7](https://mentor.ieee.org/802.11/dcn/24/11-24-0171-20-00bn-tgbn-motions-list-part-1.pptx): 11-25-0014-07-00bn-tgbn-motions-list-part-2, Alfred Asterjadhi (Qualcomm Inc.)
3. 11-25-0014r13: 11-25-0014-13-00bn-tgbn-motions-list-part-2, Alfred Asterjadhi (Qualcomm Inc.)

**Relevant passed motions (since draft D0.1):**

All the passed motions in TGbn up to and including those in the 2025 March IEEE 802.11 TGbn meeting (see [3]).

[Motion #2, [1]]

Move to add the following text to the TGbn SFD

* + 11bn defines a mechanism that enables a non-AP MLD to roam from one AP MLD to another AP MLD and the non-AP MLD remains in state 4 (see 11.3) during and after roaming to the other AP MLD

[Motion #26, [1]]

Move to add the following text to the TGbn SFD:

* Define in 11bn that when a non-AP MLD is in the process of roaming from the current AP MLD to a target AP MLD, the context related to the non-AP MLD is transferred to the target AP MLD such that it preserves the data exchange context for the non-AP MLD or the context can be renegotiated with the target AP MLD
  + Details on what context can be transferred and what context can be renegotiated are TBD
  + How to transfer the context is TBD.

[Motion #27, [1]]

Move to add the following text to the TGbn SFD:

* As part of the seamless roaming procedure, during roaming,
  + after the request/response exchange that initiates notification of the DS mapping change from the current AP MLD to the target AP MLD,
    - The current AP MLD may deliver buffered DL data frames for a TBD period of time.
    - The non-AP MLD may retrieve buffered DL data frames from the current AP MLD
    - The non-AP MLD may send UL data to target AP MLD.
    - It is assumed that the target AP MLD is able to deliver data frames to non-AP MLD after the DS mapping change
  + 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

[Motion #44, [1]]

Move to add to the TGbn SFD the following:

* Define a request frame sent by a non-AP MLD in state 4 to initiate the roaming procedure
* The roaming procedure performs context transfer to the target AP MLD and perform the necessary changes of the DS mapping from the current AP MLD to the target AP MLD
* Define a response frame sent to the non-AP MLD to indicate readiness for the non-AP MLD to send class 3 frames to the target AP MLD
* TBD on data transmission from non-AP MLD to current AP MLD during the request/response frame exchange
* NOTE – What context is transferred is TBD.
* NOTE – TBD on which request/response frame to use

[Motion #162, [1]]

Move to add to the TGbn SFD the following:

* As part of seamless roaming procedure, before the request/response exchange requesting the roaming transition from a current AP MLD to a target AP MLD, a roaming preparation procedure can be performed that includes:
* Transfer or renegotiation of the context to a target AP MLD, and
* Setting up the link(s) with a target AP MLD.
* Details on what context can be transferred or renegotiated is TBD

**Jan 2025 Kobe**

[Motion #279, [2]]

Move to add to the TGbn SFD the following:

* 11bn defines a Seamless Mobility Domain (SMD, exact name TBD) that covers multiple AP MLDs, where a non-AP MLD can use the UHR seamless roaming procedure to roam between the AP MLDs of the SMD
  + A logical SMD Management Entity (SMD-ME, exact name TBD) provides association, IEEE 802.1X Authenticator (except for the management of 802.1X control ports which is TBD) and RSNA Key management for non-AP MLDs across all AP MLDs of the SMD.
  + A non-AP MLD transitions between AP MLDs within the SMD while maintaining its association and security association with the SMD-ME.
  + The non-AP MLD can transition from one SMD to another SMD that are part of the same MD (Mobility Domain) using FT with improvements

[Motion #280, [2]]

Move to add to the TGbn SFD the following:

* 11bn defines that within a Seamless Mobility Domain (SMD, exact name TBD) the data path includes either one MAC-SAP for the SMD or a separate MAC-SAP per AP MLD of the SMD.
* In the case of a separate MAC-SAP per AP MLD, the DS mapping is updated when the non-AP MLD roams to another AP MLD within the SMD.
* In the case of a separate MAC-SAP per AP MLD, 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.
* 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.

[Motion #282, [2]]

Move to add to the TGbn SFD the following:

* When a non-AP MLD is in the process of roaming from a current AP MLD to a target AP MLD, the non-AP MLD can request to the current AP MLD what context needs to be transferred from the current AP MLD to the target AP MLD.
  + What context can be requested is TBD
  + It applies when the current AP MLD and the Target AP MLD support the context transfer

[Motion #283, [2]]

Move to add to the TGbn SFD the following:

* As part of seamless roaming procedure, a non-AP MLD can initiate a roaming preparation procedure with a target AP MLD by sending a TBD request frame to its current AP MLD.
  + The request frame indicates the set of links to be set up with the target AP MLD.
  + The request frame indicates the context to be transferred or renegotiated with the target AP MLD.
  + The current AP MLD sends a TBD response frame to the non-AP MLD to indicate the status (accept/reject) of the link setup.
    - If the link setup is accepted, the transferable context is transferred to the target AP MLD.
  + TBD on whether/how the renegotiation of context is performed in these request/response frames
  + TBD – multiple candidate target AP MLDs selection

[Motion #284, [2]]

Move to add to the TGbn SFD the following:

* As part of seamless roaming procedure, a non-AP MLD in state 4 with the SMD-ME can perform roaming transition through a target AP MLD that is a part of the SMD.
* TBD on the conditions and details for performing roaming through target AP MLD

[Motion #285, [2]]

Move to add to the TGbn SFD the following:

* For security in seamless roaming, when a non-AP MLD is in the process of roaming from the current AP MLD to a target AP MLD within the SMD, the same PMKSA, established with the SMD-ME, shall be used to protect communications with the current AP MLD and the target AP MLD.

[Motion #286, [2]]

Move to add to the TGbn SFD the following:

* For security in seamless roaming, when a non-AP MLD is in the process of roaming from the current AP MLD to a target AP MLD within the SMD, the same PTKSA, established with the SMD-ME, shall be used to protect communications with the current AP MLD and the target AP MLD.

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[Motion #333, [3]]

**Move to add to the TGbn SFD the following:**

* Define a mechanism to retrieve probe response content for neighboring AP MLD(s) of the current AP MLD, through the current AP MLD
* Note. The neighboring AP MLD and the current AP MLD are in the same ESS

[Motion #335, [3]]

**Move to add to the TGbn SFD the following:**

* After the roaming preparation request/response exchange, there is an indicated timeout
  + If there is no successful transmission of the roaming execution request frame from the non-AP MLD within the indicated timeout, then the target AP MLD may delete all preparation information related to the non-AP MLD
    - NOTE - This includes security context, i.e., new derived TK if new TK is derived
  + if the roaming preparation request for a target AP MLD is accepted in the roaming preparation response, and the non-AP MLD sends a following roaming execution request for the target AP MLD received within the indicated timeout, then the roaming execution request shall be accepted in the roaming execution response
  + TBD on indication of the timeout
* After the latest roaming preparation request/response exchange, the setup links with the target AP MLD is not modified until after the roaming execution request/response exchange is finished.

[Motion #336, [3]]

**Move to add to the TGbn SFD the following:**

* There is only one target AP MLD indicated in the roaming preparation request frame from a non-AP MLD.

[Motion #337, [3]]

**Move to add to the TGbn SFD the following:**

* The roaming preparation request frame includes Listen Interval field of the non-AP MLD for the target AP MLD
* The roaming execution request frame includes Listen Interval field of the non-AP MLD for the target AP MLD if there is no roaming preparation request/response exchange beforehand
* After the roaming execution request/response exchange with the current AP MLD, the non-AP MLD is by default in power save mode for all the setup links with the target AP MLD
* After the roaming execution request/response exchange with the current AP MLD, during the TBD period to receive DL data from the current AP MLD, the non-AP MLD is not required to listen to any Beacon frames of the APs affiliated with the target AP MLD.

[Motion #338, [3]]

**Move to add to the TGbn SFD the following:**

* After the roaming execution request/response exchange with the current AP MLD, the TBD period to receive DL data from the current AP MLD ends after the indicated timeout in the roaming execution response.

[Motion #344, [3]]

**Move to add to the TGbn SFD the following:**

* TGbn does not define a requirement for a UHR AP to report non-collocated APs in the Reduced Neighbor Report element that is carried in its Beacon and FILS Discovery frames

[Motion #345, [3]]

**Move to add to the TGbn SFD the following:**

* The Link Reconfiguration Request/Response frames (with necessary extensions) shall be used as the roaming preparation Request/Response frames
  + The Per-STA Profile subelement of the Multi-Link shall be present and each corresponds to the requested/accepted links
  + TBD signaling to indicate that the request is to initiate roaming preparation
  + Other extension (if needed) TBD

[Motion #346, [3]]

**Move to add to the TGbn SFD the following:**

* The Link Reconfiguration Request/Response frames (with necessary extensions) shall be used as the roaming execution Request/Response frames?
  + The Per-STA Profile subelement of Multi-Link element is not required to be present.
  + TBD signaling to indicate that the request is to initiate roaming execution transition
  + Other extension (if needed) TBD

[Motion #348, [3]]

**Move to add to the TGbn SFD the following:**

* TGbn allows a second mode for security in roaming (in addition to the first mode with single TK used across all AP MLDs of the SMD) where a non-AP MLD can derive a new TK under the same PTKSA with the target AP MLD
  + The new TK is derived as part of the single PTKSA
  + The PN is maintained per PTKSA: The new TK negotiated with the target AP MLD shares the same PN space with the TK of the current AP MLD (PN is monotonically increasing)

[Motion #349, [3]]

**Move to add to the TGbn SFD the following:**

* During the TBD time for retrieving DL from the Current AP MLD, the non-AP MLD may provide an indication to the Target AP MLD that the TBD time for DL retrieval is early-terminated before the TBD time
* TBD signaling of the indication

[Motion #350, [3]]

**Move to add to the TGbn SFD the following:**

* During a roaming transition, the current AP MLD shall be capable of signaling termination of downlink data transmission to the non-AP MLD before the TBD time period to receive buffered downlink data from current AP MLD ends
  + Signaling TBD

NOTE: AP sends the indication when there is no more pending DL data (all TIDs). TBD other conditions.

[Motion #351, [3]]

**Move to add to the TGbn SFD the following:**

* In the seamless roaming procedure, non-AP MLD can request not to transfer from the current AP MLD to the target AP MLD any of the following as part of the context transfer
  + The next SN for existing DL BA agreements of all TIDs
  + The latest SN that has been passed up for existing UL BA agreements of all TIDs

[Motion #352, [3]]

**Move to add to the TGbn SFD the following:**

* 11bn defines an SMD element that provides identification for the SMD and SMD level capabilities for a seamless mobility domain
  + The SMD element is advertised in Probe Response frames
  + The SMD element is included in Authentication frame when performing authentication with an SMD
  + The SMD element is included in (Re)Association Request & Response frames when performing initial association with the SMD-ME

[Motion #353, [3]]

**Move to add to the TGbn SFD the following:**

* 11bn enhances Neighbor Report element to provide SMD related information
  + Add a ‘Same SMD’ indication in the BSSID Information in the NR element, to signal whether the reported neighboring AP is part of the same SMD as the reporting AP
  + Allow including the SMD element as a subelement in the Optional Subelements of the Neighbor Report element, when reported neighboring AP is not part of the same SMD

[Motion #354, [3]]

**Move to add to the TGbn SFD the following:**

* Enable the following contexts to be transferred to target AP MLD to preserve the data exchange context for the non-AP MLD
* Block Ack Parameters and Block Ack Timeout Value indicated by the non-AP MLD for existing BA agreement of a TID
* Next SN to be assigned for DL individually addressed data frame of each TID
* Latest duplicate receiver cache for TID without BA agreement
* latest SN that has been pass up for TID with UL BA agreement
* Starting PN to be assigned for DL individually addressed frame by the target AP MLD
* Initial value to be used by each replay counter of the target AP MLD for UL individually addressed frame
* WinStartO of an existing DL BA agreement
  + So that the target AP MLD does not exceed reordering buffer window of the non-AP MLD
* TBD for other contexts

[Motion #356, [3]]

**Move to add to the TGbn SFD the following:**

* TBD request frame initiating roaming preparation carries the Diffie-Hellman Parameter element of the non-AP MLD when new PTK is derived
* TBD response frame during roaming preparation carries Diffie-Hellman Parameter element generated by the target AP MLD when new PTK is derived
* Non-AP MLD and the target AP MLD derive the PTK based on the shared PMK and DHss in TBD request and TBD response frames

Note: Details of the algorithm used to derive the DHss are TBD

[Motion #364, [3]]

**Move to add to the TGbn SFD the following:**

* A serving AP MLD can use the BTM procedure with update(s) (if required) to recommend one or more candidate target AP MLDs within the UHR seamless roaming mobility domain to a non-AP MLD for roaming.
  + Note – An AP can transmit the BTM Request frame unsolicited or as a response to BTM Query from a non-AP MLD.
* TBD – detailed information to be carried

[Motion #368, [3]]

**Move to add to the TGbn SFD the following:**

* For seamless roaming, a non-AP MLD is allowed to request preparing more than one candidate target AP MLDs in an SMD during the roaming preparation phase
  + Preparation with multiple AP MLDs is performed using a separate roaming preparation request for each AP MLD
  + If successful roaming preparation was performed with multiple candidate target AP MLDs, then the non-AP MLD shall attempt roaming execution with only one of those target AP MLDs at a time.
    - Retries with other target AP MLDs are permitted for roaming execution
  + TBD on policy indication from the AP on multiple target AP MLDs preparation

[Motion #369, [3]]

**Move to add to the TGbn SFD the following:**

* For a Seamless Mobility Domain (SMD), the SMD and the 802.1X Authenticator component in the corresponding SMD-ME are uniquely identified by an SMD identifier
  + The SMD identifier is in the format of a 48-bit MAC address
  + The SMD identifier is used in establishing single PMKSA and PTKSA for a non-AP MLD that associates with the SMD-ME

[Motion #378, [3]]

**Move to add to the TGbn SFD the following:**

* If the SMD is part of an FT mobility domain the following applies
  + The single PMKSA to be used in the SMD is the PMK-R1 SA and is bound to the SMD-ME, when the non-AP MLD initially associates with the SMD ME using FT initial MD association.