IEEE P802.11
Wireless LANs

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| D1.0 CIDs FA mechanisms summary |
| Date: 2025-07-29 |
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Abstract

This submission proposes resolution of comments received against the following sections of TGbi Draft 1.0 (see [1]):

* 3.2 (Definitions specific to IEEE 802.11)
* 3.4 (Abbreviations and acronyms)
* 4.5.4.10a (Enhanced Data Privacy (EDP) enhancements)
* 10.71.1 (Introduction)
* 10.71.3 (Establishing frame anonymization parameter sets)
* 10.71.4 (Establishing BPE frame anonymization parameter sets)

We propose draft specification text for TGbi draft D1.3.

Resolved CIDs (32): 128, 153, 157, 221, 222, 223, 224, 225, 352, 512, 514, 515, 516, 517, 561, 755, 795, 796, 797, 798, 814, 941, 1024, 1026, 1031, 1032, 1033, 1034, 1035, 1036, 1037, 1038

Revisions:

* Rev 00: Initial version of the document.
* Rev 01: Applying this set of CIDs to 10.71.3 (#130, #223) and 10.71.4 (#223)
* Rev 02: Noting existing changes in 3.2 and 3.4 are for CID #223.
* Rev 03: Changes during 2025-07-07 (Monday) ad-hoc session.
* Rev 04:
	+ Changes during 2025-07-08 (Tuesday) ad-hoc session.
	+ Added resolvutions to CIDs #153, #755,
	+ Moved (to another contribution), MIB definition and other requirements addressing CIDs: #129, #130, #131, #156, #510, #957.
* Rev 05: Minor updates during 2025-07-28 Tuesday PM2 session in Madrid.

**Background**

Overview of noteworthy changes

* Updates to 4.5.4.10a:
	+ Alignment of text on CPE FA mechanisms and BPE FA mechanisms (#223)
	+ Text explaining why SA/DA needs to be updated (#225)
* Updates to 10.71.1 (Introduction):
	+ Description of the mechanisms comprising frame anonymization
	+ Explaining that the set of BPE FA mechanisms includes the CPE FA mechanisms
	+ Use of MIB in text
* Updates to Annex C.3 (MIB detail):
	+ Definition of an MIB for enabling CPE FA mechanisms or BPE FA mechanisms (noting BPE FA includes CPE FA)

Note that the authors have further changes to 4.5.4.10a and 10.71.1 which are provided in in 25/0951.

Note that the authors have further changes to 10.71.3 which are provided in in 25/1103.

| **CID** | **Commenter** | **Clause** | **Page.Line** | **Comment** | **Proposed Change** | **Resolution** |
| --- | --- | --- | --- | --- | --- | --- |
| 512 | Mark RISON | 10.71.1 | 75.02 | At 25.1 we have "An AP MLD supporting BPE EDP features may reduce the availability of information about itself to a third party observer such as the ESS to which it belongs" but at 75.26 we have "Frame anonymization addresses unencrypted fields and elements in Beacon frames and individually addressed frames containing values that facilitate presence monitoring of a non-AP MLD", so it's not clear whether BPE is about the privacy of the AP or of the non-AP. Ooh, and in 10.71.8 it's both: "BSS Privacy Enhancement (BPE) operations protect privacy of BPE AP MLDs and associated BPE non-AP MLDs."! | Clarify the intent of BPE | **Revised**. **Discussion.** Agreed. This comment is like CID #223. Changes in 4.5.4.10a and 10.71.1 address this comment. **Changes**:Instructions to Editor: Apply the changes in this document identified by “#512” |
| 153 | Stephen McCann | 10.71.1 | 75.22 | If you expand "EDP CPE" you have "Enhanced Data Privacy Client Privacy Enhancements". I think some of this terminology can be optimised. | Replace "EDP CPE" with "CPE" and also at P81L44, P81L47 and P82L3. | **Revised****Discussion:** Specific changes are required for each identified instance.**Changes:****P75 line 22**Replace “EDP CPE” with “EDP”Instructions to Editor: Apply the changes in this document identified by “#153”**P81 line 44, P81 line 47,** This text is deleted by CID #816 in 25/1103. No change required.**P82 line 02**No changes required. |
| 1024 | Philip Hawkes | 10.71.1 | 75.23 | FA provides CPE features and BPE features. | Replace "EDP CPE feature" with "EDP feature" | **Accepted** |
| 221 | Jarkko Kneckt | 10.71.1 | 75.23 | The frame anonymization clause should introduce BPE MLDs. The BPE MLDs should be mentioned in the first sentence and there should be clear introduction to both operations easily available. | Change the first sentence to read:" Frame anonymization (FA) is an EDP feature available when MLO is supported." | **Revised.****Discussion:** it seems more accurate to finish the sentence with “…enabled” rather than “supported”.**Changes**Editor: Apply the changes in this document identified by “#221” |
| 222 | Jarkko Kneckt | 10.71.1 | 75.23 | There DS address has value for non-MLO devices. For MLDs, i.e. operation with the CPE and BPE operations DS address does not have value. The DS address is very similar with MLD address.If a (CPE /BPE) non-AP MLD is identified by PMKID, then link address and MLD address can be selected freely. | Allow CPE and BPE MLDs to operate without the DS MAC Address. | **Rejected****Discussion**: My understanding is that DS MAC address is a prerequisite. However, I’m not confident on this, so I am open to further discussion on this. |
| 224 | Jarkko Kneckt | 10.71.1 | 75.26 | The Beacon frames are anonymized only in the BPE mode. | Please clarify that Beacon and AP parameters in general are anonymized only in the BPE mode | **Revised****Discussion**: Agree in principle to identifying which frames are anonymized as part of CPE and BPE as part of the description of FA mechanisms for CID #223**Changes:**Instructions to Editor: Apply the changes in this document identified by “#224” |
| 1026 | Philip Hawkes | 10.71.1 | 75.27 | BPE FA prevents presence monitoring of AP MLD (in addition to non-AP MLD already noted) | Replace "non-AP MLD" with "MLD" throughout the paragraph (4 occurences) | **Revised****Discussion:** The text that was in this paragraph has been deleted by CID #938. **Changes**: None |
| 223 | Jarkko Kneckt | 10.71.1 | 75.36 | The frame anonymization levels (CPE and BPE) should be described in the introduction. | Please add CPE and BPE introduction. | **Revised****Discussion**: Partition FA mechanisms into:- CPE FA mechanisms: - EDP epoch operation - AID anonymization - CPE MAC header anonymization (MHA), - BPE FA mechanisms: - BPE MAC header anonymization (MHA)-Using A-MSDU to hide SA and DA(If desired, Privacy Beacon can be included as a BPE FA mechanism)**Changes**:Instructions to Editor: Apply the changes in this document identified by “#223”  |
| 1031 | Philip Hawkes | 10.71.1 | 75.45 | There is no text explaining what FA provides with and without BPE enabled. | Insert the following text:"If an AP MLD does not have BPE enabled, then FA mitigates presence monitoring of non-AP MLDs only. If an AP MLD has BPE enabled, then FA mitigates presence monitoring of both non-AP MLDs only. " | **Revised****Discussion:** This is addressed by the resolution of CID #223**Changes**: None |
| 1032 | Philip Hawkes | 10.71.1 | 75.52 | There is no text about AID anonymization | Insert the following text:The AP MLD anonymizes AID by assigning random temporary AID for each non-AP MLD. | **Revised****Discussion:** Include a summary of AID anonymization as part of the overview of FA mechanisms introduced by #223.**Changes**Instructions to Editor: Apply the changes in this document identified by “#1032” |
| 514 | Mark RISON | 10.71.1 | 75.57 | "over the air values" should be "over-the-air values". Also 75.65, 76.1/5 | As it says in the comment | **Revised****Discussion**: This text has been deleted by CID #223. However, in any new text only “over-the-air values” is used. **Changes**Instructions to Editor: Apply the changes in this document identified by “#514” |
| 515 | Mark RISON | 10.71.1 | 75.57 | "safely transmitted in the clear while maintaining anonymity" -- not clear what "safely" means here | Delete "safely" | **Revised****Discussion**: This text has been deleted by CID #223. However, since the identified sentence applies to all “over-the-air” values, it makes sense to include a general statement towards the start of the section.**Changes**:Instructions to Editor: Apply the changes in this document identified by “#515” |
| 755 | Jerome Henry | 10.71.1 | 75.59 | The address is said to be set to a random MAC, but randomness implies that no one knows its value, as it is picked with a random algorithm, which is not how this works. | the address is not set to a random value, as the AP and the STA know which value it is going to be. We may want to say that the address is a "local MAC address" Following 802 naming convention) | **Revised****Discussion**: This text is deleted by CID #223, so the comment is no longer applicable.**Changes**: None |
| 1033 | Philip Hawkes | 10.71.1 | 75.59 | Update this item to indicate that it applies to individually addess frames, and identify processing of affiliated AP addresses when BPE is enabled. | The Address 1 field and/or the Address 2 field of individually address frames are set to a temporary random MAC address for the affiliated STA of the non-AP MLD on the link on which the frame is transmitted and, if the AP MLD has BPE enabled, then a temporary random MAC address for the affiliated AP of the AP MLD on the link on which the frame is transmitted. | **Revised****Discussion**: This text is deleted by CID #223, so the comment is no longer applicable.**Changes**: None |
| 1034 | Philip Hawkes | 10.71.1 | 75.62 | There is no text about group addressed frames. | Insert the following bullet in the list:- For group addressed frames transmitted by an AP MLD with BPE enabled, the Address 1 field transformed into over the air values that can be safely transmitted in the clear while maintaining anonymity. and the Address 2 field is set to a temporary random MAC address for the affiliated AP of the AP MLD on the link on which the frame is transmitted. | **Revised****Discussion**: This text is deleted by CID #223, so the comment is no longer applicable.**Changes**: None |
| 1035 | Philip Hawkes | 10.71.1 | 75.62 | There is no text about Timestamp anonymization when BPE is enabled | Append the following bullet to the list:- If the AP MLD has BPE enabled, then the Timestamp in Privacy Beacon frames are transformed into over the air values that can be safely transmitted in the clear while maintaining anonymity. | **Revised****Discussion**: This text is deleted by CID #223, so the comment is no longer applicable.**Changes**: None |
| 516 | Mark RISON | 10.71.1 | 75.63 | "The intended receiving MLD" is normally just known as "The receiving MLD" | Change as suggested | **Revised****Discussion**: This text is deleted by CID #223, so the comment is no longer applicable.**Changes**: None |
| 941 | Robert Stacey | 10.71.1 | 75.63 | The word "intended" in "intended receiving" is superfluous. If the intended receiving MLD does not receive anything how can it know what it is supposed to do? It only makes sense to define behavior for the device that actually receives something. | Delete "intended" | **Revised****Discussion**: This text is deleted by CID #223, so the comment is no longer applicable.**Changes**: None |
| 795 | John Wullert | 10.71.1 | 75.65 | When used as a single adjective, "over the air" should be hyphenated | Change "over the air" to "over-the-air" | **Revised****Discussion**: This text is deleted by CID #223, so the comment is no longer applicable.**Changes**: None |
| 796 | John Wullert | 10.71.1 | 76.01 | When used as a single adjective, "over the air" should be hyphenated | Change "over the air" to "over-the-air" | **Revised****Discussion**: This text is deleted by CID #223, so the comment is no longer applicable.**Changes**: None |
| 1036 | Philip Hawkes | 10.71.1 | 76.01 | Update this item to indicate that it applies to individually addess frames, and identify processing of affiliated AP addresses when BPE is enabled. | Replace the bullet text with the following:During address filtering of individually addressed frames, the over the air value(s) in the Address 1 field and/or the Address 2 field are matched to the temporary random MAC address for the affiliated STA of the non-AP MLD on the link on which the frame is transmitted and, if the AP MLD has BPE enable, the temporary random MAC address for the affiliated AP of the AP MLD on the link on which the frame is transmitted. | **Revised****Discussion**: This text is deleted by CID #223, so the comment is no longer applicable.**Changes**: None |
| 1037 | Philip Hawkes | 10.71.1 | 76.04 | There is no text about filtering group addressed frames. | Insert the following bullet in the list:During address filtering of group addressed frames transmitted by an AP MLD with BPE enabled, the over the air value in the Address 2 field is matched to a temporary random MAC address for the affiliated AP of the AP MLD on the link on which the frame is transmitted, and the the over the air value in the Address 1 field is transformed back to the original group address assigned by the AP MLD. | **Revised****Discussion**: This text is deleted by CID #223, so the comment is no longer applicable.**Changes**: None |
| 797 | John Wullert | 10.71.1 | 76.05 | When used as a single adjective, "over the air" should be hyphenated | Change "over the air" to "over-the-air" | **Revised****Discussion**: This text is deleted by CID #223, so the comment is no longer applicable.**Changes**: None |
| 1038 | Philip Hawkes | 10.71.1 | 76.07 | There is no text about Timestamp anonymization when BPE is enabled | Append the following bullet to the list:- If the AP MLD has BPE enabled, then the over the air values for the sequence Timestamp in Privacy Beacon frames are transformed back t the original timestamp assigned by the AP MLD. | **Revised****Discussion**: This text is deleted by CID #223, so the comment is no longer applicable.**Changes**: None |
| 225 | Jarkko Kneckt | 10.71.1 | 76.19 | Introduction should describe how SA and DA can be used for STA tracking. | Please add justifications for SA and DA protection to the introduction. | **Revised****Discussion:** Text added to 4.5.4.10a.**Changes**:**p25 line 08:** (End of 4.5.4.10a) Append new text |
| 798 | John Wullert | 10.71.1 | 76.19 | Requirements indicate that MSDUs should/shall be transmitted in A-MSDUs. It is not totally clear whether these requirements hold when a STA has only a single MSDU to transmit. | Revise requirements on CPE STAs and BPE STAs to clarify handling of single MSDUs. (Could be added as a note.) | **Revised****Discussion:** See discussion on CID #517**Changes:**Instructions to Editor: Apply the changes in this document identified by “#798” |
| 517 | Mark RISON | 10.71.1 | 76.23 | But it could be an A-MSDU with just one MSDU | Add to the NOTE: "An A-MSDU can contain a single MSDU." | **Revised****Discussion:** Agreed in principle. Suggest moving include the contents of this note, and a summary of the preceding normative requirements on using A-MSDU, in new description of FA mechanisms added at page 75 line 51**Changes**:Instructions to Editor: Apply the changes in this document identified by “#517” |
| 561 | Mark RISON | 10.71.3  | 81.33 | Having two headings "Establishing frame anonymization parameter sets" is very confusing | Change the first to "... for CPE" and the second to "... for BPE" | **Revised:****Discussion**: Further renamed of this title is required by CID #223.**Changes**: Instructions to Editor: Apply the changes in this document identified by “#561” |
| 814 | John Wullert | 10.71.3  | 81.33 | The distinction between clauses 10.71.3 and 10.71.4 would be clearer if the title of 10.71.3 reflected that it addresses CPE FA parameter sets. | Change title to "Establishing CPE frame anonymization parameter sets". | **Revised:****Discussion**: Further renamed of this title is required by CID #223.**Changes**: Instructions to Editor: Apply the changes in this document identified by “#814” |
| 157 | Stephen McCann | 10.71.3  | 81.34 | Since clause 10.71.4 is entitled "Establishing BPE frame anonymization parameter sets", why is clause 10.71.3 entitled "Establishing frame anonymization parameter sets"? It does not appear to be consistent. | Replace the cited title with "Establishing CPE frame anonymization parameter sets". | **Revised:****Discussion**: Further renamed of this title is required by CID #223.**Changes**: Instructions to Editor: Apply the changes in this document identified by “#157” |
| 352 | Carol Ansley | 10.71.3  | 81.34 | Change section title to include CPE | Change title to "Establishing CPE frame anonymization parameter sets" | **Revised:****Discussion**: Further renamed of this title is required by CID #223.**Changes**: Instructions to Editor: Apply the changes in this document identified by “#352” |
| 128 | Chaoming Luo | 10.71.6.1 | 90.01 | The address filtering rules imply that a BPE non-AP MLD shall be a CPE non-AP MLD, is that true? | Add text to clarify that. | **Revised****Discussion**: Correct, BPE FA mechanisms include all CPE mechanisms.**Changes:** Instructions to Editor: Apply the changes in this document identified by “#128” |

***The baseline for this text is Draft P802.11bi\_D1.2.***

***TGbi editor: Add the following definition to 3.2 (******Definitions specific to IEEE 802.11).****Addresses CIDs: #223,*

**Medium access control (MAC) header anonymization**: [MHA] frame anonymization mechanisms applied to selected fields of the MAC header (#223)

***TGbi editor: Add the following acronym to 3.4 (Abbreviations and acronyms).****Addresses CIDs: #223,*

MHA MAC header anonymization (#223)

***TGbi editor: Apply the following changes to 4.5.4.10a (Enhanced Data Privacy (EDP) enhancements), starting at page 24 line 61.****Addresses CIDs: #223, #225*

The CPE frame anonymization mechanisms anonymize fields that identify a non-AP MLD (such as the MAC address(es) of its affiliated STAs) during an association.(#223, #881, #304, #771, #297)

The BPE frame anonymization mechanisms anonymize fields that identify an AP MLD and its set of associated non-AP MLDs (such as the MAC address(es) of its affiliated Aps, the ESS to which it belongs, and its group addresses).(#223, #512, #789, #882) A BPE AP MLD can protect the content of its Beacon frames and only be discoverable by BPE non-AP MLDs that are configured to recognize the BPE AP MLD. A BPE EDP AP MLD and its associated non-AP MLDs can change their OTA MAC addresses and other trackable fields for both unicast and group transmissions. (#11, #382, #385, #387, #388, #389, #787, #789, #904, #297)

NOTE—EDP features might be generally described with MLO terminology, but separate descriptions are provided for individual features to explain when the behavior(#Ed) of MLO and non-MLO devices will differ.(#788)

A third party can also determine the long-term presence of an MLD by exploiting other unencrypted fields and elements that contain static or predictable values that are not assigned to the transmitter or receiver. For example, the SA (or DA respectively), when present, provides the MAC address of the source (or destination respectively) of the frame. These MAC addresses can remain unchanged for a relatively long time or might never change. If SA and/or DA are not encrypted, these values might be used to profile the transmitter and/or receiver. FA transmits MSDUs in A-MSDUs (which encrypt SA and DA) to mitigate such profiling. (#225)

***TGbi editor: The following changes are to 10.71.1 (Introduction).***

***TGbi editor: Apply the following changes starting at page 75 line 23.****Addresses CIDs: #153, #221, #1024*

Frame anonymization (FA) is an optional EDP feature available during an association in which MLO is enabledand DS MAC address is supported. (#153, #221 #1024)***TGbi editor: Append the following text to the end of the paragraph starting at page 75 line 23, after applying all other changes to this paragraph.****Addresses CIDs: #514, #515*

The over-the-air values can be transmitted in the clear while maintaining anonymity. (#514, #515)

***TGbi editor: Apply the following changes at page 75 line 51 to page 76 line 06.****Addresses CIDs: #128, #223, #224, #515, #517, #798, #1031, #1032*

 (#223)

FA operations comprise client privacy enhancement frame anonymization (CPE FA) mechanisms and BSS privacy enhancement frame anonymization (BPE FA) mechanisms: (#223, #1031)

* The CPE FA mechanisms mitigate detection of a non-AP MLD. The CPE FA mechanisms are the “baseline” FA operations. The CPE FA mechanisms comprise:
* the non-AP MLD and AP MLD agreeing on timing for EDP epochs, as described in 10.71.2 (EDP epoch operation).
* the AP MLD assigning the non-AP MLD a temporary, per-EDP-Epoch AID (see 10.71.7 (Frame anonymization and AID)) that is then used in AID fields and in fields and elements derived from the AID. (#223, #1032)
* the non-AP MLD and AP MLD applying CPE MAC header anonymization (CPE MHA) to individually addressed frames, as described in 10.71.5 (MAC header anonymization and transmitting functions) and 10.71.6 (MAC header anonymization and receiving functions), using CPE MHA parameter sets established as described in 10.71.3 (Establishing CPE MAC header anonymization parameter sets). (#223, #224)
* The BPE FA mechanisms mitigate detection of an AP MLD and its associated non-AP MLDs (#1031). If an AP MLD has BPE FA operations enabled, then the AP MLD only permits associating non-AP MLDs that have BPE FA enabled. BPE FA is continuously applied by the BPE AP MLD. BPE FA mechanisms include all CPE FA mechanisms, with the additional BPE FA mechanisms comprising: (#128, #223, #512):
* the non-AP MLD and AP MLD applying BPE MAC header anonymization (BPE MHA) to individually addressed frames, group addressed frames and Privacy Beacons, as described in in 10.71.5 (MAC header anonymization and transmitting functions) and 10.71.6 (MAC header anonymization and receiving functions), using BPE MHA parameter sets established as described in 10.71.4 (Establishing BPE MAC header anonymization parameter sets). (#223, #224, #512)
* Confidentiality of SA and DA (optional for CPE FA and mandatory for BPE FA) is provided by transmitting an MSDU in an A-MSDU, noting that an A-MSDU can contain a single MSDU. (#223, #517, #798)

***TGbi editor: Apply the following changes starting at page 76 line 23.****Addresses CIDs: #798*

 (#798)***TGbi editor: The following changes are to 10.71.3 (Establishing frame anonymization parameter sets).****Addresses CIDs: #157, #223, #352, #561, #814*

* Establishing CPE MAC header anonymization parameter sets

(#157, #223, #352, #561, #814)

This subclause describes how an AP MLD and associated non-AP MLD establish the CPE MHA parameter set for each EDP epoch for the CPE non-AP MLD. The creation of the BPE MHA parameter sets is described in 10.71.4 (Establishing BPE frame anonymization parameter sets). (#223)

***TGbi editor: The following changes are to 10.71.3 (Establishing BPE frame anonymization parameter sets).****Addresses CIDs: #223*

* Establishing BPE MAC header anonymization parameter sets

(#223)

All associated BPE non-AP MLDs and the BPE AP MLD shall generate BPE MHA parameters for a given EDP epoch by computing a single pseudorandom EDP BPE FA block which is partitioned into a set of EDP BP frame anonymization parameters according to the following tables. (#223)

**References:**

[1] <https://mentor.ieee.org/802.11/dcn/25/11-25-0286-09-00bi-ieee-802-11bi-lb288-comments.xlsx>