IEEE P802.11
Wireless LANs

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| Frame Anonymization (FA) and EDP Epoch operation |
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Abstract

We propose the draft specification for the following requirements in contribution “11-23-0892-03-00bi-requirements-and-issues-tracking” for TGbi draft D0.1.

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|  | **Requirement** | **Issue**  | **Status** |
| 7 | 11bi shall define a mechanism for a CPE Client to initiate changing its own OTA MAC Address used with a CPE AP in Associate STA State 4 without any loss of connection. | MAC address change while associated | Discussions underway |
| 9 | Edited to: 11bi shall define a mechanism for a CPE Client and CPE AP to change the transmitted SN and the scrambler seed on downlink and uplink to uncorrelated new values in Associate STA State 4, without any loss of connection when the OTA MAC address of the CPE Client is changed. | MAC address change while associated | Discussions underway |
| 10 | Edited to: 11bi shall define a mechanism for a CPE Client and CPE AP to change the transmitted PN on downlink and uplink to uncorrelated new values in Associate STA State 4, without any loss of connection when the OTA MAC address of the CPE Client is changed. | MAC address change while associated | Discussions underway |
| 11 | 11bi shall define a mechanism for a CPE Client and CPE AP to change the CPE Client’s AID to an uncorrelated new value in Associate STA State 4, without any loss of connection when the OTA MAC address of the CPE Client is changed | MAC address change while associated | Discussions underway |

*Notes:*

* *Requirement 13 (11bi shall define or reuse a mechanism for CPE Clients and CPE APs to protect the SA/DA values from exposure OTA to 3rd parties) is expected to use a different mechanism which will be introduced separately.*

Revisions:

* Rev 0: Initial version of the document, formed by merging
	+ “11-23-2098-03-00bi-frame-anonymization-fa-normative-text-for-11bi.docx” (reviewed text and skeleton) and
	+ “11-24-0079-02-00bi-edp-epoch-operation-normative-text-for-11bi.docx” (reviewed text).

Editorial enhancements noted in comments.

**High level summary of the changes:**

The text addresses EDP epoch operation and CPE features only – leaving open the option of introducing BPE features in the future.

**Key to highlighting:**

* Yellow highlighting: identifies instructions to the TGbi editor.
* Blue highlighting: identifies items that may need addressing in the future.

**Proposed spec text:**

The baseline for this text is 802.11 REVme D4.1.

***TGbi editor: Add new definition to clause 3.2 (Definitions specific to IEEE Std 802.11):***

**Active EDP Epoch**: EDP Epoch, for a given non-AP MLD, having the latest expired EDP Epoch start time.

**EDP Epoch:** time window in which a set of EDP parameters remain constant.

**EDP Epoch Reference Interval**: Fixed reference duration between two successive EDP Epochs start time of an EDP Epoch sequence.

**EDP Epoch parameters:** set of parameters characterizing an EDP Epoch.

**EDP Parameter**: CPE or BPE parameter.

**EDP Epoch Sequence**: one or more successive EDP Epochs characterized by a starting time determined using same EDP Epoch parameters.

**Frame Anonymization**: MLO mechanisms mitigating against presence monitoring using unencrypted fields in beacon frames and individually addressed frames.

**Frame Anonymization Parameter Set**: set of parameters used in frame anonymization mechanisms.

**Group EDP Epoch**: time window in which each non-AP MLD of a set of non-AP MLDs applies a set of EDP parameters that is valid for the duration of that Group EDP Epoch.

**Individual EDP Epoch:** time window in which a single non-AP MLD applies a set of EDP parameters that is valid for the duration of that individual EDP Epoch.

**Over-The-Air Sequence Number**: value transmitted in an individually addressed MPDU header in the place of the sequence number as part of frame anonymization.

**Over-The-Air Packet Number**: value transmitted in an individually addressed CCMP header or GCMP header in the place of the packet number as part of frame anonymization.

**presence monitoring**: determining the ongoing presence of non-AP MLDs associated to an AP MLD

***TGbi editor: Add new acronyms to clause 3.4 (Acronyms and abbreviations)as follows:***

FA frame anonymization

OSN over-the-airsequence number

OPN over-the-airpacket number

***TGbi editor: Add new subclause of 10.y (EDP Epoch operation) under clause 10 (MAC sublayer functional description) as follows:***

# 10.y EDP Epoch operation

## 10.y.1 Introduction

An EDP Epoch is a time window in which a set of EDP parameters remain constant. EDP Epoch operation is an EDP feature that is valid when MLO is supported.

An EDP Epoch is either an Individual EDP Epoch or a Group EDP Epoch:

* An Individual EDP Epoch sequence request is initiated by a non-AP MLD and associated AP MLD shall send a response. The EDP Epoch parameters of an individual EDP Epoch are negotiated by a non-AP MLD with its associated AP MLD as defined in the subclause 10.y.2.1 individual EDP Epoch negotiation. The non-AP MLD applies the negotiated EDP Epoch parameters, of the Individual EDP Epoch, to determine corresponding EDP Epoch sequence of one or more EDP Epoch start times.
* A Group EDP Epoch sequence is initiated by an AP MLD by advertising the EDP Epoch parameters to a set of non-AP MLDs as defined in the subclause 10.y.2.2 Group EDP Epoch advertisement. Each non-AP MLD of the set of non-AP MLDs applies the advertised EDP Epoch parameters of the Group EDP Epoch to determine the same EDP Epoch sequence of one or more EDP Epoch start times.

At any given time, an AP MLD has at most one active EDP Epoch assigned to a given associated non-AP MLD.

A non-AP MLD has at most one active EDP Epoch.

An EDP Epoch becomes active for a given non-AP MLD when the EDP Epoch start time occurs, and ends when another EDP Epoch becomes active for the same non-AP MLD.

## 10.y.2 EDP Epoch setup

### 10.y.2.1 Group EDP Epoch

TBD: This section describes the mechanism, for an AP MLD to provide same EDP Epoch parameter set to one or more of its associated non-AP STA.

### 10.y.2.2 Individual EDP Epoch negotiation

TBD: This section describes the usage of dedicated protected Action frames during an individual EDP Epoch negotiation process, to negotiate the EDP Epoch parameter set between a non-AP MLD and its associated AP MLD.

## 10.y.3 Determination of EDP Epoch parameters value

TBD: EDP Epoch parameters correspond to a set of parameters used to determine the start time of an EDP Epoch based on a fixed EDP Epoch Reference Interval with a limited pseudo random variation.

The process to setup the EDP parameters value is defined in clause 10.y.2.1 or 10.y.2.2.

***TGbi editor: Add new subclause of 10.x (Frame Anonymization) under clause 10 (MAC sublayer functional description) as follows:***

# 10.x Frame anonymization

## 10.x.1 Introduction

Some unencrypted fields in beacon frames and individually addressed frames contain values which facilitate *presence monitoring*, determining the continued presence of a client even if the long-term identity of the client cannot be determined. Presence monitoring can be a threat to privacy of the client user. User privacy can be improved by shortening the presence-monitoring time-windows. It is possible to limit presence-monitoring time-windows by doing (re-)association as defined in 11.3. However, (re-)association results in leaving State 4 and introduces a loss in connectivity which could create a negative user experience. <The paragraph is currently focused on presence monitoring of clients only. To accommodate BPE, the paragraph can be updated to cover presence monitoring of AP also.>

Frame anonymization (FA) is a EDP feature available when MLO is supported.

The unencrypted fields which facilitate presence monitoring of a non-AP MLD are:

* Traffic indication map (TIM), which allows determining the AIDs of associated non-AP MLDs.
* AID of associated non-AP MLDs.
* Address 1 (on the downlink) and Address 2 (on the uplink) which contains the MAC address of the Affiliated STA of the non-AP MLD on the link on which the frame is transmitted. <To accommodate BPE, the paragraph can be generalized to cover BSSID as well>
* Sequence Number (SN).
* Packet Number (PN).

FA enables restricting presence-monitoring time-windows to portions of a single association (that is, without leaving State 4). These time-windows are the EDP Epochs described in clause 10.y (EDP Epoch operations). A new *frame anonymization parameter set (FA parameter set)* is established between the AP MLD and non-AP MLD for each new active EDP Epoch of the non-AP MLD as described in 10.x.2 (Establishing FA parameter sets). An FA parameter set includes the following:

* *FA AID*: new random value to be used as the non-AP MLD AID. The FA AID is selected by the AP MLD using implementation-specific means.
* *FA STA MAC*: New random values for the Affiliated STA MAC address randomization for each set link. <To accommodate BPE, the paragraph can be generalized to cover FA BSSID or similar>
* *FA SN offsets*: new random values for use in SN anonymization are generated for each supported sequence number space of the AP MLD and each supported sequence number space of the non-AP MLD, see Table 10-5 (Transmitter sequence number spaces).
* *FA* *PN offsets*: new random values for use in PN anonymization are generated for the PN assigned by the AP MLD and the PN assigned by the non-AP MLD.

FA provides the following functions:

* **AID randomization:** The FA AID is used directly wherever AID is currently used.
* **Affiliated STA MAC address randomization**. For each link, the FA STA MAC address, is used directly in MAC header creation of the transmitter. These addresses are also used in the MAC header processing of the receiver: e.g., in address filtering. <To accommodate BPE, the paragraph can be generalized to cover FA BSSID or similar>
* **SN / PN anonymization**: The transmitter applies the FA SN offset and FA PN offset to the SN and PN values to produce over-the-air values which can be safely transmitted in the clear while maintaining anonymity. The transmitted values appear to do a random “jump” to a new starting value, and then continue incrementing from the new starting value. The intended receiver transforms the over-the-air values back to the original values of SN and PN.

NOTE—The following list clarifies the scope of attacks which FA mitigates:

* FA mitigates against presence monitoring across multiple FA epochs.
* FA does not mitigate against presence monitoring within a single FA epoch.
* FA does not mitigate identifying frames belonging to a single MLD within a single FA epoch.
* FA does not mitigate using traffic analysis using known transmission behavior of upper layer protocols for presence monitoring across multiple FA epochs.

<Further introductory text on transitioning between EDP epochs might be appropriate here>

## 10.x.2 Establishing frame anonymization parameter sets

1. This clause describes how an AP MLD and associated non-AP MLD establish the FA parameter set for each active EDP epoch for the non-AP MLD.
2. The non-AP MLD and AP MLD establishes the EDP epochs used for frame anonymization as described in 10.y (EDP epoch operation).
3. Details for establishing the FA parameter set for a given EDP epoch are TBD.

## 10.x.3 Frame anonymization and transmitting functions

1. This clause describes the changes to transmitting functions when frame anonymization is enabled.

**SN /PN anonymization**: Details are TBD.

**Frame header creation**: Details are TBD.

## 10.x.4 Frame anonymization and receiving functions

1. This clause describes the changes to receiving functions when frame anonymization is enabled.

**Address filtering**: Details are TBD.

**SN /PN de-anonymization**: Details are TBD.

## 10.x.5 Frame anonymization and AID

This clause describes the changes to the use of AID when frame anonymization is enabled. Details are TBD.

## 10.x.6 Frame anonymization, TXOP and retransmissions

This clause describes the considerations for TXOP and retransmissions when frame anonymization is enabled. Details are TBD.